Forthcoming in *American Antiquity*
April 2016

AN ELEMENTAL APPROACH TO THE DISTRIBUTION OF LEAD-GLAZED COARSE EARTHENWARE IN THE EIGHTEENTH-CENTURY CHESAPEAKE

Lindsay Bloch

Lindsay Bloch Research Laboratories of Archaeology, CB3120, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3120 (lbloch@live.unc.edu)

Abstract: *Unlike many goods in the eighteenth century, which were wholly imported, utilitarian coarse earthenwares were also produced locally within the American colonies. In the Chesapeake region it has been suggested that these local wares were primarily reserved for those unable to directly participate in transatlantic credit economy fostered by the tobacco consignment system. Rather than relying on ambiguous visual attributes to identify these wares, this study utilized elemental analysis via LA-ICP-MS. Coarse earthenwares from domestic plantation contexts of varying social status were assigned to production zones based on shared elemental composition with a reference dataset. This reference dataset incorporated sherds from historic earthenware production sites across the mid-Atlantic and in Great Britain, representing twelve geologically distinct production zones. The results emphasize the diversity of coarse earthenware sources that Chesapeake residents accessed, both local and imported. There was a steady decrease in the use of imported wares in favor of domestically made products over time. There were no sharp differences among plantation households of different statuses, suggesting that these everyday wares were equally accessible to all, perhaps via plantation provisioning strategies. The omnipresence of local wares is evidence for the pragmatic and political strengths of local production.*

The British American colonies were developed to foster mercantilist goals, centered on the extraction of resources from the colonies and the creation of new markets for manufactured British goods. As detailed in Bloch 2015, in the Chesapeake colonies of Maryland and Virginia (Figure 1), this transatlantic exchange was implemented through credit relationships backed by the staple crop of tobacco. Archaeologists and historians in the region have long studied the changing consumption patterns of colonists over the course of the eighteenth century (e.g., Carson 2003), as the consumer revolution made imported luxury items available to a wider public. Most domestic items found archaeologically from that time were imported from Europe: ceramics of refined earthenware and stoneware, glass, personal adornment items, and household tools. It is more challenging to recover proof of the consumption of locally made products, many of which were ephemeral, made of materials such as leather, wood, or fiber, and distinctly non-luxury items. However, the presence of local goods provides evidence for distinct economic and social networks, and discrete forms of credit from those of the transatlantic trade. To evaluate the significance of local production to colonial Chesapeake citizens, I concentrate on defining the origins of lead-glazed coarse earthenwares, omnipresent components of the colonial American domestic toolkit.

Lead-glazed coarse earthenwares are an ideal artifact type for investigating these economic networks because unlike many other material goods, which were wholly imported from Great Britain or elsewhere, coarse earthenwares were also produced domestically. In 1736, acting Virginia Governor William Gooch explained to the British Board of Trade, "the poorest Familys...who not being able to send to England for such Things would do without them if they could not get them here " (in McCartney and Ayres 2004:56-57). Gooch was not writing about luxury or specialty items, but instead describing the necessary local production of utilitarian pottery. Gooch's assertion may be taken in part as a willful downplaying of local production, assuring no threat to British imports. However, his words also convey a stratified economy, in which the wealthy could obtain goods directly from agents in Britain, while the poor relied upon domestic products. Archaeologists working in the region have also suggested that locally produced coarse earthenwares were less desirable but more affordable than imports (Noël Hume 1969:98-99). Were there indeed status-based disparities in access to everyday goods such as coarse earthenwares?

To investigate this question, I analyzed ceramic assemblages from the eighteenth century, the time during which coarse earthenware production and use peaked in the Chesapeake. I limited the study to nine plantations (ca. 1690-1830), focusing on plantations as the dominant residential units in the region. On each plantation, when possible, I sampled coarse earthenware assemblages from at least two categories of households: bonded and enslaved laborers, free white workers, or the planter's family. These household categories were simplistic but provided a basis on which to examine social and temporal patterns. Homogeneity in coarse earthenware assemblages on a plantation could indicate plantation-wide purchasing and provisioning strategies. Conversely, differences in the types of coarse earthenwares used in households of varied status could signal distinct degrees of access to certain products.

The sources for coarse earthenwares cannot be adequately identified through visual differences. Rather than relying upon macroscopic attributes for these wares, I concentrated on elemental variation in the clay source, following the provenience postulate (Weigand et al. 1977:24). Sherds recovered from 37 historic earthenware production sites across the mid-Atlantic and in Great Britain became a reference set for establishing geologically distinctive production origins. These sherds were analyzed via laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) and assigned to groups based on elemental variation. Then, coarse earthenwares from domestic plantation contexts were elementally analyzed and assigned to the existing groups. The results show clear temporal trends in the sources of earthenwares available over time and a dramatic increase in the consumption of locally made wares. Individual plantation strategies such as provisioning are suggested by the patterning of assemblages within plantations. By connecting the production origins of these wares and their use contexts, we can visualize the overlapping networks of trade and exchange—from local relationships to trans-Atlantic commerce—that operated in the historic Chesapeake, and identify who was able to participate within these networks.

Background

The settlement history, economic development, and demographics of the Chesapeake region created special conditions for the trade of coarse earthenware. Many excellent histories of the region have been written, and I draw on Breen (2001), Earle (1975), Kulikoff (2000), Morgan (1998), Russo and Russo (2012), and Walsh (2010) to outline the features of the eighteenth-century Chesapeake. From early in the colonial period, the colonies of Maryland and

Virginia were seen as fundamentally related. They shared the Chesapeake Bay with its navigable rivers and fertile land, and by the mid 1600s they also shared an economic system based on tobacco agriculture. This staple shaped settlement patterns, yearly schedules, and social interactions. Successful production of tobacco required land and labor, and nearly every worker in the Chesapeake directly or indirectly supported the tobacco trade. The land requirements for tobacco growing and the need to easily ship the harvested crop prompted a dispersed plantation settlement pattern with few towns (Walsh 1988). Spatially, plantations consisted of a plantation core, which housed the main dwelling and specialized activity areas, and the agricultural areas, which included fields in various states of cultivation, barns, pasturage, and other subsidiary activity areas. A large plantation would often be divided into quarters that operated semi-independently, housing separate groups of workers.

Indentured servants largely fulfilled labor needs in the seventeenth century (Horn 1979). As conditions improved in Europe, the supply of servants decreased and the trans-Atlantic slave trade became the primary source of labor in the form of enslaved African people. The plantation may be conceptualized as an extension of household, or nested household (Anderson 2004) in which the labor of all plantation residents contributed towards the economic benefit of the planter. The corporate strategies of the plantation as a whole were balanced atop those of smaller household groups divided spatially and by social and economic status.

Credit and Debt

The Chesapeake colonies operated within the larger mercantilist doctrine of the British government. As colonies, their role was to provide raw materials and staple crops. Manufacture of finished goods was discouraged and imports from other countries limited through heavy tariffs. Instead, colonies were expected to purchase their manufactured goods from Britain. In order to function, this system relied upon trans-Atlantic relationships of credit and debt (Breen 2004). Large-scale English and Scottish merchants offered credit to wealthy planters on the promise of a successful tobacco harvest, and extended credit to smaller merchants pursuing trade in the colonies (Kulikoff 2000). These lines of credit trickled down through increasingly local economic relationships to poorer market participants.

One of the primary reasons for reliance on forms of credit was the lack of hard currency. Nominally, the primary currency system in the colonial Chesapeake was British pounds sterling. Given colonial constraints on coinage, agricultural products, especially tobacco, came to replace it in many contexts. Taxes were assessed in pounds of tobacco (Russo and Russo 2012:55; Walsh 2010:596), as were fines, tolls and fares, rent (Earle 1975:217), and a host of other fees. Despite attempts to create local currency and other workable specie alternatives, direct and immediate exchange of coinage or paper equivalent for goods and services was the exception rather than the rule (Shammas 1982).

During the eighteenth century, planters had two main ways to sell their tobacco, and later, wheat. In the consignment system, the planter would have his crop loaded onto a ship to England. It remained his property and also his risk until unloading in Europe. Planters would request items that they wished to purchase from Great Britain with the proceeds of the year's crop. Additional profits above the outlay for supplies would be carried as credit into the next year and could be used for paying off other debts, buying land, or other ventures. Small-scale planters relied upon more local forms of credit and obtained their goods from merchants or craftsmen operating domestically rather than directly from Britain (Martin 2008). In selling to a local merchant, a planter typically received a mixture of cash, credit, and goods, with a higher exchange rate for goods (Soltow 1959:89). Stores became important sites for carrying credit and the repayment of debt.

Access to credit, whether local or transatlantic, affected the goods and services available to a particular household. The wealthy possessed the greatest access, utilizing a mixture of cash, and local and international credit. Through consignment they were able to purchase expensive and fashionable items directly from London and continental Europe (Martin 2008). At the same time, they developed economic relationships locally and in the intercolonial market, carrying credit with neighbors and associates to obtain common goods more readily.

On the local level, craftsmen and merchants often accepted payment in kind. Store accounts record many entries of goods paid off through crops, animals, labor, and craft products such as butter, shoes, or cloth (Martin 2008). These economic exchanges could be drawn out over months or years. While no money changed hands, these exchanges may be thought of as "bookkeeping barter" (Baxter 1946:158), as they were still reliant upon defined monetary value for goods and services.

There were three main tiers of market: global, intercolonial, and local, and the nature of the goods available from different markets and through different lines of credit varied. The Chesapeake was a huge colonial market for British products, comprising 40 percent of all mainland colonial trade (Breen 2004:60). Intercolonial trade also expanded during the eighteenth century, as goods from the more industrialized colonies of the Northeast and Mid-Atlantic arrived, alongside British and West Indian goods (Shepherd and Williamson 1972). Stores also sold local goods, which were either purchased wholesale or collected as payment. Craftsmen such as potters sold their products directly on similar terms as storekeepers.

Coarse Earthenware

Lead-glazed coarse earthenware is one of the most frequently recovered artifacts on historic period domestic sites in North America. Often called redware, this wheel-thrown ceramic served a variety of foodways, hygiene, and industrial functions from the time of the first European colonization through the nineteenth century (Figure 2). As handmade items the vessels are inherently distinctive in individual appearance. At the same time, as outlined in Bloch 2011, the general technology and vessel forms were broadly homogeneous across Europe and its colonies, reflecting specific functional requirements. While some vessels were decorated, most coarse earthenware was unadorned and produced in a limited range of forms and surface treatments. Storage vessels such as crocks and jars, food preparation vessels such as milk pans and bowls, and cooking or baking vessels, all with a simple lead glaze, formed the bulk of a potter's trade. Visually, there may be no clear indicator of whether a vessel was made in England, elsewhere in Europe, or in North America, as they were rarely marked or signed, and clay differences have been masked by the firing process. The overall result is a seemingly contradictory individuality of single artifacts, and homogeneity of the class as a whole.

