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AN EXPLORATORY STUDY INTO THE CHEMICAL CHARACTERIZATION OF CARIBBEAN CERAMICS:

AN INTRODUCTION TO A SPECIAL VOLUME OF THE JOURNAL OF CARIBBEAN ARCHAEOLOGY IN MEMORY OF JAMES B. PETERSEN

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The papers presented in this issue of the *Journal of Caribbean Archaeology* were presented at the 2006 Society for American Archeology (SAA) annual meetings in San Juan, Puerto Rico. The conference papers were part of a session entitled "An Exploratory Study into the Chemical Characterization of Caribbean Ceramics: In Memory of James B. Petersen." A participant in and strong supporter of the session, Prof. James B. Petersen was tragically murdered in the summer of 2005 while conducting fieldwork in Brazil. The organizer for the session was Christophe Descantes; the session chair was Michael D. Glascock. Ronald Bishop (Smithsonian Institution) served as the discussant for the session and offered invaluable comments on the papers. For the journal issue, Christophe Descantes, Robert J. Speakman, Michael D. Glascock, and Matthew T. Boulanger are the special editors. Descantes, Speakman, and Glascock were involved in the instrumental neutron activation analysis (INAA) of the ceramic and clay specimens at the University of Missouri Research Reactor Center (MURR), and Boulanger helped in the editing, typesetting, and pre-press of the articles. Daan Iseendoorn et al.'s work was analyzed using x-ray fluorescence (XRF) at Vrije Universiteit Amsterdam.

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THE AUTHORS DEDICATE THE PAPERS IN THIS VOLUME TO THE MEMORY OF

JAMES B. PETERSEN
1954–2005

Among his many passions, Jim Petersen was dedicated to the thorough analysis of human material culture, past and present. His meticulous study of Amerindian technologies including ceramics, stone tools, and perishable textiles, led to groundbreaking insights into the material signatures of social interaction and ethnic boundaries. During his career, Jim analyzed hundreds of thousands of artifacts, all the time focused on what the careful study of objects could tell us about people.

Above all other classes of artifacts, ceramics held a special place for Jim. He could squeeze diamonds of data from the smallest of fragments. While decorated vessels certainly caught his eye, he loved every sherd equally. He always looked beneath the surface, always went one step further in his quest to learn more about pots and their potters. Jim was a champion of the small and underappreciated attributes, defending them with countless hours of his free time and the binocular microscope he lugged around in his carry-on bag. While Jim practiced his own more "traditional" approach to ceramic analysis, he was eager to explore the ways in which INAA could help us elevate our understanding of ceramic manufacture and exchange in the Caribbean. He would be excited by the progress this volume represents.

John G. Crock
University of Vermont

Jim Petersen, Anguilla 1992 (photo by David R. Watters).

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COMPOSITIONAL STUDIES OF CARIBBEAN CERAMICS: AN INTRODUCTION TO INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

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The University of Missouri Research Reactor Center (MURR) initiated a research program in 2003 centered on the chemical characterizations of ceramics from the Caribbean region. This article describes the technique and procedures involved in instrumental neutron activation analysis (INAA), applied to all but one of the studies in this issue. These papers were presented at the 2006 Society for American Archaeology (SAA) 71st annual meetings in San Juan, Puerto Rico. The collaborative studies presented are preliminary in nature, but hold promise for addressing a myriad of issues regarding Caribbean prehistory, ranging from island settlement to culture change.

The Caribbean region has been one of the most underrepresented areas of the world for chemical characterization studies of ancient material culture. In recent years, compositional studies have begun to address this deficiency (e.g., Bohus et al. 2005; Carini 1991; Crane 1993; Fitzpatrick 2000; Hofman et al. 2005; Lundberg et al. 2002; Padilla et al. 2003; Padilla et al. 2006; Winter and Gilstrap 1991). This paper introduces one such program initiated at the University of Missouri Research Reactor Facility (MURR) where ceramics from eight projects were investigated to begin building a compositional database of Caribbean ceramics. A description of the techniques and procedures of INAA applied to the ceramics and clays of most of the papers, is presented followed by an introduction of the different papers and a discussion of the potential of the techniques for addressing issues of Caribbean archaeology. Isendoorn et al.'s paper introduces the archaeometric program at Leiden University where various archaeometric techniques have been used for the study of Caribbean ceramics (see also Hofman et al. 2005).

The senior author initiated this archaeometric project on Caribbean ceramics in 2003 while a postdoctoral researcher at the Research Reactor Center. Several leading Caribbean researchers based at US academic institutions were invited to participate in the study and were offered 50 free analyses in exchange for participating in the SAA conference session. The long-term goal of the study is to address some of the major anthropological questions of the region by building an elemental database of the most common artifact type found in the historic and prehistoric Caribbean archaeological contexts—ceramics. The technique has been applied successfully to numerous other cultural regions in the Americas, notably the American Southwest and Mesoamerica (Glowacki and Neff 2002; Nichols et al. 2002). INAA has allowed for the exploration of the changing roles of markets and the development of preindustrial markets in the Basin of Mexico. In the American Southwest, INAA has become a useful tool in understanding exchange, migration, social identity, and economic organization.

Financial support for the INAA studies presented in this issue was provided by the National Science Foundation (BCS-0102325) and the US Department of Energy Office of Nuclear Energy, Science and Technology (Award No. DE-FG07-03ID14531) to the Midwest Nuclear Science and Engineering Consortium under the Innovations in Nuclear Infrastructure and Education program. Isendoorn et al.'s X-ray fluorescence (XRF) analyses and fieldwork were funded by the NWO VIDI-project "Mobility and exchange: dynamics of social, material and ideological relations in the pre-Columbian insular Caribbean" directed by Professor C. L. Hofman and by the Byvanck Fonds.

The Yale University Peabody Museum of Natural History and the late Professor Irving Rouse graciously facilitated Christophe Descantes' compositional studies of Indian Creek ceramics from the West Indian island of Antigua. The INAA study of these data was submitted for publication in the Proceedings of the 21st Congress of the International Association for Caribbean Archaeology (IACA) in Trinidad and Tobago (Descantes et al. 2007). Antiguan data presented in the paper above are used in this introductory paper to illustrate the INAA technique and the reduction of the data.

In addition to the compositional programs at Leiden University and MURR described in this volume, there have been other recent compositional studies of Caribbean ceramics—most notably the work of Román Padilla et al. at the Centro de Aplicaciones Tecnológicas y Desarrollo Nuclear (CEADEN) in Cuba, and of Magdalena Mackowiak de Antczak and Andrzej Antczak at Simón Bolívar University in Caracas, Venezuela.

The INAA work of Padilla et al. (2003) from CEADEN successfully combined INAA and scanning electron microscopy X-ray analysis (SEM–EDX) to study Cuban pottery from prehistoric and historic assemblages. Incorporating petrographic analyses in their work, they confirmed that different clay regions in central Cuba have different clay compositions. When investigating the provenance of Majolica ware recovered at Cuban sites, Padilla et al. (2003) argue that the pottery originates from Spain, Old Havana in Cuba, and possibly Veracruz, Mexico. Recently, Padilla et al. (2006) combined two energy dispersive X-ray fluorescence methods—improved sensitivity polarized X-ray fluorescence analysis (EDPXRF) and radioisotope X-ray fluorescence (R-XRF)—for fast and non-destructive analyses of ceramic sherds. They found the chemical measurements were comparable to that of INAA, provided the surface of the sherd was flat and had no evident signs of physical alteration, such as cracks or cavities.

Similarly, Magdalena Mackowiak de Antczak and Andrzej Antczak from Simón Bolívar University in Caracas, Venezuela, collaborated with the Institute of Isotope and Surface Chemistry in Budapest to determine specific areas of production of Los Roques Archipelago ceramic figurines. As in other archaeometric studies into Caribbean material culture, various analytical techniques, such as INAA, total reflection X-ray fluorescence (TXRF), and prompt gamma activation analysis (PGAA) are combined with traditional petrographic analyses to not only provenance the stylistically diverse ceramic figurines, but also to investigate the social and ideological aspects of the figurines in their respective archaeological deposits. Preliminary results reported indicate that similar styled figurines from the Los Roques Archipelago and from the Lake Valencia region in Venezuela differ significantly in chemical composition (Bohus et al. 2005:255).

The INAA Technique

Instrumental neutron activation analysis is a powerful quantitative analytical technique that has been widely applied in archaeological studies for the last 50 years (Glascock and Neff 2003; Neff 2000; see papers in Speakman and Glascock 2007). The precision and accuracy of this radiometric technique in generating empirical data for major, minor, and trace elements of objects of interest makes it one of the most reliable compositional characterization techniques, especially useful for addressing questions of provenance or origins.

In brief, INAA involves activating the nuclei of objects by bombarding them with neutrons generated from a nuclear reactor (Figure 1). Once activated, nuclei emit gamma rays with characteristic energies that can be measured and attributed to specific isotopes. Quantitative INAA data can be generated by including known reference standards in the analyses (see Glascock 1992).

Sample Preparation

Standard MURR procedures were used in the INAA of the Caribbean ceramics and clay samples (see Glascock 1992). Fragments of about 1cm^2 were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. Specimens were then washed with deionized water before being crushed into fine powder in an agate mortar. Where possible a portion of each specimen was retained, unpowdered, for the MURR archive of analyzed ceramic fabrics. Powdered samples were oven-dried at 100 degrees Celsius for 24 hours. Portions of approximately 150 mg were weighed and

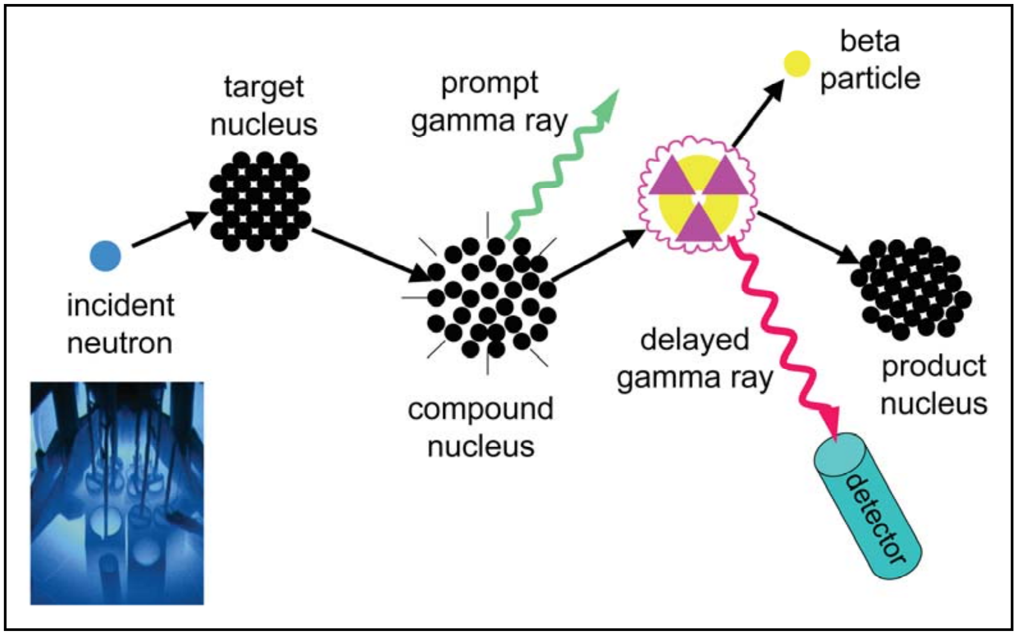

Figure 1. Schematic diagram of instrumental neutron activation analysis (adapted from Glascock 1998:100).

placed in small polyvials used for short irradiations. At the same time, 200 mg of each sample were weighed into high-purity quartz vials used for long irradiations. Along with the unknown samples, reference standards of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (an in-house standard).

Irradiation and Gamma-Ray Spectroscopy

INAA of ceramics at MURR consists of two irradiations and three gamma counts. As discussed in detail by Glascock (1992), a short irradiation is carried out through the pneumatic tube irradiation system (Figure 2). Samples in the polyvials are sequentially irradiated, two at a time, for five seconds at a neutron flux of 8×10^{13} n cm^{-2} s^{-1}. The 720-second count yields gamma spectra containing peaks for nine short-lived elements: aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples encapsulated in quartz vials are subjected to a 24-hour irradiation at a neutron flux of 5×10^{13} cm^{-2} s^{-1}. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 1800 seconds (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely: arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 9,000 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr). The element concentration data from the three measurements are tabulated in parts per million using Microsoft Excel.

Quantitative Analysis of the Chemical Data

The following section is a brief description of the data reduction and analytical procedures used in the chemical compositional analysis. See Neff (1994, 2000) for more detailed information. As is customary in ceramic provenance studies at MURR (Bishop and Neff 1989), the data are converted to base-10 logarithms of concentrations. Use of log concentrations rather than raw data compensates for differences in magnitude between major elements. Chemical data values for the 33 elements in the analyzed samples are examined prior to identifying compositional groups. Specimens with anomalous concentrations are treated as outliers and rejected from subsequent statistical procedures. In addition, elemental abundances that are non-existent or below detection limits in many of the samples are also dropped from further analyses. The elimination of nickel measurements is not uncommon in the chemical analysis of ceramics in general and in Caribbean ceramics in particular. The last procedure involves searching for a pattern of calcium concentrations greater than 1% or 10,000 parts per million. The high calcium abundances are most likely a result of either of the original clay sources or a calcium-rich temper. A correction factor is applied to all of the elemental data to counter the dilution effect of calcium on the other elemental abundances (see Cogswell et al. 1998). As in

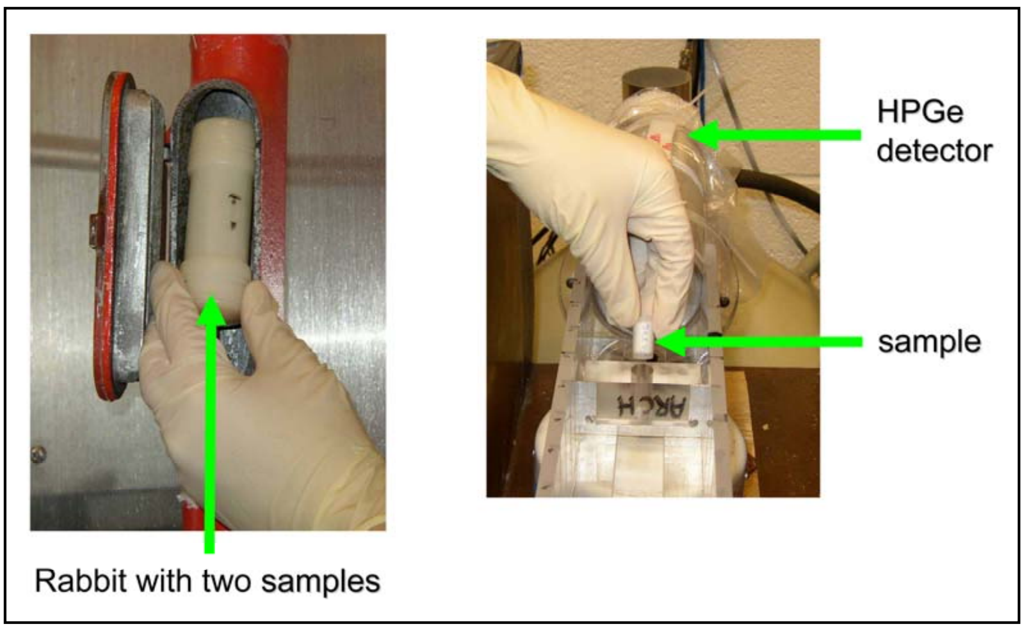

Figure 2. Short irradiation of a rabbit carrying two samples in a pneumatic tube system (left) and the measurement of gamma-ray emission in front of a high-resolution germanium detector (right).

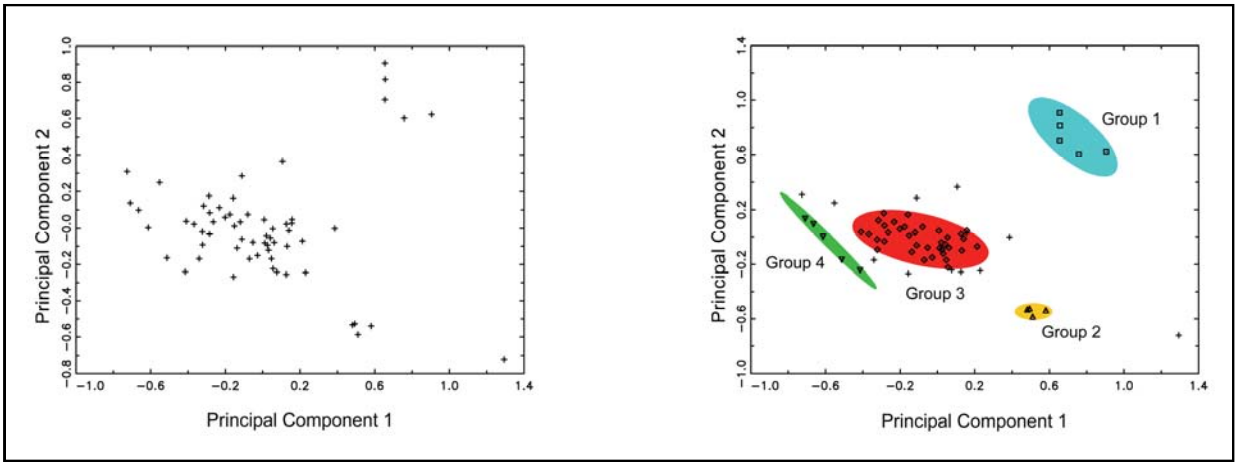

Figure 3. Plot of principal components 1 and 2 displaying the ceramic INAA data from the Indian Creek Site, Antigua (left) and plot of the same data with identified compositional groups (right). Unassigned specimens (+) are not labeled.

previous treatments of ceramics with enriched calcium concentrations, we eliminated the elemental concentrations of calcium and strontium. A calcium correction factor was applied to the ceramic data from the Dominican Republic and Puerto Rico.

The goal of quantitative analysis of the chemical data is to recognize compositionally homogeneous groups (that are hopefully anthropologically meaningful) within the analytical dataset. Based on Weigand *et al*.'s (1977) "provenance postulate", such groups are assumed to represent geographically restricted sources or source zones. The location of sources or source zones may be inferred by comparing the unknown groups to knowns (source raw materials) or by indirect means. Such indirect means include the "criterion of abundance" (Bishop et al. 1982) or arguments based on geological and sedimentological characteristics (e.g., Steponaitis et al. 1996).

Initial hypotheses about source-related subgroups in the compositional data are derived from the application of pattern-recognition techniques to the chemical data. Principal components analysis (PCA) is used to recognize patterns, that is subgroups in the compositional data (Figure 3). PCA provides new reference axes that are arranged in decreasing order of variance subsumed. PCA can be used in a pure pattern-recognition mode, i.e., to search for subgroups in an undifferentiated data set or in a more evaluative mode to assess the coherence of hypothetical groups suggested by other criteria, such as archaeological context and decoration.

Biplots are used to display both the variables (elements) and objects (individual analyzed samples) on the same set of principal component reference axes (Figure 4). Displaying objects and variables on the same plots makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups.

The Mahalanobis distance statistic is used to statistically test the separation between groups or between individual points and groups on multiple dimensions (see Bieber et al. 1976; Bishop and Neff 1989; Harbottle

1976; Neff 2001; Sayre 1975. Mahalanobis distance takes into account variances and covariances in the multivariate group and is analogous to expressing distance from a univariate mean in standard deviation units. Similar to standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for each individual specimen (e.g., Bieber et al. 1976; Harbottle 1976).

Mahalanobis distance-based probabilities of group membership for members in small groups may fluctuate dramatically depending on whether or not each specimen is assumed to be a member of the group to which it is being compared. This limitation can be circumvented by cross-validation or "jackknifing", that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1992; Leese and Main 1994). All probabilities discussed in each of the papers in this issue were cross-validated.

Mahalanobis distances can be calculated for the log concentrations and the principal components extracted from the variance-covariance or correlation matrix of the complete data set. Calculating Mahalanobis distances on the principal components permits us to reduce the dimensionality of the data set and statistically test the separation of the chemical groups, which is crucial when dealing with small groups. We use enough principal components to subsume approximately 90% of total variance in the data set. Typically, elemental plots are provided in the analysis to demonstrate that the identified compositional groups are not an artifact of the PCA algorithm (see Figures 4 and 5).

Potential of INAA studies

The compositional study of ceramic materials from archaeological sites promises to shed light on some of the major archaeological questions of the region. Such questions include ancient population movements within the region, the development of exchange networks both within and among various island archipelagoes, and local adaptations and historical developments from ca. 4000 BC up to and including the time of Euroamerican contact.

Material culture in the Caribbean has long served as a marker for identifying cultural traditions and modeling population movements (Keegan 1995; Rouse 1992). In regards to the original movements of preceramic peoples into the Antillean region, many areas have been suggested as possible sources (e.g., Cruxent and Rouse 1969; Veloz and Vega 1982; Wilson et al. 1998). The Yucatan Peninsula is favored as the most likely source for the early people who settled the Greater Antilles (Keegan 2000). In contrast, the later horticultural ceramic-producing peoples who populated the Lesser Antilles sometime during the first millennium BC are hypothesized to be migrants from northern South America (near the mouth of the Orinoco River). Compositional analyses of the material culture, and where possible, isotope ratios (e.g., Sr) of human bone and teeth, will contribute to our understanding of the complex migration movements into the region, and serve as an important counterpoint to previous migration hypotheses based on artifact attributes and historical linguistic studies. Compositional data for ceramics from early assemblages can provide quantifiable evidence and track technological changes during the rapid island

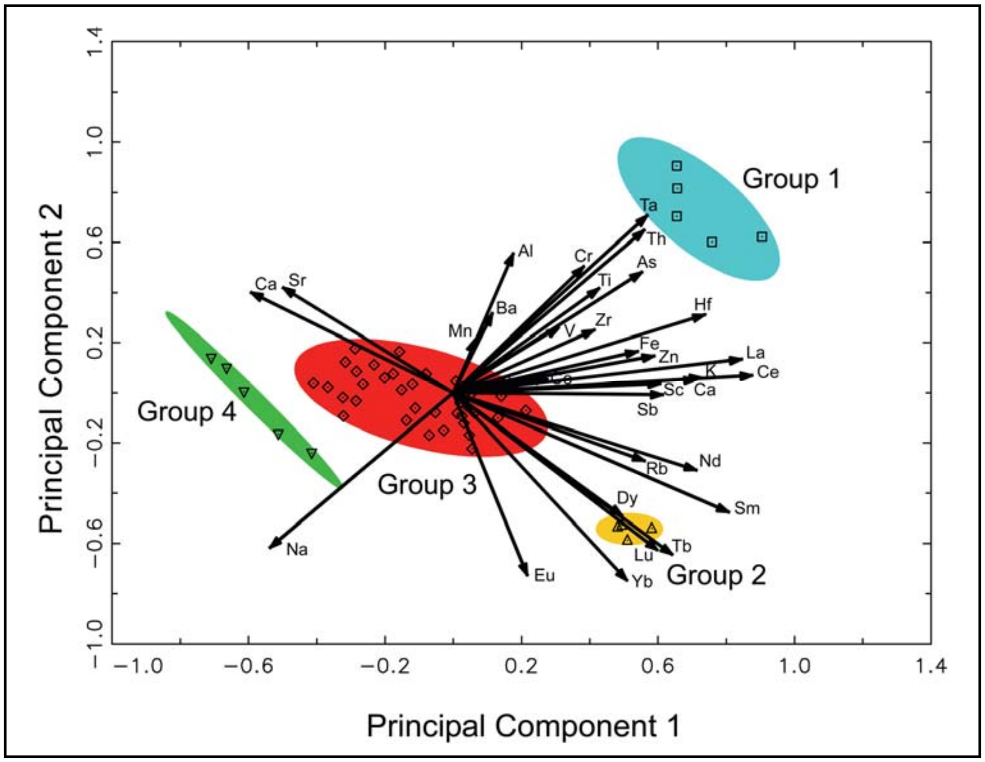

Figure 4. Correlation matrix PCA biplot of principal components 1 and 2 showing the four compositional groups identified in the Indian Creek Site ceramic sample. Ellipses represent 90% confidence level for membership in the groups. Unassigned specimens are not shown.

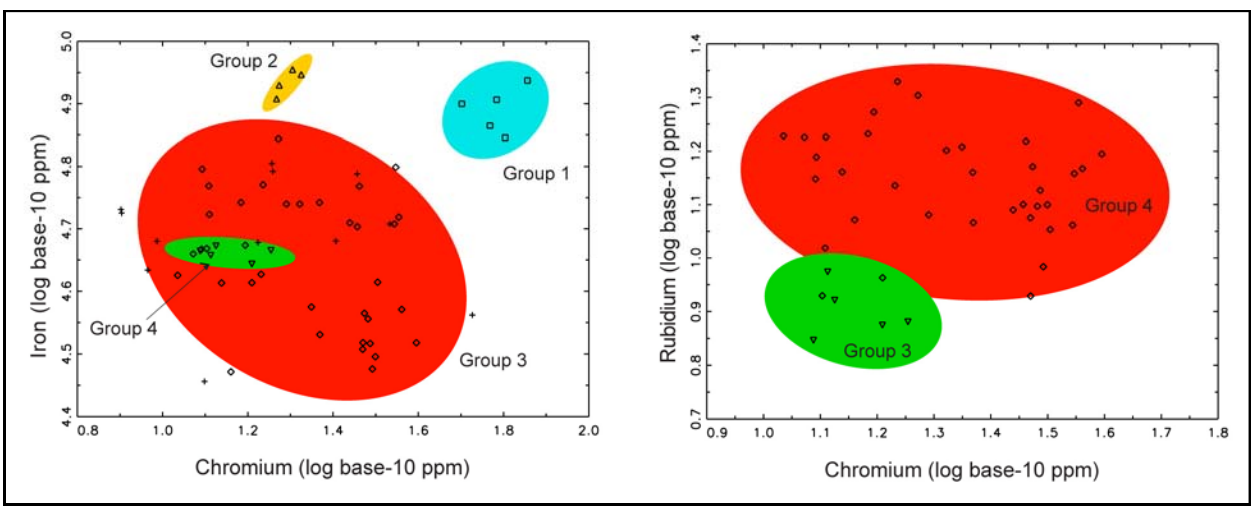

Figure 5. Left: Plot of base-10 logged chromium and iron concentrations of the four ceramic compositional groups at the Indian Creek Site, Antigua. Ellipses represent 90% confidence level for membership in the groups. Unclassified samples (+) are not labeled. Right: bivariate plot of base-10 logged chromium and rubidium concentrations displaying the chemical distinctiveness of compositional Groups 3 and 4. Ellipses represent 90% confidence level for membership in the groups. Unclassified samples are not shown.

settlement of the Caribbean. In particular, the acquisition of ceramic and clay compositional data can allow one to identify the possible interactions between people of new island settlements with the people from whence they came. Finally, studies using INAA can also contribute insights into the origin of ceramic technological behaviors of African slave societies in the Caribbean by investigating comparable technologies in West Africa.

Constructing past exchange models is a major task facing Caribbean archaeologists (e.g., see Crock and Petersen 2004; Hauser 2001; Knippenberg 2006). Exchange networks are extensive in Caribbean prehistory; ceramics, cherts, and other materials found in the archaeological record are important sources of evidence for identifying past exchange behaviors. Petrographic analyses of ceramics in the region have long provided invaluable evidence for addressing questions of ceramic production and exchange, and still have a vital role to play as a complimentary technique to finer-grained analytical techniques. Detailed studies that employ INAA and petrographic analysis to study the material culture of the peoples of the Caribbean contribute to our understanding of exchange networks, which are important for developing and testing hypotheses about the origins, the operation, and the transformation of exchange systems.

Permeating all aspects of island life, exchange initiates interaction between people and is an important dynamic in discussions of culture change. Exchange studies based on compositional data can provide insights on cultural processes of ethnogenesis, enculturation, colonialism, and resistance in the prehistoric and recent past. Leiden University's Archaeology Program presently heads several Caribbean research projects that employ state-of-the-art archaeometric techniques, such as thermal ionization mass spectrometry (TIMS), to gain insights into the movement of objects and their impacts on the societies involved.

Compositional analyses of ceramics can provide insights into the technologies of past peoples (e.g., Curet 1997). Compositional analyses of undecorated and decorated wares aimed at understanding behavioral processes, from procurement of clay at specific geologic sources to the deposition of broken ceramic vessels in the archaeological record can allow archaeologists to explain local adaptations and historical developments in the societies of the region. INAA analyses of Caribbean ceramics permit an investigation into the technological attributes of the decoration-based typological categories of the ceramics. A diachronic perspective based on the composition of particular ceramic wares allows us to investigate issues of the so-called decrease in ceramic quality as well as the great cultural diversity in the West Indies around AD 800 (e.g., see Keegan 2000:155). We know that dramatic changes in subsistence and pottery decoration mark the boundary between Saladoid and Ostionoid cultures of Puerto Rico (Keegan 2000:152). Is this shift represented in the compositional record of the sherds? It has been argued that cultural pluralism is a key factor in understanding the emergence of Taíno chiefdoms (Wilson 1999:2). Is this pluralism represented in their ceramic recipes? In conjunction with the ethnohistoric sources (see e.g., Hofman and Bright 2004) that exist for the region, the compositional studies we propose stand to gain from understanding pottery manufacturing in changing and social and cultural environments and understanding how pottery was negotiated in African, European, and indigenous societies.

Relying on small data sets, the papers in this issue use compositional data from ceramics to address some of the major questions of the region and offer preliminary interpretations. All of the studies presented here are works in progress, and will undoubtedly be expanded upon by enlarging the sample sizes of the clays and ceramics, and applying various analytical techniques to the research questions. The work by Isendoorn et al. presents preliminary results of a case study on St. Lucia to address wider concerns of reconstructing contact and/or distribution networks in the Lesser Antilles during the Ceramic Age. Their micro-regional case study involving three archaeological sites in southern St. Lucia finds that the majority of ceramics originate from local clays in the region. Siegel et al.'s exploratory paper attempts to identify compositional signatures for ceramics from various periods in Puerto Rican prehistory to investigate exchange. They conclude that ceramic production and exchange remained at the local domestic level despite the changing social and political contexts of the island. Crock et al. with a dataset of Late Ceramic Age ceramic sherds from Anguilla in the British West Indies and the Salt River Site in St. Croix of the U.S. Virgin Islands depend on stylistic analyses and INAA compositional work to suggest a degree of specialized production and the use of a limited number of ceramic recipes for both island communities. They conclude that ceramic recipes were limited in both island contexts; the ceramic sample from St. Croix appeared to have more of a local origin than that from Anguilla.

Conrad et al. use the compositional heterogeneity of Taíno ceramics from the Dominican Republic to argue that the site of La Aleta served as a ceremonial center for a regional rather than a local population. Fitzpatrick et al. attempt to reconcile differences in their petrographic and chemical characterization interpretations of ceramics on the island of Carriacou in the southern Grenadines. To offer preliminary insights into the production and exchange of ceramics on the island of Carriacou in the southern Grenadines from ca. AD 400–1200, they suggest several different possible exotic sources for their ceramic sample.

Several papers in the volume address issues in the more recent historical past. Kelly et al. investigate low-fired earthenwares to address issues of exchange and interaction by focusing on the enslaved peoples of African descent in Guadeloupe during the French Colonial Period of the eighteenth and nineteenth centuries. Preliminary conclusions on the heterogeneity of ceramic recipes imply complex interisland trade of industrial wares. Ahlman et al. examine the wares of enslaved Africans at Brimstone Hill Fortress National Park on St. Kitts from contexts dating from1790–1850 for insights in their systems of production and exchange. Incorporating possible local clay sources in their compositional analysis, and using a mineralogical and chemical compositional approach, they interpret that most of the ceramics in their sample were locally made. They also suggest the possibility of socio-economic differences amongst the enslaved Africans at Brimstone Hill, where slaves with specialized tasks at the fortress had the means to purchase more expensive non-local pottery than the less skilled laborers, such as plantation slaves. Finally, Hauser et al. focus on the mineralogical and chemical compositions of Yabba ware for insights into the eighteenth century craft production of enslaved and free Jamaicans. At this preliminary stage, it appears that ceramic pot recipes on the north and south coasts and the central part of the island were similar, indicating a larger than expected scale of production.

Conclusion

Caribbean pottery technology has received relatively little attention (Curet 1997:497). To address this need, several analytical programs have begun to use compositional data of ancient and historic Caribbean material culture to address the salient research questions of the region. MURR has initiated a new program for the chemical characterization of ceramics using INAA, as well as other analytical techniques at its disposal such as inductively coupled plasma mass spectrometry (ICP-MS), energy dispersive X-ray fluorescence spectrometry (EDXRF), and portable X-ray fluorescence spectrometry (PXRF). All of the papers in this volume were presented at the 2006 Society for American Archeology (SAA) annual meetings in San Juan, Puerto Rico, in a session entitled "An Exploratory Study into the Chemical Characterization of Caribbean Ceramics: In Memory of James B. Petersen. The INAA compositional data for eight of the nine papers in this volume were generated at MURR; the XRF data for one paper was generated at Vrije Universiteit Amsterdam.

The research reported in this conference session and the baseline ceramic compositional data generated for the Caribbean will serve as a foundation for future research into the prehistory of this region. We are optimistic that archaeologists are beginning to recognize the value of integrating such studies for understanding important aspects of prehistoric human and social dynamics. Our hope is that we will foster greater collaboration between archaeology and the physical sciences in this region of the world by demonstrating the intrinsic value of provenance studies to understanding past human social dynamics.

Acknowledgments

We express our gratitude to the contributors in this volume, whose participation has made this collaborative study a success. We thank Ronald Bishop of the Smithsonian Institution who served as discussant for the session at the SAA annual meetings in San Juan, Puerto Rico and for his invaluable comments on the papers in this volume. They provided a wide array of research questions to the archaeological ceramic sherds collected from diverse Caribbean island locations and varied temporal contexts. We also thank Jonathan Dake, Mark Hammond, Nicole Little, Rebecca Schmidt, and Tessa Schut for carrying out the preparation and irradiation of samples in all of the INAA studies. Operating support for the MURR Archaeometry Laboratory was provided by grants from the National Science Foundation. The INAA work was also partially funded by the US Department of Energy Office of Nuclear Energy, Science and Technology Award (No. DE-FG07-03ID14531) to the Midwest Nuclear Science and Engineering Consortium under the Innovations in Nuclear Infrastructure and Education program. Finally, we would like to acknowledge the important support and contributions of the late Professors Irving Rouse and James B. Petersen.

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BACK TO THE SOURCE: PROVENANCE AREAS OF CLAYS AND TEMPER MATERIALS OF PRE-COLUMBIAN CARIBBEAN CERAMICS

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Current knowledge regarding the provenance of pre-Columbian ceramic raw materials, i.e. clays and temper materials, and the identification of exchange wares is largely insufficient. Only in rare cases have technological aspects such as the temper constituents of the pottery been analyzed, and even then rarely combining conventional and archaeometric techniques. In this paper the methodology of a project that started at Leiden University in 2004 will be discussed and illustrated by the preliminary results obtained from a micro-regional case study carried out in southern St. Lucia. Potsherds from three archaeological sites have been analyzed. The results show that pre-Columbian potters on the island made use of both locally available as well as non-local clays.

Leiden University initiated ceramic technology research in the Lesser Antilles in the late 1980s. Results of these studies, mainly based on conventional methods involving workability tests, fabric analysis, and thin-sectioning have been published ever since. This research formed the impetus for a PhD project on the provenance and exchange of ceramics (raw materials and finished products) within the Lesser Antillean archipelago combining conventional and archaeometric techniques. The project is part of the pluri-annual VIDI-program on Mobility and Exchange in the pre-Columbian Caribbean (started in 2004 and funded by the Netherlands Foundation for Scientific Research. It is directed by Professor Corinne L. Hofman).

The main objective of the PhD project is to identify clay sources on the islands and reconstruct contact and/or distribution networks in the Lesser Antilles between 400 BC and AD 1492.

A combined approach is chosen to tackle these objectives. These are the collection of clay and pottery samples from the various islands, testing the workability properties of clays, determining the mineral constituents of both clays and pottery samples, and analyzing the chemical composition of the clay and pottery by means of conventional as well as archaeometric techniques such as X-ray fluorescence (XRF), and in the future, thermal ionization mass spectrometry (TIMS). In combination, these methods complement each other rather than cancel each other out (see Arnold et al. 1991; Bishop et al. 1982).

Contemporary clay sources have been sampled and clays and potsherds from several islands of the Lesser Antilles have been subjected to this combined approach (see Stark 1966; Hofman et al. in press for similar sampling methods). To date, 210 clays and 600 potsherds have been collected from twelve islands in the Lesser Antilles. These are currently being submitted for analysis at the laboratories of the Faculty of Archaeology at Leiden (Laboratory of Ceramic Studies) and at the Faculty of Life and Earth Sciences at the Vrije Universiteit Amsterdam.

So far, the collection of clay samples and potsherds, needed for the project, has been completed. The analysis of all clay samples and of the potsherds, from the northern Lesser Antilles, has also been finalized. All analyses on the clay samples and the potsherds that are described in this paper are finalized[1]. Analyses of the remaining samples will be conducted during the coming year and are expected to provide an overall picture of the provenance and distribution of ceramic raw and/or finished products throughout the Lesser Antilles.

Clay Sampling Strategies

Between 2004 and 2006 three field trips were made in order to collect clay and pottery samples from various islands in the chain. In addition, pottery samples were obtained from fellow institutions such as Yale University, the University of the West Indies, Trinidad, the Florida Museum of Natural History, Calgary University, the Barbados Museum and Historical Society, the St. Lucia Archaeological and Historical Society, the University of Vermont and the Antigua Museum. This was accomplished with the cooperation of many colleagues: Reg and Nicky Murphy, Mary Hill Harris, Peter Harris, Bill Keegan, Joe Moravetz, John Crock, Birgit Faber Morse and Eric Branford.

Sampling of clay and pottery has been carried out in the main geological regions that characterize the Lesser Antillean archipelago; the southern continental islands (Trinidad and Tobago) (Boomert 2000, van Soest 2000), the southern to central volcanic islands (Grenada, St. Vincent and St. Lucia) and the central to northern split-arc region with volcanic islands (Guadeloupe’s Basse Terre, St. Eustatius and Saba) and limestone/extinct-volcanic islands (Guadeloupe’s Grande Terre, Antigua, St. Martin and Anguilla). Barbados, the sub-aerial expression of the sedimentary wedge that overlies the southern to central part of the Lesser Antilles subduction zone, has also been included. The geological survey was conducted in collaboration with the Vrije Universiteit Amsterdam (see also Hooijkaas and Booden 2004)and the aim of the surveys was to collect a representative sample of the clay deposits on each island, by taking into account the great variability of geological formations. Sampling procedures were proposed for each island and were designed beforehand on the basis of archaeological inventories, soil maps, and geological maps. Furthermore, the sampling was aimed at establishing an overall geochemical picture of the variety in clay deposits present. A final aim was to search for specific clay sources in the vicinity of known archaeological sites.

Potsherds from three archaeological sites on St. Lucia were analyzed. These include Black Bay, a late Cedrosan Saladoid site (AD 400-600), Giraudy and Saltibus Point, multi-component sites containing late Cedrosan Saladoid and Suazan Troumassoid components (AD 400-1200).

Of the 104 clay samples that were collected on St. Lucia (Figure 1) in 2004, 12 samples are geographically associated with the three archaeological sites. Sampling of the clays was carried out according to the sampling strategy and clay sources were found in a variety of locations such as inland hillsides and valleys. Clays were often collected on roadside cuts. Furthermore agricultural fields and meadows were seen as possible sampling areas, but to avoid contamination, the samples were preferably collected on ridges, because contamination of a sample can come from fertilizers, the presence of industrial waste dumps, waste from villages such as laundry detergent, sea spray, and nearby construction sites.

Workability Tests and Experiments

To evaluate the suitability of the clay mixtures for Amerindian manufacturing techniques, the workability and plasticity properties of the clays were tested by making testpots and testbars (Hofman et al. 1993; Hofman and Jacobs 2000/2001). Of the twelve clays, five clays from Black Bay, two from Giraudy and two from Saltibus point were well suited for coil building. In the case of the Black Bay clays, the coils tended to adhere to each other easily while the paste can be smeared to fix the coils firmly together. They are also well suited for pinching and modeling. On some of the samples scraping and tapping could easily be executed. These clays contained “enough bones” and therefore probably would be suitable for coiling and the production of large vessels. The amount of natural grains prevented the clays from shrinking too much upon drying and firing of the testbars. Although, these clays already have enough plasticity, some of them might even improve in workability with aging. Two of the clay samples (STL-1 and STL-3) improved with the addition of some fine sand. Furthermore the presence of fine divided organic material in the clay is recognizable on the testbars. Testbars in this case show a black core after firing at 650°C under oxidizing conditions. Three of the clay samples (STL-2, STL-31 and STL32) contain clear quartz crystals (i.e. approx. 6%), which resembled the fabric of the analyzed potsherds from Black Bay.

The clays collected near Saltibus Point (STL-19 and STL-20) also proved to be well suited for coiling, pinching and modeling. They have good workability properties and the fabric of one of them (STL-20) resembles one of the potsherds from the Saltibus Point site (SP-175). Both the clay and the potsherds

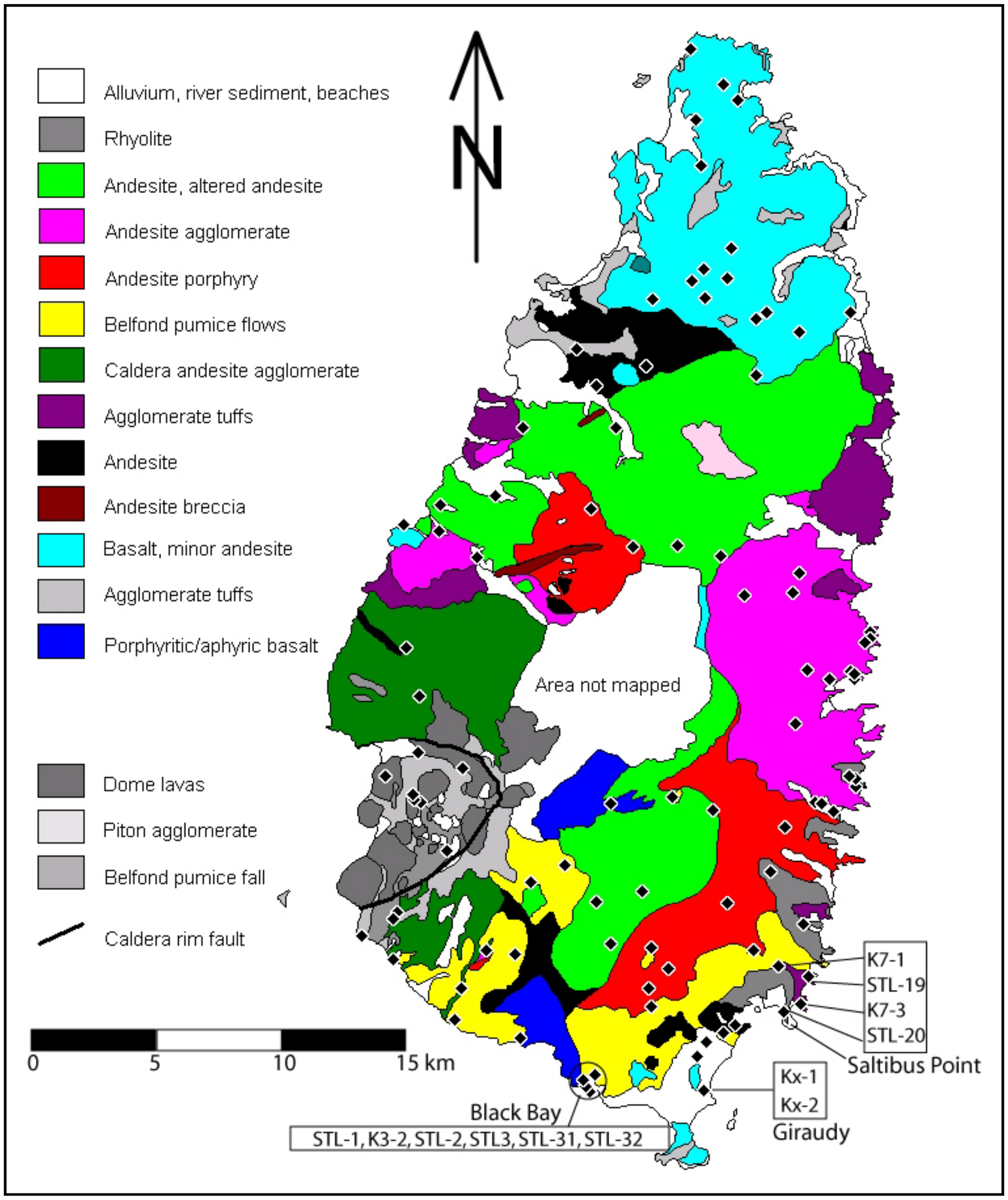

Figure 1. Geological map of St. Lucia, after Tomblin (1964). Sample sites are indicated and samples and settlements discussed are identified.

contain iron-oxide siltstone. Experiments showed that the clay's workability could be improved by the addition of a shorter clay, that is, a clay of low plasticity, or some fine sand.

