PUT WHAT(?) IN YOUR PIPE AND SMOKE IT: A METHODICAL APPROACH TO THE SMOKING CULTURE OF A NINETEENTH CENTURY PLANTATION IN THE SOUTHEASTERN UNITED STATES

by

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ABSTRACT

REBECCA LEIGH BUBP. Put What(?) in your pipe and smoke it.: A Methodical approach to the smoking culture of a nineteenth century plantation in the southeastern United States. (Under the direction of DR. DENNIS OGBURN)

Holly Bend, a prolific and successful late 18th and early 19th century plantation owned by the Davidson family in Mecklenburg County, North Carolina has seen multiple excavations and research projects over the past several years. In this project, I analyze a collection of ceramic tobacco pipe fragments that have been excavated from the site to better understand the local smoking culture. Several methods are used, including X-ray fluorescence spectrometer analysis to examine the sources of the ceramics, residue analysis to identify plant material smoked in the pipes, and a pipe typology to aid in identification. The residue analysis is a new source of information for historical archaeology in the South and gives insights into smoking culture and plantation life in North Carolina.

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LIST OF ABBREVIATIONS

CAIS	Center for Applied Isotope Studies
CAS	Chemical Abstract Service
CMHLC	Charlotte-Mecklenburg Historic Landmark Commission
GC-MS	gas chromatography mass spectrometry
IUPAC	International Union of Pure and Applied Chemistry
MW	molecular weight
pXRF	portable x-ray fluorescence
ppm	parts per million
THC	tetrahydrocannabinol
UGA	University of Georgia
UNCC	University of North Carolina at Charlotte
USGS	United States Geological Survey
XRF	x-ray fluorescence

CHAPTER 1: INTRODUCTION

"By all accounts. North Carolinians enjoyed their tobacco no less than their whiskey, and so the production of molded clay pipe heads remained an important sideline for the potters for some two centuries." (Zug 1986:338)

Holly Bend is located in Huntersville, North Carolina. The plantation property originally spanned over 2,803 acres along the Catawba River, a major watershed passing through central North Carolina (Dixon, 1956). The Catawba River and surrounding areas were significant battle landscapes in the Revolutionary War. The name Holly Bend was given to the property as it protrudes out in the Catawba River creating a large bend in the river. There is also an abundance of holly growing naturally in this particular region. It was a large plantation in the early nineteenth century and was owned by Robert (Robin) Davidson. The initial acreage was gifted to Robin from his father, Major John Davidson, as it was an area neighboring his own plantation, Rural Hill (Dixon, 1956). Robin was one of the larger corn and wheat planters in Mecklenburg County. Robin Davidson was also the largest slave holder in the area, with 109 slaves (49 males and 60 females) in 1850 (Dixon, 1956; Schmidt, n.d.). The *1850 Census of Mecklenburg County, NC (including Mortality and Slave Schedules)* lists a total of 5,419 slaves in Mecklenburg County, along with the identification of race such as white, black, and mulatto (Schmidt, n.d.). At Holly Bend, an overseer is listed as a resident along with Robin and Peggy; a 21-year-old, Caucasian male named Sydney Lucky (Schmidt, n.d.).

Robin Davidson built the main house at Holly Bend between 1801 and 1803. Davidson and his wife, Peggy, occupied the house until their deaths in 1853 and 1864 respectively (Dixon, 1956). Holly Bend was inherited by a nephew who sold off tracts of the land, including the house. In 1871, after changing ownership one more time, the house was sold to John Parks (Dixon, 1956). The house and surrounding portion of the property stayed in the Parks family until 1930, after which it was owned by various entities (Dixon, 1956). According to the Charlotte Historic Landmarks Commission, in 1970 Holly Bend was sold to the Eakes family, who would later rent the home and property to tenants (2018).

Currently the property is owned by the Charlotte-Mecklenburg Park and Recreation Department. The land was gifted to the county by the Eakes in 2007. The original plantation house of Holly Bend still stands and is in good condition. The house has a Federal style façade with intricate detail and wood work adorning the interior. Due to the history and uniqueness of the house, Holly Bend was designated a historical landmark in 1972.

In agreement with the Charlotte-Mecklenburg Park and Recreation Department, the University of North Carolina at Charlotte (UNCC) began archaeological surveys with Alan May of UNCC and the Schiele Museum in Gastonia, North Carolina. In 2011, excavations began through the Archaeological Field Project course, a five-week intensive program for undergraduate and graduate students at UNCC. I originally took the course during my undergraduate career in 2013. In 2015, I was hired through the Schiele Museum as an assistant to May. I worked with May and the students during the project and continued working with May at the Schiele Museum processing, analyzing, and entering records in the artifact database for Holly Bend. As a graduate student in 2016, I was hired through UNCC to work as a Research/Teacher's Assistant to May once again for the field project at Holly Bend. Over the five years of excavations at Holly Bend, over one thousand artifacts have been collected.

Among the collection of artifacts were glass fragments, pottery sherds, cut nails, hand forged iron farm tools, animal bone, and much more. Ceramic tobacco pipe fragments have also been excavated, though they are few in comparison to other ceramics and materials. In 2016, significantly more tobacco pipe fragments were discovered in the field school, including one mostly intact ceramic tobacco pipe and large fragments from two additional pipes.

Objectives of Study

I examine the recovered ceramic tobacco pipe fragments from Holly Bend to contribute to the understanding of the smoking culture at a prolific and successful nineteenth century plantation in the southeastern United States. In this process, X-ray fluorescence spectrometer analysis was performed to investigate the kilns in the region that were likely sources of the pipes. The pipe fragments were outsourced to a chemistry lab for residue analysis, providing content analysis. After researching previous studies of pipe smoking from the seventeenth to early nineteenth centuries such as Fox (2015) and Thackeray, N. Van der Merwe, and T. Van der Merwe (2001), a list of potential plant and material species were submitted to the chemistry lab for identification purposes. With this information, I gained knowledge about plant materials smoked in the pipes. Local resources available in the early nineteenth century were analyzed to determine if the materials smoked at Holly Bend were potentially farmed at the plantation or local to North Carolina.

In addition, I identified the typology of pipe fragments through style and form. I evaluated photographs and a memory map in an effort to locate and identify previous structures associated with the main house. Based on the approximate locations of the pipe fragments and their association with former structures identified outside of the main house, I am able to discuss which plantation population groups were using the pipes. These may include the plantation owner's family or guests, or enslaved or free workers.

Four Research Questions

The four main research questions are: (1) Who are the different people who may have used or owned these pipes? (2) What information do the different type of pipes provide? (3) What can be understood about the smoking culture based on the contents of the pipes? (4) What is the source of the pipes, are they locally made? As a whole, this study will contribute the archaeological knowledge of the smoking culture associated with a nineteenth century plantation in the southeastern United States, specifically in the piedmont region of North Carolina.

CHAPTER 2: PLANTATION LIFE

Planters and Enslaved African Americans

In the late seventeenth century, the slave population began to increase in the southeastern United States resulting in a major change of cohabitation between the planters, servants, and slaves (Deetz, 1977). Along with servants, slaves were moved out of the main house and into separate quarters (Deetz, 1977). By the time Robert Davidson built Holly Bend around 1801, this living dynamic was already well established. Deetz theorizes that this general pattern was the result of disintegrating of social relationships between servants and masters (Deetz, 1977). During this era, beginning at the turn of the eighteenth century, the color of one's skin, or race, had become the determining factor of who would be enslaved or not (Deetz, 1977).

Another element of large plantations that changed in the early eighteenth century was the confinement of different cooking tasks to separate buildings, located away from the main house (Vlach, 1993, p. 43). This move was due to a number of practical reasons including the risk of fire, odors, noise, heat, and the overall commotion involved in the preparation of food and meals (Vlach, 1993). However, Vlach suggests that the more important reason behind this move was the plantation owner's establishment of a clear separation between the people that were served and those who served (Vlach, 1993, p. 43). Black and white living in the same house was progressively replaced by stringent racial segregation asserted by physical separation (Vlach, 1993).

> "…the detached kitchen was an important emblem of hardening social boundaries and the evolving society created by slaveholders that increasingly demanded clearer definition of status, position, and authority…the onset of a more rigid

> form of chattel slavery that would persist until the middle of the nineteenth century" (Vlach, 1993, p. 43).

However, even though the kitchen was moved out of the main house, or as Vlach calls it the "Big House," often times the kitchen (including the associated smoke house) would be located in close proximity to the main house, so that everything would be placed "under the master's eye" (Vlach, 1993, p. 44). This model of planation architecture applies to the Holly Bend planation due to the close proximity of both the kitchen and the smoke house to the main house. The plantation architecture and landscape, in addition to the relationship between the plantation owner and slaves are important to this study and will be revisited.

Smoking Culture

Tobacco

Historical records document tobacco consumption by Native Americans in the late sixteenth century at the English settlement on Roanoke Island (Beaman, 2005). All forms are noted such as cigarettes (a corn husk or cane tube), cigars, snuff, and pipes (Beaman, 2005). Tobacco was exported from the New World to areas of Europe including England (Beaman, 2005). During the colonial period, North Carolina regions such as the Roanoke River Valley, Albemarle Sound, and various northern counties bordering Virginia grew tobacco as the state's main export (Lefler & Powell, 1973). Lefler and Powell note that by 1772, almost two million pounds of tobacco was being exported from North Carolina in addition to quantities for domestic use (1973).

Clay Pipes

Though all social classes smoked, Rafferty and Mann (2004) discuss how historically, smoking pipes are closely associated with working-class populations and smoking was often part of a social gathering. Cigars and cigarettes were smoking habits associated with higher class groups. In addition, smoking was an expression of identity and group affiliations during the eighteenth and nineteenth centuries (Rafferty & Mann, p. xiv, 2004). In the past, researchers made general assumptions about the use of "tobacco pipes" in that they were used only for smoking nicotine products, however in a historical context "Indian tobacco" or "wild tobacco" was also a reference to *Cannabis* (Thackeray, N. Van der Merwe, & T. Van der Merwe, 2001). Thackeray et al. (2001) led a pilot study to re-examine and interpret texts which included Shakespeare's reference to substances and which substances other than nicotine (tobacco) are identifiable from smoking pipe residues of seventeenth century ceramic smoking pipe fragments recovered from his residence in England.

As slave populations increased across the southeastern United States, so did a distinct style of ceramics, commonly known in contemporary times as colonoware. These unique ceramics were produced by slaves for their personal use and the stylization has been traced back to their traditional West African heritage (Fairbanks, 1984; Howson, 1990). The ceramics included plates, bowls, and other housewares including tobacco smoking pipes. While very few colonoware ceramic sherds have been identified at Holly Bend, none of them are identifiable as smoking pipe fragments. However, this is to be expected based on the history of both Holly Bend and colonoware production. Holly Bend is an early nineteenth plantation and by this era, most colonoware production had ceased across southern plantations as slaves and workers had increased access to trading and purchasing goods (Fairbanks, 1984). In addition, Robin Davidson, as previously mentioned, was a wealthy planter. This is significant because as Joseph (1989) discusses, there are identifiable patterns and a direct correlation between the wealth of planter and the material culture of slaves and workers on the plantation.

Otto (1984) identifies differences in the smoking culture, or smoking habits, between the planter and slaves based on patterns in material culture on the plantation. Planters smoked cigars and/or used decorative, English style pipes. Slaves were either given, bought, or traded livestock or garden vegetables for clay pipes (Otto, 1984). Overseers also smoked cigars, as they attempted to align their perceived power with that of the planter (Otto, 1984).

Smoking and Social Relations

As Orser (1998) notes in the past, plantation research has focused on the planters, farms, and production. In recent decades, focus has turned to the enslaved population, to understand and give enslaved African Americans a history, which has gone undocumented in the light of dominant cultures. Orser (1998) also discusses the importance of archaeological excavation and the clues it can provide about the culture regarding of participants of the African diaspora. Charles Fairbanks (1984) also discusses the plantation archaeology of southeastern U.S., specifically slave sites, and the presentation of both problems and opportunities which can be uncovered through interpretation of material culture related to food remains, tools, and living spaces. Such cultural materials and objects are in short supply and non-material data is required to complete the broader picture (Fairbanks, 1984, p. 1).

Howson notes that the research of Handler and Lange (1978) suggests that reward/incentive systems were used on plantations, and that archaeological material recovered from excavation indicates that pipes and tobacco were used as rewards to slaves (1990). Owners used this system to instill obedience and to establish a hierarchy among slaves. However, the "rewards" of tobacco and pipes meant something else to the slaves; it shaped a resistance and fabricated the cultural and social uniqueness of slaves, opposite of what planters pictured (Howson, 1990). Howson suggests that the contextual use of clay tobacco pipes on slave plantations could provide greater insight and valuable information for the study of slave life (Howson, 1990, p. 84).

Based on research by Handler and Lange (1978) and Otto (1984), smoking was an important recreational practice among slaves, and its use represented leisure time and was considered a social activity (Howson, 1990). For slaves, smoking was not only a leisure activity but had a deeper meaning: it was something done on their time, not their master's time (Howson, 1990). While slave owners used pipes and tobacco for control, this mechanism furthered a cultural and social distinctiveness among slaves. The social context of smoking was also the private and internal lifestyle within the slaves' quarters.

The importance of smoking and clay pipes can also be observed through Handler and Lange's burial excavations, which contained clay pipes, symbolizing values among slaves (1978). No slave burial sites have been discovered at Holly Bend but this aspect is brought forward to argue or add to the importance of smoking and pipes in the social context of the enslaved African Americans. This archaeological interpretation of social meaning continues to be debated (Howson, 1990).

CHAPTER 3: MATERIALS AND METHODS

In investigating the different people who may have used or owned the pipes, the research discussed in the above section indicates they were used by slaves. The differences in the smoking habits of planters and overseers make it unlikely that the pipes were used by them. In researching the provenience of the pipes and using methods such as the analysis of documented photographs and Arc Map software additional information is provided about which particular people used and discarded the pipes. A memory map is also used to identify locations of past structures and buildings at Holly Bend.

It is important to identify what potential information the different types of pipes provide. Pipes can be produced from molds or by hand using a variety of clays. By identifying the types of pipes in the assemblage of fragments from Holly Bend, it can be determined if the pipes were produced in England or were perhaps a fancy replication that would be more expensive and difficult to acquire based on economic conditions pertaining to the people who obtained them. Local pipes however, would be easier to acquire and less costly. In addition to identifying the types of pipes that the fragments match, XRF analysis can aid in identifying whether the clay is potentially local or not.

To understand the smoking culture based on the contents of the pipes, it is important to understand what plant materials were being smoked at the time as well as why they might have been consumed. This is done by identifying various plant materials in the historical record that may have been smoked and using residue analysis to detect any of these plants from the pipe scrapings. Historically, tobacco was the main plant used for smoking however it is noted that tobacco was mixed with other plants for different tastes or experiences. For example, adding mint to tobacco adds a variety of flavor whereas adding kinnikinnick or mugwort may produce a different experience when inhaled. Identifying plant materials used in addition to tobacco may provide evidence of variation in availability, preference based on cost or possibly cultural traditions.

Identification of the source of the pipes, i.e., the area where they were produced, provides insight to potential local kilns and economic considerations such as trade and cost. XRF analysis and pipe identification are two methods used to provide such information. Researching local pottery kilns and their trade also aids in identifying local pipes. Local pipes were easier to purchase as well as being cheaper than pipes produced farther away. Imported pipes as well as domestic pipes made in other regions are more expensive and exclusive.

Methods used in this study to provide insight into the questions raised above include photograph analysis and the use of a memory map of the plantation house and surrounding structures and building. Pipe identification and sourcing through XRF analysis are also utilized to investigate the pipe fragments. The remaining contents and scrapings from the pipes are examined through residue analysis to identify plant materials consumed via smoking on the plantation.

Photograph Analysis

The evaluation of photographs, specifically the comparison of historic photographs and the surrounding landscape to identify the location of structures was utilized to determine excavation sites for the 2016 UNCC Archaeology Field School. Several photographs of the main house at Holly Bend have been captured over the years. The following were examined: Figure 1 is a photograph taken as part of a collection commissioned by the Carnegie Architecture Survey in the South, in 1938 by Frances

Benjamin Johnston (1938). To the left of the house there is a partial view of a structure. Figure 2 is a photograph from the Charlotte-Mecklenburg Historic Landmarks Commission, date unknown. Again, to the left of the house there is a very partial view of a structure. Figure 3 is a photograph that I took in 2016 for scale. There is no existing structure visible to the left of the house.

The photographs provide evidence of the original, separate kitchen near the back of the main house, which, as previously referenced was the common plantation layout in the late 18th and early 19th centuries. The two early photographs definitively show a structure to the left and back of the house. As mentioned previously, a separate kitchen would have been run by servants or slaves. The overseer and planter would not regularly be present in this area, and rarely if so. This is important to this study as the majority of the pipe fragments were excavated from this area. The location of the pipes reflects who used and disposed of them.