The ambiguity of coarse earthenware has meant that archaeologists have largely overlooked this ceramic in lieu of more visibly distinctive and tightly datable artifacts. The bulk of utilitarian coarse earthenware tends to lack meaningful categorization, instead being relegated to catchall categories like "redware," which could refer to any red-bodied, lead-glazed vessel made within a 500-year span on one of hundreds of sites in Europe or North America. On Chesapeake sites in DAACS, the Digital Archaeological Archive of Comparative Slavery, these generic coarse earthenwares make up nearly 80 percent of all coarse earthenwares (Bloch 2011:31).

In the early period of colonization when the tobacco trade was booming, there were few identified potters or other craft specialists. Artisans who immigrated to the colonies often gave up their trade in order to capitalize on the tobacco profits (Metz 1999:12). There has been a general tendency to dismiss craft production in the Chesapeake, as it was economically trivial in comparison to agriculture. Furthermore, earthenware imported to the colonies was inexpensive, arriving as ballast on ships that would then return laden with tobacco (Russo and Russo 2012:152). In spite of these limitations, the archaeological evidence for historic kiln sites in the region (e.g., Barka 2004; Comstock 1994; Kelso and Chappell 1974; Magid 1995; Myers 1984a; Russ 1995; Straube 1995) demonstrates that local potters had a viable market for their wares.

What drove the demand for locally made coarse earthenwares? James Deetz (1996:73) distinguished four factors that establish pottery in foodways: "availability, need, function, and social status." Availability may be thought of in absolute terms, whether a product existed and was potentially obtainable. During the earliest phase of colonization in the Chesapeake, coarse earthenware from domestic sources was less available in absolute terms, because of the lack of established pottery industry (Straube 1995). Instead, coarse earthenwares were most abundant as English exports. The expansion of local and intercolonial trade networks over the course of the eighteenth century increased the availability of these wares. Aside from absolute availability, it is necessary to consider the economic availability or accessibility of these wares for households of varying social classes. Archaeological evidence demonstrates that broadly these wares were among the most accessible, as they are nearly omnipresent in eighteenth-century domestic assemblages. Nevertheless, depending upon financial and social resources, and connections within networks of trade and exchange, purchasing power for specific sources of coarse earthenwares may have been limited.

Need and function are closely tied, related to the intended uses for the objects, as well as the suitability and desirability of ceramics to fulfill a necessary task. Certain tasks, such as dairying, were traditionally performed using earthenwares (Yentsch 1991). Finally, social status involves a consideration of the prestige associated with owning, using, and displaying a particular object. There has been an implicit assumption that the consumption of coarse earthenware is to be understood more in terms of availability and need rather than status (e.g., Noël Hume 1969:98-99). Unlike fancy tablewares, coarse earthenwares remained cheap, plain, and relegated to private areas of the home throughout the colonial and early Federal period. However, a local product conveys different meanings from an imported product. In some situations, the social value of these wares may have rested in the relationships that they mediated between neighbors or associates. Local potters often tailored their products to specific needs within their community, producing in direct response to commissions much more quickly than an order could be requested and received from England.

Local products such as ceramics gained further significance in the context of colonial unrest. The demand for pottery from local sources was fueled by politics during the time of the American Revolution, a time in which Benjamin Franklin (1837[1768]:253) urged fellow colonists to "industriously manufacture that we can for ourselves." Compared to imported ceramics, domestically made wares composed a negligible economic portion of the overall ceramic market in the American colonies. Yet, Carl Steen (1990:58) has argued that the capacity of American potters to produce necessary items "would be retained and referred to when considering the arguments for and against an agreement to boycott English goods—including ceramics." The demand for coarse earthenware in the colonial and early Federal Chesapeake had roots in functional, economic, and social strategies. As with other classes of material culture, the meanings embodied by these wares were on the whole mundane, which does not detract from their significance as markers of social meaning.

Sampling and Methods

While a sourcing study, the goal was not to concretely source a vessel used domestically to a specific production site. The transient nature of pottery production on the historic landscape made it unlikely that a sherd from one of the included domestic sites could be definitely attributed to a single workshop or potter included in this study. Instead, I focused on defining compositional groups that represented “production zones” (Monette et al. 2007). The production zone is a synthetic grouping that is primarily based on expected internal geological consistencies. In this study, production zones based on physiographic regions formed the smallest source groups, with broader regional and continental aggregations considered as appropriate.

Given the lack of documentary evidence for ceramic production and purchasing, and the generic appearance of historic coarse earthenwares, elemental analysis is a valuable tool for linking ceramic producers and ceramic consumers in the Chesapeake. I first assembled a reference set of provenienced earthenwares from potential historic sources. This represented a training dataset, which I used to define the chemical characteristics of ceramics from distinct production zones. Then, I assigned samples of unknown origin to these production zones based on shared elemental composition. I identified 37 historic pottery production assemblages from across the mid-Atlantic United States, as well as from England and Wales, and sampled wasters from each, for a total of 400 samples in the training dataset (Table 1; Figure 3). Wasters, the sherds representing vessels broken or damaged during the production phase, are common artifacts found on production sites. They embody not only local clay, but also the potential admixture of clays and inclusions by potters. The use of wasters to establish a reference set is ideal in that they encompass both the natural and cultural factors that are a part of pottery production (Mommsen 2001:658; e.g. Monette et al. 2007; Scarlett et al. 2007). In the historic period, as with ethnographic examples today (Arnold 2008), most potters established their workshops near clay sources as the weight and bulk of clay made transporting it costly and time-consuming (Myers 1984b:192). Thus, the clay used on pottery sites may be assumed to have a relationship to local geological formations.

Instrumentation

Historic ceramics have been less frequently subjected to elemental analysis, as many have readily identifiable diagnostic attributes and well defined production spans and locations. Previous studies conducting elemental characterization of historic coarse earthenwares include Monette et al. (2007), Owen and Greenough (2010), Skowronek et al. (2014), and Smith et al. (1995), but the current study is the largest in a British colonial context. I conducted the elemental analysis using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS), directed only on composition of the ceramic paste. LA-ICP-MS permits rapid collection of precise measurements on a wide range of isotopes. In LA-ICP-MS, small portions of a sample are vaporized, and carried to a plasma torch. The high heat of the torch (7,000-10,000K) causes the analyte to dissociate into individual isotopes. The isotopes are then sent into the mass spectrometer, which sorts them on their mass-to-charge ratio (Neff 2003:23; Pollard and Heron 2008:56). This minimally destructive technique has been well tested for ceramic paste analysis (e.g., Beck and Neff 2007; Cochrane and Neff 2006; Eckert and James 2011; Golitko and Terrell 2012; Niziolek 2011; Stoner and Glascock 2012).

Analysis was completed in the Mass Spectrometry Laboratory, housed within the Chemistry Department at the University of North Carolina at Chapel Hill (UNC-CH). I exposed a freshly broken surface for each ceramic sample, and then mounted small fragments of each sample on standard microscope slides. The samples were introduced via an Excite 193 ultra short pulse excimer laser and ablation system (Photon Machines [now Teledyne], Bozeman, MT), coupled to an Element XR double-focusing magnetic sector field ICP-MS (Thermo Fisher Scientific, Bremen, GER).

Each sample was analyzed three times along the fresh surface, in three different locations to obtain an average representation of the clay matrix. Laser ablation lines, .6 mm long and .11 mm wide, were positioned on the sample surface to avoid inclusions and voids in the matrix. Each measurement line was pre-ablated with a repetition rate of 10 Hz, 20 percent laser power (1.77 J/cm^2), and 50 µm/sec scan speed. This removed potential surface contamination. For data collection, the laser was set to a repetition rate of 20 Hz, 35 percent power (4.13 J/cm^2), and 10 µm/s scan speed. These settings were optimized to provide even sample ablation. The line length and laser velocity resulted in 60 seconds of ablation for each scan line. Data were collected on 44 isotopes: ^{7}Li, ^{23}Na, ^{27}Al, ^{30}Si, ^{39}K, ^{44}Ca, ^{45}Sc, ^{47}Ti, ^{51}V, ^{52}Cr, ^{54}Fe, ^{55}Mn, ^{59}Co, ^{60}Ni, ^{63}Cu, ^{64}Zn, ^{85}Rb, ^{88}Sr, ^{89}Y, ^{90}Zr, ^{93}Nb, ^{98}Mo, ^{107}Ag, ^{115}In, ^{120}Sn, ^{121}Sb, ^{133}Cs, ^{137}Ba, ^{139}La, ^{140}Ce, ^{142}Nd, ^{152}Sm, ^{153}Eu, ^{159}Tb, ^{164}Dy, ^{174}Yb, ^{175}Lu, ^{180}Hf, ^{181}Ta, ^{197}Au, ^{208}Pb, ^{209}Bi, ^{232}Th, and ^{238}U. Elements were selected for success in ceramic sourcing, and particular isotopes were chosen to minimize polyatomic interferences.

For each measurement line, data were collected on 12 scans, for a total of 108 seconds. The first and last two scans measured background signal during laser pause, with eight scans of laser ablation data collection. Only the scans with stabilized signals for all elements were included in the final signal average, resulting in the averaging of four replicates per ablation line (scans 5-8). Background signal was independently measured for each scan from the initial laser pause, and subtracted from the averaged intensities. The Gratuze method for standardization (Gratuze 1999; Speakman and Neff 2005) controlled for differences in sample signal strength, with silicon as the internal standard. The concentrations for each data point were calculated using response coefficient factors (Gratuze 1999:873; Neff 2003), based on the linear regression of normalized counts of standard reference materials (SRM) against their reported values (Golitko and Terrell 2012:3573; Speakman and Neff 2005:7). The reference materials for this study, NIST SRM 679 (Brick Clay), NIST SRM 610 and NIST SRM 612 (Trace Elements in Glass) were analyzed under the same settings as artifacts. They were scanned after every 10-15 samples. The relative standard deviation values for elemental concentrations of standards were on par with published values for laser ablation studies (e.g., Niziolek 2011; Sharratt et al. 2009; Wallis and Kamenov 2013). Elements with poor relative standard deviation were removed from the dataset. These included Ni, Ag, In, Sb, Hf, and Au. Lead was measured, but not included in analyses, due to the potential for contamination from the lead glaze. The remaining elemental values were log-transformed. Unless otherwise noted, all data transformations and explorations were conducted using the R program for Statistical Computing, version 3.1.2 (R Core Group 2014). The packages used for specific routines are noted as applicable.

Two of the remaining elements measured via LA-ICP-MS, Mo and Bi, had missing values for one or more observations. The missing values were imputed using the Amelia package in R. Amelia uses an expectation-maximization algorithm to estimate the statistics of an incomplete dataset, and infer the missing values (Honaker et al. 2011). The final dataset included values for 37 elements. These became the foundation used to define the elemental characters of production zones. These reference data were then applied to predict the zone assignment for sherds of unknown origin recovered from domestic contexts.

