Portable X-ray Fluorescence Analysis of Pottery at the Bayshore Homes Site in Pinellas County, Florida

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Portable X-ray Fluorescence Analysis of Pottery at the Bayshore Homes Site in Pinellas County, Florida

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts
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DEDICATION

This work is dedicated to my mother and father. They taught me at an early age to do what makes me happy and supported my wanderings through this world with love and understanding. I credit them with my love of learning, my desire to know the why of everything, and my healthy skepticism of established paradigms.

My mother, Judith, inspired my love of books and also demonstrated on a daily basis, her endless dedication and support of her family. I think my mother managed to spoil me just enough… Enough to feel special, but not enough to feel entitled. She is the one that inspires me, though not always successfully, to be the kindest most tolerant version of myself. If I fall short of her example, it is no one’s fault but my own. Still, she is the reason I strive to always try harder and give more.

My father, Donald, inspired my love of nature. He was a boilermaker by necessity, but a landscaper at heart. He enjoyed building things as well, and anything he built had to be perfect! My desire for perfection comes from him. When others judge our work and find it great, we will inevitably focus on the small flaws that we couldn’t fix to our satisfaction. I also credit my father for my love of archaeology, it combined some of our favorite things … getting dirty and unraveling the mysteries of life! The completion of my Masters degree in archaeology has been a goal for many years and I wish he were here to see it. Still, if archaeology teaches us anything, it is that nothing lasts forever. The flow of time is inevitable. Humans and empires alike will rise and fall. And if we are lucky, someone will bare witness to what has passed, and honor it.
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ABSTRACT

The Bayshore Homes site was occupied intermittently over a period of approximately twelve hundred years, with the two main occupation periods being CE 150-550 and CE 900-1350. During those lengthy occupations a substantial amount of plain and decorated pottery was discarded at the site. A portable X-ray fluorescence (pXRF) spectrometer was utilized to analyze the elemental composition of 133 sherds, both decorated and plain. The resulting elemental composition data were then analyzed using multivariate statistics in an attempt to discern discrete clay sources that may have been exploited by inhabitants of the Bayshore Homes site. Principal component analysis (PCA) and discriminant function analysis (DA) were employed to identify three discrete clay sources exploited in the production of pottery. The results of the statistical analyses were then used to answer two basic, yet pertinent, questions about the Bayshore pottery: 1) Were the same clay sources exploited during both occupation periods? 2) Were the same clay sources exploited for both decorated and plain pottery?

The results of the statistical analyses indicate that the same clay sources were exploited for both occupation periods, though evidence suggests that the dominant clay source in use did change over time. The results also imply that the same clay sources were utilized in the production of plain and decorated pottery, which suggests that at least some portion of the decorated pottery excavated from the Bayshore site was produced locally, and not obtained through trade. Finally, the results of this research demonstrate that pXRF is a useful tool for preliminary differentiation of clay sources in Florida.
CHAPTER ONE
INTRODUCTION

“Pottery was the first synthetic material humans created – artificial stone – ...” – (Rice 2005:3)

In archaeology, ceramic studies are a valuable tool for enhancing understanding of prehistoric peoples. Technology, subsistence, ideology, and trade are some of the areas that can be informed by various types of ceramic analyses. Ceramic studies that are based on compositional analyses of the pottery can inform archaeological understanding of resource utilization as well as trade. Compositional analyses allow one to determine the elemental makeup of the pottery being tested. A ceramic sourcing study utilizing compositional analysis could potentially pinpoint, on the modern landscape, the specific clay source exploited in the manufacture of prehistoric pottery. This would be achieved by comparing the elemental signature of an excavated piece of pottery with the elemental signatures of available clay sources located on the landscape. Determining this type of information augments our understanding of resource utilization by prehistoric people. Does the elemental composition of analyzed pottery indicate the use of multiple clay sources for pottery manufacture? Are particular clay sources utilized for particular styles of pottery or types of vessels? Was all the pottery at a particular site manufactured locally, or were some vessels made from exotic (non-local) clay sources, indicative of inter-site trading? These are some of the questions that could be answered by a compositional analysis of pottery.

In Florida archaeology, a complex geology can make it difficult to successfully locate discrete clay sources that would have been associated with prehistoric occupation. Additional
complications arise with locating prehistoric clay sources in modern urban areas where substantial land development has altered large portions of the natural landscape. Identification of discrete clay sources utilized on the landscape better informs an archaeological understanding of site resource utilization than relying solely on the compositional analyses of site pottery. However, locating and “matching” these clay sources to pottery at a site is not always possible or practical. Even when clay sources on the landscape cannot be identified or linked to a particular piece of pottery, relevant data can still be gleaned from just the pottery analyses (Forouzan et al. 2012:3; Goren et al. 2011; Papachristodoulou et al. 2010). Significant differences in the elemental signatures of the pottery, would suggest multiple ceramic sources were used and potentially even exotic sources. Discerning discreet clay sources utilized in pottery production can provide a better understanding of resource utilization within a site.

Portable XRF (portable X-ray fluorescence) is one type of technology utilized for compositional analysis on pottery. The non-destructive and portable aspects of pXRF are an important consideration when the pottery being tested cannot be physically altered or moved. These qualities of pXRF were necessary for analyzing pottery sherds from the Bayshore Homes site because many of the sherds being analyzed were the property of museums and private citizens.

To date, there has been no compositional analysis of the pottery at the Bayshore Homes site. This thesis serves as a preliminary investigation of the ceramics excavated from the Bayshore site. Two basic, yet pertinent, questions were addressed in an attempt to establish a baseline understanding of the site’s pottery:

1) Are the clay sources utilized in the manufacture of plain utilitarian pottery the same clay sources utilized in the manufacture of decorative burial pottery?
2) Are the same clay sources utilized throughout the site’s occupation? The Bayshore Homes site possesses at least two distinct occupation periods and this line of inquiry looks at possible changes in clay use over time.

Though these are simple questions, they are an appropriate first step in deciphering the rather complex archaeological context of the Bayshore Homes site. Addressing these two questions can advise future research at Bayshore Homes and other contemporary sites in close proximity. Utilizing the results and conclusions of this thesis can also assist in refining future research questions regarding pottery manufacture in Pinellas County and beyond.

Background on Research Area

The Bayshore Homes site, listed as site 8PI41 in the FMSF (Florida Master Site File) is located along Boca Ciega Bay in Pinellas County, Florida (Figure 1). The northern tip of the approximately 35 acre site is located near the mouth of Long Bayou and stretches along the eastern coast of Long Bayou southward into Boca Ciega Bay. The landmarks used to approximate the boundaries of the site are Abercrombie Park in the south, Park St. on the east and Tyrone Boulevard in the north. The mouth of Long Bayou serves as the western boundary of the site. These are the current boundaries of the site, but there are historical accounts (Austin et al. 2008; Sears 1960) indicating that shell middens in close proximity to the known site extended farther north along the eastern side of Long Bayou and possibly south of Abercrombie Park as well. Unfortunately, significant development of this area over the years has destroyed most visible evidence of these prehistoric structures and gaining permission/performing further excavations is a time consuming and expensive endeavor. Due to fluctuating sea levels, it is also
possible that some of the site may be off the Boca Ciega coast and under a few feet of water now. At the very least, the marine areas adjacent to the site were likely utilized extensively by the inhabitants of the prehistoric village for gathering resources.

A majority of the Bayshore Homes site is located within the residential subdivision of Parque Narvaez. This originally excavated area is cataloged as 8PI41 in the FMSF, however newer excavations include a midden in Abercrombie Park (8PI58 in the FMSF) and the Kuttler Mound (8PI10650 in the FMSF), that is located between the midden in Abercrombie Park and

Figure 1. Location of Pinellas County within the state of Florida. The red square outlined within the Pinellas County insert depicts the general location of the Bayshore Homes site on Boca Ciega Bay. A composite of a Pinellas County map enhanced to include the general area of study for this thesis.
the rest of the site in the Parque Narvaez subdivision. The three sites together form the Bayshore Homes Complex, which includes: two burial mounds, one flat-topped platform mound and extensive shell middens running along the shoreline (Figure 2). The Kuttler mound is defined as a large shell mound, but is actually more likely a spoil created by a later occupation at the site. Evidence indicates that this later occupation (starting around CE 900) may have moved midden material from the more northern (earlier) part of the site to the southern end of the site to create the Kuttler Mound (Austin et al. 2008).

Multiple people have made notations on the Bayshore site over time, starting in the later 1800s. Early investigators, like W. Fuller (1972), mentioned the presence of many more mounds than exist today. C.B. Moore (1900) excavated the area around the turn of the twentieth century, however the first professional archaeologist to excavate there was William Sears in the late 1950s. Sears’ excavation centered on Mound B, the larger burial mound at the site, which was located farther inland and closer to the present day Park Street on the eastern side of the site. Sears excavated 118 burials out of Mound B. Sears also took measurements and provided a description for Mound A, the temple mound, but the only other place he excavated was a test unit at the southern end of the shoreline midden. The stratigraphy of this midden unit would lead Sears to make some interesting hypotheses about the occupants of the Bayshore site. The stratigraphy of the unit did not seem to follow the conventional understanding of culture periods in 1950s archaeology. In the unit Sears found pottery types generally associated with later cultures buried beneath pottery generally associated with earlier cultures. In essence, the stratigraphy seemed to be reversed from what would be expected (Sears 1960).
Sears explained this unusual stratigraphy by suggesting an influx of ideas, or actual people, from some unknown southern Glades culture moving into the site after the original occupation, associated with the Tampa Bay region, had abandoned it (Sears 1960). Later excavations performed by CGCAS (Central Gulf Coast Archaeological Society) from 1998-2006, led to a reevaluation of Sears’ ideas. Robert Austin, the Principal Investigator (PI) for the CGCAS
Bayshore Homes site excavation, suggested that the reason for the unusual stratigraphy was because prehistoric inhabitants of the site from a later occupation period engaged in earthmoving activities (Austin and Mitchem, in press; Austin 2008). In short, they dug up older portions of the site and dumped the material on newer/later material, thus creating the seemingly reversed stratigraphy. Current interpretation of the site suggests that a majority of the northern portions of the site, including the northern portion of the shoreline midden, Burial Mound C, and the Ross Rooney mound are more closely associated with an earlier occupation that inhabited the site from approximately CE 150-500. The southern portions of the site, including the Kuttler Mound, and the shell midden in Abercrombie Park, seem to be more closely associated with a later site occupation from approximately CE 900-1350. Temple Mound A and Burial Mound B are tentatively associated with the later occupation as well (Austin and Mitchem, in press). The southern part of the known shoreline midden excavated by Sears in the 1950s appears to have been utilized by both occupation periods. Perhaps the southern part of the shoreline midden had worn down over time and the newer occupation utilized portions of the older occupation to the north to help fortify the southern portion of the site that they were using. The Kuttler mound also shows evidence of being constructed by using older portions of the site. The test unit excavated by CGCAS in the Kuttler Mound uncovered a very complex and rather convoluted stratigraphy. The prevailing hypothesis for the jumbled stratigraphy is that later occupants of the site relocated midden material from the northern/earlier part of the site to construct mounds farther south. If the hypothesis is correct and large amounts of midden material were being moved around the site, one question to ask would be why. Why move significant amounts of material from the north part of the site to the south to create new mounds? Why not just occupy the northern/earlier portion of the site and save the time and effort necessary to transport all that material?
One possibility to explain the earth moving activities could involve sea level rise. Even a relatively minimal sea level rise could have been enough to inundate a low-lying area near the shore. Due to considerable construction over the past decades, it is difficult to discern what the original shoreline looked like, especially in the northern part of the site. It is quite possible that a fluctuation in sea level between CE 500 and CE 900 could have rendered the northern part of the site uninhabitable. A rise in sea level could even explain why the first occupation abandoned the site. Perhaps this is a question that could be answered in the future, as archaeological understanding of sea level change through time improves. Was the apparent relocation of the village southward based on resource availability or territoriality? Though the site is only about a kilometer long, perhaps the estuary off the northern part of the site was overexploited causing the center of the village to shift south. Archaeological evidence suggests that the native population of the area would have increased, and more villages would be present, by the time of the later occupation (Milanich 1994). Did the Bayshore inhabitants of the later occupation move farther south to distance themselves from a village to the north? Or were they moving closer to a village to their south? Two other known archaeological sites that may have been contemporary with one or both of the major time periods associated with Bayshore Homes were the Narvaez mound and the Andersen Mound. What was Bayshore’s connection with these two sites, if any? Considering their proximity to the Bayshore Homes site its seems extremely unlikely that they would have been unaware of each other.

Cultural Periods of Florida

Florida is unique both archaeologically and geologically. Currently, archaeologists believe some of the earliest humans in the United States lived in Florida. Current archaeological
theory suggests there is ample evidence (Brown 1994; Daniel et al. 1986; Milanich 1994) indicating humans have utilized the Florida landscape for about the last 12,000 years, and some suggest even longer than that (Purdy 2008; Rink et al. 2012; Webb 2006). In the Paleolithic period, Florida’s landmass was significantly larger than it is now and more arid with limited fresh water supplies (Figure 3). Many of the earliest human camps were in close proximity to paleo rivers or one of the deep springs in the karstic regions of the state, since fresh water was scarce at that time. Today, many of those early sites are submerged beneath the waters of the Gulf of Mexico. There has also been at least one inundated Paleoindian site found in Boca Ciega Bay, as well submerged sites in Tampa Bay (Goodyear and Warren 1972). Other Paleoindian sites, like Harney Flats are located further inland (Milanich 1994). Most likely there are more submerged sites west of Tampa Bay on the Gulf’s continental shelf. Through the millennia, a slowly evolving climate promoted resource variability and continued modification of human subsistence strategies. The transitions between these different subsistence strategies provide the general timeframes for different prehistoric periods of human evolution.

The transformation from the more nomadic subsistence of the Paleoindian culture (or “lifeway”) to the more sedentary subsistence of the early, middle and late Archaic cultures began between nine and ten thousand years ago. At this time the climate was becoming warmer and more humid and the rising sea level was shrinking the landmass of Florida. Increased access to fresh water, in conjunction with a warmer and more humid climate, supported an increase in the number and size of human settlements. More abundant food and water resources, provided by a more hospitable climate, bolstered a less nomadic lifestyle (Milanich 1994). This more sedentary existence encouraged humans to engage in activities that a more mobile subsistence would not have supported, including a move towards permanent villages and the material expression
of ideologies. It is during the progression from the early to late Archaic period that we begin to see increased evidence of burial practices. Originally, cultural demarcations between distinct lifeways within the larger Archaic period were based primarily on changing tool technologies. More recent research also considers the fluctuations in climate and its subsequent impacts on human subsistence strategies, to further distinguish early, middle and late period cultures within the general Archaic period. It is believed that early archaic sites, like some of the Paleo sites before them, could be located off shore in the waters of the Gulf of Mexico. There is also evidence of archaic sites in the Tampa Bay area, both submerged and terrestrial (Goodyear and Warren 1972; Milanich 1994).
The climate stabilized around 5,000 years ago, and with that stability came the increasing importance of estuaries along the coast that could provide abundant food resources for larger settlements throughout much of the year. Near the end of the Archaic, roughly 4,000 years ago, the first evidence of pottery manufacture appears (Sassaman 1993). Evidence of pottery continues with increasingly sophisticated design throughout the rest of the late Archaic, which ended around 2,500 years ago. Archaeologically speaking, the end of the Archaic period seems to mark the end of a more generalized overview of human history in Florida. After the Archaic period, human settlements become larger and far more sedentary, adapted to local environments with specialized subsistence strategies created to successfully exploit their particular environment (Milanich 1998).