Figure 1. Photograph of Holly Bend, main house, F.B. Johnston, taken in 1938.

Figure 2. Photograph of Holly Bend, main house, photographer unknown.

Figure 3. Photograph of Holly Bend, main house, taken by author in 2016.

Memory Map

In addition to previous excavations and photographic documentation analysis, a memory map (Figure 4) was examined in determining the 2016 excavate sites. The map was created by Mary Alice Parks in 2009 in an effort to document the layout of Holly Bend in the early twentieth century. The Parks family purchased Holly Bend in the 1920s and occupied the property through 1930. While the map is not to scale, it provides a significant representation of the gross proximities of multiple structures in relation to the main house. This memory map helps us identify the small adjacent structure shown in the older photographs as likely the original separate kitchen.

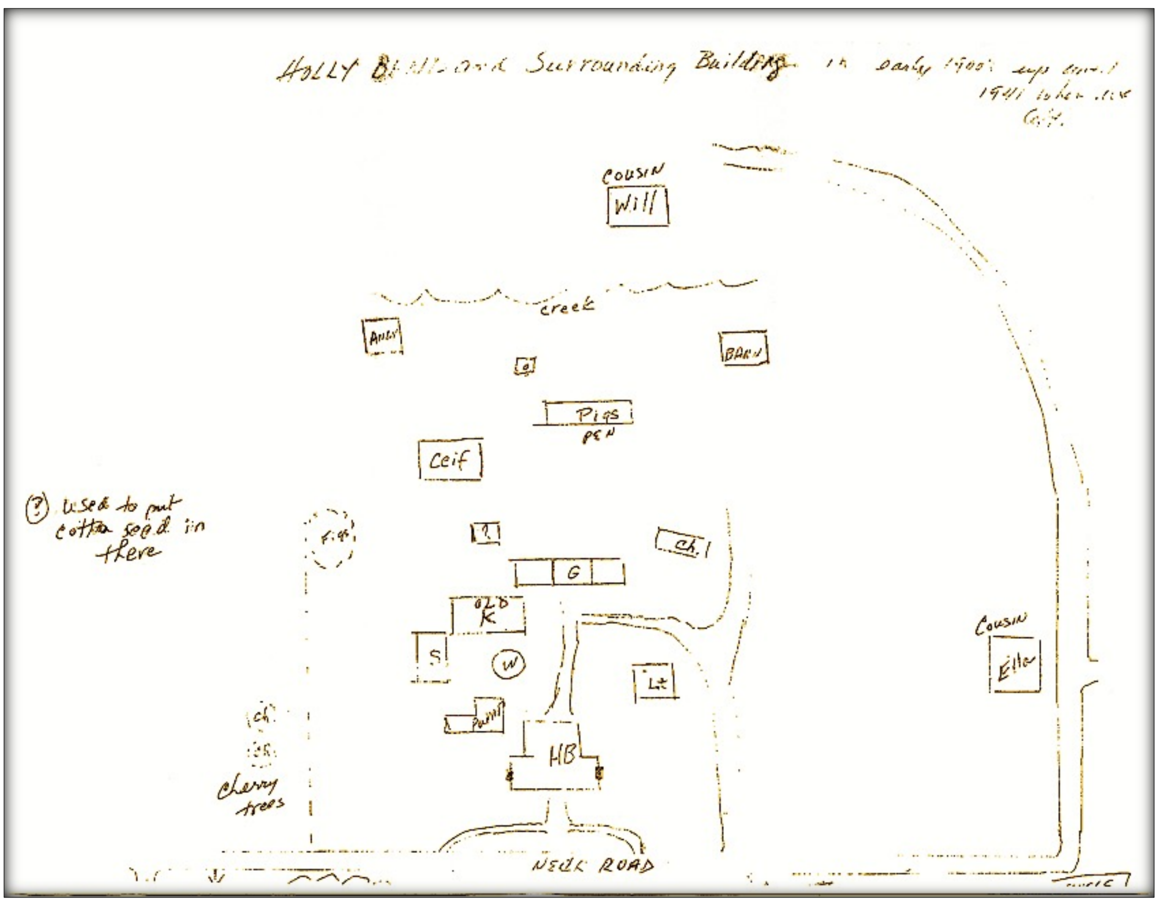


Figure 4. Mary Alice Parks Memory Map

ArcGIS

ArcGIS was used to map artifact distributions at Holly Bend. The cluster shown to the left and rear of the house marks the area where photographs and the memory map suggest the kitchen was located. Additional excavations in this area in 2016 added to the artifacts found in this area, and yielded important pipe fragments.

Mapping artifact location was valuable to this study in plotting the 2016 excavation sites. In addition, the resulting map provides the density of artifacts in geographic areas for assessment in a "layered" model. In designing the map shown below (Figure 5) an additional layer was necessary to transfer to the Universal Transverse Mercator (UTM) grid system used by the UNCC fieldschool project to corresponding latitudinal and longitudinal coordinates of the area. In addition to excavation sites, previous and future metal detection surveys and shovel tests that yield artifacts can be included in the distribution. Mapping unit information in ArcMap organizes the elements of the Holly Bend database into a useable platform. This allows an analysis that includes determining the distribution and density of artifacts present in the database, including the 2011 through 2014 total artifact distribution.

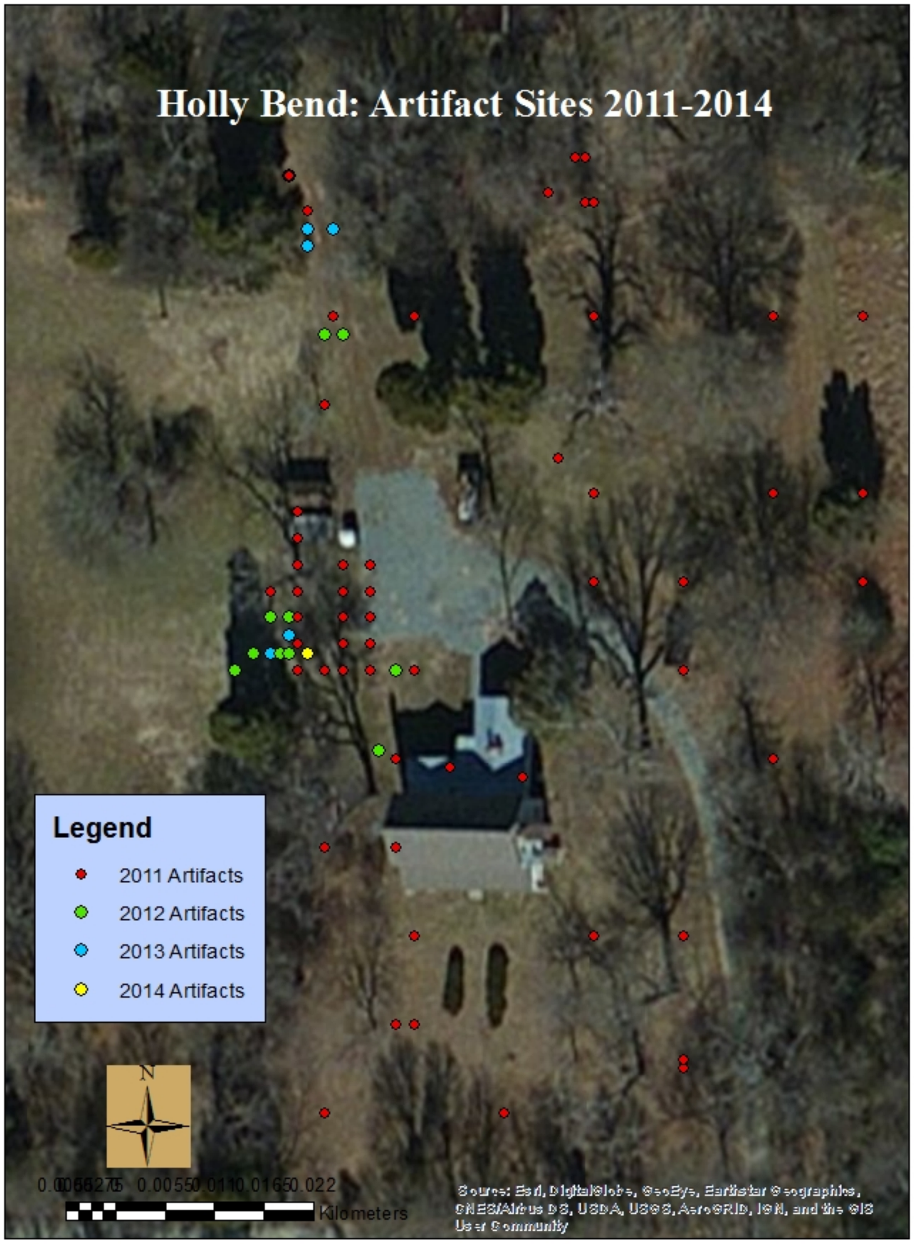


Figure 5. Map of artifacts 2011-2014 (Bubp, 2016).

Samples

The UNCC Archaeology Field School project excavated in several site areas at Holly Bend. Excavations were conducted from 2011 to 2017 and consisted of 2 x 2 meter units with varying levels to 40 cm in depth. Several ceramic tobacco pipe fragments were found among excavated artifacts over the years during the project. The majority of the pipe fragments came from these units including two large fragments, samples 8 and 10. Of the fifteen samples, items 1, 4, 11, 13, and 15, as well as 8 and 10, were the most important for this research and are discussed in some detail below. Samples 4, 8, and 10 were not cleaned after excavation, hopefully preserving residues for analysis. These samples, along with the entire assemblage are also described in Table 1.

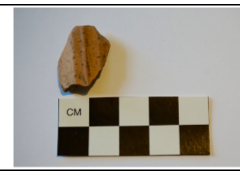
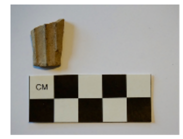
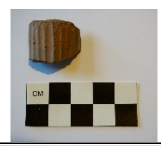
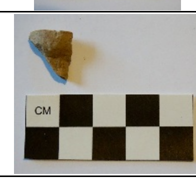
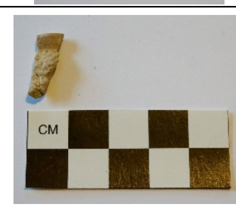
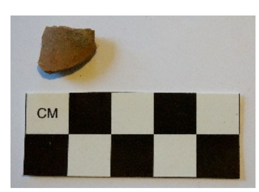
Sample 1, a coarse earthenware (previously known as a redware) ceramic fragment, made with a fluted mold, was excavated in level one of unit 522N/470E. This unit is part of the area which has been determined to be the kitchen located near the main house. The sample is a pipe bowl fragment.

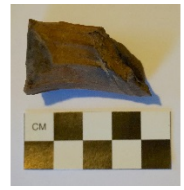
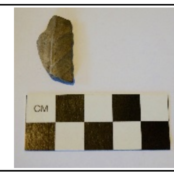
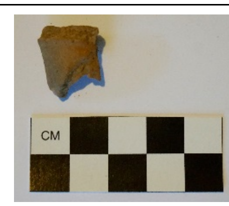
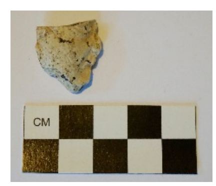
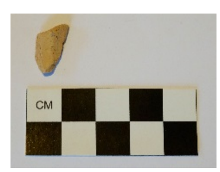
Sample 4 is an earthenware, bowl fragment excavated from unit 524N/472E, level four. After excavation, this sample was not cleaned for analysis. Sample 8 is an almost intact ceramic coarse earthenware, fluted pipe with only a small fragment of the rim absent. The sample was excavated from level three, unit 524N/472E, a unit within the boundary for the kitchen. This fragment was separated from the artifact collection and was not cleaned post-excavation. Pipe sample 10 is a large coarse earthenware, shank sherd from a fluted mold. The shank is intact with the bowl portion absent. This sample was excavated from the same unit as samples 4 and 8, 524N/472E, and was found in level four. This sample remained unwashed until after analyses were complete.

Sample 11 is comprised of two mendable bowl fragments of a coarse earthenware (redware) anthropomorphic, possibly an Indian tribute pipe. The fragment was excavated in level 2, the same unit as samples 4, 8 and 10, once again located within the kitchen boundary. Sample 13 was excavated within the kitchen boundary, from unit 526N/470E, in level 2. It was recovered from a rock feature that may have been associated with a hearth, though this is yet to determined with future research. The fragment is half of the bowl portion of a coarse earthenware, fluted pipe. Sample 15 was excavated from level 2 of unit 522N/468E, also part of the kitchen. The pipe fragment is an earthenware, bowl sherd made of kaolin, featuring an anthropomorphic design.

It is important to note that not all samples in this study were excavated near the kitchen site. Samples 3, 6, 7, and 14 were excavated at different sites, some several hundred feet from the kitchen and the main house. Interestingly, these four samples are unique in that two of them, samples 3 and 7, have an anthropomorphic design, a type of pipe that would have cost more than the plain, fluted pipes. Sample 6 has a morphology consistent with English pipes, has a small bowl, and was made from kaolin. Sample 14 is a coarse earthenware, made from a red clay type, which is plain in design with a rounded bowl. Other samples match this style, resembling the Moravian forms from the Piedmont.

Table 1. Samples

Sample #	Year excavated	Source information and description	Photograph
01	2015	Holly Bend/N522E470/Level 1	
		Body sherd-bowl	
		Coarse earthenware (Redware)	
		Fluted/Early to mid-1800s	
02	2015	Holly Bend /N520E472/Level 2	
		Rim sherd- bowl	
		Coarse earthenware	
		Fluted/ Early to mid-1800s	
03	2011	Holly Bend/N544E496/Level 2	
		Body sherd- bowl	
		Coarse earthenware	
		Anthropomorphic/ Early to mid-1800s	
04	2016	Holly Bend/N524E472/Level 4	
		Body sherd- bowl	
		Coarse earthenware (redware)	
		Unwashed/ Early to mid-1800s	
05	2015	Holly Bend/N522E470/Level 3	
		Rim sherd –bowl	
		Stoneware	
		Fluted/ Early to mid-1800s	
06	2015	Holly Bend/N501E427/Level 2	
		Body sherd- bowl	
		Stoneware	
		Kaolin/Early 1800s	
07	2015	Holly Bend /N503E427/Level 2	
		Rim sherd- bowl	
		Stoneware	
		Kaolin	
		Anthropomorphic/ Early to mid-1800s	
08	2016	Holly Bend /N524E472/Level 3	
		Pipe Fragment-Mostly intact	
		Coarse Earthenware	
		Fluted	
		Unwashed/ Early to mid-1800s	
09	2016	Holly Bend /N526E472/Level 3	
		Sherd- bowl	
		Coarse Earthenware	
		Redware	
		Unglazed/ Early to mid-1800s	

10	2016	Holly Bend /N524E472/Level 4 Body sherd- shank Earthenware Fluted Unwashed/ Early to mid-1800s	
11	2016	Holly Bend /N524E472/Level 2 Rim sherd- bowl 2 Fragments (mended) Coarse Earthenware (Redware) Early to mid-1800s Anthropomorphic-Indian Tribute	
12	2016	Holly Bend /N524E472/Level 4 Balk Sherd- bowl Coarse Earthenware Fluted/ Early to mid-1800s	
13	2016	Holly Bend /N526E470/Level 2/Rock Feature Sherd- bowl Coarse Earthenware Fluted/ Early to mid-1800s	
14	2015	Holly Bend /N503E427/Level 1 Sherd- bowl Coarse Earthenware (Redware) Unglazed/ Early to mid-1800s	
15	2014	Holly Bend /N522E468/Level 3 Sherd- bowl Stoneware Kaolin Anthropomorphic/ Early to mid-1800s	
16	2016	Holly Bend /N524E472/Level 2 Sherd- bowl Coarse Earthenware (Redware) Unglazed/ Early to mid-1800s	

Pipe Identification

The next step was to identify possible sources for these pipes. In researching the ceramic pipe fragments it is plausible that they were made locally; however, there has been limited research in determining a connection between possible area kilns and ceramics pipes in Mecklenburg county. To identify the different pipes, I researched regionally known historic ceramic pipe potters of the early to mid-nineteenth century in the western piedmont of North Carolina and compared the Holly Bend pipe fragments to other pipe and/or mold collections. Figure 6 is a map of kilns and associated clay sources in North Carolina (Zug, 1986). This research was greatly facilitated by consultation with Linda Carnes-McNaughton, and Eleanor and Hal Pugh.