The clay mixtures were experimentally fired to test their firing and post-firing behaviors and to facilitate comparison with the pre-colonial potsherds. It is remarkable that most of the St. Lucia clays could be used to produce a well-fired pottery at relatively low firing temperatures of 650˚C. This implies that the pre-colonial pottery that was manufactured with clays from St. Lucia clays also could have been fired at such low temperatures.

Fabric Analysis

Mineralogical fabric analysis[2] was carried out to identify the mineral and non-mineral constituents in the clays and potsherds as has been done in other regional ceramic studies (e.g., Bullen and Bullen 1968, 1972; Donahue et al. 1990).

Fabric analysis on 19 potsherds from the sites of Black Bay, Giraudy and Saltibus Point demonstrates that the majority of the potsherds have a mineral assemblage characteristic of volcanic islands in the region in general.

The fabrics of the testbars that were made with these clays resemble the fabrics of the potsherds from the three sites. Typically the same grain types occur in the various fabrics. Angular crystals and broken grains of transparent quartz are abundant in all the sherds (i.e., approx. 6%). Additionally, crystalline or partly weathered grains of feldspar, kaolinite and iron-oxide siltstone are present in all the samples albeit in lower numbers (i.e., approx. 2%–4%).Dark minerals like pyroxene and amphibole were found in most of the sherds, but predominantly in relatively low numbers (i.e., approx. 4%–6%). They showed somewhat higher percentages in only a few sherds from Saltibus Point. The homogeneity of grain types suggests a local origin of the majority of the pottery from Black Bay, Saltibus Point and Giraudy.

Exceptions are several sherds from Giraudy that show a non-local origin on the basis of their fabric. For example one sherd (GIR-192, a Cedrosan Saladoid sherd) shows differences in the color of the fabric and the size and sorting of the grains. This sherd is clearly different compared to other sherds from Giraudy suggesting the use of non-local clay.

Archaeometric Techniques

Similar to instrumental neutron activation analysis (INAA), which was used for the analyses that are presented in other papers in this issue, X-ray fluorescence (XRF) can be used to determine the provenance of clay and pottery samples. In this project, XRF was preferred because of its ability to process large numbers of samples (Fitton 1997). The results will eventually be combined with those from TIMS, which determines the abundance ratio between certain isotopes within a sample. This technique will be used in the future to determine, for example, $^{87}Sr/^{86}Sr$, $^{207}Pb/^{206}Pb$ and $^{143}Nd/^{144}Nd$ ratios.

XRF is a relatively inexpensive method and sample preparation is a relatively fast process. Four grams of each sample were needed. The technique is destructive, because the material to be sampled must be in the form of a fine and homogeneous powder. However, the samples do not require any special treatment after analysis so powdering and pressing the powder to hard pellets for use in the spectrometer are the only preparation steps. There is no need to dissolve the sample chemically, and the XRF technique is insensitive to the bonding state of elements. This ensures that absorption of secondary X-rays within the sample is the only main source of error. Because most absorption is by major elements, the measured major element abundances can be used to correct for this effect. The resulting data generally have analytical precision and detection limits in the order of 2 ppm for trace elements. Analytical accuracy is within a few percent for most of those same elements, the error being mainly due to absorption of secondary x-rays by the pressed powder matrix.

A Philips Panalytical Magix'Pro XRF spectrometer was used in this study to determine the concentrations of over 30 selected major and trace elements in each sample. The resulting data are analyzed graphically and through multivariate statistical analysis[3].

Both clays and potsherds from Black Bay, Saltibus Point, and Giraudy that were submitted for fabric analyses were also submitted for analysis by XRF. Major elements were examined to determine the degree of geochemical weathering of the clays. It is important to determine the degree to which the compositions of bedrock, clays and sherds were altered in order to be able to compare potsherds to clays on the basis of their geochemical composition. In addition, the trace element ratios of elements not susceptible to chemical weathering were used to distinguish between sherds produced with different source clays.

The graphs contain the element ratios of TiO_2/Th plotted against those of Nb/Th of the whole sample[4] (Figures 2 and 3). These elements have been chosen on the basis of their immobile behavior during chemical weathering, and because they provided the clearest results. Recently the study of element ratios based on Ba, Y, and Zr abundances have also provided promising results (Hofman et al. 2005; Hofman et al. in press).

The graph shows two different "composition lines" that are defined by the majority of the samples (Figure 2). One line is defined by a majority of potsherds, and its

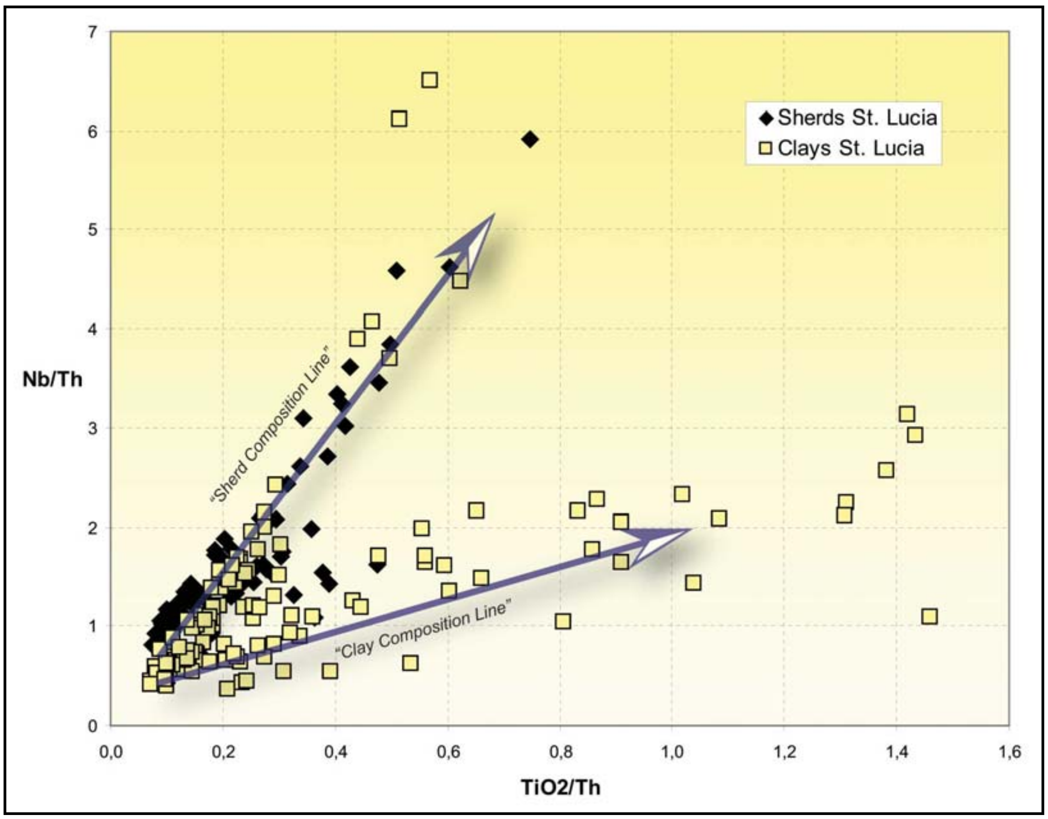

Figure 2. Graph showing the results of the XRF measurements for TiO_2/Th and Nb/Th of all clay samples and potsherds from St. Lucia.

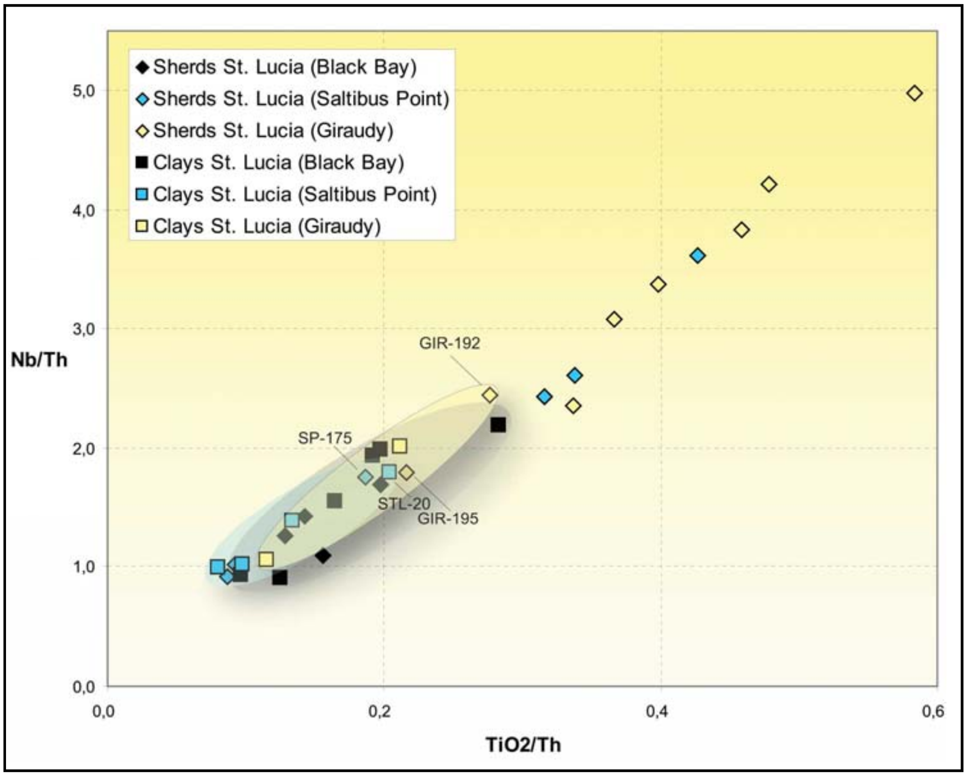

Figure 3. Graph showing the results of the XRF measurements for TiO_2/Th and Nb/Th of clay samples and potsherds selected from the sites Black Bay, Saltibus Point and Giraudy.

lower end, by a minority of clays ("sherd composition line"). The other consists of few sherds and mostly clays ("clay composition line").

Four sherds from Black Bay fall on the clay composition line. Their chemical composition is similar. The clays plot at different positions in the Southern End Member range. The associated sherds are scattered within the same range but mostly plot at positions intermediate between the clay samples. This indicates that these sherds were all produced from mixtures of locally available clays and temper materials.

Seven of the sherds from Giraudy plot on the sherd composition line in the graph shown in Figure 2. These sherds are apparently mixtures between clays from the Southern End Member range and an as yet unidentified clay source. The two clays from Giraudy plot in the Southern End Member range, but all except one sherd plot outside this range on the high-Nb/Th array (see Hooijkaas and Booden 2004). These sherds are characterized by very low Th contents. It is possible that the sherds are mixtures of Southern End Member clay and a low-Th component, which would suggest import of material. Low-Th material is found on St. Lucia in the Sulphur Springs hydrothermal crater. Sulphur Springs-type material is a potential explanation. Alternatively, the results could suggest that Th bearing phases may have been preferentially removed from the clay or temper components during production. The majority of sherds from Giraudy form a distinct group. Two sherds

(GIR-192 and GIR-195) do not plot in this group. These are also the only Giraudy sherds that do not have a low Th concentration.

Seven sherds from Saltibus Point fall on the sherd composition line indicating a mixture of southern clay and either one of the anomalous clays that fall on that line or an unknown clay, presumably from the Sulphur Springs area. Figure 3 provides a view on the composition line of potsherds from the archaeological sites that are discussed in this paper and the clay samples that were geologically associated with these sites. As opposed to Figure 2, Figure 3 only shows the results of part the sample and not the whole sample.

In summary, the majority of the pottery from the three St. Lucian sites appears to be of local origin, as is to be expected, given that sources providing excellent clays for the production of pottery are abundant on this island.

Three main provenance areas can be distinguished on the island based on ratios of immobile trace elements in clays: the northern, central and southern parts with increasing Nb/TiO_2 ratios. The majority of the sherds, showing a relatively uniform geochemistry, are made of clays with a southern St. Lucia provenance. Several sherds, however, have compositions suggesting that they were manufactured with non-local clays or that their constituents have been imported from as yet unidentified sources in other parts of the island.

Concluding Remarks

The islands in the Lesser Antilles are very diverse geologically. This diversity is responsible for the variation in availability of clay sources on the various islands. Volcanic islands such as St. Lucia are extremely rich in suitable clays whereas in general limestone islands such as Anguilla offer a more limited number of clay sources. This differential availability of clays must have entailed the establishment of a network for the procurement and distribution of pottery raw materials and/or finished products, which probably paralleled similar networks in which lithic raw materials, exotics, perishable materials and ideas were carried throughout the archipelago.

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Notes

[1]Fieldwork in 2006 was generously funded by the Byvanck Fonds.

[2]Mineralogical fabric analysis was performed with a binocular microscope with the use of direct light. Samples were first cut with a diamond saw and treated with sandpaper to obtain a flat surface. Additionally they were re-fired at 700˚C under oxidizing atmosphere before analyzing them under the microscope.

[3]Geochemical analyses were performed at the Faculty of Earth and Life Sciences of the Free University Amsterdam under the responsibility of Prof. Gareth Davies.

[4]Zr/Th and Hf/Th have also been plotted against Nb/Th, but TiO_2/Th–Nb/Th provided the clearest results.

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PRE-COLUMBIAN POTTERY IN THE WEST INDIES: COMPOSITIONAL CHANGE IN CONTEXT

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Raw material selection in the production of pottery was examined in the context of site location, developing settlement hierarchies, and evolving institutional inequality in pre-Columbian Puerto Rico. Distinctive sherds ranging in age from 200 BC to AD 1200 were selected from various contexts in the Maisabel site. This time frame spans occupations of the earliest single-village egalitarian communities (Hacienda Grande and Cuevas complexes) through the development of multi-village territorial polities (Monserrate and Santa Elena complexes). Sherds were also selected from Site HU-7, occupied during the transition between two late prehistoric complexes, ca. AD 1000. All sherds were subjected to instrumental neutron activation analysis to characterize compositional variability regionally and through time.

Pottery was of fundamental importance to pre-Columbian cultures in the Caribbean. Broad similarities in surface decorations, vessel morphologies, and technology within and across many islands of the archipelago hint at social networks, through which ideas and perhaps pots were exchanged. Dramatic social and political changes occurred from the early to late ceramic age in some parts of the Caribbean, documented archaeologically in site distributions; settlement organization; and such domains of material culture as ceramic styles, rock art, and iconography. The degree to which raw materials or finished products flowed through exchange networks and within and across settlement systems or polities is poorly understood. In the present study, raw-material selection in the production of pottery is examined in relation to site location, developing settlement hierarchies, and emergent social inequality in Puerto Rico. Selected sherds from two pre-Columbian sites were subjected to neutron activation analysis to assess compositional variability geographically and through time.

The paper is divided into six sections. First, background is provided into Saladoid and post-Saladoid (Ostionoid) social and political organization in the West Indies; second, we present the problem and hypotheses addressed in this study; third, a brief review of the methods used in the study are discussed; results are detailed in the fourth section, followed by a discussion section; the paper closes with avenues for additional research.

Social and Political Context of Pre-Columbian Cultures in the Caribbean

The earliest ceramic-age colonists to the West Indies departed from northeastern South America approximately 2,500 years ago. These people were horticulturalists, who relied extensively on fishing and the collecting of marine and terrestrial faunal resources (deFrance 1989, 1990; deFrance et al. 1996; deFrance and Newsom 2005; Newsom and Wing 2004; Siegel 1991a, 1991b). They produced thin-walled elaborately painted, incised, and modeled ceramic vessels and figurines; fine groundstone celts, adzes, beads, and amulets; carved and ground shell, bone, and coral objects; in addition to many everyday items fabricated from stone, bone, shell, clay, coral, wood, cloth, and feathers (Rouse 1992). Similarities in material culture across sites and through time provide the basis for assigning the groups to a single series of Saladoid cultures, named after the Saladero type site excavated by Irving Rouse and José Cruxent (1963). It is generally agreed that Saladoid peoples displaced pre-existing Archaic groups who were already occupying the Caribbean archipelago. However, the extent and nature of interactions between the ceramic and lithic-age groups in the Caribbean are poorly understood, and recently have become the topic of considerable interest (Rodríguez Ramos 2005; Siegel 1989; Siegel et al. 2005).

The earliest Saladoid colonists arrived to Puerto Rico by approximately 200 to 300 BC. For the next six to seven centuries (ca. 300/200 BC–AD 400), early Saladoid (Hacienda Grande complex) groups occupied sizable villages located in coastal to near-coastal settings. It is likely that Saladoid newcomers came to landscapes already modified by the previous Archaic residents. Well-developed Archaic occupations have been documented in the southern portions of the Caribbean (Allaire and Mattioni 1983; Boomert 2000; Harris 1973; Williams 2003). Emily Lundberg (1980:135) observed long ago that “the first pottery-making people to migrate into the West Indies did not move into a vacuum. Archaic groups (or at least people who made no use of pottery) were living all along their pathway.” In addition, ceramic-age colonists brought with them established ideas for how to make a living, how to organize their villages, and how the universe was structured. Ceramic iconography and village organization are vivid expressions of the Saladoid connection to the South American tropical rainforest (de Hostos 1919; Moravetz 2005; Roe 1989; Siegel 1995, 1996, 1999).

Settlement patterns and burials indicate that early-Saladoid social structure was based on

Table 1. Ceramic-age chronology for Puerto Rico.

Period	Date Range	Cultural Complex	Cultural Series
IIa	ca. 200 BC–AD 400	Hacienda Grande	Saladoid
IIb	AD 400–600/700	Cuevas	Saladoid
IIIa	AD 600/700–900	Monserrate	Ostionoid
IIIb	AD 900–1200	Santa Elena	Ostionoid
IV	AD 1200–1500	Esperanza/Boca Chica	Ostionoid/protohistoric

an egalitarian ethic. Institutional social inequality was not a feature of early-Saladoid society (Rodríguez López 1990; Siegel 1993, 1995, 1996; Versteeg 1989). By about AD 400, we see an increase in the number of sites and habitats occupied compared to previous occupations. The late-Saladoid period (AD 400-600/700) was associated with continued habitation of coastal areas, in addition to substantial occupations in interior valley settings (Curet et al. 2004; Rodríguez López 1990; Siegel 2004).

The post-Saladoid occupations of the island are associated with an explosion in the frequency of sites and site types. At this time, formal civic-ceremonial plazas were constructed in a number of settlements. Combining lines of evidence from site locations, relative site sizes, architectural and structural organization, and mortuary patterns there appear to have been fundamental transformations in social relations beginning around AD 700 (Curet and Oliver 1998; Oliver 1998; Siegel 1996, 1999, 2004). Given the rather coarse chronology that we currently work with, where our finest degree of control is no better than two to three hundred years, the underlying shift in social organization was probably more gradual than it appears to us archaeologically (Table 1). Over the span of about seven centuries, from ca. AD 700 to AD 1400, the cultural landscape of Puerto Rico progressed through a series of gradual but dramatic shifts. Tracking the locations of civic-ceremonial centers, as a proxy for mapping the political geography of the island, we see power initially broadly dispersed in the south and, through time, increasingly concentrated in the high interior mountains (Curet et al. 2004; Siegel 1999; Torres 2005). This trend was “associated with [the establishment] of well-defined group territories, increased solidarity among group members, and notions of exclusive rights over resources, land, and people” (Siegel 2004:93). Ethnohistoric documents reveal tensions between groups, ranging from low-level rivalries to casual feuding to out-and-out warfare and military campaigns of conquest (Siegel 2004:89–90). Numbers of sites in general, and ball courts/ ceremonial plazas in particular, increased to their greatest levels by the Esperanza (protohistoric) period. From demographic trends apparent in the regional archaeological database, we might infer that population increases within the geographically circumscribed border of the Puerto Rico coastline combined with emergent and aspiring leaders in post-Saladoid times were responsible for changes in sociopolitical organization.

The Problem

In this context of institutional inequality fundamental questions are raised regarding the circulation of materials and loci of production. Unambiguous ceramic-style changes have been documented with the shift from single-village communities to multi-village polities (e.g., Roe 1989; Rouse 1992). Assemblages from early-Saladoid sites suggest a strong local focus on food supplies, combined with systematic long-distance exchange for semi-precious stones used in craft production (Cody 1991; deFrance and Newsom 2005). In the post-Saladoid world, settlement patterns evince a linked and hierarchical system of villages and camps that eventually formed into territorial chiefly polities (*cacicazgos*), well described in the sixteenth-century Spanish accounts.

The trajectory of ceramic-style shifts are well documented over approximately 2,000 years in the Caribbean, from about 500 BC to AD 1500 (Petersen et al. 2004; Rainey 1940; Roe 1989; Rouse 1992). In short, the early-Saladoid series of styles include elaborately decorated and technically sophisticated vessels in a variety of forms, ranging from bottles with multiple carinations, open bowls, and restricted flying-saucer shaped bowls. In contrast, the later Ostionoid series of styles are characterized by less complexly decorated and simpler vessel forms. The best explanation that I've heard for this "devolutionary" shift relates to concomitant changes in social organization: egalitarian to institutionalized inequality (Roe 1989, 2005). That is, with social and political changes there were distinctive material transformations in how power and prestige were expressed and displayed. In Saladoid communities, where power was of the achieved variety, the locus of prestige was in the small personal-presentation realm of material culture (Roe 1989, 2005). We find exquisitely carved and polished stone and shell artifacts and fine pottery. At the scale of small and portable, these diminutive objects were designed to be admired up close and personal. During the following Ostionoid periods, in the context of developing chiefly polities, the locus of power shifted from the achievements of individuals to corporate groups, where people were born into positions of power and high status. Materializations of this group power are seen in the large easily visible and not-easily-movable petroglyphs and ceremonial plazas.

It is in this context of shifting power relations, developing settlement hierarchies, and evolving institutional inequality that we will address the production of pottery. Maisabel is a large ceramic-age site located on the north-central coast of Puerto Rico. It was intensively occupied from about 200 BC to AD 1200, spanning the full range of the Saladoid period and much of the Ostionoid period. Importantly, this occupational history spans the transition from tribal egalitarian communities to chiefdoms in Puerto Rico. Maisabel was a highly structured village, with a cemetery/plaza, series of mounded middens, and residential area (Siegel 1992, 1995, 1996, 1999). Sherds were selected distinctive of the Hacienda Grande, Cuevas, Monserrate, Santa Elena, and Esperanza styles from well-controlled contexts in the site.

Site HU-7 is a small Ostionoid village or camp located on the east coast of Puerto Rico (Figure 1). The site contains a buried sealed deposit of pottery that is stylistically transitional between Monserrate and Santa Elena (Siegel 2002). Sherds were selected from several vessel types in the site to assess

Figure 1. Map of Puerto Rico showing the locations of the Maisabel and HU-7 sites.

variability in pottery composition during this period of polity formation and integrated settlement hierarchies.

With the development of multi-village polities and regional settlement hierarchies, there is an expectation for the systematic movement of goods within and across settlement systems. The flow of tribute and trade and exchange were important aspects of Taíno chiefly polities, especially in negotiating alliances (Wilson 1990). With the increasing importance of trade and tribute in emerging and competitive polities we might expect to find artifacts laden with symbols and iconography to be moving through exchange networks. Saladoid and Ostionoid decorated pottery constitutes one class of symbolically charged easily movable artifacts and thus are uniquely appropriate to address the flow of materials through and across emergent polities (Roe 1989, 2005). Goals of the research were to identify distinctive compositional signatures in the fabrics of sherds from the various time periods. Two hypotheses guided this study:

H_1: Pottery vessels from early periods exhibit a narrow range of compositional variability compared to those from later periods. Shifts in compositional variability through time relate to changes in settlement patterns, from single-village communities to large multi-village polities and the attendant development of regional social networks, through which pottery circulated.

H_0: There is no discernible compositional variability in sherds from the various periods, suggesting that pottery did not circulate through regional social networks.

H_2: The production, use, and ultimate disposal of ceramic vessels were tethered to individual villages or communities, regardless of time period and degree of social complexity.

H_0. Pottery was manufactured in places different from where it was used and eventually discarded.

Other relevant studies have been conducted in the Lesser Antilles. In their petrographic analysis of Saladoid and post-Saladoid pottery from sites on Barbuda, Montserrat, Anguilla, and St. Martin (northern Lesser Antilles), Donahue et al. (1990) found generally distinct temper associations on the different islands. Saladoid and post-Saladoid sherds from the Sufferers site on Barbuda were compositionally/mineralogically similar, leading them to conclude "that virtually identical temper agents were being used in the two periods," unless some sherds were misidentified as to temporal placement (Donahue et al. 1990:251). Viewing all sherds as a group, they observed that post-Saladoid pottery was more diverse in temper associations than Saladoid pottery (Donahue et al. 1990:252).

Based on her compositional analysis of La Hueca and Hacienda Grande-style sherds from the Hope Estate site on St. Martin, Corinne Hofman (1999:184) concluded that "although both styles are distinct in decorative motifs, the composition of the paste is often identical and that on this basis the La Hueca pottery should indeed be classified as a member of the Saladoid series, rather than as a separate series." This conclusion is consistent with Carini's (1991) compositional analysis of early Saladoid pottery. Although we are in agreement with the conclusion that La Hueca pottery is of the Saladoid series, we would only suggest that it is entirely conceivable that potters of different cultural series could have made pots using similar, if not identical clay recipes, especially if source materials were derived from the same locales.

Methods

Fifty-three sherds from the Maisabel and HU-7 sites were submitted to the University of Missouri Research Reactor Center (MURR) for instrumental neutron activation analysis (INAA). Of these, 40 were collected from Maisabel and 13 from Site HU-7. Discussions of INAA, analytical procedures, and sample preparations are presented by Descantes and Glascock (2005) and Descantes et al. (this volume).

The INAA produced concentration values for 33 elements in most of the specimens (Descantes and Glascock 2005:3). These data were standardized to base-10 logarithms to compensate for differences of magnitude between major and trace elements and to approximate normal distributions, especially for the trace elements. Calcium levels for most of the sherds were found to be quite high, ranging from concentrations of 1 percent to values exceeding 25 percent (approximate mean of 3%). This is not surprising given the calcareous sediments and rocks and karst topography that characterize much of the coastal plains in Puerto Rico. Calcium values were corrected using MURR's UNSHELL program (Cogswell et al. 1998). In their studies of the Maisabel and HU-7 sherds, MURR staff employed elemental plots to identify subgroups in the compositional data (compositionally homogeneous groups within the analytical database). Three compositional groups ranged in size from 5 to 21 members, with 8 sherds not assigned to any group.

Geological and Pedological Contexts of the Maisabel and HU-7 Sites

Puerto Rico is the smallest and most easterly of the Greater Antilles. It is 3,421 square miles in area and is included in the Greater Antilles Geologic Province. Puerto Rico is surrounded by the Atlantic Ocean to the north, Mona Passage to the west, the Caribbean Sea to the south, and Vieques Sound to the east. Approximately 75 percent of the island is characterized by rugged steeply sloped mountains. These mountains form the Cordillera Central, the Sierra de Luquillo, and the Sierra de Cayey. Much of the island's periphery consists of a coastal plain that averages approximately 5 km in width. Although the climate of Puerto Rico in general may be classified as humid sub-tropic, considerable variation exists within the island, from the mountains to the coast and from the island's northern shore to its more arid southwestern coastal plain.

Puerto Rico is divided into seven physiographic regions: Mountain Uplands, St. John Peneplain, Caguana Peneplain, Foothill Zone, Interior Lowlands, Belted North Coastal Zone, and Playas and Alluvial Plains (Beinroth 1969; Mitchell 1954). The Maisabel and HU-7 sites are located within portions of the Playas and Alluvial Plains physiographic region. Although most sections of this region are situated along the north and south coasts, sizable pockets of playas and alluvial plains are found on the east and west coasts. In general, the playas and alluvial plains are flat and mostly sandy and located along the mouths of larger streams. The playas and alluvial plains date to the Holocene and Pleistocene ages (Beinroth 1969:11).

The Maisabel site landscape encompasses both beachfront and inland positions, each with attendant geology, soil types, and formation processes. An expansive mangrove swamp at the mouth of the Río Cibuco is located about a half kilometer southeast of the site. An assortment of calcareous sediments and rocks occur in the north-central coast region. These range from Tertiary limestone in the higher uplands well south of the coast to various Pleistocene and Holocene terrace and beach deposits along the coast itself (Beinroth 1969; Guillou and Glass 1957). In the immediate vicinity of the site the main geologic materials are recognized simply as marine-terrace deposits as well as eolian sands, typical for nearly any low-lying coastline location.

Soil variability in the vicinity of Maisabel is related to soil parent material type and landscape position. Three main parent material or deposit types occur within and around the site. These consist of eolian sand concentrated mainly between the shoreline and the crest of an interfluve ridge, sandy residual limestone comprising nearly all of the upland landscapes south of the ridge, and alluvial and peat deposits associated with the Río Cibuco and associated karst features. Sizable deposits of clay are associated with the Río Cibuco and adjacent mangrove swamp within 1 km of Maisabel.

Site HU-7 is located on the east-central coast of the island, just south of the Río Antón Ruíz (Figure 1). The site is positioned on sandy near-shore Holocene sediments, approximately 300 meters from the beach. A large area of tidal-marsh soils occurs west of the site along with smaller pockets of salt marsh. Portions of the tidal-marsh soils developed on alluvium. The upland area backing the site contains soils formed on volcanic rocks. Deposits of clay and gravelly clay loam are located in close proximity to the site (Boccheciamp 1977).

Results

Thirty-three elements were measured in 53 sherds selected from the Maisabel and HU-7 sites located on the north and east coasts of Puerto Rico, respectively. Nickel was subsequently deleted because of its absence in most specimens (Descantes and Glascock 2005:5). The log-transformed dataset was divided into two groups for an initial round of analysis: Maisabel vs. HU-7 sherds.

Maisabel contains pre-Columbian occupations spanning approximately 14 centuries, from ca. 200 BC to AD 1200. These occupations are represented by the Hacienda Grande, Cuevas, Monserrate, Santa Elena, and Esperanza cultural complexes, each associated with distinctive ceramic styles. The test hypothesis states that potters from each of the five cultural complexes selected unique recipes in their manufacture of ceramic vessels. If true, then the compositional dataset should sort into five groups of sherds, each representing a distinct cultural complex or ceramic style. The null hypothesis states that potters through time did not create clay recipes distinctive of each ceramic style.

Elemental plots and Mahalanobis distance calculations using a subset of the principal components were performed to define compositionally homogeneous groups of sherds (Descantes and Glascock 2005; Ferguson 2007). Three compositional groups were identified in the Maisabel sample of sherds (Table 2, Figure 2). Group B, with 21 members, consisted of 9 Hacienda Grande-style sherds, 3 or 4 Cuevas, 3 or 4 Monserrate, 2 Santa Elena, 2 Esperanza, and 1 undifferentiated Ostionoid (Table 2;

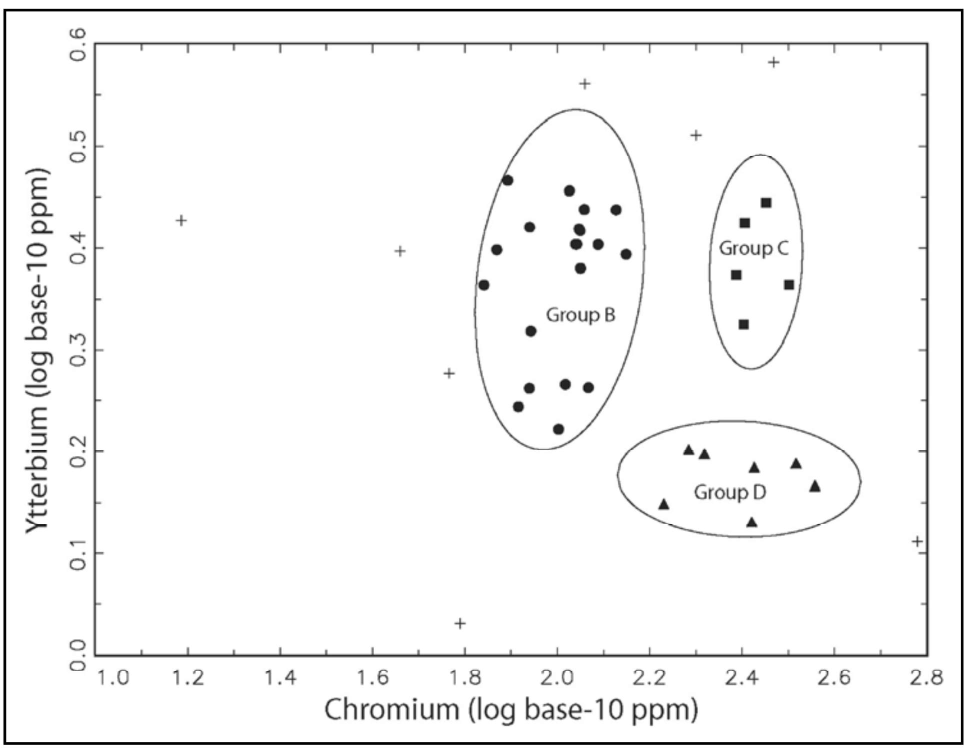

Figure 2. Compositional groups of Maisabel sherds. Unassigned samples shown (+).

Table 2. Compositional groups of the Maisabel sherds.

Group							
B		**C**		**D**		**Unassigned**	
PUR No.	*Cultural Affiliation*	*PUR No.*	*Cultural Affiliation*	*PUR No.*	*Cultural Affiliation*	*PUR No.*	*Cultural Affiliation*
2	SE	16	HG	3	Cu	1	HG
4	HG	18	Ost	7	Cu	2	Se
5	HG	19	Ost	13	HG (ZIC)	8	Esp
6	HG	27	SE	14	HG (ZIC)	24	SE
9	HG	35	Mon	22	Mon	25	Esp
10	Mon			33	Mon	28	SE
11	HG (ZIC)			36	Mon	28	SE
12	HG (ZIC)					39	Ost
15	HG						
17	Ost						
20	Cu						
21	Esp						
23	Mon						
26	Cu/Mon						
29	Esp						
30	Cu						
31	Mon						
32	SE						
37	HG						
38	Cu						
40	HG						

HG: Hacienda Grande complex
HG (ZIC): Hacienda Grande complex, zoned-incised cross-hatched
Cu: Cuevas complex
Mon: Monserrate complex
SE: Santa Elena complex
Esp: Esperanza complex
Ost: Ostionoid series

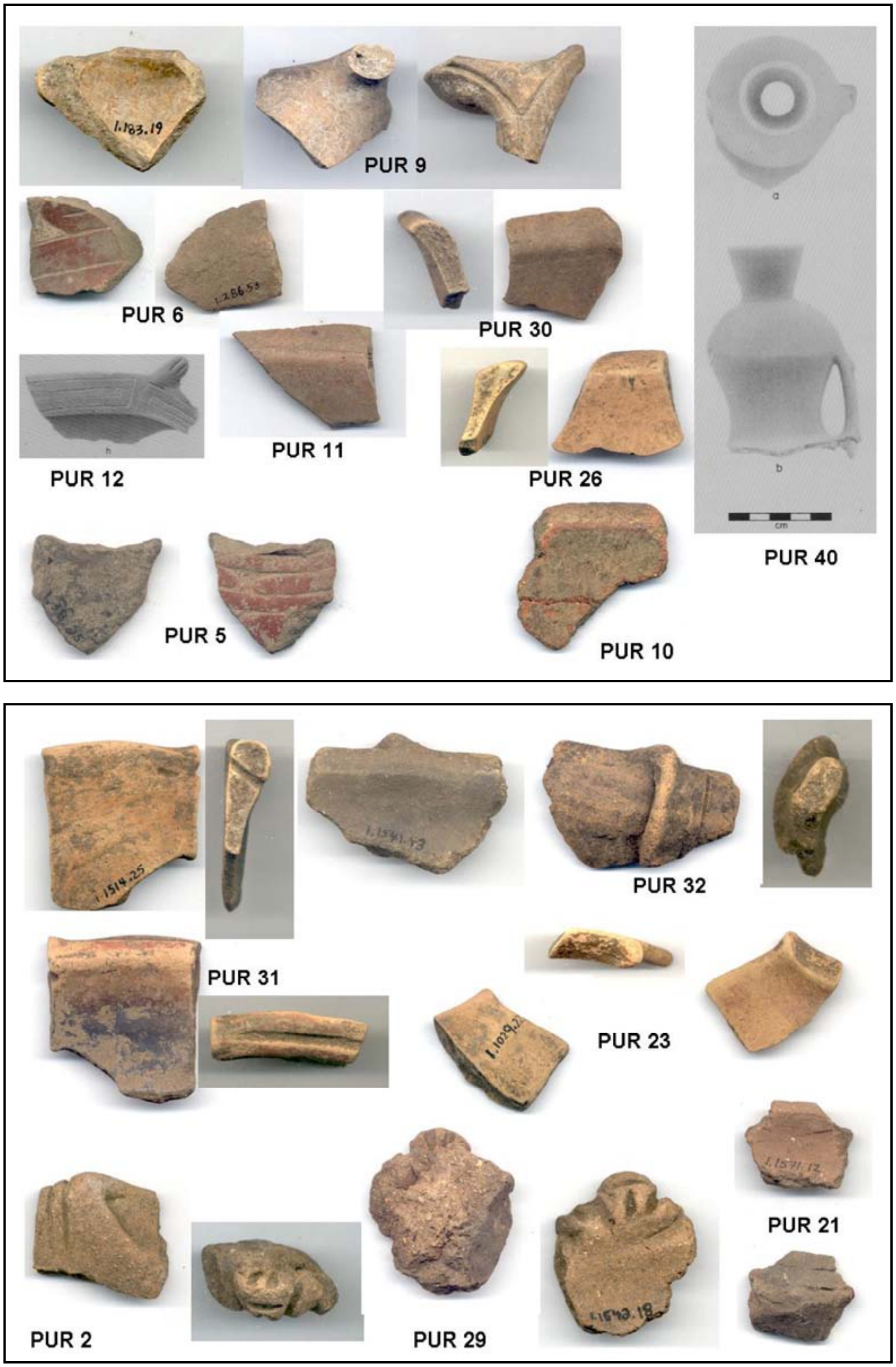

Figure 3. Sample of sherds from Maisabel Compositional Group B.

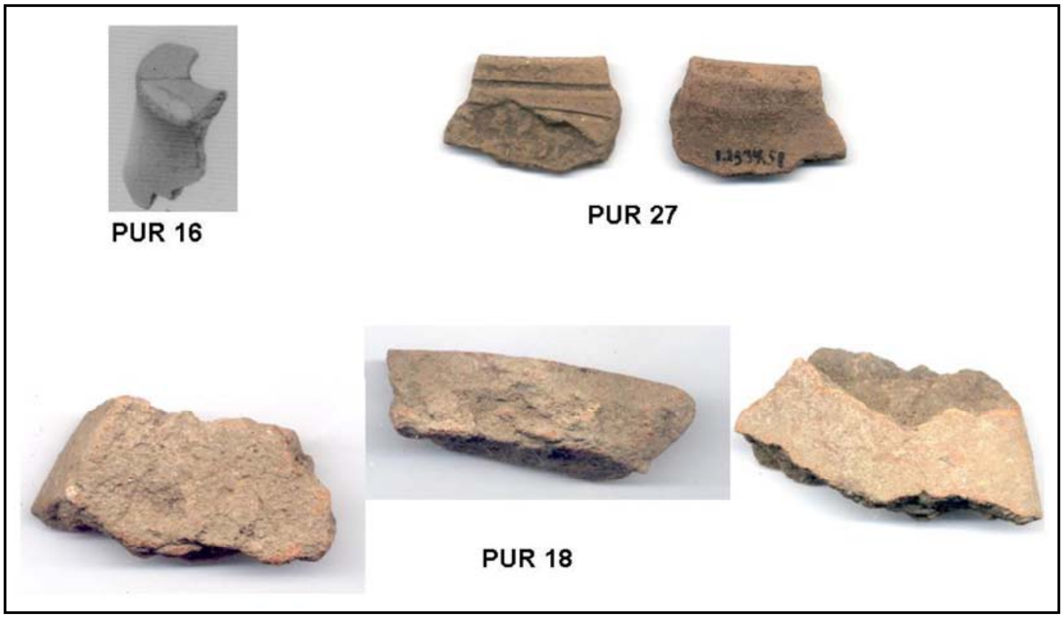

Figure 4. Sample of sherds from Maisabel Compositional Group C.

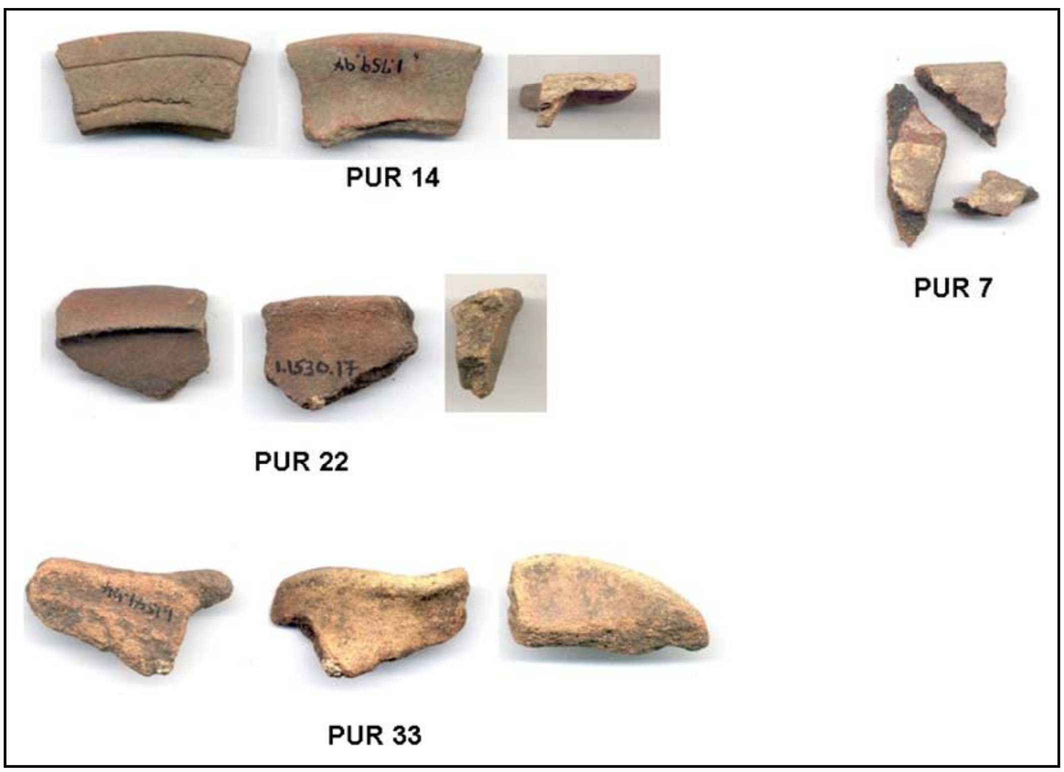

Figure 5. Sample of sherds from Maisabel Compositional Group D.

Figure 3). Group C contained 1 sherd each of the Hacienda Grande, Monserrate, and Santa Elena styles and 2 of undifferentiated Ostionoid (Figure 4). Group D consisted of 2 sherds each of Hacienda Grande, Cuevas, and Monserrate and 1 of undifferentiated Ostionoid (Figure 5). Eight sherds were unassigned to any group and consisted of 1 Hacienda Grande, 1 Monserrate, 3 Santa Elena, 2 Esperanza, and 1 undifferentiated Ostionoid (Table 2; Figure 6). Based on elemental compositions, there do not appear to be unique recipes, by cultural complex, in the production of ceramic vessels at Maisabel. The null hypothesis is accepted in this test.

A second hypothesis was posed to test for geographic distinctions in ceramic production: there are unique recipes in the production of ceramic vessels based on settlement locations. The null hypothesis states that settlement location does not bear on the compositional makeup of vessels. The compositional databases of the Maisabel and HU-7 sherds were combined to test the hypothesis that pottery production is linked to settlement location.

Four compositionally discrete groups and one subgroup were identified (Figure 7). Again, all ceramic styles in the assemblage are represented in Groups B, C, and D. Groups A and A2 consist exclusively of Site HU-7 sherds. Two HU-7 sherds were placed in Group D, along with 7 Maisabel specimens. One HU-7 sherd was not assigned to any group. Based on these data, the null hypothesis is rejected. Regardless of time period, geographic location of a settlement is important in determining the compositional makeup of the associated pottery.