Manasota Period

The Manasota culture was a regional culture confined to the Greater Tampa Bay area and extending south to the top of Charlotte Harbor. The Manasota culture occurred after a Florida Transition culture which, aptly named, covered the transition period between the end of the Archaic and the beginning of various regional cultures marked by unique lifeways based on locally advantageous subsistence strategies (Bullen 1959; Luer and Almy 1982). The Manasota culture begins roughly around 500 BCE, as a regional expression of the post-Florida Transitional period, and after several centuries becomes increasingly influenced by the Weeden Island culture. The Weeden Island related Manasota culture eventually falls under the influence of the powerful Mississippian culture to the north, which leads to the transition of the Manasota culture into the Safety Harbor culture around 800 CE. Luer and Almy originally defined the Manasota culture in the late 1970s to explain a unique type of pottery and settlement structure. People of the
Manasota culture seemed to live in larger coastal settlements, generally found on estuaries in close proximity to terrestrial environments. This allowed for access to both aquatic and terrestrial food sources, which made larger more sedentary villages possible. The coastal manifestation of the Manasota culture often had long middens that ran parallel to the coastline. In between larger coastal communities were smaller less frequently used hunting and fishing sites that probably existed to exploit a particular aquatic or terrestrial resource. It is hypothesized that there were Manasota sites farther inland serving as secondary seasonal sites for the coastal communities. Perhaps these sites were used for a limited time during a part of the year when the estuaries provided inadequate amounts of food for the community. In general, the majority of the year would have been spent near the estuaries on the coast.

The ceramic tradition of the Manasota culture is also unusual. They were known for their thick undecorated Sand-Tempered Plain pottery (STP), which they fashioned into a fairly limited number of vessel shapes, mostly for cooking. In the later Manasota period, the thickness of the vessels would decrease, but would otherwise remain the same in style and dimensions. Examples of this type of pottery have been discovered in the older portions of the Bayshore Homes site. In the early Manasota period, the dead were buried in the shell middens, generally with no grave goods. Any ceramics found near the burials were Sand-Tempered Plain sherds scattered over the general area. As time went on, the Manasota people began burying their dead in sand burial mounds, but there was still little in the way of grave goods. Towards the middle of the Manasota period, there seems to be increasing influence from the Weeden Island culture. This influence led to changes in the nature of the burials, from the early flexed burials in the shell midden to secondary burials in a separate sand burial mound. The Weeden Island culture influence also led to an increasing number of decorated grave goods, such as Weeden Island type pottery, and more
exotic goods. After CE 100 the Manasota culture began transitioning into a Weeden Island related culture, generally incorporating the mortuary practices of the regional Weeden Island culture prevalent in the north. The Manasota culture serves as just one of the many environmentally diverse regional Weeden Island related cultures spread throughout Florida. By around CE 750 the Weeden Island related Manasota culture, coinciding with the late Weeden Island period in other areas of Florida, was phasing out as a new culture from the north began to exert its influence in the Tampa Bay area. (Luer and Almy 1982; Milanich 1994; Austin et al., in press).

Mississippian Influence

A regional variant of the influential and widespread Mississippian culture from the north, led to the Safety Harbor culture centered in the Tampa Bay area, but extending from the mouth of the Withlacoochee in the north to the top of Charlotte Harbor in the south. The Englewood period, lasting for a couple hundred years, seems to be an early phase of the Safety Harbor period restricted to a mortuary complex. The Englewood period was a transition from the earlier Weeden Island related cultures to a culture increasingly influenced by the large Mississippian culture to the north. The Safety Harbor culture represents a regional expression of the Mississippian culture beginning about 1150 years ago and fading away after European contact approximately 500 years ago (Austin and Mitchem, in press; Mitchem 1989).

Recently, the geographic extent of the Englewood period has been questioned (Austin and Mitchem, in press; Austin et al., in press). Aside from some particular types of mortuary pottery: Englewood Incised, Sarasota Incised and Lemon Bay Incised, it is uncertain how widely this culture was expressed and whether it was represented by anything beyond a few decorative
pottery styles. A new synthesis of Englewood culture sites indicate that the traits associated with
the Englewood period were more prevalent at archaeological sites south of the Tampa Bay area.

Historically, evidence of the Mississippian influenced Safety Harbor culture, was based
on traits such as the construction of temple mounds, plazas and the use of Pinellas Plain pottery
(Sears 1960; Willey 1998). More recently, archaeology has provided evidence that suggests
temple mounds were being built long before the Mississippian period and the presence of
Pinellas Plain pottery can be found at pre-Safety Harbor culture sites (Austin and Mitchem, in
press). A transition from Sand-tempered Plain (STP) to Pinellas Plain (PP) as the dominant
utilitarian pottery of a site can be indicative of the Safety Harbor culture, but Pinellas plain
pottery with modified rims (notched or flat-lipped) are more diagnostic of the period. Since the
majority of Safety Harbor utilitarian pottery is undecorated and it is not uncommon to find both
STP and PP at a Safety Harbor site, archaeologists generally have to rely on the decorated Safety
Harbor period pottery in burial mound associations to comfortably identify a Safety Harbor
component at a site (Austen and Mitchem, in press; Mitchem 1989).

Once again, as with the earlier Weeden Island related cultures spread throughout the state,
the regional variants of the Safety Harbor culture shared mainly mortuary practices and pottery
types, but had significantly different subsistence strategies based on their varied environments.
Despite external ideological influences from other cultures, it seems a dominant feature in every
culture that utilized the Tampa Bay coasts was a subsistence strategy based on estuaries and
adjoining terrestrial areas. Exotic cultures may have influenced aspects of the Tampa Bay
cultures, particularly mortuary practices, but the extent to which external ideas were adopted was
likely filtered through their local subsistence strategies.
It is important to note that the above overview of human occupation in Florida is both very brief and very general. The information given above serves as a rough framework for the history of cultures. In reality, humans are individuals and it is highly unlikely that human societies throughout history were concerned or even aware that the prevailing themes, ideas, technologies, subsistence strategies and climate that existed in their time were part of some greater cultural system archaeologist would one day use to “define” them. This means that the dates of cultural change are not exact and can vary not only by regions, but also by individual communities. The adoption of new technologies and ideologies were most likely not sudden or complete. Human societies existed within their own understanding of the world and adapted to it as best as they could. An individual settlement could be the text book example of their archaeologically defined time period, or they could be an anomaly that has been successfully carbon dated to a particular time period despite having no material culture representative of the “culture” period they existed in. The purpose in belaboring this point is because the Bayshore site is a bit anomalous in its own right, particularly regarding the second (later) occupation which “should” correspond to the Safety Harbor period, but really exhibits limited evidence of that culture (Austin et al. 2008). The later occupation at Bayshore has been technically associated with the Englewood period, a transitional period before the Safety Harbor culture, which seems to be predominantly expressed through mortuary practices. However, the current definition of the Englewood period is evolving as new research questions the regional extent of the period (Austin et al., in press).
In essence, the Florida terrain was formed by water. The repeated inundation of the Florida landscape through the millennia created the hilly inland areas of central and northern Florida, which are actually ancient sand dunes. During periods of higher sea level, the movement of water across the land flattened certain areas creating level plains, and long-term inundation of these areas led to shallow seas surrounded by swales of land. In times of lower sea levels, the retreating waters led to erosion of the interior landscape, which was then re-deposited along the shores creating a complex and convoluted shoreline. The Florida landscape has been flooded multiple times over millions of years, shrinking and expanding the landmass from a large island to something about twice the current size of Florida. The relatively flat terrain with elevations barely above sea level in most places means that when sea level rise occurs, a modest rise in the water level can make a vast difference in the amount of landmass. The low flat terrain and limestone substrate allows for a coastal environment with many marshes and estuaries, and an interior filled with lakes, rivers and swamps. A significant portion of southern Florida is basically a large slow moving river with scattered cypress dome islands, though the original movement of the Everglades have been impaired by human activity. A karstic environment, created by the dissolution of the limestone substrate, is prevalent in northern Florida. Limestone erodes more easily than most rock, which can create sinkholes in locations where the limestone substrate is closer to the surface. Springs and deep pools are often found in these karstic areas, and in Paleolithic times, often served as an oasis for early humans in an arid and harsh climate. In addition to the incredible impacts of sea level change, a significant portion of the geology of the Florida gulf coast was influenced by periods of tremendous sediment runoff carried by large
rivers from mountainous regions farther north of Florida to the gulf coast and its surrounding waters (Hine 2013; Randazzo and Jones 1997).

The large amount of erosion that has occurred with every inundation and retreat of the sea, and the relocation of massive amounts of sediment from mountains to the north, has left a large portion of Florida “sediment starved”. A considerable portion of the Florida landscape has poor quality soil, ill suited to large-scale agriculture. In general, the soils of the Tampa Bay area and coastal points south, are of poor quality. The poor quality of the soil is probably a reason why there is little evidence of an agricultural subsistence strategy for prehistoric people in the central and south gulf regions, especially in comparison with their more northern and eastern contemporaries. Despite the poor quality of soil in portions of the state, the climate and temperature of Florida were relatively hospitable to human occupation, particularly by the Archaic period. Thus, humans occupied the Florida landscape thousands of years ago, and flourished through time.

One of the interesting characteristics that make Florida unique from the rest of the United States is the origin of the Florida platform that supports the landscape we know today. Geologically speaking, the substructure of Florida was once part of Western Africa. The supercontinent of Pangea began breaking apart approximately 200 million years ago. The ancient continent of Africa was meshed with the ancient continent of North America and as Pangea began to break apart, a piece of Africa stayed attached to the southeastern part of North America while the rest of the African continent moved away. This part of Africa that was left behind would eventually separate further, becoming Florida, the Bahamas and the Yucatan Peninsula (Hine 2013; Randazzo and Jones 1997).
Aside from being fascinating geologically, the origins of Florida are also interesting from a clay-sourcing perspective. Since the early formations of the Florida platform, large amounts of material from the Appalachians and other points further north of Florida have flowed into the state covering the substrate with layers of exotic material, sometimes hundreds of meters thick. Based on my current understanding of the geology and chemistry of the Florida landscape, I am uncertain how the elemental composition of local clay sources would be impacted by the combination of: an African substrate; covered with a northern effluvial; numerous marine sediment inundations and the continual relocation of sediments through erosion.

What is more certain is how the combination of all these factors has led to a subtle and extremely complex landscape, with significant amounts of chemical variation over relatively small areas. When one adds the overwhelming human alterations to the landscape in certain densely developed areas, it becomes clearer why finding discrete clay sources on the landscape to match with particular ceramics from a site, is a difficult endeavor.

Geology of Pinellas County

Pinellas County lies on the southwestern part of the Ocala Platform, underlain by a series of limestone formations. The Suwannee formation runs underneath the entire county, while the Tampa and Hawthorne limestone formations sit on top of it and actually reach the surface. The Suwannee, made of granular limestone, is the oldest formation associated with the county and is about 30 meters below the surface in the north part of the county and drops to about 76 meters below surface in the southern part of the county (Pinellas County Planning Department 2008; Randazzo and Jones 1997).
The Tampa formation also covers the county, but in parts south of Palm Harbor and Safety Harbor it dips down below the Hawthorne formation, which can be found near the surface in the southern portion of the county. The Tampa formation is a hard limestone, mixed with sand and phosphate. The Tampa formation contains many solution channels, openings where the limestone has dissolved over time. It is for this reason that sinkholes are prevalent in the northern part of the county. In comparison, the Hawthorne formation is primarily made of sandy clays. It is actually these sandy clays that decrease the number of sinkholes found in the southern part of Pinellas County. The clays in the Hawthorne formation help to slow the heavy rains characteristic of Florida and impede the fast percolation of rainwater, which dissolves the limestone substrate through a process called carbonation. Limestone is made of calcium carbonate. The surface deposits found on top of the Tampa and Hawthorne formations are not generally influenced by the underlying geology of the area, but are primarily caused by redistribution of marine sediments through sea level changes over time. These fluctuations in sea level have resulted in the creation of four marine terraces within Pinellas County, each corresponding to a particular sea level (Pinellas County Planning Department 2008; Randazzo and Jones 1997). The marine terraces primarily consist of shell and sand, with some clay deposits and organic matter. The combination of marine inundations, and heavy rains that leach away minerals, has resulted in a sediment-starved landscape that provides poor quality soils for agricultural purposes. This fact provides a realistic explanation for the relative absence of prehistoric agriculture in the Pinellas County area. The geology of Pinellas County probably made agriculture untenable for prehistoric people, but the existence of the Hawthorne formation in the southern part of the county could have been beneficial to those interested in pottery
manufacture, although the availability and quality of the sandy clays probably varied throughout the area.

*Research Questions*

As mentioned earlier in the Introduction, the two research questions focus on the utilization of clay sources for pottery manufacture. One is the question of whether the clay sources being utilized at the site altered through time. Since archaeological evidence indicates that there were at least two distinct occupations at the site, separated by a few centuries, were they using the same clay sources the whole time?

The second question looks at clay source use between decorated and plain pottery. In the early stages of the first occupation, which was during the Manasota period, the use of decorative pottery in a mortuary context, or indeed any context, is rare. However, as the local Manasota cultures are increasingly influenced by the Weeden Island culture to the north, there is an increase in the amount of decorative pottery utilized in burials. The question then is whether the decorative pottery found at the site came from the same clay sources as the plain pottery found at the site.

A corollary to both of these questions is, if there are differences in the clay sources utilized, whether through time or by pottery style, could any of the clay sources be exotic? Based on the complex nature of Florida geology and the time constraints of this thesis, there was no attempt made to locate clay sources on the landscape to compare to the analyzed Bayshore pottery samples. Preliminary statistics will be performed on some previously pXRF analyzed pottery from other Florida sites located a considerable distance from the Bayshore site. These
additional statistical analyses will be performed to aid understanding of how elemental composition differs between sites from significantly different areas of the state.

The remainder of this thesis will begin with Chapter 2, providing a more in-depth look at the Bayshore site and its historical context. This chapter will also include a general overview of the previous research that has been executed in the area of pXRF analysis of pottery. Chapter 3 will focus on the methods utilized to collect and analyze the ceramic data, including the statistical analyses performed. Chapter 4 will provide the results of the statistical analyses, while Chapter 5 will discuss the possible conclusions that can be drawn from the pottery analyses. The final chapter will provide suggestions for possible future research that can build upon the work performed in this thesis and enhance our understanding of the Bayshore site and its place in the larger picture of prehistoric Florida archaeology.
CHAPTER TWO
HISTORICAL OVERVIEW

“The Bayshore Homes site was one of the major sites of the aboriginally crowded Tampa Bay area in terms of size, midden depth, and number and size of structures. In spite of this, there are no previously published references.” – (Sears 1960:1)

Bayshore Homes

The known boundaries of the Bayshore Homes site (8PI41) have been expanded over time. In the late 1950s when William Sears excavated the site, the area included two burial mounds (Mound B and Mound C), a temple mound (Mound A) and a shell midden running parallel to the coastline (Figure 4). Sears mentions a little unnamed creek that cuts through the northern part of the shoreline midden and meanders inland past the interior mounds. This creek still exists and demarcates a portion of the northern boundary of the site. Whether the creek existed during the prehistoric occupation of the site is another question. The majority of Sears’ excavation took place in burial Mound B; it appears he was not even aware of burial Mound C until shortly before he left the site. In his report, Sears discusses the importance of the large site despite its relative obscurity. He attributes the site’s archaeological obscurity to the dense vegetation cover along the western part of the site and the inhospitable terrain, which hosted a significant rattlesnake population. In contrast, the interior of the site was far more sparsely vegetated, particularly near Mound B and points farther east. Quite possibly, the less intrusive vegetation encouraged Sears to focus his excavation on Mound B.

The Central Gulf Coast Archaeological Society (CGCAS) performed a second set of excavations, from 1998 – 2006, as part of a survey and National Register evaluation. During this
second set of excavations, spanning eight years, the size of the site was expanded to the south to incorporate a midden, within the city owned Abercrombie Park (8PI58), and the Kuttler Mound (8PI10650), located within the Parque Narvaez subdivision on a resident’s private property. The 2008 report, created from the CGCAS excavations, refers to this newly expanded site as the Bayshore Home Site Complex. It is quite possible that the site is even larger, perhaps extending further to both the north and south along the shoreline (Austin et al. 2008; Sears 1960). Archaeological notations on the area from the late 1800s and early 1900s indicate that there were a significant number of shell middens running parallel to large portions of Boca Ciega Bay and up into Long Bayou. There is what appears to be a contemporary site south of the existing Bayshore Homes Site Complex, called the Anders site (8PI1252), which may be a continuation of the Bayshore Homes coastal midden. To date, no significant work has been done there. Unfortunately, significant development beginning in the twentieth century has destroyed many of these prehistoric structures. A majority of the excavations and survey work performed by the CGCAS were in the yards of subdivision residents. Despite the large amount of construction in the area, a surprising amount of the prehistoric Bayshore Homes site still exists within the Parque Narvaez subdivision.