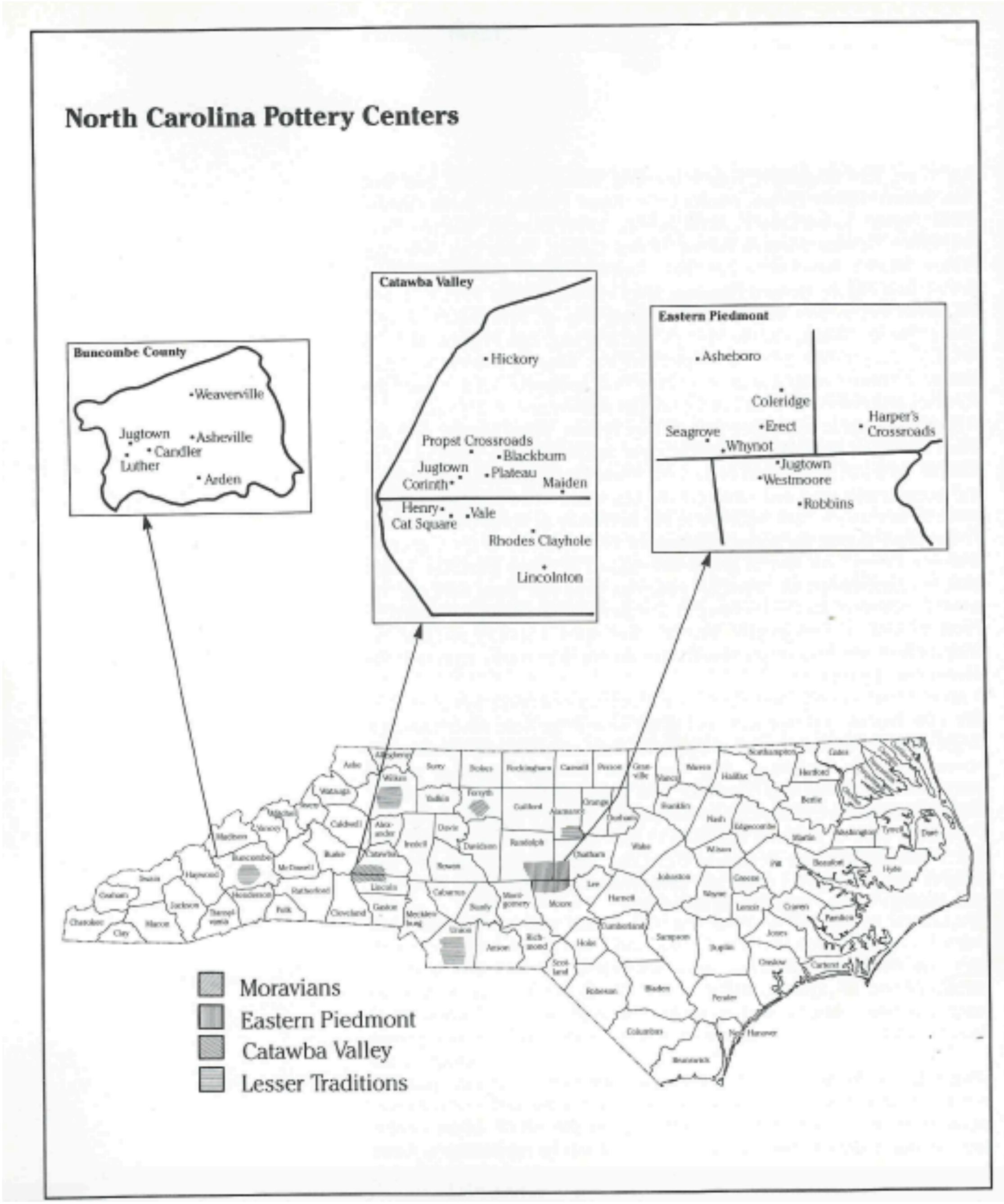


Figure 6. Historical North Carolina Potters (Zug, 1986)

Sarah "Sally" Micles is a potter that produced ceramic tobacco pipes in the region from roughly the mid 1820s to the late 1860s (Arthur, 1997). Micles acquired her clay from Silver Creek and Hunting Creek, west of Morganton, North Carolina (Arthur, 1997). She and her husband moved to Burke County, North Carolina in 1820 and produced the ceramic pipes from her home (Arthur, 1997). Micles used kaolin, a light blue-gray colored clay in her pipe production (Arthur, 1997). Micles sold the pipes along the side of a road in Morganton for thirty years, at twenty-five cents a piece including the stem (Shaffer, 1994). The pipes were sold to Union and Confederate army soldiers which created a nationwide distribution (Zug, 1986). However, it is noted that Micles' pipes were "well known in Western North Carolina long before the Civil War" (Arthur, 1997, p. 12). Today, three pipes are kept in a collection of the Historic Burke Foundation in Morganton (Arthur, 1997). There are several kaolin pipe fragments that have been excavated at Holly Bend.

Heinrich Schaffner and Daniel Krause are two prominent historic potters in the region, with a kiln located in Salem, North Carolina (Hartley, 2009). In 1834, Schaffner began to acquire his clay from Blum's meadow in Salem and was recognized early in his career as a Moravian master potter (Hartley, 2009). Currently, there are over 1,700 fragments of Moravian ceramic earthenware and kaolin tobacco pipes with a total of twenty-one mold forms identified, with examples as seen in Figure 9 (Hartley, 2009). The majority of the ceramic pipe fragments recovered from Holly Bend are earthenware and a "fluted" style (see Table 1). Two of the kaolin pipe fragments (samples 7 and 15) are also a plausible match, due to the clay composition and anthropomorphic style.

Hal and Eleanor Pugh, owners and potters of New Salem Pottery and Old Salem ceramics specialists have researched both Moravian and Quaker potters of North Carolina. Hal Pugh examined the Holly Bend pipe samples and made comparisons to the museum's collection of samples and molds for identification, as well as his historical collections for identification (See Figures 7, 8, 9, and 10).

Figure 7. Old Salem Pipes, author.

Holly Bend samples 8 and 10 are fluted earthenware pipes and are stylistically a match to the Old Salem (also referred to as Moravian) pipes and molds, as seen in Figures 7, 8, 9 and 10.

Figure 8. Old Salem Pipe Mold, author.

Figure 9. Old Salem Pipe Mold, author.

Figure 10. Moravian Salem Pottery Pipe Examples (Hartley, 2009).

Daniel Seagle

Daniel Seagle's pottery was established in Lincoln County between 1823 and 1825 (Nash, 1980). Seagle acquired his clay from Howard's Creek, part of his family's fifty-acre property (Nash, 1980). While Seagle is mainly known for his alkaline glaze jugs and wares, he also produced ceramic smoking pipes. This information was provided through personal communication with Linda Carnes-McNaughton (March, 2017) based on her fieldwork discovery of unglazed stoneware pipes found on the floor of an excavated kiln.

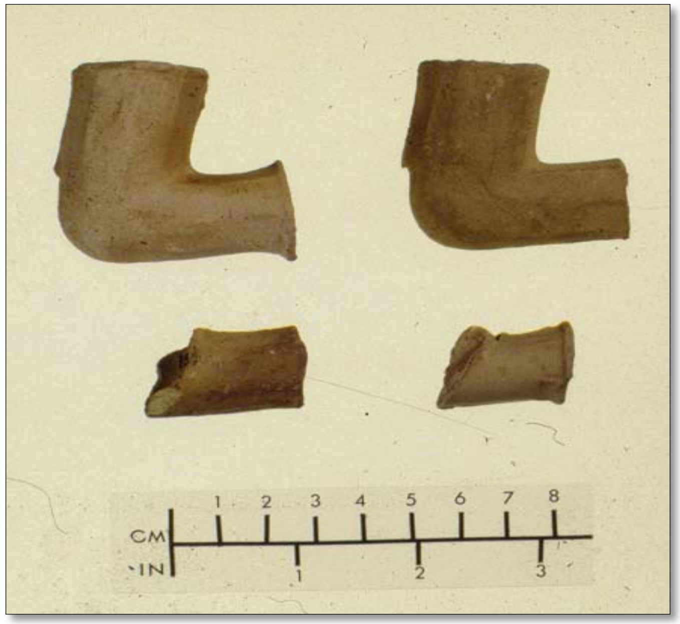


Figure 11. Daniel Seagle Pipes, (Carnes-McNaughton, 1997)

XRF and pXRF

X-ray fluorescence (XRF) analysis is a form of chemical analysis and a potentially non-destructive method utilizing high energy X-rays (Shackley, 2011). A focused beam of X-rays irradiates a sample which then causes it to fluoresce (re-emit) radiation and either the energy (EDXRF) or wavelength (WXRF) of that radiation is used to determine elemental components of the material (Shackley, 2011). This method is a mass analysis, meaning that the entirety of material submitted to the irradiation is analyzed (Shackley, 2011). In addition to being a nondestructive method, XRF requires little preparation, is simple to use, fast, and cost-effective (Shackley, 2011).

Another type of XRF analysis is the use of the portable X-ray fluorescence spectrometry (pXRF). The non-portable XRF is referred to as XRF or lab/desktop/bench XRF. From this point forward it is referred to as XRF for consistency. pXRF utilizes the same functions as the XRF (Shackley, 2011). The calibration routine of each machine differs and yields significant differences requiring specific parameters to be met when comparing samples (Shackley, 2011).

XRF and pXRF analyses are important research tools in studying archaeological ceramic samples and sediments as they are both engineered to determine the provenance of raw materials and identify activity areas (Hunt & Speakman, 2015). This is critical to the identification of sources of ceramics as many vessels including smoking pipes appear similar in their morphology and stylistic forms including decoration (Pillay, Punyadeera, Jacobson, & Erikson, 2000). While the identification of pipes based on morphology is very useful, recent methodological approaches provide supplemental information in examining the elements identified in fired clays (Pillay, et al., 2000). Sourcing is dependent upon the detailed knowledge of the geochemistry of a region in addition to geochemical analysis of artifacts (Pillay et al., 2000). Pillay et al. (2000) also discuss that combining the archaeological and analytical information provides insight on both exchange and social interactions which cannot be asceratained from visual examination of the archaeological materials. This combined analysis implies that ceramics produced in a specific area will bear a unique geochemical fingerprint (Pillay et al., 2000).

In his book, *Turners and Burners*, Charles Zug identifies the composition of clays such as earthenware clay, stoneware clay, and kaolin along with a comparison of earth clay (1986). The major elemental composition of these clay types include silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), iron (III) oxide (Fe_2O_3), magnesium oxide (MgO), calcium oxide (CaO), sodium oxide (Na_2O), potassium oxide (K_2O), titanium dioxide (TiO_2), and water (H_2O) (Zug, 1986). These major elements are expressed as oxide wt.%, with minor and trace elements expressed in parts per million (ppm). The elemental composition of clays can be seen below in Table 2.

Table 2. Composition of Clays (Zug, 1986).

The Composition of Clays				
	Earth	Earthenware Clay	Stoneware Clay	Kaolin
SiO_2	59.14	57.02	57.08	45.56
Al_2O_3	15.34	19.15	26.11	38.65
Fe_2O_3	6.88	6.7	4.64	0.41
MgO	3.49	3.08	0.16	0.08
CaO	5.08	4.26	0.2	0.05
Na_2O	3.84	2.38	1.42	0.55
K_2O	3.13	2.03	1.42	0.8
TiO_2	1.05	0.91	0	0.1
H_2O	1.15	3.45	8.52	13.9

Most of these elements can be measured with XRF, two elements, phosphorus (P) and sodium (Na) have limited detection with XRF analysis and are omitted in this study as is H_20 (Hunt & Speakman, 2015). Low/mid-Z trace elements identified in this study include chromium (Cr), zinc (Zn), rubidium (Rb), arsenic (As), strontium (Sr), manganese (Mn), yttrium (Y), zirconium (Zr), niobium (Nb), thorium (Th), and lead (Pb) (Hunt & Speakman, 2015). Below is a Periodic Table of Elements with relevant elements identified in highlighted colors according to Hunt and Speakman (2015).

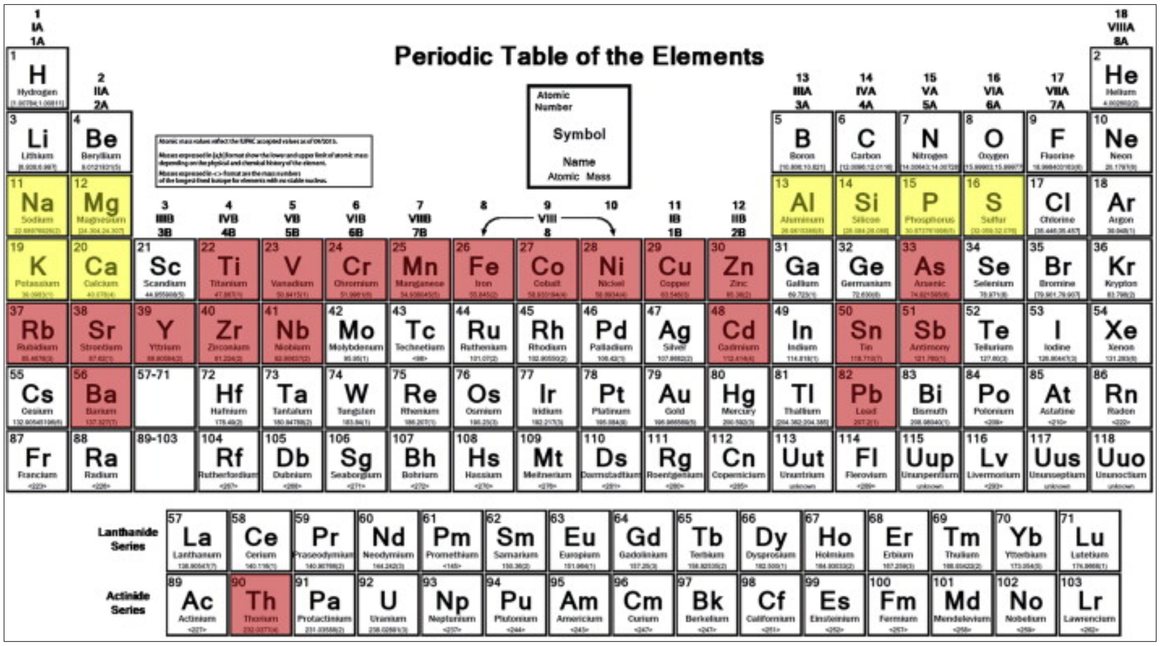


Figure 12. Elements of Significance in XRF Analysis of Ceramics (Hunt & Speakman, 2015).

For my study, I submitted a sample set of twelve ceramic tobacco pipe fragments recovered from Holly Bend, for XRF analysis at the Center for Applied Isotope Studies (CAIS) at the University of Georgia (UGA). Dr. Robert Speakman, a specialist in the field and the director of the CAIS research lab, performed the sample analyses. The XRF analysis yielded the elemental composition of each of the ceramic tobacco pipe fragments in the sample set. One sample was rejected as it was identified as bone. This data is analyzed to determine if the clay utilized in the ceramic process is locally sourced from any specific region of North Carolina.

Mineral and element soil content maps of the United States constructed by Smith et al. (2014) for United States Geological Survey (USGS) were referenced and analyzed to distinguish different possible clay source deposits. Each map shows the concentrations of individual elements in soils across the country. My analysis was done by comparing the elemental composition of the ceramic samples obtained by XRF analysis to the elemental composition of the soil in North Carolina and surrounding areas. Figure 13 shows a Periodic Table of Elements for identified elements highlighted in green in the study (Smith et al., 2014).

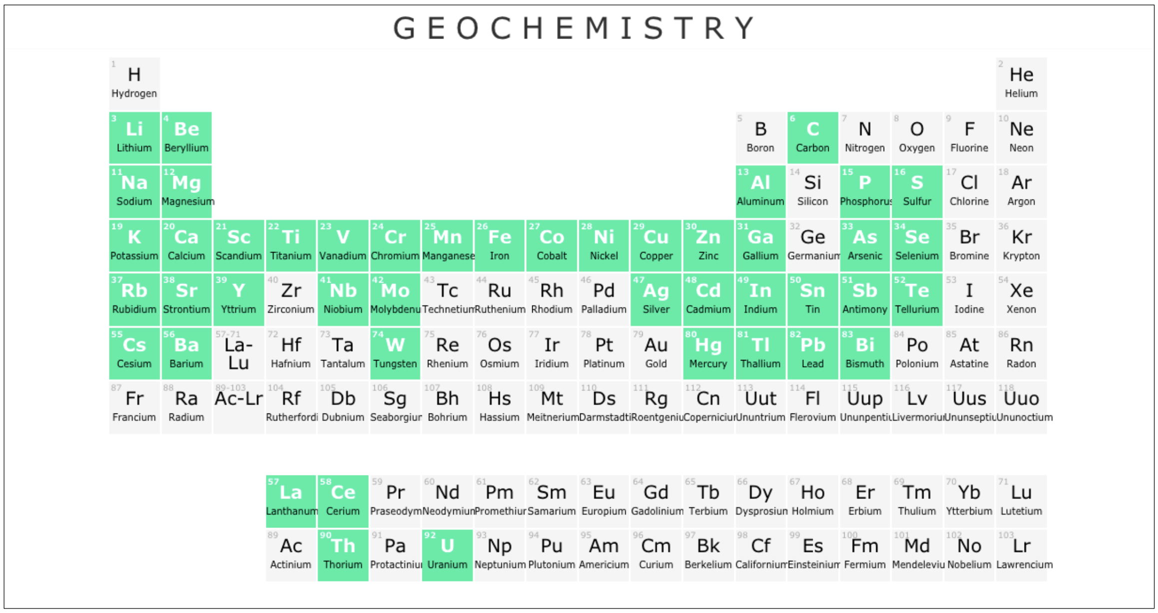


Figure 13. Periodic Table of Elements for identified elements in USGS study (Smith et al., 2014).