Discussion

This pilot study resulted in unexpected findings. Sherds were carefully selected from

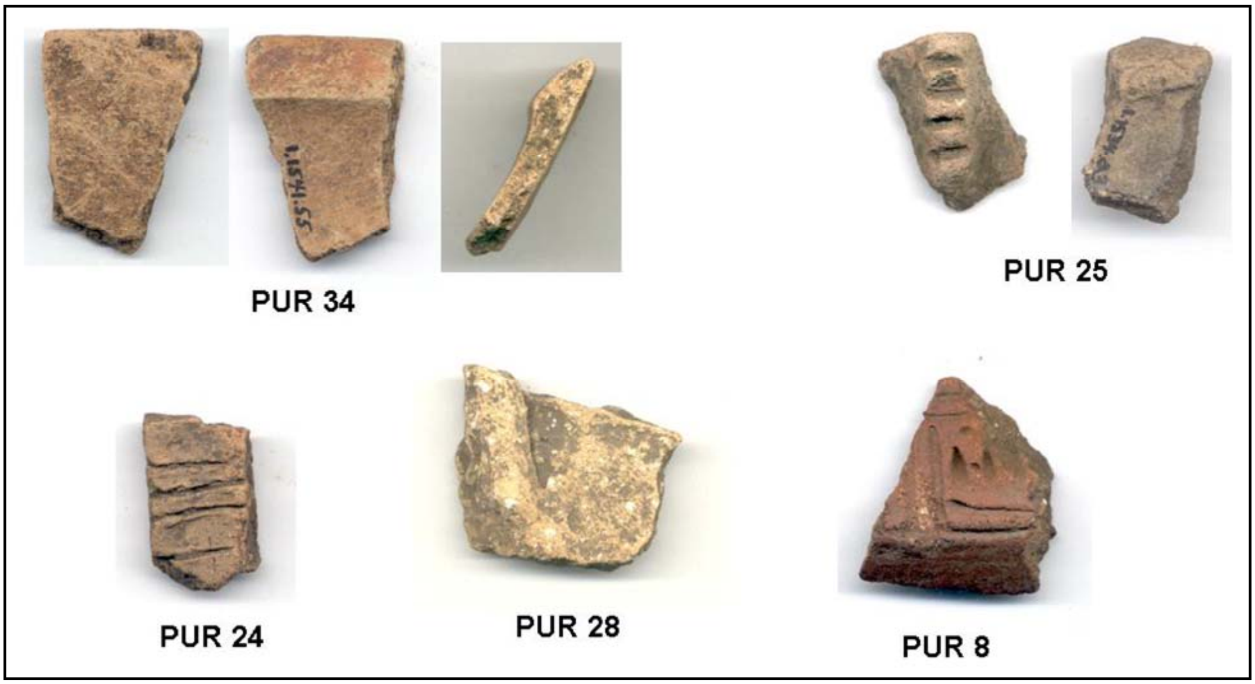

Figure 6. Sample of Maisabel sherds unassigned to any compositional group.

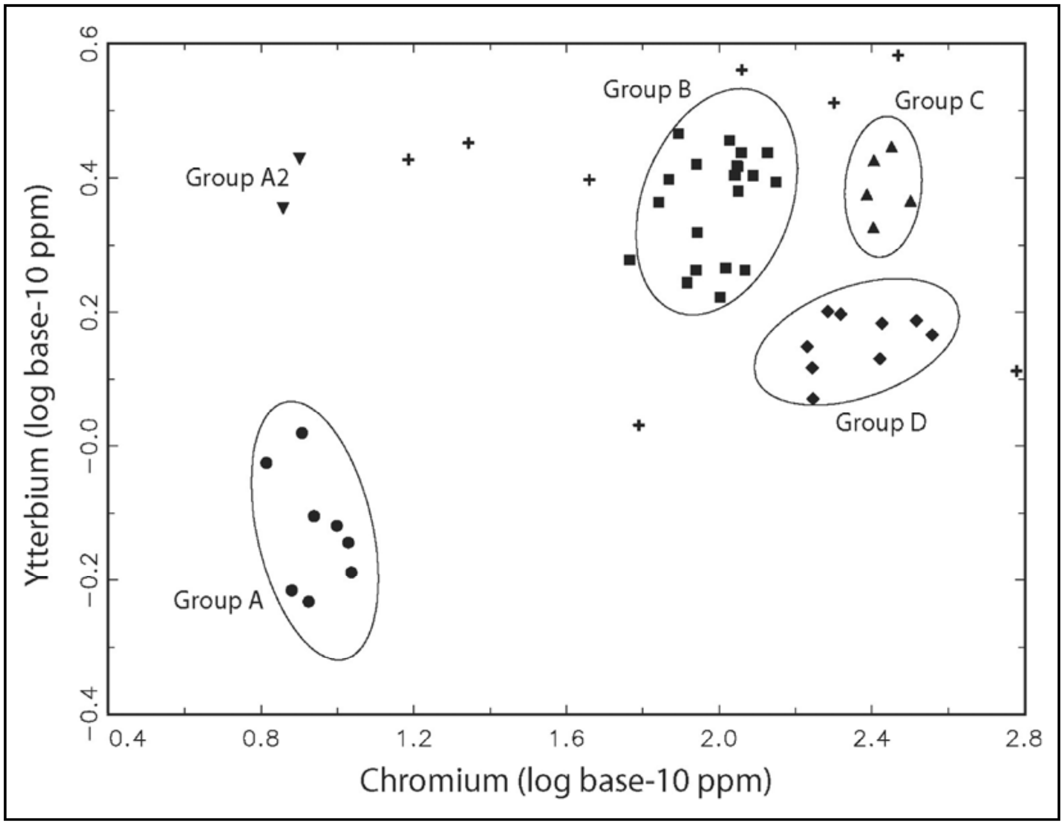

Figure 7. Compositional groups of Maisabel and HU-7 sherds combined. Unassigned samples shown (+).

well-documented contexts in the Maisabel site to investigate ceramic compositional variability through approximately 14 centuries of pre-Columbian occupations, spanning the Hacienda Grande, Cuevas, Monserrate, Santa Elena, and Esperanza cultural complexes. Current understanding of ceramic-age settlement patterns and political organization for Puerto Rico suggests that the earliest (Saladoid) occupations (Hacienda Grande [ca. 200 BC–AD 400] and to some extent Cuevas [AD 400–600/700]) consisted of egalitarian single-village communities. Villages tended to be large and widely spaced around the island in coastal to near-coastal settings. The earliest formally constructed ball courts on the island date to approximately AD 700 (Monserrate complex). During the post-Saladoid occupations (Monserrate [AD 600/700–900], Santa Elena [AD 900–1200], Esperanza/Boca Chica [AD 1200–1500]), we see an explosive increase in the number of sites and site types and the development of settlement hierarchies. Post-Saladoid settlement patterns relate to the formation of and, through time, increasingly competitive chiefly polities (Siegel 2004).

Viewing for the moment the long trajectory of the ceramic age from the perspective of the terminal endpoints (Hacienda Grande vs. Esperanza), we expected that ceramic compositional variability would be lower at the older single-village community terminus (Hacienda Grande) than at the later integrated-settlement hierarchy end

(Esperanza/protohistoric). This expectation relates to the presumed systematic movement of materials through the post-Saladoid polities, especially in the context of tributary relations (Moscoso 1986).

Results of the current study suggest that the production and circulation of ceramic vessels remained at the local domestic level, regardless of the larger social and political context. Individual groups of sherds from Maisabel, produced by similarities in elemental compositions, contained specimens from all cultural complexes. Based on this analysis of 40 sherds from Maisabel, we conclude that the occupants of the settlement procured clays and temper materials from the local area throughout the ceramic age. Importantly, ceramic vessels found in the site apparently were not transported from other places. When elemental compositions of the Maisabel and HU-7 sherds were combined into a single analysis, there was nearly perfect segregation of the sherds, by site, further support for the emphasis on the local area in the production, use, and final disposition of pottery throughout the pre-Columbian occupations of Puerto Rico.

When multi-village polities formed during post-Saladoid times some villages may have maintained a certain degree of autonomy. For example, Maisabel, and perhaps other large Saladoid villages, continued to thrive as relatively autonomous villages even as networks of integrated settlements developed across the post-Saladoid landscape of Puerto Rico. Continuity of village autonomy would explain the lack of differentiation in paste content of ceramic vessels produced at Maisabel from early to late ceramic times. John Hoopes (2005:10) suggested a similar phenomenon in the early formation of chiefdoms for the Chibchan world of southern Central America and northern Colombia: "Although there are some indications of settlement hierarchies, it remains to be demonstrated that some centers exercised political control over others and that some villages lost autonomy as they were incorporated into multivillage polities."

Future Research

This pilot study leads to three lines of additional research that will help to clarify the use of ceramic vessels during the ceramic age: (1) clay sourcing, (2) functional variability within ceramic assemblages, and (3) regional variability in ceramic assemblages.

Clay Sourcing

Results of the current study suggest that settlement occupants relied on local sources of clay in the production of pottery. In Maisabel, ceramic vessels produced by artisans of all the major ceramic-age complexes shared common elemental compositional distributions. Except for two sherds, the Maisabel and HU-7 samples sorted into two distinct ceramic clusters.

It will be important to clarify raw material sources in ceramic production by conducting systematic soil surveys in relation to each archaeological site. In particular, clay samples need to be collected, analyzed for elemental distributions, and compared to the database created for the current study. Published soil surveys may be used to guide this fieldwork (Table 3; Acevido [1982]; Boccheciamp [1977]). The soils map for the Maisabel setting shows sizable patches of clay within 1 km and especially within 3 km of the site (Table 4).

Functional Variability within Ceramic Assemblages.

Sherds selected for the current study generally targeted good examples of distinctive styles recognized for Puerto Rico

Table 3. Potential sources for clay for pre-Columbian pottery production in the vicinity of the Maisabel and HU-7 sites.

Maisabel		HU-7	
Bajura clay	Deep, nearly level, and poorly drained. Located on floodplains. Permeability is slow and available water capacity is high. Organic matter content is high	Caguabo clay loam	Shallow, well drained, and moderately permeable. Formed from partly weathered volcanic rocks. Moderate available water capacity
Jareales clay	Deep, nearly level, and poorly drained. Located in coastal lowlands. Permeability is very slow and available water capacity is high. Organic matter content is high	Coloso silty clay loam	Deep, nearly level, somewhat poorly drained. Located on floodplains and occasionally flooded. Permeability is slow. High available water capacity.
Santa Clara clay	Moderately deep, gently sloping to sloping, and well drained. Located on foot slopes and small hills. Permeability and available water capacity are moderate	Fortuna clay	Nearly level on river floodplains. Permeability is slow. High available water capacity.
		Junquitos gravelly clay loam	Moderately deep and well drained and moderately slowly permeable. Located on foot slopes in humid volcanic uplands. Formed in alluvial and colluvial sediment derived from extrusive volcanic rocks. High available water capacity.
		Pinones silty clay	Deep, poorly drained, and very slowly permeable. Located on coastal lowlands. High available water capacity.

and neighboring islands. This selection necessarily was weighted to decorated vessels and thus undoubtedly limited the analysis to a narrow range of functionally specific wares. An important follow-up study will be to systematically select a cross section of vessel types, defined on the basis of morphology and technology, from each of the cultural complexes. Functionally specific wares may be associated with distinct clusters of elemental concentrations, which also may be linked to specific clay sources identified in the soil surveys.

Regional Variability in Ceramic Assemblages

A large follow-up study will entail the systematic collection of sherds from other sites in the vicinity of Maisabel and HU-7. Maisabel is located in the Cibuco valley, where there are numerous documented late Saladoid and post-Saladoid sites. We have good evidence for the gradual development of settlement hierarchies and increasingly integrated polities after the Hacienda Grande period (Siegel 2004). In particular, it will be important to analyze samples of pottery from

Table 4. Distribution of potential clay sources in the vicinity of Maisabel.

Catchment Distance (km)	Bajura clay (m^2)	Jareales clay (m^2)	Santa Clara clay (m^2)
0.5			65,800
1.0			290,700
2.0	7700		96,700
3.0	973,400	403,300	93,000
Total	**981,100**	**403,300**	**546,200**

the large Paso del Indio site located a short paddle ride up the Río Cibuco from Maisabel (Walker 2005) and samples from some of the many smaller hinterland sites documented for the valley (Siegel and Joseph 1993).

Site HU-7 represents a small household settlement that was occupied for approximately 10–20 years during the transition between Periods IIIa and IIIb (Monserrate to Santa Elena periods). The site is located within the largest remaining mangrove swamp on Puerto Rico. Based on location, we can reasonably assume that the inhabitants of Site HU-7 took advantage of the bountiful resources surrounding them. Further, the small settlement was undoubtedly linked to a larger network of settlements across the post-Saladoid landscape. By Period IIIb, a site with a small ceremonial plaza was located in Sabana Arriba, approximately 22 km to the northwest of Site HU-7 (Rodríguez López and Rivera 1983). Assuming that ball court/plaza sites served as political or administrative centers then Sabana Arriba may have included the east-central coast within its jurisdiction during Period IIIb (Siegel 1999: Figure 6). Social and economic relations revolving around tribute may have been established by Period IIIa, associated with the earliest evidence for institutionalized social inequality on Puerto Rico. As such, small household-based camps dating to the post-Saladoid occupations on the island must be viewed as potential resource-extraction places in the primary production of tribute. In this regard, it will be important to compare elemental distributions of pottery from sites within and across polities.

Acknowledgments

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Notes

[1] Twenty-one sherds contained nickel; all except for one came from Maisabel. The Maisabel sherds with nickel spanned all of the cultural complexes.

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PRELIMINARY INTERPRETATIONS OF CERAMIC COMPOSITIONAL ANALYSIS FROM LATE CERAMIC AGE SITES IN ANGUILLA AND THE SALT RIVER SITE IN ST. CROIX

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Late Ceramic Age ceramic samples from five sites in Anguilla, British West Indies, and from the two most recent occupations at the Salt River Site, St. Croix, U.S. Virgin Islands, were analyzed by instrumental neutron activation analysis (INAA) at the University of Missouri Reactor Center (MURR). Compositional analysis of ceramic sherds from various archaeological contexts on these two islands help address issues related to ceramic production, interisland trade and exchange, and cultural affiliation.

Historically, ceramic research in the Caribbean has focused on establishing and refining typological and chronological sequences based on decorative style and vessel shape (cf. Rouse 1992). This necessary and essential work has formed the basis for reconstructions of pre-Columbian migration patterns and general spheres of cultural interaction. Unfortunately, due to the regional homogenization of ceramic form and decoration, style-based analyses cannot typically be used to discern specific patterns of intraisland and interisland ceramic trade and exchange. Compositional analysis of ceramics offers a complementary line of inquiry that helps address these issues with greater precision, allowing the identification and/or exclusion of possible production source areas, information that is vitally important for evaluating the role of ceramic

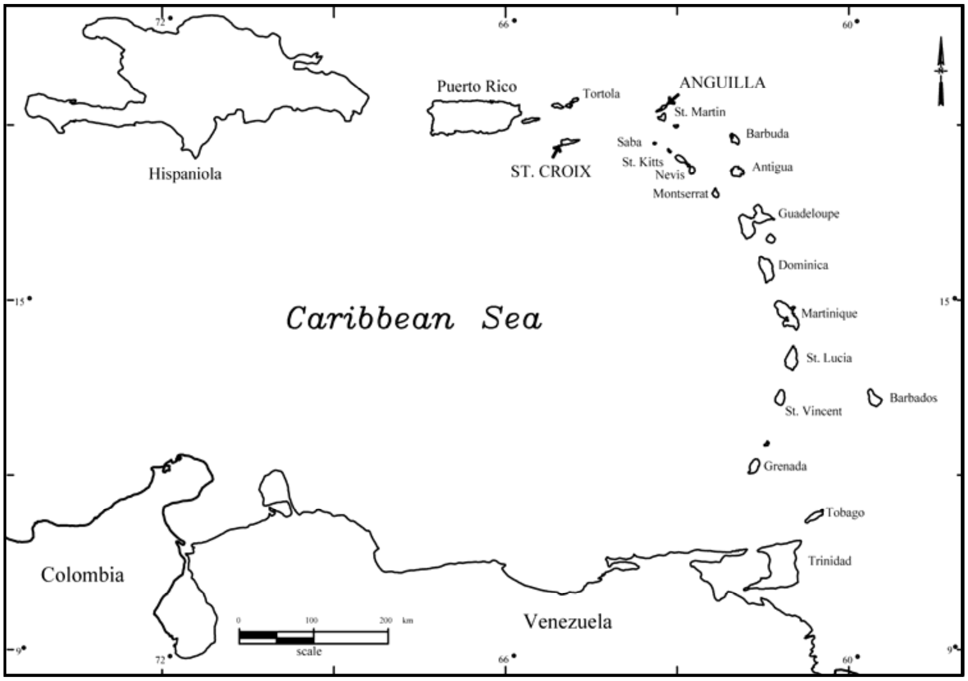

Figure 1. Map showing the location of Anguilla and St. Croix within the Caribbean Region.

vessels within a system of socioeconomic interaction.

In this paper, we report the preliminary results of INAA of ceramic sherds recovered from archaeological sites on the small Caribbean islands of Anguilla and St. Croix. Compositional analysis using INAA was undertaken to characterize and enumerate potential sources for the ceramics recovered from sites on these two islands. The results suggest that, during the Late Ceramic Age, ca. AD 600–1500, there were multiple manufacturing locales for the ceramics utilized at sites in Anguilla and St. Croix, and that, in many cases, production did not likely occur on the same island where the vessels ultimately were used and discarded. Though only preliminary, these data contribute to a better understanding of the dynamics of interisland interaction and the potential significance of ceramic trade and exchange in the development and maintenance of social organizations in the northern Lesser Antilles and Virgin Islands during the Late Ceramic Age.

Environmental Background

Anguilla is a relatively flat island with an area of only 102 square km and a maximum elevation of only 65 m. It is the northernmost of the outer, lower, islands in the Lesser Antillean chain (Figure 1) that are largely comprised of Oligocene limestones overlying a basal volcanic series and an intermediate series of feldspathic tuffs, conglomerates, and cherts (Earle 1923). Anguilla is made up of bedded white or cream-colored limestones with fossils that were laid down directly on top of an igneous basement. The underlying volcanic material is exposed only in a small area of the uplifted north coast (Earle 1923), below Crocus Hill, the island's highest point.

St. Croix is the southernmost of the Virgin Islands and is situated at the southeastern end of the Greater Antilles, about 100 km southeast of Puerto Rico (see Figure 1). The closest of the Lesser Antilles are Anguilla, St. Martin and Saba, all of which are located on a north-south axis about 150 km to the east. Throughout the history of Caribbean archaeology, St. Croix always has been of great interest because of its somewhat isolated geographic location between the Greater and the Lesser Antilles, and its ethnohistoric position between the Classic Taino in the west and the Eastern Taino to the east (Rouse 1992; Morse 2004).

St. Croix is divisible into several geographical zones, the character of which undoubtedly had a considerable effect on prehistoric settlements. The two major physiographical areas include the late Cretaceous Oldland, underlain by rock of volcanic origin, and the Central Kingshill Plain, based on Tertiary marls and limestones, which divide the Oldland into a northwestern and an eastern part. The latter is partly covered by more recent alluvium (Cederstrom 1941, Nagle and Hubbard 1989). St. Croix has an area of about 220 square km and more than 50 known Amerindian sites that can be found in almost every sector of the island. Most sites are situated on or within 1 km of the coast, near sheltered bays or reefs, and the fewer inland sites are near waterways (Morse 2004).

Methods

The samples analyzed from Anguilla were obtained from 0.5 m by 0.5 m test pits systematically excavated at 25 m intervals across five different sites occupied during the Late Ceramic Age (ca. AD 600–1500). These include the Sandy Ground, Shoal Bay East, Barnes Bay, Sandy Hill and Forest North sites (Figure 2). Sandy Ground and Shoal Bay East have longer occupational histories with deposits that date between ca. AD 400/600–1500, whereas the other three date solely to more recent periods between ca. AD 900–1500. The 50 sherds studied were drawn from a larger grab sample of close to 300 sherds that were selected previously for basic temper analysis conducted by Crock and Petersen (Crock 2000). Two sherds were selected from each test pit excavated at each of the five sites, one randomly from an “upper” level and one randomly from a “lower” level in an effort to produce samples representative of earlier and later occupations at each site.

For the St. Croix sample, a total of 50 ceramic sherds from the two most recent Ceramic Age occupations at the Salt River site were analyzed. Previously, a basic temper analysis of these same sherds was conducted by Morse. The site is located on the island’s northern shore at the base of Salt River point, which is a small, prominent, brush-covered peninsula stretching east towards the Salt River inlet. It was here that Columbus supposedly had an encounter with Amerindians on his second voyage in 1493. St.Croix’s only ballcourt (*batey*) was also discovered at the site (Hatt 1924, Figure 3). The ballcourt is the easternmost known in the Caribbean and its construction is attributed to the last ceramic horizon (Taino). The Salt River site seems to have been the largest coastal settlement on the island at the European Contact, and the only one with continuous habitation throughout the Pre-Columbian Ceramic Age, which in the Virgin Islands, began shortly before AD 1 and lasted into the historic period. The site’s chronology is known from two well-documented excavations, the results of which have been analyzed and compared with current research findings in St. Croix and nearby islands (Morse 1997). One of the excavations was

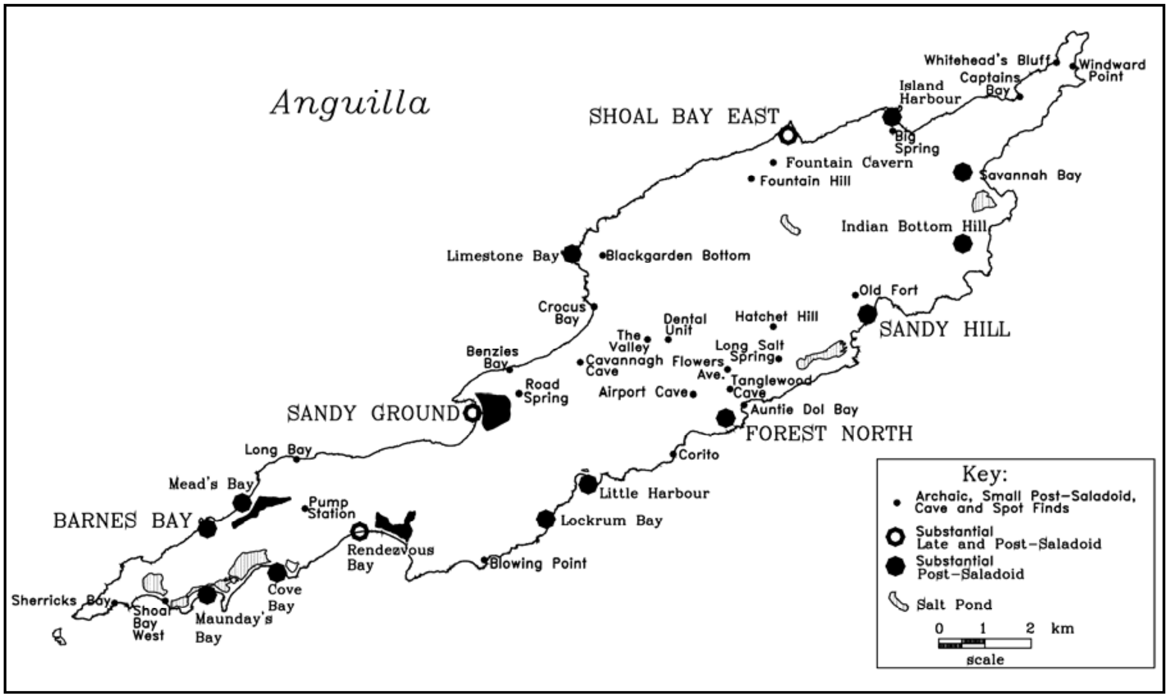

Figure 2. Map of Amerindian archaeological sites in Anguilla, B.W.I., with the five sites studied highlighted.

Figure 3. View of the Salt River site, St. Croix. Note petroglyph-lined ball court in foreground. Photo by Gudmund Hatt, 1923.

led by Gary Vescelius, whose comprehensive survey of the island in 1951 was carried out under the auspices of the St. Croix Museum Commission and the Yale Peabody Museum where his collections are presently housed.

Vescelius excavated 12 different units (pits) at the site, and the excavated ceramics proved essential to developing a ceramic seriation for St. Croix and the broader region (Vescelius 1951). For the present study, 10 sherds were selected from each of Vescelius' pits 1, 2, 4, 7 and 10. Five sherds from each of these excavation units were randomly selected from levels containing Elenan Ostionoid ceramics dating to between ca. AD 900–1200 (Figure 4), and five from shallower levels containing Chican Ostionoid ceramics dating to between ca. AD 1200–1500 (Figure 5). These two ceramic horizons represent the most recent Late Ceramic Age periods for the site, island, and region and are basically comparable to the temporal periods represented by the Anguilla materials.

Results

A previously conducted temper study found that 80% of Anguillian ceramics contain one or more volcanic minerals, the majority including rounded black sand grains (Crock 2000). Although Anguilla does have local clays that are suitable for the manufacture of ceramics, volcanic minerals, such as those visible with a low power microscope in sherds from Anguillian sites, do not occur naturally on the limestone island. Exposures of volcanic material do exist in deeper basement sections of the uplifted north coast. However, none has been readily identified as sources for the temper observed in any samples. These data have been used to suggest that more than half of the pottery found in Anguilla was manufactured on volcanic islands, including those with black sand beaches, and/or manufactured using local clays tempered with sand from these sources (Crock 2000). The closest islands to Anguilla with black sand beaches include St. Kitts, Nevis, Montserrat, and Antigua located approximately 80–160 km to the southeast. Finer grained, thin section petrography conducted by Donahue and others on samples from two Anguillian sites suggests the percentage of "exotic" ceramics is closer to 100%, with no sherds exhibiting exclusively carbonate temper (Donahue et al. 1990).

Principal components analysis conducted by Descantes and Glascock (2005a) on a subset of the same samples studied earlier by more conventional means indicates the five site samples are representative of three chemically distinct groups (Figure 6). A total of 10 of the 50 sherds (20%) fall within the range of Group 1, 27 (54%) fall within the range of Group 2, 6 (12%) fall within the range of Groups 3 and 7 (14%) could not be assigned to any of the three groups. Based on the earlier analysis of the temper used in the production of the same samples, all three groups identified in the compositional analysis likely represent off-island sources, or at least recipes containing off-island or "exotic" constituents. The identification of three distinct groups in the principal components analysis is surprising in that it excludes the possibility that all ceramics found in Anguilla derive from a single source of manufacture as well as the possibility that each village or household had its own unique ceramic recipe. Multiple sources for pottery vessels, like other commodities, is consistent with evidence that indicates Anguillian communities were major participants in an extensive interisland trade and exchange network during the Late Ceramic Age (Crock and Petersen 2004; Knippenberg 2006).

Figure 4. Elenan Ostionoid decorated ceramic sherds recovered by Gary Vescelius from the Salt River site in St. Croix. Yale Peabody Museum collection.

Figure 5. Chican Ostionoid decorated ceramic sherds recovered by Gary Vescelius from the Salt River site in St. Croix. Yale Peabody Museum collection.

In terms of possible site-based correlations, Group 1 is represented by samples from three of the five sites, Sandy Hill, Barnes Bay, and Forest North. Group 1 samples are enriched in the rare earth elements (REEs) and several transition metals (Co, Fe, Mn, V, etc.) relative to Groups 2 and 3. The latter groups are enriched in the alkali metals (K, Rb, Cs, and Ba) and in elements associated with quartz or sand temper such as Hf and Zr. The common trait shared by all of these sites is that they were occupied solely during post-Saladoid times, ca., after AD 900. The two sites without representation in Group 1—Sandy Ground and Shoal Bay East—have occupations that date to earlier periods. It is therefore possible that Group 1 may represent temporal patterns of ceramic production. That is, Group 1 may be associated with pottery production post-dating AD 900. However, given that the analyzed samples from all sites were derived from both earlier and later contexts (deeper and shallower), the absence of Group 1 ceramics from Sandy Ground and Shoal Bay East might be more related to social factors or simply a function of the small sample studied.

Group 2 comprises the majority of samples and includes pottery from all of the five sites studied. Relative to Groups 1 and 3, Group 2 is a core group and intermediate on most elemental concentrations. The lack of any statistically significant patterning within or between sites for Group 2 indicates that it

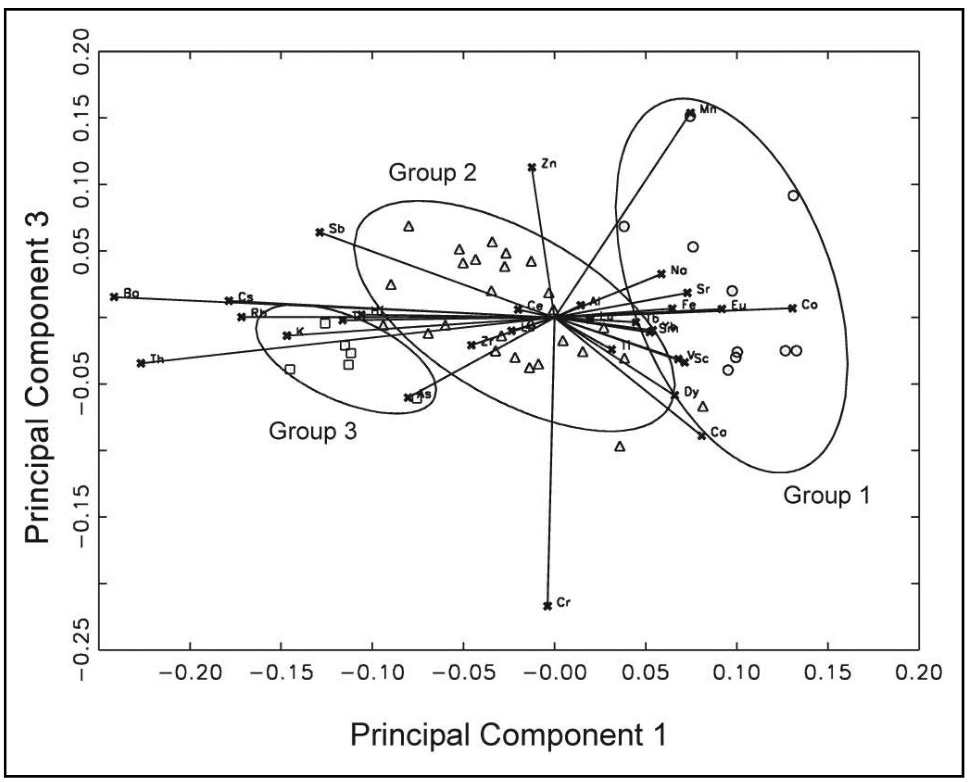

Figure 6. Biplot of principal components 1 and 3 displaying three compositional groups identified in the sample of ceramic sherds from five sites in Anguilla. Ellipses represent 90% confidence level for membership in groups. Vectors denote elemental influences on the ceramic data. Unassigned specimens are not shown (from Descantes and Glascock 2005a, Figure 1)

Figure 7. Broad-line incised rim sherd from the Barnes Bay Site in Anguilla. It was the only decorated sherd within the samples studied from Anguilla and a member of compositional Group 3

represents a consistent and enduring source for Anguillian ceramics, throughout the history of Amerindian occupation on the island. Based on simple falloff curve models of trade and exchange, the high proportion of ceramics exhibiting a variation of this particular "recipe" may represent a closer source than others, perhaps on the nearby island of St. Martin. St. Martin is the origin of a large proportion of the imported lithic materials, including greenstone used in the production of stone axes and calcirudite used to manufacture three-pointed zemis.

Group 3, the least represented of the three groups, is highly enriched in the alkali metals. It is worth noting that the three sites with samples assigned to Group 3 also are sites (Sandy Ground, Shoal Bay East and Barnes Bay) that exhibit a higher relative percentage of decorated sherds and other objects argued to be related to social status (Crock 2000). Of the two sites that did not contain pottery assigned to Group 3, one of them, Forest North, also happen to produce the lowest recorded estimated proportion of decorated sherds. Additionally, Group 3 included the only decorated sherd analyzed in the study of Anguilla ceramics, a slipped, broad-line incised sherd, possibly from a "pelican bowl" (Figure 7). Though very tentative due to sample size, this may suggest that there is a relationship between the provenance of Group 3 ceramics and the production of rarer decorated ceramics during the Late Ceramic Age, ca. AD 600–1500.

Three distinct groups were also identified in the ceramic samples from Salt River, St. Croix, based on principal components analysis of INAA results by Descantes and Glascock (2005b) (Figure 8). A total of 24 samples fall into Group 1 (48%), 20 in Group 2 (40%), and three in Group 3 (6%). Three specimens (6%) could not be assigned to any of the three groups identified. Relative to Group 1, Group 2 clearly has higher concentrations of the alkali metals and REEs, and is also enriched in zinc and antimony, when compared with compositional Group 1. Group 3 is enriched in thorium. The small member size in this group makes it difficult to test the probability of membership for samples in Group 3 relative to Groups 1 and 2 (Descantes and Glascock 2005b).

The identification of three separate groups of ceramics in the principal components analysis points to the use of at least three separate recipes in the production of the ceramics recovered from the two temporal components studied at the Salt River site. It is possible that all three groups represent ceramics that were manufactured on St. Croix from materials local to St. Croix. Alternatively, one or more of the compositional groups could represent off-island production locales.

Given the geologic characteristics of St. Croix with its two major physiographic areas, the sherds from compositional Groups 1 and 2, which are represented in both ceramic periods and date between AD 900–1500, may well represent locally manufactured ceramics utilizing clays from these two environments. Alternatively, these groups may also represent non-local sources, potentially

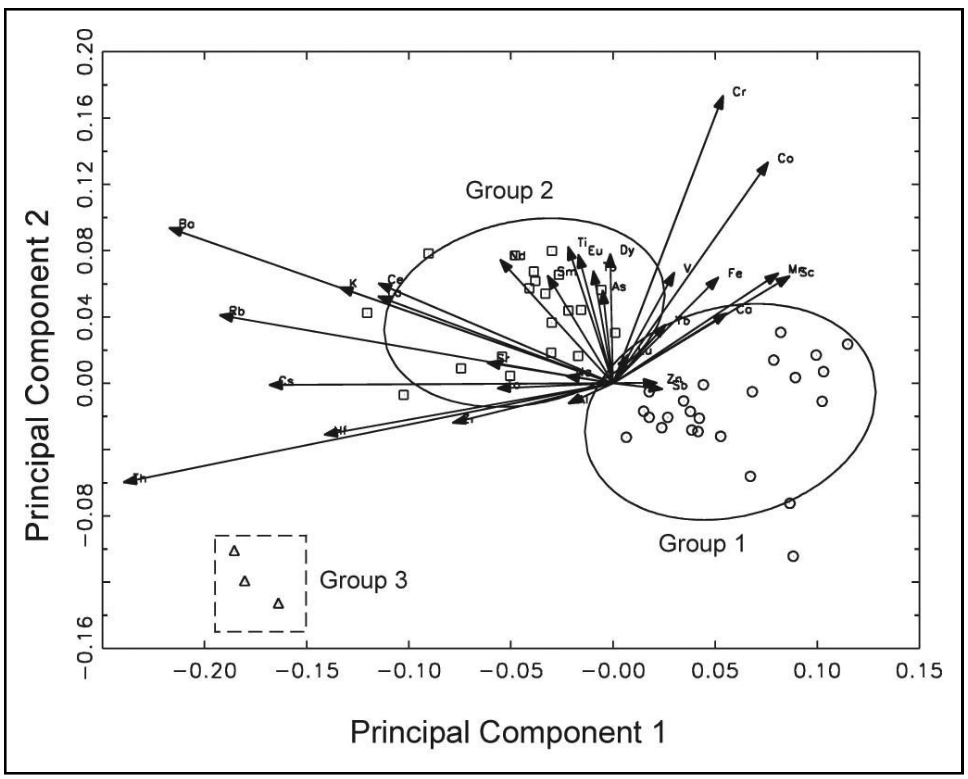

Figure 8. Biplot of principal components 1 and 2 displaying the three compositional groups identified in the sample of ceramic sherds from the Salt River site, St. Croix. Ellipses represent 90% confidence level for membership in the groups. Vectors denote elemental influences on the ceramic data. Unassigned specimens are not shown (from Descantes and Glascock 2005b, Figure 1).

including production locales on nearby islands such as Puerto Rico. Ceramics from sites in St. Croix and Puerto Rico are closely linked based on stylistic attributes and the geographic proximity of the two islands certainly would have favored cultural relatedness as well as trade and exchange. The Salt River Bay with its well-protected harbor, and the island's midway position between the Greater and the northern Lesser Antilles, were undoubtedly important factors in the site's settlement and position within a broader inter-island exchange network. When compositional data for St. Croix clay samples and for ceramics recovered from sites in Puerto Rico becomes available we will be able to better assess the relationship between the two islands in terms of ceramic production and consumption.

The three samples from the least well-represented group, Group 3, all derive from the latest ceramic period dating from AD 1200–1500. One of these samples exhibits a compositional affinity to samples of ceramics from the Dominican Republic (Descantes and Glascock 2005b). The one sherd from the Salt River site chemically resembles the Dominican Republic samples as a whole, which derived predominantly from the southeast side of Hispaniola in and around the ceremonial center of La Aleta. A possible compositional relationship between ceramic samples from Salt River and sites in southeastern Dominican Republic is not surprising based on the similarity between the two in terms of ceramic style and archaeological context (Hatt 1932). Though tentative, the potential relationship between ceramics found at a ceremonial site like Salt River and ceremonial sites in Hispaniola such as La Aleta, is intriguing. Based mainly on geographic distance, Salt River has long been more closely identified with Puerto Rico in terms of potential sociopolitical ties. Possible direct links with other ballcourt sites, like those known in Hispaniola, may help better identify and broaden the understanding of Salt River's position relative to broader issues of regional Taino sociopolitics.

Discussion

Compositional analysis presents an extremely valuable "new" perspective on regional interaction in the eastern Caribbean as indicated by the provocative results obtained in the pioneering analysis for two island contexts presented here. Clearly, we need to analyze samples of locally available clays, both in the context of Anguilla and St. Croix to identify/rule out potential clay source areas. As is always the case, analysis of additional ceramic samples from other sites will also further advance our understanding of ceramic production over time and help identify the potential number and variability of contemporaneous manufacturing locales.

Even at this early stage, however, we are able to discount the extremes when reconstructing the production and distribution of ceramics. As stylistic analysis already has long suggested, the results from Anguilla indicate that there were fewer ceramic "recipes" than households and sites and therefore, Late Ceramic Age vessels were more likely the products of some degree of specialized production at locations likely determined by the differential availability of suitable clays and tempering agents. The opposite extreme can also be discounted because of the compositional analysis. That is, that there was not a single-source manufacturing center for the Late Ceramic Age pottery used by the occupants of villages in Anguilla or for the pottery used by the people living at Salt River, St. Croix. Rather, ceramic production was more likely dispersed. Based on the sites studied in Anguilla and its geology, the majority of the vessels were likely produced using a very limited number of recipes at a limited number of off-island locations. For the vessels used at Salt River, St. Croix, ceramic production was also seemingly limited to a handful of recipes from locations that were more likely to have been local to the site/island based on the local availability of constituent materials.

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COMPOSITIONAL ANALYSIS OF CERAMICS FROM LA ALETA, DOMINICAN REPUBLIC: IMPLICATIONS FOR SITE FUNCTION AND ORGANIZATION

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La Aleta is a major Taíno site that we believe served as a regional ceremonial center. The site's features include a flooded sinkhole and four stone-lined plazas similar to contact-period plazas used for ball games and dances. This paper uses data derived from instrumental neutron activation analysis (INAA) of ceramics from the sinkhole and plazas to evaluate hypotheses about La Aleta's importance and internal organization. The INAA data are not inconsistent with the interpretation that La Aleta served a regional, rather than local, population, but the results to date are probably best described as equivocal. The data do not support the hypothesis that each of the four plazas was used by people from a different locality. Instead, the data are more consistent with alternative hypotheses about the use of the plazas and/or the manufacture of the ceramics found therein.

This paper is an experiment in using data derived from instrumental neutron activation analysis (INAA) of ceramics to evaluate hypotheses about inter-site functional variability and intra-site spatial organization in Taíno settlements. A research team from Indiana University, in cooperation with Dominican colleagues, has been working in and around the Parque Nacional del Este in the southeastern Dominican Republic (Figure 1) since 1996. This zone formed part of the core of the Taíno chiefdom of Higüey, one of the principal cacicazgos of Hispaniola at the time of European contact (Las Casas 1967:I:22–26).

Among the sites we have been investigating is La Aleta (Figure 1), which contains a flooded sinkhole known as the Manantial de la Aleta (Atiles and Ortega 2001; Guerrero 1981; Ortega and Atiles 2003). Elsewhere we have argued that the Manantial de la Aleta was an important center for ritual offerings connected with the life-giving properties of water, female fertility, the female qualities of the universe, female supernaturals, and ancestor worship (Beeker et al. 2002; Conrad et al. 2001; Conrad, Beeker, and Foster 2005). Seven AMS radiocarbon dates on organic artifacts from the Manantial range from cal A.D. 1035 to 1420 (Conrad et al. 2001:14–15, Table 1).

In addition to the Manantial, La Aleta also contains four *bateyes* (ceremonial plazas) that are typical features of major Taíno ceremonial centers in the Greater Antilles, especially in Puerto Rico and Hispaniola (Atiles and Ortega 2001; Guerrero 1981; Ortega and Atiles 2003). During the contact period such plazas were used for ritual activities, including dances and ballgames. The presence of the Manantial and the four plazas suggests La Aleta was a regionally important ceremonial center that served a relatively wide area. The four plazas also suggest that the site was used by multiple Taíno sociopolitical groups, each of which may have been associated with particular zones within the settlement—for example, with a particular plaza.

Our purpose here is to ascertain whether compositional analyses of ceramics can contribute to the evaluation of these specific hypotheses about La Aleta, and by extension to the investigation of broader questions about Taíno history and culture, and Caribbean prehistory in general. Our data derive from INAA studies of 175 sherds: 125 from La Aleta, consisting of 25 samples each from the Manantial and the four plazas; 25

Figure 1. Schematic diagram of instrumental neutron activation analysis.

sherds from a nearby shoreline village site called La Cangrejera; and a total of 25 sherds from three sites in the Punta Macao region, farther to the north (Figure 1).

The samples from the Manantial de la Aleta were selected from collections recovered by the Indiana University team during dives in 1996 and 1997 (Beeker et al. 2002; Conrad, Beeker, and Foster 2005). The sherds from the plazas at La Aleta were excavated by Elpidio Ortega and Gabriel Atiles in 1997 (Atiles and Ortega 2001; Ortega and Atiles 2003), whereas those from La Cangrejera were excavated by Atiles and Harold Olsen Bogaert in 1998 (Andújar and Atiles 2003). The sherds from the Punta Macao sites, which were investigated by Atiles in 2003 and 2004 (Andújar 2004), were initially collected for a different purpose, but proved to have some relevance to the problems under consideration. In May of 2004, the Museo del Hombre Dominicano, at that time directed by Carlos Andújar, graciously made all of these materials available to us for analysis.

INAA Results

The INAA was carried out at the Archaeometry Laboratory of the University of Missouri Research Reactor Center (MURR), using the standard MURR procedures described by Christophe Descantes et al. in the introductory paper of this volume (see also Baxter 1992; Bieber et al. 1976; Bishop and Neff 1989; Descantes and Glascock 2004; Glascock 1992; Neff 1994, 2001; Sayre 1975). We identified five compositionally homogeneous groups within the ceramics (Figure 2), designated La Aleta 1 (n=6), La Aleta 2 (n=11), Punta Macao (n=24), Group 1 (n=101), and Group 2 (n=4); 29 samples were unassigned (Table 1). Each of these groups is distinguished from the others by being relatively enriched (or diluted) in a different set of elements. Compared to the other groups, La Aleta 1 ceramics are enriched in chromium and cobalt, whereas La Aleta 2 ceramics are enriched in antimony, arsenic, terbium, samarium, lutetium, and uranium (actinide). The Punta Macao group is enriched in sodium, potassium, hafnium, rubidium, and barium. Group 1 ceramics are enriched in manganese, while those in Group 2 are enriched in hafnium, zirconium, uranium, and actinide. Following the "provenance postulate" of Weigand et al. (1977), these compositional groups are assumed to represent geographically restricted sources or source zones.[1]

We should note that there may be only a three-group structure, because there is a possibility that compositional groups La Aleta 2 and Group 2 are transformations of Punta Macao and Group 1. All of the sherds in those first two groups were recovered from the flooded sinkhole known as the Manantial de la Aleta, and their chemical composition may have been altered by their prolonged immersion in deep water. In other words, there is the possibility that the underwater postdepositional environment of the La Aleta sherds may have affected the sherds by enriching them in uranium.