Temple Mound A is a flat topped temple mound, pyramid shaped with a ramp on its southern side. This mound was destroyed during the creation of the Parque Narvaez subdivision. According to survey information, the temple mound was 45.7 m wide, 53.3 m long, and ranging between 4.6-5.5 m in height. There is now little remaining evidence of the mound, and what parts of the mound still exist are currently eroding into the unnamed creek on the northern border of the site.
Mound B, the larger burial mound on the site, was the focus of Sears’ work at Bayshore. The mound was partially destroyed by his excavation work and today a house sits on top of what remains. He excavated 118 mainly flexed burials out of Mound B and found little in the way of grave goods. The minimal amount of pottery that was recovered from the excavation was undecorated. The burial mound was situated 91 meters southeast of Mound A. When originally surveyed the mound was approximately 51.8 m wide, 45.7 m long and about 6 m in height. The burial mound was constructed in stages and, based on the CGCAS analysis of the scant pottery excavated, is probably more likely associated with the later occupation at the site.
Mound C was located 106.7 m west of Temple Mound A, and was about 15.2 m diameter and a diminutive .9 m tall. Sears determined that the mound had been destroyed by heavy machinery, though people continue to find artifacts in the mound today. A small portion of it still exists under brick pavers in a residents yard. Sears did obtain a small surface collection of pottery from the area, with several forms of decorated pottery including varieties of check stamped, complicated stamped and various Weeden Island types. Based on these artifacts and some human bones found at the Mound C site, Sears interpreted the mound as being related to the Weeden Island culture and having been utilized for a prolonged period of time. Mound C, unlike Mound A and B, is generally believed to be more closely associated with the earlier occupation of the site. Frank Bushnell, an amateur archaeologist who lived near the Mound C site, collected the majority of Mound C pottery available for current archaeological analysis. He is not a professional archaeologist, but he is familiar with the scientific method (as a biology teacher) and acquainted with multiple archaeologists. He published several articles based on his own work at Mound C and recorded his observations on the context of the artifacts and burials he unearthed. Bushnell was not a looter and took his research seriously, however the validity of his findings remains questionable because he is not a professional archaeologist. The hope was to analyze Bushnell’s Mound C sherds and compare them with the Mound C sherds that Sears surface collected during his work at Bayshore in the 1950s. If the elemental compositions between the two sets were statistically similar, it would have provided an additional level of verification that the Bushnell sherds were, in fact, from the area he claimed they were. Unfortunately, due to NAGPRA concerns with analyzing burial associated pottery, the Mound C sherds at the Florida Museum of Natural History (FLMNH) could not be analyzed. Despite the unavailability of the Sears’ collection of Mound C sherds, the analysis of the Bushnell pottery
was utilized in this thesis for multiple reasons. For one, the Bushnell’s Mound C pottery sherds were the largest collection of decorated pottery available for analysis. The Kuttler mound also had a significant amount of decorated sherds, but all the Kuttler Mound sherds are part of a private collection and the owner was not comfortable allowing access to the decorated pottery. She did however allow access to the plain ware sherds, some of which were analyzed. The second reason for using the Bushnell Mound C collection is because that is the only accessible pottery from a burial mound. Sears did most of his excavating in the larger more intact Mound B, but there was a definite dearth of artifacts in general. The general hypothesis was that by the time Mound B was in use it was towards the end of the Weeden Island period when mortuary practices were shifting away from burials accompanied by decorated pottery. Being able to access a burial mound with accompanying decorated pottery is an important element for one of the research questions, since any potentially exotic pottery found at the site would most likely be tied to a mortuary context. The final reason for using the Bushnell Mound C pottery is because, the principal investigator of the Bayshore Homes site report (R. Austin) has personally spoken with Bushnell and has expressed confidence in the accuracy of his statements regarding the authenticity of the pottery sherds in question (personal communication with Robert Austin 2013). Of course, one could also question the validity of the “authenticated” Sears Mound C collection, because it was only a surface collection of about 30 pottery sherds, some of which could have been moved or dropped there as opposed to actually being associated with Mound C burials. Potential concerns regarding the provenance of the Bushnell collection will be kept in mind when drawing conclusions from the statistical analyses of the Bayshore pottery. Analysis of the Sears Mound C pottery will be performed should the collection be made available by the
museum. Portable XRF analysis was performed on twenty-five (25) sherds from Bushnell’s Mound C collection.

The Shoreline Midden extends from the southern boundary of Abercrombie Park to slightly beyond the unnamed creek in the north. During Sears’ 1950s excavation, a 10x10 ft unit was placed in the southern portion of the shoreline midden. The location of the midden unit was based on elevation, he wanted to excavate in the area with the highest elevation to ensure the fullest picture of the midden stratigraphy possible. The unit excavation of the midden revealed an unusual stratigraphy that caused some confusion and resulted in Sears’ forming an interesting theory to explain it. The stratigraphy was the opposite of what one would expect archaeologically, with the pottery generally associated with an earlier period overlaying pottery generally associated with a more recent period. Sears suggested that the late pottery was actually evidence of a more southern culture influencing the local area, if not outright occupying the area after the older occupation had abandoned the site. The CGCAS excavations of the 2000s (Figure 5) led to the formation of a far simpler explanation to explain the unexpected stratigraphy. The later, more recent occupants of the site dug up and moved older portions of the site to the location where Sears happened to dig. Perhaps they were building up the southern portion of the shoreline midden by using sections of the older occupation, associated with the northern part of the site, as building material. This would seem to be a more reasonable explanation for a pottery assemblage dominated by Sand-tempered Plain (a pottery style associated with pre Safety Harbor culture) overlaying a pottery assemblage dominated by Pinellas Plain (a pottery style often associated with a Safety Harbor culture). There was also a subset of unusually thick STP pottery (greater than 1.5 cm) discovered at the site. In the midden unit excavated by Sears most of the thick STP excavated came from the upper levels of the unit, which with a reversed stratigraphy
Figure 5. A composite of a Bayshore Homes Complex site archaeological survey map (denoting all test units and shovel tests performed by the CGCAS) overlain on a 1975 SWFWMD aerial survey of the Parque Narvaez subdivision and Abercrombie Park. Created by Robert Austin.
would correspond to the older levels. This would make sense because thick STP pottery is associated with the Manasota culture period, which would correlate to the earlier occupation of the Bayshore site. Charcoal carbon dates from these upper levels of the midden unit give a time frame of CE 200 – CE 400.

Twenty-eight (28) sherds were analyzed from the Sears’ Shoreline Midden collection, housed at the FLMNH in Gainesville. The initial sampling strategy planned for the shoreline midden pottery was altered when it was determined that the Sears’ Mound C pottery collection, also housed at FLMNH, would not be available for pXRF analysis. The Sears’ Mound C pottery collection would have increased the number of decorated sherds analyzed for this thesis. In an attempt to compensate for this loss of decorated pottery in the Bayshore analysis, any rare or decorated sherds within the Sears’ midden unit collection were analyzed. In addition to any decorated or rare sherds available, STP, PP and Wakulla Check Stamped pottery were also analyzed to compare with other areas of the site. Within the pottery collection from the Sears midden unit, analysis was focused on pottery from three levels within the unit. A level from the upper, middle and lower portions of the excavation unit were chosen to improve the likelihood of analyzing pottery from both hypothesized occupation periods.

Test Units from CGCAS Excavations

Test Unit 1 was established at the northern end of the shoreline midden near a positive shovel test that yielded midden deposit and possible wood fragments. The unit was placed to the east of the midden ridge and was excavated to a maximum depth of 100 cm on the west and 80 cm on the east. The unit contained a rather complex stratigraphy, suggestive of a context that had been disturbed by natural and/or manmade activities. There is generally little in the way of
artifacts or faunal remains for this unit, but the recovery of a few diagnostic sherds place this unit in a post CE 700 time frame consistent with the later occupation of the site. No pottery was analyzed from this test unit.

**Test Unit 2 (TUT)** was located in the northern portion of the shoreline midden, just east of the midden’s center. CGCAS chose this spot for a test unit after a shovel test in that area yielded pottery, shell and faunal remains. The test unit was excavated to a maximum depth of 101 cm on the western side and a maximum depth of 90 cm on the eastern side. Pottery was found throughout the excavation, with STP dominating the assemblage and PP represented by only slightly higher amounts than St. Johns Check Stamped. There were several other types of pottery in small amounts, including several varieties of plain ware and cord marked pottery as well as sherds of Wakulla Check Stamped. Though the stratigraphy of this unit was less complex than some of the other units excavated, it did possess human remains (about 70 cm down). This discovery curtailed the amount of excavation possible within the unit. It appears that the burials were in fact, reburials. The current interpretation of the unit is that the burials were probably pre CE 700, most likely from the earlier occupation. The bodies were dug up, intentionally or accidentally, during the later occupation and reinterred in the current location. The upper portion of the unit contains several diagnostic sherd types associated with post CE 700 cultures. For instance, check stamped pottery of various types is considered to be diagnostic of post- CE 700 cultures. Below 70 cm, STP and PP were found. Pinellas Plain pottery is associated with post CE 700 cultures, but its discovery in lower levels of the unit could have been the result of later occupation pottery sherds being accidentally included during the reinterment of the bodies. Fifteen pottery sherds were analyzed from this sub-site.
Test Unit 3 was located on an elevated area further inland from the other test units, between the shoreline midden and Mound B. The area was chosen for a unit because a previous shovel test in that area yielded evidence of a possible interior shell midden. The unit was a 1x2 m. The maximum depth of the excavation was 78 cm in the northern half of the unit. To analyze the faunal remains of a suspected pit feature, a 50x50 cm column sample was taken from the area. A series of posthole tests were also performed in the area to discern the dimensions of the suspected shell midden. The posthole tests indicated there was a shell midden that ran north-south for about 10 meters, with a maximum height of 36 cm in the area near Test Unit 3.

Excavation within the test unit revealed a midden with jumbled strata due to looting activities. The significant disturbance to the area means that the original context of any prehistoric artifacts has been lost. In Test Unit 3, STP was the dominant pottery type and there were no PP sherds found. However, the CGCAS investigators still consider this area of the site to likely be associated with the later occupation because of the presence of St. John’s Check Stamped pottery. Check Stamped pottery in general, is considered a post-CE 700 pottery style. No pottery was analyzed from this test unit.

Test Unit 4 (TUF) is situated about 30 m west of Test Unit 2 and incorporated a previous shovel test into the unit’s 1x2 m dimensions. Like Test Unit 2, human remains were also found in the lower levels of this unit (at 86 cm). Test Unit 4 was the most productive of the four test units placed in the northern part of the Bayshore site, containing significant quantities of ceramics and faunal remains. There were over 500 pottery sherds recovered from the unit. As with most areas of the site, STP was the dominant pottery type discovered, followed by PP. The artifact assemblage in this unit is similar to the Test Unit 2 and Kuttler mound assemblages. Like Test Unit 2, there is an absence of decorated pottery in the lower levels, in particular the check
stamped pottery generally associated with post-CE 700 times. This suggests that the lower levels of the midden in the northern area of the site, correspond to the older occupation (pre-CE 700) and the higher levels correspond to the younger occupation (post-CE 700). Twenty sherds were analyzed from this sub-site.

The Ross Rooney Mound was located in a Parque Narvaez resident’s backyard. It was a small shell mound situated along the same general line as the shoreline midden. It is uncertain whether the small shell mound was originally part of the shoreline midden or a separate prehistoric structure. It is also uncertain how much the structure was altered during the construction of the house that now occupies the area. The multiple shovel tests performed by the CGCAS indicated the shell mound was at least 14 meters in diameter and 1 meter high. About a year after the shovel tests were performed, the owners of the property removed the mound and allowed CGCAS to salvage artifacts during part of the demolition process.

A test pit was also dug along the northern edge of the Ross Rooney mound before its complete demolition to study the submound stratigraphy. The underlying stratigraphy of the Ross Rooney mound was similar to the stratigraphy of the shoreline midden, but different from the stratigraphy of Test Units Two and Four. This is interesting considering that Test Units Two and Four, located in the shoreline midden, were fairly close to the Ross Rooney mound. Sand-tempered Plain dominates the ceramic assemblage of the Ross Rooney mound. Amongst the pieces of pottery that were salvaged, there was evidence of pre CE 400 sand tempered vessels with restricted orifices. There were also several examples of very thick (greater than 1.5 cm) Sand-tempered Plain pottery, reminiscent of the thick STP found in the older levels (carbon dated CE 200 – CE 400) of Sears’ shoreline midden unit located further south. The occurrence of that same unusually thick STP at the Ross Rooney site, in combination with the site’s almost
complete absence of check stamped pottery suggest limited use of the Ross Rooney site during the later occupation. The presence of the very thick STP sherds is suggestive of the Manasota period. I analyzed 15 sherds from surface collected from the area.

The **Kuttler Mound** is a large shell mound, located just north of Abercrombie Park, at the southern end of the Parque Narvaez subdivision. CGCAS analyses of the Kuttler mound suggest that the “mound” is probably more accurately referred to as a spoil, created by the relocation of midden/mound material from other parts of the Bayshore site. The Kuttler mound is about 75 m long, 30 m wide, and 2 m high. There is currently a residence on top of the mound. The CGCAS placed a 1x2 m unit on the mound’s upper southern slope, with most of the excavation being done with trowels due to the “extremely complex” strata (Austin et al. 2008:25). The unit revealed evidence of multiple features as well as several areas of discarded material, which is what led CGCAS archaeologists to the supposition that the Kuttler Mound was really a spoil formed from “haphazard dumping of shell and refuse” (Austin et al. 2008:29). However, this hypothesis is only a preliminary interpretation based on the limited excavation done at the mound so far.

The Kuttler Mound excavation yielded lithics, shell and bone pieces, faunal remains and over 1500 pottery sherds. Sand-tempered plain pottery accounts for over 50% of the ceramics, with Pinellas Plain comprising about 30%. The Pinellas Plain is slightly more prevalent in the upper levels of the midden. Shell-tempered pottery, St. Johns Check Stamped and Wakulla Check Stamped are also more likely to be found in these levels. There are small amounts of various decorated Weeden Island pottery types that are also associated with a post CE 700 periods. Three radiocarbon dates were obtained from the mound, that place its use between CE 1010 and CE 1260. This indicates the Kuttler Mound was created and utilized during the later,
and most likely, last pre-contact occupation of the site. There were a surprising number of disk beads and bead blanks found throughout the Kuttler Mound excavation, suggesting there was substantial bead production occurring during the later occupation of the Bayshore site.

Though there was a substantial amount of Pinellas Plain excavated from the Kuttler mound, it is still not the dominant pottery type. The carbon dates, mentioned above, indicate the mound falls within the timeframe generally associated with the Englewood and Safety Harbor periods. One of the characteristics of a Safety Harbor period site is the dominance of Pinellas Plain pottery. The continued dominance of Sand-tempered Plain at the Kuttl er Mound, during these late pre-contact time periods, when much of the Tampa Bay area had transitioned into the Safety Harbor culture, illustrates one of the curiosities of the Bayshore site. Twenty-five (25) sherds were analyzed from the Kuttler Mound. The sherds were excavated by stratigraphic level, but given the convoluted nature of the Kuttler Mound stratigraphy it is unlikely the stratigraphic context of the Kuttler pottery is comparable to the stratigraphy of other prehistoric structures on the site.

Other Prehistoric Structures

South of the Kuttler mound in Abercrombie Park, there was a small shell mound inland, and on the coast what appeared to be a continuation of the Bayshore shoreline midden. CGCAS conducted a series of shovel tests throughout Abercrombie Park to determine the extent of the prehistoric structures. Based on this survey and analysis of private artifact collections, it was determined that a portion of the Abercrombie Park shoreline midden was contemporaneous with the Kuttler mound. There was one sherd of Pinellas Plain with a notched lip found in the Abercrombie midden, which is a pottery style actually associated with the Safety Harbor period.
The CGCAS report indicates that this type of Pinellas Plain pottery was also found at the nearby Anderson/Narvaez site (8PI54) and carbon dated to around CE 1400 or later (Austin et al. 2008:36; Mitchem 1998, Tykot 1998). Unfortunately, a single sherd is hardly conclusive evidence of a culture period and could have been dropped there at any point before the archaeological excavation. The small shell mound located inland in Abercrombie Park was mostly demolished and used to create a walkway. According to a local avocational archaeologist, Frank Bushnell, the now defunct shell mound in Abercrombie Park was originally connected to Temple Mound A, located at the northern end of the Bayshore site, by a shell causeway. Other features were discovered during a comprehensive shovel testing survey of the Parque Narvaez area, including evidence of shell middens east of the shoreline midden, which could be related to the shell causeway mentioned by Bushnell. The survey also uncovered evidence of lithics, indicative of an earlier archaic occupation at the site. The implications of the survey and excavation work done at the greater Bayshore site by CGCAS are that the Bayshore site is larger than previously thought; has been an area of intermittent occupation for thousands of years; and, despite the intense levels of development in the area, is still a site with valuable archaeological information to offer.