Building the Training Model

Preliminary analysis of the structure of the data through bivariate plots and principal component analysis (PCA) demonstrated that the ten production zones initially identified by physiographic region (Table 1) formed groups that were elementally distinctive (Supplemental Figure 1). Furthermore, the Coal Measures zone within Northwest England and North Wales could be reliably divided into Buckley and Liverpool groups, and samples from the town of Alexandria, VA separated from the broader Tidewater Chesapeake zone, both based on elemental differences (Supplemental Figures 2 and 3), resulting in twelve production zones. Given these readily defined groups, discriminant analysis (DA) became a powerful tool for creating a robust training model to predict the assignment for unknown sherds. DA shares similarities with PCA in that it retains and recombines the variance within a dataset into new linear combinations of variables, called discriminant functions (DFs). In contrast to PCA, DA generates discriminant functions based upon predefined groups in such a way that the functions maximize distances among group means. The discriminant functions can then be applied to assign samples of unknown origin to the predefined groups. Here, DFs were generated using elemental data from the training set, grouped by production zone. The resulting discriminant functions were then used to assign samples of unknown origin to the production zone from which they were most likely produced.

To ensure that the training set only contained samples that were representative of their groups, posterior probabilities of group membership were calculated using leave-one out cross-validation with Mahalanobis distances (Kovarovic et al. 2011). Mahalanobis distance (MD) is a calculation of the generalized distance of each sample from the centroid of the cluster of which it is presumed to be a member. Mahalanobis distance probabilities were computed using the linear discriminant functions as variables (Huberty and Olejink 2006: 287; e.g., Bartlett et al. 2000; Cochrane and Neff 2006; Kuhn and Sempowski 2001). MD probabilities were jackknifed as a conservative measure to mitigate the effect of small group sizes.

While a threshold of one percent probability is commonly used for assigning group membership based on Mahalanobis distance probabilities (i.e., Joyce et al. 2006, Niziolek 2011), in order to obtain the most complete representation of each training group, all production site samples that were attributed to the expected groups were retained, even with weak probability of assignment. The prediction function was run several times, removing and reinserting outliers until all remaining sherds were assigned to the expected training groups. The posterior probabilities of group membership for the 12 production zones after cross-validation produced a correct group assignment rate of 92 percent.

Thirty-four samples were removed from the training set in order to yield 100 percent assignment to the expected groups. These samples could not be assigned to any group, or had predicted assignment to a zone different from that in which they were recovered. In either case, the samples were uncharacteristic, or shared significant characteristics with multiple zones, resulting in similar probabilities of membership for two or more groups. Removing these sherds yielded a modified training set of 366 production site sherds, representing each of the 12 production zones. This dataset became the model for projecting the assignment of unknown sherds from domestic contexts. Mahalanobis distance probabilities for all samples are provided in Supplemental Table 1. A summary of elemental concentrations by zone is provided in Supplemental Table 2.

Figure 4 is a plot of the DA with the training set (n = 366) for the 12 production zones. The North Carolina Piedmont is the most distinct production zone, showing no overlap with any other groups and driving the patterning of the first DF. High aluminum and depletion in trace elements serve to distinguish the North Carolina group. European zones, the Buckley, Liverpool, Staffordshire, Surrey-Hampshire, and London Area groups, have distinct orientation compared to the Chesapeake and Philadelphia samples along DF 2. European groups fall below zero, while American groups plot above zero. European groups are correlated with cesium, strontium, and potassium, among others.

In the first two dimensions of DA, there is significant overlapping of zones. The Shenandoah Valley zone and the Tidewater zone appear especially similar. This is logical as the clay found in the Coastal Plain arrived as alluvium from the rivers flowing through the Shenandoah Valley and other upland areas. The resulting chemical homogeneity within the region has been found in several other studies of Chesapeake archaeological materials (e.g., Bollwerk 2012, Steadman 2008). However, in the multidimensional space of the full DA (11 DFs), these zones resolve further into separate groups, making it possible to correctly predict group assignment. Elemental differences driven by depletion in trace elements distinguish the Chesapeake Tidewater, Alexandria, and Shenandoah Valley zones from one another along DF 2 and DF 3 (Figure 5). Furthermore, along DF 3, the London Area zone exhibits greater separation, driven by a higher concentration of vanadium.

Assignment of Domestic Samples

For this study, I chose the unknown samples (n = 184) from plantation assemblages across the Chesapeake that spanned the eighteenth century and differed in plantation size and planter status (Table 2). The majority of sites were part of the Digital Archaeological Archive of Comparative Slavery (DAACS; www.daacs.org), thus their excavation and artifact data were fully available online in a consistent format . When possible, multiple assemblages were sampled from each plantation to investigate potential variation in household earthenware acquisition. These include assemblages associated with planter households as well as assemblages associated with overseers or tenants and enslaved or bonded workers.

Since the goal of this project was to identify the origins of visually homogeneous earthenwares, the majority of samples taken from each assemblage (87 percent overall) represented vessels that lacked readily identifiable geographic or cultural markers. These sherds were cataloged in DAACS as “Coarse Earthenware, unidentified” or “Redware”, depending on paste color (Aultman et al. 2014). The remaining represent four geographically bounded British ware types currently identified by Chesapeake archaeologists based on visual attributes. They were included in this study to verify their classification, and to account for the presence of the ware types within the assemblages as a whole.

To assess temporal variation among the assemblages it was necessary to develop a consistent dating method. I relied upon mean ceramic dates and correspondence analysis as methods for classifying assemblages into constructive temporal categories, which is described fully in Bloch (2015). Based on the prevalence of different temporally specific ware types, the assemblages split into four general phases, each roughly corresponding to a quarter of the eighteenth century (Table 2).

The domestic samples were prepared, analyzed via LA-ICP-MS, and the elemental concentrations calculated concurrently with the production site samples, as outlined above. The log-transformed elemental concentrations were then projected into the DA space of the training set using the DFs previously developed. While the majority of sherds cluster within the spaces defined by the 12 production zones, there is a distinct cluster of unknowns to the right of the Mid-Atlantic assemblages that cannot be reliably linked to any zone (Figure 6). The majority of samples that plot to this group come from Monticello and Poplar Forest, two Virginia Piedmont plantations owned by Thomas Jefferson. Following the criterion of abundance (Bishop et al. 1982), this cluster likely represents production local to the central Virginia Piedmont. Furthermore, the elemental concentrations are most similar to those of the other piedmont zones, indicating shared geological basis. As no historic earthenware production sites have yet been uncovered within the central Virginia Piedmont, there are no provenienced reference materials for the region.

DA and Mahalanobis distance probabilities share the assumption that the groups identified by the researcher represent all possible groups. The measures will calculate probabilities for group membership only to identified groups, so missing groups can cause poor predictions. Recognizing a latent group within the unknown dataset, it was then logical to add its members into the training set as a new group to better account for the structure of the data. The core samples (n = 32) within this cluster were defined by their DF 1 scores and added to the training set. When the discriminant analysis was rerun, the new production zone exhibited clear discrimination from other groups in the training data. The resulting modified training set of 13 zones was used for the remainder of the analysis.

MD probabilities were calculated for the modified dataset of 152 unknown sherds (184 original, -32 assigned to new group). A one percent cutoff was followed for group assignment of the unknown domestic sherds. All but seven sherds had at least a one percent probability of group assignment to one of the 13 zones (Table 3; Supplemental Table 1).

Results

The results demonstrate that there is a startling heterogeneity of coarse earthenware sources within eighteenth-century Chesapeake ceramic assemblages (Figure 7). In addition to examples of the geographically named British ware types, eight additional production zones were identified: Liverpool, Philadelphia, Northern Virginia Piedmont, Alexandria, Tidewater Chesapeake (excluding Alexandria), Shenandoah Valley, Southern Ridge and Valley, and a newly discovered zone that is likely the Central Virginia Piedmont. Given the prior inability to distinguish different American sources, this represents a significant improvement in resolution. The North Carolina Piedmont was included as a potential source, but no domestic sherds had a predicted assignment to this zone. These probabilities represent the best association with the given groups; with the acknowledgment that group membership may shift if additional production groups are included.

The Philadelphia area is the only interregional production zone that was represented in the Chesapeake domestic assemblages. Notably, earthenware from this zone was found in the earliest phase (pre-1720), while the Philadelphia industry was still nascent. Though Philadelphia potters produced utilitarian forms and tableware forms, Bower (1985) has suggested that potters marketed the utilitarian wares specifically to rural areas, presumably because they had greater need for food storage.

Thirteen sherds from Coastal Plain domestic assemblages have predicted probabilities placing them in upland production zones. Due to the elemental homogeneity of the Chesapeake as a whole and the transport of sediment into the Coastal Plain, it is likely that these outlying sherds were not produced in these upland zones, but represent distinct secondary clay sources from within the Coastal Plain. This is supported by the fact that a number of the production zone samples known to have been produced in the Coastal Plain were earlier excluded from the training set because they had predicted probabilities placing them in upland production zones. I have retained the predicted group assignments, with the acknowledgement that these sherds were produced from "Shenandoah Valley-like", or "Piedmont-like" clay sources, but probably not in the Shenandoah Valley or the Piedmont.

Coarse earthenwares made up 29 percent (n = 12, 770) of all ceramics from the sampled sites (n = 44, 365). Based on visual attributes, 48 percent (n = 6, 175) of these were cataloged with some degree of specificity to nine different coarse earthenware types (Buckley, Colonoware, Derbyshire, Iberian, North Devon, London Area Redware, Red Agate, Staffordshire, and Surrey-Hampshire Border Ware), most of which are named for their presumed geographic origin. The remaining 52 percent (n = 6, 595) were identified only as unidentified coarse earthenware or redware. In comparison, the overall rate of assignment for the elementally analyzed domestic samples in this study was 96 percent (Figure 7). The results suggest that the sampling procedure successfully included the production zones that were the primary sources for these wares in the Chesapeake, and affirms that wasters from production sites can be elementally tied to sherds found in domestic contexts. Given that this study focused primarily on the most visually generic wares, this indicates significant potential for correctly identifying coarse earthenwares in existing collections.

There are clear temporal shifts in the sources of coarse earthenware, and in particular a steady decrease in the use of imported wares in favor of domestically made products (Table 4). While in the early eighteenth century the proportion of imported to domestic wares were nearly equal, by midcentury just over 10 percent of the sampled sherds were imported. As would be expected following the criterion of abundance, the most common American-made wares in each assemblage tended to be from the production zone in which the plantation was located. Furthermore, all plantation households used at least some locally made wares, and no sharp differences were seen among the assemblages for households of different status, or on plantations of different size, suggesting that these commonplace wares were equally available to all. At the individual plantation level, assemblages associated with lower-status households of indentured servants or slaves had similar numbers of coarse earthenware sources represented as assemblages associated with planter households. Both were equally likely to contain locally made wares. Regionally, the intra-plantation pattern held, as there was greater similarity in richness within plantations than within contexts of shared social status across plantations. Greater differences in richness were seen among plantations. This trend is broadly temporal: plantations occupied earlier have more coarse earthenware sources represented than plantations occupied later.

Discussion

At the outset, I introduced coarse earthenwares as a class of artifact distinctively able to speak to the nature of trade in the historic Chesapeake. As goods produced both domestically and imported, they are material evidence of the friction between British mercantilist aims and colonial economic goals. The historical narratives emphasizing a staple economy and the dominance of British imports in the region conflict with the numerous physical remains of coarse earthenware production sites and the presence of locally made coarse earthenware in every assemblage sampled in this study. Rather than verifying the dominance of transatlantic sources, the results presented here demonstrate that locally made wares were necessary tools, even for those heavily engaged in the consignment trade. In order to understand why this might be, we must resume a discussion of the functions of coarse earthenware, considered in light of the sourcing results.