The five (or three) groups have different distributions. The groups designated La Aleta 1, La Aleta 2, and Group 2 occur only at the site of La Aleta. As indicated above, all of the Group 2 and La Aleta 2 specimens were recovered from deep-water contexts in the Manantial. In contrast, all of the La Aleta 1 sherds came from the four plazas at the site. Group 1 ceramics were found at three sites: La Aleta, La Cangrejera, and Punta Macao proper. The Punta Macao group had the widest distribution, being represented at all

Table 1. Sherds by compositional group

Site	La Aleta 1	La Aleta 2	Group 1	Group 2	Punta Macao
La Aleta					
Manantial	0	11	2	4	0
Plaza A	2	0	21	0	0
Plaza B	2	0	22	0	1
Plaza C	1	0	20	0	1
Plaza D	1	0	18	0	0
La Cangrejera	0	0	16	0	4
Punta Macao Sites	0	0	2	0	18
Total	**6**	**11**	**101**	**4**	**24**

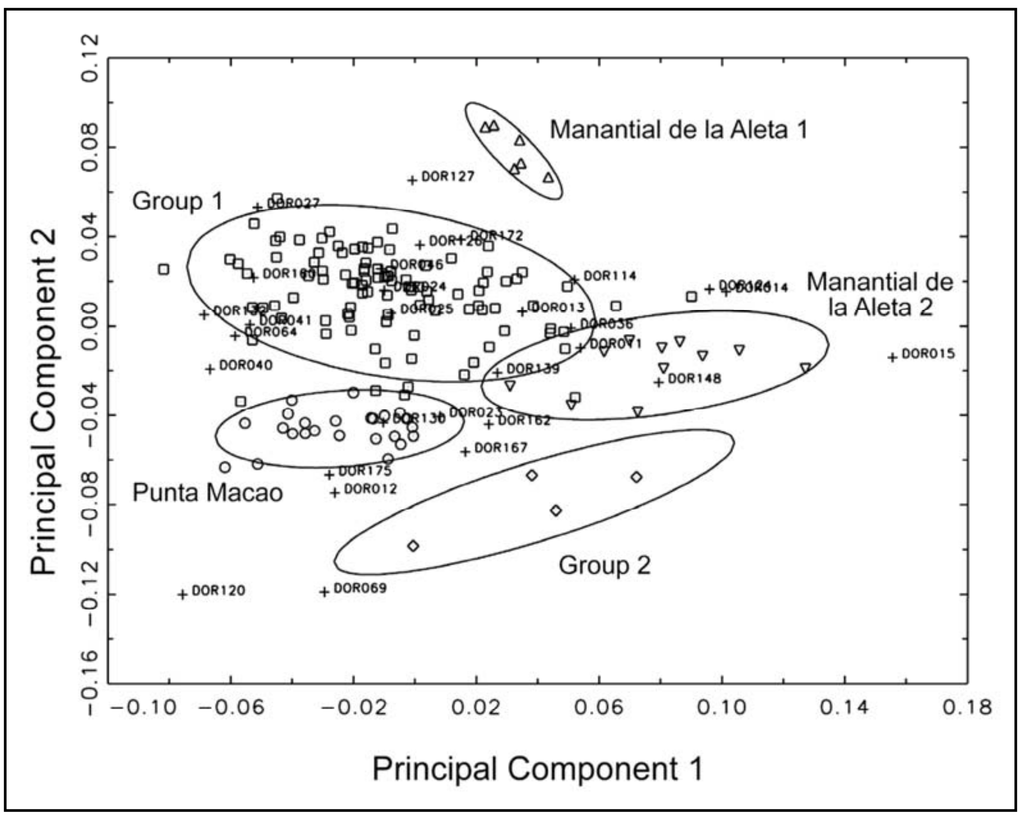

Figure 2. Plot of the five compositional groups (ellipses represent 90% confidence level).

five sites: La Aleta, La Cangrejera, and the three sites in the Punta Macao area (see Table 1).

La Aleta as a Regional Center: INAA Evidence

In terms of our first hypothesis, if La Aleta was indeed a regionally important center, pottery found at the site would have been drawn from—and manufactured across—a wider area than the pottery from La Cangrejera, a village site with only local importance.[2] If so, we would expect compositional analyses of ceramics from the two sites to produce different results. For example, if the pottery from La Cangrejera was indeed manufactured within a restricted geographical area, we would expect the chemical range of variation to be minimal in terms of clay sources and paste "recipes," and thus have few recognizable compositional groups. In contrast, if La Aleta had a broader regional importance, we would expect its ceramics to be more heterogeneous in terms of sources, recipes, and composition, and therefore have more identifiable groups than comparable sites in the area.

Compositional analysis does indeed reveal that samples from La Aleta have a wider range of variation than samples from La Cangrejera (Figure 3). The first 50 samples submitted for analysis were the 25 sherds from the Manantial de la Aleta and the 25 from La Cangrejera. Clear chemical compositional differences exist between the ceramics from these two sites, most visible in bivariate projections that include uranium and arsenic concentrations, however, it should be

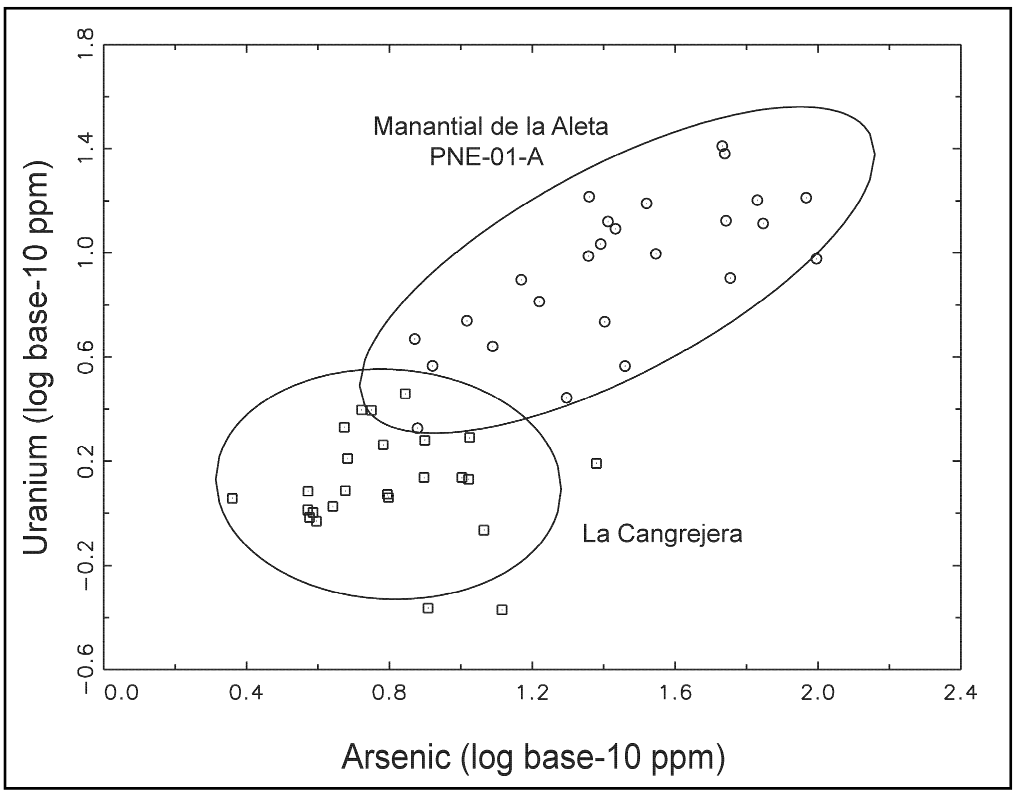

Figure 3. Plot of arsenic and uranium concentrations showing the contrast between ceramics from La Aleta and La Cangrejera.

noted again that the underwater postdepositional environment may have affected the sherds at the Manantial de la Aleta by enriching them in uranium. Overall, the La Cangrejera ceramics are more homogeneous than the specimens from the Manantial de la Aleta. When the ceramics from the four plazas are included in the comparison, the heterogeneity of the ceramics from La Aleta increases considerably, magnifying the contrast between the two sites. All five (or three) of the compositional groups are represented at La Aleta, whereas only two groups are represented at La Cangrejera. Admittedly, when the samples from the plazas are included, the sample size for La Aleta is five times as large as that from La Cangrejera .

In brief, compositional analyses offer some, albeit limited, support for the hypothesis that La Aleta was a ceremonial center that served a regional Taíno population. The compositional evidence is consistent with some stylistic evidence we have published elsewhere, although that evidence is also limited (Beeker et al. 2002). At this point much work remains to be done before we can delimit the region served by La Aleta, which may well have fluctuated through time. To judge from the results of the preliminary work presented here, however, it seems very likely that additional compositional analyses could be very helpful in resolving this question.

Use of the Plazas: INAA Evidence

Our second hypothesis is concerned with the internal organization of La Aleta, and specifically with the four plazas. If the artifacts recovered from La Aleta were drawn from—and manufactured across—a wide area, ceramics *from the site as a whole* should be relatively heterogeneous in terms of sources and recipes. A closer examination of intra-site patterning, however, might provide additional information about La Aleta. That is, if each plaza was used by Taíno groups from a different locality or set of localities, with every group providing its own ceramics, we would expect compositional analyses of sherds from each of the plazas to produce different results.[3] On the other hand, if all plazas were used by all groups but for different ceremonies, the results from all of the plazas should look similar.

INAA data indicate that the compositions of the plaza ceramics cannot be separated in elemental or principal component space (Figure 4). No statistical difference exists among the chemical compositions of the ceramics found on the four plazas; i.e., none of the plazas appear to have chemically distinctive or unique ceramics. At first glance these data suggest that the use of any given plaza was not restricted to a particular group or groups. Instead, the data are more consistent with the hypothesis that each plaza was used by all groups for a different set of activities distinguished by content, timing, or other factors. In other words, it seems likely that what differentiated the four plazas from one another was the ceremonies that took place in them, not the people who participated.

In reality, however, the similarity in the chemical compositions of the ceramics does not preclude either possibility: that each plaza was used by all groups, as above, or that the four plazas were used by different groups. The hypothesis as stated assumes that each group was bringing its own pottery, made with its own local clays, for use in ceremonies at La Aleta, and that there was no centralized ceramic production for the site. In

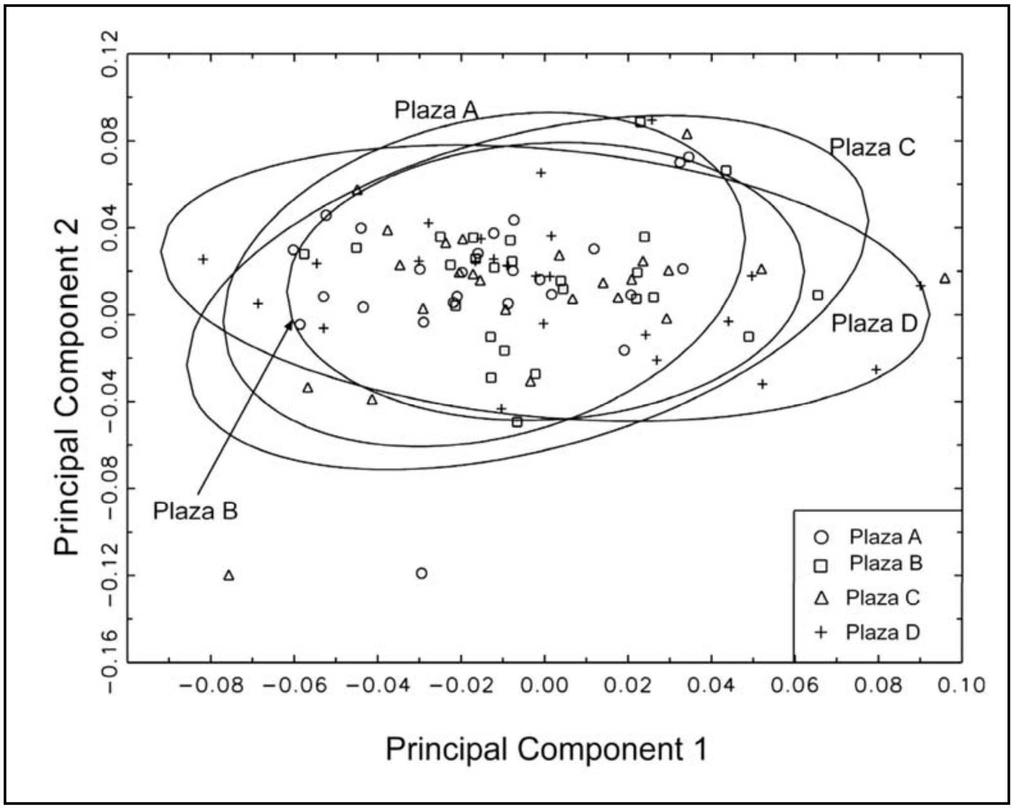

Figure 4. Plot showing no compositional difference among the ceramics from the four plazas.

fact, the data for the ceramic groups from the plazas may raise questions about this assumption. The vast majority of the sherds from the plazas—81 percent—are assigned to Group 1, with only rare occurrences of ceramics from other compositional groups (Figure 5). The proportion of Group 1 sherds in the individual plazas ranges from 72 to 88 percent. If we consider only samples that can be assigned to one of the five compositional groups, the proportion of Group 1 increases to 91 percent, with a range of 88 to 95 percent for the individual plazas. The overwhelming preponderance of Group 1 in these samples might reflect centralized, and possibly specialized, production of ceramics for use in the ceremonies held in the plazas, regardless of the group or groups participating. If so, we do not know at present where this production might have occurred.

A third possibility is that the ceramics have nothing to do with the use of the plazas but are simply rubbish deposited as construction fill. In that case, the high percentage of Group 1 ceramics might indicate that the fill in the four plazas originated from a single source, a large midden in which Group 1 pottery predominated. We cannot completely discount this possibility, but we consider it unlikely, as no one has yet identified any substantial midden deposits at La Aleta outside the plazas themselves. For the moment, we consider it more probable that the results of the INAA analyses reflect use

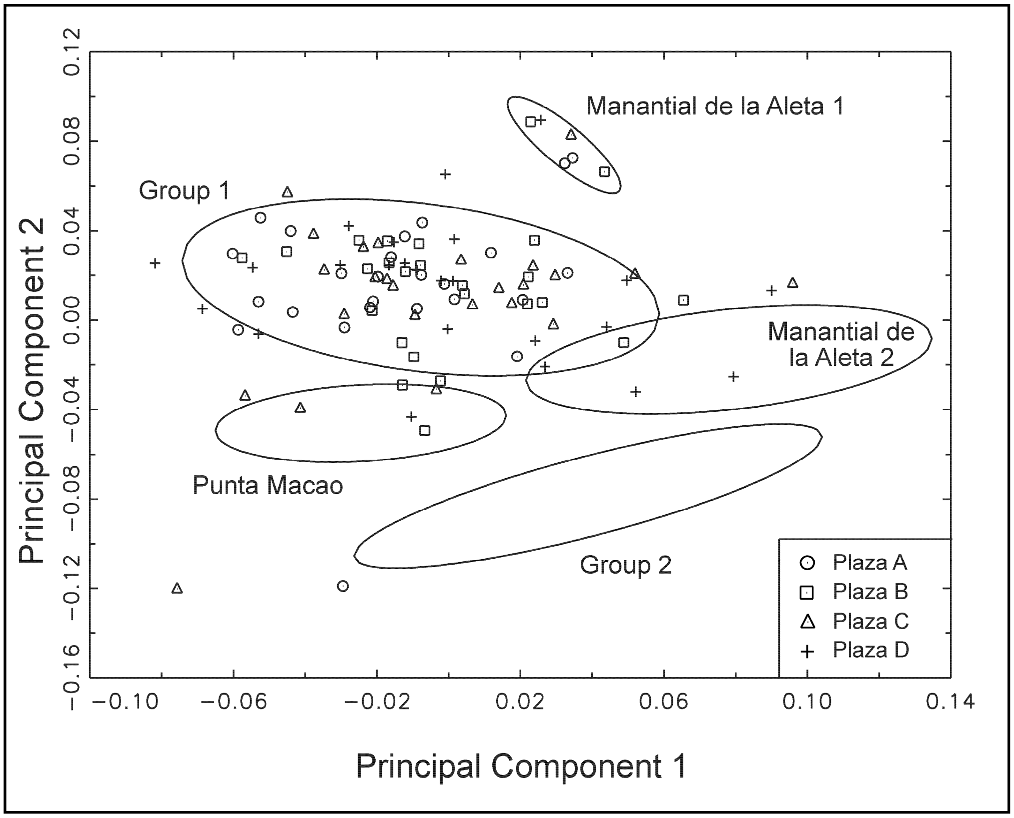

Figure 5. Plot showing the sherds from the four plazas affiliated primarily with Group 1.

of each plaza in different ceremonies, localized and perhaps specialized production of ceramics for use in the ritual activities carried out in the plazas, or both.

Vessel Forms and Compositional Groups

In response to an earlier version of this paper (Conrad, Descantes, VanderVeen, and Glascock 2005), Emily Lundberg (personal communication 2005) asked whether we had attempted to control for vessel form, and whether it might be an important variable. The answer to the first question is "no," except unintentionally in the case of the sherds from the Manantial de la Aleta. For pragmatic reasons we chose nondiagnostic body sherds from most contexts.[4]

Twenty-two of the 25 specimens from the Manantial can be categorized by vessel form, however. Sixty-four percent (51 of 80) of the recognizable vessels or fragments recovered from the Manantial were bowls (Beeker et al. 2002), and 68 percent of the identifiable sherds from the Manantial that were sent to MURR (15 of 22) were bowl fragments. Of the identifiable sherds that could be assigned to specific compositional groups, the percentage of bowls in each group ranged from 60 to 100 (Table 2). This limited evidence suggests that the percentage of bowls in each compositional group mirrors the percentages in the sample submitted to MURR and the total assemblage from the Manantial; we suspect the same is true of other vessel forms as well. Accordingly, there does not appear to be a strong correlation between vessel forms and compositional groups, but at this point the sample is really too small to permit definite conclusions.

Conclusion

Clearly, our sample sizes are small, and Ronald Bishop (personal communication 2006) has rightly characterized our results as "equivocal." Accordingly, our interpretations can only be viewed as preliminary. Nonetheless, the results do indicate that compositional analyses have the potential to make major contributions to Caribbean archaeology—even if all they do at this point is call our attention to new questions. What do the INAA results tell us about La Aleta? Did the Manantial serve a regional population, whereas the plazas were used only by local groups? Was pottery "mass-produced" for use in activities connected with the plazas, but not the Manantial? If so, does that mean the Manantial was reserved for use by regional elites, while the plazas were accessible to local commoners? Was the Manantial in some way a more sacred space than the plazas?

It is true that our results to date can provide at best equivocal answers to these questions. Nonetheless, without INAA analysis we could not address these problems, because the ceramics from the different contexts look the same stylistically. In fact, without the INAA analysis, would we even know that these questions existed? The analysis of additional samples from the sites under consideration here, as well as samples from clay sources in the region, would not simply support or cast doubt on our current interpretations. As above, they would lead us to new research questions about the Taíno occupation of the Parque Nacional del Este region. In terms of even broader, longer-term implications, the work presented here indicates that compositional analysis has the potential to reveal significant spatial groupings, and ultimately temporal groupings as well, in Caribbean artifacts. If so, it can make powerful contributions to a host of questions in Caribbean archaeology that are now debated inconclusively on the basis of stylistic and documentary evidence alone.

Acknowledgments

We are grateful to the Secretaría de Estado de Cultura of the Dominican Republic and two of its agencies, the Museo del Hombre Dominicano and the Oficina Nacional del

Table 2. Manantial de la Aleta: vessel form by compositional group.

	Group 1	**Group 2**	**LA2**	**Unass.**	**Total**
Bowl	2	3	6	4	*15*
Olla	0	0	1	0	*1*
Jar	0	1	0	2	*3*
Bottle	0	0	1	0	*1*
Platter	0	0	1	0	*1*
Buren	0	0	1	0	*1*
??	0	0	1	2	*3*
Total	**2**	**4**	**11**	**8**	**25**

Patrimonio Cultural Subacuático, for all they have done to make our research possible. The samples from the Manantial de la Aleta and La Cangrejera were processed through the operating support for the MURR Archaeometry Laboratory by the National Science Foundation (Grant BCS-0504015). Analysis of the samples from the plazas at La Aleta was made possible by a grant-in-aid from the Office of the Vice President for Research (now the Office of the Vice Provost for Research), Indiana University. Tessa Schut and Nicole Little of MURR carried out the preparation and irradiation of the samples. Figure 1 was prepared by Ellen Sieber of the William Hammond Mathers Museum, Indiana University. We are grateful to all of those institutions and individuals for their help. We also appreciate Ronald Bishop's insightful comments on the version of this paper we presented at the original SAA symposium. Any errors of interpretation are our responsibility.

Finally, and with a profound sense of loss, we want to express our thanks to James B. Petersen, who saw value in an early and quite rough version of this paper and went out of his way to tell us so. That was typical of Jim. He was a fine scholar and a warm and engaging human being. We miss him on both counts.

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Notes

[1] For detailed descriptions of the INAA results see Descantes and Glascock (2004) and Descantes et al. (2006).

[2] The hypothesis as stated here assumes that the pottery found at La Aleta was made elsewhere, or at least with clays obtained elsewhere. Earlier reports on our INAA work presented at conferences (Conrad, Descantes, VanderVeen, and Glascock 2005; Conrad et al. 2006) stated incorrectly that there are no clay sources within 15 km of La Aleta. This claim was based on the initial stage of a survey by Robert Green of the Department of Anthropology, Indiana University. More recently Green (personal communication 2006) has found clay at La Granchorra, about 5 km east of La Aleta.

[3] This hypothesis assumes that that all of the plazas are contemporaneous. The available evidence does not indicate any major chronological differences among the plazas (Atiles and Ortega 2001; Ortega and Atiles 2003). For our purposes here, however, the INAA results render the point moot.

[4] In his discussion of the papers presented at the symposium that was the basis for this volume, Ronald Bishop pointed out that for INAA analyses, diagnostic ceramics are preferable to nondiagnostic ones. We agree, but for the specific analyses discussed in this paper, we deliberately asked for nondiagnostic sherds because we thought it might facilitate approval of our

request. In 2004 Gabriel Atiles (personal communication) told us that he did not know of any earlier requests to remove artifacts from the Museo del Hombre Dominicano for destructive analysis and that, in his opinion, previous administrations of the museum would not have granted one. As it turned out, the administrations of the museum with which we have worked have been extremely helpful in making specimens available for INAA, and we have selected diagnostic sherds for subsequent analyses.

For the initial analysis of specimens from the Manantial de la Aleta, small, undecorated fragments were removed from larger, diagnostic pieces, which is why vessel form is known in most cases.

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PRELIMINARY PETROGRAPHIC AND CHEMICAL ANALYSES OF PREHISTORIC CERAMICS FROM CARRIACOU, WEST INDIES

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Petrographic and chemical analysis of prehistoric ceramic sherds from the island of Carriacou in the southern Grenadines, West Indies offers preliminary insight into resource exploitation, manufacturing techniques, and the distribution of pottery from ca. AD 400–1200. Thin-section petrography of two different suites of sherds (Suite 1: n=24 from six sites; Suite 2: n=54 from five of the same sites plus three others) indicates that there are at least five temper groups, all or most of which appear to be exotic to Carriacou. Instrumental neutron activation analysis (INAA) of 56 sherds from Suite 2 reveals the existence of two main geochemical compositional groups. This may be a reflection of prehistoric potters selecting clays derived from two geochemically different substrates in the location(s) of manufacture. A comparison of these findings suggest that: 1) exotic materials are predominant in manufacture; 2) both local and regional transport of ceramics occurred prehistorically; 3) the correspondence between the temper and INAA compositional groups is unclear, suggesting that the paste geochemistry might mask minor temper differences; and 4) clay and temper preferences may have changed through time, although this will require further testing.

The analysis of ceramics from archaeological sites, both on the surface and excavated from stratified deposits, can help us explore issues related to the production, distribution, and movement of artifacts across time and space. In the Caribbean, most ceramic studies have focused on examining stylistic motifs and morphological attributes of pottery (e.g., Righter 1997; Roe 1989; see also Keegan 2000), whereas technological aspects of production such as firing temperature, porosity, and density have only been cursorily studied (for one exception see Curet 1997). Unfortunately, there has been a paucity of research dedicated to investigating the mineralogical and chemical composition of pottery in general (but see Carini 1991; Donahue et al. 1990; Fuess et al. 1991; Fuess and Donahue 1992;Lambert et al. 1990; Mann 1986; Winter and Gilstrap 1991; van As and Jacobs 1992), despite the usefulness of such approaches for answering a number of important provenance and manufacturing/ technology-related questions and their widespread use in other regions worldwide.

To remedy this situation and provide the first compositional analysis of ceramics from the island of Carriacou in the southern Grenadines, we conducted thin-section petrography and INAA on nearly 80 sherds (Suite 1: n=24 sherds, detailed petrography only; Suite 2 = 56 sherds, all INAA and 54 cursory petrography). This study is one component of the Carriacou Archaeological Survey Project and part of a larger regional effort by researchers at the University of Missouri Research Reactor (MURR) to develop a database of Caribbean ceramics that will be beneficial to the greater Caribbean archaeological community. In this paper, we first provide a brief archaeological and environmental background to contextualize research thus far conducted on Carriacou. We then discuss the methods we used for sampling and analyzing prehistoric ceramics. Our results suggest that there are at least five major geological sources of temper components, with two major chemical groups (paste?) identified using INAA. Both types of analyses indicate that prehistoric Carriacouan pottery was produced using primarily exotic materials however, there does not appear to be any direct correlation between the temper and chemical groups. Nonetheless, the data still have implications for understanding local manufacturing techniques, the movement of pottery and other raw materials within the Lesser Antilles, how cultural interactions and resource exploitation may have changed over time, and the utility of combining these two methods for examining prehistoric pottery production.

Archaeological Research on Carriacou

Jesse Fewkes (1907:189–190) was one of the first scholars to investigate Carriacou and adjacent islands and described the ceramics found there as “among the finest West Indian ware that has yet come to the Smithsonian Institution.” Bullen (1964) investigated Grenada in the 1960s and made several short trips to St. Vincent and the Grenadines to collect artifacts and excavate exploratory trenches, including the Sabazan site on Carriacou (Bullen and Bullen 1972). Sutty (1990) surveyed portions of Carriacou and recorded surface finds at Grand Bay, Sabazan, and a number of other prehistoric sites, but did not conduct any excavation.

In July 1999, Kappers visited the Grand Bay site on Carriacou and noted a substantial amount of cultural material visible on the surface. The project’s field directors (Kaye, Kappers, and Fitzpatrick) later surveyed nearly the entire coastline of Carriacou in March–April 2003, as well as interior areas that were relatively flat or easily accessible. The team recorded 11 locations with evidence for prehistoric occupation, six of which had significant finds (primarily ceramics and faunal refuse) that were indicative of long-term settlement activities (Kaye et al. 2004). Of these six sites, Sabazan and Grand Bay had the most extensive stratified coastal profiles and an abundance of faunal remains, artifacts, and archaeological features, although other sites were also thought to have good potential for further study. As part of a long-term plan to investigate Carriacou's prehistoric occupation, the research team has focused on conducting limited testing at Sabazan and large area excavations at Grand Bay since 2004 (Fitzpatrick et al. 2004; Kappers et al. 2005; Kaye et al. 2004, 2005).

A total of 20 radiocarbon dates (charcoal, marine shell, and human bone) from Grand Bay, Sabazan, and Harvey Vale suggest that the island was first settled by ceramic making peoples during the terminal Saladoid period around A.D. 400, with later periods of cultural development characteristic of the Troumassan Troumassoid (ca. A.D. 600–1000) and Suazan Troumassoid (ca. A.D. 1000–1400) subseries of ceramics (Fitzpatrick et al. 2004, in press; Harris 2005). Material recovered from excavations at Grand Bay includes a vast array of mostly undecorated pottery sherds, ceramic adornos (modeled appliqué of animals or zoomorphs attached to the rims of vessels), two rare stone cemís, bone needles and tools, carved turtle plastron, shell beads and adzes, charred seeds, an enormous amount of fishbone (LeFebvre 2005), turtle bone, and mollusk shells, at least ten human burials, and numerous posthole, pit, and hearth features.

Environmental Background

Carriacou is located in the southern Lesser Antilles approximately 250 km north of Venezuela and 30 km north of Grenada (Figure 1). Politically, Carriacou is part of the tri-island nation of Grenada along with Petite Martinique, but also includes the smaller islands of Petite Dominica, Petite St. Vincent, Saline, and Frigate. Carriacou is the largest island in the Grenadines chain measuring 10.4 km from north to south, 8.7 km across at its widest point, and roughly 32 km^2 in area—it has a maximum elevation of 290 m.

Geologically, Carriacou lies on the southern Lesser Antilles platform between the two most active volcanoes of the Lesser Antilles magmatic arc, the subaerial St. Soufriere volcano on St. Vincent (Heath et al. 1998b) and the submarine volcano Kick'em Jenny near the volcanic island of Grenada (Heath et al. 1998a). Outcrops of Neogene (2.7 to 11.2 Ma) magmatic rocks dominate the western half of Carriacou, whereas outcrops of older Miocene to Eocene sedimentary units dominate the eastern half (as summarized by Speed et al. [1993]). These outcrops include basaltic to andesitic intrusive, extrusive, and epiclastic volcanic rocks and fossiliferous limestone (Caldwell 1983; Donovan et al. 2003; Jackson 1980; Pickerall et al. 2001, 2002; Robinson and Jung 1972; Speed et al. 1993).

Methods

One of the research goals of archaeological investigation on Carriacou is to determine how pottery, the most ubiquitous artifact class found on the island (and the Caribbean in general), was manufactured by native groups, used for domestic or other activities, and perhaps transported either across or between islands through time. A fundamental

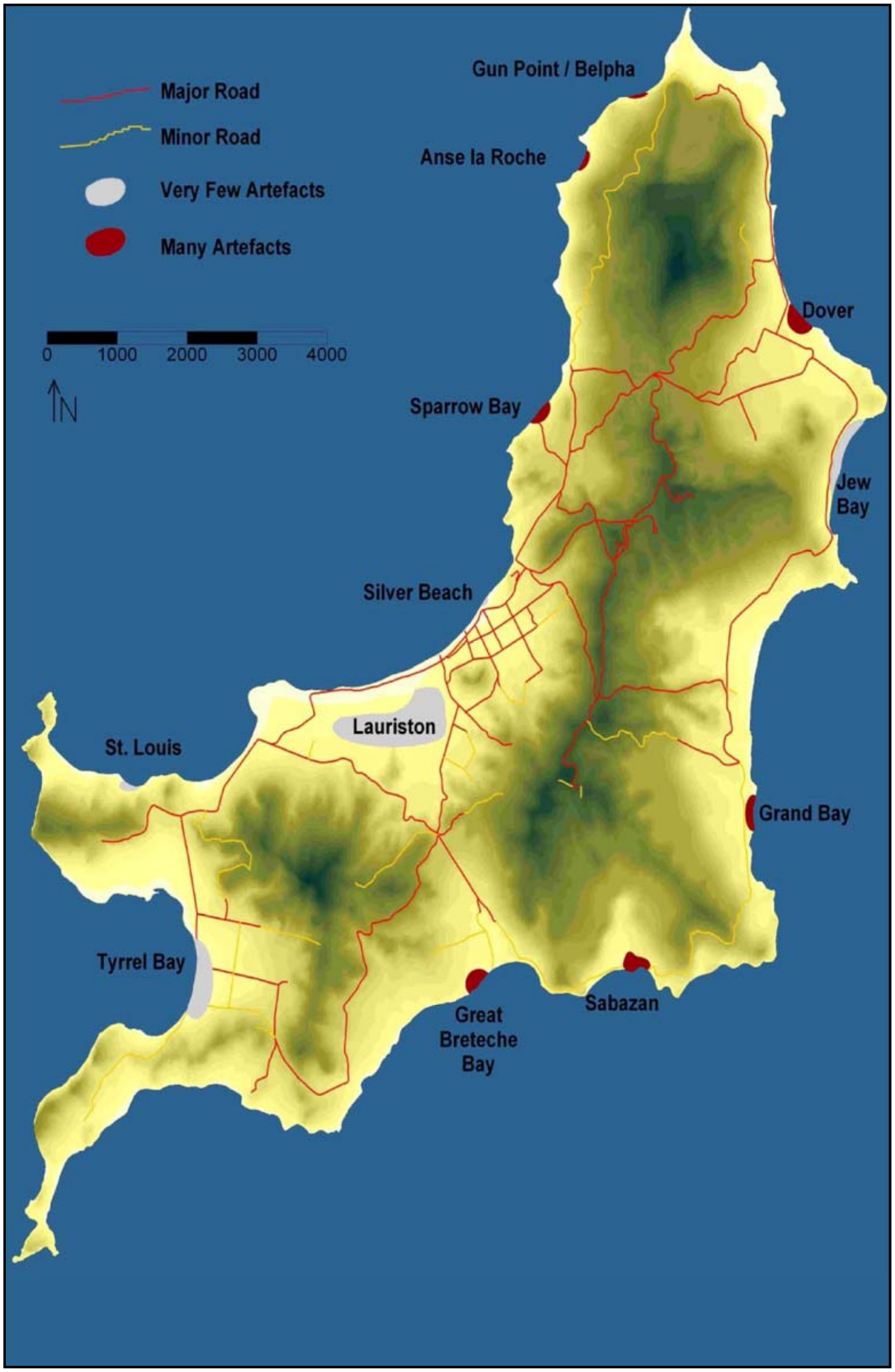

Figure 1. Map of Carriacou with locations of sites mentioned in this study.

part in answering these questions is conducting mineralogical and chemical analyses on sherds found at archaeological sites to examine whether there are any differences in sherd composition that are spatially or temporally distinct. For this study we used two techniques—thin section petrography and INAA. Both of these have had limited application, or in the case of the latter, have never been used in the Caribbean prior to MURR's initiation of the current regional study. Both of these analytical techniques have been successfully used elsewhere for deciphering patterns of clay and temper provenience and resource use prehistorically (e.g., Bishop et al. 1982; Dickinson 2001; Fitzpatrick et al. 2003; Glascock 1992; Harbottle 1976; Neff 1992, 1994, 2000, 2001; Stoltman 2001) and provide a strong foundation for examining changes to ceramic assemblages over time and space. Below we briefly discuss the analytical procedures, followed by the results of our analyses.

Petrography

A total of 78 sherds were examined petrographically. The first suite of samples (n=24) were undiagnostic surface finds from the sites of Anse la Roche, Jew Bay, Grand Bay, Sabazan, Great Bretache Bay, and Tyrell Bay (Figure 1). The second suite consisted of 54 thin sections of the same 56 sherds analyzed by INAA (described in the section below). Many of the sections prepared from the sherds were stained to enhance the recognition of calcium and potassium feldspars. All thin-sections were petrographically examined and sherds were classified into groups based on their composition (Table 1). A representative subset of 11 stained thin sections from suite 1 were point counted using a petrographic microscope equipped with a Swift automated stage and counter to better define group compositions; up to ~1000 points were counted on each thin section using the Gazzi-Dickinson method (Ingersoll et al. 1984). Sand-sized temper components were classified as individual mineral grains or rock fragments according to criteria discussed in Marsaglia (1992), with the addition of carbonate and matrix silt/clay paste categories (see Tables 2 and 3).

INAA

A total of 56 ceramic sherds from eight sites on Carriacou (Lauriston, Sabazan, Jew Bay, Tyrell Bay, Great Bretache Bay, Dover, Grand Bay, and St. Louis), as well as the nearby island of Petite Martinique, were sent to MURR for INAA analyses (see Table 1). Samples were primarily undiagnostic surface finds with the exception of Grand Bay sherds which were recovered from stratified deposits during excavation of the site in 2004. A selected portion of the sherd suite included specimens that were identified by Harris (2005) as Saladoid, Troumassan, or Suazan Trousmassan. The ceramics were prepared for INAA using standard MURR procedures that are explained in detail in Descantes et al. (this issue).

Results

Petrographic Analyses

Temper to matrix ratios in the 11 point-counted sherds range from 1:2 to 1:6. The samples contain mainly rock tempers with carbonate debris and grog, rare to absent (Figure 2). The main monomineralic temper components in the sherds are plagioclase feldspar and dense minerals such as pyroxene and amphibole. Quartz is predominant in one unusual sample and potassium feldspar is predominant in another. Volcanic rock

Table 1. Petrographically analyzed sample sets. Group 1 = Volcanic/Pyroclastic; Group 2 = Igneous Basement; Group 3 = Placer; Group 4 = Potassic Volcanic; Group 5 = Quartzose. FG = Fine Grained, CG = Coarse Grained, VL = Volcaniclastic Lathwork, VM = Volcaniclastic Microlitic.

SUITE 1

Sample	Site	Cultural period	Petro group	Detailed petro group	INAA group
Site 1-GB-1	Grand Bay	---	1	CGVL	---
Site 1-GB-2	Grand Bay	---	1	CGVM	---
Site 1-GB-3	Grand Bay	---	1	CGVL	---
Site 2-SZ-1	Sabazan	---	1	CGVL	---
Site 2-SZ-2	Sabazan	---	1	CGVL	---
Site 2-SZ-3	Sabazan	---	1	CGVL	---
Site 2-SZ-4	Sabazan	---	3	Placer	---
Site 2-SZ-5	Sabazan	---	1	CGVL	---
Site 4-AR-1	Anse La Roche	---	1	Fine-grained Volcan. lathwork	---
Site 4-AR-2	Anse La Roche	---	1	FGVL	---
Site 4-AR-3	Anse La Roche	---	1	CGVM	---
Site 4-AR-4	Anse La Roche	---	1	FGVL	---
Site 5-GTBB-1	Great Bretache Bay	---	4	K-rich volcaniclastic	---
Site 5-GTBB-2	Great Bretache Bay	---	1	CGVL	---
Site 5-GTBB-3	Great Bretache Bay	---	1	CGVL	---
Site 5-GTBB-4	Great Bretache Bay	---	1	CGVL	---
Site 5-GTBB-5	Great Bretache Bay	---	5	Quartzose	---
Site 6-TB-1	Terrell Bay	---	1	FGVL	---
Site 6-TB-2	Terrell Bay	---	1	CGVL	---
Site 6-TB-3	Terrell Bay	---	1	CGVL	---
Site 10-JB-1	Jew Bay	---	1	FGVM	---
Site 10-JB-2	Jew Bay	---	2	Basement	---
Site 10-JB-3	Jew Bay	---	2	Basement	---
Site 10-JB-4	Jew Bay	---	1	FGVL	---

SUITE 2

Sample	Site	Cultural period	Petro group	Detailed petro group	INAA group
SMF001	Dover	Saladoid	1	CGVL	1
SMF002	Grand Bay	Troumassan	1	FGVL	2
SMF003	Grand Bay	---	1	CGVL	2
SMF004	Grand Bay	---	1	CGVM	2
SMF005	Grand Bay	---	---	---	1
SMF006	Grand Bay	Suazan	2	Basement?	1
SMF007	Grand Bay	Suazan	1	CGVL	1
SMF008	Grand Bay	---	1	CGVL	1
SMF009	Grand Bay	---	1	CGVL	1
SMF010	Grand Bay	---	1	tuff or tephra sample	U
SMF011	Grand Bay	---	---	---	2
SMF012	Grand Bay	---	1	CGVM	2

Table 1 continued.

SMF013	Grand Bay	---	1	CGVL	2
SMF014	Grand Bay	---	1	CGVL	2
SMF015	Grand Bay	---	1	CGVL	2
SMF016	Grand Bay	---	1	CGVM	U
SMF017	Grand Bay	Saladoid	1	CGVM	1
SMF018	Grand Bay	---	1	FGVL	2
SMF019	Grand Bay	---	3	Placer	2
SMF020	Grand Bay	Suazan	1	CGVL	1
SMF021	Grand Bay	Suazan	1	CGVL	U
SMF022	Grand Bay	Suazan	1	CGVL	1
SMF023	Grand Bay	---	1	CGVL	1
SMF024	Grand Bay	---	1	CGVM	2
SMF025	Jew Bay	---	2	Basement?	2
SMF026	Jew Bay	---	1	CGVL	2
SMF027	Lauriston	Suazan	1	FGVL	1
SMF028	Lauriston	---	1	CGVL mixed CGVM	1
SMF029	Lauriston	---	1	CGVL	1
SMF030	Lauriston	---	1	CGVL	1
SMF031	Lauriston	---	1	FGVL	1
SMF032	Petite Martinique	---	1	CGVM	U
SMF033	Petite Martinique	---	1	FGVL	1
SMF034	Petite Martinique	---	1	CGVL	1
SMF035	Petite Martinique	---	1	CGVL	1
SMF036	Petite Martinique	---	2	Basement?	2
SMF037	Sabazan	Saladoid	1	CGVL	1
SMF038	Sabazan	---	1	CGVL	1
SMF039	Sabazan	---	1	FGVL	1
SMF040	Sabazan	---	1	CGVL w/ common carbonate	1
SMF041	Sabazan	---	1	CGVL	1
SMF042	Sparrow Bay	---	1	CGVL	1
SMF043	Sparrow Bay	---	2	Basement	1
SMF044	Sparrow Bay	---	1	FG mixed volcaniclastics	1
SMF045	Sparrow Bay	---	1	CGVL	U
SMF046	Sparrow Bay	---	1	CGVL	1
SMF047	Sparrow Bay	Suazan	4	K-rich volcaniclastic	U
SMF048	Sparrow Bay	---	1	FGVL	U
SMF049	Sparrow Bay	---	3	Placer	1
SMF050	Sparrow Bay	---	1	CGVL	2
SMF051	Sparrow Bay	Saladoid	1	FGVM	U
SMF052	St. Louis	---	1	CGVL	U
SMF053	Tyrell Bay	---	1	FGVL	1
SMF054	Tyrell Bay	---	1	CGVL	1
SMF055	Tyrell Bay	Suazan	4	K-rich volcaniclastic	U
SMF056	Tyrell Bay	Troumassan	1	FGVL	2

U: group indeterminable

---: undiagnostic or analysis not conducted

Table 2. Definition of counted categories and recalculated petrographic parameters.

Sand-Sized Temper Categories

Qm	Monocrystalline quartz
Qp	Polycrystalline quartz
P	Plagioclase feldspar
K	Potassium feldspar
Op	Opaque dense mineral
Cpx	Dense mineral - clinopyroxene
Opx	Dense mineral - orthopyroxene
Hbl	Dense mineral - amphibole
Lvv	Volcanic lithic with vitric texture
Lvml	Volcanic lithic with microlitic texture
Lvl	Volcanic lithic with lathwork texture
Lvo	Holocrystalline volcanic lithic composed of plagioclase and dense minerals
Lm	Metamorphic lithic
Biocl	Calcareous bioclast
Biot	Biotite
Musc	Muscovite
Unk	unknown Grain
Grog	Grog (recycled ceramic fragment)

Recalculated parameters

QFL%Q=100*((Qm+Qp)/(Qm+Qp+P+K+Lvo+Lvv+Lvml+Lvl+Lm))
QFL%F=100*((P+K)/(Qm+Qp+P+K+Lvo+Lvv+Lvml+Lvl+Lm))
QFL%L=100*((Lvo+Lvv+Lvml+Lvl+Lm)/(Qm+Qp+P+K+Lvo+Lvv+Lvv+Lvml+Lvl+Lm))

QmKP%Qm=100*(Qm/(Qm+P+K))
QmKP%K=100*(K/(Qm+P+K))
QmKP%P=100*(P/(Qm+P+K))

LvvLvmlLvl%Lvv=100*(Lvv/(Lvv+Lvml+Lvl))
LvvLvmlLvl%Lvml=100*(Lvml/(Lvv+Lvml+Lvl))
LvvLvmlLvl%Lvl=100*(Lvl/(Lvv+Lvml+Lvl))

fragments are present in most samples; these exhibit microlitic to lathwork textures with variable proportions of glass, plagioclase, and dense minerals. Volcanic debris ranges from fresh to altered. The compositional variability of the tempers is represented in Figure 3 where modal results are displayed on a series of ternary plots used in sandstone provenance studies.

Overall the samples fall into five general groups as illustrated by the photomicrographs in Figure 2 and the descriptions outlined below. Groups are roughly listed in their order of importance:

Group 1 (n= 65): Volcanic/Pyroclastic Temper. This is the most varied of the groups and could be further divided into several subgroups depending on volcanic lithic types and proportions present. Temper variability is

Table 3. Petrographic data and recalculated parameters.