Terrain of the Bayshore Homes Site

The Bayshore site sits on the edge of a coastal ridge system along Boca Ciega Bay. The terrain generally slopes from east/inland to west/coast. The eastern border of the site near Park Street is approximately 2.7 meters higher in elevation than the coastal areas just east of the shoreline midden. A secondary ridge near the middle of the site interrupts the natural change in elevation from the interior to the coast of the site. There are two small creeks, one near the
northern border of the site, and one separating the Parque Narvaez subdivision from Abercrombie Park in the south. The largest existing wetlands are in the northwest portion of Abercrombie Park at the southern end of the Bayshore site. Before modern land alterations there were likely more wetland areas on the site, which could have influenced the areas of prehistoric site occupation. Subsistence data from the site excavations indicate significant exploitation of the available estuaries in Boca Ciega Bay as well as utilization of some interior fresh water and terrestrial resources. In addition to Boca Ciega Bay, there is also Long Bayou, which is a waterway that extends to the north. Long Bayou is in close proximity to Bayshore and probably provided the occupants of the site with additional wetland resources. West of Boca Ciega Bay are a set of barrier islands that stand between the bay and the Gulf of Mexico. It is possible that the inhabitants of the Bayshore site also could have utilized these islands and the Gulf beyond them for additional marine resources. Between the ample wetland and marine resources to the west, and the terrestrial sources to the east, the Bayshore site appears to sit in an enviable location that would have provided a rich array of foods to anyone living there. Stable isotope analysis of skeletal remains at the site, has suggested some level of maize use in the local diet, but there has been no conclusive evidence of maize production at the site (Austin et al. 2008). Any significant production of maize seems unlikely given the overall poor quality of the local soil.

The local soils include Orlando fine sand by the coastline, which is a poor draining soil prone to flooding. Orlando fine sand generally supports vegetation like Oak, Pine, Palmettos and woody shrubs. The secondary interior ridge towards the middle of the site consists of Paolo fine sand, which normally provides an environment favorable to a xeric landscape consisting of Sand Pine, Turkey Oak, Palmetto and grasses. Soil in the eastern part of the site has been defined as
Immokalee Complex. Like the other soils in the area, it is sandy and poor draining. It would normally have supported a Pine Flatwoods environment, but the Immokalee fine sand in the eastern part of the site has been significantly altered by urban development (Austin et al. 2008:9). None of the soils on the site are suitable for large-scale agriculture. The current vegetation of the site has been largely altered, with most of the understory removed and many non-native species of trees, shrubs and grasses in use throughout the residential neighborhood and the landscaped Abercrombie Park. There is evidence, from the shoreline midden, that Bayshore may have been inundated by floods during the prehistoric occupation periods. It is uncertain how much these floods could have altered the original stratigraphy of the site.

The results of the research conducted at the greater Bayshore site have led to some interesting questions. One of the primary questions revolves around the general lack of evidence for an Englewood or Safety Harbor culture at Bayshore, despite the dates of the second occupation being in the time frame generally associated with that cultural period in the Tampa Bay area. This anomaly prompts the question of why the Bayshore site seems to be lagging behind other contemporaneous prehistoric sites in close proximity to it. Is there a reason that evidence of the Safety Harbor culture seems largely absent from the Bayshore site? The apparently prolonged Weeden Island related period at the site has also supported the recent hypothesis that the Englewood phase of the Safety Harbor period may not have been as widespread as originally thought. A recent paper discusses the possibility of the Englewood phase originating farther south and being less influential in the Tampa Bay region (Austin et al. 2013). The pottery analyses performed for this thesis will hopefully further our understanding of pottery manufacture at the Bayshore Homes site.
It is not the intention of this thesis to reiterate every detail of the Bayshore Homes site report. I have attempted to give adequate background on the site and its features to provide a framework for my research. The original Sears report and the more recent Bayshore Homes Site report, derived from the extensive work performed by R. Austin and the Central Gulf Coast Archaeological Society, can provide a comprehensive assessment of all the archaeological work performed at the site. This thesis focuses on the analysis of pottery from six different areas within the larger Bayshore Homes Complex: the Burial Mound C private collection of Frank Bushnell; the Sears shoreline midden unit; and the Kuttler mound, Ross Rooney mound, Test Unit 2 and Test Unit 4, which were surveyed during the CGCAS excavations.

Literature Review

Pottery is a popular material to study for multiple reasons. It is rather ubiquitous; both being a common object found at a majority of sites after the archaic period and also because it is a material that tends to survive in the archaeological record. Though vessels are not always found intact, the broken sherds of those vessels are commonly occurring artifacts. Pottery is also commonly used by all levels of a society, providing archaeologists with a broader view of culture. There may have been differences in the quality, functionality and style of the pottery used, but all members of a society seemed to utilize it in some form. The various methods of studying pottery can provide different types of information. Pottery studies can inform our understanding of manufacturing methods including: the clay sources and tempers utilized; the technological skills of potters; firing techniques; and the levels of production within a community. The types and styles of pottery created can provide insight into a society’s ideology; the degree of stratification within a society; their subsistence strategies and their food preparation techniques.
Pottery can be used to study all theses different aspects of a society both synchronically and diachronically. In the case of this study, pXRF has been employed to analyze the composition of pottery sherds, and explore synchronic and diachronic questions about clay source utilization at the Bayshore site.

In a recently published paper by Frahm and Doonan (2013), they prepared a literature review of peer reviewed pXRF papers in an attempt to determine what, where and why researchers were utilizing pXRF for their work. Frahm and Doonan looked at 200 papers from not only the field of archaeology, but also other fields such as Museum Curation and Environmental Testing. One interesting fact discussed in the paper is the rather varied definitions of what constitutes a portable XRF device. Of the subset of archaeological papers utilizing “pXRF”, less than 50% state they used a handheld pXRF, which is a fundamental characteristic of a true pXRF (Frahm and Doonan 2013:1428). The other papers utilized various types of benchtop units that could be moved, but could definitely not be easily carried around an archaeological site for quick evaluation of artifacts or geological materials (Frahm and Doonan 2013:1426). The vast majority of papers that specifically used a handheld pXRF involved environmental testing research and not archaeology (Frahm and Doonan 2013:1428). Also, the most significant use of any type of pXRF machine on archaeological materials was focused on obsidian or other lithics (Frahm and Doonan 2013: 1430). The summation of the above statistics is that pottery sourcing studies, employing true pXRF, make up a very small percentage of the original 200 papers that were surveyed for the recent Frahm and Doonan article. The nascent status of pXRF and the uncertainty regarding pXRF’s effectiveness means there are a limited number of ceramic provenance, or sourcing studies, that have been completed and published. The studies that have been published tend to fall into one of two categories, pXRF provenance
studies where pXRF is used alone or as a complement to other methods of pottery analysis; or studies that focus on the viability of pXRF as a suitable tool for pottery analysis.

Of the various papers testing the validity of pXRF, several of them seemed encouraged by the results of their analyses. Often the ceramics in question, which ranged from Corinthian amphorae (Barone et al. 2011) to Asian glazed sherds (Mitchell et al. 2012), have been analyzed with a more established technique like instrumental neutron activation analysis (INAA). The pottery was then re-analyzed using pXRF and the two methods were compared to determine if similar composition categories were established for both methods. In many cases the researchers deemed the two sets of analyses comparable (Barone et al. 2011; Bonizzoni et al. 2010; Mitchell et al. 2012; Morgenstein and Redmount 2005). Though destructive techniques like inductively coupled plasma-optical emission spectrometry (ICP-OES) and INAA are definitely more comprehensive for compositional analyses than the non-destructive method of pXRF, the resulting source groups created from the pXRF analyses were mostly consistent with the other more destructive techniques. The results and conclusions of these projects suggest that the success of pXRF depends on the research questions being asked. Portable XRF often seems to be a sufficient method of analysis when the goal is to simply separate pottery into groups based on their elemental composition, which should correspond to specific clay sources used in manufacture. However, if the research questions were to involve an in depth understanding of the pottery composition, a more comprehensive method would be prudent.

Not every researcher was as impressed with pXRF’s capabilities. Speakman et al. (2011) lamented the limited number of elements pXRF was capable of measuring, as well as the inferior level of precision and accuracy offered by pXRF in comparison with INAA. Articles by Shackley (2010) and Goodale et al. (2012) are not about actual provenance studies utilizing
pXRF. Instead they discussed the promising possibilities for pXRF in the future, but also the potential pitfalls of inappropriately utilizing the technique. There are concerns that the comparatively simple, inexpensive and accessible method of pXRF could lead to archaeologists misapplying the method because they fail to understand the limitations. There are also concerns with establishing standards and protocols specifically tailored to the portable X-ray fluorescence. Something as simple as the distance and angle of the pXRF beam or the grain size and surface roughness of the pottery sherd can alter the resulting elemental measurements (Forster et al. 2011; Trojek et al. 2010). In addition to establishing protocols and standards for pXRF utilization and results, Goodale et al. actually looks at the possible disparity between different brands of pXRF. One should not only concern themselves with creating standards specific to pXRF, there are differences between types of pXRF that can lead to calibration discrepancies as well as discrepancies in actual results of the analysis.

The other category of pXRF articles involves archaeologists actually utilizing portable X-ray fluorescence to investigate pottery manufacture or provenance. In some papers pXRF is the only method of analysis and in other cases, pXRF is used to complement other methods. As mentioned previously, the use of pXRF for ceramic sourcing is still relatively new. Obsidian artifact sourcing is a more popular subject for pXRF analysis (Forster and Grave 2012; Millhauser et al. 2011; Nazaroff et al. 2012; Sheppard et al. 2011; Tykot et al. 2013) because obsidian is a far more homogenous material with a limited number of sources available on the landscape. In comparison, pottery is more heterogeneous and manufactured from a more ubiquitous and varied material, clay. These characteristics of clay can make it more difficult to match the elemental composition of a piece of pottery to the elemental composition of a specific clay source on the landscape (Anderson et al. 2011; Neff et al. 1992). An additional
consideration is whether or not a particular clay source utilized in the manufacture of a prehistoric pot actually still exists on the landscape today. The clay source may have been exhausted by a prehistoric group or destroyed by modern earth moving activities associated with development. Despite these difficulties, archaeologists use pXRF to analyze pottery sites throughout the world. The relative “newness” of this pottery analysis method makes every project utilizing pXRF a valuable learning experience for archaeologists. Every pXRF paper that addresses an unforeseen complication, details the steps and consequences of a particular protocol or tackles an archaeological site with unique geology, expands our understanding of pXRF’s capabilities and limitations. These insights can aid future researchers in choosing the most effective and appropriate uses of pXRF for pottery analysis.

The inherent lack of homogeneity in most pottery has led many archaeologists utilizing pXRF, to record multiple measurements on each pottery sample analyzed. These multiple analyses allow for a more accurate measurement of the elemental variation within each pottery sherd (Forouzan et al. 2012:5). In analyzing approximately 70 sherds of pre-colonial pottery in Brazil, researchers (Ikeoka et al. 2010) averaged nine measurements per sherd. During the course of their analyses, they noted that the degree of elemental variation between sampling areas on a single sherd depended on the element. Some elements showed significant variation within a single sherd while other elements were measured at relatively constant concentrations throughout the sherd. In their study they were interested in both the raw material utilized in the manufacture of the vessel as well as surface treatments of the pottery. Based on the multiple measurements taken on the external and internal surfaces, as well as measurements focused on the paste in particular, they were able to differentiate a subset of the pottery that had a specific surface treatment while other vessels had no surface treatment. The analysis also pinpointed a subset of
elements that were most effective in differentiating clay sources within their geological area of study. In this study, the researchers were focused less on the question of local versus exotic (non-local) pottery manufacture and more on the variation of clay sources utilized over time at the pre-colonial site.

The number of sherds analyzed varies greatly between projects. One study analyzed 400 sherds for their research (Frankel and Webb 2012), with the pottery coming from four dispersed sites, while another study (Sakalis et al. 2012) analyzed only 44 samples from a single site. Frankel and Webb’s research focused on differentiating between local and exotic pottery within the four sites under study, to enhance their understanding of inter-village trading. Discriminating between local and exotic potteries at a site is a common research objective in sourcing studies, regardless of the compositional technology utilized (Ashkanani 2014; Ashkanani and Tykot 2013; Bakraji 2011; Beck and Neff 2007; Hall et al. 2002; Herbert and McReynolds 2004; Mcphee and Kartsonaki 2010; Vaughn and Neff 2000). In Frankel and Webb’s study they noted differences in pottery manufacture between the sites. Some sites contained predominantly local pottery, both decorated and plain, while other sites contained local plain pottery with varying amounts of exotic decorated pottery. Additionally, there was evidence of certain types of pottery being associated with a particular clay source.

In an analysis of Neolithic pottery from northern Greece (Sakalis et al. 2012) the archaeologists focused on decorated pottery, looking at pottery paints and slips as well as ceramic pastes. Through pXRF, the Neolithic pottery was classified into several distinct compositional categories, with a certain subset of elements being most beneficial in differentiating between clay groups. The Sakalis et al. study, like many sourcing studies, regardless of the technology used, simply focuses on measuring the composition of pottery
samples excavated from a particular site. Quite often sourcing studies do not actually have clay samples from the landscape to compare their analyzed pottery with (Ashkanani 2014; Ashkanani and Tykot 2013; Frankel and Webb 2012; Hall et al. 2002; Ikeoka et al. 2011; Goren et al. 2011). This indicates that their attempt to establish clay categories must be based solely on compositional differences found within the analyzed pottery. In the case of Ashkanani and Tykot (2013), one of their goals was to use Bronze Age pottery with a known provenance as a kind of proxy for potential clay sources near archaeological sites in Kuwait and Bahrain. The Ashkanani and Tykot study had to work around a problem common to many ceramic studies, limited availability of local geochemical data. Knowledge of local geology and data on the composition of local soils enhances our understanding of pottery manufacture at a site.

Those who attempt to locate discrete clay deposits on the landscape for their sourcing study are often utilizing more comprehensive and destructive techniques, including XRD (X-ray diffraction), INAA (Fowles et al. 2007; Lazzari 2009; Lynott et al. 2000; Neff 1999) or even a destructive form of XRF that utilizes ground pieces of the pottery sample (Andaloro et al. 2011). Grinding a portion of the pottery sample down into a powder is a way to more accurately determine the overall composition of the pottery. In its ground powder state it will have a more uniform composition than a piece of pottery whose elemental make-up can vary from one point to another.

In the Forouzan et al. (2012) provenance study, the clay artifacts under investigation were expanded to include zoomorphic clay figurines, tokens and sling bullets as well as Iranian pottery, while another paper was studying the provenance of Ancient Near Eastern clay cuneiform tablets (Goren et al. 2011). Forouzan and colleagues were trying to differentiate local from exotic artifact manufacture to better inform their understanding of the possible “social and
economic function” (Forouzan et al. 2012:87) of the artifacts. As in other sourcing studies, the researchers are not comparing their clay artifacts to existing clay sources on the landscape, but are instead relying on substantial differences in the elemental composition of the analyzed pottery to denote different clay sources. In some cases, the vastly different elemental compositions suggests exotic manufacture of some objects. To help validate the hypothesis of exotic manufacture, pottery and clay sources from non-local areas should be analyzed and compared with the originally analyzed samples. In the research preformed by Goren and colleagues, pXRF was used to re-analyze a set of tablets that were originally examined with the destructive method of INAA. Once the researchers received favorable results utilizing the pXRF on the tablets, and had created a baseline of the elemental variation of the samples, they analyzed another set of tablets with pXRF that had not been previously examined. The analysis of the new tablets yielded positive results allowing for adequate differentiation to categorize the tablets by composition. Goren et al. favors the utilization of a destructive compositional analysis method, such as INAA, followed by a pXRF analysis to establish a “translation” of the more in depth INAA sample analysis, to a simpler pXRF analysis. Once this baseline understanding of elemental variation in the samples has been established, more previously unexamined samples can be analyzed using pXRF, and the results of these analyses can be compared with the established baseline. Though the process discussed in these two studies is different, both projects successfully employed pXRF to enhance their understanding of clay artifact provenance. In both projects pXRF serves as a complement to other forms of analysis. Forouzan et al. (2012) utilized pXRF as a tool for preliminary investigation of clay artifacts while Goren et al. employed pXRF to supplement work performed with INAA, and to serve as a non-destructive method of analysis when INAA was not a viable option. In comparison to other methods of elemental analysis,
pXRF is faster, cheaper, non-destructive and easier to use. These characteristics make pXRF an excellent tool for preliminary archaeological investigations, allowing for rapid results that can advise and focus future research.