Fragmentation made it difficult to determine the form for the majority of these wares; only 14 of the 184 sherds sampled have been cataloged as part of a specific vessel form. These include items such as milk pans (n = 7) and storage vessels (n = 3). Eighty-eight sherds, or 52 percent were identified at the level of "Unid: Utilitarian," nine (five percent) as "Unid: Tableware," and a single sherd was identified as "Unid: Teaware" (less than one percent). The remaining seventy-two sherds (42 percent), were deemed "Unidentifiable," or were missing that level of cataloging information. Considering only the sherds that were cataloged with some degree of specificity, approximately 90 percent represent utilitarian wares such as milk pans, butter pots, and general storage vessels.

Utilitarian ceramics served basic functions of food preparation and storage in the eighteenth century. Certain foodstuffs, especially liquids, could best be stored in ceramic. Large-mouthed storage vessels could store both dry goods and liquid items, providing a pest and moisture resistant container for daily and long-term storage. Especially during winter months when fresh produce was scarce, the ability to store fruits and vegetables would have improved the nutritional content and variety of meals within households.

Some earthenwares were not initially purchased for the vessel itself, but as carriers for other goods. Butter was one commodity that was often sold in the pot. A 1662 Act of English Parliament regulated the size and weight of butter pots, stipulating, "a pot of butter must weigh 20lbs out of which the pot must weigh not more than 6lbs" (Staffordshire County Council Education Committee 1981), and similar controls followed in the colonies. Rum, molasses, and other liquids were also sold in reusable containers of ceramic or glass, with a surcharge added for the container if customers did not supply their own.

Coarse earthenwares were also used for food preparation, including cooking, dairying, and brewing. "Virginia Housewife," Mary Randolph penned a cookbook in the early nineteenth century, in which she specifically recommends the use of "earthen" pots or dishes for preparing recipes such as okra soup and ducks with onion sauce (Randolph 1838 [1824]). Food cooked in earthenware is cooked at a lower temperature and more slowly than in metal (Skibo and Schiffer 2008:15). This method retains moisture and allows time for the softening of meat and vegetables and the blending of flavors. Food preparation in coarse earthenware became less common over the course of the eighteenth century, but was retained for specialized and culturally specific uses.

On some plantations domestic industries were implemented on a large scale. In January 1814, Jefferson wrote to his cousin Richard Randolph who operated a stoneware pottery outside of Richmond, Virginia, asking, "would you be so good as to send me two gross of your beer jugs; the one gross to be quart jugs and the other pottle [ditto]" (Jefferson 1987:417; pottle is equivalent to half-gallon). Later that year, he posed another request, explaining, "I am now engaged in brewing a year's supply of malt strong beer, which however I have no chance of saving but by a supply of quart jugs from you. I received (I think) 10 ½ dozen and must ask the favor of 4. gross more for which Mr. Gibson will pay your bill" (Jefferson 1987:418).

These large orders of ceramics were necessary for Jefferson's household industry at

Monticello, evidence of the scale of his production. In an archaeological and documentary study of Virginia planters, Bell (2000) argued that these men were more concerned with "conspicuous production," than conspicuous consumption of luxury items, channeling their wealth to increase their plantations' productivity, showcasing their ambition and social position. From this perspective, Jefferson's wholesale orders of ceramics were signals of his success as a planter. These investments in plantation infrastructure relied upon local relationships with craftsmen, facilitating special orders and obtaining prompt results.

At the same time, Jefferson's orders give a glimpse into the system of local credit so fundamental to the Chesapeake economy. Patrick Gibson, Jefferson's factor in Richmond, Virginia, mediated the transaction between Jefferson and Randolph. Gibson, an English-born merchant, extended Jefferson credit and managed his purchases that arrived in Richmond for shipment upriver to Monticello and Poplar Forest (Founders Online 2015). In exchange, he received the products of Jefferson's plantations. These transactions demonstrate the complicated web of social and economic relationships in which local craftpersons contributed, where third parties and extended family were common participants. The interdependence fostered by exchanges such as this extended beyond economic concerns into social realms. A local pot acted as a social lubricant in addition to its functional roles.

Consumerism

General homogeneity of assemblages within plantations indicates shared access, and potentially plantation-wide strategies such as provisioning. Planter households and slave households made use of pots from the same sources, indicating no status-based differences associated with wares from specific places. Did enslaved individuals individually purchase these wares, or were they part of plantation provisioning strategies? Little has been recorded about the provisioning of non-food or textile related goods on Chesapeake plantations, but it must be considered as a potential route of access for enslaved members of the plantation community. Slaves in the Chesapeake were typically provided with weekly food rations, and yearly cloth or clothing allotments. Other items such as beds and blankets were less frequently provided (e.g., Jefferson 1987), and provisioning of ceramics was not noted in plantation accounts.

On the other hand, there is a large body of evidence demonstrating that enslaved Chesapeake residents were active patrons of stores (e.g., Heath 1997; Martin 2008). They commonly purchased personal adornment items, tools, and a variety of other goods, and certainly could have afforded these inexpensive wares. Yet, a search of 20 Virginia store accounts from the eighteenth century uncovered only a single reference possibly associating the purchase of coarse earthenware to an enslaved person (Virginia Historical Society). The question of how coarse earthenwares entered slave households in the Chesapeake requires further research.

The presence of locally made wares explicitly signals local trade, either through stores or directly from potters. Still, there is a troubling issue of equifinality in understanding local purchasing behavior, as goods from local, intercolonial, and global sources could all be purchased from local stores. The presence of British pots in an assemblage does not necessarily confirm global trade at the plantation or individual household level, though it does suggest a general reliance on imported goods. Lacking documentary evidence, the distribution mechanisms of these imported wares remain uncertain for most assemblages.

The decrease over time in the consumption of imported coarse earthenwares can be visualized inversely as an increase in local economic relationships. The growth of pottery industries in towns like Alexandria and Philadelphia over the course of the century, and the spread of production to newly settled reaches of the region, assured residents a steady supply of these necessary domestic tools. Meanwhile, imports of refined earthenwares for the table continued unabated and actually increased (Miller 1984), so the shift towards local ceramic products was largely specific to coarse earthenwares. This pattern challenges the idea that there was a real or perceived inferiority of local products. Instead, their omnipresence is evidence for their value, from allowing for custom orders and local credit, to promoting American self-sufficiency for the nascent revolution. These factors, cemented in neighborly relationships, sustained local industry in the Chesapeake even in the face of equivalent imported wares.

Conclusion

The results of elemental sourcing outlined here transform our understandings of the generically defined earthenwares within archaeological collections across the region. The representation of local production in every area sampled was unexpected, given the patchy nature of archaeological and documentary evidence of pottery production in the region. These results provide a valuable starting point for discussing the broader social and economic history of the Chesapeake, and the ways in which plantation residents participated in consumption practices.

Consumption of coarse earthenwares has been an expected and unremarkable aspect of household archaeology in the Chesapeake. These utilitarian wares are equally as representative of producers' strategies and consumers' choices as more decorative or showy artifacts, but our analytical methods have not been adept at recovering this information. Increasingly available analytical technologies such as LA-ICP-MS revitalize the study of colonial craft, offering new avenues for identifying the products and markets of craftspeople. In coming years this project and database will expand geographically and temporally to encompass additional production zones and domestic sites within and beyond the Chesapeake, moving away from plantations to consider how residents of towns and smallholdings participated within this world of goods.

Though historical archaeology is inextricably tied to historical narratives, in this study I demonstrate that historical models fall short when it comes to understanding the economy of coarse earthenware in the eighteenth-century Chesapeake. By substantiating the presence of distinct products within specific sites and times, this project illuminates social and economic strategies that were unexpected. In particular, these results foreground the significance of a largely undocumented local and interregional ceramic trade to Chesapeake households, and situate potters as strategic community members providing a necessary service. The implications of this study are relevant to scholars working in a variety of locations and times, offering a historical view of the intersections of local, regional, and global economic systems.

Acknowledgments. The elemental analysis was supported by a Dissertation Fieldwork Grant from the Wenner-Gren Foundation. Funding from the Archeological Society of Virginia, Research Labs of Archaeology, UNC-CH, the Center for the Study of the American South, UNC-CH, the Maryland Archaeological Conservation Lab, the Virginia Historical Society, and the International Center for Jefferson Studies and DAACS supported data collection and analysis. I thank Sohrab Habibi, Jeff Speakman, and Fraser Neiman for assistance with the technical and quantitative analyses. Samples were provided by Alexandria Archaeology, Archaeological & Cultural Solutions, Inc., Linda Carnes-McNaughton; the Fairfield Foundation, Linden Fravel; Gloucester County, Virginia, the Guildford Borough Council, the Harlow Museum, the James River Institute for Archaeology, the Maryland Historical Trust and Maryland Archaeological Conservation Lab, the Mount Vernon Ladies' Association, the Museum of Liverpool, NAVFAC

Washington, Oxford Archaeology, Hal Pugh and Eleanor Minnock-Pugh, the State Museum of Pennsylvania, the Stoke on Trent Museum Archaeological Society, Scott Suter, the Thomas Jefferson Foundation, Monticello, Thomas Jefferson's Poplar Forest, the Virginia Department of Historic Resources, and Washington and Lee University. Thanks to three anonymous reviewers for their valuable comments. The Spanish abstract was provided by the author and checked by Andrés Izeta.

Data Availability Statement. Ceramic samples prepared for LA-ICP-MS are housed at the Research Laboratories of Archaeology, UNC-CH. The author will provide full catalog data and raw compositional data for samples upon request.

Supplemental Materials. Supplemental materials are linked to the online version of the paper, accessible via the SAA member login at www.saa.org/members-login.

Supplemental Table 1. Mahalanobis Distance Probabilities of Group Membership

Supplemental Table 2. Average Elemental Concentration by Production Zone.

Supplemental Figure 1. Principal component analysis biplot of training set.

Supplemental Figure 2. Bivariate plot of tin and potassium concentrations for production samples.

Supplemental Figure 3. Bivariate plot of chromium and rubidium concentrations for production samples.

References Cited

Anderson, Nesta

2004 Finding the Space between Spatial Boundaries and Social Dynamics: The Archaeology of Nested Households. In *Household Chores and Household Choices: Theorizing the Domestic Sphere in Historical Archaeology*, edited by Kerri S. Barile and Jamie C. Brandon, pp: 109-120. University of Alabama Press, Tuscaloosa.

Aultman, Jennifer, Kate Grillo, Nick Bon-Harper, and Jillian Galle

2014 DAACS Cataloging Manual: Ceramics. Electronic document, http://www.daacs.org/about-the-database/daacs-cataloging-manual/, accessed November 3, 2014.

Arnold, Dean E.

2008 *Social Change and the Evolution of Ceramic Production and Distribution in a Maya Community*. University Press of Colorado, Boulder.

Barka, Norman F.

2004 Archaeology of a Colonial Pottery Factory: The Kilns and Ceramics of the "Poor Potter" of Yorktown. *Ceramics in America* 2004:15-47.