Sample	**Qm**	**Qp**	**P**	**K**	**Op**	**Cpx**	**Opx**	**Hbl**	**Lvv**	**Lvml**	**Lvl**	**Lvo**	**Lm**	**Biocl**	**Biot**	**Musc**	**Unk**	**Grog**
1-GB-1	0	1	229	4	13	14	0	0		1	15						11	
1-GB-2	2	1	45			2		15		12	4	18					8	
2-SZ-4			31		2	161	4	81	3					9	1		11	
6-TB-1			144	3	2	2					7				1		46	
10-JB-2	1	1	149	5	6	11				1			3	1	3		19	
10-JB-1			147		2	11				2	8							
5-GTBB-5	116	10	11	2								1?	4		3	4	15	
6-TB-3			126	5						1	29							
10-JB-4			117	1		21				31	21							
4-AR-1			270		4	11		3	1	1	5				2		18	
5-GTBB-1			2	104	1	1				29	43			2				

						QFL%			QmKP%			LvvLvmlLvl%		
Sample	**Total Grains**	**Matrix Clay**	**Matrix Silt**	**Total Matrix**	**Total Count**	**Q**	**F**	**L**	**Qm**	**K**	**P**	**Lvv**	**Lvml**	**Lvl**
1-GB-1	**288**	518	186	704	**992**	0.4	93.2	6.4	0	1.7	98.3	0	6.3	93.8
1-GB-2	**107**	331	100	431	**538**	3.7	54.9	41.5	4.3	0	95.7	0	75	25
2-SZ-4	**303**	409	21	430	**733**	0	91.2	8.8	0	0	100	100	0	0
6-TB-1	**205**	285	318	603	**808**	0	95.5	4.5	0	2	98	0	0	100
10-JB-2	**200**	362	199	561	**761**	1.3	96.3	2.5	0.6	3.2	96.1	0	100	0
10-JB-1	**170**	115	104	219	**389**	0	93.6	6.4	0	0	100	0	20	80
5-GTBB-5	**165**	621	224	845	**1010**	88.1	9.1	2.8	89.9	1.6	8.5			
6-TB-3	**161**			287	**448**	0	81.4	18.6	0	3.8	96.2	0	3.3	96.7
10-JB-4	**191**	311	112	423	**614**	0	69.4	30.6	0	0.8	99.2	0	59.6	40.4
4-AR-1	**315**			0	**315**	0	97.5	2.5	0	0	100	14	14.3	71.4
5-GTBB-1	**182**	750	69	819	**1001**	0	59.6	40.4	0	98	1.9	0	40.3	59.7

a function of the proportions of volcanic glass, plagioclase, and dense minerals within individual volcanic fragments, as well as degree of alteration and grain size of the temper. The more holocrystalline varieties are consistent with epiclastic sand derived from basaltic to andesitic lava flows, whereas the glassy varieties are consistent with derivation from andesitic to basaltic pyroclastic ash. Where altered, they could have been mined from weathered outcrops or diagenetically modified older units.

Group 2 (n= 6): Igneous Basement Temper. These tempers are composed of angular plagioclase and dense minerals without volcanic glass. Some are limited to plagioclase crystals only, whereas others consist of plagioclase with minor dense minerals. These suggest anorthosite to diorite igneous source rocks.

Group 3 (n= 3): Placer Temper. These are thought to be concentrated dense mineral deposits derived from intermediate igneous rocks based on their mineralogy (clinopyroxene, amphibole, plagioclase) and small amounts of intermediate volcanic rock fragments. A high-energy beach environment is indicated by the moderately-well sorting, the high degree of grain rounding, and the presence of calcareous bioclastic debris.

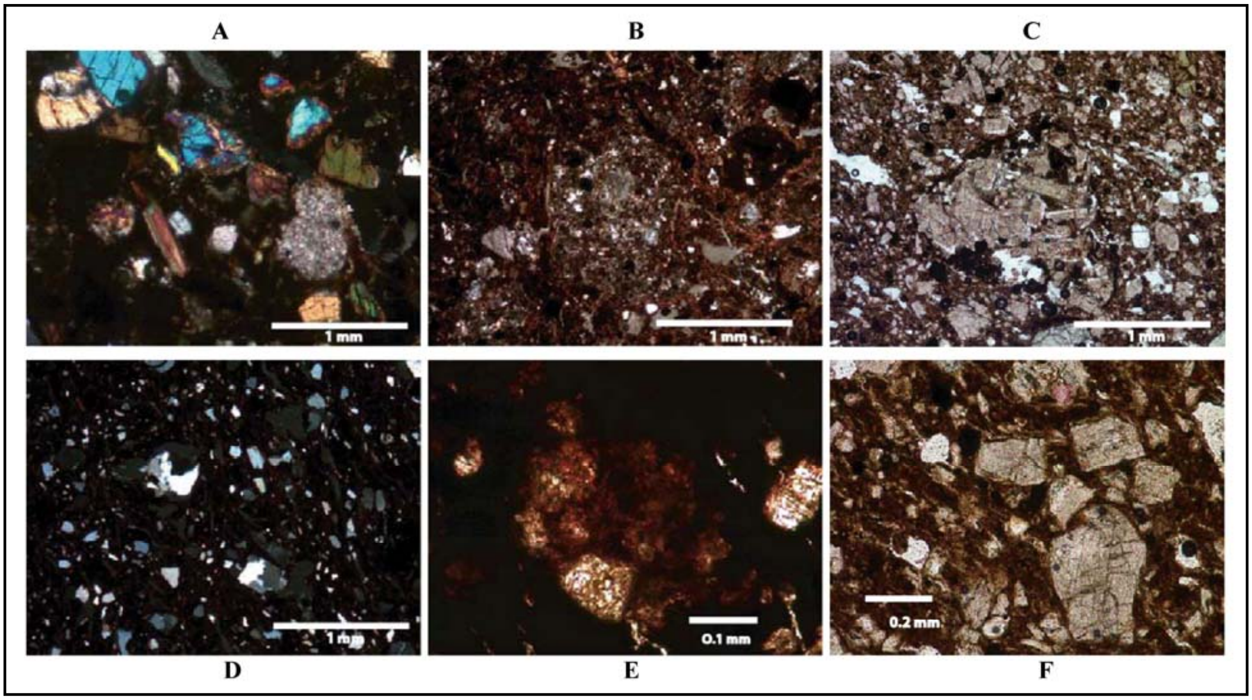

Figure 2. Photomicrographs of sherds illustrating temper provenance groups defined in this study [Temper Groups: A = placer; B = Coarse-grained microlitic; C = Coarse-grained lathwork; D = Quartzose; E = K-spar volcanic; F = Basement]. Top left (A) is a placer temper with grains of brightly birefringent carbonate bioclasts and strongly colored dense minerals highlighted under crossed nicols. Top middle (B) is a volcanic temper of volcanic fragments with microlitic texture under crossed nicols. Top right (C) is a temper of volcanic fragments exhibiting lathwork texture under plane light. Bottom left (D) is a quartzose temper under crossed nicols to highlight the low birefringence (grey to white) and shapes of the quartz temper grains surrounded by nonbirefringent paste. Bottom center (E) shows the yellow stained, postassium feldspar crystals set in black paste under plane light. Bottom right (F) shows a temper dominated by coarse euhedral (rectangular) to subheadral plagioclase crystals set in a dark paste.

Group 4 (n= 3): Potassic Volcanic Temper. This temper is limited to potassium feldspar and traces of volcanic lithic fragments. Volcanics/pyroclastics with high potassium feldspar are very unusual, but may be related to hydrothermal alteration of tuffs.

Group 5 (n= 1): Quartzose Temper. This sand temper is mineralogically mature (~90% monocrystalline and polycrystalline quartz), moderately sorted, with angular to subrounded grains. The grains suggest some mechanical abrasion and transport. Such sediment is associated with a continental provenance.

Discussion of Temper Provenance

The dominance of plagioclase feldspar (QmKP plot, Figure 3), pyroxene, amphibole, and microlitic to lathwork volcanic lithic textures in temper Groups 1, 2 and 3 is consistent with intermediate to basaltic igneous sources. Overall, these tempers are more feldspar enriched than natural basaltic/andesitic sands from beach, fluvial, and deep marine environments (e.g., Marsaglia 1993; Marsaglia and Ingersoll 1992), suggesting that many may represent rock ground up by prehistoric potters, rather than sand gathered from streams or beaches. Sherds with high concentrations of dense minerals (Group 3), however, can be explained as beach/stream placers derived from volcanic and/or plutonic igneous rocks. There is no evidence of volcanic lithics being recycled from older sedimentary units. Hypothetically, some of the Group 1, 2, and 3 tempers could have been derived from crushing shallow intrusive to extrusive magmatic rocks on Carriacou, but work in progress (Pavia, in prep.) indicates little textural similarity between Carriacou volcanic outcrops and Carriacou tempers implying an extra-Carriacou source.

The “local” regional geology can be subdivided into three main potential sources of volcaniclastic temper: 1) the active volcanic center to the north (e.g., St. Vincent); 2) the active volcanic center to the south (Kick’em Jenny, Isle de Caille, and Grenada); and 3) the Grenadine islands on the intervening southern Lesser Antilles arc platform (SLAAP). The SLAAP includes larger (e.g., Carriacou, Union, Canouan, Mustique, and Bequia), as well as numerous smaller islands (e.g., Petite Martinique, Mayreaus, Jamesby). The series of islands on the SLAAP between Grenada and St. Vincent (the Grenadines), are distinctly different in their geology, being mainly composed of older Tertiary intrusive to extrusive igneous rocks, epiclastic arc-derived volcaniclastic units, chert, marl, and limestone. There is no source for fresh pyroclastic debris on the SLAAP islands, so the volcaniclastic temper or pottery must have been imported from active volcanic centers, the St. Vincent or Grenada centers being the most proximal.

The surface of St. Vincent is mainly covered by late Pleistocene pyroclastic deposits, red oxidized scoria, and flows and scoria falls from historic (1718, 1812, 1902, 1971, 1979) eruptions associated with explosive eruptions of the Soufriere stratovolcano (Heath et al. 1998a). The latter consists of basaltic and basaltic andesite lava flows and a significant rapidly deposited scoriaceous to pumiceous yellow tuff unit (Rowley 1978) that erupted 3600 to 4500 years B.P. (Heath et al. 1998a). Younger overlying pyroclastic deposits were produced by as many as 20 subsequent vulcanian explosive eruptions. Thus, there are ample sources of fresh pyroclastic temper on St. Vincent. The St. Soufriere volcano also ejected blocks of plagioclase-rich anorthosite (Lewis 1973), a source rock that when crushed could perhaps best explain the pure plagioclase end member tempers.

In contrast, fresh pyroclastic sources associated with the Grenada volcanic center are not as extensive. Grenada is composed of Pliocene to Pleistocene basaltic to andesitic volcanic centers, the youngest of which is Mt. St. Catherine. Young (1000 yrs. B.P.) fresh pyroclastic outcrops available to prehistoric potters would have been limited to a glassy basaltic scoria cone near Radix village and small volcanic centers on nearby Isle de Caille (Arculus 1976; Devine 1995; Devine and Sigurdsson 1995).

Future work on the geochemistry of glassy pyroclastic tempers and plagioclase phenocrysts may help to fingerprint the volcanic source(s) of this material. The St. Soufriere basaltic-andesitic magmas of St. Vincent are calc-alkaline to tholeiitic (Heath et al. 1998a, 1998b), whereas to the south in the southern Grenadines and Grenada the lavas are alkaline (Brown et al. 1977). Volcanic islands north of St. Vincent are calcalkaline, but show no tholeiitic tendencies (Heath et al. 1998b). There are also distinct changes in the Sr isotopes of plagioclase phenocrysts in volcanic centers

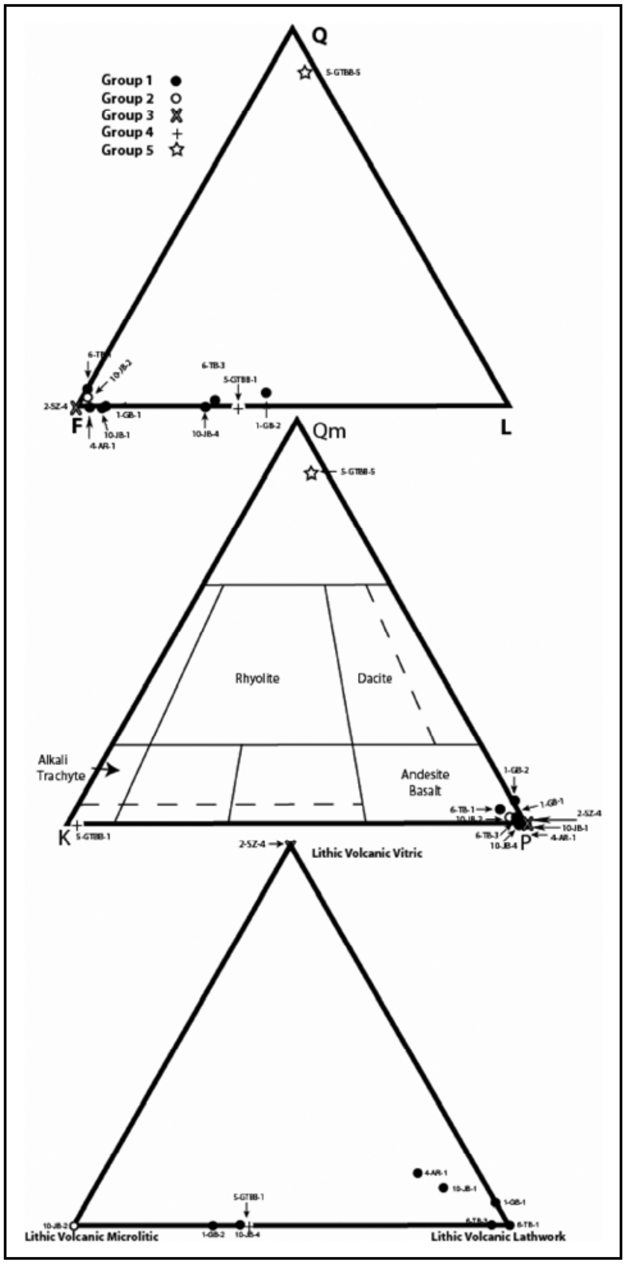

Figure 3. This series of ternary plots illustrates some of the compositional variability of the temper groups pictured in Figure 2 and discussed in the text. Top is a QFL ternary plot where Q= total quartz grains, F = total feldspar grains, L = total lithic or rock fragments. Note that in the case of these temper samples the lithics are all of volcanic origin. This plot best discriminates the quartzose Group 5 from the other groups. Middle is a QmKP ternary plot where Qm = monocrystalline quartz, K = potassium feldspar, and P = plagioclase feldspar with fields after LeMaitre (1989). This ternary discriminates Groups 4 and 5 from the other groups. Bottom is a ternary plot of different volcanic lithic groups, those with vitric (glassy), microlitic and lathwork textures. This illustrates lithic texture variability within Group 1 samples. These are the standard plots used in sand provenance studies, and so do not completely discriminate the five groups because they do not include key components such as dense minerals, carbonate, or grog. For example, the placer group (3) which is dominated by dense minerals shows significant overlap with the other groups.

along the Lesser Antilles chain (Van Soest et al. 2002)

The Group 4 temper is likely volcanic, but with anomalously high potassium feldspar content. In the Caribbean, such potassium-rich rocks have only been described in the literature in hydrothermally altered igneous rocks from Puerto Rico (e.g., Pease 1976). This does not preclude a local, here-to-fore undocumented source on one of the Lesser Antilles volcanic islands.

The high quartz content of the Group 5 temper (single sample) implies a continental rather than a magmatic arc source. Interestingly the island of Barbados is partly constructed of quartzose sediments shed off the South American continent into the Atlantic Ocean basin and then scraped off during the subduction process that has produced the Lesser Antilles magmatic arc (Kasper and Larue 1986). This accretionary prism has grown to the surface and outcrops of such quartzose sediments are present on Barbados, which have and still serve as temper sources for potters (Drewett and Fitzpatrick 2000). Alternatively, the temper could be from the parent South American source. Unfortunately, the two Great Bretache Bay samples were part of Suite 1 and thus not analyzed with INAA, which might give us a better indication of whether it was part of one of the two main compositional groups identified chemically. Furthermore, given that only one sample with this temper type was found and it was a surface find, there is also the possibility that it represents an historic/modern fragment. In sum, the temper compositions suggest that all of the sherds from Carriacou appear to have been produced outside of Carriacou and imported to the island.

INAA

Exploratory data analyses of the 56 sherds from Suite 2 were conducted on 33 elemental abundance measurements before identifying compositional groups (elemental concentrations of nickel were removed from subsequent analyses due to low detection limits). Of the 33 elements, thorium, potassium, rubidium, cesium, and antimony created the most variance between groupings. A two-group structure was identified in the ceramic specimens: Group 1 (n=30) and Group 2 (n=16). The compositional groups can be graphically represented in principal component space (Figures 4 and 5) and in elemental space (Figure 6). Statistical tests based on Mahalanobis distance-derived probabilities using eight principal components were conducted subsuming 90.7% of the total variance (see Tables 5–8) to support the graphical representation of the group structure (Figures 4–6). A cut-off of 1% was generally used to refine the membership of Groups 1 and 2. However, exceptions were made based on the graphical representation of the data. Ten specimens (18%) could not be assigned to any of the identified compositional groups (Figures 5 and 6; Table 8). It is highly probable that analyzing more samples could identify additional compositional groups more clearly in the Carriacou ceramic assemblage.

Chemical characteristics for the compositional groups are represented in Figure 4. Relative to Group 2, Group 1 clearly has elevated concentrations of antimony, dysprosium, and ytterbium. Antimony is a semi-metal whereas the other several are rare earth elements. Antimony can be enriched in soils developed on volcanic materials (e.g., Terashima et al. 2002). Group 2, on the other hand, is enriched in several rare earth elements, an actinide, and a transition metal (that is Cs, La, Th, and Ta), when compared to Group 1. Within the St. Vincent rocks, feldspar phenocrysts contain much less Th (~10%) as compared to the volcanic groundmass (Heath et al. 1998a). Thus, some of the temper chemical variation could be explained by different proportions of glassy groundmass versus plagioclase crystals in sherd tempers. Furthermore, this suggests that soils developed on more glass-rich units might contain higher Th concentrations than those developed on plagioclase-rich units. Additional chemical analyses of sherd paste and temper components are needed to clarify these relationships.

Given the relatively small sample size, only tentative statements can be made about the relationship between the provenance of the sherds and their group assignments (see Table 8). Interestingly, the Grand Bay site has almost equal amounts of both compositional types. Another possibly significant observation is that only Group 1 ceramics were collected from the sites of Dover, Lauriston, and Sabazan, while Jew Bay only has compositional Group 2 ceramics. However, these distributions do not appear to be geologically constrained (i.e., based on site location within a particular geological formation). Finally, the Troumassan sherds with potassic tempers (SMF047, SMF055) do show unusual chemistries and fall outside the compositional range of the INAA Groups 1 and 2.

In sum, INAA of the 56 samples has identified two distinct ceramic compositional

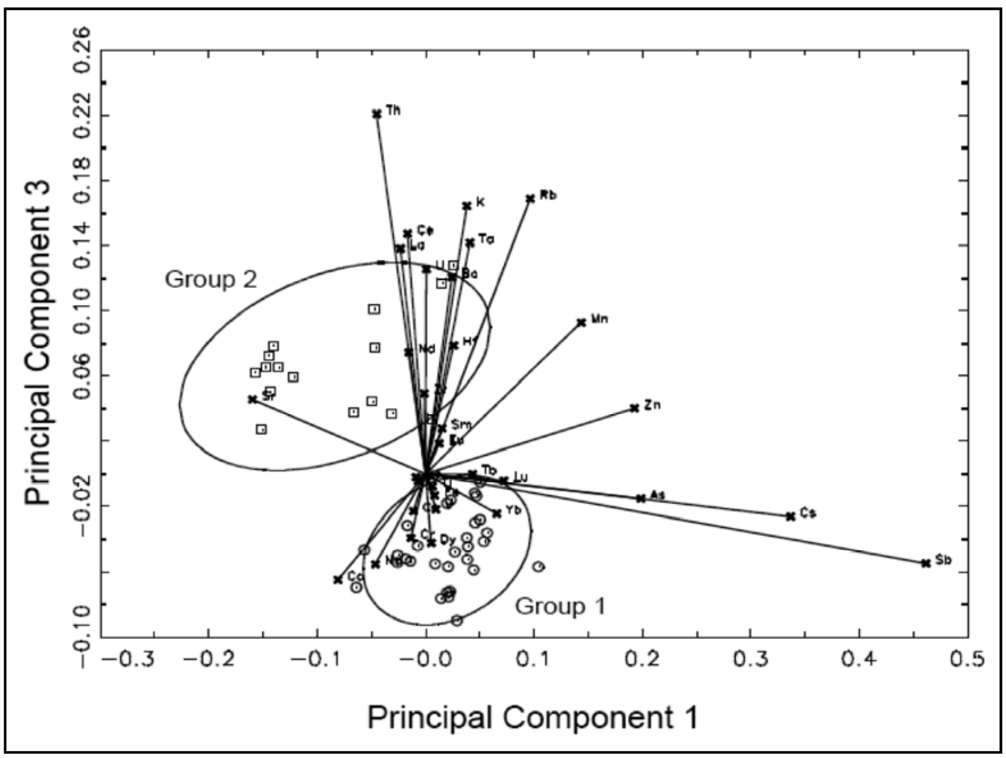

Figure 4. Bivariate plot of principal components 1 and 3 displaying two compositional groups. Ellipses represent 90% confidence level for membership in the groups. Vectors denote elemental influences on the ceramic data. Unassigned specimens are not shown.

Table 4. Principal components analysis of 56 specimens. Simultaneous R-Q factor analysis based on variance-covariance

PC	***Eigenvalue***	***%Variance***	***Cum. %Var.***
1	0.4868	32.4368	32.4368
2	0.3097	20.6338	53.0705
3	0.2395	15.9603	69.0308
4	0.0938	6.2468	75.2776
5	0.0754	5.0249	80.3025
6	0.0605	4.0321	84.3346
7	0.0500	3.3312	87.6658
8	0.0457	3.0464	90.7122
9	0.0252	1.6769	92.3891
10	0.0233	1.5510	93.9401
11	0.0181	1.2067	95.1468
12	0.0159	1.0570	96.2038
13	0.0114	0.7624	96.9661
14	0.0105	0.6986	97.6647
15	0.0081	0.5397	98.2044
16	0.0059	0.3947	98.5992
17	0.0046	0.3039	98.9031
18	0.0035	0.2359	99.1390
19	0.0034	0.2275	99.3665
20	0.0021	0.1366	99.5032
21	0.0019	0.1241	99.6272
22	0.0012	0.0796	99.7068
23	0.0011	0.0712	99.7780
24	0.0009	0.0633	99.8413
25	0.0006	0.0409	99.8822
26	0.0005	0.0337	99.9159
27	0.0004	0.0277	99.9436
28	0.0003	0.0183	99.9619
29	0.0002	0.0140	99.9759
30	0.0002	0.0115	99.9873
31	0.0001	0.0088	99.9961
32	0.0001	0.0039	100.0000

Table 5. Mahalanobis distance calculated probabilities and posterior classification for compositional Group 1 members. Eight principal components were used. Probabilities are jackknifed for specimens included in each group.

ID. NO.	***Group 1***	***Group 2***
SMF001	84.322	2.143
SMF005	88.743	1.224
SMF006	94.633	2.335
SMF007	17.885	0.104
SMF008	35.883	0.523
SMF009	28.550	0.694
SMF017	53.663	3.327
SMF020	44.278	3.244
SMF022	99.172	1.422
SMF023	14.475	0.303
SMF027	52.882	2.843
SMF028	74.355	0.244
SMF029	96.047	0.777
SMF030	19.257	0.117
SMF031	77.422	0.950
SMF033	28.140	3.970
SMF034	4.634	0.914
SMF035	35.558	2.375
SMF037	48.573	1.747
SMF038	7.878	0.328
SMF039	25.094	0.466
SMF040	86.945	1.037
SMF041	53.455	0.349
SMF042	2.478	0.533
SMF043	90.214	0.463
SMF044	10.815	0.020
SMF046	51.148	1.051
SMF049	26.230	1.004
SMF053	47.917	0.091
SMF054	82.972	2.220

Table 6. Mahalanobis distance calculated probabilities and posterior classification for compositional Group 2 members. Eight principal components were used. Probabilities are jackknifed for specimens included in each group.

ID. NO.	*Group 1*	*Group 2*
SMF002	0.000	78.209
SMF003	0.000	55.485
SMF004	0.000	87.512
SMF011	0.000	26.309
SMF012	0.000	97.785
SMF013	0.000	16.903
SMF014	0.000	47.163
SMF015	0.000	70.300
SMF018	0.000	59.265
SMF019	0.000	4.147
SMF024	0.000	81.479
SMF025	0.000	84.574
SMF026	0.000	31.292
SMF036	0.000	37.114
SMF050	0.000	1.010
SMF056	0.000	31.923

groups. Possible tendencies or associations between the chemical compositions of the sherds and their site provenance were found. The submission of more samples from these contexts could further test these identified patterns as well as delineate more groups (7 of the 10 unassigned samples clearly have no affinity with the two compositional groups) and subgroups. Determining whether the identified compositional groups refer to local or exotic sources will require either the chemical analysis of raw clay samples or the mineralogical analysis of raw clay samples and ceramics.

Discussion and Conclusions

Thin-section petrography (n=78) and INAA (n=56) of two suites of ceramic sherds from archaeological sites on Carriacou suggest that pottery was made from primarily or even

Table 7. Mahalanobis distance calculated probabilities and posterior classification for unassigned members into compositional Groups 1 and 2. Eight principal components are used.

ID. NO.	*Group 1*	*Group 2*
SMF010	0.000	0.000
SMF016	0.000	0.001
SMF021	40.016	8.913
SMF032	0.000	0.168
SMF045	0.148	0.540
SMF047	0.000	0.000
SMF048	0.002	0.166
SMF051	0.000	0.001
SMF052	0.000	0.000
SMF055	0.000	0.839

exclusively exotic materials using volcanic sand as temper with minor amounts of carbonate and/or grog. The Quartzose and Potassic groups suggests that some samples may have tempers possibly derived from quartzose outcrops on Barbados and potassic outcrops on Puerto Rico. The identification of two major chemical groups using INAA is not suggestive of Carriacouan pottery having either a local or exotic source; at least 10 of the 56 (17.8%) samples in Suite 2 are outliers that could not be assigned to either compositional group, perhaps indicating that they were produced and transported from another source. Four of the five sherds from Petite Martinique analyzed with INAA fell into compositionally defined groups (n=3 [Group 1]; n=1 [Group 2]), indicating that inter-island transfer of ceramics was occurring at least on a local scale.

Only 14 of the sherds from both suites were stylistically identified; of these, none appear to fall into any compositional pattern based on temporality or cultural design, with both early (Saladoid), middle (Troumassan Troumassoid), and late (Suazan

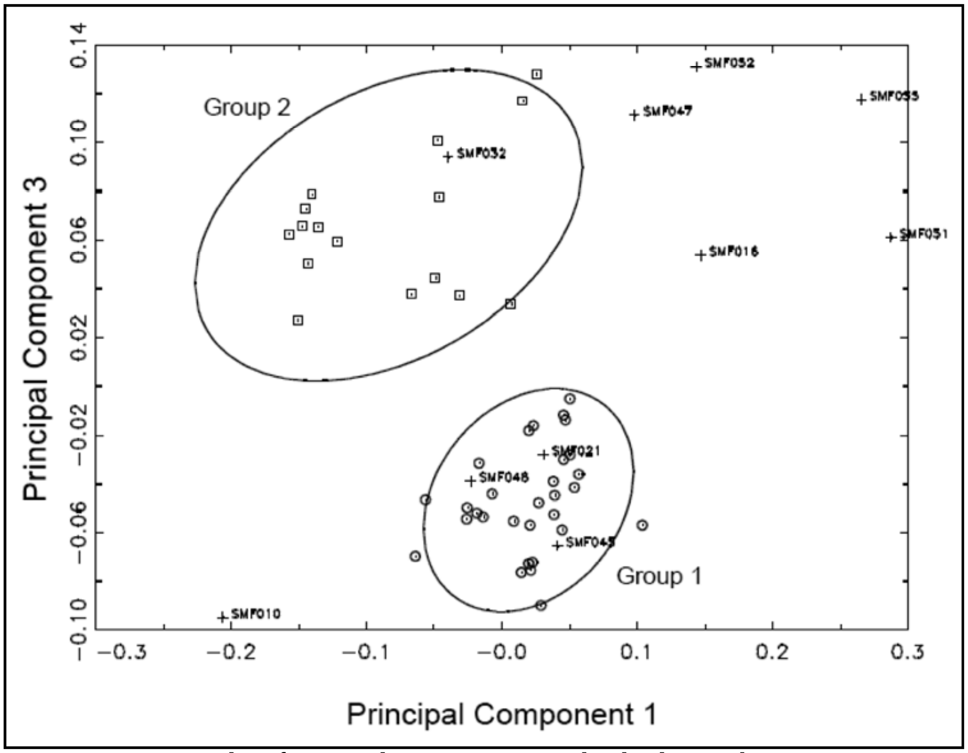

Figure 5. Bivariate plot of principal components 1 and 3 displaying the two compositional groups and labeled unassigned specimens (+). Ellipses represent 90% confidence level for membership in the groups.

Table 8. Compositional group assignments and site provenience.

Site	*Group 1*	*Group 2*	*Unassigned*
Dover	1	0	0
Grand Bay	9	11	3
Jew Bay	0	2	0
Lauriston	5	0	0
Sabazan	5	0	0
Sparrow Bay	5	1	4
St. Louis	0	0	1
Tyrrel Bay	2	1	1
Petite Martinique	3	1	1
Total	30	16	10

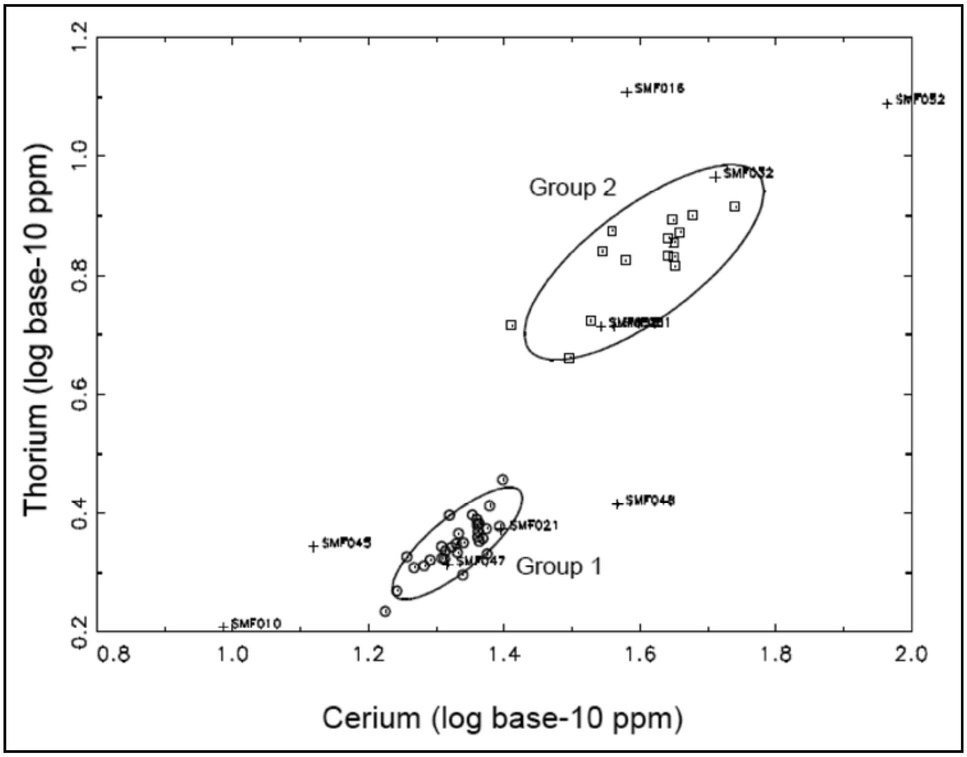

Figure 6. Bivariate plot of base-10 logged cerium and thorium concentrations showing the chemical distinctiveness of the two compositional groups. Ellipses represent 90% confidence level for membership in the groups. Unclassified samples (+) are labeled.

Troumassoid) periods falling into Group 1 using either petrography or INAA, for example. This could indicate that there was little preference by prehistoric potters in seeking out specific clay or temper resources. It is interesting to note, however, that all sherds from Sabazan and Lauriston in Suite 2, as well as the four Saladoid samples, fell into the same petrographic and INAA groups (as did four out of the five Sabazan sherds analyzed petrographically in Suite 1; Saladoid sample SMF051 could not be grouped using INAA). It is also notable that three of the six Jew Bay samples present in both Suites 1 (n=4) and 2 (n=2) fell into petrographic Group 2, of which only six are known from the total number of sherds analyzed. Whether these represent real cultural preferences for potting is unknown.

Although the results are preliminary, thin-section petrography, used in conjunction with INAA, has provided a means for explaining how ceramics were manufactured prehistorically, the compositional diversity of geological materials used in production, and the differences between sherds found at various archaeological sites. QFL and QmKP ternary plots suggest that there are at least five different possible sources of material, most of which appear to be exotic. INAA suggests two main chemical groups. However, these observations will have to be confirmed by additional testing of these and other sherds. Without more information, if the ceramics were made using non-local resources, it would appear at this stage to signify two distinct clay sources. Alternatively, the geochemical groupings may be related to the chemistry of the volcanic temper components.

Research now in progress is focused on petrographically analyzing the INAA suite of sherds in more detail and comparing the geochemisty from sherds and source material from lavas and volcanic centers in the Lesser Antilles. This will allow us to infer whether the exotic sherds are anomalous or are a ubiquitous component to sherd suites from archaeological sites on Carriacou. The analysis should also help us test models of interisland interaction between Carriacouan groups and those on other islands. The preliminary data now suggests that all of the sherds within the total Carriacou sherd suite could be exotic, suggesting that movement of these artifacts was widespread. This phenomenon is not unheard of in the Caribbean. Cordell (1998), for example, estimated that all of the pottery found at the Coralie site (GT-3) on Grand Turk, in the Ostionan style dating from AD 700–1100, was imported from Hispaniola nearly 200 km away. In addition, three ceramic inhaling bowls (one recovered from deposits at Grand Bay dating between ca. AD 1000–1300 and two unprovenienced from the Carriacou Historical Society Museum) were dated with luminescence to 430 ± 192 BC (weighted average). This is several hundred years older than the earliest ^{14}C dates of ca. AD 400 from the island, suggesting that they may have been heirlooms transported from elsewhere. This hypothesis is supported by petographic analysis which shows that these samples were likely produced with non-local materials, and luminescence dating of two diagnostic sherds recovered from stratified deposits at Grand Bay that overlap with the existing radiocarbon chronology (Fitzpatrick et al. n.d.).

Further examination of sherds that are stylistically identifiable, versus undiagnostic (which provided the bulk of samples used in this study) will be critical for testing whether Carriacou, or some communities within, had greater access to imported goods versus others and if these varied through time.

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COMPOSITIONAL ANALYSIS OF FRENCH COLONIAL CERAMICS: IMPLICATIONS FOR UNDERSTANDING TRADE AND EXCHANGE

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There is a considerable literature that explores the significance of low-fired earthenware production as a component of African Diaspora identity creation and maintenance both in the West Indies and in the American Southeast. Yet very little analysis has gone into understanding the role of industrially-produced, low-fired, earthenware ceramics in the Caribbean. We believe that these ceramics may be an overlooked archaeological resource. Although they do not typically reflect the fairly rapid changes in style that make European ceramics useful for chronology building, and whereas they do not usually exhibit stylistic and morphological variations that enable clear identification of their origin, they were produced in great quantity and transported around the West Indies to serve a wide variety of uses. We suggest that industrially-produced, low-fired, earthenwares may provide us with more information than simply their functional purpose. They may also prove useful as a key aspect of material culture to aid in the reconstruction of trade and interaction patterns, dependant, of course on being able to identify the place of origin of these ceramics. This article discusses compositional analysis of archaeological ceramics and wasters (poorly fired ceramics) recovered from historic kiln sites on the islands of Martinique and the Guadeloupe Archipelago. Compositional data from kiln sites are then compared to ceramic sherds from excavated domestic contexts elsewhere on these islands to begin to reconstruct trade and exchange patterns during the French Colonial period. The results from these analyses not only point to expected routes of trade, but also routes which contravened colonial boundaries.

Historical archaeologists, ethnoarchaeologists, and ethnographers of material culture have documented the presence and persistence of low-fired earthenware traditions on many islands of the West Indies. Present day earthenware production is known from islands with colonial histories as diverse as St. Lucia, Martinique, Nevis, St. Kitts, and Jamaica (Beuze 1990; Ebanks 1984, 2000; England 1994; Heath 1988; Hoffman and Bright 2004). Low-fired earthenware also is known archaeologically from these islands, as well as Antigua, St. Croix, Montserrat, and St. Martin (Gartley 1979; Handler 1963, 1964; Heath 1990; Petersen et al. 1999). These low-fired earthenwares have been studied by a number of scholars who have viewed their production and use as aspects of identity creation and resistance throughout African Diaspora related sites in the West Indies and the Southeast United States (e.g., Crane 1993; Ebanks 1984; England 1994; Ferguson 1992; Hauser and Armstrong 1999; Hauser and DeCorse 2003; Heath 1988; Mathewson 1972; Mouer et al. 1999; Petersen et al. 1999;). However, an extensive (indeed probably outnumbering hand-built ceramics) and potentially very important subset of low-fired earthenware production has generally been overlooked in archaeological investigations of the plantation-era West Indies. These wares, produced industrially in the Caribbean, include sugar cones, drip pots, and other "industrial" ceramics used in the plantation economies, as well as other forms, and are typically seen as evidence of the production of sugar. This stands in contrast to hand-built wares that are usually seen as a product of African inspired cultural resilience and creativity. In this article we explore how these industrially produced low-fired ceramics may be able to yield evidence of their origin through compositional analysis that will allow archaeologists to use them to address anthropological questions of trade and interaction rather than mere function.

This project originated as one of us (Kelly) was recovering large quantities of low-fired, but apparently industrially produced wares (wheel-thrown, controlled firing, etc.) from excavations at two plantation sites on Guadeloupe (Kelly and Gibson 2005). The sherds are similar to those observed on the surface at two known pottery production sites on the island. However, it was impossible to ascertain their origin because they lacked any distinguishing characteristics. We later discussed this problem, and developed a research plan to attempt sourcing sherds through petrographic analysis of thin sections. We were subsequently approached by Christophe Descantes and invited to participate in a region-wide survey of ceramics using instrumental neutron activation analysis (INAA) which was supported by the University of Missouri Research Reactor Center (MURR). This allowed us to expand our samples and begin addressing broader questions regarding provenience and manufacture of ceramics.

In 2004, we began this study of ceramic production in the French West Indies by collecting ceramic sherds from as many historic pottery production sites as we could find on the islands of Guadeloupe and Martinique. Although some sites were little more than large waster heaps associated with historically documented pottery production sites, others were very impressive with substantial standing remains. Of these, the Fidelin kiln on Terre de Bas, Les Saintes (a small island in the southern portion of the Guadeloupe archipelago, between Guadeloupe and Dominica) where there is a

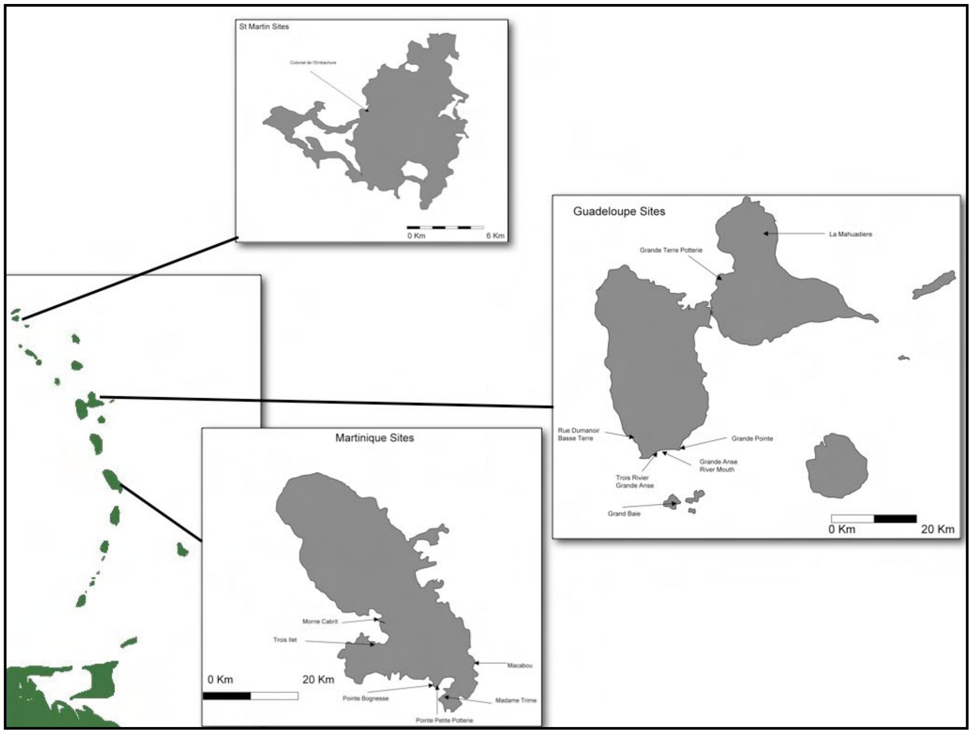

Figure 1. Sampled sites in Martinique, Guadeloupe, and St Martin.

double-chamber kiln, each chamber of which measures about 4 m square, and the still-active pottery at Trois Ilets, Martinique, are most notable. The sherds collected from eight production sites (three on Guadeloupe, five on Martinique) were augmented by sherds excavated from two plantation sites on Guadeloupe, an urban site in Basse Terre, Guadeloupe, a surface collection from the island of St. Martin, and sherds of modern production in St. Anne, Martinique (Figure 1). In most cases these sherds were remains of industrial pottery vessels such as sugar drip jars and sugar cones, although some domestic wares such as cooking and serving vessels and pitchers were included as well. These samples were analyzed by INAA and optical thin-section petrography to identify chemical, mineralogical, and physical composition properties.

Context

Although locally- and regionally-produced ceramics in the Caribbean have been studied by a number of scholars (see Crane 1993; Ebanks 1984, 2002; Handler 1963; 1964; Hauser and Armstrong 1999; Hauser and DeCorse 2003; Heath 1988; Mathewson 1972; McCusick 1960; Petersen et al. 1999; Vérin 1963), few have systematically catalogued and completed compositional studies of these wares. During the eighteenth and nineteenth centuries, local earthenwares were manufactured at scales of both craft and industrial production as utilitarian household wares for use by enslaved laborers and others, and industrially as vessels used in the processing and storing of sugar in the plantation industries. Among the few compositional studies that have been undertaken of either hand-built or wheel-thrown earthenwares are those of Brian Crane (1993), who analyzed a set of *Criollo* wares recovered from San Juan, Puerto Rico using INAA in 1992; Mark Hauser (2001) who completed petrographic analysis on similar ceramics called *Yabbas* in Jamaica in 2001; and James Petersen and David Watters (1988; see also Watters 1997) who petrographically analyzed ceramics from Barbuda and Montserrat. However, none of these studies have been integrated to consider regional interaction spheres between neighboring islands.

Excavations from the French West Indies (see Figure 1) have also produced a series of local coarse earthenware. In Martinique, Suzannah England (1994) completed a dissertation on a ceramic production site near Trois Ilets at Habitation Vatable, in which she used formal characteristics to define wares. In Guadeloupe, Isabelle Gabriel (2003) conducted test excavations at the Fidelin kiln site at Grande Baie on the island of Terre de Bas, Les Saintes (Figure 2). Gabriel's (2003) excavations produced a large number of ceramic sherds, but they have not been analyzed in any detailed or systematic fashion. Hauser (2001) and Mathew Reeves (1997) have both inferred that evidence of glazing on earthenware ceramics recovered from Jamaica indicates the use of kilns in their manufacture, but the production sites themselves remain unknown. Therefore, the identification of the kiln sites on Guadeloupe and Martinique used to produce utilitarian wares is archaeologically unique in the historic Caribbean, but remains understudied in the French Antilles. We hope that analysis of the ceramics from this French industry can be used to help understand distribution systems and compositional characteristics of local earthenware production in the Caribbean.

Figure 2. Fidelin Kiln, Grande Baie, Les Saintes, Guadeloupe, 2005.

Figure 3. Industrial ceramics used in sugar processing. Diderot Vol 18, Oeconomie rustique, Sucrerie.

The Ceramics

Here, we examine three types of ceramics recovered from the surface collections at kiln sites and from excavations on Guadeloupe and Martinique. The first ceramic type is related to the industrial processing of sugar and is shown in this contemporary illustration (Figure 3). These ceramics (Figure 4) are a thick-walled, wheel-thrown earthenware. The paste is coarse, orange-red, and contains large grog, limestone, and detrital inclusions. The surfaces are untreated. These ceramics are found in forms that include drip jars (Figure 3, lower ceramic) and sugar cones (Figure 3, upper ceramic).

The second type of ceramic (Figure 5) is a utilitarian ware associated with household cooking and serving. They also appear to be wheel-thrown and are thin-walled. The paste is coarse, reddish brown and contains felspathic detrital inclusions and limestone. These ceramics are smoothed and treated with a red slip, and cores indicative of an oxidizing environment are present on the majority of this type. With both types there appears to be variation in the texture of the paste and the nature of the visible inclusions dependent upon from which kiln the surface collection was obtained. These ceramics have also been recovered in archaeological excavations at La Mahaudière and Grande Pointe by one of the authors (Kelly) and also salvaged from construction sites in Basse Terre and St. Martin by Antoine Chancerel and Christian Stouvenot (pers. comm. 2005).