A paper by Hall et al. (2002) posited research questions similar to the ones addressed in this thesis. In this study each sherd was analyzed twice. Hall and associates were investigating clay sources and paste utilization at a single site over a prolonged period of time that spanned multiple cultural periods. The researchers concluded that multiple clay sources were utilized and that these same clay sources were exploited through time.

In the excavation work performed at the Bayshore Homes site, both by Sears and later by the CGCAS, a plethora of pottery was unearthed. In the 1950s, Sears identified and classified the pottery excavated during his fieldwork. A majority of the pottery excavated during the CGCAS fieldwork in the early 2000s has been identified and classified by Jeffery Mitchem. At some point after the Sears excavations, J. Mitchem revisited the original pottery classifications assigned by Sears. Though a large portion of the Sears’ pottery retained its original classification, there were a number of sherds that were re-categorized based on a more recent and informed interpretation of the Bayshore site. Despite the visual and physical examination of the Bayshore Homes sherds to determine pottery style, there has been no compositional analysis of the Bayshore pottery. The work discussed in this thesis serves as a first effort in examining the elemental composition of the site’s pottery. It is a preliminary investigation that seeks to provide an overview of elemental variation in Bayshore pottery. The research can also provide some insight into how any elemental variation within the pottery correlates to any assumptions made about the pottery based on the archaeological context established from excavation. Finally, the
thesis furthers understanding of the efficiency and appropriateness of pXRF in distinguishing between clay sources utilized in the manufacture of Florida pottery.

Research Questions

Question 1: Are the clay sources utilized during the earlier occupation (CE 150-500) the same clay sources utilized during the later occupation (CE 900-1350)?

Question 2: Are the clay sources utilized for decorative pottery the same as the clay sources utilized for plain ware pottery?

Both of these questions have a synchronic and diachronic element to them because there are at least two distinct occupations at the site, apparently separated by multiple centuries. Though it is likely that the prehistoric people occupying the site during the later occupation were in some way related to the inhabitants of the earlier occupation, approximately three hundred years of separation between the two significant occupations would seriously decrease the possibility of continuity at the site. This indicates that, even if there is a genetic link or an oral history passed down through the generations connecting the two occupation groups, it would be doubtful that the later occupation would have detailed knowledge of the site resources before moving there. In addition, the two occupations technically fall under two different culture periods. This could cause different resources or clay sources to be valued, based on their suitability for expressing the current cultural ideology. Though, as expressed in the first chapter, “culture periods” can only provide a very general classification of a geographic area and the traits associated with the people who lived there. In reality, it is far more likely that individual
groups adapted to their particular local environment, and incorporated external ideas as applicable.

In considering the two research questions above, one can further break down separate points within each question. How many clay sources were utilized within each occupation period? And if there are multiple clay sources utilized, what does that suggest? Are particular types of pottery (Sand-tempered Plain, Pinellas Plain) made from a particular clay source? Is the decorated pottery made from distinctly different clay sources than the domestic pottery?

Traditional thought in archaeology assumes that plain pottery is generally utilitarian in nature, and decorated pottery is more likely to be utilized for special occasions, like burials or important feasting events. In a large stratified society, decorated pottery could also be an elite prestige item, but this last scenario is unlikely to be the reason for decorated pottery at the Bayshore site. Since utilitarian pottery is used for everyday domestic activities, it is likely that the production of these vessels would be manufactured utilizing clay sources in close proximity to a site (Arnold 1985; Rice 2005; Shepperd 1985). If this hypothesis were applicable to Bayshore, the existence of multiple clay sources for domestic pottery could imply a household level of pottery production with multiple local clay sources freely utilized by site inhabitants. A natural extension of the hypothesis that domestic plainware pottery would have been locally manufactured, is the idea that if any pottery were manufactured exotically and traded into the site it would be decorated pottery used in a burial context. If the decorated Weeden Island style pottery found in the burial mound has a distinctly different composition from the domestic wares, does that mean the pottery was made from an exotic clay source?

Following the criterion of relative abundance, it would generally be assumed that styles of Florida pottery discovered outside their designated “culture area” would have been acquired
through trade. Additionally, in the case of highly decorated Weeden Island pottery, it was generally assumed only one site would have manufactured these vessels within the larger culture area and then traded the pottery to other sites (Sears 1973).

In comparison, current archaeological understanding of Florida pottery manufacture indicates that many pottery styles could have been replicated and manufactured by people outside of the designated culture area associated with a particular style (Cordell 1992; Rice 2005; Sheppard 1985), and it is more likely that there were multiple sites within the Weeden Island culture area producing decorated Weeden Island pottery. These multiple sites would then either utilize the decorated pottery locally or disseminate the pottery over the larger “culture” area through trade. In some cases even trading decorated pottery with other sites that specialized in producing decorated Weeden Island pottery (Cordell 1983; Pluckhahn and Cordell 2011; Rice 1980).

Work done at sites like McKeithen, in northern Florida, and Kolomoki in southern Georgia, provides evidence for the “multiple center” hypothesis. Studies at the McKeithen site indicate that several local pottery sources were exploited for both plain and decorated pottery production. There was also evidence that some of the decorated pottery at the site was of exotic (non-local) origin (Cordell 1983), most likely traded in from other Weeden Island period sites in Florida or Georgia. Rice’s utilization of INAA on McKeithen site pottery mainly corroborated Cordell’s conclusions of the McKeithen site, as a producer, consumer and trader of different Weeden Island pottery styles (Rice 1980). A recent study at Kolomoki also suggests several local clay sources were exploited for plain and decorated pottery, for both local consumption and inter-village trade. Further evidence from the Kolomoki site also indicates that the clay source
utilized did not follow a “plain vs. decorated” dichotomy. The same clay sources were utilized for both decorated “prestige” pottery and utilitarian pottery (Pluckhahn and Cordell 2011).

Applying the above insights to the analysis of Bayshore pottery promotes multiple avenues of investigation. The Bayshore site is unusual in that it does not neatly fit into any particular culture definition. The earlier occupation at the site was initially a Manasota culture that slowly incorporated more elements of the Weeden Island culture over time. However, the earlier Bayshore occupation did not appear to be a major center for decorated Weeden Island pottery nor did it ever really qualify as a “Weeden Island culture”. The later occupation maintains Weeden Island related attributes beyond the established terminus of the Weeden Island period and does not evolve into a full Safety Harbor culture; though the later occupation is currently considered to be associated with the Englewood phase, a transitional period before the true Safety Harbor culture (Austin and Mitchem, in press).

If decorated pottery analyzed from the Bayshore site does have a significantly different clay composition from the domestic ware, this could suggest exotic manufacture. It is also possible that a clay source could have been obtained from an exotic location and the actual pottery manufacture was local. However, considering the time spent finding, procuring and transporting an exotic clay back to the site, it is unlikely that this hypothesis would account for a significant percentage of any exotic pottery found. Barring some potent ideological incentive for a particular exotic clay source, most likely any exotic clay sources transported back to a site would have been exploited opportunistically during other resource gathering missions. The more plausible reasons for decorated pottery to have a distinctly different composition are direct, or indirect, trade with a non-local village or the use of a locally available clay source that was intentionally exploited expressly for decorated pottery manufacture.
There are myriad questions that could be asked about the Bayshore site and many different methods that could be utilized to address those questions. This thesis research focuses on two rather basic questions that archaeologists could intuitively answer based on experience at other sites. By addressing these questions through compositional analysis, the groundwork can be laid for future pottery analyses at the Bayshore site as well as test some of the assumptions archaeologists make about pottery manufacture.

Concentrating on these clay sourcing questions can also provide insight into the daily lives of the inhabitants of the Bayshore site. The question of clay source continuity through time can increase our understanding of clay availability at the prehistoric site. A better understanding of the clay sources utilized during a particular occupation period may help interpret the complex stratigraphy of the Bayshore site. Answering the more interesting question of domestic versus decorated pottery clay sources may help to endorse or contradict the idea that a limited number of specialized pottery production sites are responsible for the majority of decorated pottery found within a cultural region. Were these specialized centers literally disseminating decorated pottery to nearby contemporaneous sites or were many sites manufacturing their own decorative pottery and merely incorporating exotic decorative motifs?

Chapter 3 will include a discussion of the pXRF method in general and the analyses utilized for this thesis in particular. Additionally more detail will be provided on the pottery sherds sampled at Bayshore and the different statistical methods utilized in the analysis of the pXRF results.
CHAPTER THREE
METHODS

“X-ray fluorescence spectrometry (XRF), particularly energy-dispersive XRF (EDXRF), has been a primary tool for elemental compositional analysis of stone and ceramic artifacts, particularly obsidian for decades in American archaeology” – (Shackley 2010:17)

X-ray Fluorescence

As stated in the above quote, X-ray fluorescence has been utilized by archaeologists for decades. Though provenance studies (artifact sourcing) focused on obsidian have proven to be the most successful use of XRF to date, sourcing studies analyzing pottery are becoming more common. Before technologies like XRF, INAA (Glascock et al. 2004; Speakman and Glascock 2006), LA-ICP-MS (Laser Ablation Inductively Coupled Mass Spectrometry) (Neff 2003; Robertson et al. 2002) or PIXE (Particle Induced X-ray Emission) (Robertson et al. 2002; Roumie et al. 2006) were utilized to varying degrees in the compositional analysis of pottery, simpler techniques like ceramic typologies were employed to explain the evolution of pottery development at a site. The introduction of new pottery styles and decorative motifs and the phasing out of older styles could often be deciphered from simple observations of the pottery excavated from a site, assuming there was some level of chronological control. However, to establish these trends in pottery at a site would require a very large sample of sherds for any level of accuracy. Also the questions regarding the location of manufacture would be difficult to answer from just macroscopic analysis of the pottery. An inability to determine if pottery was locally made or imported from some external source could also lead to confusion in the ceramic typology established for a particular site.
Petrography techniques were utilized in an attempt to determine the fabric of the pottery, an additional level of analysis beyond a macroscopic investigation. Microscopic analysis of thin sections of the pottery allowed for a more substantial understanding of the ceramic paste makeup (Cordell 1992, 1993, 2013; Rice 2005; Shepard 1985). This additional level of scrutiny allowed for physically different clay sources to be separated, regardless of the vessel type or decorative style of the pottery. Utilization of more recent technologies like INAA and other spectroscopic techniques can provide an accurate and precise analysis of ceramic composition. INAA is also capable of measuring actual concentrations of an element within a sample and can detect a broader range of elements than pXRF can. However, technologies such as INAA are more time consuming, more expensive, destructive and are not portable.

In contrast to INAA or ED-XRF, provenance studies utilizing portable X-ray fluorescence spectrometry are less common because pXRF has some obvious limitations and is a relatively new technology that is still evolving. X-ray fluorescence is used to analyze the elemental composition of the pottery in an attempt to isolate a unique chemical signature that would correspond to a discrete clay source within a larger geographic landscape. Archaeologists and museum professionals have used XRF for decades, however the advent of a more portable, inexpensive, simpler and non-destructive version has increased its popularity. In XRF, the material being analyzed is irradiated for a short period of time. The addition of X-rays to the object excites the electrons in the atoms within the material being analyzed. When the radiation is removed from the object, the electron will stabilize and release the energy in the form of X-ray photons they gained from the irradiation. The XRF machine measures the energy released by the electrons as they return to a more stable state. The atomic weight of atoms of a particular element is a constant and will react in a predictable manner when exposed to an energy
input, like X-rays. The resulting release of energy is also predictable and comparing these predictable elemental values (characteristic energy transition values) with the energy output values from the unknown samples being analyzed, allows us to identify the elemental composition of unknown samples and determine relative amounts of each element within that sample (Creagh and Bradley 2000; Neff 2000; Pollard 2007). Unfortunately, the trade off of utilizing a portable XRF unit is the decreased sensitivity.

Like the standard or lab XRF, the portable XRF instrument is capable of measuring multiple elements simultaneously, within a 5x7 mm area. These measurements are then displayed as an emission spectrum, a series of peaks, corresponding to different elements. The position of the peak along the axis is based on the energy value associated with a particular elemental concentration, which is measured in parts per million (ppm). The relative height of the peak is related to the atomic number of the element, with higher atomic number elements fluorescing at higher levels, leading to higher peaks (Morgenstein and Redmount 2005; Neff 2000; Podsiki 2009). The 5x7mm area of analysis that can be covered by the pXRF spectrometer’s beam is actually more substantial than the coverage area for some other compositional technologies, like LA-ICP-MS. The pXRF’s larger area of coverage helps to ameliorate potential problems associated with the innate heterogeneity of pottery.

Since pXRF analysis of pottery is a relatively new area with great archaeological potential, each well-documented use of this method can enhance our understanding of the assets and limitations of this technology in regards to pottery sourcing. This testing of a new method extends to properly deciphering the results of the pXRF analysis. Concerns regarding the precision and accuracy of pXRF have been raised. Additionally, researchers have questioned whether the limited number of elements pXRF can detect is adequate to answer questions
involving the delineation of individual clay sources (Speakman et al. 2011). The answer to that question could depend on the geology of the archaeological site being studied. Portable XRF is adequate for the research undertaken in this thesis, a preliminary investigation of the Bayshore Homes ceramic assemblage.

The work performed for this thesis is a first look at the compositional variation of the Bayshore site pottery, which will inform future research and help define more pertinent questions. The thesis research also serves as a test of the usefulness and limitations of pXRF for the compositional analysis of the rather chaotic Florida stratigraphy.

Figure 6. Emission spectrum of sherd TUT15 with the Fe, Rb, Sr, Y, Zr and Nb peaks labeled.
Bayshore Homes Pottery

The Bayshore ceramic analyses were performed with a Bruker III-V portable X-ray fluorescence spectrometer. The majority of the pottery analyses, including Kuttler mound, Mound C, Ross Rooney, and Test Unit 2 and 4 were performed using one machine, but before the Sears midden unit (MUS) sherds could be analyzed, the machine malfunctioned and was replaced by a new spectrometer. The second machine was obtained from the same company, but was a newer model with improved sensitivity (Model III-SD), that allowed for a decrease in analysis time from 180 to 120 seconds. Several tests were conducted to verify that any differences in analysis between the two spectrometers would not be significant enough to skew results. The results of the two analyses were comparable, with minimal differences in the calibrated elemental concentrations of the sherds.

With the original pXRF, the time of each analysis was 180 seconds with settings of 40kV and 10µA. A Cu-Ti-Al filter was utilized to increase instrument precision when measuring the abundance of trace elements (Rb, Sr, Y, Zr, Nb). These trace elements are particularly helpful in pottery sourcing analyses because many of the major elements are commonly occurring in the earth, and are therefore poor choices for discerning discrete clay sources. The settings remained the same when the second machine was utilized for the MUS sherds, but the efficiency of the second machine allowed for a decrease in the analysis time from 180 seconds to 120 seconds.

During the analyses, the Bruker III-V pXRF was placed on a lucite stand with the scanning surface facing up. A ceramic sherd was then placed over the scanning eye and left untouched until the analysis time of 120 or 180 seconds was complete. Each pXRF scan performed analyzed a 5x7mm area of the sherd. Each sherd was analyzed once on the interior and once on the exterior surface.
Prior to analysis, each sherd was cleaned and visually inspected. In addition to removing dirt and debris from the surface of the sherd, areas with surface inclusions were noted and avoided during the pXRF analysis to more accurately analyze the clay as opposed to the possible temper utilized in the ceramic paste.