XRF Results

Using soil mineralogical and geochemical maps of the conterminous United States for comparative measures of XRF analysis:

In determining if the ceramic smoking pipe samples are locally sourced in North Carolina, information from the United States Geological Survey (USGS) were used. This information includes a comparison analysis of the soil geochemical and mineralogical make up of soil three soil horizons, O horizon, A horizon, and C horizon.

The USGS conducted this research as part of the North American Soil Geochemical Landscapes Project (Smith et al., 2014). The sampling protocol is comprised of a sample from the depth of 0-5 centimeters (O horizon), a topsoil sample or horizon A which consists of organic material soil and from 5 centimeters to almost a meter in depth, and finally the C horizon, or deeper soil, at depths of 1-2 meters and beyond, which is also considered parent soil (Smith et al., 2014). If the top of C horizon began at depths greater than 1 meter, the soil was then sampled from 80-100 centimeters (Smith et al., 2014). Each sample was analyzed using a <2-millimeter fraction to determine a group of 45 major and trace elements by methodology yielding the near-total or total elemental content (Smith et al., 2014). In samples from the soil A and C horizons, major mineralogical components were determined by a method of quantitative X-ray diffraction using Rietveld refinement (Smith et al., 2014). This soil survey was started in 2007 and completed in 2010 (Smith et al., 2014). The mineralogical analyses were completed in 2013 (Smith et al., 2014). Tables 3 and 4 contain the XRF results conducted at the CAIS lab at UGA.

Table 3. XRF Results, Major Elements.

Element	**MgO**	**Al2O3**	**SiO2**	**P2O5**	**K2O**	**CaO**	**TiO2**	**Fe2O3T**
Sample	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
01	1.12	18.69	51.4	0.13	0.89	1.621	1.127	9.02
02	1.14	12.78	31.8	1.06	2.70	2.624	1.337	10.16
03	0.68	20.65	27.3	0.72	2.62	2.386	0.981	7.75
04	0.94	17.02	46.3	0.18	5.14	2.140	0.717	10.94
05	1.01	17.98	52.1	0.11	1.04	2.560	1.018	9.30
06	0.74	20.81	47.3	0.17	2.43	0.325	1.311	5.55
07	0.20	17.96	35.5	0.12	1.85	0.213	1.137	5.96
08	0.47	17.24	48.5	0.15	2.92	3.505	1.143	3.91
09	1.91	17.98	50.5	0.18	6.24	1.048	0.913	11.23
10	1.11	15.30	48.0	0.18	1.24	4.100	0.969	7.75
11	0.55	15.74	45.9	0.23	2.21	3.412	0.978	6.84

Table 4. XRF Results, Low/mid Z-trace Elements.

Element	Cr	MnO	Zn	As	Pb	Th	Rb	Sr	Y	Zr	Nb
Sample	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
01	108	1395	136	31	107	9	38	162	27	236	15
02	121	2382	1097	49	132	9	148	187	49	220	18
03	90	2541	478	32	107	7	118	120	33	97	8
04	80	1040	211	41	160	15	194	139	45	134	9
05	97	1236	129	16	51	10	39	175	29	236	17
06	106	1044	182	14	80	16	162	75	59	416	30
07	75	946	214	55	221	21	230	70	67	458	33
08	101	1550	137	11	57	22	122	127	53	321	27
09	88	972	263	22	74	12	207	98	48	202	12
10	100	1290	101	45	256	7	39	195	29	234	14
11	88	1443	110	11	57	14	113	119	36	244	18

In the following section, I provide soil maps for specific elements of interest in identifying locally sourced clays for the aforementioned potters of North Carolina. The first map for each element of interest is of the contiguous U.S. The second map for each element is zoomed on North Carolina. Each North Carolina map is annotated with the locations of clay sources used three groups of potter(s), Sally Micles (SM), Daniel Seagle (DS), and Moravian Potters (MP), Heinrich Schaffner and Daniel Krause.

Magnesium (Mg)

As mentioned, magnesium is a main elemental component of clay composition. In the U.S. map of the magnesium content, the element is observed as fairly sparse on the east coast among the soil composition of the A-Horizon (Figure 14). Upon further inspection and focusing on North Carolina, magnesium is observed in high concentrations in four specific areas as indicated by the red zones on the map (Figure 15). Of the three pottery kilns identified as potential matches to the pipe fragments, one area in particular stands out with a high magnesium concentration, the Moravian Pottery clay and kiln location as seen in Figure 15. Of the 11 samples submitted for XRF analysis, 8 samples have high magnesium concentrations between 0.68% to 1.91%. Based on the USGS map of magnesium soil content, orange zones consist of 0.67-0.85%, orange-red zones measure at 0.85- 1.20%, and red zones measure at 1.2-13.3%.

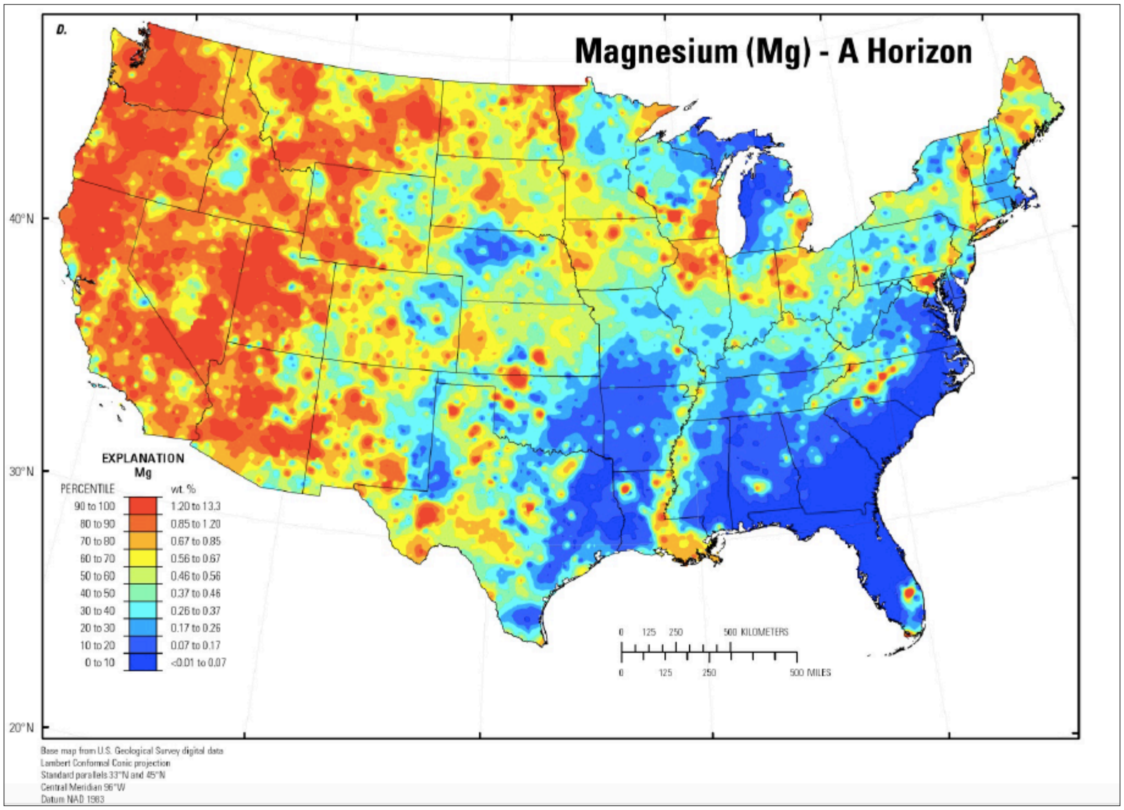


Figure 14. U.S. Map of Magnesium, A-Horizon (Smith et al., 2014)

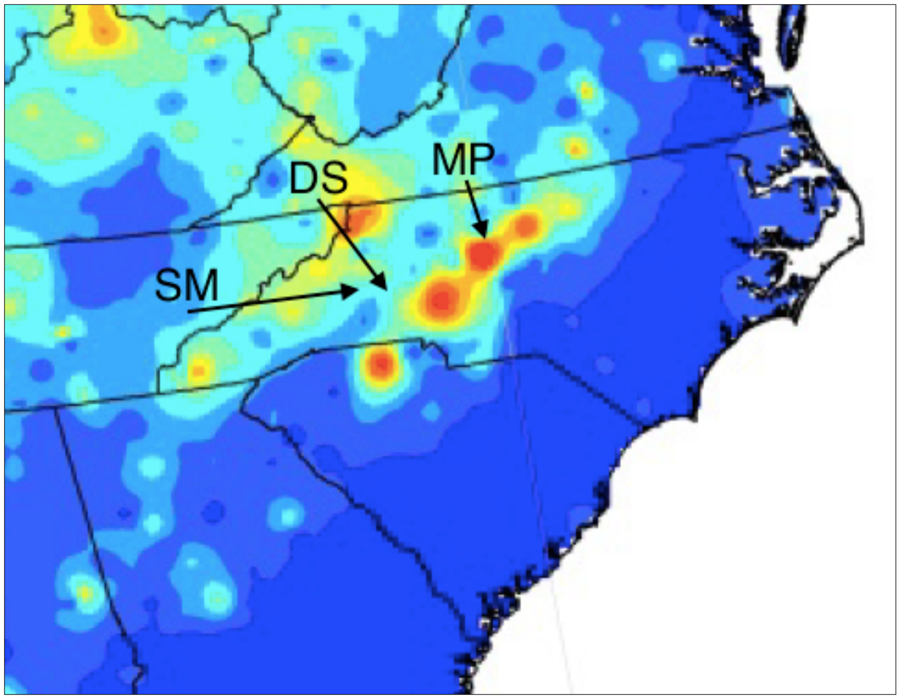


Figure 15. N.C. Map of Magnesium, A-Horizon (Smith et al., 2014)

Rubidium (Rb)

Rubidium, a mid/low Z-trace element, is found commonly in the C-Horizon of northern regions of the eastern United States as seen in Figure 16. It is also present in several areas of the southeastern states yet absent along piedmont and coastal areas. Red zones yield rubidium concentrations of 112 to 267 ppm (mg/kg). Eight of the Holly Bend samples yielded results within this zone, ranging from 113- 230 ppm. Three samples fell within a low concentration range of 51.9- 58.9 ppm marked by the light blue zones. The morphology of the pipe samples and close proximity to the area associated with the Sally Micles, this suggests a potential signature for Sally Micles' clay source. The geology of the area near the Moravian pottery site suggests that it is possible that the three samples with lower rubidium concentrations may have been sourced from that particular area.

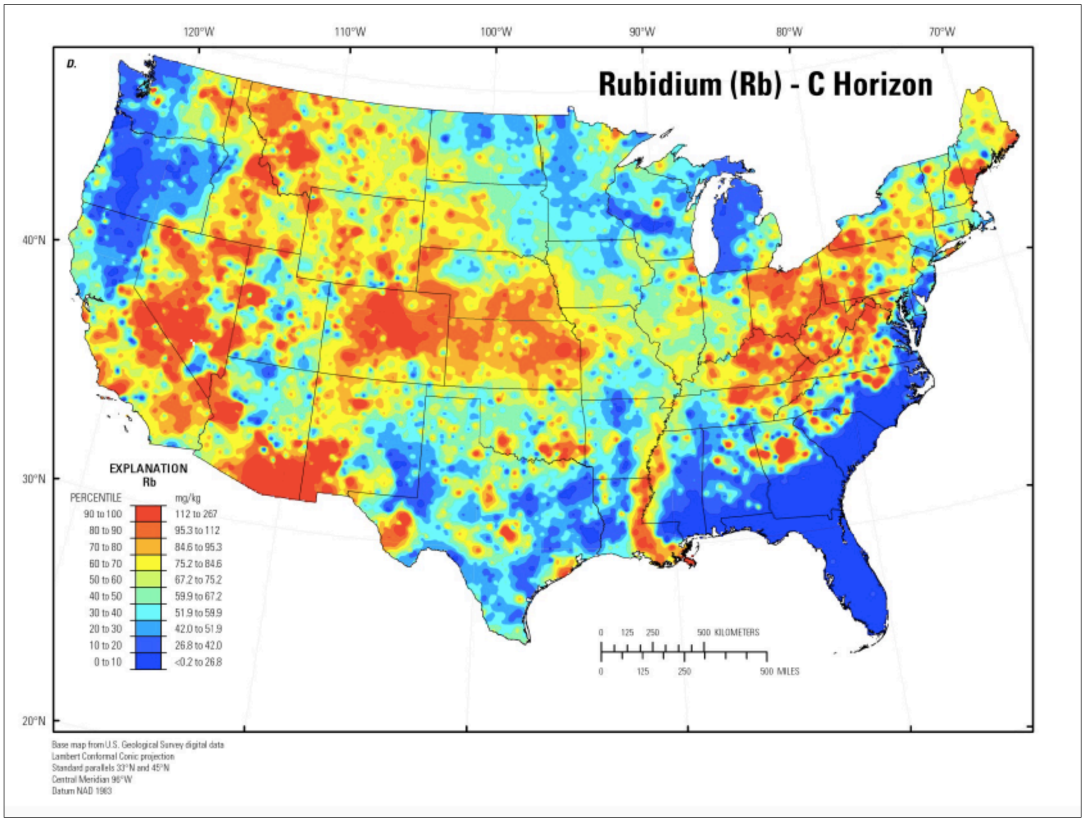


Figure 16. U.S. Map of Rubidium, C-Horizon (Smith et al., 2014)

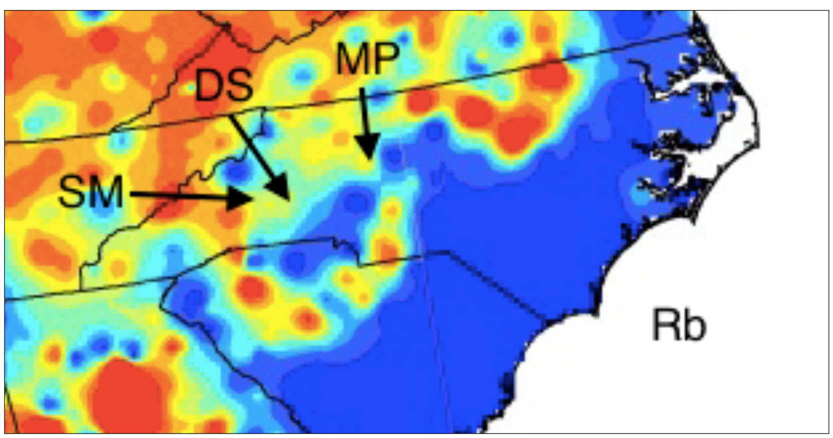


Figure 17. N.C. Map of Rubidium, C-Horizon (Smith et al., 2014)

Strontium (Sr)

Strontium is another mid/low Z-trace that is significant in analyzing the soil composition maps. This element is found in low concentrations in the A-Horizon soil of the eastern U.S. as seen in Figure 18 with a few exceptions such as southern Florida. There is also a high concentration found in North Carolina (Figure 19). In examining the North Carolina map, a high concentration zone is identified at the Moravian Potter clay and kiln area. The concentration zones are measured as follows: red zone-between 330-2810 ppm; red/orange zone- 233-330 ppm; orange/yellow zone - 182-233 ppm; yellow zone - 150-182 ppm; green/blue zone – 96.9-122 ppm; light blue zone – 75.2 – 96.9 ppm. Nine of the samples (sample #1-5, 8-11) fall between the ranges of 98 – 195 ppm, having a higher than normal (for the region) strontium concentration. This particular geochemical analysis provides significant information of the sourcing as strontium is scarce in the region as seen in Figure 19.