The third ceramic type is a hand-built ceramic similar to those described by Lyn-Rose Beuze (1990) in her ethnographic description of the potter Madame Trime in the Commune of Sainte Anne in Martinique (Figure 6). This is a coil-made, thick-walled ceramic. The surfaces are evened and smoothed using a scraper and a rag (Beuze 1990). The highly variable cores in the ceramic paste, and the surface clouding indicate that the ceramics were fired in an oxidizing and relatively uncontrolled environment, probably fired in an open pit (Rye 1981:116). The ceramics are both slipped and burnished. Seven forms of this type are identified by Vérin (1960) using créole nomenclature including “Terrine”, “Canari”, “Tesson”, “Kastol”, “le Leshwit”, “Krish”, “Jé”, “Shodie”, “Plate” and “Potaflé”. An eighth form described by Madame Trime is the Coco Nèg’ (Beuze 1990:42–43; pers. comm. 2005). We collected several wasters from Madame Trimes' house yard in Ste. Anne. Archaeological examples of this kind of pottery were collected from La Mahaudière and Grande Pointe in Guadeloupe, and surface collections in Martinique.

Methods

The ceramic sherds from Guadeloupe and Martinique used for the study included surface collections from known or hypothesized kiln sites, sherds excavated from sugar plantation slave village contexts, material from urban salvage excavations, and waster sherds from the last remaining traditional earthenware maker in Martinique. These samples were augmented by surface-collected sherds from St. Martin, a French island and dependency, 250 km to the north of Guadeloupe. We also selected samples from a diverse array of geological environments, ranging from southern Martinique to Les Saintes, Guadeloupe, and

Figure 4. Sugar cone recovered from River Mouth Grand Anse, Basse Terre, Guadeloupe. Note the “F” on the base of the cone, which represents the Fidelin Kiln.

Figure 5. Wheel-thrown utilitarian ceramics recovered from Grande Pointe, Basse Terre, Guadeloupe.

Figure 6. Ethnographic examples of hand-built utilitarian ceramics manufactured by Madame M. Trime, Ste. Anne, Martinique, 2007.

St. Martin. The specific context of each collection is discussed below.

Surface Collections

Guadeloupe Kiln Sites

Fidelin Kiln, Grande Baie, Terre de Bas, Les Saintes. These sherds were collected from the surface of a very large industrial-scale operation active on Terre de Bas during the eighteenth and nineteenth centuries (Gabriel 2003). The sherds were primarily from forms that are associated with sugar production (e.g., sugar cones, drip jars), but also included some forms that were probably produced for domestic use (open pots of various sizes).

Kiln site, Grande Anse, Trois Rivières, Guadeloupe. These sherds were collected on the surface from what remains of a large waster heap that is now eroding into the sea and partially destroyed by the modern coastal road. The waster heap is the only visible portion of the production site; any kiln remains are either gone or hidden by vegetation in private lands that were not accessible. The site dates to the eighteenth and possibly the nineteenth century. It is located approximately 100 m west of the Grande Anse beach parking lot.

Kiln site, River mouth, Pointe de la Grande Anse, Trois Rivières, Guadeloupe. These sherds were collected on the surface from an extensive waster deposit surrounding the ruins of a single chamber kiln about 20 m west of the Rivière de la Grande Anse, and about 150 m from the ocean near the parking area for the municipal swimming pool. This site probably dates to the eighteenth and nineteenth century.

Martinique Kiln Sites

Kiln site, Morne Cabrit, Lamentin, Martinique. These sherds were collected on the surface from a waster deposit adjacent to the kiln chamber ruins at the south end of Morne Cabrit, a small rocky island in the mangrove swamps of the east end of the Baie de Fort de France. The island, currently used as a yacht club, contains the ruins of a large eighteenth century house on the north end which may have been the owner's house. The site is noted as a *Habitation Poterie* (pottery production estate) on the *Carte de Moreau du Temple* map (Bousquet-Bressolier et al. 1998), dating to the 1760s.

Habitation La Poterie, Trois Ilets, Martinique. These sherds were collected on the surface from the area surrounding the slave village of the Habitation La Poterie, a large pottery production estate. The sherds date to the eighteenth and nineteenth century. The kiln area is no longer present, as modern production has completely eradicated the earlier kilns. The site is noted as a *Habitation Poterie* on the *Carte de Moreau du Temple* (Bousquet-Bressolier et al. 1998), dating to the 1760s.

Pointe Borgnesse, Le Marin, Martinique. These sherds were collected on the surface from waster accumulations adjacent to the kiln chamber of this large pottery production complex. The complex is on the coast and literally built on beach sand. The site is noted as a *Habitation Poterie* on the *Carte de Moreau du Temple* (Bousquet-Bressolier et al. 1998) map, dating to the 1760s.

Pointe Petite Poterie, Le Marin, Martinique. These samples were collected adjacent to the ruins of the kiln structure, approximately 100 m from the sea. The site is described as an *Habitation Poterie* on the *Carte de Moreau du Temple* (Bousquet-

Bressolier et al. 1998) map, dating to the 1760s.

Macabou, Le Vauclin, Martinique. These sherds were collected from the surface of a site at the mouth of the bay among the mangroves. The site has Amerindian material on the surface, including faunal remains, so it is possible that it was not used to produce historic era pottery. The sherds from this site were distinct due to the presence of shell temper and were included based upon suggestion of the then-Conservator of Archaeology for Martinique, Olivier Kayser, because there may have been a kiln site there. Furthermore, we felt that if the sherds were Amerindian, they would provide a useful alternate sample for the petrography and the INAA because of different production techniques and inclusions, such as shell temper.

Excavated or Non-Production Samples

Habitation La Mahaudière, Anse Bertrand, Guadeloupe. These sherds came from excavated contexts dating to the late eighteenth and nineteenth century slave and laborer village site associated with a large sugar plantation.

Habitation Grande Pointe, Trois Rivières, Guadeloupe. These sherds were excavated from the late eighteenth to mid nineteenth century slave village site associated with a sugar plantation.

Rue Dumanoir, Basse Terre, Guadeloupe. These sherds were part of two nearly complete pitchers or carafes and a globular pot salvaged by Antoine Chancerel, then Conservator for Archaeology in Guadeloupe, from a pipeline excavation along Rue Dumanoir in the historic (seventeenth to nineteenth centuries) center of the city of Basse Terre, administrative capital of Guadeloupe. This sample was included because it resembled some very small fragments found at La Mahaudière and Grande Pointe and because they bore a strong morphological resemblance to water carafes traditionally produced in Martinique and visible on display in the Ecomusée de la Martinique, Rivière Pilote.

Colonial de l'Embachure, Saint Martin, Guadeloupe. These sherds were obtained from an assemblage of between four to six nearly complete large pots that were found cached under a rock shelter on the side of one of the principle hills of the French portion of St. Martin. Other artifacts recorded with the earthenware pots suggested a late eighteenth or early nineteenth century date to the assemblage. The site has no known association with any recorded historic habitation and may represent an intentionally hidden place of refuge. The sherds were included because they were the only samples available from the island of St. Martin, a dependency of Guadeloupe.

Château Dubuc, La Trinité, Martinique. These sherds were surface collected from the eighteenth to mid-nineteenth century sugar plantation.

Ethnographic Collection

Madame Trime, St. Anne, Martinique. These sherds were donated to our project by Madame Trime, a potter active in St. Anne. Madame Trime is believed to be the last potter working in Martinique who continues to use traditional methods, including hand building and open firing to produce earthenwares.

INAA and Petrographic Methods

As Mason and Keal (1988) have pointed out in south Yemen and Jordan and Schrire and Miller (1999) have demonstrated in South Africa, ceramic petrography can detail the economic relationship between imported ceramics and local pottery traditions. We employed both petrography and INAA on a sample of archaeological and ethnographic ceramic sherds recovered from the above-mentioned sites in order to discern the relative homogeneity and heterogeneity of recipes employed by potters in the production of pottery in the eighteenth century. In this analysis we were interested in assessing both the compositional similarity of ceramic materials from different proveniences as well as discerning any differences in processes associated with manufacture. INAA has a long history of successfully utilizing these analytical means to characterize and identify the provenance of archaeologically recovered materials (e.g., Hegmon et al. 1997; Hoard et al. 1993; Steponaitis et al. 1996). Thin-section petrography is a widely used technique to assess the compositional heterogeneity of detrital inclusions, added temper and the paste within the matrix of a ceramic vessel (e.g., Jordan et al. 1999; Mason and Keal 1988; Stoltman 1989). In tandem, these techniques enable researchers to develop a recipe of ceramic sherds and gain better understanding of the source materials used in manufacturing pottery including the weathering and petrogenesis of clay and tempering materials (e.g., Hegmon et al. 1997:455; Hill et al. 2004; Mandal 1997).

Our study comprised 56 ceramic sherds which were analyzed petrographically. These included samples that were hand-built utilitarian ceramics (n=17), wheel-thrown utilitarian ceramics (n=20), industrial ceramics (n=18), and pre-Columbian ceramic (n=1). We subjected fifty of these sherds to INAA (See Table 1). Initial sample preparation occurred at the Field Museum of Natural History, Island Archaeology Lab. Sherds were cut along the vertical axis of the pottery using a slow saw.

Fifty six samples were sent for sample preparation to Arizona Quality Thin Sections in Tucson, Arizona. Following standard techniques of sample preparation in ceramic petrography, these samples were vacuum impregnated with epoxy, mounted on a 46 mm slide and finished to a 30 micron thickness. All thin sections were analyzed using Brunell XP-201 polarizing light microscope and mechanical stage. Relative abundance of constituent materials was established by employing an areal count technique discussed by Velde and Druc (1999:232) using a 10 mm counting reticule under 40x magnification. Although Chayes has argued that this technique enables a fairly accurate measure of constituent materials (Chayes 1956, 1955 cited in Stoltman 1989:146), the size of larger inclusions exceeded the 0.5 mm grid of the counting reticule. We therefore took the estimations to be only semi-quantitative. We paid specific attention to identifying mineral inclusions within the clay matrix noting size, angularity, relationship with other mineral inclusions, chemical, and mechanical alteration. The relative abundance of specific minerals and their texture provide some indication of the potential geological maturity of the source materials. Fifty of the sampled sherds were sent to MURR and prepared for INAA under the direction of Michael D. Glascock and Christophe Descantes according to a standard set of procedures (Glascock 1992). By use of two irradiations and three measurements, a total of 33 elements were measured by INAA. Descantes conducted the data reduction and employed principle components analysis to identify compositional clusters.

Results

Instrumental Neutron Activation Analysis

Before identifying compositional groups, exploratory data analyses were conducted on the thirty-three elemental abundance measurements. The elemental concentration of nickel (Ni) was dropped from subsequent analyses because many of the samples were below the detection limits. In addition two specimens, GUA037 and GUA045, were excluded from further analyses because of unusually high concentrations of metal that likely result from contamination of the samples. Specimen GUA037 had excessive concentrations in calcium, cesium, nickel, and the rare earth elements; specimen GUA045 exhibited an uncharacteristically high concentration of arsenic.

A three-group structure was identified among the ceramic specimens: Group 1 (n = 19), Group 2 (n = 16), and Group 3 (n = 4). The compositional groups can be graphically represented in principal component space (Figures 7 and 8) and in elemental space (Figure 9). Statistical tests based on Mahalanobis distance-derived probabilities using nine principal components (that is 90.5% of the cumulative variance) support the graphical representation illustrating the group structure. A cut-off of 1% was generally used to refine the membership of Groups 1 and 2; however, exceptions were made because of the low numbers of samples in each of the compositional groups. The small membership size of compositional Group 3 precluded a robust statistical test of its validity. We therefore tested the probability of its samples having membership in Groups 1 and 2. The elevated statistical probability that specimen GUA019 has membership in Group 2 is anomalous and is partly due to the heterogeneous nature of compositional Group 2. Upon closer inspection (e.g., Figure 9), we decided to identify GUA019 as an unassigned sample. Nine specimens (19%) could not be assigned to any of the three compositional groups (Figures 8–9).

The chemical characteristics describing the compositional groups are the following (see Figure 7): Group 1, in relation to Groups 2 and 3 has elevated concentrations of manganese, rubidium, and the rare earth elements. Group 2, on the other hand, is enriched in the transition metals chromium, iron, antimony, scandium, titanium, and vanadium, relative to the other compositional groups. Compositional Group 3 is enriched in the transition metal element of cobalt and the alkali earth metal element of strontium. Finally, Group 1 is chemically more homogenous, whereas Groups 2 and 3 are somewhat more diverse. It is possible that analyses of additional samples would allow us to identify subgroups within the three compositional groups or assign more of the unknown specimens to one of the established groups.

Tendencies and patterns can be found when comparing the archaeological attributes of the data belonging in the three compositional groups. Sampling issues aside, the ceramic specimens from six of the thirteen sites (River Mouth Grande Anse, Trois Rivières Grande Anse, Grande Baie, La Mahaudière, Grande Pointe, and Rue Dumanoir), have membership in a single compositional group (Group 1). All but one sample of industrial ceramics collected from Guadeloupe belonged to compositional Group 1. The same pattern exists for the wheel thrown utilitarian ceramic. Only one hand-built pot belongs to this group. Ceramic specimens from six sites (Pointe Petite Poterie, Point

Table 1. Samples analyzed

Site	Site Type	Hand-Built Utilitarian Ceramics		Wheel-Thrown Utilitarian Ceramics		Industrial Pottery		Amerindian		Grand Total	
		Petrog.	INAA	Petrog.	INAA	Petrog.	INAA	Petrog.	INAA	Petrog.	INAA
Château Dubuc	Plantation	1	—	1	—	—	—	—	—	2	—
Colonial de l`Embachure	Refuge?	2	2	—	—	—	—	—	—	2	2
Grande Baie	Kiln	—	—	—	1	1	3	—	—	1	4
Grande Terre Poterie	Kiln	—	—	1	—	3	1	—	—	4	1
Grande Pointe	Plantation	1	1	1	1	1	1	—	—	3	3
La Mahaudière	Plantation	—	—	2	2	2	2	—	—	4	4
Macabou	Midden	2	2	—	—	1	1	1	1	4	4
Madame Trime	Ethnographic	4	—	—	—	—	—	—	—	4	—
Morne Cabrit	Kiln	2	2	3	3	1	1	—	—	6	6
Pointe Petite Poterie	Kiln	2	2	2	2	—	—	—	—	4	4
Pointe Borgnesse	Kiln	—	—	3	3	2	2	—	—	5	5
River Mouth Grande Anse	Kiln	—	—	3	3	2	2	—	—	5	5
Rue Dumanoir	Urban excavation	2	2	1	1	—	—	—	—	3	3
Trois Ilets	Kiln	—	—	1	1	3	3	—	—	4	4
Trois Rivières Grande Anse	Kiln	1	1	2	2	2	2	—	—	5	5
	Grand Total	**17**	**12**	**20**	**19**	**18**	**18**	**1**	**1**	**56**	**50**

Table 2. Chemical membership. HB=handbuilt, WT=wheel thrown, IC=industrial ceramic, ph=presumed prehistoric

Site	Island	Group1			Group 2			Group 3			Unassigned			Excluded			Total
		HB	WT	IC	HB	WT	IC	HB	WT	IC	HB	WT	IC	HB	WT	IC	
River Mouth Grande Anse	Basse Terre, Guadeloupe	—	3	2	—	—	—	—	—	—	—	—	—	—	—	—	*5*
Grande Baie	Les Sainte, Guadeloupe	—	1	3	—	—	—	—	—	—	—	—	—	—	—	—	*4*
La Mahaudiere	Grande Terre, Guadeloupe	—	1	2	—	—	—	—	—	—	—	—	1	—	—	—	*4*
Troi Rivieres Grand Anse	Basse Terre, Guadeloupe	1	2	1	—	—	—	—	—	—	—	—	1	—	—	—	*5*
Grand Pointe	Basse Terre, Guadeloupe	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	*3*
Rue Dumanoir	Basse Terre, Guadeloupe	—	1	—	—	—	—	—	—	—	2	—	—	—	—	—	*3*
Morne Babrit	Martinique	—	—	—	2	3	1	—	—	—	—	—	—	—	—	—	*6*
Pointe Petite Poterie	Martinique	—	—	—	2	2	—	—	—	—	—	—	—	—	—	—	*4*
Trois Ilet	Martinique	—	—	—	—	1	3	—	—	—	—	—	—	—	—	—	*4*
Pointe Borgnesse	Martinique	—	—	—	—	2	2	—	—	—	—	1	—	—	—	—	*5*
Macabou	Martinique	—	—	—	1	—	—	1	—	—	1	—	—	—	—	1	*4*
Colonial de l'Embachure	St. Martin	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	*2*
Grande Terre Poterie	Grande Terre, Guadeloupe	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	*1*
	Grand Total	**1**	**9**	**9**	**5**	**9**	**6**	**1**	**0**	**0**	**5**	**1**	**3**	**0**	**0**	**1**	**50**

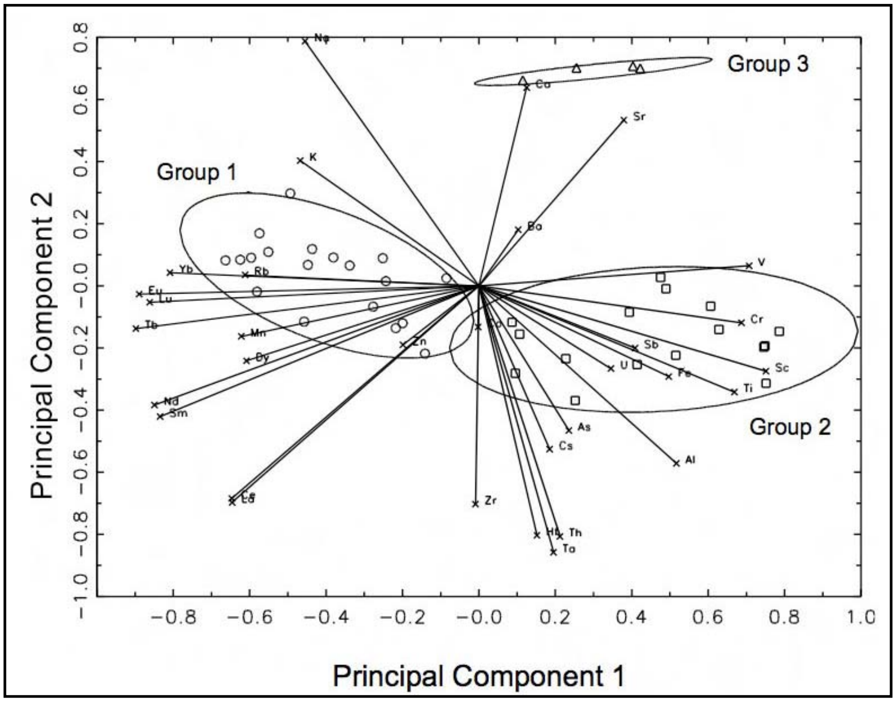

Figure 7. Bivariate plot of principal components 1 and 2 displaying three compositional groups. Ellipses represent 90% confidence level for membership in the groups. Vectors denote elemental influences on the ceramic data. Unassigned specimens are not shown.

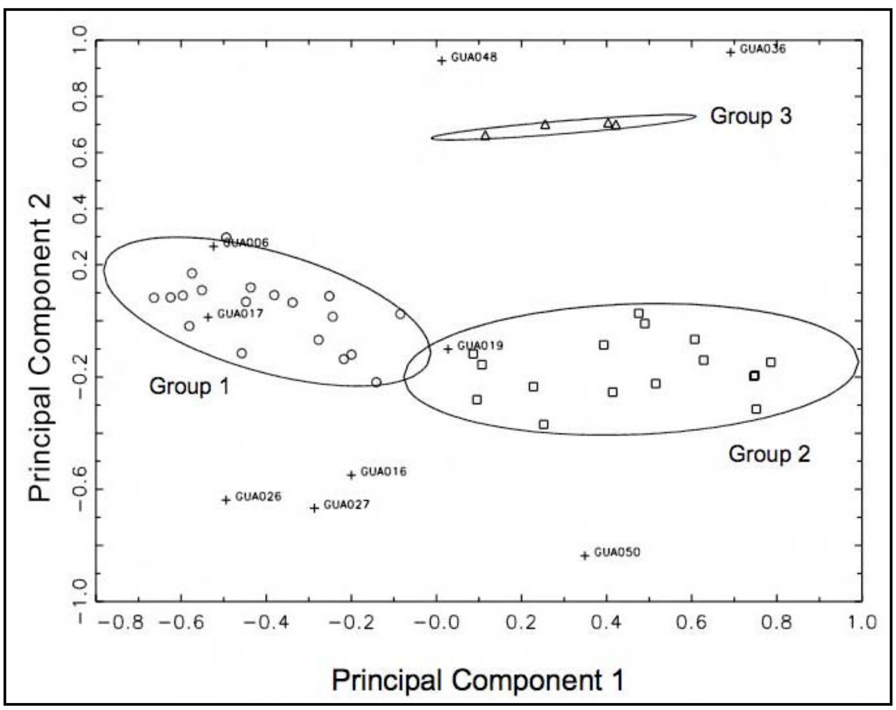

Figure 8. Bivariate plot of principal components 1 and 2 displaying the three compositional groups and labeled unassigned specimens (+). Ellipses represent 90% confidence level for membership in the groups.

Borgnesse, Morne Cabrit, Trois Ilets, Macabou, and Grande Pointe) belong to Group 2. Three of the six industrial ceramics recovered from Martinique belong to this group. Seven of the nine wheel-thrown utilitarian vessels recovered from Martinique belong to this group. In this group, five of the six ceramics that were hand-built were recovered from Martinique. Only one was recovered from Guadeloupe. Lastly, ceramics from plantation proveniences tend to have membership in compositional Group 1.

INAA identified three compositional clusters interpreted to be chemically similar (n=39) and several outliers (n=2) and unassigned samples from presumably unknown provenances (n=9) (Table 2). Among the industrial ceramics and wheel-thrown utilitarian wares the compositional groups correlate well with the island from which they were excavated. Among the hand-built domestic ceramics one sample was assigned to Group 1 (Guadeloupe); six samples were assigned to Group 2 (five from Martinique and one from Guadeloupe); three samples were assigned to Group 3 (two from St. Martin and one from Guadeloupe); and two were left unassigned. This would seem to indicate a degree of trafficking in pottery between islands, or rather probably what was inside the pottery.

Ceramic Petrography

Temper-to-matrix ratios in the ceramic samples ranged from 1:3 to 1:7. The most

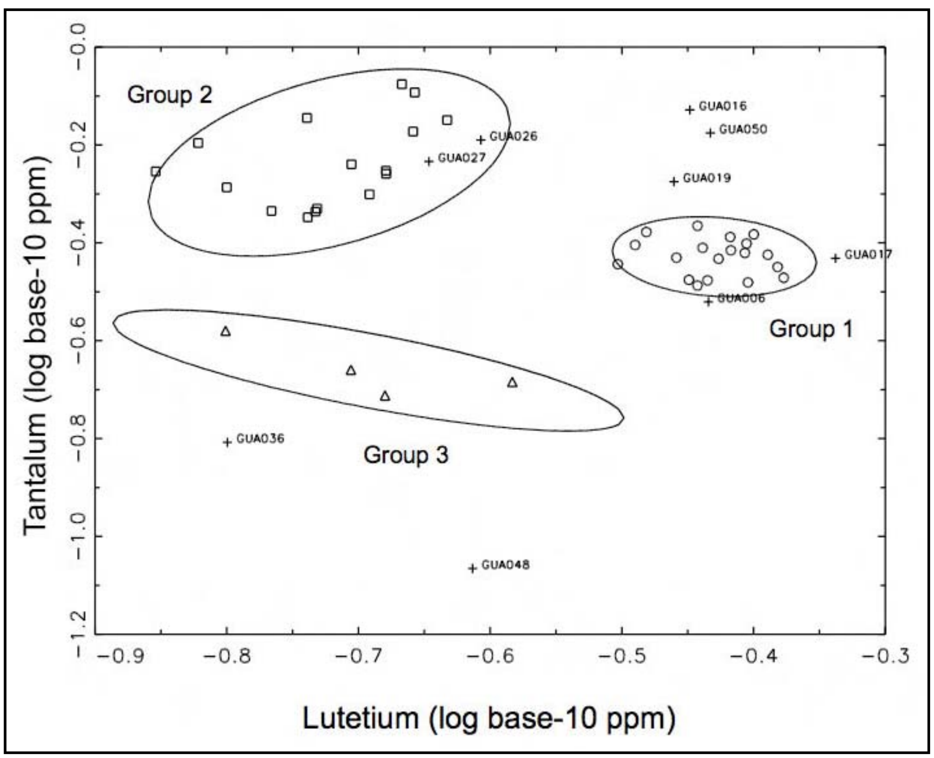

Figure 9. Bivariate plot of base-10 logged lutetium and tantalum concentrations showing the chemical distinctiveness of the three compositional groups. Ellipses represent 90% confidence level for membership in the groups. Unclassified samples (+) are labeled.

commonly observed mineral inclusions were volcanic rock fragments, monomineral plagioclase feldspars, quartz, hornblende, and biotite. For the most part, the ceramic petrography results were concordant with the INAA, but also served to identify additional mineralogical variation within the defined chemical groups.

Petrographically, Group 1 appears to be a tightly clustered group of ceramics and includes wheel-thrown domestic pottery (n=10), and industrial ceramics (n=9). The sites represented in this group include Grande Pointe, Grande Anse River Mouth, Grande Anse, Grande Baie, and La Mahaudière, all in Guadeloupe. Petrographically, members of this group are relatively similar, and diagnostic inclusions within the clay matrix are volcanic clasts (0.5 to 0.75mm), quartz fragments with undulatory (0.05mm) extinction and plagioclase feldspar (0.05 to 0.1 mm), (Figure 10). There is some variation in the clastic inclusions, including one variant that contained fine-grained clasts with large feldspar inclusions. These inclusions are identified as rhyolite. These ceramics include industrial ceramics (n=5), and domestic wheel thrown ceramics (n=3) from La Mahaudière, Grande Anse, and Trois Rivières. The second variant contains more coarse grained clasts within a poikalitic texture with volcanic glass (approx. 1 mm), plagioclase feldspar (0.1 to 0.2 mm). There are also accessory pyroxenes in the clay matrix. These samples include wheel thrown domestic ceramics (n=4) and industrial ceramics (n=7) from La Mahaudière, Grande Anse, and Grande Pointe.

Ceramics identified as Group 2 contain domestic hand-built pottery (n=6), domestic wheel-thrown pottery (n=7), and industrial ceramics (n=3) from Grande Pointe, Guadeloupe (n=1), Macabou (n=1), Morne Cabrit (n=6), Pointe Petite Poterie (n=4), Trois Ilets (n=2) and Pointe Borgnesse (n=2). Petrographically, this cluster of ceramics is defined by the large presence of amphiboles identified as hornblende, plagioclase, quartz with undulatory extinction, orthopyroxenes, augite, and the accessory minerals of calcite, magnetite, and garnets (Figure 11). The mineral assemblage of these ceramics is consistent with the geology of Martinique, as well as pre-Columbian ceramics previously described by Walters (1991) and England (1994). Samples identified as unassigned by MURR are included in this group, specifically three from Pointe Borgnesse (GUA 16, 17, 19), one from Trois Ilets (GUA 27), and one from Rue Dumanoir.

We recorded three variants in this cluster of ceramics through petrography. The first variant includes industrial ceramics from Morne Cabrit and Trois Ilets (n=3) in Martinique. This variant contains large hornblende inclusions that comprise 15% of the counted inclusions. Samples also contain quartz (approx. 50%) and plagioclase feldspar inclusions (approx. 25%). The hornblende shows signs of hemical deformations and range in size from 0.25 to 1 mm. The quartz is simple angular and exhibits undulatory extinction. The plagioclase feldspar exhibits deformed carlsbad twinning indicating regional metamorphism.

The second variant is dominated by domestic wheel-thrown ceramics from Trois Ilets (n=1), Morne Cabrit (n=3), Pointe Petite Poterie (n=2), and Pointe Borgnesse (n=3), (all from Martinique). This group contains quartz (approx. 50%), plagioclase feldspar (approx 20%), and biotite (approx. 10%). The quartz is between 0.25 and 0.5 mm and

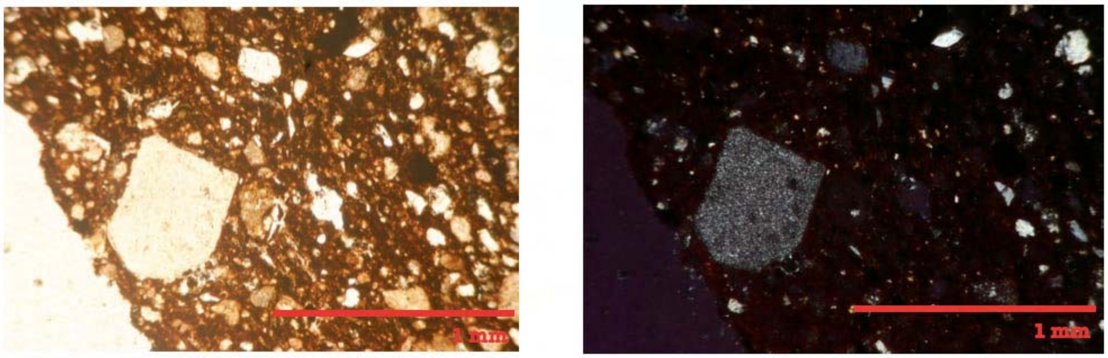

Figure 10. Petrographic Group 1 (40x ppl and 40x xpl). Dominated by microlithic lithic fragments, plagioclase feldspar and quartz.

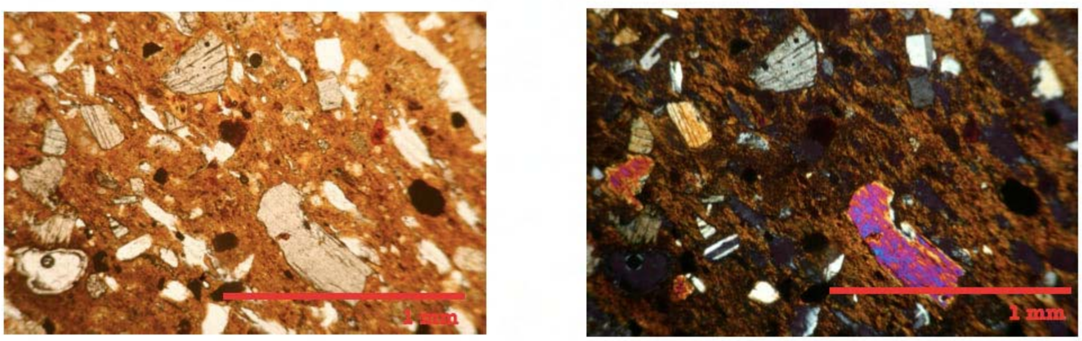

Figure 11. Petrographic Group 2 (40x ppl and 40x xpl). This sample contains hornblende, biotite, plagioclase feldspar, and quartz.

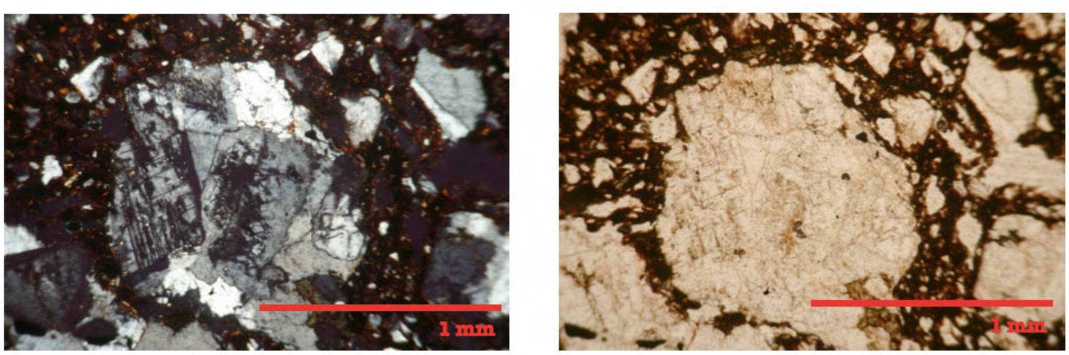

Figure 12. Petrographic group 3 (40x ppl and 40x xpl). This sample contains large quantities of recrystallized quartz and plagioclase feldspar.

exhibits undulatory extinction. Plagioclase feldspar is anhedral and ranges between 0.1 and 0.5 mm. It exhibits carlsbad twinning and shows signs of mechanical deformation. The hornblende is smaller than other variants (approx. 0.25 mm) and is anhedral.

The third variant includes only hand built ceramics from Rue Dumanoir and Grande Pointe in Guadeloupe (n=1), and Macabou (n=1), Pointe Petite Poterie (n=2), and Morne Cabrit (n=2) in Martinique. These samples contain hornblende (approx. 0.75 to 1 mm), plagioclase feldspar (0.2 to 0.5 mm) and quartz (0.1 mm). The hornblende is lathlike and shows some signs of chemical deformation. The plagioclase feldspar exhibits both microcline and carlsbad twinning. Alhough for the most part, the plagioclase is anhedral, it shows little sign of chemical or mechanical deformation. Petrographic analyses of ethnographic samples taken from Madame Trime also are included in this group.

The smallest compositional group defined through INAA was Group 3. Samples include wares from St Martin (n=2), Rue Dumanoir (n=1) (from Guadeloupe), and Macabou (n=1) (Martinique) (Figure 12). Petrographically, the ceramics from St. Martin and Guadeloupe are distinct from previously described samples and from the one sample from Macabou. The pastes of the Rue Dumanoir and St. Martin samples are dominated by recrystalized lithic fragments containing predominately quartz (approx 60%), plagioclase feldspar (20%) and trace amounts of potassium feldspar. The quartz is anhedral, but does exhibit undulatory extinction under cross-polarized light. Although most plagioclase feldspars are anhedral, there are a few inclusions examples of euhedral, lathlike feldspar inclusions in a poikalitic relationship with quartz. The anhedral feldspars exhibit some deformed twinning indicating source rocks that underwent regional metamorphism (Figure 12).

The one sample from Macabou appears to be a petrographic outlier for this group. The ceramic was typologically identified as Amerindian and contains a mineralogical assemblage consistent with other hand-built ceramics recovered from Martinique, with one major exception—the sample contains high quantities of shell temper (ca. 5%), a manufacturing technique that is inconsistent with present-day ethnographic production and other colonial ceramics. The addition of shell temper explains the anomalous chemical results for this sample.

Conclusion

The majority of the samples within this initial study were recovered from historically known kiln sites. These potteries were situated by their owners based on a number of criteria including the convenience to water-born carriage and access to resources required for the production of pottery. For these large scale pottery production sites, key resources include fresh water, fuel, and most importantly access to nearby clay sources. Although INAA establishes the chemical recipe of all constituent components including clays, detrital inclusions within the clay, and added tempering agents, the method does not characterize the clay component exclusively. We believe that due to the strategies employed by the kiln owners, it is likely that the clays employed at each location are distinct, and not from a common source. Further work identifying distinct clay sources would clarify this.

The results of the combined analysis point to two interesting trends. First, there was a ceramic industry on Guadeloupe in the eighteenth and nineteenth centuries. This industry, however, appears to have focused solely on wheel-thrown industrial and domestic ceramics produced at the known kiln sites in southern Basse Terre and Les Saintes. Although hand-built ceramics were recovered from Guadeloupe, the chemical and mineralogical constituents point to at least two production sites distinct from the known Guadeloupe and Les Saintes kiln sites, and the heterogeneity of ceramic recipes as represented in membership to chemical and petrographic groups points potential inter-island trade. The formal characteristics of these samples, coupled with the chemical and petrographic data, suggest that Martinique is the source of these ceramics. This demonstrates that some demand on Guadeloupe was satisfied through inter-island trade or *cabotage* bringing ceramics (and no doubt other things). The second insight gained from the combined analysis of ceramics is the variation in manufacturing choices in both the historic and pre-Columbian pottery. The two ceramic traditions can be readily differentiated based on the presence or absence of shell temper.

This pilot study points to the potential of compositional studies of industrial and domestic ceramics produced in the eighteenth and nineteenth centuries. Our data are preliminary. The small sample size, lack of comparative clay samples, and restricted geographic distribution of the study limits our ability to draw significant conclusions about the extent and nature of inter-island trade within the Antilles. Because of this, resolution in terms of provenance appears to be at the scale of segregating island production. More importantly, whereas anomalous results point to potential social and economic networks the limited nature of our data restricts our ability to generalize from these results and understand the impact of this trade on the daily life of the enslaved and free island residents.

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Appendix 1. Samples analyzed by INAA, their sites, types, forms, and contexts.

Sample	Site Name	Type	Form	Context
GUA001	Pointe Petite Poterie	Domestic Hand-Built	Pitcher	Kiln
GUA002	Pointe Petite Poterie	Domestic Wheel	Restricted Bowl	Kiln
GUA003	Pointe Petite Poterie	Domestic Hand-Built	Coco Nèg	Kiln
GUA004	Pointe Petite Poterie	Domestic Wheel	Storage	Kiln
GUA005	Trois Rivières Grande Anse	Domestic Wheel	Pitcher	Kiln
GUA006	Trois Rivières Grande Anse	Industrial	Drip Jar	Kiln
GUA007	Trois Rivières Grande Anse	Industrial	Drip Jar	Kiln
GUA008	Trois Rivières Grande Anse	Domestic Hand-Built	Pot	Kiln
GUA009	Trois Rivières Grande Anse	Domestic Wheel	Storage	Kiln
GUA010	River Mouth Grande Anse	Industrial	Tile	Kiln
GUA011	River Mouth Grande Anse	Industrial	Drip Jar	Kiln
GUA012	River Mouth Grande Anse	Domestic Wheel	Bowl	Kiln
GUA013	River Mouth Grande Anse	Domestic Wheel	Unknown	Kiln
GUA014	River Mouth Grande Anse	Domestic Wheel	Storage	Kiln
GUA015	Pointe Borgnesse	Industrial	Sugar Cone	Kiln
GUA016	Pointe Borgnesse	Industrial	Drip Jar	Kiln
GUA017	Pointe Borgnesse	Domestic Wheel	Storage	Kiln
GUA018	Pointe Borgnesse	Domestic Wheel	Unknown	Kiln
GUA019	Pointe Borgnesse	Domestic Wheel	Pitcher	Kiln
GUA020	Morne Cabrit	Industrial	Tile	Kiln
GUA021	Morne Cabrit	Domestic Hand-Built	Coco Nèg	Kiln
GUA022	Morne Cabrit	Domestic Wheel	Vase	Kiln
GUA023	Morne Cabrit	Domestic Wheel	Vase	Kiln
GUA024	Morne Cabrit	Domestic Wheel	Pitcher	Kiln
GUA025	Morne Cabrit	Domestic Hand-Built	Coco Nèg	Kiln
GUA026	Trois Ilets	Industrial	Tile	Kiln
GUA027	Trois Ilets	Industrial	Tile	Kiln
GUA028	Trois Ilets	Industrial	Tile	Kiln
GUA029	Trois Ilets	Domestic Wheel	Pitcher	Kiln
GUA030	Grande Baie	Domestic Wheel	Pitcher	Kiln

Appendix 1 (continued).

Sample	Site Name	Type	Form	Context
GUA031	Grande Baie	Industrial	Drip Jar	Kiln
GUA032	Grande Baie	Industrial	Storage	Kiln
GUA033	Grande Baie	Industrial	Storage	Kiln
GUA034	Macabou	Huecoid	Bowl	Midden
GUA035	Macabou	Domestic Hand-Built	Unknown	Midden
GUA036	Macabou	Domestic Hand-Built	Unknown	Midden
GUA037	Macabou	Industrial	Unknown	Midden
GUA038	Colonial de l`Embachure	Domestic Hand-Built	Pot	Refuge
GUA039	Colonial de l`Embachure	Domestic Hand-Built	Pot	Refuge
GUA040	Grande Pointe	Domestic Hand-Built	Pot	Plantation
GUA041	Grande Pointe	Industrial	Storage	Plantation
GUA042	Grande Pointe	Domestic Wheel	Pitcher	Plantation
GUA043	La Mahaudière	Domestic Wheel	Pitcher	Plantation
GUA044	La Mahaudière	Industrial	Storage	Plantation
GUA045	La Mahaudière	Domestic Wheel	Unknown	Plantation
GUA046	La Mahaudière	Industrial	Drip Jar	Plantation
GUA047	Rue Dumanoir	Domestic Hand-Built	Pitcher	Urban
GUA048	Rue Dumanoir	Domestic Hand-Built	Jar	Urban
GUA049	Rue Dumanoir	Domestic Wheel	Jar	Urban
GUA050	Grande Terre Poterie	Industrial	Tile	Kiln
GUA051	La Mahaudière	Vallauris	Cooking Pot	Plantation
GUA052	Château du Buc	Domestic Hand-Built	Cooking Pot	Plantation
GUA053	Château du Buc	Domestic Wheel	Unknown	Plantation
GUA054	Grande Pointe	Vallauris	Cooking Pot	Plantation
GUA055	Grande Pointe	Vallauris	Cooking Pot	Plantation
GUA056	La Mahaudière	Vallauris	Cooking Pot	Plantation
GUA057	Mme Trime	Domestic Hand-Built	Coco Nèg	Ethnographic
GUA058	Mme Trime	Domestic Hand-Built	Coco Nèg	Ethnographic
GUA059	Mme Trime	Domestic Hand-Built	Coco Nèg	Ethnographic
GUA060	Mme Trime	Domestic Hand-Built	Coco Nèg	Ethnographic

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CERAMIC PRODUCTION AND EXCHANGE AMONG ENSLAVED AFRICANS ON ST. KITTS, WEST INDIES

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Archaeological investigations at Brimstone Hill Fortress National Park on St. Kitts have recovered 665 Afro-Caribbean ware sherds dating 1790–1850. Analysis of 40 sherds and five clay samples by instrumental neutron activation analysis is designed to determine if any of the Brimstone Hill Afro-Caribbean ware sherds were locally manufactured. Contrary to the common belief that Afro-Caribbean ware found on St. Kitts had originated on Nevis where there is a long history of pottery-making, the elemental analysis indicates the majority of the pottery in the sample was made from locally available clay sources. Nevertheless, macroscopic and elemental analysis provide evidence for some inter-island exchange of Afro-Caribbean pottery. Ultimately this research will enhance our understanding of ceramic production and trade among enslaved Africans in the Caribbean.

On the island of St. Kitts, West Indies, Afro-Caribbean ware is found in a variety of contexts dating from the seventeenth century to modern times indicating that locally-made pottery played an important role in the households of the island’s people. Until recently, the origins and history of the Afro-Caribbean ware from St. Kitts were poorly known, and it was thought that the majority of the Afro-Caribbean ware on the island was likely produced on the nearby island of Nevis where there is a long pottery-making tradition. Archaeological investigations at the Brimstone Hill Fortress National Park

(Brimstone Hill) have recovered 665 sherds of Afro-Caribbean ware from different contexts within the fortress. Macroscopic analysis (Ahlman 2005) suggests that the majority of the Brimstone Hill sherds were manufactured on St. Kitts using locally available clay resources. Comparisons with descriptions of Afro-Caribbean wares found on other islands (Heath 1988; Peterson and Watters 1988; Peterson et al. 1999; Gilmore 2004) imply that enslaved and free Africans on St. Kitts might have participated in a larger inter-island trade network (Ahlman 2005).

Instrumental neutron activation analysis (INAA) data generated at the University of Missouri Research Reactor (MURR) was used to 1) examine similarities in chemical signatures of a variety of sherds from Brimstone Hill, and 2) compare the chemical signatures of these sherds to clays from five sources on the island to study Afro-Caribbean ware production and exchange on St. Kitts. The goal of this study is to learn more about the intra- and inter-island trade networks among enslaved Africans and to discover the role Afro-Caribbean ware played in the daily life of enslaved Africans at Brimstone Hill.

History of Brimstone Hill

Located approximately 350 kilometers southeast of Puerto Rico in the Leeward Islands (Figure 1), St. Kitts was settled by the British in 1623 and the French in 1625. The two countries jointly occupied the island until 1713, after which the island remained a British colony until it gained independence in 1983. St. Kitts' greatest economic value lay in its fertile soils used to grow sugar cane. Enslaved Africans were the labor source used to plant, cultivate, and harvest cane. By the end of the eighteenth century, Africans and their descendants outnumbered Europeans on the island 20 to 1 (Hubbard 2003). St. Kitts' intrinsic economic value and strategic location resulted in frequent territorial battles between the British and its European adversaries, especially the French.

Brimstone Hill Fortress was a British fortification situated atop an approximately 222-meter-high volcanic extrusion on the northwest coast of St. Kitts (Figure 2). The British first armed Brimstone Hill in 1690 during a French siege in an effort to provide strategic support for Charles Fort, located along the coast below Brimstone Hill (Smith 1994). The most intensive period of construction at the fort occurred after another French siege and occupation of the fort in 1782 (Smith 1994, 1995; Hubbard 2003). After regaining control of the fort, the British initiated a massive construction and renovation plan that was carried out from the 1780s to the early 1800s, resulting in the configuration of the fort as it stands today. The fort was manned until the British abandoned it in 1854.