Sampling

The ceramic sherds were chosen from six different areas of the Bayshore site. R. Austin, the PI for the CGCAS excavations at Bayshore, advised on the areas he thought would be most
valuable to this study. The ceramics came from both the earlier and later site occupations, with plainware (associated with domestic use) and decorative pottery (more prevalent as grave goods) being analyzed for each occupation period. The plainware consisted of Pinellas Plain and Sand-tempered Plain. The decorative sherds included a large number of different ceramic styles, most of which were confined to the burial Mound C area, with some being excavated from the Sears Midden unit as well. The most widespread decorated pottery type analyzed was the Wakulla Check Stamped, it is debatable whether this would be considered a utilitarian or a true decorative pottery type associated with burials. It is a pottery style that is more ubiquitous than some of the decorated Weeden Island styles and is also more likely is often found in middens as well. At least one sample of Wakulla Check Stamped was analyzed from all six areas, however this pottery style is generally associated with the later occupation period (post-CE 700). In choosing the ceramic sherds to be analyzed, every attempt was made to ensure that the sherds were from different ceramic vessels. Where possible, rim pieces were chosen. In general, obtaining unique ceramic samples for the decorative pottery were easier than ensuring uniqueness among the plain ware sherds.

An effort was made to choose sherds that had obvious differences in thickness, temper and/or amount of firing to avoid analyzing two sherds from the same vessel. At sub-sites where there was controlled excavation, only 1 to 4 sherds of a particular pottery type were chosen per excavation level (often an arbitrary 10 cm), and then one or more levels would be skipped before more sherds were sampled. This sampling plan was utilized to further decrease the possibility of collecting multiple sherds from the same broken vessel.

The six sub-sites in Bayshore where sherds were analyzed include: Kuttler Mound (K), Sears midden unit (MUS), Ross Rooney mound (RR), Test Unit Two (TUT), Test Unit Four
(TUF) and the Bushnell collection from Mound C (MCB). I had originally intended to analyze 150 samples (over a three day period), but some of the material I had hoped to access at the NFMH (Mound C surface collection) was not available to me. The analysis of the Mound C ceramics surface collected by Sears at the end of his Bayshore site excavation would have aided me in validating the authenticity of the Mound C ceramics collected by Bushnell (an avocational archaeologist who lived in the area). One hundred thirty-three (133) sherds from Bayshore were analyzed (Table 1).

Table 1: Number of pottery sherds analyzed from each Bayshore sub-site

<table>
<thead>
<tr>
<th>Location</th>
<th>Sherds Analyzed</th>
<th>Occupation</th>
<th>Number of STP</th>
<th>Number of PP</th>
<th>Number of WCS</th>
<th>Number of other decorated styles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuttler</td>
<td>30</td>
<td>Later</td>
<td>16</td>
<td>8</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Mound C Bushnell</td>
<td>25</td>
<td>Earlier</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>20 – Including various incised, punctuated &amp; stamped styles</td>
</tr>
<tr>
<td>Midden Unit - Sears</td>
<td>28</td>
<td>Earlier &amp; Later</td>
<td>8</td>
<td>7</td>
<td>3</td>
<td>10 – Including stamped and cord-marked styles</td>
</tr>
<tr>
<td>Ross Rooney</td>
<td>15</td>
<td>Earlier</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Test Unit Two</td>
<td>15</td>
<td>Later</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Test Unit Four</td>
<td>20</td>
<td>Earlier &amp; Later</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>133</strong></td>
<td></td>
<td><strong>54</strong></td>
<td><strong>28</strong></td>
<td><strong>21</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>
The classification of the Bayshore sherds into different categories (or groups) based on elemental composition was determined through a series of statistical operations. Theoretically, these statistically created pottery groups should correspond to different clay sources utilized to manufacture the pottery found at the Bayshore site. This assumption was based on the application of the Provenance Postulate, which was originally hypothesized by Weigand et al. (1977) and applied to chemistry based analyses. In 2000, Hector Neff suggested a broader interpretation of the Provenance Postulate to include other types of compositional analyses as well.

After all the sherds were analyzed, the raw compositional data were opened in an Excel spreadsheet where the data could be calibrated using a set of reference standards. Once these calibrations were complete, the elemental data could be analyzed statistically. An Excel spreadsheet was created as a scan log for all one hundred and thirty-three (133) ceramic samples tested with the pXRF. The spreadsheet was used to record several pieces of information including establishing a unique identifier for each ceramic sherd. Each ID was a combination of a Bayshore sub-site abbreviation based on where the sherd was collected from, and a number corresponding to the order in which the sherds were analyzed. The six sub-site locations were Kuttler (K), Ross Rooney (RR), Mound C – Bushnell collection (MCB), Test Unit Two (TUT), Test Unit Four (TUF), and the Midden Unit – Sears’ excavation (MUS). Other data recorded on the scan log included excavation depth of the sample (where applicable), the pottery style, a detailed description of the ceramic sherd, and a list of the digital photos taken of each sample. Since many of the samples were not directly labeled, a category on the scan log that recorded any
other site excavation data that would help relocate the sample in the future for further analysis was included (see Appendix 1).

The calibrated raw data and the scan log data were merged to create a single Excel spreadsheet containing all pertinent information for each sherd analyzed. Since each sherd was analyzed twice, once on the interior surface and once on the exterior, the scan log contained two entries for each sherd. *Example: the fourth sherd analyzed from the Kuttler Mound would be listed as K4a and K4b, with K4a corresponding to the interior analysis and K4b corresponding to the analysis of the exterior surface of the sherd.* To aid in statistical analyses, a single entry was created for each ceramic sherd by taking the average of the interior and exterior surface analyses for each element. The table created from these elemental averages for each sherd was the table manipulated in Excel and SPSS to identify discrete compositional groups corresponding to different clay sources on the landscape. The preliminary attempts at analysis were performed within Excel, with the data being manipulated in different ways to observe any patterns. In one set of spreadsheets the sherds were separated into different pottery types (decorative vs. plain ware or STP vs. PP). Sherds were also separated based on probable occupation period. The assignation of certain areas of the Bayshore site to a particular occupation period was based on the archaeological research performed by the CGCAS. It was deemed likely that the Kuttler mound and different levels of the Sears Midden Unit, Test Unit Two and Test Unit Four were from the younger time period. Where as Mound C, the Ross Rooney spoil and parts of the Sears Midden Unit, Test Unit Four and Test Unit Two were probably from the older occupation on the site (Austin et al. 2008).

After the preliminary analyses in Excel, the calibrated raw data were then manipulated using SPSS, a statistical software program, where several types of statistics, including principal
components analysis (PCA), k-means cluster analysis and discriminant function analysis (DA), were run on the compositional data. Before running a PCA on the raw data the elemental values for each sherd were transformed through log 10 to “normalize” the variables (elemental concentrations). The classification of sherds into statistically significant groups is difficult when there are vast differences in the concentration levels (in ppm) of the elements. Though the trace elements are the more important elements to utilize in statistically sourcing pottery, other commonly occurring elements can also aid in differentiating clay sources. An example of this from the Bayshore sherd analyses would be the major element iron (Fe) that commonly has concentration levels over 10,000 ppm, compared to trace niobium, which is often found in concentrations of 10 ppm or less. In its raw form the compositional data from Bayshore is not normally distributed. Normalizing the data helps to diminish skewed results that can occur when element concentrations within a sample are of vastly different quantities, either because the clay sources utilized in the pottery manufacture are vastly different or because of outliers.

Normalizing elemental composition data is a common practice often utilized in ceramic sourcing studies before quantitative statistical analyses are performed. Though utilizing the raw data for statistical analysis is generally preferred, sometimes manipulation of the data is necessary to provide more accurate results. When performing quantitative analyses on a combination of major and trace elements, the log 10 transformed data was used. Quantitative analyses were also performed utilizing only the trace elements from the sherds, which had a more normal distribution of values. The narrower range of values for the trace elements allowed for quantitative analyses with the raw (non-transformed data).
Principal Components Analysis

PCA is a commonly utilized method of statistical analysis when addressing questions of sourcing or provenance (Bardelli et al. 2011; Frankel and Webb 2012; Goren et al. 2011; Hall et al. 2002; Sakalis et al. 2012). Whether the artifact in question is pottery, obsidian, glass or metal, PCA provides a method of analyzing and categorizing compositional data, provided by analyses like XRF, into groups that minimize the intergroup differences while maximizing the differences between groups. The successful application of PCA on a dataset should, by design, illustrate/satisfy the provenance postulate. PCA is an appropriate method to use for this study because it does not assume there is a correlation between the variables being tested. The results of the analysis will establish whether a correlation between the variables does exist.

Principal components analysis is a statistical procedure utilized to reduce the number of variables associated with a set of data. In the case of the Bayshore pottery, the variables are the various elements detected and measured by the pXRF during the analysis of each sherd. Though pXRF is capable of detecting and measuring many elements, there were seven variables (elements) that were the focus of analysis for the Bayshore sherds, including iron (Fe), barium (Ba), strontium (Sr), zirconium (Zr), niobium (Nb) rubidium (Rb) and yttrium (Y). The PCA process attempts to create a limited number of artificial variables, called components, from a larger set of observed variables with, presumably, some level of correlation. When successful, these created components should explain the majority of variation observed in the original variables. It is surmised that the different groups that will be created based on the variable reduction process will correspond to different clay sources utilized by the people of the Bayshore site. By cross-referencing the different groups of sherds created by PCA with other site related variables, such as occupation period or ceramic type, one should be able to determine any links
between clay source use and time periods or pottery types. This would help to answer the two main thesis questions regarding clay source utilization through time and potential clay source differentiation by pottery type.

Principle components are created by optimally weighting the observed variables, in this case the elemental concentrations, in a way that allows for each component created to account for the maximum amount of variation possible. There were actually seven components created from the PCA (because there were 7 elements), but most of the components account for small amounts of the overall variation in the dataset and are deemed inconsequential to the identification of clay sources. To reduce the number of components to the ones that account for significant amounts of the overall variation, the PCA was repeated and only principal components with eigenvalues higher than one (1) were displayed. The results of the second PCA provided two (2) components. In the end, it was decided that three principal components were the optimum number, accounting for a significant amount of the variation in the original dataset without defeating the purpose of simplifying the number of variables.

The first component extracted accounts for the highest total variation in the dataset and has the greatest possibility of correlating with one or more of the variables. The second component will be uncorrelated with the first component and accounts for the maximum amount of variance not explained by the first component and will probably be correlated with variables that the first component was not correlated with. This establishes the most important means of identifying distinct groups within the given dataset. The third component will be uncorrelated with the first two components and account for the maximum total variation not accounted for by either of the other components. The point of PCA is to reduce the number of observed variables to a subset of artificial variables (components) with the idea that these components will define
significantly different groups within the dataset, highlighting correlations between some variables and disassociations between others. With regards to Bayshore, the PCA will hopefully differentiate unique clay sources utilized in the production of the pottery. It is important to note that PCA is not a factor analysis because it does not assume that a relationship exists between the observed variables, as in a factor analysis. PCA is merely used to reduce the number of observed variables to see if there are any underlying correlations to be found.

PCA was performed multiple times, using the original data and the log 10 transformed data as variables. The number of variables (elements) was also varied, using all seven elements and then using just the trace elements by removing iron and barium from the analysis. The results of these many different analyses were then compared to see which PCA yielded the most cohesive groups and what the overall patterns of association were for the pottery that was tested.

k-Means Clustering

Following PCA of the sherds, the three components (regression factors) created by the principal component analyses, were then subjected to a k-means cluster analysis. k-means cluster analysis is a relatively neutral method of grouping data with the intention of minimizing inter-group variation while maximizing intra-group variation. The biased part of the analysis is in determining the number of clusters to be created. The number of clusters or groups being established is decided before the analysis is performed and is based on the researchers assumptions about the data and the number of different groups one presumes will exist. For the Bayshore pottery, initially four (4) clusters were chosen for the k-means cluster analysis, with the idea being that there could be at least four different clay sources being utilized throughout the two separate occupation periods. Within SPSS, the k-means cluster analysis results in each sherd
being assigned to the group (1-4) that it has the highest probability of belonging to. However, there could easily be fewer or more than four clay sources at the Bayshore site. With this in mind, multiple k-means cluster analyses were run on the PCA generated components, varying the number of groups to be formed to see if there was an optimum number of cluster groups that produced the strongest clustering within groups and the most distance between groups. The k-means cluster groups created from the PCA regression factors are based purely on correlations found within the elemental composition of each sherd, with no reference made to its archaeological context within the site. As with the previous step, the PCA, the k-means cluster analysis was run repeatedly. Each set of components created from various principal component analyses were run multiple times through the k-means cluster analysis in an attempt to find the optimum number of groups.

Discriminant Function Analysis

In essence, discriminant function analysis is used to determine if a set of variables is effective for determining group membership. Discriminant function analysis is used when a correlation between the variables being tested has been established. Despite this fact, DA is often utilized in different sourcing studies to create groups even when the correlation between the tested variables has not been established, but only assumed. In this study, the reason for performing the discriminant function analysis was as an independent check of the principal component analysis results. Discriminant function analysis is often utilized for sourcing studies, however it is not the most statistically sound method of analysis. The reason being that DA assumes a correlation between variables that may not exist. PCA is a neutral method of determining whether there are any correlations within a data set. Thus it is more statistically
sound to test for variable correlations before assuming they exist. Through PCA a correlation between variables, in this case compositional elements, has been confirmed, though some variables are definitely more closely correlated than others. DA was utilized to qualify the results of the PCA and to compare both the PCA group rankings and the resulting DA group rankings against the plausible groups created through visible observations of the sherds and their context within the site. Comparison of these three different grouping methods can help discern any patterns of clay source utilization at Bayshore, but it can also clarify or undermine the assumptions made about the pottery based on archaeological observations made on site.

In the discriminant function analysis the independent variables are the original elemental composition data used as variables in the PCA. The dependent (grouping) variable in the DA is the k-means cluster groups created using the PCA components. By using the original data and the PCA created groups, the DA will provide results that show how accurate the PCA created groups were. Do the DA and PCA classify the sherds by the same groups or are the sherd groups created by the DA vastly different from the PCA created groups? The results of the DA will confirm, or refute, the validity of the PCA results. Did the principal component analysis find valid correlations between the variables (elements) being tested and group the pottery sherds in a meaningful way that could correspond to unique clay sources? The more overlap that exists between the DA and PCA created groups, the more confident one can be that the PCA found valid correlations between the elements and established compositionally unique clay groups.

As with the first two analyses, the discriminant function analysis was also executed multiple times, utilizing the different PCA results and k-means cluster results. When looking at the DA results, the primary goal was to find the optimum number of groups that provided the
most inter-group cohesion and intra-group separation. The optimum number of groups varied depending on the number of variables (elements) being utilized.

After completion of the analyses outlined above, the process was repeated utilizing all of the original seven elements, except iron and barium. It was determined that barium should be removed from the statistical analysis because it is an element that pXRF has difficulty measuring accurately. Iron was also eliminated from the analysis because it naturally occurs in the environment at high levels and was a common ingredient for pottery slips. The compositional values for iron were significantly higher (even after transformation of the data) than any other element and could have skewed the analysis. The final statistical analysis relied upon the 5 trace elements (Zr, Y, Nb, Rb and Sr), which are the most effective for discerning discrete compositional groups. Extensive statistical analyses were performed on the pottery composition data in an attempt to find the strongest and clearest statistical results possible. These final, and most informative, results will be discussed in Chapter 4.
CHAPTER FOUR
RESULTS

“Sourcing is possible as long as there exists some qualitative or quantitative chemical or mineralogical differences between natural sources that exceed the qualitative or quantitative variation within each source” – the provenance postulate (Neff 2000:108).

The results and conclusions drawn in this thesis largely depend on the ideas originally posited by Weigland (1977) and later refined by Neff (2000) in the provenance postulate. The provenance postulate allows archaeologists to classify pottery by distinct elemental compositions, which then, in theory, correspond to a discrete clay source on the landscape. Providing an elemental analysis for pottery previously classified by visual inspection into groups based on pottery type or style can yield new insights into resource utilization and pottery production. Comparing and contrasting the pottery manufactured with a particular clay source can also further understanding of inter-village trade and potentially even the adoption and spread of ideology across regions. The following statistical analyses are based on the premise set forth in the provenance postulate.