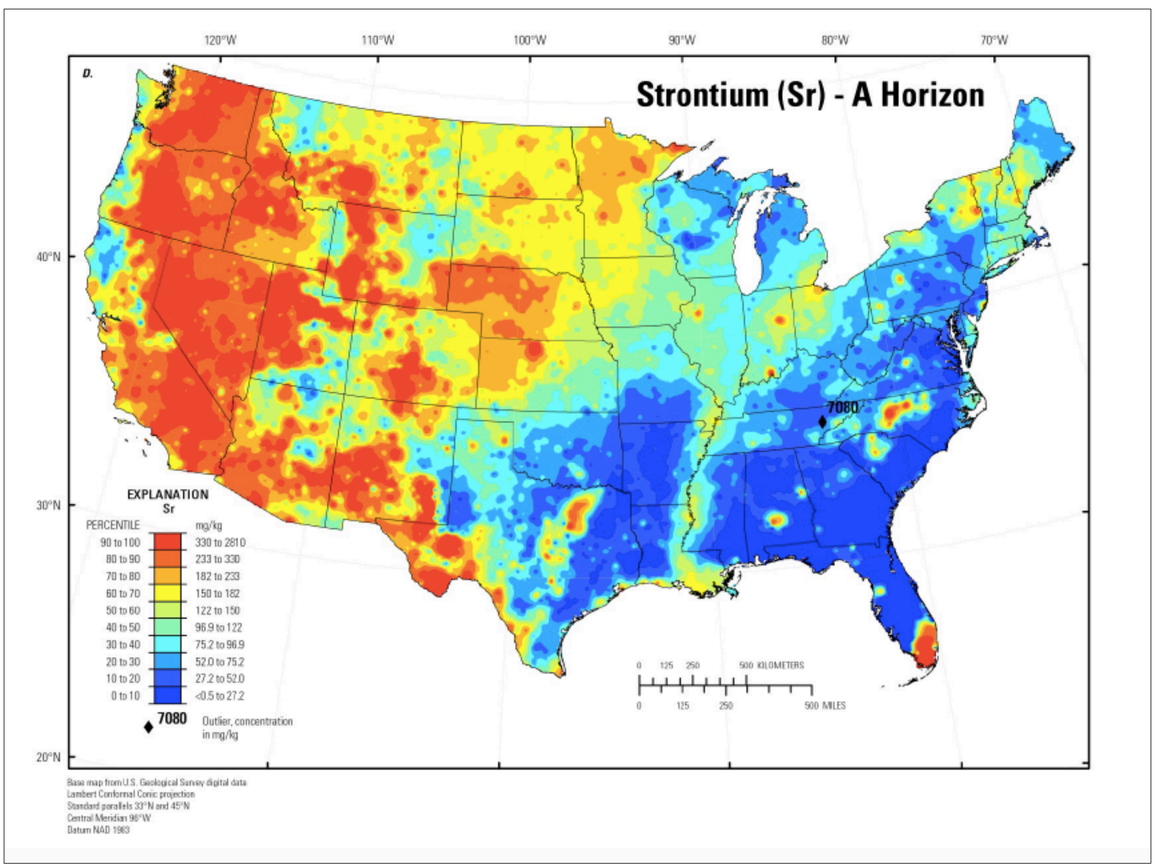


Figure 18. U.S. Map of Strontium, A-Horizon (Smith et al., 2014)

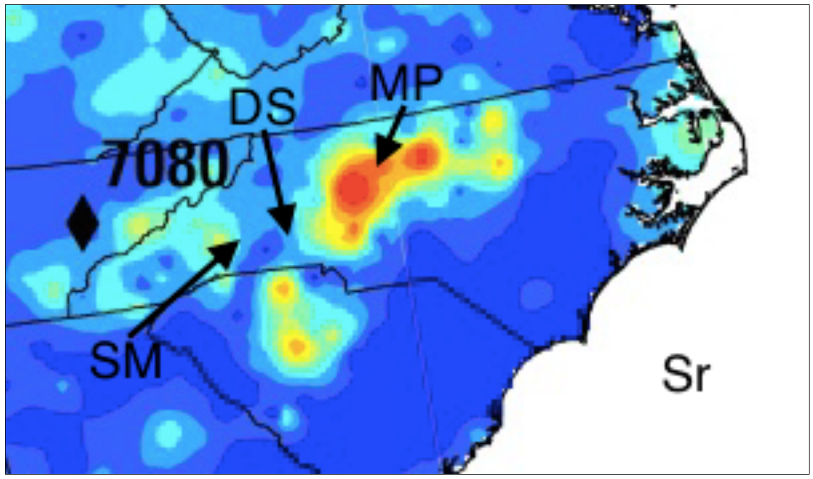


Figure 19. NC. Map of Strontium, A-Horizon (Smith et al., 2014)

Yttrium (Y)

Yttrium is a mid/low Z-trace element identified in the C-Horizon soils throughout the U.S. (Figure 20). Upon closer examination, it is found in a high concentration band ranging from Maryland to Tennessee, western North Carolina, and a few areas located in the piedmont region as seen in Figure 21. All eleven samples yielded results between 27 – 59 ppm which are high concentrations marked by red zones (25- 288 ppm) on the map. Potential clay sources are the Moravian potters and Sally Micles.

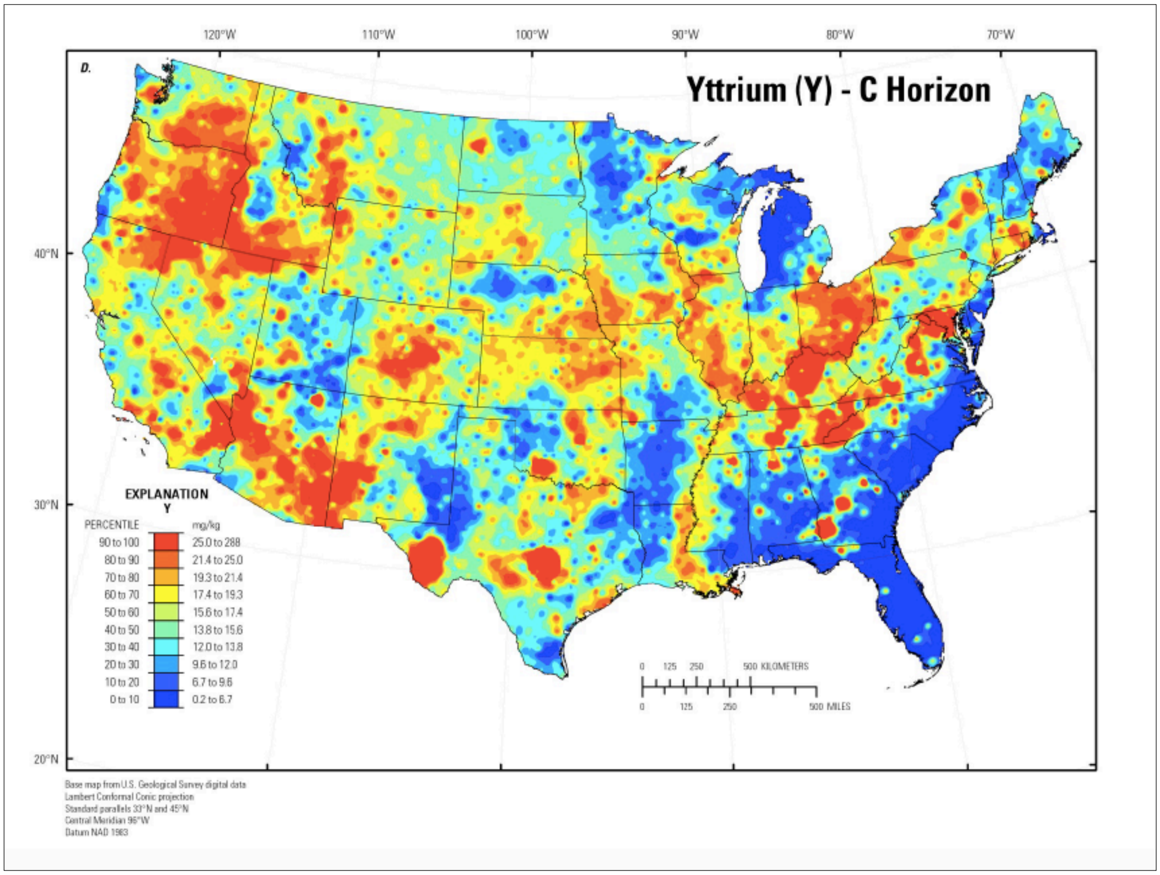


Figure 20. U.S. Map of Yttrium, C-Horizon (Smith et al., 2014)

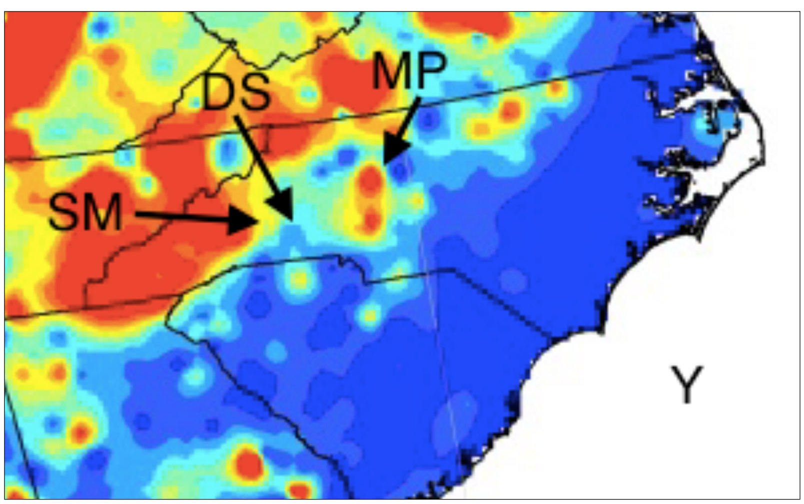


Figure 21. N.C. Map of Yttrium, C-Horizon (Smith et al., 2014)

Niobium (Nb)

Another mid/low Z-trace element that yielded significant results in this study is niobium. As seen in Figure 22, niobium is present throughout the U.S. in the A-Horizon soils. It is found in high concentrations in the western region of North Carolina and a few areas of the piedmont (Figure 23). XRF analysis revealed moderate to high niobium concentrations among the Holly Bend samples, ranging from 8- 33 ppm. Eight of these samples fall in the red zone area concentrations of 14.40 – 96.8 ppm. Areas of pipe production that correlate with the geochemical analysis are the Daniel Seagle and Sally Micles clay sources.

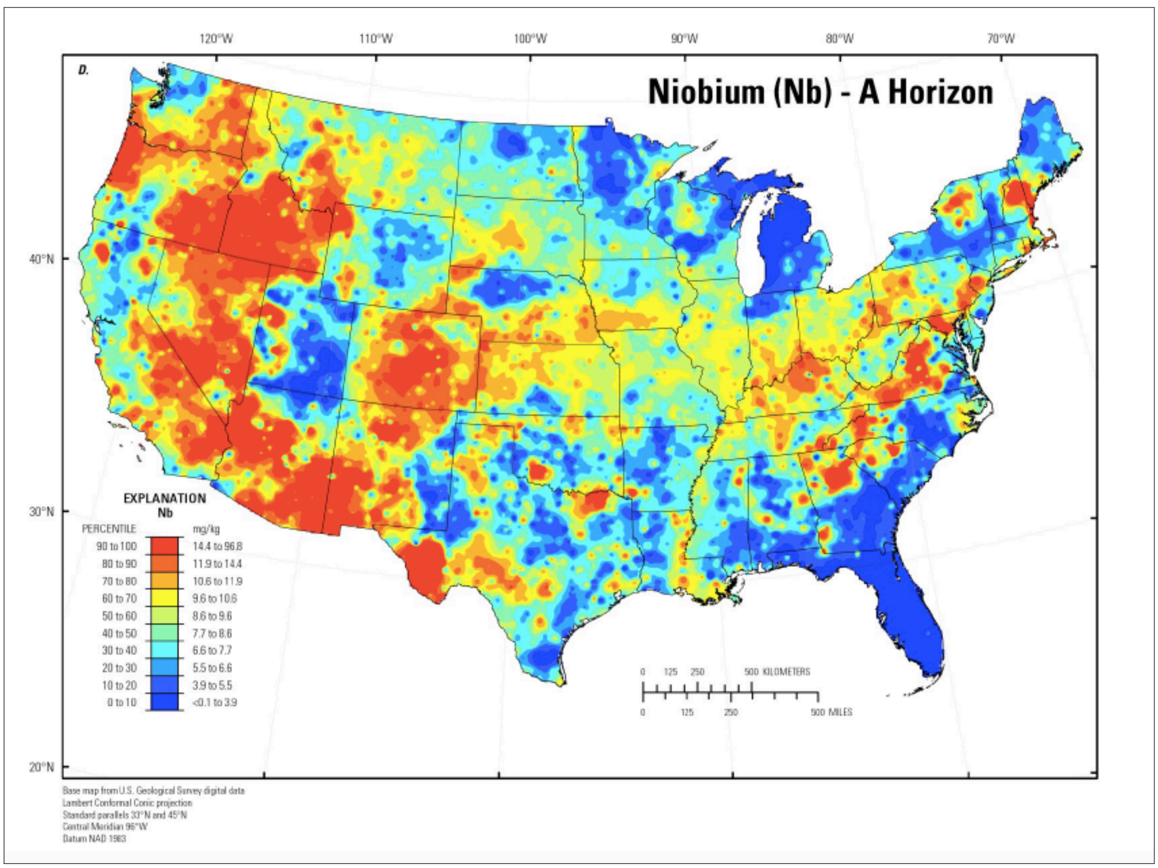


Figure 22. U.S. Map of Niobium, A-Horizon (Smith et al., 2014)

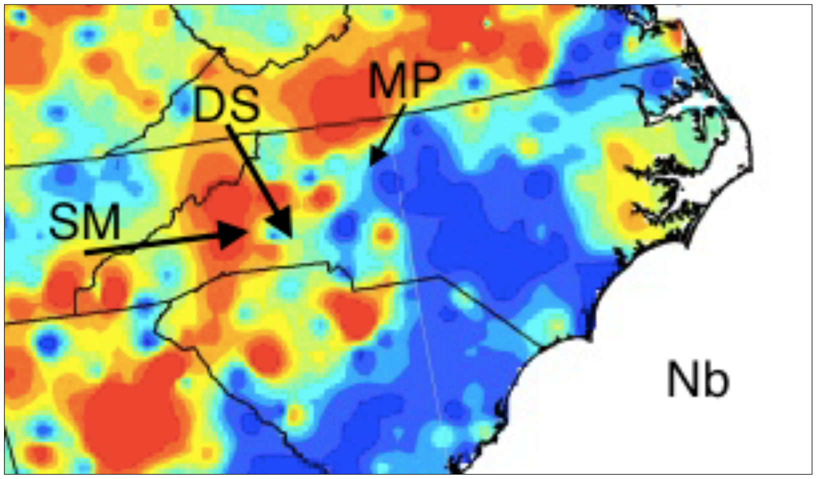


Figure 23. N.C. Map of Niobium, A-Horizon (Smith et al., 2014)

XRF analysis can provide insights to pottery production based on the geochemical composition and comparison to soil composition. By using XRF analysis combined with pipe identification, new insight into archaeological interpretations can be gained. Though the information provided in this study in relation to using both methods suggests that the samples from Holly Bend are from local clay sources, more research is need for confirmation. XRF analysis of known ceramics from the aforementioned ceramic pipe production sites, Daniel Seagle, Sally Micles, and the Moravian potters would provide more support for the results of this study.

Residue Analysis

Residue analysis is an application that uses gas chromatography-mass spectroscopy (GC-MS) and other instruments to identify organic compounds (Rafferty, Lednev, Virkler, & Chovanec, 2012). This method has been applied to detect organic residues of archaeological ceramic pipe specimens in previous studies. Rafferty (2002) uses GC-MS to detect nicotine degradation compounds in three pipe specimens: two pipes from Early Woodland sites dating between 2300 and 2500 B.P., and a nineteenth-century pipe from Ghana (Rafferty, 2002). Rafferty's study was successful in demonstrating that GC-MS instruments and current analytical protocols are appropriate in the detection of nicotine, indicative of tobacco, in historic and prehistoric residues (Rafferty, 2002; Rafferty et al., 2012). In addition to the detection of nicotine in the residue, the technique supports previous research which indicates the introduction of tobacco in the Eastern Woodland Period from Eastern North American sites dated between 2300 and 2500 B.P. (Rafferty, 2002; Rafferty et al., 2012). With the collaboration of Jonathan Russ, a professor with the chemistry department at Rhodes College and his graduate student, Hope Elliot, the ceramic pipe fragments were analyzed for organic residues using GC-MS instrumentation.