There was a distinctive multiethnic community living at Brimstone Hill throughout its occupation (Schroedl and Ahlman 2002; Schroedl 2005). Not only did British army officers and enlisted men live there, but also women, children, and enslaved Africans. Local civilians, plantation owners, and colonial officials were frequent visitors to the fort, and sometimes these individuals lived within its confines. In addition to the British military and the local white militia, military personnel of African descent—including members of the St. Kitts Corps of Embodied Slaves and soldiers of the First, Third, and Fourth West India Regiments—also lived there (Schroedl 2005). Although British military engineers designed the fortress, enslaved Africans undertook the majority of the labor. This included the Corps

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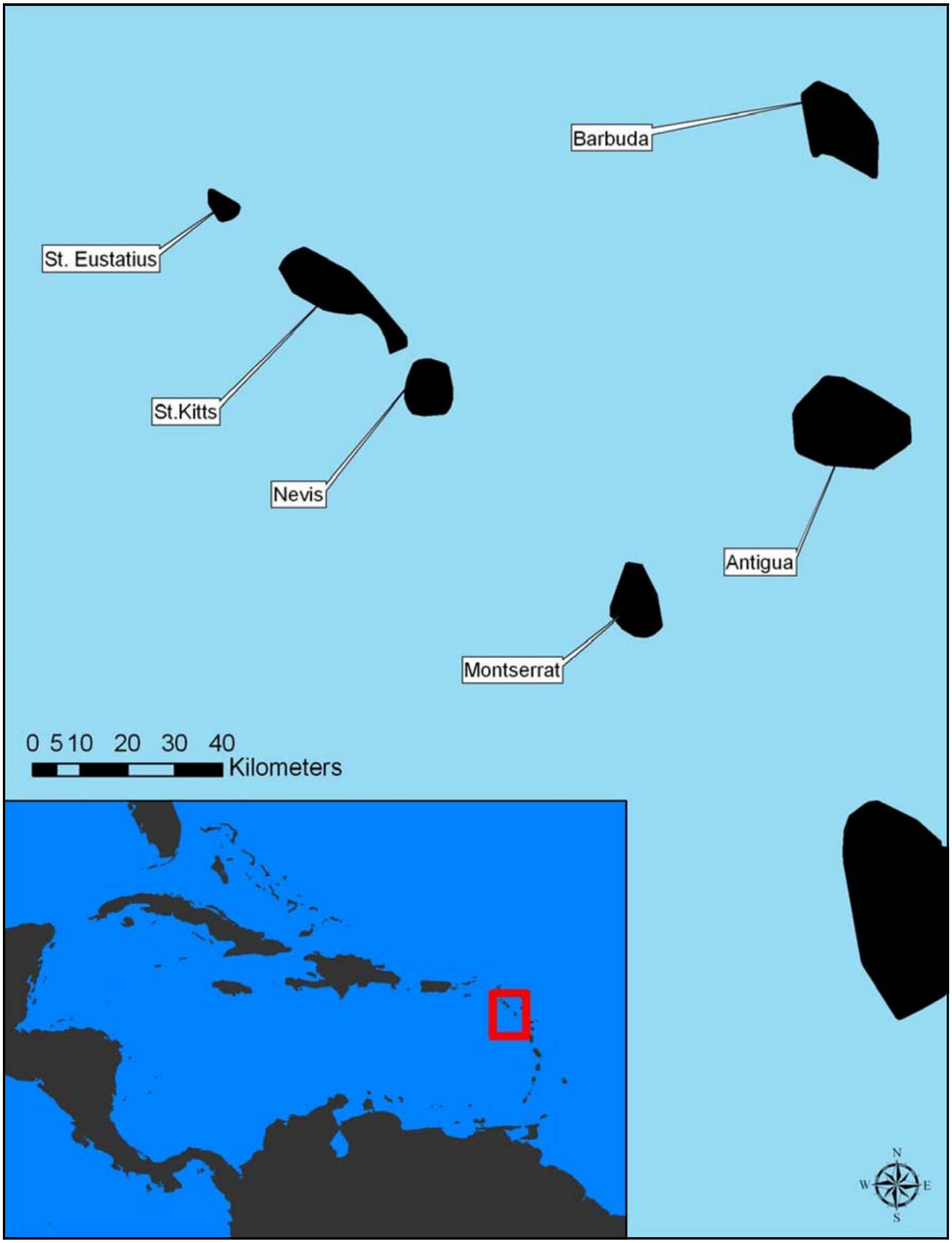

Figure 1. Location of St. Kitts.

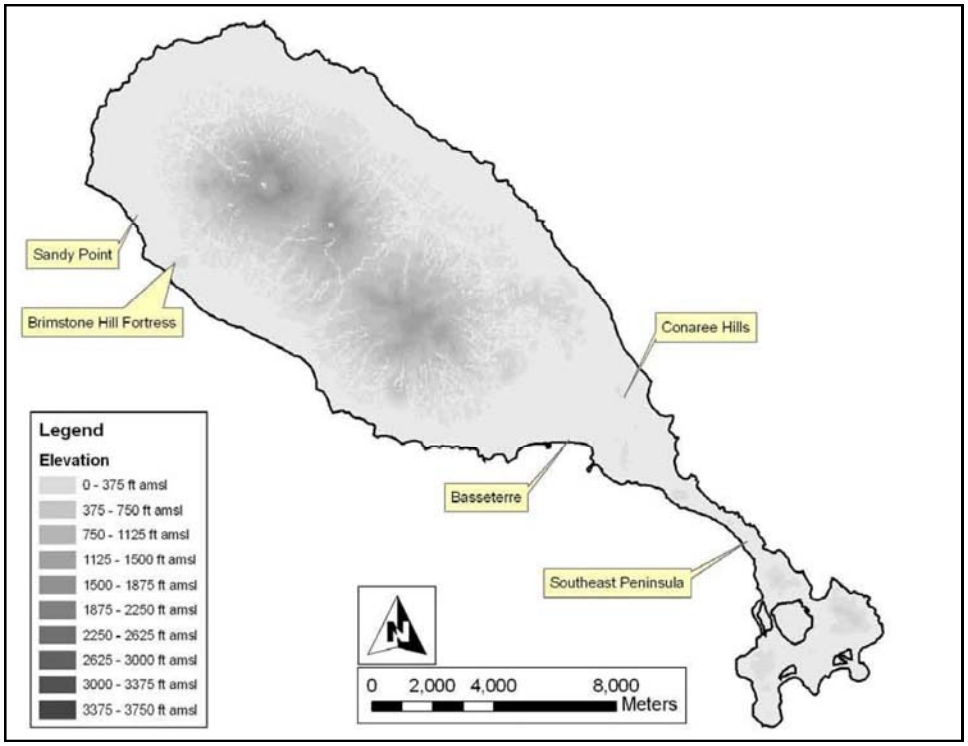

Figure 2. Location of Brimstone Hill Fortress National Park.

of Black Military Artificers and Pioneers, who were enslaved Africans owned by the British government, and also enslaved Africans from local plantations forced to work at Brimstone Hill to fulfill levies placed upon their enslavers. At various times from 1790 to 1815, at least 50 and sometimes more than 200 enslaved Africans lived and worked at Brimstone Hill. Two lists of enslaved Africans compiled in 1791 (St. Kitts Archives), identified more than 118 people conscripted from plantations throughout the island to labor at Brimstone Hill.

Archaeological Investigations of Brimstone Hill

Archaeological investigations at Brimstone Hill were conducted from 1996 to 1999. They resumed in 2004 and are planned to continue through 2008. Four areas, each with its own site number, have been investigated (Figure 3). These include 1) the lime-kiln area at the base of the hill (Site BSH 1); 2) the area below the defensive wall connecting the Orillon and Magazine bastions where a workshop, two hospitals, and a kitchen were occupied and used by enslaved Africans (Site BSH 2); 3) the Royal Engineers officer's quarters that includes one building occupied by enslaved Africans (Site BSH 3); and 4) the area at the foot of the Orillon Bastion's salient (Site BSH 4).

To date, these excavations have produced nearly 150,000 artifacts consisting primarily of European-made glass and ceramics (Ahlman et al. 1997; Schroedl 2000; Gomez and Ahlman 2005). The majority of the recovered artifacts date to the late eighteenth and early nineteenth centuries during the period when the British were undertaking major construction and renovation of the fortress. Of particular note are 665 low-fired, hand-made earthenware sherds recovered from excavated contexts at the fortress. These sherds are comparable to Afro-Caribbean ware found throughout the West Indies (Heath 1988; Hauser and Armstrong 1999; Peterson et al. 1999), and they represent the most distinctive class of artifacts indicative of the African presence at the fortress.

Previous Studies

Previous research into the production and exchange of Afro-Caribbean ware on St. Kitts has largely been based on macroscopic analysis of sherds from Brimstone Hill (Ahlman 2005). Ahlman (2005) identified eight different ceramic types based on macroscopic characteristics of inclusions and paste (Table 1). Types 1 through 4 and 6 generally account for differences in the quantities and sizes of primary and secondary inclusion classes; Types 1 and 3 are the most similar. Inclusions and the pastes of Types 5, 7, and 8 differ greatly from the other types. For example, Type 7 has crushed schist and a micaeous paste and Type 8 contains crushed-quartz inclusions.

The macroscopic study (Ahlman 2005) concluded that the majority of the Brimstone Hill Afro-Caribbean ware was made on St. Kitts because: 1) the mineral inclusions in most sherds are consistent with the volcanic geology of St. Kitts; 2) similar minerals are found as beach sand across most of the island and these minerals occur naturally in the clays at the southeastern peninsula of the island; and 3) clays suitable for pottery

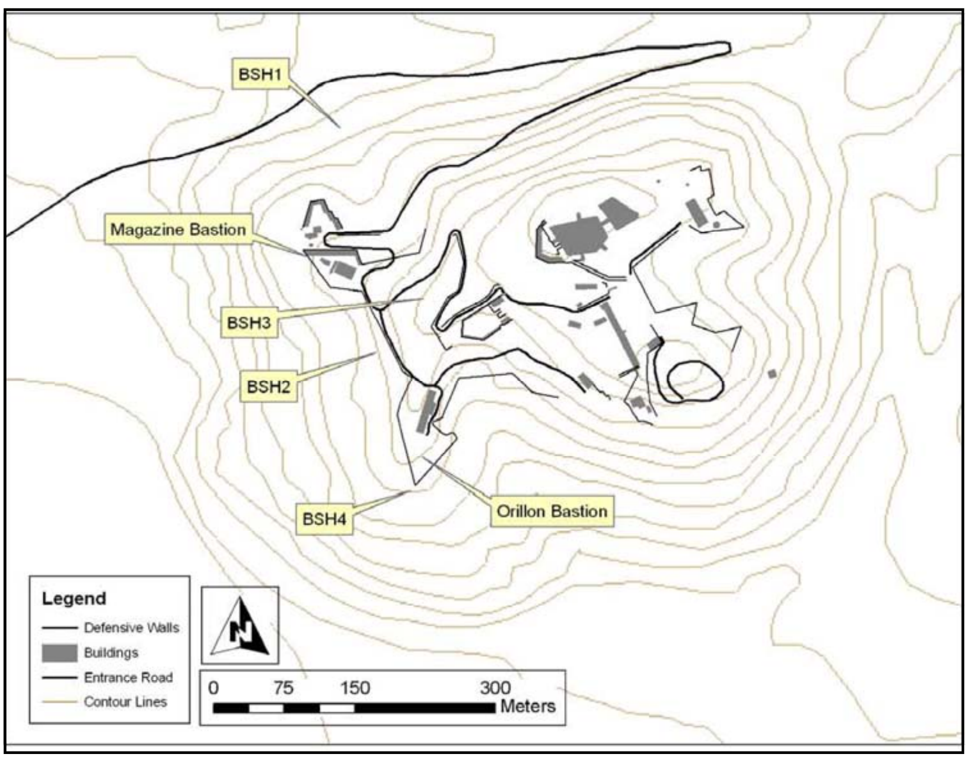

Figure 3. Location of archaeological investigation undertaken at the Brimstone Hill Fortress National Park.

Table 1. Summary of pottery type characteristics (Source: Ahlman 2005).

Type	# Sherds	Primary Temper	Secondary Temper
1	140	Black and Opaque sand	
2	363	Black and Opaque sand	Grog, hematite, limestone
3	111	Black and Opaque sand	Grog, hematite, limestone
4	19	Black and Opaque sand	quartz
5	2	Black sand	
6	21	Grog, hematite, limestone	Black and opaque sand
7	1	Mica and Schist	
8	8	Quartz	

production come from different places on the island. Preliminary petrographic analysis of two sherds from Brimstone Hill and comparisons with contemporary Nevisian Afro-Caribbean ware shows that the Brimstone Hill pottery differs from the Nevisian wares not only in manufacturing method, but also in paste and inclusion characteristics (Elaine Morris, personal communication, 2005).

The Brimstone Hill Afro-Caribbean ware is also similar to wares from other islands based on macroscopic descriptions. All Brimstone Hill Afro-Caribbean ware sherds are similar to sherds from Montserrat and Anguilla that contain black mineral inclusions derived from volcanic materials (Petersen et al. 1999). Analyses of Afro-Caribbean ware from nearby St. Eustatius (Statia), where Heath (1988) identified six types based on temper and one type based on surface treatment, are also comparable to the Brimstone Hill sherds. The Brimstone Hill Afro-Caribbean ware is most comparable to Heath's Type 1, which has black and clear mineral inclusions. Gilmore's (2004) recent petrographic analysis has identified similarities among many of the sherds from Statia, St. Croix, Nevis, and Antigua. The Brimstone Hill and Statia material appear similar with the exception that some of the Brimstone Hill pottery has limestone inclusions.

Some Afro-Caribbean ware from Statia and Montserrat also has mica and schist inclusions. Mica is present in the paste of several sherds from Brimstone Hill, but this appears to be a natural occurrence, rather than intentional as observed on Statia (Heath 1988:174). Type 7 sherds from Brimstone Hill, however, closely resemble the Statia sherds, and quite possibly may originate from the same, as of yet unidentified, source.

Ceramic Samples

The enslaved Africans who lived and worked at Brimstone Hill had access to, and probably acquired goods (including Afro-Caribbean ware) from, local markets. The enslaved Africans who came to the fort from different plantations around the island brought some of their own supplies including food and ceramic vessels for cooking. This suggests that the Afro-Caribbean ware found at Brimstone Hill originates from multiple

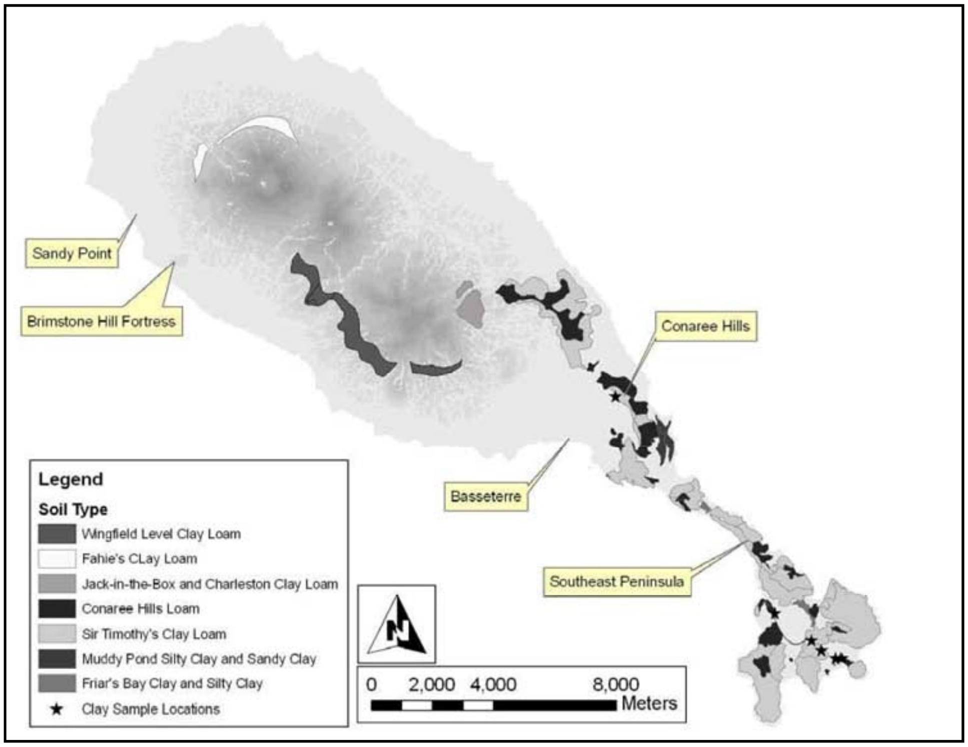

Figure 4. Location of classified soil types containing clay and sources where clay samples have been found.

locations on the island and is a representative sample for INAA analysis.

A total of 40 Afro-Caribbean ware sherds from three of the investigated areas at Brimstone Hill were analyzed by INAA (Table 2). The sample represents seven of the eight types defined from inclusion and paste characteristics.

Clay Sourcing

Cursory pedestrian surveys by the senior author have been made on St. Kitts to locate clay sources suitable for pottery production. Survey thus far has focused on the Conaree Hills area near Basseterre and on the southeastern peninsula, where the island soil survey (Lang and Carroll 1966) indicates likely locations of clay soils. Six viable clay sources have been found, one near the Conaree Hills and five on the southeastern peninsula (Figure 4). The clays are poorly sorted with naturally occurring volcanic mineral inclusions, variable amounts of organic material, and occasional pieces of limestone or coral fragments. Five clay samples were analyzed by INAA with the Afro-Caribbean ware sherds.

One clay sample submitted for INAA is from Conaree Hills (see Figure 4), where a deep bed of clay was recently exposed during housing development activities. Conaree is a termed used on Barbados to describe an open-mouthed, straight sided, wheel-turned pot with a glazed interior used to make pepper pot (Edwards and de Verton 2004:68). The Conaree Hills are named after the nearby estate rather than in reference to pottery making. The Conaree Hills clay required extensive processing because it has considerable numbers of small-to-medium

Table 2. Cross-tabulation of samples submitted for INAA by site and type.

Site	Type								Un-assigned	Total
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*		
2	2	11	4	-	-	1	-	-	1	*19*
3	5	9	1	1	-	1	1	1	-	*19*
4	2	-	-	-	-	-	-	-	-	*2*
Total	**9**	**20**	**5**	**1**	**-**	**2**	**1**	**1**	**1**	***40***
Complete Assemblage	*140*	*363*	*111*	*19*	*2*	*21*	*1*	*8*	*1*	*665*

sized, naturally occurring andesite and limestone inclusions. It was processed by drying, crushing, and sifting the clay through 1/16-inch hardware cloth. Naturally occurring beach sand was added as temper to some of the Conaree Hills clay and petrographic analysis of this sample found abundant shell within the sand. The clay from Conaree Hills was formed into both pots and tiles and fired in a traditional open-fire method. The sample submitted for INAA did not have any added sand.

Four clay samples from the Southeast Peninsula were submitted for INAA analysis. Three were obtained from the rim of the salt ponds. The fourth was recovered from deposits approximately 20 cm below the surface in a shallow early nineteenth century road cut that may have been known to potters at that time. These four clay samples have subangular sand inclusions that are similar to the inclusions noted in the Afro-Caribbean ware from Brimstone Hill. This clay was formed into bricks and fired without further processing (drying or sifting).

INAA Results

The INAA of the 40 Afro-Caribbean ware sherds from Brimstone Hill and the five clay samples followed standard MURR procedures of sherd preparation, irradiation, and counting (Speakman and Glascock 2006). The raw data were transformed to a log base-10 scale to standardize the element concentrations, and missing data were estimated by deriving values that minimized the Mahalanobis distance to the overall sample centroid. Four compositional groups were proposed based on differences among the rare earth elements (e.g., thorium/ europium and lanthanum/samarium) apparent in bivariate plots of the element data (Figure 5). Two sherds and one clay sample were not assigned to any of the compositional groups. The validity of the proposed subgroup structure was statistically confirmed by means of Mahalanobis distance and posterior classifications using a cross-validation procedure. The first nine principal components representing over 96% of the cumulative sample variation were used for this analysis (Speakman and Glascock 2006).

Bivariate plots of the rare earth element data (Figure 5) show that Groups 1 and 2 have subtle differences in composition. As the two plots in this figure suggest, Groups 1 and 2 tend to mirror each other with higher concentrations of certain elements (again thorium and lanthanum are used as examples) in Group 2 than in Group 1. Groups 3 and 4,

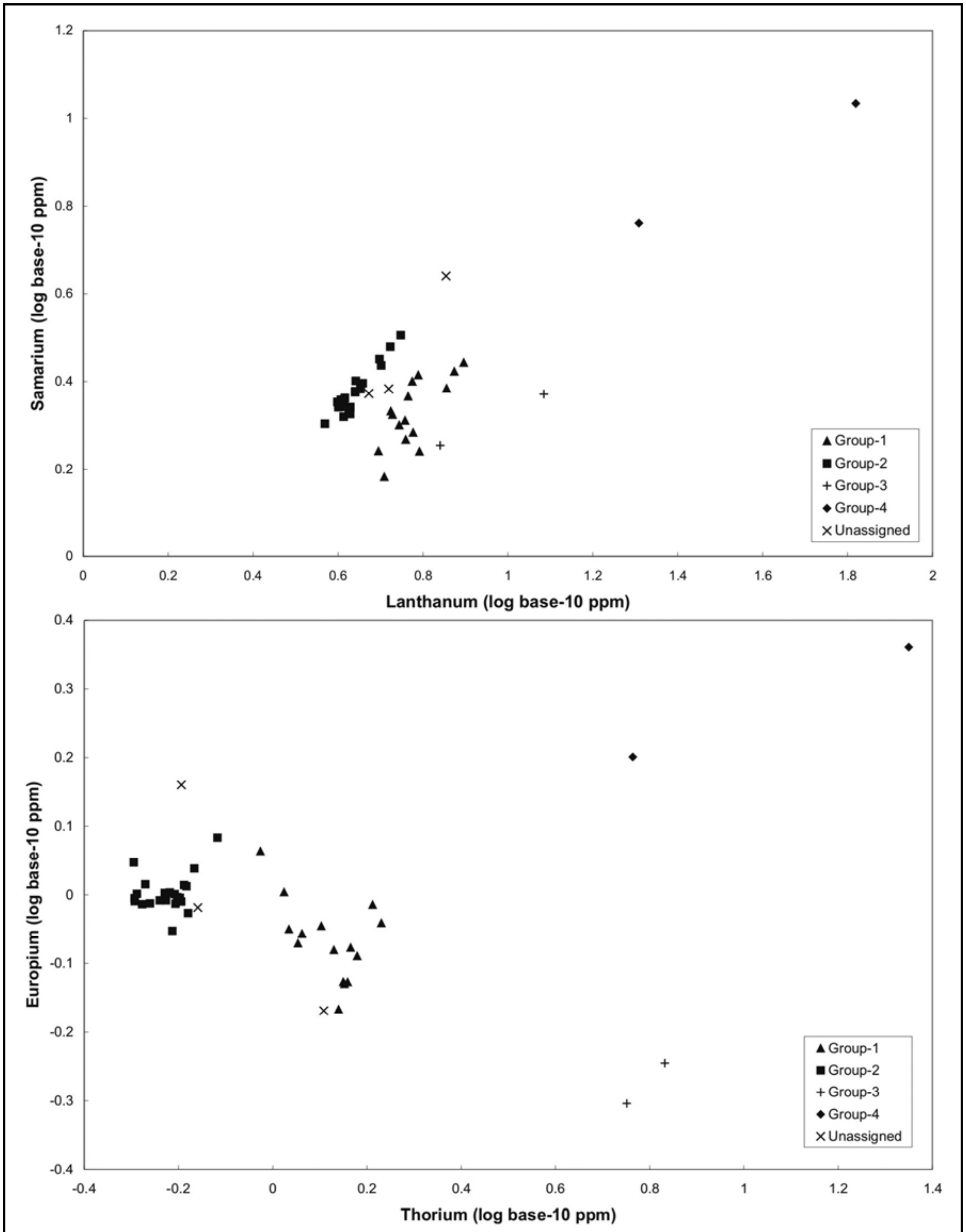

Figure 5. Bivariate plots of selected rare earth elements as base-10 logged concentrations showing the proposed compositional groups.

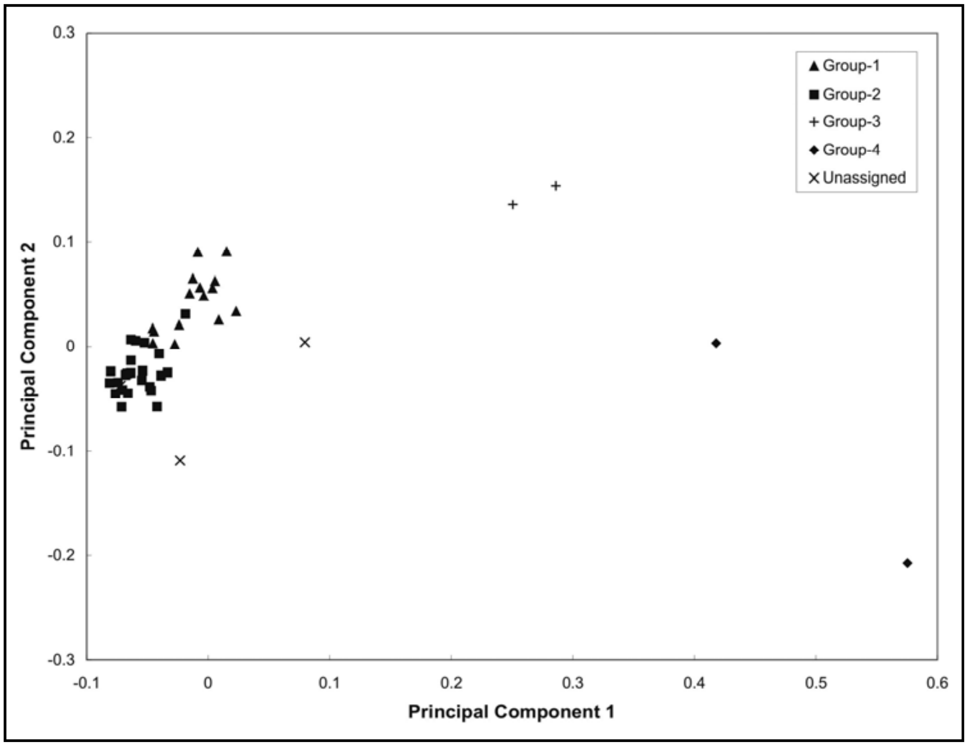

Figure 6. Biplot of the first two principal components showing distribution of the compositional groups. The first two principal components account for more than 75% of the cumulative variance.

however, are distinctive from Groups 1 and 2 and each other. Compositionally, these groups have little in common with Groups 1 and 2. A biplot of the first two principal component scores (Figure 6) illustrates again the distinctiveness of Groups 3 and 4 and the similarity of Groups 1 and 2. As Figure 6 shows, Groups 1 and 2 exhibit some overlap in multivariate space, suggesting that these two groups may derive from geologically similar clay resources.

Group 1 is composed of 12 Afro-Caribbean ware sherds and 3 clay samples suggesting that the sherds within this group were made from local clays. The three clay samples in this group come from the salt pond rims and two samples are from sources in the same general area but located approximately 100 m apart. This group contains 11 sherds from BSH 3 and 1 from BSH 4 (Table 3; Figure 7). The sherds have been assigned to Types 1 through 3 as defined by Ahlman (2005) (Table 4).

Group 2 is the largest group with 22 Afro-Caribbean ware sherds and 1 clay sample, also suggesting the sherds in this group were made from local clays. The clay sample originates from the road cut identified above and is within 200 m of two of the clays assigned to Group 1. Group 2 includes 17 sherds from BSH 2 and 5 sherds from BSH 3 (Figure 7). The sherds have been assigned to Types 1, 2, 3 and 6, all of which have similar inclusions and paste characteristics.

Group 3 consists of 1 sherd from BSH 3 assigned to Type 4 and 1 sherd from BSH 4 assigned to Type 1 (Figure 7). These sherds are similar, but the Type 4 sherd has quartz as a secondary inclusion whereas the Type 1 sherd does not. Given that only two samples are assigned to this group, it is obvious that additional sampling is necessary to fully characterize the range of chemical variation within this group. Group 4 consists of two sherds from BSH 3 assigned to Type 7 and 8 (Figure 7). As with Group 3, only two samples are assigned to Group 4. We can state with some degree of certainty that these samples are more similar to one another than to the other pottery analyzed. It seems likely, however, based on chemical differences between the two samples, that Group 4 pottery represents two distinct pottery production locales (e.g., the differences between the samples as illustrated in Figure 4). The INAA and macroscopic analyses suggests Groups 3 and 4 sherds are probably not made from St. Kitts clay. Other than the one Type 1 sherds, these sherds have quartz and schist/mica inclusions that distinguish them from the rest of the assemblage.

Conclusion

The compositional analysis of Afro-Caribbean ware sherds from Brimstone Hill demonstrates: 1) that some of the Afro-Caribbean ware found at Brimstone Hill was manufactured on the island and 2) that enslaved Africans on St. Kitts likely participated in inter-island exchange of the ware. The 34 pottery sherds assigned to INAA Groups 1 and Group 2 are clearly derived from local clays. The likely origin of these clays is the southeastern end of the island. The pottery that was produced with clays from the southeastern peninsula appears to have been widely distributed across the island and may have been the least costly and

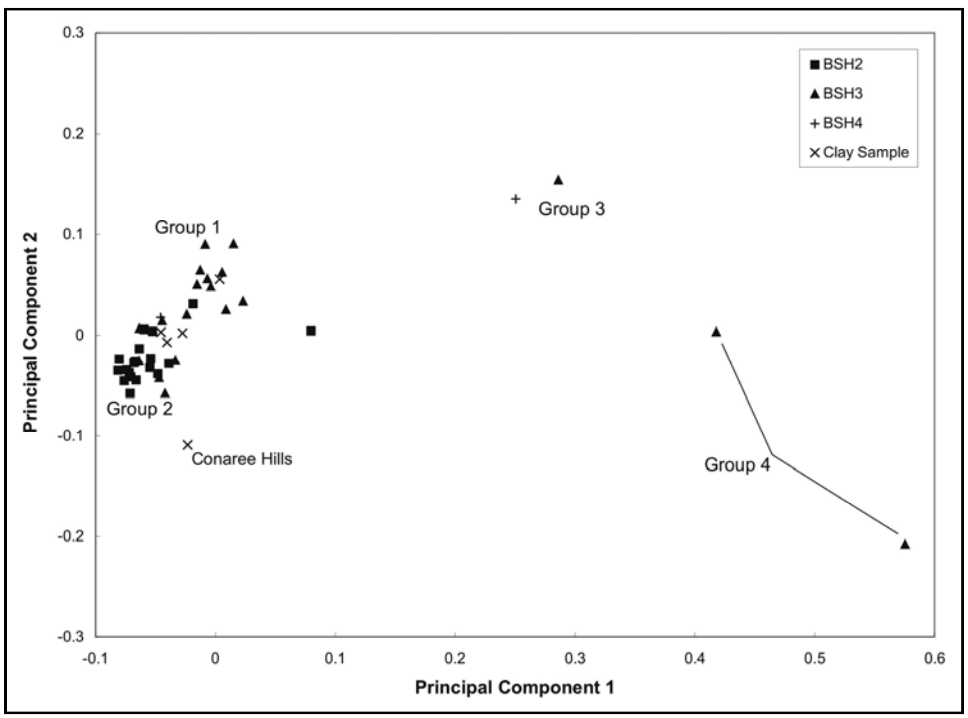

Figure 7. Biplot of the first two principal components showing the BSH site association for each sherd and the clay samples. The first two principal components account for more than 75% of the cumulative variance.

most widely available wares on the island. These data also demonstrate that the clay from this area was preferred over other clays for making the pottery on the island. There is no evidence, either chemical or petrographic, that clays from Conaree Hills were used to manufacture any of the pottery found at Brimstone Hill. The clays from the southeastern peninsula are approximately 40 km from Brimstone Hill. Prior to modern times, the best access to the southeast peninsula was by boat given that the road to this location was often treacherous. It is unknown whether enslaved Africans from the southeast peninsula brought the raw clays or finished pottery to various markets, or whether potters from around the island went to that location and acquired what they needed from the source. In either case, significant amounts of time were needed to transport either the clay or finished pots to the island's markets.

The BSH 2 assemblage, consisting of Group 2 sherds only, was likely created by government-owned slaves, as well as slaves from island plantations who may have had limited access to markets and funds for purchasing pottery. By extension, these enslaved Africans had limited access to pottery produced from other clays. The assemblage at BSH 3 includes sherds assigned to all four groups and was generated by enslaved Africans who were likely government-owned and continuously lived at the fort. Because these individuals worked directly for the British Royal Engineers (who controlled the organization and conduct of work), these slaves likely had greater access to and greater purchasing power at the island's markets than plantation slaves conscripted to labor at the fortress. At the markets where these government slaves visited, potters or merchants were either selling or reselling raw clay or finished pottery made with clay from the southeast peninsula as well as pottery made from likely non-local sources.

It is also possible that some members of the Brimstone Hill community, who had relatively greater freedom, were making their own pottery from clay they acquired from either a market or directly from the southeast peninsula.

The idea of inter-island exchange of Afro-Caribbean ware among enslaved Africans is widely accepted (Heath 1988; Hauser and

Table 3. Cross-tabulation of INAA composition groups and Brimstone Hill site contexts.

Group	**Site**			**Clay Sample**	**Total**
	2	*3*	*4*		
1	-	11	1	3	*15*
2	17	5	-	1	*23*
3	-	1	1	-	*2*
4	-	2	-	-	*2*
Unassigned	3	-	-	1	*4*
Total	**20**	**20**	**5**	**5**	**40**

Armstrong 1999; Petersen et al. 1999; Ahlman 2005), but poorly documented. The inclusions and paste characteristics of one sherd in Group 4, made from a clay that is likely not from St. Kitts' southeast peninsula, is similar to descriptions of pottery found on Statia and Montserrat suggesting the pottery was made on either one of these islands or elsewhere. Its infrequent occurrence in all the assemblages, however, indicates that it was not widely traded and, as it is 'finely' made, this ware may have been considered high quality and expensive compared to pottery made from local clays.

The results of the INAA of 40 Afro-Caribbean Ware sherds from Brimstone Hill and five clay samples supports Ahlman's (2005) hypothesis that the majority of the Afro-Caribbean ware found at Brimstone Hill was made from locally-available St. Kitts clay. In addition, a small number of the sherds are likely made from non-local clays, indicating both intra- and inter-island trade networks among enslaved Africans. The analysis also suggests the possibility of socio-economic differences among enslaved Africans living and working at Brimstone Hill. It appears that slaves who undertook specialized tasks may have had the ability to purchase non-local pottery, which was likely more expensive than the locally-produced pottery, because they had greater purchasing power than did unskilled laborers like local plantation slaves.

Acknowledgments

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Table 4. Cross-tabulation of INAA groups by petrographic 'type' groups.

Group	**Type**								**Clay Sample**	**Total**
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*		
1	5	6	1	-	-	-	-	-	3	*15*
2	2	14	4	-	-	2	-	-	1	*23*
3	1	-	-	1	-	-	-	-	-	*2*
4	-	-	-	-	-	-	1	1	-	*2*
Unassigned	1	-	-	-	-	-	-	-	1	*3**
Total	**9**	**20**	**5**	**1**	**-**	**2**	**1**	**1**	**5**	**40***

* = includes the sherd unassigned to a specific type

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LOCATING ENSLAVED CRAFT PRODUCTION: CHEMICAL ANALYSIS OF EIGHTEENTH CENTURY JAMAICAN POTTERY

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Archaeological sites from eighteenth century Jamaica contain significant quantities of locally-produced coarse earthenware. Historical accounts are replete with references to street markets through which enslaved and freed African Jamaicans bought and sold goods, including such earthenwares and the products contained within them. This study attempts to understand the significance of these markets and determine the scale of the informal economic sector in which enslaved and free African Jamaicans operated through ceramic compositional analysis.

Archaeologists working with ceramics of the African Diaspora have generally assumed that the production of these materials occurred at the level of a household craft industry within enslaved residences for use in a given plantation (Bueze 1990:40; England 1994; Handler 1963, 1964; Wheaton and Garrow 1985: 183) and that the pottery that made its way into urban settings was a result of links created by the planter (Crane 1993) or through systems of internal trade including Sunday markets and itinerant country peddlers (Hauser 2006, 2007, 2008; Hauser and Armstrong 1999; Joseph 2004, 2007). Whether relying on potential waster sherds (Wheaton and Garrow 1985) or ethnographic evidence and analogical reasoning (Bueze 1990:42; Handler 1964), there has been little evidence to date to challenge the model that local, low-fired, coarse earthenware were the product of part-time labor on the potters' part resulting in intermittent and indirect distribution. Kiln-fired, wheel-thrown ceramics, like those discussed by Handler (1963) and England (1994), were the result of more intensive production and distribution systems. In initiating our analysis of ceramics from Jamaica, we framed, uncritically, our models around these rather dichotomous production strategies, mirroring the two predominant types of local pottery in Jamaica: Slipped and Glazed Yabba.

The focus of this article is the Yabba, a coarse, low-fired earthenware. Yabbas are generally associated with the independent production of African Jamaicans and are recovered from archaeological contexts associated with laboring and enslaved peoples of African descent. As such, they are one of the few forms of archaeologically recovered material culture that are directly related to enslaved independent production, trade, and use. Based on insight gained from the ethnographic record, we can go further and say that they represent the independent production of enslaved women. This production was rooted in a larger web of social networks and commodity production.

As many archaeologists and ethnoarchaeologists have argued, the process through which systems of technical knowledge are passed from one generation to the next, from one community to another is inherently complex and social. The knowledge is simultaneously explicit and implicit, where the routine of craft production is punctuated by specific active decisions made by the potter (Dietler and Herbich 2000; David and Kramer 2001; Dobres 2000; Gosselain 1992; 1998, 1999, 2000; Stark 1998). The women who made these pots used systems of knowledge and ways of doing things that they learned from their mothers, in some cases, brought with them from Africa, and employed in new economic tasks. The pottery they made had to respond to the demands of the informal markets in which they were sold. This pottery can be seen, therefore, as a material embodiment of the social networks that linked generations of women and communities of enslaved laborers within informal and formal political economy.

Yabbas—An Archaeological Type and a Function Form

To introduce and explain some ambiguity, in Jamaica the term “yabba ” refers to several types of ceramic and a specific form. The <u>type</u>, Yabbas are a local coarse earthenware produced in Jamaica as early as 1692 and up to the present day. They can be either glazed or slipped and the common attribute is that they are hand-made (as opposed to wheel thrown) and are perceived to be of local manufacture. Indeed Yabba-type pottery can be made into a pot, a Spanish jar, a monkey, or even a yabba. The form <u>yabba</u> refers to a large restricted-orifice, direct-rim bowl used to cook stews, rice, and fried foods. In this study, Yabba-type pottery proved to be a mechanism through which to understand the extent of this internal economy. These ceramics were used by people of African Descent, made by people of African Descent, and most importantly sold in the internal markets of Jamaica (Figure 1).

Phillip Mayes (1972) and Duncan Mathewson (1972a, 1972b, 1973) were the first archaeologists to identify the local seventeenth through nineteenth century production of low-fired ceramics in Jamaica. Both researchers classified these ceramics as “Yabbas”, employing a traditional Jamaican term. Its use implies a link between a twentieth century African Jamaican Yabba pottery tradition practiced in Spanish Town

Figure 1. Pottery sellers in Kingston, Jamaica. Unknown photographer, late-nineteenth or early twentieth century. Courtesy of the Smithsonian Institution National Anthropological Archives. Neg. 92-246.

by potter Ma Lou and her daughter, Munchie, and archaeologically-recovered low fired earthenwares. Jamaican local pottery has been described by several researchers, including Armstrong (1990), Ebanks (1984), Hauser (2000), Higman (1998), Mathewson (1972a, 1972b, 1973), Mayes (1972), Meyers (1999), Pasquariello (1995), and Reeves (1997).

In its derivation, Yabba actually refers to the form rather than the specific method of manufacture or decoration. The term itself is believed to be either derived from the Twi word “ayawa’ meaning “earthenware dish” or a local ‘Arawak (sic)’ word for ‘Big Mouth’ (Mathewson 1972b:55). The strongest evidence of production comes from ethnographic accounts. In his analysis of a present-day Spanish Town potter, Roderick Ebanks (1984) described the method of manufacture for slipped Yabbas. Ma Lou made coiled pots that were smoothed with a piece of wood and evened with a scraper (Ebanks 1984:33). The pots were dried slipped with hematite and then burnished. Finally, the pots were fired with green wood (Ebanks 1984:35). Similar coiled pots were recovered from seventeenth century contexts in Port Royal (see below). Also represented in the archaeological record are glazed pots of a similar shape, which Ebanks termed “Syncretic.” The glazing presupposes a kiln firing for this particular type of pottery. There is absolutely no ethnographic evidence of production of this type of ceramic with the exception of oral history citing a large number of kilns along the Rio Cobre. The final type represented are untreated Yabbas.

1. Glazed Yabbas (Figure 2)—Glazed Yabbas appear to be made in a tradition similar to that described by Roderick Ebanks as syncretic wares. Breakage patterns in the sherds indicate that the pots are coil-made. Finger marks indicate that the pots are pulled even into a final form, and smoothed externally. These pots are relatively well-fired earthenware and oral history seems to indicate the use of a kiln. However, the presence of coring and variability in coring suggest that firing temperatures and lengths were inconsistent.
2. Slipped and/or Burnished Pottery (Figure 3)—Slipped and/or burnished Yabbas are indistinguishable from pots made by Ma Lou and Munchie. Breakage patterns in the sherds indicate that the pots are coil-made. Finger marks indicated that the pots are pulled even into a final form, and smoothed externally. These pots were fired at a lower temperature than the glazed Yabbas. The firing environments were highly variable, as evident from the clouding and coring
3. Untreated Yabbas (Figure 4)—Untreated Yabbas are friable. The clay is coarse and sandy. In the catalogue for his dissertation Hauser (2001) as irregular in texture. The clay is also well sorted. The clay is light brown. Coring is not common, and when it is present, it commonly indicates a reducing environment. The clay contains fine quartz and mica inclusions. These inclusions were recorded as fine in size and subangular in texture. These pots were made into a relatively few number of forms including small everted and vertical pots or open and restricted bowls

Figure 2. Glazed Yabba with handle. Yabba from the Marx Collection, Port Royal, Jamaica. Photograph by author.

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Figure 3. Slipped and burnished vertical pot. Yabba from the Marx Collection, Port Royal, Jamaica. Photograph by author.

Figure 4. Untreated Yabba with punctuated decoration. Yabba from the Marx Collection, Port Royal, Jamaica. Photograph by author.

The documentary record is limited in terms of the background of the people who made this pottery. There is only one source that attributes the manufacture of the pottery to people of African descent. Examination of archaeological ceramics, along with ethnographic analogues, is able to shed some light on who made the pottery and the manner in which it was traded. As Hauser has discussed elsewhere (Hauser 2006, 2007; Hauser and DeCorse 2003), the pottery would have been only one item of many traded in this system of markets. However, that being said, because Yabbas are one of the few items of material culture that survive in the archaeological record and speak directly to the independent production of enslaved laborers, they can speak to the silences of the documentary record on the scale and scope of the internal economy. In so doing, they give us an idea of the extent to which social networks were refashioned beyond the plantation community.

Low-fired ceramics have been found throughout the central region of Jamaica in contexts associated with the seventeenth, eighteenth, and nineteenth centuries. On rural sites, locally manufactured forms are usually excavated from domestic contexts related to the houses of enslaved Africans. In urban settings, however, low-fired ceramics have been recovered from contexts associated both with palatial structures, as in the case of King's House, (Mathewson 1972a, 1972b, 1973) and much smaller tenements in Port Royal (Mayes 1972). There are two potential reasons for this distribution: community based manufacture and distribution and regional based manufacture and distribution.

According to the first scenario, free and enslaved persons in urban and rural contexts would obtain their ceramics from a potter in the area of their residence. The simplicity of the forms and the crudeness of the manufacture would support a mechanism of localized manufacture and distribution. It would follow that ceramics in the study collection reflect local articulations, structurally and compositionally. Therefore, the ceramics would be compositionally heterogeneous.

The second scenario involves a centralized manufacture of pottery and an island-wide distribution. In this scenario, systems of trade and distribution, including transportation by itinerant sellers, would be responsible for selling pottery across a broad region to a number of communities. Indeed, the similarity of the ceramics' matrix, form, and decorative inventory suggest that a similar group of potters produced them. There is evidence suggesting that one such group of potters was located along the Rio Cobre River near Spanishtown, Jamaica. Currently, one of the few surviving pottery traditions with ceramics similar to those found in the archaeological record is produced in Spanishtown. In this scenario, we would expect a relative homogeneity of ceramic between sites from which the study sample was collected.

Both scenarios remain plausible given our current state of knowledge on ceramic manufacture and distribution in the eighteenth century. While ideally distinct, archaeological evidence could suggest that these two strategies are not mutually exclusive mechanisms of ceramic distribution. It is possible, for instance, to find evidence of both scenarios at a specific site; where one group of ceramics is produced and distributed locally and another group of ceramics is produced centrally and distributed island-wide. Determination of a ceramic recipe is required to identify the strategies of ceramic distribution.