Bartlett, Mary Lee, Hector Neff, and Patricia A. McAnany

2000 Differentiation of Clay Resources on a Limestone Plain: The Analysis of Clay Utilization during the Maya Formative at K'axob Belize. *Geoarchaeology* 15:95-133.

Baxter, William T.

1946 Credit, Bills, and Bookkeeping in a Simple Economy. *The Accounting Review* 21:154-166.

Beck, Margaret E., and Hector Neff

2007 Hohokam and Patayan Interaction in Southwestern Arizona: Evidence from Ceramic Compositional Analyses. *Journal of Archaeological Science* 34:289-300.

Bell, Alison K.

2000 C*onspicuous Production: Agricultural and Domestic Material Culture in Virginia, 1700-1900*. Ph.D. dissertation, Department of Anthropology, University of Virginia.

Bishop, Ronald L., Robert L. Rands, George R. Holley
1982 Ceramic Compositional Analysis in Archaeological Perspective. *Advances in Archaeological Method and Theory* 5:275-330.

Bloch, Lindsay
2011 *An Archaeological Study of Common Coarse Earthenware in the Eighteenth-Century Chesapeake*. Master's thesis, Department of Anthropology, University of North Carolina, Chapel Hill.
2015 *Made in America? Ceramics, Credit, and Exchange on Chesapeake Plantations*. Ph.D. dissertation, Department of Anthropology, University of North Carolina, Chapel Hill.

Bollwerk, Elizabeth Anne
2012 Seeing What Smoking Pipes Signal(ed): An Examination of Late Woodland and Early Contact Period (A.D. 900-1665) Native Social Dynamics in the Middle Atlantic. Ph.D. dissertation, Department of Anthropology, University of Virginia, Charlottesville.

Bower, Beth A.
1985 The Pottery-Making Trade in Colonial Philadelphia: The Growth of an Early Urban Industry. In *Domestic Pottery of the Northeastern United States*, edited by Susan Peabody Turnbaugh, pp. 133-152. Studies in Historical Archaeology, Academic Press, Orlando.

Breen, T. H.
2001 *Tobacco Culture: The Mentality of the Great Tidewater Planters on the Eve of Revolution.* Princeton University Press, Princeton, New Jersey.
2004 *The Marketplace of Revolution: How Consumer Politics Shaped American Independence.* Oxford University Press, New York.

Carson, Cary
2003 Consumption. In *A Companion to Early America,* edited by D. Vickers, pp. 334-365. Blackwell Publishing, London.

Cochrane, Ethan E., and Hector Neff
2006 Investigating Compositional Diversity Among Fijian Ceramics with Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS): Implications for Interaction Studies on Geologically Similar Islands. *Journal of Archaeological Science* 33:378-390.

Comstock, H. E.
1994 *The Pottery of the Shenandoah Valley Region*. The Museum of Early Southern Decorative Arts. The University of North Carolina Press, Chapel Hill.

Deetz, James
1996 *In Small Things Forgotten: An Archaeology of Early American Life*. Anchor Books, New York.

Earle, Carville V.
1975 *The Evolution of a Tidewater Settlement System: All Hallow's Parish, Maryland, 1650-1783*. The University of Chicago Department of Geography Research Paper No. 170. Department of Geography, University of Chicago, Chicago.

Eckert, Suzanne L., and William D. James

2011 Investigating the Production and Distribution of Plain Ware Pottery in the Samoan Archipelago with Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS). *Journal of Archaeological Science* 38:2155-2170.

Founders Online

2015 National Archives. Electronic document, http://founders.archives.gov/documents/Jefferson/03-04-02-0412, accessed February 1, 2015.

Franklin, Benjamin

1837 Causes of the American Discontents before 1768. Reprinted. In *The Works of Benjamin Franklin*, vol. 4, edited by Jared Sparks. Hilliard Gray, Boston. Originally published 1768.

Galle, Jillian E.

2010 Costly Signaling and Gendered Social Strategies among Slaves in the Eighteenth-Century Chesapeake: An Archaeological Perspective. *American Antiquity* 75:19-43.

Golitko, Mark, and John Edward Terrell

2012 Mapping Prehistoric Social Fields on the Sepik Coast of Papua New Guinea: Ceramic Compositional Analysis using Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry. *Journal of Archaeological Science* 39:3568-3580.

Gratuze, Bernard

1999 Obsidian Characterization by LA-ICP-MS and Its Application to Prehistoric Trade in the Mediterranean and the Near East: Sources and Distribution of Obsidian within the Aegean and Anatolia. *Journal of Archaeological Science* 26:869-881.

Heath, Barbara J.

1997 Slavery and Consumerism: A Case Study from Central Virginia. African Diaspora Archaeology Newsletter 4(2):1-7. Electronic document, http://scholarworks.umass.edu/adan/vol4/iss2/1, accessed February 28, 2015.

Honaker, James, Gary King, and Matthew Blackwell

2011 Amelia II: A Program for Missing Data. *Journal of Statistical Software* 45(7):1-47.

Horn , James P.

1979 Servant Emigration to the Chesapeake in the Seventeenth Century. In *The Chesapeake in the Seventeenth Century: Essays in Anglo-American Society*, edited by Thad W. Tate and David L. Ammerman, pp.51-95. University of North Carolina Press, Chapel Hill.

Huberty, Carl J., and Stephen Olejnik

2006 *Applied MANOVA and Discriminant Analysis, Second Edition*. John Wiley and Sons, Hoboken, New Jersey.

Jefferson, Thomas

1987 *Thomas Jefferson's Farm Book, with Commentary and Relevant Extracts from Other Writings*, edited by E. M. Betts. Charlottesville: University Press of Virginia.

Joyce, Arthur A., Hector Neff, Mary S. Thieme, Marcus Winter, J. Michael Elam, and Andrew Workinger

2006 Ceramic Production and Exchange in Late/Terminal Formative Period, Oaxaca. *Latin American Antiquity* 17:579-594.

Kelso, William M., and Edward A. Chappell

1974 Excavation of a Seventeenth Century Pottery Kiln at Glebe Harbor, Westmoreland County, Virginia. *Historical Archaeology* 8:53-63.

Kovarovic, Kris, Leslie C. Aiello, Andrea Cardini, and Charles A. Lockwood
2011 Discriminant Function Analyses in Archaeology: Are Classification Rates Too Good to Be True? *Journal of Archaeological Science* 38:3006-3018.

Kuhn, Robert D., and Martha L. Sempowski
2001 A New Approach to Dating the League of the Iroquois. *American Antiquity* 66:301-314.

Kulikoff, Allan
2000 *From British Peasants to Colonial American Farmers*. University of North Carolina Press, Chapel Hill.

Magid, Barbara H.
1995 An Archaeological Perspective on Alexandria's Pottery Tradition. *Journal of Early Southern Decorative Arts* 21(2):41-82,

Martin, Ann Smart
2008 *Buying into the World of Goods: Early Consumers in Backcountry Virginia*. Johns Hopkins University Press, Baltimore.

McCartney, Martha W. and Edward Ayres
2004 Yorktown's "Poor Potter": A Man Wise Beyond Discretion. *Ceramics in America* 2004:48-59.

Metz, John
1999 Industrial Transition and the Rise of a "Creole" Society in the Chesapeake. In *Historical Archaeology, Identity Formation, and the Interpretation of Ethnicity*, edited by Maria Franklin and Garrett Fesler, pp. 11-30. Colonial Williamsburg Research Publications. Dietz Press, Richmond, Virginia.

Miller, George L.
1984 Marketing Ceramics in North America: an Introduction. Winterthur Portfolio 19(1):1-5.

Mommsen, Hans
2001 Provenance Determination of Pottery by Trace Element Analysis: Problems, Solutions, and Applications. *Journal of Radioanalytical and Nuclear Chemistry* 247:657-662).

Monette, Yves, Marc Richer-LaFleche, Marcel Moussette, and Daniel Dufournier
2007 Compositional Analysis of Local Redwares: Characterizing the Pottery Productions of 16 Workshops Located in Southern Quebec Dating from the Late 17th to Late 19th-Century. *Journal of Archaeological Science* 34:123-140.

Morgan, Phillip D.
1998 *Slave Counterpoint: Black Culture in the Eighteenth-Century Chesapeake and Lowcountry*. University of North Carolina Press, Chapel Hill.

Myers, Susan H.
1984a Marketing American Pottery: Maulden Perine in Baltimore. *Winterthur Portfolio* 19:51-66.
1984b The Business of Potting, 1780-1840. In *The Craftsman in Early America*, edited by Ian M. G. Quimby, pp. 190-233. The Henry Francis du Pont Winterthur Museum. W. W. Norton & Co., New York.

Neff, Hector

2003 Analysis of Mesoamerican Plumbate Pottery Surfaces by Laser Ablation-Inductively Coupled-Plasma Mass Spectrometry (LA-ICP-MS). *Journal of Archaeological Science* 30:21-35.

Niziolek, Lisa C.
2011 *Ceramic Production and Craft Specialization in the Prehispanic Phillipines, A.D. 500 to 1600.* Ph.D. dissertation, Department of Anthropology, the University of Illinois, Chicago.

Noël Hume, Ivor
1969 *A Guide to the Artifacts of Colonial America*. Alfred A. Knopf, New York.

Owen, Victor, and John D. Greenough
2010 Mineralogical and Geochemical Characterization of Eighteenth-Century Moravian Pottery from North Carolina. *Ceramics in America* 2010:168-187.

Pollard, A. Mark, and Carl Heron
2008 *Archaeological Chemistry* 2nd Edition. Royal Society of Chemistry, Cambridge.

R Core Team
2014 R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Electronic document, http://www.R-project.org/, accessed September 1, 2015.

Randolph, Mary
1838 *The Virginia Housewife, or, Methodical Cook*. Plaskitt and Cugle, Baltimore. Electronic document, http://digital.lib.msu.edu/projects/cookbooks/html/books/book_10.cfm, accessed March 12, 2015.

Russ, Kurt C.
1995 Exploring Western Virginia Potteries. *The Journal of Early Southern Decorative Arts* 21(2):98-138.

Russo, Jean B., and J. Elliott Russo
2012 *Planting an Empire: The Early Chesapeake in British North America*. Johns Hopkins University Press, Baltimore.

Scarlett, Timothy James, Robert J. Speakman, and Michael D. Glascock
2007 Pottery in the Mormon Economy: An Historical, Archaeological, and Archaeometric Study. *Historical Archaeology* 41(4): 72-97.

Shammas, Carole
1982 Consumer Behavior in Colonial America. *Social Science History* 6:67-86.

Sharratt, Nicola, Mark Golitko, P. Ryan Williams, and Laure Dussubieux
2009 Ceramic Production during the Middle Horizon: Wari and Tiwanaku Clay Procurement in the Moquegua Valley, Peru. *Geoarchaeology* 24:792-820.

Shepherd, James F., and Samuel H. Williamson
1972 The Coastal Trade of the British North American Colonies, 1768-1772. *The Journal of Economic History* 32:783-810.

Skibo, James, and Michael. B. Schiffer
2008 *People and Things: A Behavioral Approach to Material Culture.* New York: Springer.