Figure 8 is a scatter plot created by the discriminant function analysis of the five trace elements, Sr, Rb, Zr, Y and Nb, measured in the pXRF analysis of the 133 Bayshore sherds. In the DA the five trace elements were the independent variables, while the dependent variable was the composition group assignation given to each sherd based on the k-means cluster groups derived from the original principal component analysis of the same five trace elements. The reason for analyzing the same set of elements with two different forms of statistical analyses is to validate the resulting compositional groups created (the three categories illustrated in Figure 8).
The normalized (log10 transformed) data recorded through pXRF analysis is first run through a PCA to determine if there is any correlation between the 5 trace elements. The three resulting principal components are then run through a k-means cluster analysis to determine the optimum number of compositional groups. In this case three compositional groups yielded the most in-group cohesion and between-group separation. The same 5 trace elements were then run through DA, with the trace elements as independent variables and the 3 PCA derived k-means cluster groups as the dependent variable. The results of the DA indicate that the vast majority of sherds

Figure 8. Scatter plot displaying the classification of 133 sherds into one of three elemental composition groups. The group centroid defines the statistical center of each elemental group.
were assigned to the same compositional groups (96.2%) for both the DA and PCA. This consistency of group assignment between the two different methods of analyses promotes confidence in the resulting compositional groups. Figure 8 is a plot of the three distinct elemental compositions that resulted from those multiple analyses. It is hypothesized that these three distinct compositional groups represent three distinct clay sources on the landscape that were exploited by prehistoric peoples for pottery manufacture.

Another DA was run that utilized the same five trace elements as the independent variable and substituted the sub-site for the PCA derived k-means cluster group, as the dependent (or “grouping”) variable. In essence, Figure 9 illustrates the compositional analyses of all the sherds grouped according to their subsite of origin. Each colored symbol represents a sub-site from Bayshore where sherds were collected and analyzed. The final symbol labeled “Group Centroid” denotes the statistical center of every subsite grouping. To aid in the understanding of this graph it is important to remember the presumed age of each sub-site, which was assigned through archaeological context and, occasionally, carbon dated material. Both the Mound C (MCB) and Ross Rooney (RR) sub-sites are considered to be of the older (CE 150 - CE 500) occupation. The midden unit excavated by Sears (MUS) and Test Unit Four (TUF) are considered to be a mix of the two occupations, with the upper portion of MUS and the lower portion of TUF being associated with the older occupations and the lower portions of MUS and upper portion of TUF being associated with the younger occupation (CE 900 - CE 1350). Finally, Test Unit Two and the Kuttler mound are considered to be predominantly younger occupation, though the Kuttler mound was quite possibly constructed utilizing midden material from structures created during the older occupation.
Though it is clear from the first graph (Figure 8), that there are three compositionally distinct sherd groups, those sherd groups do not seem to correlate to any obvious archaeological context. Looking at Figure 9, sherd composition (or presumably, the clay source utilized for pottery manufacture) is not sub-site specific. There are subsets of sherds belonging to the same sub-site that seem to be of similar composition. For instance, there are a significant number of sherds from the Mound C sub-site (MCB), the group of green triangles on the left side of the graph, which are separate from the mass of sherds associated with the other five sub-sites.

Figure 9. Scatter plot displaying the elemental composition of 133 Bayshore sherds grouped by sub-site.
Despite these small cohesive groups within the larger collection, there is no sub-site consisting of pottery made from a single clay source.

Figure 10 clarifies the number of sherds from each sub-site that correspond to each of the three clay groups. As illustrated by the chart, there is no sub-site that contains sherds manufactured exclusively with a single clay source. All six of the sub-sites have sherds manufactured from all three distinct clay sources. Though in the case of sub-sites such as the Kuttler Mound and Mound C, there are certain clay sources that are more prevalent than others. Of the sherds analyzed from the Kuttler mound, only two of them appear to utilize the “Group 2” (G2) clay source.

Figure 10. Column chart illustrating the number of sherds associated with each sub-site (K, MCB, RR, MUS, TUT and TUF) broken down by clay group (Group 1, 2 and 3)
Of particular interest is the Mound C site that contains far more pottery sherds manufactured with the “Group 3” (G3) clay source (20 of the 25 sherds analyzed) than the other two clay groups.

The highest concentration of G2 clay sherds were excavated from the long shoreline midden where Sears excavated, sub-site MUS. Interestingly, the MUS, Test Unit Two (TUT) and Test Unit Four (TUF) sub-sites are all located within that midden and, of all six sub-sites, have the highest number of Group 2 manufactured sherds. Ross Rooney (RR) and the Mound C (MCB) sub-sites have the highest number of G3 clay sherds relative to the other two clay groups. While Kuttler (K) also has a high count of G3 sherds and a small number of G2 sherds, its highest number of sherds comes from the group 1 (G1) clay source. The above graphs offer a general overview of how the sherds analyzed at Bayshore “break down” with regards to clay resource utilization and how the pottery within each sub-site fits into the larger picture of pottery distribution across the Bayshore site.

The next two column charts (Figure 11 and Figure 12) address the first thesis research question involving clay source exploitation over time. Figure 11 illustrates that all three clay sources were utilized in both occupation periods, the earlier period (or older occupation) in orange and the later period (or younger occupation) in purple. Though both occupation periods have sherds manufactured from all three clay groups, there is variation in the dominant clay source of a given occupation period. The later occupation seems to use G1 and G3 clay sources more than the G2 clay source. In contrast, the older occupation seems to utilize the G3 clay source significantly more than the other two sources.
Figure 11 does not take into account that the number of sherds analyzed for the older occupation and younger occupation were not equal. Of the 133 sherds analyzed, 79 of them were considered to be from the later occupation, based on their archaeological context within the site. It is difficult to say how accurate that archaeological context is considering the rather significant amount of prehistoric earth moving activities that have been hypothesized at Bayshore. To counteract the bias of unequal sherd distribution, the column chart below, has weighted results. Each column is a percentage of the total number of sherds designated later occupation or earlier occupation. Ex. The later (purple) column for group 1 was calculated by taking the number of earlier occupation sherds categorized as clay Group 1 (29) and dividing that by the total number of later occupation sherds analyzed at the Bayshore site (79) multiplied by 100. The same process was utilized to determine the percentages of earlier occupation sherds (utilizing the total number of earlier occupation sherds analyzed at the Bayshore site, 54). These weighted results
should allow for a more accurate understanding of the proportions of clay sources utilized by each occupation with regards to each other. Though the comparison between clay source utilization within an occupation period has not changed, the comparison of clay source utilization between occupation periods is more accurate. When looking at Figure 12, there appears to be a pattern. Group 3 seems to be the dominant clay group in the earlier occupation, while G2 seems to be utilized relatively equally by both occupations. However, G1 becomes the dominant clay source in the later occupation.

The second thesis question involved comparing the decorated and plainware pottery analyzed to see if there was any correlation between the type of pottery manufactured and the
clay source utilized to manufacture it. As with Figure 12, describing clay source utilization by occupation period, Figure 13 provides weighted results comparing decorated and plain pottery sherds by clay group. This was necessary because the majority of sherds (86) analyzed at the Bayshore site were plainware. The plain pottery seems to utilize all three clay groups equally, though Group 2 is a little less prevalent than the others. However, there is a definite disparity in clay group utilization when looking at the decorated pottery. The G3 clay source is, by far, the dominant clay source utilized in decorated pottery production.

Final Thoughts

When considering the above charts and plots, the most interesting result is how the three compositional groups created by analysis of the 133 Bayshore sherds do not seem to correlate to any obvious archaeological context. There seems to be no obvious connection between the sherd composition and the sub-site, occupation period, or pottery style assigned to that sherd. Though there are clearly differences in elemental composition between sherds, the compositional association between certain sherds cannot be discerned through physical appearance or archaeological context at the site.

While there seems to be no definitive visual markers that characterized a particular clay source, there are differences in the proportions of composition groups from one sub-site to another. Specifically of note is the seeming concentration of G2 clay source sherds associated with the long shoreline midden. The highest counts of G2 sherds come from excavations
that are all located in the same midden. Another point of interest in the data is the seeming prevalence of G3 clay source manufactured pottery associated with the earlier occupation areas of the site. This dominance of Group 3 pottery is illustrated in the clay group by subsite chart (Figure 10), as well as the clay group by occupation period chart (Figure 12) and the decorated vs. plainware chart (Figure 13).

In Figure 10, the chart that displays the clay group proportions by sub-site, the Kuttler mound (K) contains the highest number of Group 1 sherds. The Kuttler mound also contains a number of Group 3 sherds. It is important to note that the Kuttler mound is, through archaeological context, associated with the later occupation period (CE 900-1350). The Kuttler

Figure 13. Column chart illustrating the weighted clay group association by pottery type (decorated vs. plain). The total of decorated sherds is 47 and the total of plain sherds is 86. The results in this chart are weighted to account for the difference in the number of sherds between the decorated and plain sherds.
mound is also speculated to have been constructed utilizing midden material from the previous occupation. Considering this information leads to questions about the clay group proportions resulting from the current analyses. Given the high number of Group 3 sherds associated with the older occupation pottery, is the high number of G3 sherds excavated from the Kuttler mound evidence of prehistoric movement of midden material from one part of the site to another, or merely a sign that the late occupation also used the G3 clay source extensively for pottery manufacture?

A final area of interest is displayed in the second graph, elemental composition of sherds grouped by sub-site (Figure 10). Though the plot depicts a largely chaotic mass of points that have no clear demarcation lines, there is a subset of the Mound C sherds (green triangles) that seem segregated from the larger group of points. Does this ostensibly cohesive group of sherds within the larger Bayshore sample indicate another distinct clay source? Or is their apparent distinction coincidental?

These final observations, in addition to the original thesis research questions, will be discussed in chapter 5, Conclusions. In addition, suggested methods for further addressing these discernable patterns in the data will be broached in the final chapter, Future Research.
CHAPTER FIVE
DISCUSSION AND CONCLUSIONS

The pXRF analyses of the Bayshore pottery have yielded some beneficial data and provided some valuable insights into pottery manufacture at the site. Portable XRF has proven to be a useful and effective technique for preliminary investigations of pottery composition. This analytical technique was a suitable choice for addressing the thesis research questions and provided results detailed enough to highlight other potential areas of inquiry. The results of the data analyses lend themselves to multiple interpretations that can promote diverse avenues for future investigation at the Bayshore site, and beyond.

The results illustrated in Figure 8 indicate there are significant differences in the elemental composition of the 133 sherds analyzed at Bayshore. Application of the provenance postulate (Neff 2000; Weigand et al. 1977), assumes that if the variation in composition within the group is less than the variation in composition between the groups, then the groups can be considered separate. In a sourcing study, extrapolating from this assumption is the idea that these separate groups correspond to different clay resources being exploited for pottery manufacture. The exploitation of multiple local clay sources for pottery production has been illustrated by other ceramic studies in Florida (Cordell 1983, 1992, 2013; Rice 1980). Cordell has studied pottery from several sites in Florida often utilizing microscopy, and in some cases a petrographic analysis, to examine paste variability in the pottery. Her work comparing pottery from various sites in the Caloosahatchee area of southwestern Florida suggested that some sites exploited multiple local clay sources over time. There was even evidence to suggest that some of the
pottery that would have been traditionally viewed as exotic, based on the criterion of relative abundance, may actually have been manufactured locally (Cordell 1992). The work performed by Tykot et al. (2013) in the panhandle actually utilized pXRF in the analysis of pottery from eight sites in relatively close proximity to each other. Like Cordell’s work in southwest Florida, the sites under investigation in the panhandle spanned centuries. The earliest sites were from the Late Archaic period, where the elemental composition of baked clay objects were analyzed, to sites as late as historic Indian. Analyses of the clay objects at the Late Archaic sites suggest there may have been long distance trade between northern Florida sites and sites in Louisiana, while the analyses of the later archaeological sites suggest that multiple local clay sources may have been exploited by individual villages (Tykot et al. 2013:241). Cordell’s studies from northern Florida also indicate the use of multiple local clay sources for pottery production. The McKeithen site in northern Florida utilized several local clay sources to produce plain and decorated pottery for local consumption, but also appears to be one of the centers for the manufacture and trade of decorated Weeden Island pottery (Cordell 1983; Rice 1980). Another northern Florida study from Cordell noted changing patterns in clay source consumption over time (Cordell 1993). Cordell’s research in the St. Mary’s River region suggest that the clay sources remained the same between the earlier culture period of Deptford and the later Savannah period, but the dominant clay source utilized in each period was different. It was also noted that in the Deptford period there seemed to be no clay source differentiation between plain and decorated pottery, but in the later Savannah period there was more evidence of separate clays being exploited for plainware and decorated vessels.

The clay studies mentioned above are helpful in analyzing the results of the Bayshore sherds. The fact that only three clay sources were identified in the analyses does not mean that
there are not more clay sources represented at the Bayshore site. Further analysis of Bayshore sherds, with pXRF and other more intensive forms of analysis would be necessary to provide greater clarity. There is also still uncertainty about the locality of these clay sources. The clay compositions are clearly different, but without clay samples on the landscape to compare them to, it is uncertain whether the clays are locally exploited or from an exotic (non-local) source. Even with clay sources to compare the sherds to, it is unlikely that the exact clay source utilized by the prehistoric people would be encountered. There is also the additional question of elemental variability within each clay source. As was discussed in earlier chapters, the geology of Florida seems particularly complex and efforts to gather a baseline understanding of clay source variability throughout the state has been difficult. Regardless of the availability of clay sources on the landscape, it is generally assumed that plain or domestic pottery at an archaeological site would be locally manufactured (Arnold 1985; Cordell 1982; Rice 2005). Evidence from previous Florida pottery studies suggest this is a plausible assumption and that it is not uncommon for more than one local clay source to be exploited for plainware pottery production. In applying this idea to Bayshore, it becomes likely that the plain pottery excavated from the Bayshore site was made from potentially three local clay sources by the inhabitants of the Bayshore site.

Additionally, none of the compositional groups identified at Bayshore correspond to, exclusively, plain or decorated pottery (Figure 13). If each of the three clay groups identified at Bayshore contains both decorated and plain pottery sherds, this lends credence to the idea that at least some of the decorated pottery excavated from Bayshore was also manufactured locally. Some of Cordell’s (1983, 1993) studies in northern Florida also surmise that discrete clay sources were utilized for both plain and decorated pottery.
As stated in the previous chapter, there is no clay source that is specific to a single occupation period at Bayshore. All three clay sources are exploited for both occupation periods (Figure 12). Though there is evidence that the dominant clay source changes from one occupation period to the other. Interestingly, Cordell (1993) noted a similar pattern of clay source exploitation in her research in the St. Mary’s River region. In the earlier occupation at Bayshore, the G3 clay source is the most prevalent. However, G3 is also the dominant clay source utilized in the decorated pottery. Since a large number of the earlier occupation sherds analyzed are also decorated pottery, it is uncertain whether the dominance of the G3 clay source is due to an occupation related preference or a pottery style related preference for a particular clay source. Therefore, more sherds will need to be analyzed to determine if the seeming preference for the Group 3 clay source is occupation based or based on a preferred clay source for decorated pottery production.

The Ross Rooney sub-site is associated with the older occupation and most of the sherds analyzed from that sub-site were plainware pottery. The fact that the majority of Ross Rooney plainware sherds are also manufactured from the G3 clay increases the probability that the G3 clay is an occupation period preference. Analyzing more plainware sherds from the older occupation and more decorated sherds from the younger occupation would provide additional insight.

There is also the subset of decorated Mound C pottery that seems to be distinctive in some way. Though all those sherds fit into one of the three composition groups, additional study of those sherds and further analysis of other Mound C sherds would be helpful. Perhaps this subset of Mound C pottery is from a separate clay source that may or may not be local. In studying the original analyzed data on element concentrations, there was a group of 13 decorated
sherds that had unusually low strontium levels (less than 45 ppm) in comparison with the other 133 sherds analyzed. This group of 13 falls within the Group 3 clay source, but there are also additional Mound C sherds with higher strontium levels that also fall into the same clay group. The analysis of more Mound C sherds may help delineate a separate clay source, if one exists. Otherwise, further analysis of the low strontium sherds in Mound C could provide a post depositional explanation for low levels. Comparison with other pXRF analyzed clay sherds across the state could also help answer the question of whether the lower strontium levels are evidence of an exotic clay source, which would be indicative of exotic pottery at the Bayshore site.