The protocol of using the GC-MS instrumentation begins with extracting alkaloids from the residue of the ceramic pipe samples, which is achieved by the elution of methylene chloride (Rafferty et al., 2012). The resulting solution is then concentrated through evaporation under nitrogen flow (Rafferty et al., 2012). The concentrated solution is then inserted into the GC-MS instrument and the total operating time is five minutes (Rafferty et al., 2012). Select ion monitoring of four ions (m/z of 162, 161, 133, and 84) is recommended for small samples and nicotine was detected in the organic residues of a variety of ages in the study (Rafferty et al., 2012).

In addition to submitting the residues for the GC-MS analysis, Rafferty et al. recommends performing control tests by submitting samples of both pure nicotine and artificially prepared nicotine (Rafferty et al., 2012). Rafferty and colleagues performed these analyses in their study and had positive results in both samples for the detection of nicotine (Rafferty et al., 2012). To confirm accuracy of the sample preparation and GC-MS instrumentation, this has also been implemented and replicated with the control measures in the aforementioned study.

All pipe fragments, samples 1-15, were selected for residue analysis (Table 1). Prior to GC-MS analysis, each pipe fragment was scraped on the interior side and residues were collected in aluminum foil packaging for transport to the lab. The protocol of using the GC-MS instrumentation begins with extracting alkaloids from the residue of the ceramic pipe samples. Samples are weighed into 15 mL glass centrifuge tubes, then ~ 3 mL of solvent (2:1 chloroform: methanol) added. They are the ultrasonicated for one hour. The sample tubes are then centrifuged. In the next step, samples are filtered through sand and sodium sulfate to remove particulate matter and water and concentrated by evaporating the solvent using mild heat and a stream of nitrogen gas.

Samples were analyzed using a Varian 3900 GC coupled to a Saturn 2100T mass spectrometer and a Varian 8410 autosampler (Russ, personal communication, November 2017). GC operating procedures include 3 instrument components. The first is the injector with a temperature of 240 degrees Celsius and one microliter. The second component is the column which is initially set at 50 degrees Celsius and followed by two increases and holds in temperature to 300 degrees Celsius. The carrier gas is to run at 1ml per minute. The mass spectrometer temperature is set at 220 degrees Celsius. The transfer line is set at 280 degrees. The mass scan is set at a mass to charge ratio from 40 to 500. The extracts were transferred to GC vials with salinized inserts (250 µL) and injected directly into the GC-MS.

Residue Analysis: Plant Compounds to be Researched

A list of plant compounds is required prior to the residue analysis and was given to Dr. Russ. The list is comprised of biomarkers corresponding to the natural materials that could have been smoked in the late eighteenth and nineteenth centuries. For example, tobacco was commonly smoked during this time period, and the biomarker to look for is nicotine. In addition to tobacco, there are potentially other plant species that were grown in or imported into North Carolina and used by smokers. The analysis included looking for biomarkers for clove, marijuana, cinnamon, cocaine, bearberry, vanilla, sassafras, mint, camphor, morphine, and borneol, as well as tobacco, as Rafferty (2002) has suggested.

Nicotine (Tobacco)

Historically, in the North Carolina Piedmont, tobacco *(Nicotiana tobacum)*, or nicotine, was consumed in multiple ways such as being smoked, taken internally (oral and nasal consumption and enema), and applied externally (Moss, 1999). Rafferty note that tobacco is a potent psychoactive plant in substantial doses (Rafferty & Mann, 2004). Historically, tobacco is noted as being an abundant farming resource for North Carolina. Rafferty discusses indigenous tobacco use in the Late Woodland Period in the coastal and piedmont regions of North Carolina (Rafferty, 2002).

Eugenol (Clove)

Clove (*Syzygium aromaticum)* is a native plant of the Philippines and the Moluccas Islands and cultivated in tropical Africa and the East Indies (Moss, 1999). The plant was introduced to North America in the late eighteenth century and often used for health remedies such as toothaches and also made into ointments (Moss, 1999). In contemporary times, clove is smoked in pipes and cigarette form. The biomarker for the clove plant is eugenol.

Morphine (Poppy or Opium)

Opium *(Papaver somniferum*) is derived from the Poppy plant, more specifically from the seed pod itself. The cultivation of the plant became popular in the eighteenth century in America (Moss, 1999). Opium took on many forms for medicinal recipes such as being cooked to a sap, pills, or pounded into rolls to produce elixirs, powders, and cough drops (Moss, 1999). While tobacco is easily the most documented substance smoked in pipes, opium is at the top of list along with marijuana as psychoactive plants smoked cross-culturally (Rafferty & Mann, 2004). Opium was widely used in mid-Victorian Britain and by 1830, the British became the main drug-traffickers of the substance across the world, its popularity rivalling alcohol (Diniejko & Litt, 2002). Morphine is the most active substance in opium.

Tetrahydrocannabinol or THC (Cannabis, Hemp, or Marijuana)

Aside from tobacco, cannabis *(Cannabis sativa)* is also a well known and documented substance, having psychoactive properties and smoked across many cultures in pipes (Rafferty & Mann, 2004). Hemp is documented as an herbal remedy in the form of a milk extracted from the seeds for menstrual bleeding in the late eighteenth and early nineteenth century backcountry of the southeastern U.S. (Moss, 1999). In the mid-1760s, hemp was a heavily subsidized crop (Mitchell, 1998). The plant became most desirable during the Revolutionary War with widespread production (Mitchell, 1998). Its cultivation, along with that of tobacco, contributed to the first appearances of slavery in the southern backcountry (Mitchell, 1998). To date, marijuana is an important component of medicinal and cultural practices across the world. The biomarker for cannabis is tetrahydrocannabinol (THC).

Cinnamaldehyde (Cinnamon)

Cinnamon (*Cinnamomum verum*) is derived from an Asian tree, specifically the bark and buds. The plant was used as an herb in ointments and as additive for aromatic water that often contained spirits, or alcohol (Moss, 1999). “Cassia aldehyde” or Cinnamaldehyde (biomarker) are substances derivatives of plants from the genus *Cassia,* some of which come from India, which have medicinal uses (Thackeray et al., 2001). Historical records indicate that this particular substance has also been referred to as “pipe tree” (Thackeray et al., 2001). Cinnamon bark is often used as a spice or additive for flavor. This plant was chosen for the study as a possible flavor additive to smokable plants.

Cocaine (Coca)

Cocaine is a derivative of the South American plant, *Erythroxylon* (Thackeray et al., 2001). In one case, cocaine has been detected in smoking pipe residue from an unwashed seventeenth century pipe excavated in England (Thackeray et al., 2001). Cocaine is also documented in nineteenth century Britain for both medicinal and recreational uses from throat lozenges to elixirs (Diniejko & Litt, 2002). Cocaine is yet another substance smoked or consumed across many countries.

Hydroquinone (Bearberry or kinnikinnick)

Kinnikinnick, also known as bearberry, is a blend of tree barks that were smoked by Native Americans and often used with tobacco (Rafferty & Mann, 2004). To date there has been no research on the psychoactive effects of kinnikinnick but Rafferty suggests that the primary use was for psychoactive properties and it was a major plant inhaled with the use of smoking pipes (Rafferty & Mann, 2004). The biomarker for kinnikinnick is hydroquinone. Given the known presence of the Catawba Native American group in the region of the Holly Bend site, I felt is was important to include this in the residue analysis.

Vanillin (Vanilla)

Vanillin comes from the vanilla plant (genus *Vanilla)* from South America and has been identified in smoking residues from England (Thackeray et al., 2001). Vanilla is a flavor additive for many types of contemporary tobaccos, including cigarettes and cigars.

Safrole (Sassafras)

Sassafras (genus *Sassafras*) was commonly used for medicinal purposes in the North Carolina backcountry, often times decocted as a tea (Moss, 1999). The leaves and flowers were also cultivated for teas in London (Moss, 1999). The root bark of sassafras was also used to combat cancer, pleurisy, rheumatism, and kidney ailments among others. This plant was chosen for the study because of its common medicinal uses, like many other smokable plant materials.

Menthol (Mint)

Mint (genus *Mentha*), peppermint, or spearmint leaves and oils were often used in North Carolina to mask undesirable tastes of medicines or caster oil (Moss, 1999). Menthol, the biomarker for mint, is often used as an additive for tobacco products for flavor.

Atropine and Tropine (Jimsonweed)

Jimsonweed (*Datura stramonium*) is also known as Jamestown Weed and Thorn Apple, and is a member of the nightshade family with both poisonous and narcotic properties (Moss, 1999). The plant was used for inflammations but precautions were noted as it had effects of "giddiness and madness" if taken internally (Moss, 1999). Together, atropine and tropine are biomarkers for this plant.

Camphor

Camphor is an Asian tree (Cinnamomum camphora) which was used both externally and internally, historically, as a remedy for multiple types of inflammations (Moss, 1999). Camphor has been detected in previous residue analysis studies of both English pipes and American Late Woodland period pipes (Thackeray et al., 2001; Carmody et al., 2018).

Borneol

Borneol is a biomarker for several plant species such as Artemisia (mugwort), camphor, cardamom, cinnamon, ginger, mint, nutmeg, rosemary, sagebrush, tarragon, thyme, turmeric, and wormwood. Mugwort has common names including St. John's Wort, sailor's tobacco, chrysanthemum weed, and moxa (Hanrahan & Frey, 2014). In North Carolina, the plant is described as a "noxious, alien weed" (Hanrahan & Frey, 2014). Mugwort was often smoked as a non-nicotine tobacco (Hanrahan & Frey, 2014). The psychoactive chemical, a terpene, is known to have sedative and hallucinogenic effect, reportedly similar to cannabis (Hanrahan & Frey, 2014). In the journal article by Loeb, Garthwaite, and Transue (2014) entitled *None in common, many unique: species selection for gardens of the American South from 1734-1825*, mugwort is listed among plants in a medicinal garden located in Bethabara, the first Moravian settlement in North Carolina.

Residue Analysis Results

Fifteen samples were submitted for residue analysis in this study. Nine of the samples proved to be too small and did not yield results against the background of the instrumentation. Substances were identified in six samples, see Table 4. The chemicals positively identified are menthol, borneol, cinnamaldehyde, eugenol, and nicotine. Substances that were tested in the residue analysis but yielded negative results include hydroquinone, vanillin, safrole, camphor, tropine, atropine, cocaine, morphine, and THC.

Table 5. Positive Chemical Residue Analysis Results

Sample	Sample #01	Sample #11	Sam #08 Sediment	Sam #08	Sample #13	Sample #15
Menthol		X	X	X		X
Cinnamaldehyde			X		X	
Hydroquinone						
Vanillin						
Safrole						
Eugenol		X			X	
Nicotine				X		
Camphor						
Tropine						
Atropine						
Cocaine						
Morphine						
THC						
Borneol	X		X	X		X

Two separate analyses were conducted on sample 8 (an almost intact pipe), one analysis on the contents (a dirt sediment) and one analysis on the bowl scrapings. It is important to note that this pipe fragment was not cleaned after excavation, preserving the contents. The sediment was extracted from the bowl and then analyzed for residue which tested positive for menthol, cinnamaldehyde, and borneol. The bowl scrapings tested positive and identified menthol, nicotine, and borneol. In the residue analysis, chromatograms are used to determine if a biomarker is present in the sample. For example, the chromatogram below (Figure 24) is the total ion chromatogram from sample 8 (fragment bowl scraping). This shows all the peaks from extracted compounds with molecular masses that range from 40 to 500.

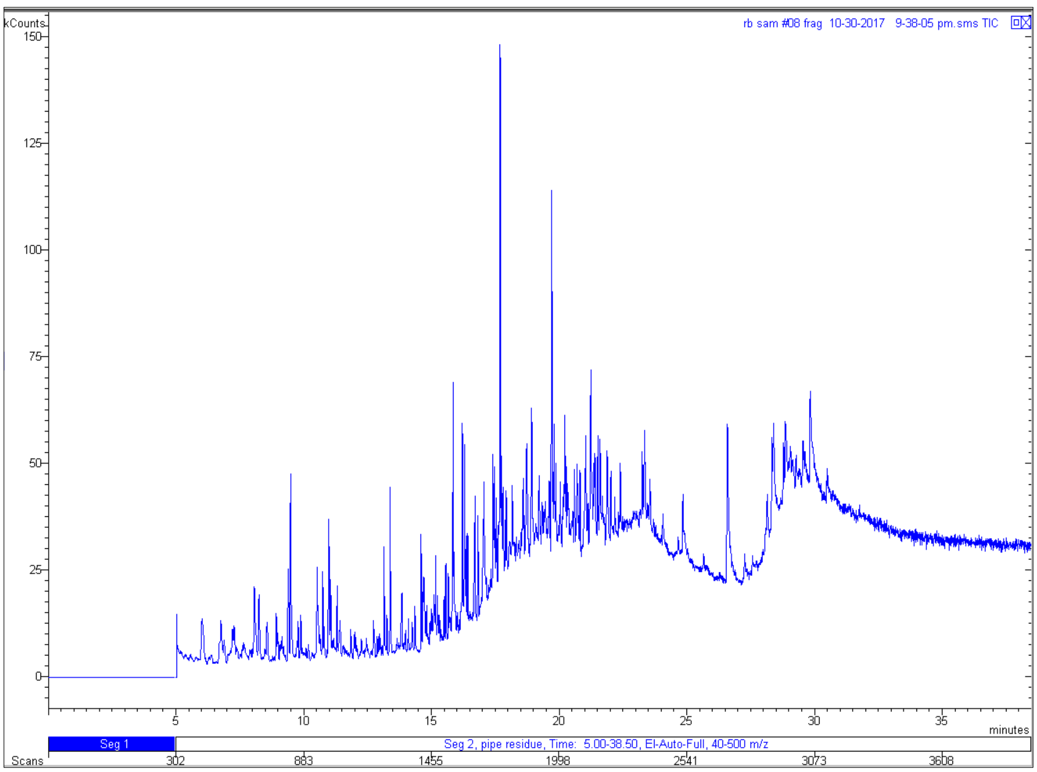


Figure 24. Sample 8 (fragment) Total Ion Chromatogram.

The two partial ion chromatograms below (Figure 25) show the total ion chromatogram and the chromatogram from selected ions with mass to charge ratios of 133 and 84. These are the two primary ions produced in the mass spectrum of nicotine. This chromatogram shows a peak with a retention time consistent with nicotine.

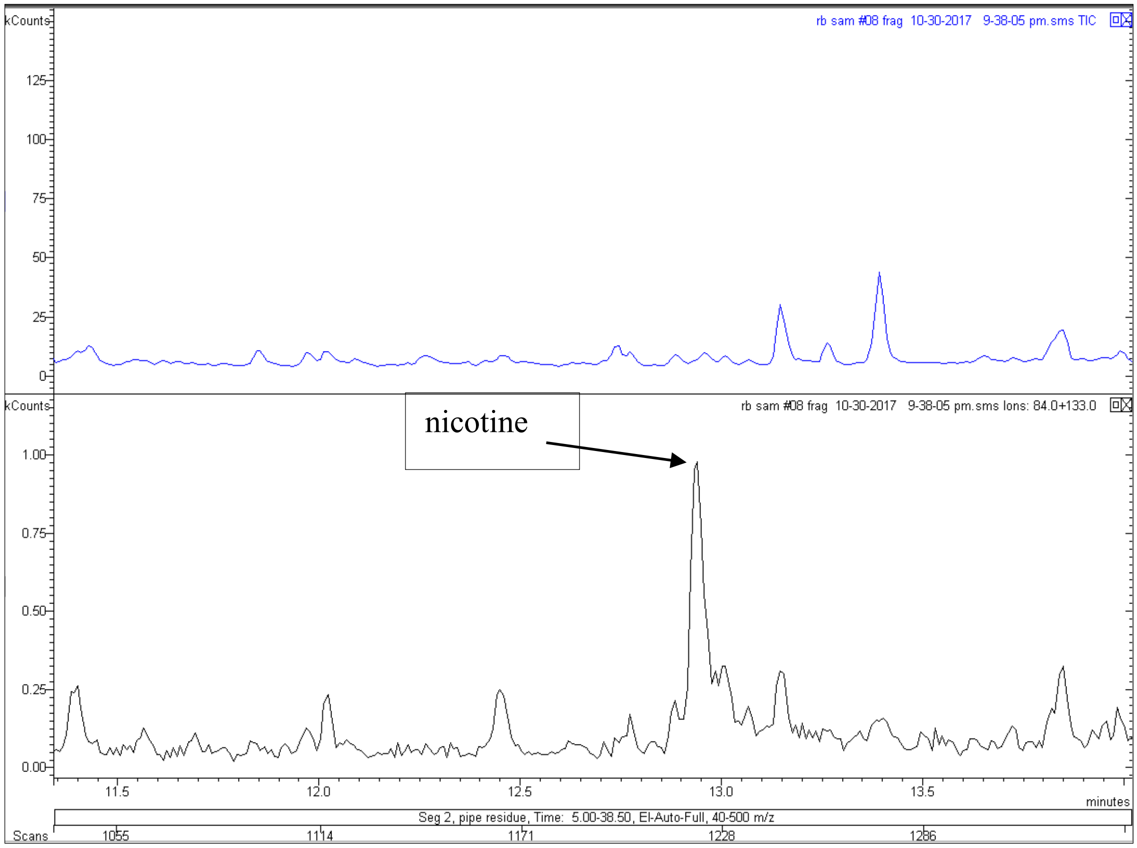


Figure 25. Chromatogram with Nicotine Peak.