Skowronek, Russell K, M. James Blackman, and Ronald L. Bishop
2014 *Ceramic Production in Early Hispanic California: Craft, Economy, and Trade on the Frontier of New Spain*. University Press of Florida, Gainesville.

Smith, Michael S., Thomas C. Loftfield, and Fiona M. Paulsson
1995 Preliminary Investigation of Orange Micaceous Earthenware from the Early Colonial Period Charles Towne Colony, Cape Fear River, North Carolina. In *Material Issues in Art and Archaeology IV*, pp. 589-595.
Soltow, James H.
1959 Scottish Traders in Virginia, 1750-1775. *Economic History Review*, New Series 12(1):83-98.
Speakman, Robert J., and Hector Neff
2005 The Application of Laser Ablation-ICP-MS to the Study of Archaeological Materials—An Introduction. In *Laser Ablation ICP-MS in Archaeological Research*, edited by Robert. J. Speakman and Hector Neff, pp. 1-16. University of New Mexico Press, Albuquerque.
Staffordshire County Council Education Committee
1981 Staffordshire Pottery Industry. Local History Source Book G. 4.
Steadman, Laura
2008 Uncovering the Origins of Abbott Zone Incised Ware. *Journal of Middle Atlantic Archaeology* 24:79-86.
Steen, Carl
1990 *The Inter-Colonial Trade of Domestic Earthenware and the Development of an American Social Identity.* Volumes in Historical Archaeology IX. Columbia: University of South Carolina.
Stoner, Wesley D., and Michael D. Glascock
2012 The Forest or the Trees? Behavioral and Methodological Considerations for Geochemical Characterization of Heavily-Tempered Ceramic Pastes Using NAA and LA-ICP-MS. *Journal of Archaeological Science* 39:2668-2683.
Straube, Beverly A.
1995 The Colonial Potters of Tidewater Virginia. *Journal of Early Southern Decorative Arts* 26(2):1-40.
Wallis, Neill J., and George D. Kamenov
2013 Challenges in the Analysis of Heterogeneous Pottery by LA-ICP-MS: A Comparison with INAA. *Archaeometry* 55:893-909.
Walsh, Lorena S.
1988 Community Networks in the Early Chesapeake. In *Colonial Chesapeake Society*, edited by Lois Green Carr, Philip D. Morgan, and Jean B. Russo, pp. 200-241. The University of North Carolina Press, Chapel Hill.
2010 *Motives of Honor, Pleasure, and Profit: Plantation Management in the Colonial Chesapeake, 1607-1763*. Omohundro Institute of Early American History and Culture. University of North Carolina Press, Chapel Hill.
Weigand, Phil C., Garman Harbottle, and Edward V. Sayre
1977 Turquoise Sources and Source Analysis: Mesoamerica and the Southwestern U.S.A. In *Exchange Systems in Prehistory*, edited by Timothy K. Earle and Jonathon E. Ericson, pp. 15-34. Academic Press, New York.
Yentsch, Anne
1991 Engendering Visible and Invisible Ceramic Artifacts, Especially Dairy Vessels. Historical Archaeology 25(4):132-155.
Submitted September 2, 2015; Revised October 8, 2015; Accepted October 13, 2015.

Figures

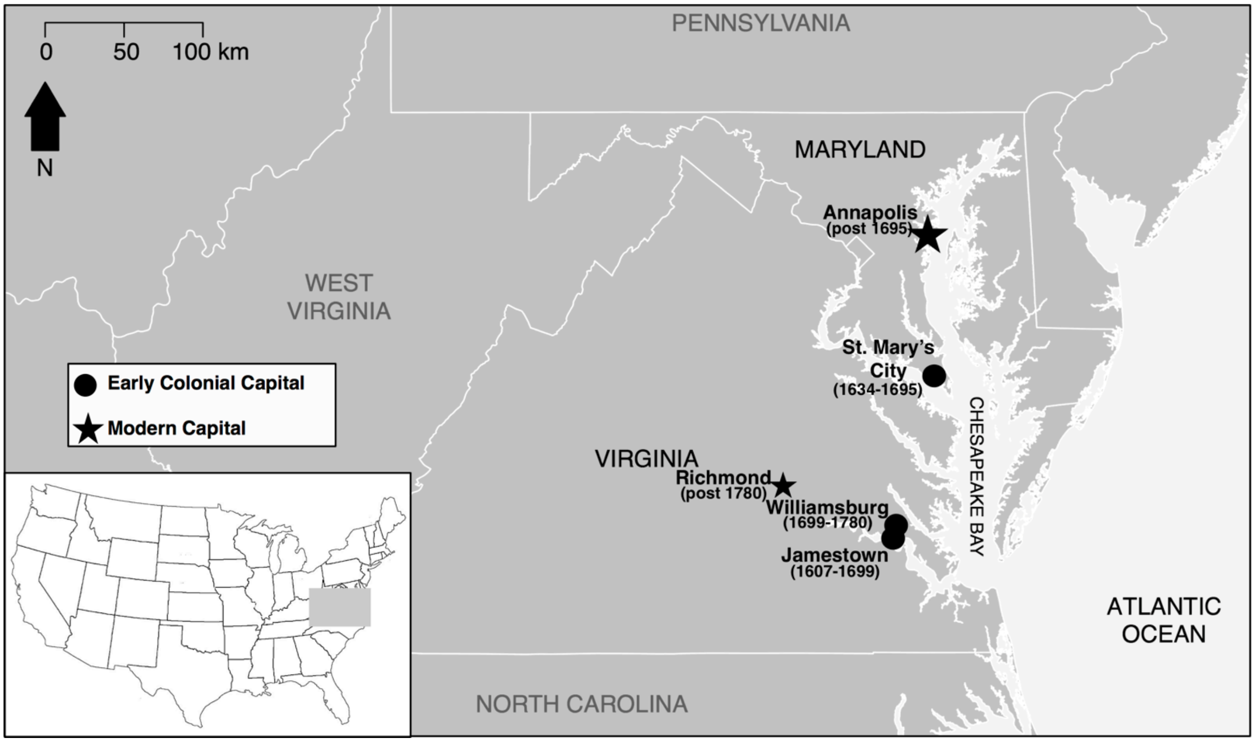

Figure 1. Map of the Chesapeake region. Dates indicate when each city operated as capital.

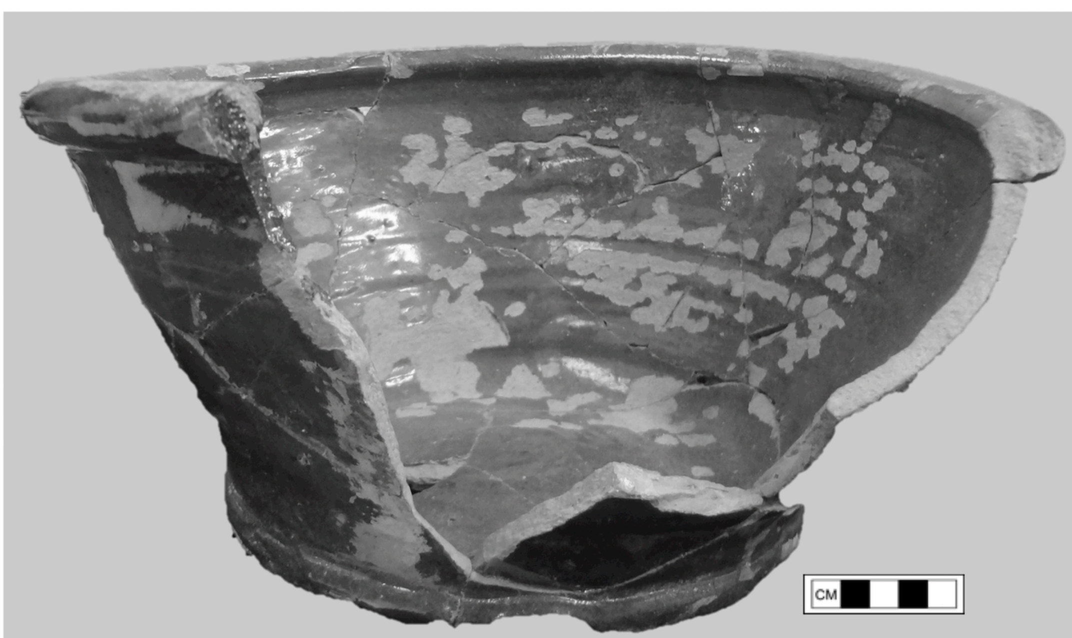

Figure 2. Lead glazed coarse earthenware pan/bowl produced in Harlow, Essex, England. (Harlow Museum, photograph by the author).

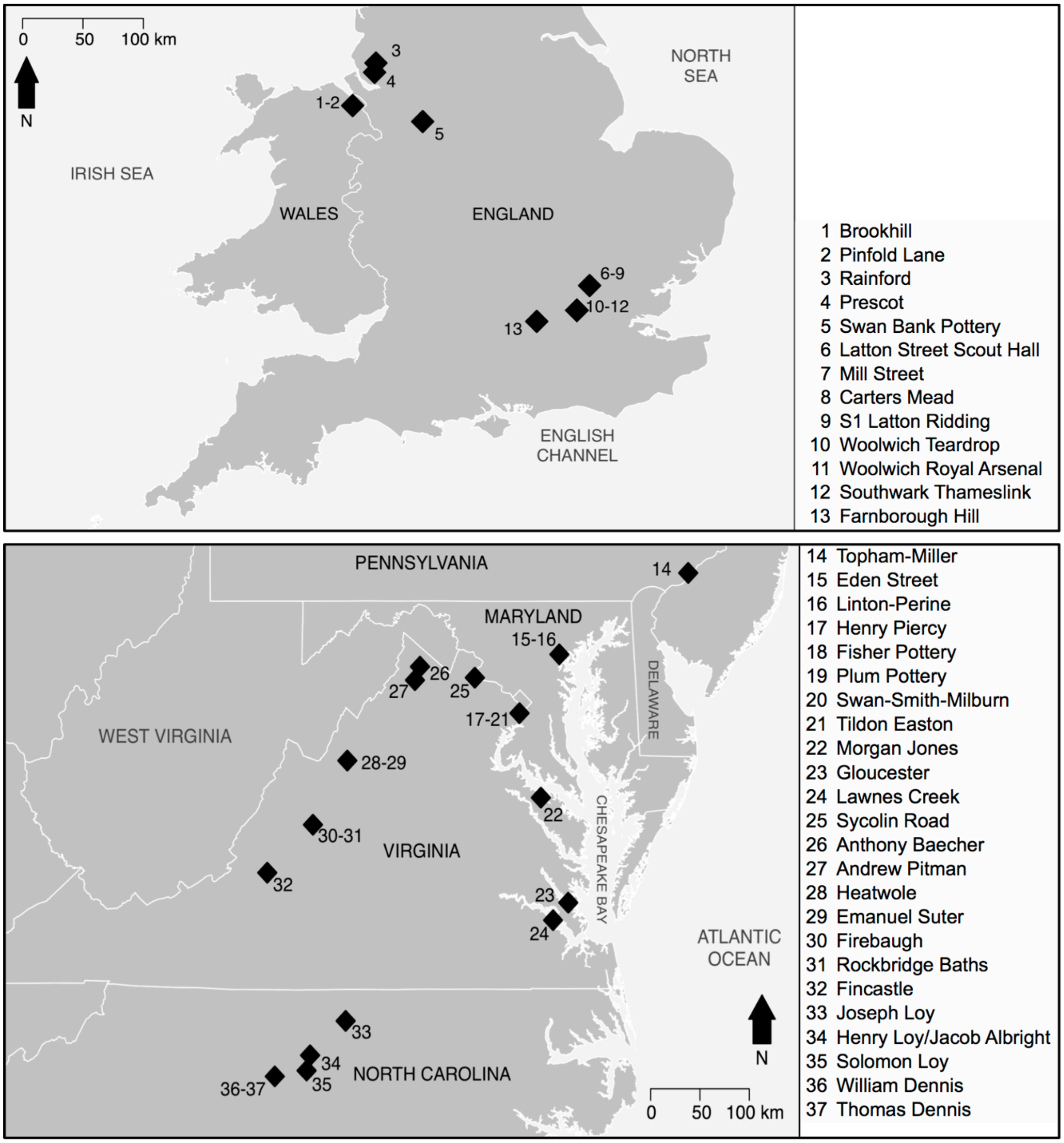

Figure 3. Map of the British (top) and Mid-Atlantic (bottom) production sites sampled.