The extenuating circumstances of the Kuttler mound make it worth a special mention. Based on the established archaeological context of the Bayshore site, the Kuttler Mound is considered to be a product of younger occupation (CE 900-CE 1350) construction. However, it is believed that, at least, a portion of the Kuttler mound was created with midden material redeposited from an earlier occupation (CE 150–CE 500) structure. With that in mind, it becomes more difficult to determine the clay group proportions utilized by the later occupation. Looking at the proportion of clay groups excavated from Kuttler (Figure 10), it appears that G1 is the dominant group, rather closely followed by G3, with G2 barely represented. Based strictly on Figure 10, it would appear that G3 is exploited almost as much as G1. However, looking at the apparent dominance of G3 sherds in the older occupation sub-sites and the minimal number of sherds associated with G1, would suggest the most likely contribution of older occupation sherds in the Kuttler mound would be from the G3 clay source. The high number of G3 sherds at Kuttler may have less to do with a clay source the later occupation utilized for pottery
manufacture and more to do with earlier occupation pottery being relocated from the northern part of the site.

Another interesting discovery while studying the statistical results is the seeming prevalence of the G2 clay source in the MUS, TUT and TUF sub-sites. Though it may not be significant that 3 of the 6 sub-sites studied have G2 as the dominant clay source, the fact that all three of the sub-sites are part of the same shoreline midden is curious. The other 3 sub-sites, K, MCB and RR, only have two G2 sherds each. Why are G2 sherds so prevalent in the shoreline midden? The Sears midden unit (MUS) and Test Unit Four both contain older and younger occupation material. The final shoreline midden sub-site, Test Unit Two (TUT), is associated with the younger occupation. Of the other non-shoreline midden sub-sites, Mound C (MCB) and Ross Rooney (RR) are associated with the older occupation, while Kuttler (K) is associated with the younger occupation even though it is, likely, partially constructed with older occupation material. This information would suggest, based on the limited sherds analyzed, that the G2 clay source does not seem to have a strong association with either known occupation period. Putting aside the reality that the analysis of more sherds at Bayshore could alter the currently perceived clay group patterns, the prevalence of G2 sherds has at least two possible explanations.

First, there could be something inherent in the shoreline midden that has led to post-depositional chemical alteration of some of the pottery. If this is the case, additional analysis of shoreline midden sherds with a more intensive technology, like INAA, should be undertaken. A more in depth analysis of other shoreline midden artifacts and the midden material itself, would also aid in understanding any pertinent post-depositional processes.

A second possibility could be that there was a period of time, either associated with the older or younger occupation, or perhaps in between the known occupation periods, when G2
became a more popular clay source. If this clay source was utilized during an intermittent period, a possible reason could be sea level rise. One of the theories for the unusually large time gap in significant occupations at the site was based on the possibility that a change in the height of the bay waters negatively impacted Bayshore’s resources. Estuaries can be extraordinarily bountiful sources of food, however, estuaries are also fragile and relatively insignificant changes in sea level or salinity can be detrimental to the quality and quantity of marine resources available for human exploitation. Just as sea level changes can impact food availability, sea level change could also expose or obscure other resources, like clay outcrops that are often found along shorelines and riverbanks. It is still likely that the clay source is local because it is utilized in smaller quantities for all the Bayshore sites tested and a significant number of the G2 sherds are plainware. Like the previous possibility, this idea requires more sherds to be analyzed from the shoreline midden. It would be worthwhile to test sherds all along the shoreline from north to south, since the general pattern of site occupation through time seems to move from north to south. Based on current understanding of Bayshore, the older occupation was located in the north, with the younger occupation in the south, but the reason why the site seems to migrate south over time remains a mystery. Following the existing dichotomy of the older and younger occupation, there seems to be a disparity in the dominant clay source between the older and younger occupations. The older occupation seems to favor the G3 clay, while the younger may favor the G1 clay. Granted this “pattern” is difficult to discern, particularly the dominant clay source for the younger occupation. The borrowed midden material used to build the Kuttler mound, and the relocated sherds that migrated with it, make it more difficult to differentiate between the clay source actually used by the people of the later occupation period and the earlier occupation sherds that were simply re-deposited. In general, the pottery type can aid in identifying the
probable time period of manufacture, regardless of where the pottery was excavated from on the site. Archaeological evidence to date indicates that the Bayshore site does not adhere to the “typical” culture periods and datelines exhibited by other contemporary sites in the region. This characteristic, in addition to the complex stratigraphy of the site, means that additional lines of evidence will have to be employed to resolve the many questions the site evokes. The above interpretations of the pottery analyses, generates the answers to the original research questions.

Question 1

Are the clay sources utilized during the earlier occupation (CE 150-500) the same clay sources utilized during the later occupation (CE 900-1350)?

Yes. The same clay sources are utilized for both occupations, but not in the same proportions. The dominant clay source appears to change through time. More work must be done to ascertain how valid the existing clay categories are and whether they will remain relevant with the analysis of more Bayshore sherds. Analysis of sherds from other contemporary sites would also be beneficial.

Aside from possible environmental changes that could impact the availability of a clay source, as discussed above, there are other possible reasons for changes in clay source utilization through time. One possibility is the preferred, or closest, clay source has been overexploited. A second reason could be cultural differences between the two occupation periods, which lead to different preferences in clay sourcing. A third choice is that a clay source utilized in the older occupation is no longer accessible due to territorial changes. It is relatively clear that the number of people and villages in the area increased from the first occupation to the later one. With
increased population comes increased exploitation of the surrounding environment, which can lead to overexploitation and scarcity of resources. The threat of resource depletion can generate increased territoriality between villages to protect existing resources, meaning that increased populations can lead to shrinking territories for villages (Fowles et al. 2007). It is conceivable that a clay source utilized by the earlier occupation may not have fallen within the territory of the later occupation of Bayshore.

Question 2

*Are the clay sources utilized for decorated pottery the same as the clay sources utilized for plain ware pottery?*

Yes. The same clay sources are utilized for both types of pottery, but there definitely seems to be a preferred clay source, G3. However, further testing needs to be performed to determine whether the G3 source is dominant with decorated pottery or dominant with older occupation pottery. Based on the current analysis, it appears that G3 was more common in the older occupation regardless of pottery type. More importantly, the use of the same clay sources in both plain and decorated pottery, suggests that at least some of the decorated pottery found at Bayshore was locally manufactured. This is a departure from some long standing ideas about decorated pottery production in prehistoric periods; the assumption that highly decorated pottery was only produced at specialized pottery production sites and then distributed to other contemporary sites through inter-village trade (Sears 1973). More recent studies indicate that there could be multiple sites within a particular culture area that engaged in the production and trade of decorated pottery (Cordell 1983; Pluckhahn and Cordell 2013; Rice 1980). The results
of the Bayshore analysis suggest that, at least sometimes, it was the decorative motifs that were distributed between villages culminating in the localized production of decorated pottery for local consumption.

Another possibility is that some of the pottery, both plain and decorated, was manufactured elsewhere and then brought to the village. This transported pottery could have been brought to the site through trade with other villages or produced by members of the Bayshore community at remote seasonal camps and carried back to camp with their return. However, both these exotic clay source possibilities imply that both occupations had access, through trade or travel, to the same clay source.

All the above interpretations assume that the archaeological context of the analyzed sherds, as currently understood, is correct. Another assumption is that the variations in clay source composition are significant enough over distance, to allow for distinct elemental differences between an exotic and localized clay source. This second assumption is of greater concern because detailed archaeological knowledge of geological composition within Florida is inadequate. Though there is ample soil science research performed in Florida, attempts to access regional baseline elemental data that is compatible with the technologies employed in the archaeological analysis of pottery, has been limited.

The completion of this research has promoted a better understanding of the sheer volume of work that needs to be done to successfully track prehistoric pottery manufacture and trade in Florida. A collaborative statewide database containing pottery composition analyses would be optimum, as well as a database of clay samples. However, the logistics of maintaining and updating a statewide database make this an unlikely project. At the very least, following the suggestions of archaeologists like Shackley, it would be beneficial to establish some sort of
protocols for measuring and recording pottery composition data. Even something as simple as establishing standard settings for the analyzing equipment, can allow for compatibility between datasets. Regardless of the site being studied, pXRF seems to be an excellent first step for pottery analysis. It cannot take the place of more intensive analyses like INAA, but it can provide a baseline understanding of clay source utilization. Portable XRF’s method of analysis is the same as with a regular XRF machine, only the size of the instrument has been altered to make it more portable for analysis of archaeological objects in situ. Unfortunately the shrinking of the XRF to a more portable size comes with a trade off. The pXRF has decreased instrument sensitivity and, therefore, cannot detect as many elements as the standard XRF can. Fortunately, many of the most useful elements for discriminating between clay sources do fall within the sensitivity range of the pXRF. In particular, trace elements such as Rb, Sr, Y, Zr and Nb are useful in categorizing clay sources. Portable XRF is the best choice for gathering large numbers of pottery and clay samples over many sites. As technology improves and prices decrease, pXRF could become a standard piece of archaeological equipment allowing for the analysis of significantly more sherds than a more expensive lab-based technology. Additionally, the ability to analyze artifacts in the field would allow archaeologists to decrease the amount of artifacts that needed to be packed, transported and archived in facilities. Archaeologists with proper training and an awareness of the benefits and limitations of pXRF, could collect large amounts of data in relatively small periods of time. Analyses of these large datasets would enhance archaeological understanding of prehistoric trade, resource utilization, pottery production and potentially trace ideological influences over long distances.
CHAPTER SIX
FUTURE RESEARCH

There are a number of different paths for pottery research at Bayshore. The simplest avenue being to increase the number of sherds analyzed with pXRF. The more sherds analyzed, the more distinct the clay sourcing patterns will be. In addition to increasing the number of sherds analyzed from the six sub-sites sampled in this thesis, other areas of the site should also be sampled.

More decorated sherds should be analyzed from Mound C, both from the Bushnell collection, as well as the small surface collection from Sears housed at the FLMNH. More of the decorated sherds from the Sears midden unit (MUS) could also be tested. The sherds analyzed from the Sears midden unit were only collected from three of the stratigraphic levels excavated. There were also a larger number of decorated sherds excavated from the Kuttler mound (K) that were not available for analysis during this thesis. However, if these decorated sherds became available, a sample set of the sherds should definitely be analyzed. The comparison of the sherd composition between Kuttler and Mound C could help validate the hypothesis that older occupation material was used in the construction of the younger occupation mound. Analysis of decorated pottery from Kuttler could also corroborate the prevalence of the G3 clay source in the older occupation pottery. There were also some decorated sherds excavated from Test Unit Three, which lies east of the long shoreline midden, in what appears to be the remnants of an inland shell midden west of Mound B. Comparing decorated sherds from this unit against the existing analyzed sherds would be interesting because of the unit’s inland location in closer proximity to
the mound Sears excavated in the late 1950s. Will the decorated pottery located inland come from the same clay sources as the shoreline pottery? Finally, there were decorated sherds collected during survey work in Abercrombie Park, which lies at the southern end of the site. The assemblage appears to be similar to the Kuttler assemblage, but do those similarities extend to the same clay source exploitation?

The analysis of plain pottery from all of the above sites would also further illuminate clay source utilization at the site. Will the addition of more analyzed sherds alter the existing clay groups or will the new analyses reinforce the groups established in this preliminary investigation? Will the analysis of more sherds provide further delineation in clay source use/preference through time? Will additional analysis of sherd composition throughout the site make the prevalence of G2 sherds in the long shoreline midden even more conspicuous? If more excavation and shovel testing is done along the shoreline midden, will any excavated sherds reinforce or undermine the dominance of the G2 clay source? If evidence of post-depositional alteration were found, would that be tied to modern day changes to the landscape? Or would the forces causing elemental alteration be tied to environmental changes in prehistoric times, such as inundation by water?

Perhaps, if the more expensive INAA testing were to be done, the shoreline midden sherds should be one of the focus groups. If the prevalence of the G2 sherds along the midden were related to some sort of post-depositional chemical alteration, a more in-depth analysis that could provide actual elemental concentrations could prove useful in detecting it. Another subset of sherds that could benefit from a more complex analysis are the Mound C sherds, particularly the subset of Mound C sherds that present unusually low strontium levels. Are these low Sr
levels simply a product of a particular clay source or are they also representative of the effects of post-depositional alterations in composition?

It has been mentioned previously that locating clay sources on the landscape can be difficult, and uncovering a clay source now that was actually exploited by prehistoric people is even more difficult. This problem does not mean that clay sources should not be analyzed when uncovered. It is a relatively simple process to map a discovered clay source and collect a sample for pXRF analysis. Even the creation of a simple database housing clay source compositions and coordinates could provide valuable insight into clay sourcing in Florida.

On a larger scale, additional pottery analyses at sites contemporaneous to Bayshore would also be useful. Do sites in close proximity to Bayshore share the same clay sources or are they different? Common clay sources could either be a sign of inter-village trade or a shared exploitation of the same clay source. Would other sites display changes in clay source utilization over time? If a contemporary site in close proximity to Bayshore showed signs of shared clay sources in earlier time periods and then separate clay sources closer to the Contact period, would that be a sign of increased resource territoriality (Fowles et al. 2007)?

What about sites further away from Bayshore? If sherds and clay samples were collected from multiple sites at varying distances from Bayshore, how different would the clay composition be? Would there be a gradation of elemental concentrations that could be mapped across the landscape or would clay composition vary randomly with no discernable pattern?

Another benefit of analyzing pottery samples from other sites, both near and far away from Bayshore, would be to compare the overall clay exploitation patterns between the sites. The Bayshore site has proven to be unusual compared to contemporary sites in the vicinity. Does that uniqueness extend to clay source utilization at the site? In particular, do other sites near by also
show evidence of local decorated pottery production? Is the decorated pottery at those sites from a distinct clay source, suggestive of specialized local production or inter-village trade?

In studying the larger topic of pottery sourcing, one concept has become abundantly clear; a fundamental understanding of the geology of the area under study is necessary if one plans to make assumptions about the composition of pottery that serve as a foundation for additional research. Portable XRF, as well as more intensive and destructive methods of compositional analyses, can usually differentiate between distinct clay sources, but any conclusions drawn on the basis of these analyses will be hampered without a basic understanding of the local variability in clay sources. Conclusions can be drawn regardless, as have been done in this thesis, but to construct confident conclusions that will not only illuminate pottery manufacture at the site of interest, but have far reaching implications for archaeology of the region, the results of compositional analyses should be supported by a baseline knowledge of the local geology. The importance of this topic is underscored by a final set of statistics preformed for this thesis. Access was granted to compare the Bayshore data to that of two other archaeological sites, utilizing pXRF pottery analysis along the gulf coast of Florida. The sites were in different regions with a highly unlikely chance of sharing clay sources and were also unlikely to have engaged in direct trade. The resulting statistical analyses comparing the three sites did result in three distinct clay-sourcing groups, however there was no obvious association between the sub-sites and the clay groups. Taking the results at face value would imply that sites from significantly different regions of Florida utilized the same clay sources. Though it is not impossible that this implication is correct, it seems extremely unlikely. Since these analyses were not part of the original thesis, and only served as an opportunistic exercise to satisfy curiosity, not a great deal of time was spent on determining the reason for these results or discovering any
possible inconsistencies in the datasets that could have led to this unexpected development. The question still remains though. Why did the analysis turn out the way it did? Are there simply mistakes within the datasets that led to a flawed conclusion or is there that little variation in clay sources in Florida that three far removed sites could have pottery of the same elemental composition? Clearly, based on the statistical analysis of the Bayshore pottery, there is compositional variation in the localized clay sources significant enough to be defined as separate groups. Extrapolating from this information, it would be expected that other areas of the state would also have localized compositional variation in their clay sources as well. This extrapolation of clay source variability in Florida is upheld by the extensive work performed by Cordell in various regions of Florida and Georgia. Unfortunately, the elemental composition of clay sources is not information readily available to archaeologists (unless they can collect the clay samples themselves), and that is the point. Portable XRF works, and it, like other compositional analysis techniques, can provide valuable insight into many aspects of prehistoric life, but a better understanding of Florida geology and clay composition is necessary to place the results of pottery analysis in their proper context.
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APPENDIX 1: Index of pXRF analyzed sherds from the Bayshore Homes site with calibrated element data

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<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
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<td>8016</td>
<td>2081</td>
<td>15</td>
<td>825</td>
<td>24</td>
<td>184</td>
<td>7</td>
</tr>
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