Figure 26 shows the mass spectrum associated with the peak above (Figure 25) marked by the arrow and the NIST library match for nicotine. The conclusion is that nicotine is present in sample 8.

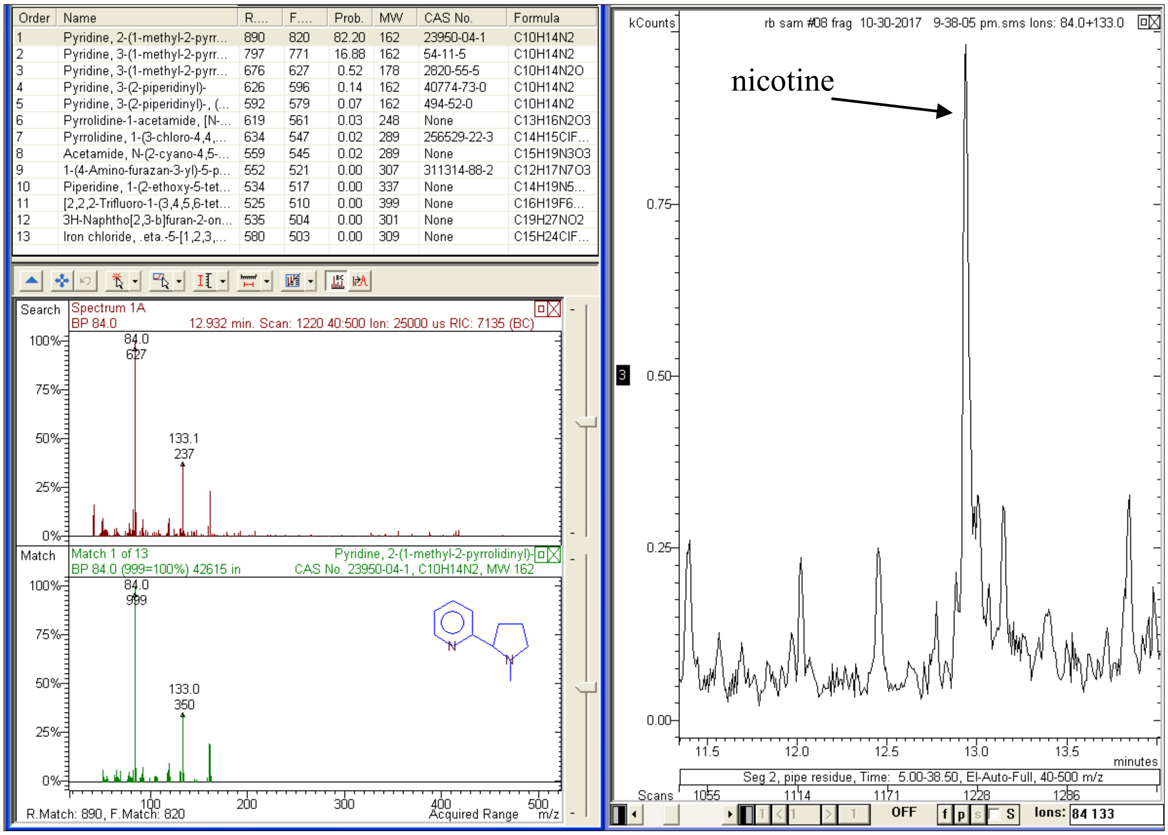


Figure 26. Mass Spectrum Associated with Nicotine Peak.

Sample 10 came from a fragment that would have been adjacent to the bottom of the bowl, where a stem would be attached. This fragment was not cleaned after excavation, yet both samples (sediment and scrapings) for this fragment were negative for all tested compounds. Sample 11 tested positive for eugenol, a biomarker for cloves, and menthol, a biomarker for mint. The analysis identified both cinnamaldehyde and eugenol in Sample 13. Sample 15 had positive identification of menthol and borneol. In total, borneol is identified in four samples. It is possible this is a contaminant from a natural insect repellent during excavation although further research is needed for confirmation.

Residue analysis is an effective method to identify plant materials from ceramics, in this case tobacco smoking pipes, that would otherwise be absent from the archaeological record. The identification of nicotine provides significant meaning in its presence in a main kitchen of a large plantation with an enslaved population. In the eighteenth century, planters moved their workers, paid or enslaved, outside of the big house as they had previously cohabitated. Whether the pipes were passed down from the plantation owners or purchased or traded, evidence suggests the pipes excavated at Holly Bend in the main kitchen were used by the enslaved African Americans. The identification of mint residue suggests this may have been an added flavor added to other plant materials such as tobacco, similar to present day menthol cigarettes. The positive identification of cloves is also important showing other plants were being smoked, perhaps an alternative to smoking tobacco.

The absence of other plant compounds in the study suggests it is possible they were not accessible or part of the smoking culture of the region. However, substances such as Cannabis, are difficult to detect in residue analysis due to the breakdown involved in the molecular structure after being burned. Furthermore, failure to detect certain compounds in residue analysis is not sufficient to conclude those plants were not used, as it may be that the compounds were not detected via this specific analytical method.

Table 6. Combined Results

Sample #	Provenience	Type of Pipe	Possible Production Source	Detected Residues
1	Kitchen	Coarse Earthenware Fluted	North Carolina Moravian	Borneol
2	Kitchen	Earthenware Fluted	North Carolina Micles, Seagle	None
3	Other	Earthenware Anthropomorphic	North Carolina Moravian	None
4	Kitchen	Earthenware	North Carolina Moravian	None
5	Kitchen	Earthenware Fluted	North Carolina Seagle	None
6	Other	Stoneware Kaolin English/Reproduction	North Carolina Micles, Moravian	None
7	Other	Stoneware Kaolin Anthropomorphic-Philosopher's Pipe	North Carolina Moravian	None
8	Kitchen	Coarse Earthenware Fluted	North Carolina Seagle	Cinnamaldehyde Menthol, Borneol Nicotine
9	Kitchen	Coarse Earthenware	Unknown	None
10	Kitchen	Earthenware Fluted	North Carolina Seagle	None
11	Kitchen	Coarse Earthenware Anthropomorphic-Indian Tribute	Unknown	Menthol Eugenol
12	Kitchen	Coarse Earthenware Fluted	North Carolina Moravian Seagle	None
13	Kitchen	Coarse Earthenware Fluted	North Carolina Moravian Seagle	Cinnamaldehyde Eugenol
14	Other	Coarse Earthenware	North Carolina Moravian	None
15	Kitchen	Stoneware Kaolin Anthropomorphic	North Carolina Moravian	Menthol Borneol
16	Kitchen	Coarse Earthenware	Unknown	None

CHAPTER 4: DISCUSSION

Question #1: Who are the different people who may have used or owned these pipes?

In this study, various aspects of plantation archaeology were examined to understand living and working dynamics among the inhabitants of the Holly Bend plantation: the planter's family, overseers, and slaves. The use of a memory map and plantation structure patterns also aided in understanding these relationships at Holly Bend. The site of the kitchen near the main house would have been a place of work for several slaves on a daily basis through the mid-1860s. With the record of a single overseer for more than a hundred slaves, evidence suggests the overseer would not be a regular worker in the kitchen. In terms of who is being served and who is serving, the planter's family and guests would probably not have a presence in the kitchen either.

Based on the different smoking habits of each type of occupant, evidence suggests the slave population used and/or owned the ceramic smoking pipes. The planter, along with family and guests would have used high-end tobacco pipes, either domestic pipes with intricate designs or those imported from England, as was the trend during this era. Cigars, cigarettes, and snuff are other forms more closely associated with higher economic status among the plantation population. The overseer's smoking habits would align strongly with those of the planter as a means of segregation from the enslaved workers.

Pipe morphology and identification also support this evidence of smoking habits as the majority of the pipes are stub-stemmed, plain or fluted tobacco pipes. People of low socio-economic status smoked locally made tobacco pipes as they were less expensive and readily available from local merchants. Based on the morphology of the pipes coupled with the geochemical analysis via XRF, evidence suggests the pipe fragments derived from locally made tobacco pipes that were very common in parts of North Carolina.

The residue analysis also offers insight into who may have used or owned the pipes. Substances other than tobacco (nicotine) were identified in the residue scrapings from 5 of the pipe samples. The substances detected through this method may also provide evidence for theoretical aspects of who may have been smoking or possibly preparing the plant materials for smoking. As previously discussed and referenced in Moss' book of *Southern Folk Medicine*, many plant substances such as mint and cinnamon are often found in the kitchen as additive flavors for cooking in addition to medicinal or recreational purposes. Tobacco was often used on plantations for reward and incentive between the overseer and slaves, though it is possible the quality may have been poor, etc. perhaps spurring a desire for flavor enhancement, or possibly more substance to be smoked if quantities of tobacco were limited. Slaves were permitted to grow their own crops for trade, many having a garden in addition to livestock for commerce, so they could have grown some of these supplemental plants.

Question #2: What information do the different types of pipes provide?

Identifying the possible different types of tobacco pipes in the assemblage provides information about availability and cost, including the economic conditions pertaining to the people who obtained them. Based on pipe morphology coupled with geochemical analysis, evidence suggests that the majority of the pipe fragments are locally made in the North Carolina piedmont. The region where the fluted pipe style is common overlaps with region where trace elements suggest that local piedmont potters acquired their clays. The research discussed in the pipe identification section provides evidence that these pipe styles were peddled often by the potters themselves or by merchants as described by Shaffer (1994) in his study of Sally Micles. Shaffer (1994) also notes that pipes were being sold in large quantities and at a low cost by Micles. In the report about Micles, Shaffer (1994) recounts a story of soldiers buying, selling, and trading her pipes as they traveled, thus spreading the range of accessibility of one pipe type. Many of the pipes in the sample assemblage match both stylistically and geochemically with the Seagle, Micles, and Moravian clay sources. However, the origin of the pipes cannot yet be definitively confirmed without XRF analysis on known samples from each of these sites.

On the Holly Bend plantation, as previously mentioned, the smoking habits as well as the smoking vessels to smoke would have differed among the different groups of inhabitants. The majority of the pipe fragments were a plain, fluted style, similar to Shaffer's description of Micles, as far as hundreds being sold together and at low cost (Shaffer, 1994). Fluted stub-stemmed pipes would have been used by the slaves on the plantation versus the planter's family who would have used fancier, more expensive pipes, if they were not using cigars or cigarettes exclusively. As mentioned, the overseer's habits would have aligned with the planter's family. In a reward/incentive context, cheap, readily available pipes may have been used for that purpose as well. Based on the archaeological excavations at Holly Bend, three of the pipes in the sample assemblage were found several hundred feet away from the main house and the kitchen, however, there is no known structure documented that is associated with these outlying sites. The three pipes, samples 3, 6, and 7 are identified as kaolin clay pipes. Though this is not unusual, as this was main type of clay Micles was known for, two of the pipe fragments have a face or anthropomorphic design molded into them. This is more indicative of a fancy Moravian style (they produced plain and fluted pipes too), often called a "philosopher's" pipe (the face of a Greek man wearing a head wreath). The third pipe appears to be an English style (the mold for which was eventually replicated in the U.S.). These pipes would have been less likely to have been acquired by slaves based on higher cost and limited availability.

Question #3: What can be understood about the smoking culture based on the contents of the pipes?

The smoking culture on the Holly Bend plantation appears to be diverse based on this small sample set. The residue analysis performed on the pipe fragment scrapings provides evidence that tobacco was not the only substance smoked by plantation inhabitants, but that other substances were available and used as well. The residue analysis positively identified cloves, mint, cinnamon, and borneol, in addition to tobacco. In contemporary times cloves are smoked as an alternative to tobacco, and menthol is also smoked as an additive to cigarettes. While the samples tested negative for other substances, it is noted that it may be due to small sample size in most cases in this study as several of the pipe fragments were small. Further research may reveal additional plant materials used in smoking culture.

As previously stated, tobacco was a major crop export for North Carolina during the 18th and 19th centuries. While the positive identification is exciting, it was the most predictable in the study to find. Tobacco smoking has been a proven leisure activity among all social classes but in particular, it was a very important part of the lives of enslaved people in their “free” time. Positively identifying additional substances such as menthol, cloves, borneol, and cinnamon provides a basis for further research as to what kinds of insight this may bring to the archaeological record of plantation archaeology. As noted, slaves often worked in the kitchen and this was likely the case at Holly Bend as well. It is possible there was an interest in different flavors, similar to experimentation of cooking foods, or in providing a substitute for a missing or small amount of an ingredient. Perhaps the tobacco smoked was of poor quality and mint was introduced similar to its use in medicine to mask or enhance flavor. If slaves were permitted to grow their own crops, it seems likely they would have grown some of these substances to use with their leisure activity of smoking.

Question #4: What is the source of the pipe fragments?

It is documented that local pipes were easier to obtain due to their relatively low cost. As with most goods, materials from farther away or great distances are more expensive and exclusive. Methodologies used to examine this question include pipe identification, XRF analysis, and previous studies of the incentive/reward systems on plantations with a slave population. The identification of the various types of pipes in the sample assemblage is imperative as it suggests that the pipes were local. By researching local potters and common trade practices, this research shows that the majority of the pipes were locally produced.

Though many of the pipes have similar patterns such as the fluting pipes, it was not possible to identify which potter produced each one. However, using XRF analysis, it was possible to identify elemental signatures in the pipes that match the soil composition of particular areas containing clays used by the identified potters. Without XRF analysis of known pipes from one of these potters, it is only suggested that they may have made them. There were several potters in the western and piedmont regions of North Carolina during the late 18th and early 19th century and those cannot be ruled out until comparative analysis is done. However, the XRF results coupled with the pipe identification does provide a local signature of style and chemical composition that is specific to North Carolina Piedmont clay and potters.

CHAPTER 5: CONCLUSION

This research was focused on the analysis of sixteen ceramic tobacco pipe fragments excavated from Holly Bend, a successful late 18^{th} and early 19th century plantation in Mecklenburg County, North Carolina. Photographic evidence coupled with the use of a memory map, depicting the plantation layout, confirmed the kitchen location near the main house. Twelve of the sixteen ceramic pipe fragments were excavated from the kitchen site. Based on identification, the majority of pipe morphology is consistent with ceramic tobacco pipes produced in the Piedmont region of North Carolina. XRF analysis of the pipe assemblage reveals the clay composition provides further elemental evidence to corroborate with the pipe identification. The residue analysis identified tobacco, cinnamon, clove, mint, camphor, and borneol, providing insight as to what plants were being smoked in the ceramic tobacco pipes. The Holly Bend plantation landscape and architecture pattern is similar to other contemporary slave plantations regarding the living dynamic between the planter's family, the overseers, and the slaves. Based on this research, evidence suggests that the tobacco pipe fragments analyzed in this study, were used by enslaved African Americans. This evidence is also supported by the accessibility of various plant materials in addition to the availability of certain types of smoking pipes based on socioeconomic status.

In regards to plantation archaeology, problems present themselves consistently due the limitation of available information and the lack of understanding of the Black experience in America (Fairbanks, 1984). Among written documents during this era, the daily lives of slaves were not considered important for comment. As Fairbanks points out, planters, overseers, and plantation guests had little idea or knowledge about the daily lives of slaves themselves (1984). Archaeology is able to recover the more durable elements of material culture such as glass, ceramics, architectural nails, and tools. Plant remains such as cloth, food, and perishables are largely absent from the archaeological record. This study contributes evidence to the archaeological record of plant materials that were consumed through the leisure activity of smoking. Based on the research and location of the pipes in correlation to the history of slave plantation architecture, evidence suggests the smokers were those who worked on the plantation through cooking and serving from the main kitchen off of the "Big House": enslaved African Americans.

To conclude, Orser best describes the role of historical archaeology by stating "…even though African men and women, both free and enslaved, have traveled the world for generations, today's archaeologists know little about them and the cultures they help construct" (1998, p. 78). The research discussed in my study contributes significantly to this history, providing evidence of the smoking culture on an early nineteenth plantation.