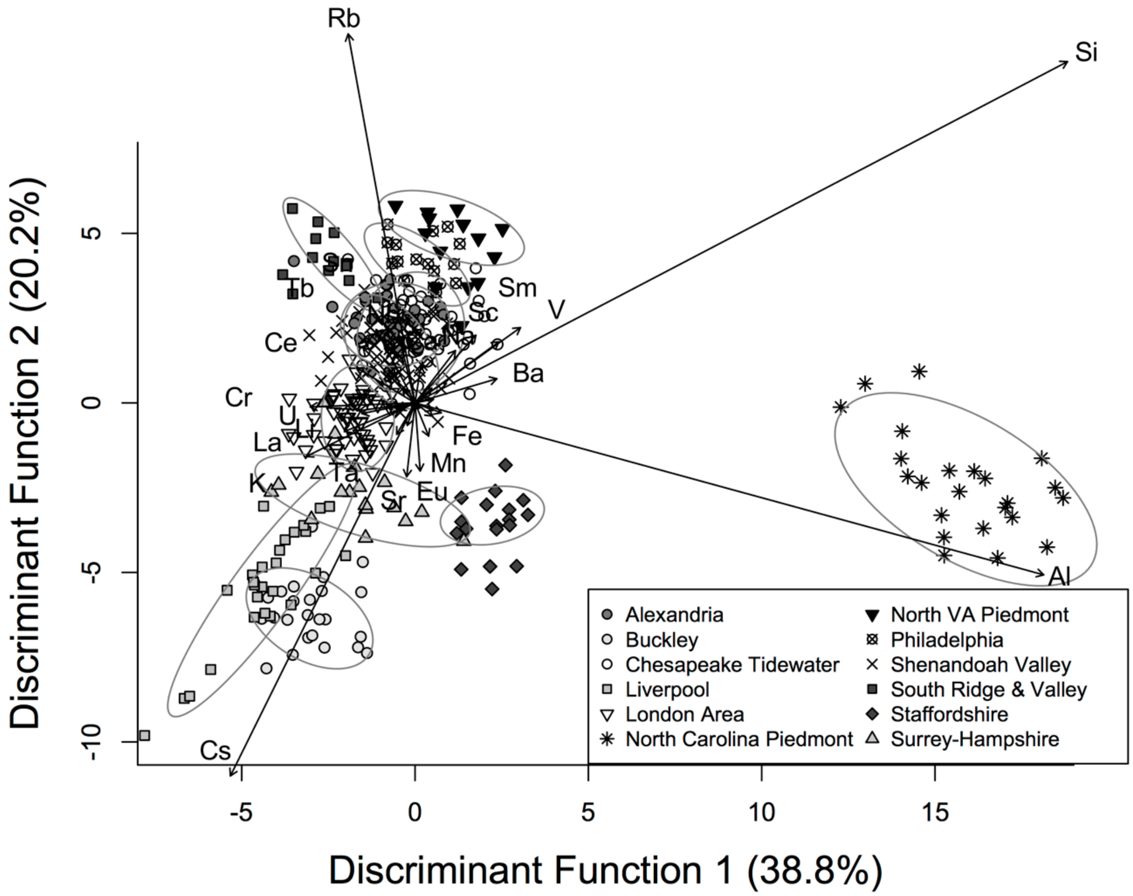

Figure 4. Biplot of discriminant analysis function 1 and 2, showing the separation of the twelve identified production zones. The ellipses represent 90 percent confidence intervals for group membership.

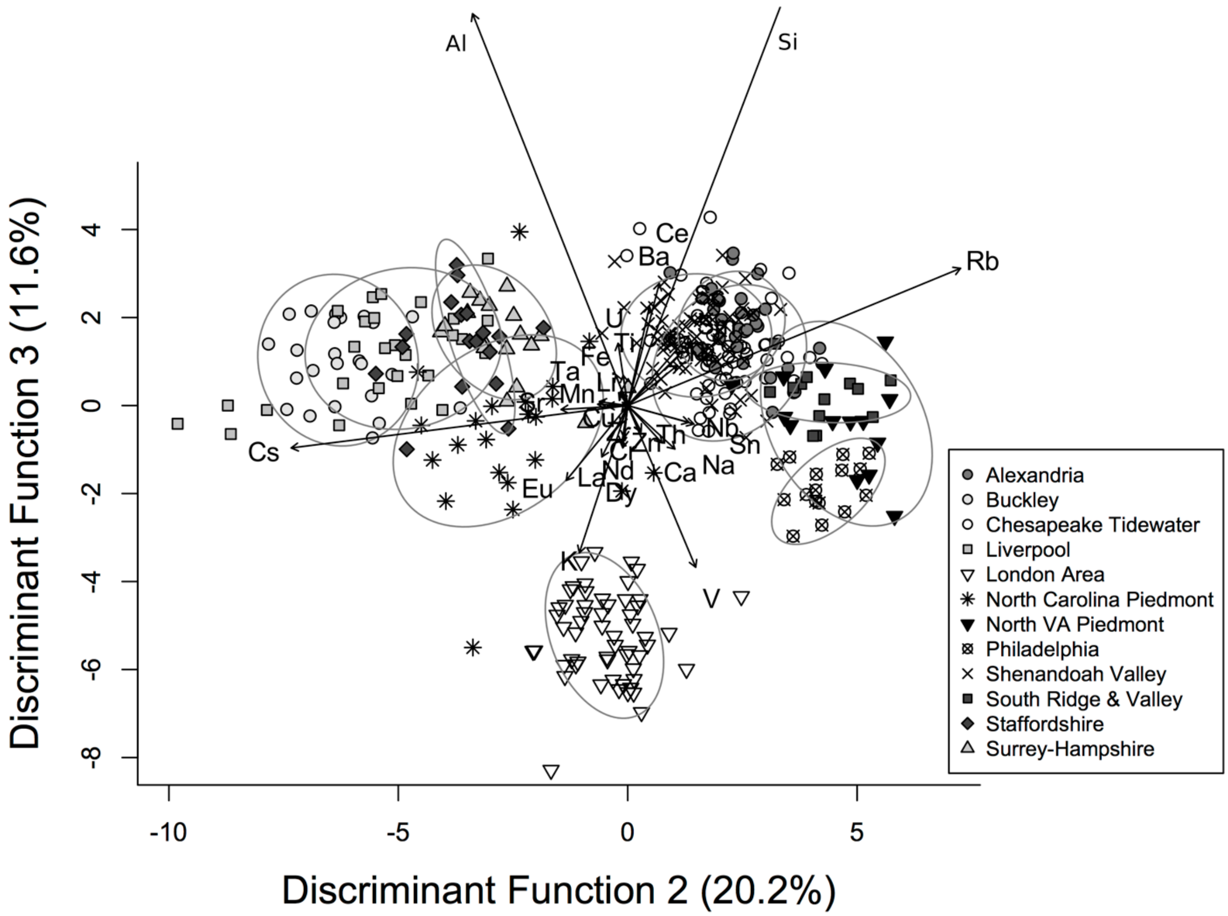

Figure 5. Biplot of discriminant analysis function 2 and 3, showing the separation of the twelve identified production zones. The ellipses represent 90 percent confidence intervals for group membership.

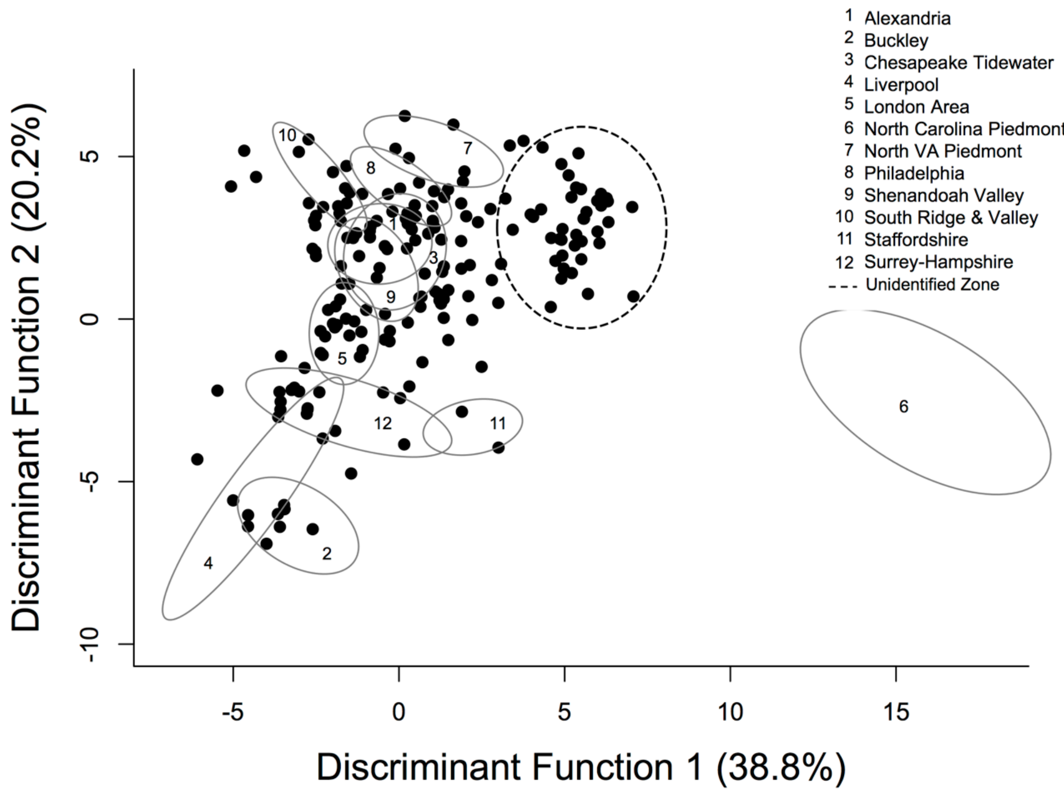

Figure 6. Projection of unknown samples from domestic sites into the discriminant analysis training model. Ellipses represent 90 percent confidence intervals for each production zone. Dashed line indicates an additional compositional group not accounted for in the model.