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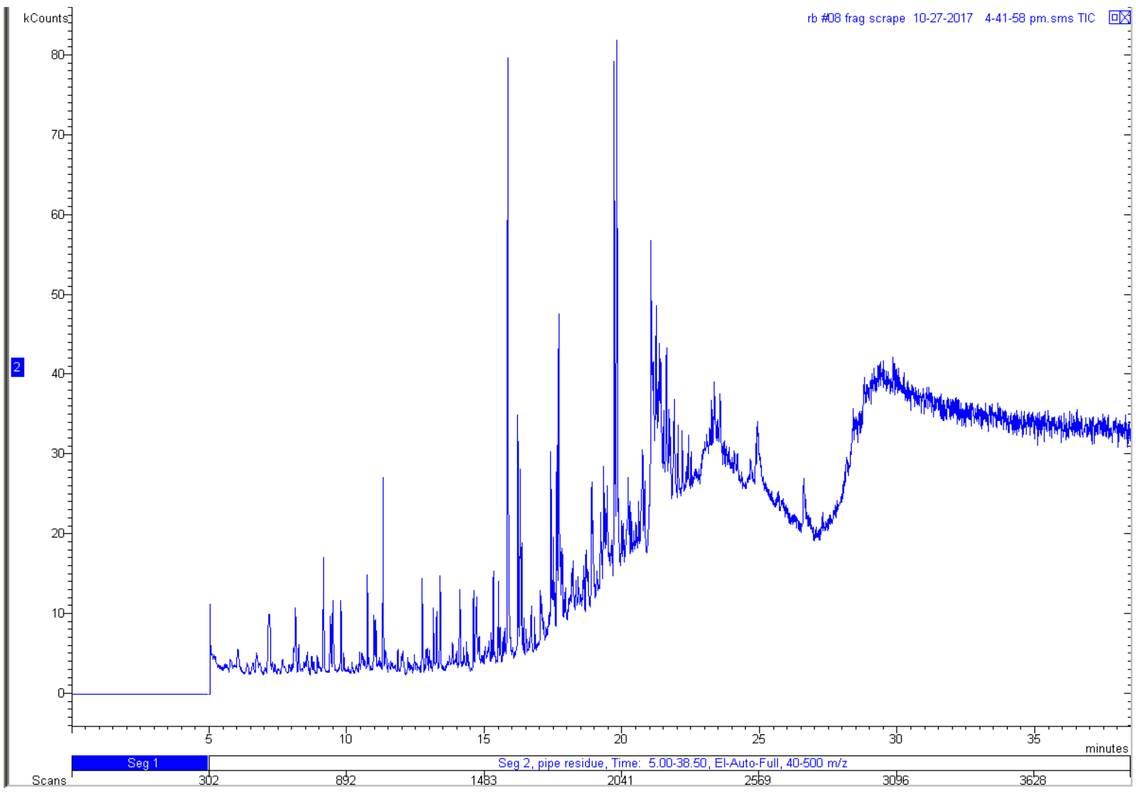
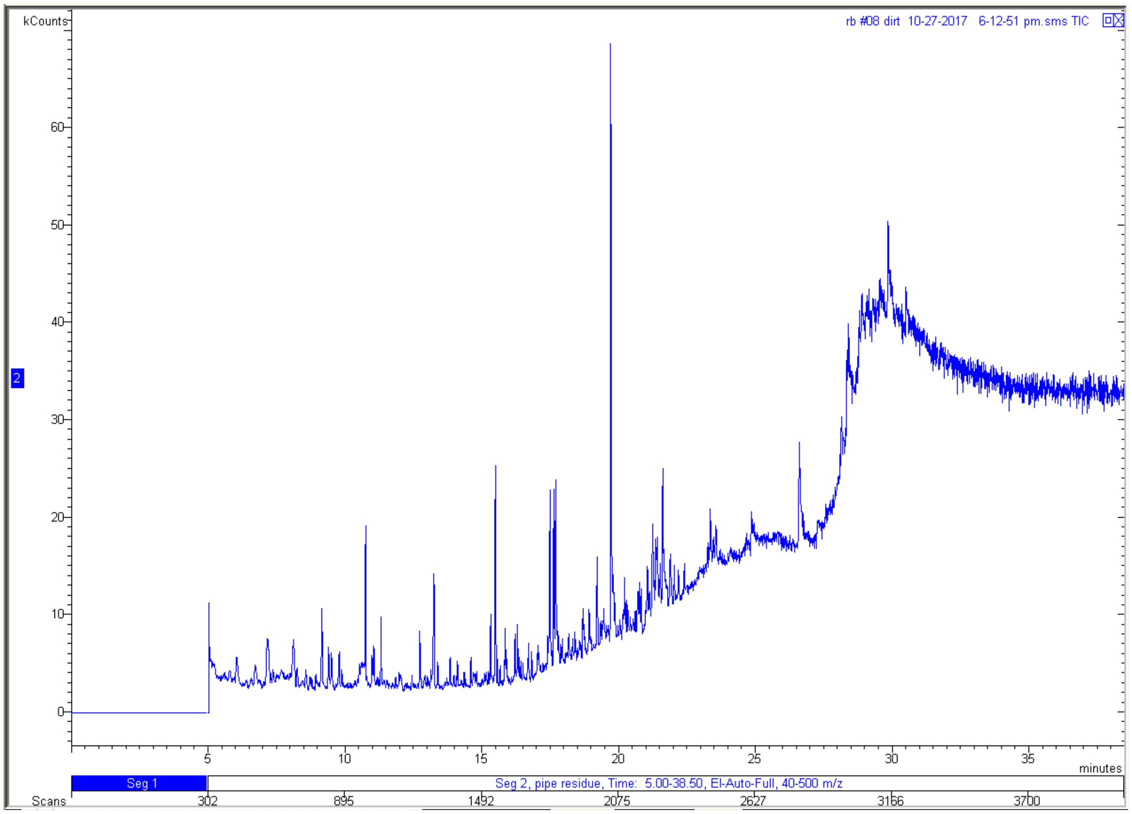
APPENDIX A: RESIDUE ANALYSIS DATA

Chromatograms-Positive Test Residues

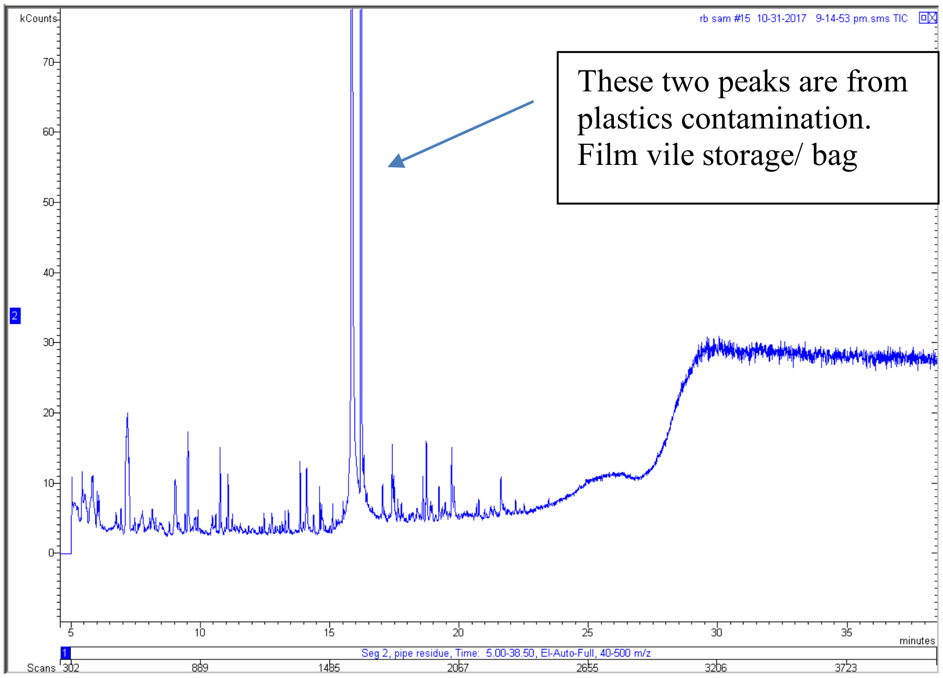
Sample 8- Fragment Bowl Scraping



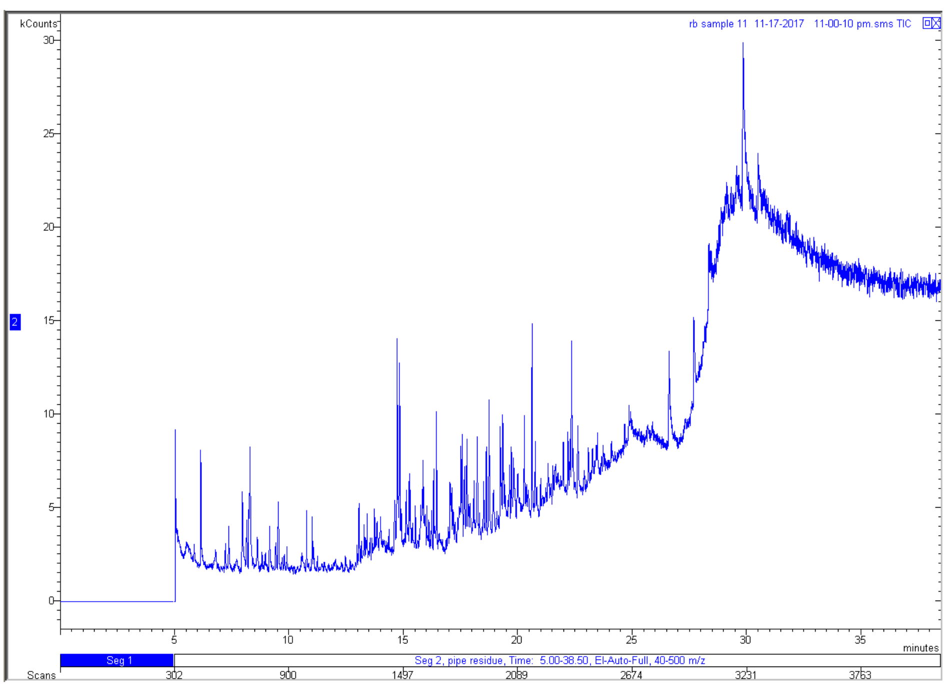
Sample 8- Sediment



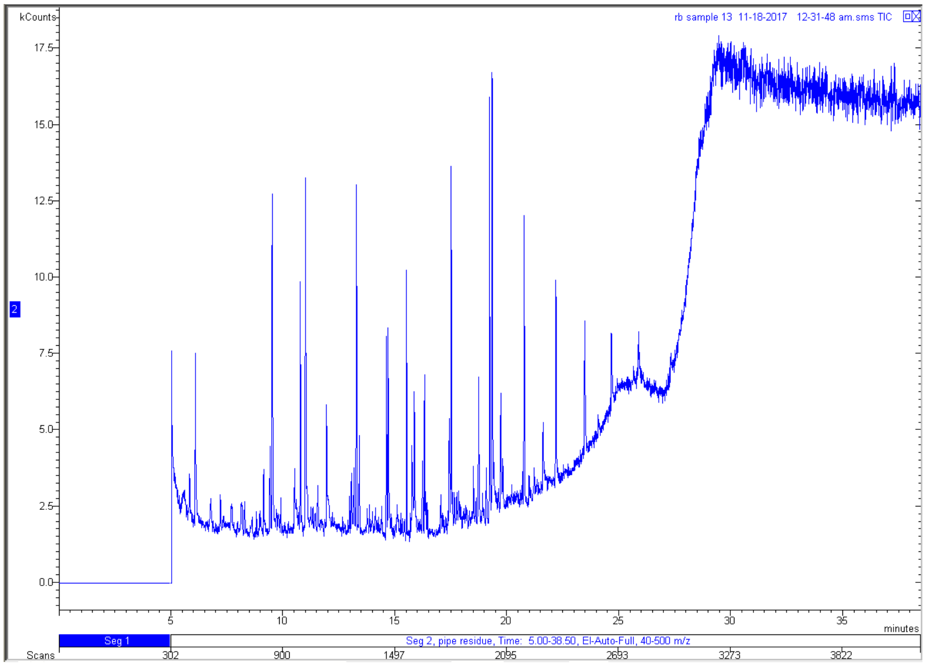
Sample 15



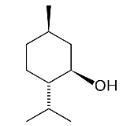
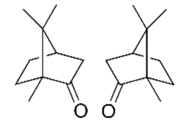
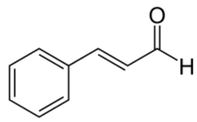
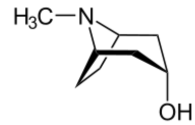
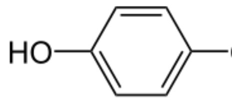
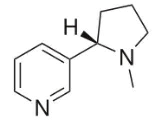
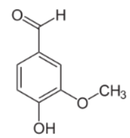
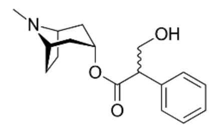
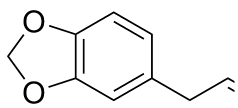
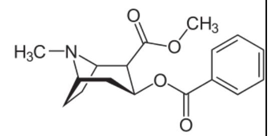
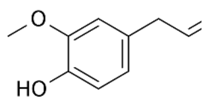
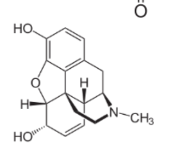
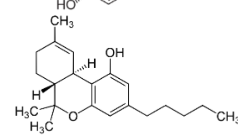
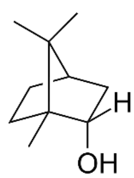
Sample 11



Sample 13


kCounts
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
2
rb sample 13 11-18-2017 12-31-48 am.sms TIC
5
10
15
20
25
30
35
minutes
Seg 1
Seg 2, pipe residue, Time: 5.00-38.50, EI-Auto-Full, 40-500 m/z
Scans
302
900
1497
2095
2693
3273
3822

Chemical Structure for Biomarkers

Menthol		Camphor	
cinnamaldehyde		tropine	
hydroquinone		nicotine	
Vanillin		atropine	
safrole		cocaine	
Eugenol		morphine	
		THC	
Borneol			

Chemical Compound Retention Time

Compound	Ret time	Base/parent	Formula	MW	IUPAC name	CAS
Camphor	9.973	95/152	$C_{10}H_{16}O$	289	1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one	101-31-5
Menthol	10.56	81/123/71	$C_{10}H_{20}O$	156	5-Methyl-2-(propan-2-yl)cyclohexan-1-ol	1490-04-6
Tropine	10.798	82/141	$C_8H_{15}NO$	141	(RS)-(8-Methyl-8-azabicyclo[3.2.1]oct-3-yl) 3-hydroxy-2-phenylpropanoate	51-55-8
Cinnamaldehyde	11.64	131/110/51	C_9H_8O	132	(2E)-3-Phenylprop-2-enal	14371-10-9
Hydroquinone	11.657	110/81	$C_6H_6O_2$	110	Benzene-1,4-diol	123-31-9
Vanillin	12.144	152/106	$C_8H_8O_3$	152	4-Hydroxy-3-methoxybenzaldehyde	121-33-5
Safrole	12.141	162/131/104	$C_{10}H_{10}O_2$	162	5-(Prop-2-en-1-yl)-2H-1,3-benzodioxole	94-59-7
Nicotine	12.908	84/162	$C_{10}H_{14}N_2$	162	(S)-3-[1-Methylpyrrolidin-2-yl]pyridine	54-11-5
Eugenol	13.015	164/149/103	$C_{10}H_{12}O_2$	164	2-Methoxy-4-(prop-2-en-1-yl)phenol	97-53-0
Atropine	22.262	124/289	$C_{17}H_{23}NO_3$	289	RS)-(8-Methyl-8-azabicyclo[3.2.1]oct-3-yl) 3-hydroxy-2-phenylpropanoate	51-55-8
Cocaine	22.299	82/182	$C_{17}H_{21}NO_4$	303	Methyl (1R,2R,3S,5S)-3-(benzoyloxy)-8-methyl-8-azabicyclo[3.2.1]octane-2-carboxylate	50-36-2
Morphine	24.221	285/285	$C_{17}H_{19}NO_3$	285	4R,4aR,7S,7aR,12bS)-3-Methyl-2,3,4,4a,7,7a-hexahydro-1H-4,12-methanobenzofuro[3,2-e]isoquinoline-7,9-diol	57-27-2
THC	24.681	299.5/314	$C_{21}H_{30}O_2$	314	(−)-(6aR,10aR)-6,6,9-trimethyl- 3-pentyl-6a,7,8,10a-tetrahydro- 6H-benzo[c]chromen-1-ol	1972-08-3
Borneol	10.438	95/154	$C_{10}H_{18}O$	154	endo-1,7,7-Trimethyl- bicyclo [2.2.1]heptan-2-ol	507-70-0