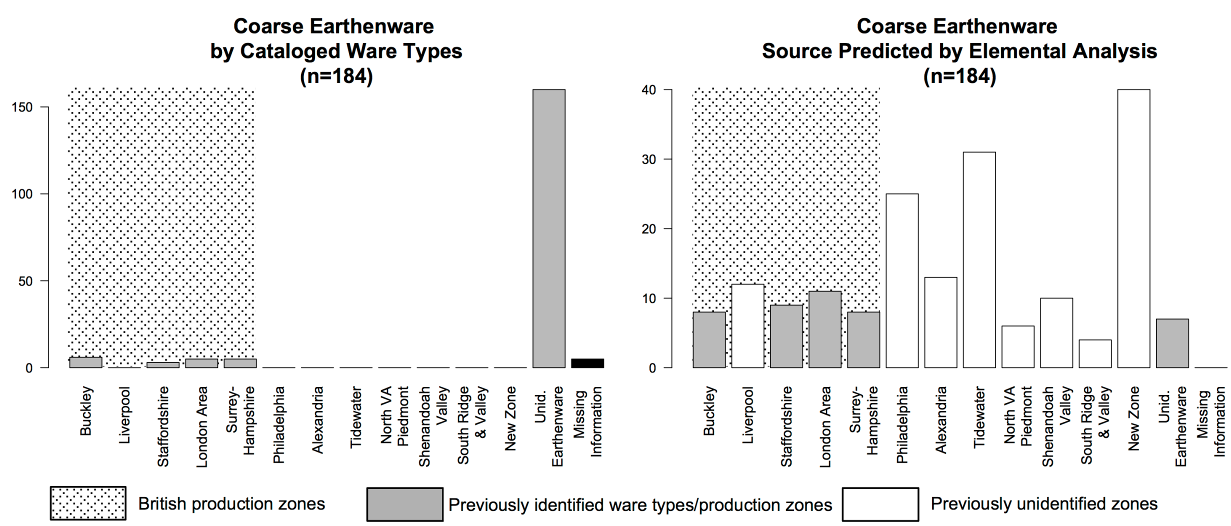

Figure 7. Comparison of the identification of the sampled coarse earthenwares from domestic assemblages as cataloged by lending institution or DAACS (left) versus by elemental analysis and Mahalanobis distance probabilities (right).

Table 1. Production Sites by Initial Production Zone

Primary Production Zone	Site Name	Location	Production Period (C.)	No. of Samples	Lending Institution
Coal Measures	Brookhill	Buckley, Wales	Mid 17th-Early 18th	14	Museum of Liverpool
	Pinfold Lane	Buckley, Wales	Late 17th-Early 18th	15	Museum of Liverpool
	Rainford	Merseyside, England	17th	14	Museum of Liverpool
	Prescot	Merseyside, England	18th	14	Museum of Liverpool
Staffordshire	Swan Bank	Burslem, Staff., England	13-18th	18	Private Collection
London Area	Latton Street Scout Hall	Harlow, Essex, England	15th-17th	14	Museum of Harlow
	Mill Street	Harlow, Essex, England	16th	12	Museum of Harlow
	Carters Mead	Harlow, Essex, England	16th-17th	4	Museum of Harlow
	S1 Latton Ridding	Harlow, Essex, England	17th-18th	11	Museum of Harlow
	Woolwich Teardrop	London, England	Late 15th-early 17th	8	Oxford Archaeology
	Woolwich Royal Arsenal	London, England	Mid 18th	5	Oxford Archaeology
	Southwark Thameslink	London, England	Mid 17th-Mid 18th	2	Oxford Archaeology
Surrey-Hampshire Border	Farnborough Hill	Hampshire, England	15th-17th C.	20	Guildford Museum
Philadelphia	Topham-Miller	Philadelphia, PA	Mid 18th-Mid 19th	20	State Museum of PA
Tidewater Chesapeake	Morgan Jones	Westmoreland Co., VA	Late 17th	15	Virginia DHR
	Lawnes Creek	Isle of Wight Co., VA	Late 17th-Early 18th	5	Archaeological & Cultural Solutions
	Gloucester	Gloucester, VA	18th	16	Gloucester County, VA
	Eden Street Kiln	Baltimore, MD	19th	12	Maryland Historical Trust
	Linton-Perine	Baltimore, MD	Mid-Late 19th	16	Maryland Historical Trust
	Henry Piercy	Alexandria, VA	Late 18th	10	Alexandria Archaeology
	Fisher Pottery	Alexandria, VA	Late 18th	8	Alexandria Archaeology
	Plum Pottery	Alexandria, VA	Early 19th	6	Alexandria Archaeology
	Swann-Smith-Milburn	Alexandria, VA	Early-Mid 19th	6	Alexandria Archaeology
	Tildon Easton	Alexandria, VA	Mid-Late 19th	11	Alexandria Archaeology
N. Virginia Piedmont	Sycolin Road	Loudoun Co., VA	Early-Mid 19th	15	Virginia DHR
Shenandoah Valley	Andrew Pitman	Frederick Co., VA	Late 18th-Mid 19th	16	Private Collection
	Anthony Baecher	Frederick Co., VA	Mid-Late 19th	13	Virginia DHR
	Heatwole	Rockingham Co., VA	Mid-Late 19th	9	Private Collection
	Emanuel Suter	Rockingham Co., VA	Mid-Late 19th	8	Private Collection
	Firebaugh	Rockbridge Co., VA	Mid 19th	16	Washington and Lee
	Rockbridge Baths	Rockbridge Co., VA	Mid-Late 19th	10	Washington and Lee
South Ridge and Valley	Fincastle	Botetourt Co., VA	Mid 19th	14	Washington and Lee
Piedmont North Carolina	Solomon Loy	Alamance Co., NC	18th-19th	3	RLA, UNC-CH
	Loy/Albright	Alamance Co., NC	19th	8	RLA, UNC-CH
	Joseph Loy	Person Co., NC	19th	5	Private Collection
	William Dennis	Randolph Co., NC	19th	4	Private Collection
	Thomas Dennis	Randolph Co., NC	19th	3	Private Collection

Note: Sites were assigned to initial production zones by physiological province, according to expected geologically based elemental variation.

Table 2. Plantation Assemblages

	Region	Primary Household Type	Occupation Range for Phases Sampled (C.)	MCD	BLUE MCD[a]	Phase	Lending Institution
King's Reach	Coastal MD						Maryland Historical Trust, Jefferson Patterson Park & Museum
King's Reach		Planter	Late17th-Early 18th	1704	1708	I	
King's Reach Quarter		Servant/slave	Late17th-Early 18th	1705	1709	I	
Fairfield	Coastal VA						Fairfield Foundation
Fairfield Midden		Planter/slave	Early-Mid 18th	1741	1757	II	
Fairfield Quarter[b]		Slave	Early-Mid 18th	1720	1725	II	
Mount Vernon	Coastal VA						Mount Vernon Ladies' Association
South Grove Midden[b]		Planter	Mid 18th	1744	1746	II	
House for Families[b]		Slave	Mid 18th	1741	1747	II	
Ashcomb's Quarter[b]	Coastal MD	Servant/slave/tenant	Early-Mid 18th	1735	1746	II	Solomons Complex,Naval District Washington; Maryland Historical Trust
Utopia	Coastal VA						James River Institute for Archaeology
Utopia III[b]		Slave	Early 18th	1719	1729	I	
Utopia IV[b]		Slave	Early-Mid 18th	1730	1741	II	
Chapline Place[b]	Coastal MD	Slave/tenant	Mid 18th	1755	1769	III	Maryland Historical Trust, Jefferson Patterson Park & Museum
Mattapany-Sewall	Coastal MD						Naval Air Station Patuxent River, Naval District Washington; Maryland Historical Trust
Mattapany Manor		Planter	18th-19th	-	-	-	
NAVAIR[b]		Slave/tenant	Mid-Late 18th	1758	1768	III	
Monticello	Piedmont VA						Thomas Jefferson Foundation, Monticello
Site 7[b]		Slave	Mid 18th	1744	1761	III	
Site 7 Overseer[b]		Overseer	Late 18th	1774	1783	IV	
Dry Well[b]		Planter	Late 18th	1769	1778	III	
Site 8[b]		Slave	Late 18th	1793	1790	IV	
Poplar Forest	Piedmont VA						Thomas Jefferson's Poplar Forest
North Hill[b]		Slave	Late 18th	1791	1794	IV	
Quarter[b]		Slave	Late 18th-Early 19th	1795	1796	IV	
Wing of Offices		Planter	Late 18th-Early 19th	1859	1843	IV	

[a]Best linear unbiased estimator MCD (Galle 2010)
[b]Artifact and excavation data available through DAACS (www.daacs.org)

Table 3. Summary of Predicted Assignments by Domestic Assemblage

	Phase	# of Samples	Predicted Production Zone												
			Buckley	Liverpool	Stafford-shire	London Area	Surrey-Hampshire Border	Phila-delphia	Chesapeake Tidewater	Alexandria	N. VA Piedmont	Shenan-doah Valley	S. Ridge & Valley	New Zone	Unassigned
King's Reach															
King's Reach	I	12	2	2	1	2	1	1	1	1					1
King's Reach Quarter	I	8		1	1		2		2	1				1	
Fairfield															
Fairfield Midden	II	13				2	1	1	6	1				2	
Fairfield Quarter	II	10	1		1	1	1	2	1	2					1
Mount Vernon															
South Grove Midden	II	8	2	2		2				2					
House for Families	II	6		2		2		1		1					
Ashcomb's Quarter	II	12		1		1		5	2	1	1				1
Utopia															
Utopia III	I	11	1			1	2			1	1	5			
Utopia IV	II	8	1		1			3	2		1				
Chapline Place	III	10	1				1	2	2	2	1				1
Mattapany-Sewall															
Mattapany Manor	-	4							4						
NAVAIR	III	11			2			4	3					1	1
Monticello															
Site 7	III	13						1	1					11	
Site 7 Overseer	IV	9						1						7	1
Dry Well	III	9		1					1			1		5	1
Site 8	IV	15		2				3	1		1			8	
Poplar Forest															
North Hill	IV	8		1				1			1	2	2	1	
Quarter	IV	10			3				4		1			2	
Wing of Offices	IV	7							1			2	2	2	
	Total	184	8	12	9	11	8	25	31	12	7	10	4	40	7

Table 4. Summary of Predicted Earthenware Source Continent by Site Occupation Phase

	Europe		North America		Unassigned		No. of Samples
	Count	%	Count	%	Count	%	
Phase I (Pre-1730)	16	*51.6*	14	*45.2*	1	*3.2*	31
Phase II (1730-1760)	21	*36.8*	34	*59.6*	2	*3.5*	57
Phase III (1761-1780)	5	*11.6*	35	*81.4*	3	*7.0*	43
Phase IV (Post-1780)	6	*12.2*	42	*85.7*	1	*2.0*	49
TOTAL	48	*26.1*	129	*70.1*	7	*3.8*	184