Ethnographic and Documentary evidence of Ceramic Manufacture and Location

The documentary record provides some clues as to the potential location of historic potters and the sources from which they extracted the clays. Historical accounts of local pottery manufacture occur as early as the seventeenth century. While referring to the production of drip jars and sugar cones, Hans Sloane discusses local ceramic industries in 1687:

> Pots for refining sugar were made at the Liguanea, and though more brittle and dearer than when bought from England, they were made here to supply the present needs of the planters, the clay of which they are made is dug up near the place (Sloane 1707-1725:xlviii).

The importance of this excerpt is two-fold. First, it locates a viable clay source in the Liguanea plain where present-day Kingston is located. Second, as Handler (1963b) has pointed out in Barbados, the craftspeople most likely employed in these workshops were enslaved peoples of African descent. Sloane, however, is alluding to sugar-wares not, Yabbas. There are excerpts in which Slaone does mention local utilitarian ceramics. To link these to Yabbas, requires some degree of inference. Following such reasoning, Sloane indicates that the enslaved were using such pottery,

> The Negroes Houses are likewise at a distance from their Masters, and are small, oblong, thatch'd Huts, in which they have all their Moveables or Goods, which are generally a Mat to lie on, a Pot of Earth to boil their Victuals in, either Yams, Plantains, or Potatoes, with a little salt Mackarel, and a Calabas or two for Cups and Spoons (xlvii).

Sloane goes on to say about Jamaica clays in general, “There are very good Bricks and Pots made here of the Clay of the Country, to the easie making of which the few Rains, as well as plenty of Firewood conduces much” (xlviii).

In the eighteenth century, written evidence describes in vague ways pottery manufacture. An anonymous writer in 1797 describes the domestic utensils of enslaved African Jamaicans in the Columbia Magazine:

> Some negroes are expert in manufacturing pots and other common vessels on which they bestow a coarse glazing. Their pans (called Yabbas) are convex at the bottom without a ring as ours (Anonymous 1797:252; also in Armstrong 1990:293).

In 1774, Edward Long described these pots as "a better sort of earthenware, manufactured by the Negroes" (Long 1774 3:851). These pots were used primarily for cooking in the following manner: "The trivet for supporting the vessel in which he prepares his food, consists of three large stones" (Anonymous 1797:252; also in Armstrong 1990:292). Again, the document is ambiguous as to which kind of ceramic Long and the Anonymous author are referring to. The fact that long is referencing the earthenware as a “better sort” could mean he is describing the coarse, internally glazed, restricted, direct rimmed vessels. They are ubiquitous in the archaeological record of Jamaica and can be found as early as the seventeenth century.

Through a discussion of the clay sources used that appears in the same archival record, we know that the pots were manufactured locally. Speaking of the local clay sources on the island, Edward Long states:

> The first is used in claying muscavado Sugars as, well as for a better sort of earthenware, manufactured by the Negroes. The second is more frequent, and supplies the inhabitants with water jars, and other convenient vessels for domestic use. It is likewise most proper for tiles, and drips (Long 1774 3:851).

Edward Long is describing the alluvial soils found in the Liguanea plain around Kingston. In 1843, James Phillippo describes another source of clay used to manufacture these ceramics: "Particles of golden mica have been found in districts near the source of the Rio Cobre, and sometimes, near Spanish Town, it has been incorporated with the potter's clay" (Phillippo 1843:72). This source of clay, and the potters Phillippo is referring to, matches up with the ethnographically described present-day potters.

The problem with the documentary record is that it is sparse, ambiguous, and vague. It concentrates on the cataloguing of local manufacture, rather than on those who manufactured it. As such, from the documents alone it is impossible to ascertain who was actually making the pots, other than people of African descent. Questions left unanswered include: Who among the enslaved made these pots? How were they made? How did people learn how to make these pots? And, most importantly, in what context were they made?

The strongest evidence of local production is ethnographic. Two present-day descriptions exist for Yabbas. In research conducted for his master's thesis, Roderick Ebanks interviewed, and documented pottery manufactured by Ma Lou, Ms. Louisa Jones. The potteries responsible for the production of at least one type of Jamaican pottery in the early to mid-twentieth century was concentrated in family compounds and organized around female members of the family (Ebanks 1984). Roderick Ebanks recorded in 1984:

> Fanny Johnson [Ma Lou's mother] was a potter, as was her mother before her. The yard in which Mother Lou was born contained a large extended family of maternal aunts and their children. All of these aunts made pots, and almost every yard in the district was occupied by a family of potters. By the time Ma Lou was nine she and her female cousins had begun to learn pottery from her mother, three aunts, and uncle's wife (Ebanks 1984:33).

In the early twentieth century, Ma Lou had learned her skill from her mother, and pottery formed a family enterprise. Ma Lou had to become a domestic servant in the 1950s when the economy crashed:

Ma Lou continued to perfect her skills until the end of the 1940s, when the introduction of the aluminum pot all but destroyed the potting industry, which appears to have relied heavily on cooking pot sales to sustain it (Ebanks 1984:31). During this time, Ma Lou claimed, she lost much of the skill she had developed as a young child.

Beginning in the 1970s, a growing involvement by the middle class in Jamaican arts and heritage revived interest in Yabbas, especially those that evoked linkages to African traditions. Ma Lou began making Yabbas again for sale at craft markets and cultural expositions in Kingston. Her work became a celebrated embodiment of Jamaica's art and heritage (Francis-Brown 1983; Morgan 1989), and Ma Lou was sometimes mentioned in the same sentence as master Jamaican ceramicist Cecil Baugh. It is during this time that Roderick Ebanks conducted most of his interviews with Ma Lou.

Ma Lou passed away in 1992, and her daughter, Munchie, took up her trade. Moira Vincentelli has recently interviewed and recorded the production of pottery by Munchie, Marlene Roden (2004). Munchie learned the trade from her mother, a transmission of knowledge that seems to be rooted in kinship ties focused on matrifocal house yards (Ebanks 1984:3; Vincentelli 2004:125). This transmission, at least from conversations Hauser had in 1999 and 2007, does have some material evidence (Hauser 2008).

In 1999, when Hauser asked Munchie how he would be able to tell the differences between her mother's pottery and her own, she laughed. She then went on to tell me that her mother's mark was made pressing her pinky fingernail into the rim three times. Munchie made four marks. Hauser then asked if her daughter would make five. She laughed and said, "No–maybe my son," and pointed to her son, who was arranging pottery to sell to me. In her house yard, all the children helped her collect the clay and fuel, prepare the clay, and sometimes shape the pottery. In 2007, Munchie was still selling pottery, though not making as much. Her son still had interest, but as Munchie said, no one comes by to buy Yabbas anymore. While the focus of pottery manufacture was certainly around these two women, a host of individuals is involved in the production and sale of the pottery. It can be inferred from the above quote that the other individuals might have been members of the potters' family.

There is little ethnographic evidence of the production of glazed Yabbas in the twentieth century. On January 13th, 1970, Henia and Jerome Handler conducted several interviews with Cecil Baugh, a master Jamaican potter. In this interview, Baugh described how he first became interested in making pottery and how he learned the craft. During this discussion he alluded to both the glazed and slipped Jamaican ceramics. He said that Yabba, “should only be applied to bowls, large or small, of earthenware” (Henia Handler Notes January 13th, 1970, courtesy of Jerome Handler). Several days later Baugh went on to describe potters living along Mountain View Road in Kingston…

> If a woman was good at making yabbah she might produce several dozen a day. They were given to people to sell in town, ‘mostly Syrian’, who would carry them down and make ‘l00 percent profit’. A small yabbah about five inches high, 8 inches across were sold to the seller at a shilling a dozen. The seller would sell them for 2 pence or threpence a piece (Henia Handler Notes January 15th, 1970, courtesy of Jerome Handler).

Earlier in the twentieth century, Martha Beckwith mentioned,

> In old days the calabash and the great clay jar called "panya" (Spanish) were the common receptacles, with a gourd for a carrier poised upon the head. . . . Today the kerosene can is the common carrier. I have seen children of eight or

> ten carrying such cans of water on their heads from the brook. . . . Earthen bowls, hand-turned and covered with a rude glaze, are always to be had in the Kingston market, but they are more rare in the hills where the old-time "yabba" is being supplanted by tinware (Beckwith 1929:47).

We must also use, however, the above quote with a degree of caution. Certainly, the excerpt demonstrates that the pottery was involved in a circuit of commodity distribution. However, it also demonstrates how technological innovations, global shifts in production, and trade had a real impact on the market for the "old-time 'Yabba.'"

Markets and Pots

In the eighteenth century, the pottery described above was one of many items in circulation among enslaved and freed peoples of African descent. The locus of this internal trade was a series of Sunday markets established by law to assist in the provisioning of enslaved laborers on the plantation and to facilitate the distribution of provision ground produce to urban populations. The markets were a meeting place of people and commodities. They were the point where imported and local goods were bought and were sold. The documentary record enables a great deal of inference in pottery manufacture and consumption. The same evidence more directly addresses the sale of local pottery on the Sunday street markets and through higglers [derivation of haggler]—itinerant, free, and enslaved traders. A 1711 legal code states, in reference to a prohibition against slaves selling goods, "This restraint is construed to extend only to beef, veal, mutton and saltfish; and to manufactures, except baskets, ropes of bark, earthen pots and such like" (Long 1774, II:487).

In 1793, Bryan Edwards recorded that, "Upwards of ten thousand assemble every Sunday morning in the market of Kingston where they barter their provisions, etc. for salted beef and pork, or fine linen and ornaments" (1793:125).

He goes on to say.

> Some of them find time on these days to make a few coarse manufactures, besides raising provisions, such as mats for beds, bark ropes of strong and durable texture, wicker chairs and baskets, earthen jars and pans ready for sale (1793:125).

The markets continued into the nineteenth century. In 1843, James Phillipo notes that Yabbas and earthen jars were sold on the Sunday markets along with mats, baskets, and other products of African Jamaican manufacture (Phillippo 1843:72).

The pottery, though a small aspect of this trade, remains a durable and archaeologically visible component. We therefore cannot assume that the pottery found in archaeological excavations are the result of village-based systems of production and distribution.

Archaeological Analysis

Focusing on eighteenth century pottery, this study attempts to determine the extent to which local ceramics were distributed through the market systems of Jamaica. Adopting an approach in which ceramics are items of exchange in a network of market systems requires a focus on distribution and provenance.

To talk about a single type of Yabba or colonial Jamaican ceramic misrepresents the archaeological assemblage and the variation in production strategies of eighteenth-century potters. Even if the ceramics were uniform, they would not represent the diversity of peoples arriving in Jamaica between 1655 and 1807. Low-fired ceramics have been found throughout the central region of Jamaica in contexts associated with the seventeenth, eighteenth, and nineteenth centuries. These contexts include domestic assemblages from house yards of slave villages, middens from Planter's houses, urban tenements, and town houses. In the eighteenth century, the ceramics seem to be an in-demand item of local manufacture that is relatively standardized and found in archaeological contexts across the island. This raises a question, however, about whether the lack of decoration and reduction of variation in forms mirrors a trend followed by artisans in different communities across the island of Jamaica, or whether it represents the consolidation of a single locus of ceramic manufacture.

Archaeological Context

Hauser examined ceramic collections from eight previously excavated sites dating to the eighteenth century and collected samples for further analysis. The sites chosen for this study offered excellent chronological and spatial control. These sites include Seville and Drax Hall excavated by Douglas Armstrong; Juan De Bollas and Thetford excavated by Mathew Reeves; Old King's House in Spanish Town excavated by Duncan Mathewson; Old Naval Dockyard, Port Royal excavated by Philip Mayes; and Saint Peter's Church, Port Royal excavated by Anthony Priddy.

Overall, these sites represent an occupational history that extends from the seventeenth century to the twentieth century. Ceramics were recovered from contexts associated with house-yards of enslaved laborers at Seville (Armstrong 1999), Drax Hall (Armstrong 1990: 74), and Juan De Bollas (Reeves 1997:50); provision grounds the laborers worked at Thetford (Reeves 1997:43); domestic assemblages that the enslaved used to cook for themselves and for their masters at Drax Hall (Armstrong 1990: 74) and Old Kings House (Mathewson 1972:3); and urban residences of enslaved and freed laborers at St. Peter's Church (Brown 1996:23) and Old Naval Dockyard (Mayes 1972:6).

Each site contained discrete eighteenth-century cultural deposits that enable an analysis of associated 'local' ceramics (Figure 5). These contexts were distinguished through a combination of associated material culture (Armstrong 1990, 1999; Mayes 1972; Reeves 1997); sealed archaeological contexts associated with known construction events (Armstrong 1998; Mathewson 1972) and geological events such as earthquakes (Brown 1996; Mayes 1972;). To ensure that ceramics examined did indeed originate from the eighteenth century, TPQ90 of associated imported material were a primary determinant in establishing chronological control.

Geological Context

Jamaica is a geologically diverse island (see Figure 6) with considerable mineralogical variation in clay deposits located across the island (Bailey 1972). The island is divided into two blocks: the Cornwall-Middlesex Block and the Blue Mountain block, separated by the Wagwater trough in the area of Mona Heights (Robinson et al. 1970:2). Distinct to the northern and western coasts of Jamaica is the coastal formation, which is dominated by sandy calcarenite, silts, and

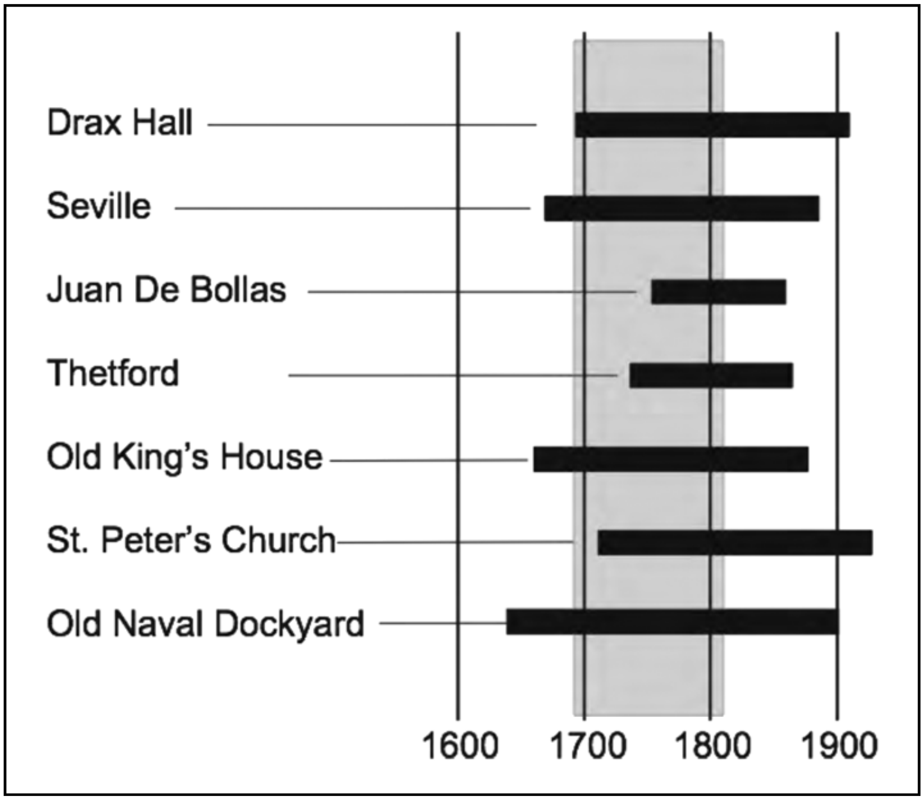

Figure 5. Chronology of sampled archaeological sites in seventeenth, eighteenth, and nineteenth century Jamaica. Chronology is based on documented occupation as well as associated material culture. Illustration by author.

bedded limestones. Texturally, sediment tends to be produced by high-energy processes, which has implications for the texture and shape of detrital mineral inclusions. Jamaica has two major limestone groups, which form a large component of Jamaica's bedrock. The Newport, Browns Town and Claremont group characterize the White Limestone formation, formed in the late Tertiary. The Yellow Limestone formation is characterized by the Chapleton and Font Hill formation. Whereas the Chapleton and Font Hill formations are found throughout the island, rocks of the Claremont are volumetrically most abundant, followed by the Browns Town formation (Robinson et al. 1970:2–6).

There are nine major inliers, three of which are important to this study: the Above Rocks granodiorite (Early Albian), the Blue Mountain and eastern Wagwater belt (Mastrichtian), and the Saint Ann's Inlier (Santonian) (Robinson et al. 1970:5). These inliers, which are of Cretaceous volcanic, metamorphic, and plutonic rocks, extend from Negril to Saint Thomas in an east-west direction.

Clays from Jamaica have been examined mineralogically by Bailey (1972). Potential sources for clay include Saint Catherine's Rio Cobre alluvium (Phillipo 1843; Reeves 1997:184), Hope River sediment in Saint Andrews, and riverine deposits in Saint Ann's. Saint Catherine's contains red burning clay deposits (Bailey 1972:1) near Bog Walk

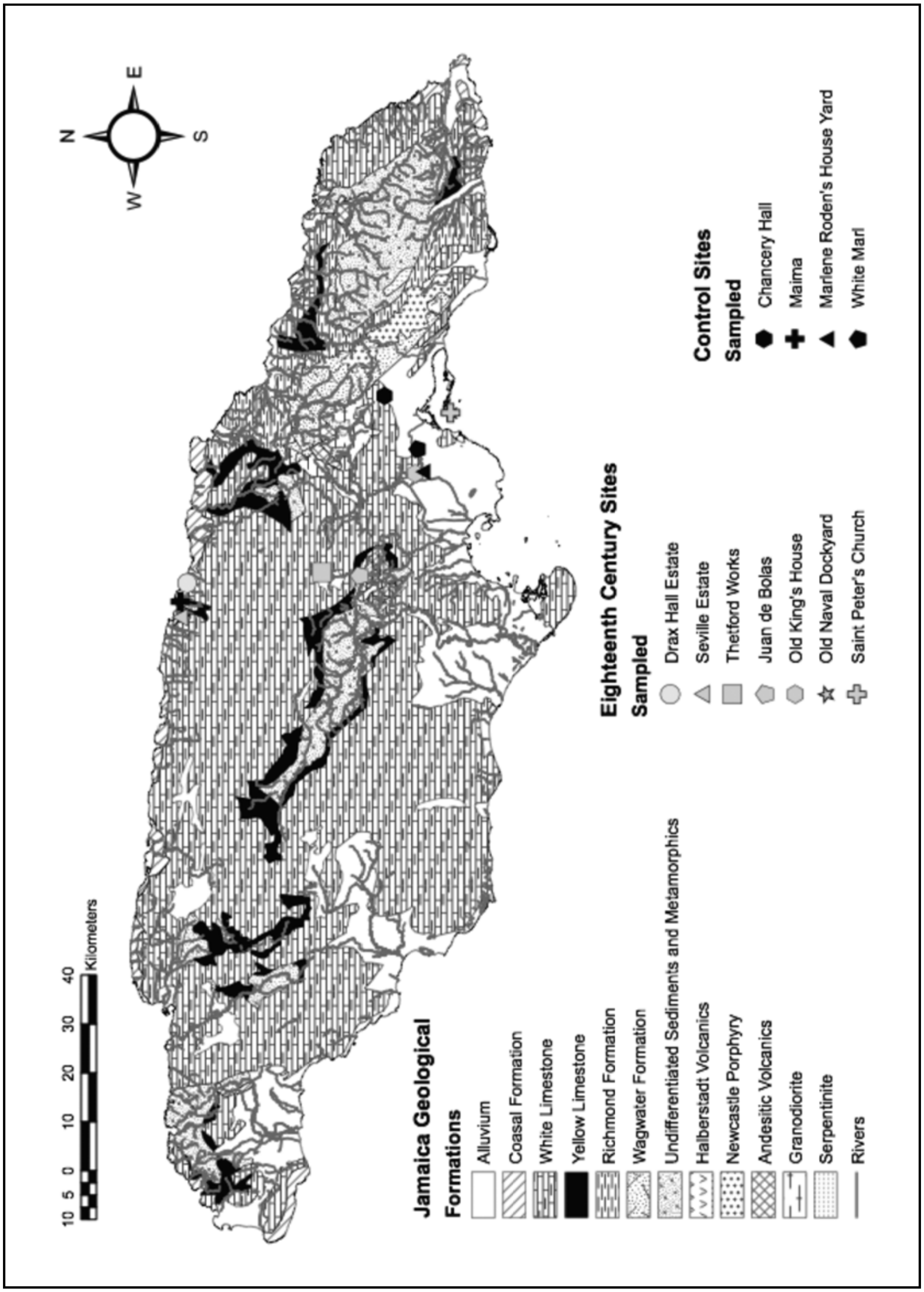

Figure 6. Geological map of Jamaica with the location of sites included in petrographic analysis. Adapted from the Jamaican Geological Survey (1969). Illustration by author.

and “silty, slightly contaminated, cream colored clays” near Spanish Town (Bailey 1972:3). At Bog Walk, clays are located in the region of Tulloch. They are reported to be of high quality and contain only limestone and organics as impurities (Bailey 1972:1).

In Spanish Town, the clay was most likely extracted from an alluvial deposit known as the older Liguanea gravels. This deposit formed when the Rio Cobre, which now flows directly into Kingston Harbor, flowed into Galleon Harbor (Green and Black 1970:8). Texturally, this alluvium is comprised of coarse gravels, sands, and clay. Mineral inclusions in these alluvial clays include residual clasts from the Above Rocks granodiorite inlier (Bailey 1972:3). Sediment derived from erosion of this granodiorite should contain large simple quartz grains.

Petrography

A sample of one hundred sixty-four sherds from the collection of excavated archaeological ceramics discussed above were examined petrographically by Mark Hauser. The sampling strategy concentrated on glazed, slipped, and untreated ceramics from each of the historic context sites (n=138). We also included ceramics of probable English and Cuban, yet unknown, origin (n=12). In addition, we included a control sample of prehistoric ceramics recovered from Chancery Hall (n=4) White Marl (n=5) and Maima (n=5) along with ethnographic ceramics recovered from Munchie’s House Yard (n=2). Initial cuts were made along the vertical axis of the pot beginning at the lip of the rim sherd at the Heroy Geological Laboratory at Syracuse University. Mark Hauser (2001, 2008) analyzed the ceramics qualitatively, noting mineral identity, size, angularity, alteration in the minerals, and relationship to each other, as well as point counting.

Previous research using petrographic analysis showed that there was limited variation in the clay sources used to produce glazed and slipped Yabbas (Hauser 2001, 2006, 2007, 2008). Detrital inclusions identified in thin section seem to resemble most closely clays recovered from the Rio Cobre around Spanish Town.

Following techniques described by Stoltman (1989, 1991, 1999), sherds were examined through a technique called point counting. Specifically, a multiple intercept approach was used (Middleton et al. 1985:66); this is essentially a systematic sampling technique in which the microscope stage is advanced at a set interval. The petrographer records the mineral at the center of the field of view. Each grain is measured regardless of whether or not it has already been recorded. Stoltman suggests that 100 observations be made at 1 mm intervals exclusive of voids in the clay. Whereas 100 observations is expedient in analysis and far more than the conventional wisdom of 50 counts (Peacock 1971), it is far less than the 150 suggested by Leese (1983:49) and 200 suggested by Fieller and Nicholson (1991:88). In this study, 385 observations were used, exclusive of voids, to describe the mineralogical variation.

The mineralogical identity of the inclusion, its size, shape, and angularity were recorded. The relative abundance of specific minerals and their shape give some indication of the relative maturity of the source materials. Several minerals were significant in the overall analysis of the composition of the ceramics: quartz, potassium feldspar, and plagioclase feldspar.

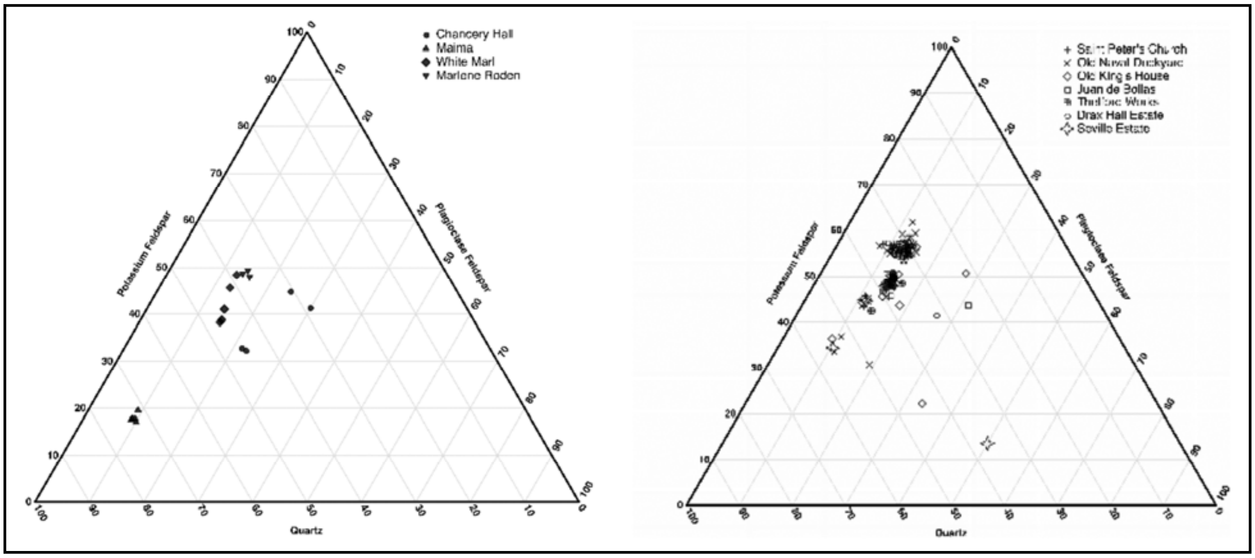

Figure 7. Ternary diagram showing the diversity of ceramic recipes used to make Yabbas (right) and Control (left) samples. Quartz includes mechanically deformed, mechanically altered, and simple quartz. Potassium feldspar percentages are based on the combination of all alkali feldspars including potassium feldspar, perthite, microcline feldspar, and sanadine. Plagioclase feldspar includes non-altered and chemically altered plagioclase. Crystals included in foliated lithic fragments were not included in the count. Ellipses are not statistically derived.

The primary mineral components of the ceramic samples are a fine clay matrix, potassium feldspar, plagioclase feldspar, and quartz. To assess the compositional variability in the parent rocks of the source material, the relative abundances of the three minerals were normalized to percentages on ternary diagrams. The prehistoric pottery was examined to see if there would be significant variation in the composition based on location. One can distinguish the Maima ceramics, which have about 55 percent quartz and about 45 percent total feldspar and the Chancery Hall and White Marl ceramics, which have from 10 to 30 percent quartz and 40 to 60 percent total feldspar (Figure 7). What is interesting is that samples from both White Marl and Chancery Hall are heterogenous and the source material used to make all nine ceramic sherds is incredibly varied. The five ceramic sherds recovered from Maima seem to be relatively homogenous and distinct from the White Marl and Chancery Hall ceramics. This underscores the utility of petrography, which is highly sensitive to variation in the sediments used to produce pottery.

In Figure 7, we plot the relative abundances of quartz, plagioclase feldspar, and orthoclase feldspar normalized to percentages on a ternary diagram. It is apparent that there are several distinct clusters. What is important in this analysis is that several of the groups contain samples from each of the archaeological sites (Table1).

Four of the compositional groups interpreted from petrographic analyses contain inclusions consistent with the alluvial sediments from the Rio Cobre in the region of Spanish Town. This includes abundant potassium feldspar, quartz, plagioclase feldspar, laterite fragments, and minor amounts of biotite. Of note was the recrystalization of quartz indicating a metamorphic source material for the clays

Table 1. A cross tabulation of groups represented from samples plotted on the ternary diagram and their provenance

		Petrographic Group					
	Site Name	*2*	*3*	*4*	*5*	*NA*	*Out*
Plantation Sites	*Sevillle*	5	3	1		2	1
	Drax Hall	6	1	1	1	1	
	Juan de Bollas	1	6	1	1	2	
	Thetford	2	9	1	1		
Urban Sites	*Old Kings House*	13	13	4	2	3	1
	Old Naval Dockyard	16	13	2	2	3	2
	St. Peters Church	13	8	2	6	1	
Ethnographic	*Munchie*		2			1	
	Grand Total	***56***	***55***	***12***	***13***	***14***	***4***

used to construct the pottery. One of the compositional groups contained inclusions that were consistent with sediments from the Liguanea Plain around Kingston. These soils had considerable amounts of feldspar and quartz, but also contained high quantities of arkose fragments. Finally, one group contained smaller inclusions of quartz, potassium feldspar and plagioclase feldspar. This compositional group is significantly different from sediment in both the Liguanea and the Rio Cobre.

To see how similar the four compositional groups were to Rio Cobre clay sources, archaeological and ethnographic samples were analyzed by instrumental neutron activation analysis (INAA). The ethnographic samples came from the waster pile of Munchie, one of the last remaining traditional potters working in Jamaica. Clay sources used in her analysis have a known provenance.

Instrumental Neutron Activation Analysis

Fifty-one ceramic specimens from eighteenth century archaeological contexts in Jamaica were submitted for INAA at the University of Missouri Research Reactor Center (MURR). These ceramic specimens comprise sherds representing three types from eight archaeological sites (Drax Hall, Juan de Bollas, Munchie, Old Kings House, Old Naval Dockyard, Saint Peter's Church, Seville, Thetford) in Jamaica's central corridor. These types include glazed (n=18), slipped (n=27) and untreated Yabbas (n=4).

The samples underwent neutron activation analysis at MURR where they were subjected to methods of sample preparation, analysis, and data reduced in manners consistent with procedures described in the introductory chapter. A two-group structure was identified in the ceramic specimens: Group 1 (n=19) and Group 2 (n=27). Chemical characteristics for the two compositional groups are represented in Figure 8. Group 1, a distinct compositional group, tends to be enriched in sodium relative to compositional Group 2. A cut-off of 1% was generally used to refine the membership of the groups, however, exceptions were made based on the graphical representation of the data. Three specimens (6%) could not be assigned to any of the identified compositional groups

There is some variation within Group 1 and it may be comprised of sub-groups (see Figure 9). Group 1a is characterized by enriched sodium concentrations and depleted arsenic concentrations when compared to Group 1b. We decided to "lump" rather than "split" Compositional Group 1 because there does not appear to be any archaeological meaning to splitting this group at the moment. Although highly mobile elements such as sodium and other alkali metals might belie patterns derived from post depositional environments exposed to sea water such as Port Royal and Seville, this does not seem to be born out in the group membership table (Table 2).

Compositional Group 2 subsumes much chemical variability and is enriched in hafnium and thorium when compared to compositional Group 1. It is highly probable that analyzing more samples will allow us to identify subgroups within Group 2 (Figure 9).

Despite the large membership of the compositional groups, tentative patterns can be identified when investigating the

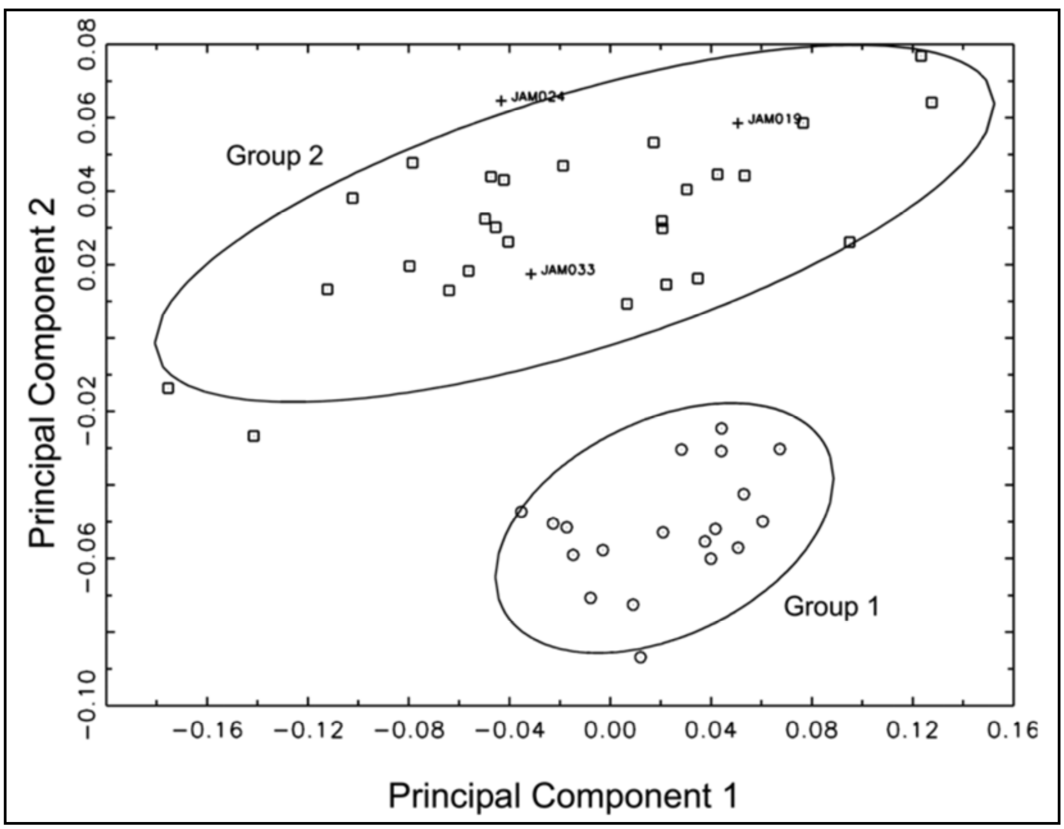

Figure 8. Biplot of principal components 1 and 2 displaying two compositional groups and labeled unassigned specimens (+). Ellipses represent 90 percent confidence level for membership in groups.

Table 2. Summary of compositional groups attributed to ceramic samples through INAA.

		Chemical Group					
	Site Name	*1a*	*1b*	*2*	*Out*	*U*	*Total*
Plantation Sites	*Sevillle*	2	1	3			6
	Drax Hall	1	3	2			6
	Juan de Bollas	1		4	1		6
	Thetford			4		2	6
Urban Sites	*Old Kings House*	1	5	5		1	12
	Old Naval Dockyard	2		4			6
	St. Peters Church	1	2	3			6
Ethnographic	*Munchie*			2	1		3
	Grand Total	***8***	***11***	***27***	***2***	***3***	***51***

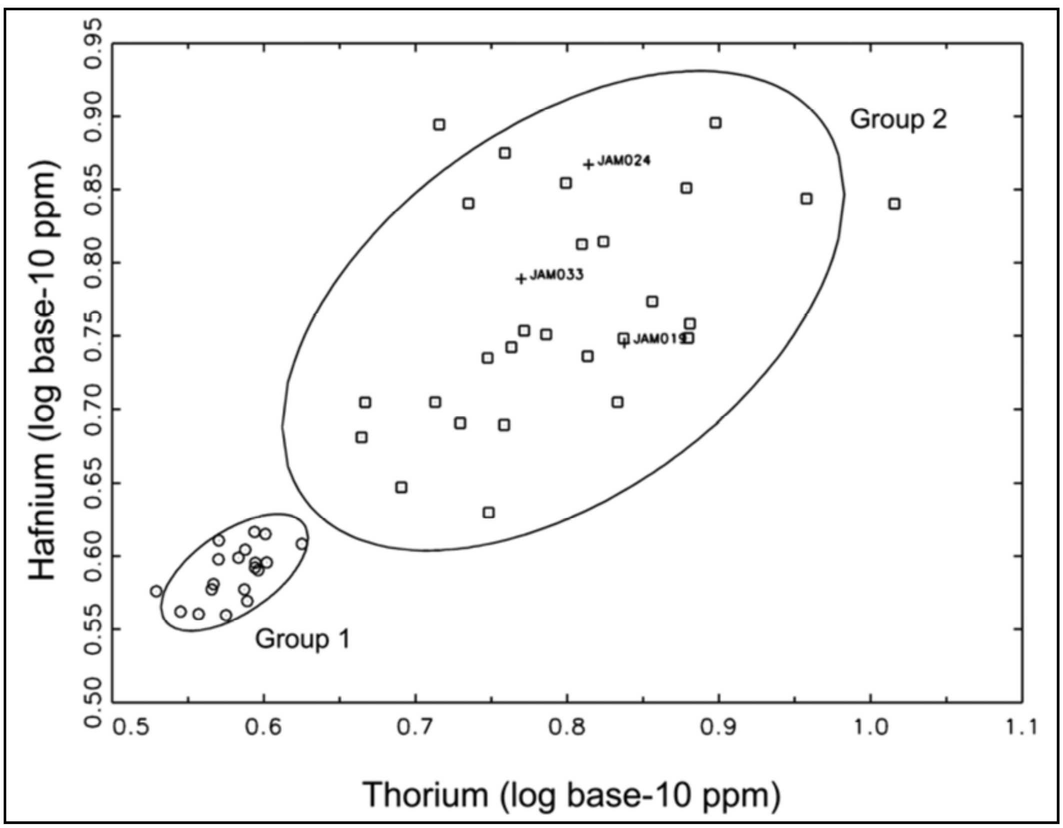

Figure 9. Bivariate plot of base-10 logged thorium and hafnium concentrations showing the chemical distinctiveness of the two compositional groups. Ellipses represent 90 percent confidence level for membership in the groups. Unclassified samples (+) are labeled.

decoration of the sherd members in each group. Compositional Group 1 members are predominantly Yabba with internal glazing, whereas compositional Group 2 members tend to be pots with vertical rims, and slipping and burnishing for decoration. We analyzed the glazed surface of specimen JAM002, a member of Compositional Group 1, with a non-destructive energy dispersive X-ray fluorescence (EDXRF) spectrometer and determined that the glaze has high concentrations of lead as would be expected for glazed pottery of this period.

Ceramic specimens from six of the eight sites have membership in both compositional groups (Figure 10). Two sites have ceramics that belong only to Compositional Group 2. But for two unassigned specimens, all of the sherds collected from the slave village contexts of the site of Thetford have membership in Compositional Group 2. Except for a single specimen that was considered an outlier and not included in the study, ceramic sherd specimens from the ethnographic contexts of the site of Munchie (Marlene Roden) only belong to Compositional Group 2.

The INAA study identified two distinct ceramic compositional groups. Possible tendencies or associations between the chemical compositions of the sherds, their provenience, and their ceramic decorative styles were identified. The study is incomplete, given the importance of sample

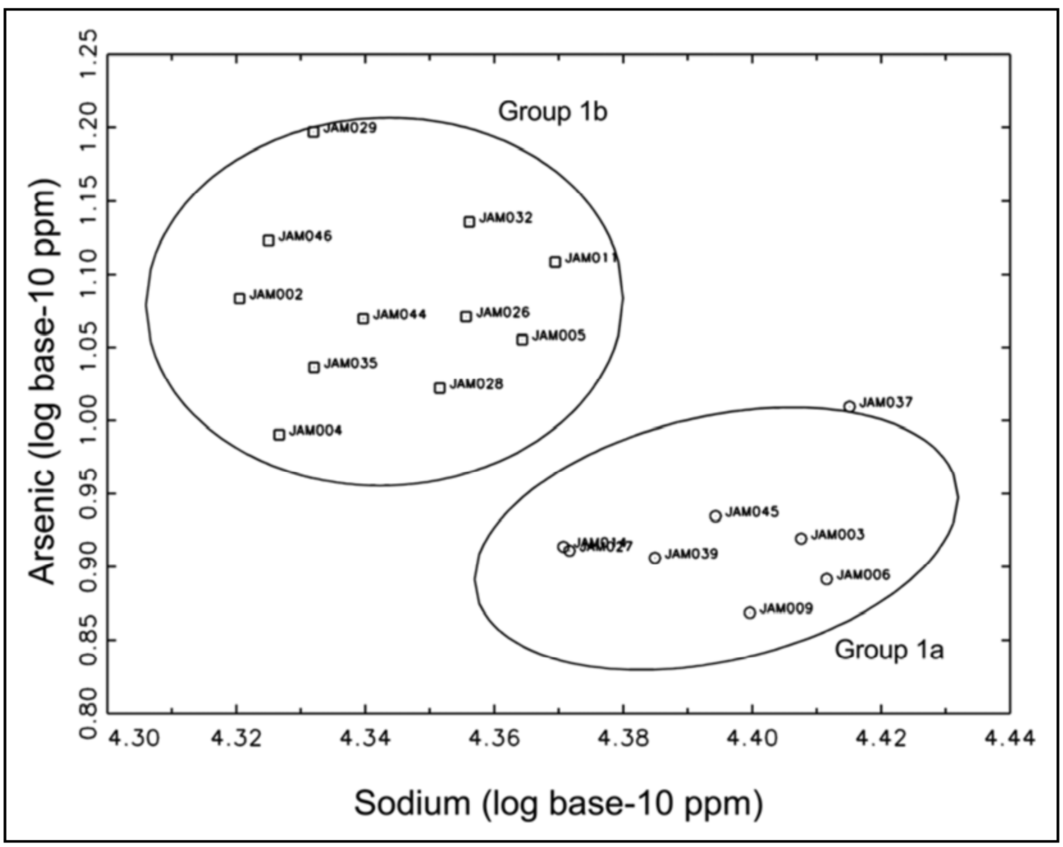

Figure 10. Bivariate plot of base-10 logged sodium and arsenic concentrations showing two possible subgroups within compositional group 1. Ellipses represent 90 percent confidence level for membership in the groups. Unclassified samples (+) are labeled.

size in establishing patterns where no geological source samples are used. The submission of more samples from these contexts could further test these identified patterns as well as delineate more groups and subgroups. Overall, the patterns of ceramics and the delineated groups seem to conform with groups established through petrographic description. Most importantly, the study indicates that samples recovered from across the island were employing similar ceramic recipes.

At this early stage, it is difficult to ascertain what the chemical compositional groups represent. Determining whether the identified compositional groups refer to local or exotic sources will require the submission of raw clay samples for chemical analysis or the mineralogical analysis of raw clay samples. However, using the criterion of abundance, it is safe to assume that both compositional groups are of local origin and that chemical differences are attributable to different local sources of raw clay, different ceramic recipes, diverse uses, or a combination of all these potential factors.

Correspondence

In general, the two methods employed in this analysis, petrographic analysis conducted by Hauser in 2000, and INAA performed by Descantes, Speakman, and Glascock in 2005, have some amount of agreement in the degree of variation and the amount of recipes (See Table 3). In general, the majority of ceramics identified as Chemical Group 1 were identified as Petrographic Group 2 (n=15). Similarly the majority of ceramics identified as Chemical Group 2 were identified as Petrographic Group 3 (n=15). The correspondence is not perfect, however. Several samples identified as Chemical Group 1 were identified as Petrographic Groups 3 (n=1), Group 4 (n=1), an Outlier (n=1), and NA (n=1). Several samples identified as Chemical Group 2 were also identified as Petrographic Groups 2 (n=2), 4 (n=4), 5 (n=5), and NA (n=1). With these two analytical techniques combined, there seems to be a high correlation between compositional groups and the archaeological types of ceramics recovered. In general, Chemical Group 1 ceramics and Petrographic Group 2 ceramics are glazed Yabbas. Chemical Group 2 and Petrographic Group 3 ceramics tend to be slipped Yabbas. As was indicated above, Chemical Group 2 was considerably varied and might contain potential subgroups. Similarly, slipped Yabbas are the most varied type of ceramic material. This could be a function of sampling error, but it could also suggest

Table 3. Correspondence of Archaeological Types (Gl.:Glazed, Sl.:Slipped, N.:None), Chemical Types (Chem. Grp.), and Petrographic Types (Petr. Grp.).

		Treatment			
Chem. Grp.	**Petr. Grp.**	*Gl.*	*Sl.*	*N.*	***Grand Total***
1	*2*	13	2		***15***
	3		1		***1***
	4	1			***1***
	NA	1			***1***
	OUT	1			***1***
2	*2*		2		***2***
	3	1	12	2	***15***
	4	2	2		***4***
	5		5		***5***
	NA			1	***1***
Out	*NA*		2		***2***
U	*2*		1		***1***
	3		2		***2***
Grand Total		***19***	***29***	***3***	***51***

Table 4. Cross tabulation of sample membership in chemical and petrographic groups.

Chemical Group	**Petro Group**	*Drax Hall*	*Seville*	*Thetford*	*Juan de Bollas*	*Kings House*	*Naval Dockyard*	*St. Peters Church*	*Munchie*	***Grand Total***
	2	3	2		1	4	2	3		***15***
	3					1				***1***
1	*4*	1								***1***
	NA					1				***1***
	OUT		1							***1***
	2		1					1		***2***
	3	1	1	3	1	3	3	1	2	***15***
2	*4*			1	1	1				***4***
	5	1	1		1	1		1		***5***
	NA				1					***1***
Out	*NA*				1					***1***
U	*2*			1						
	3			1		1				***2***
Grand Total		***6***	***6***	***6***	***6***	***12***	***6***	***6***	***3***	***51***

potential multiple locations of manufacture. However, the fact that five of the slipped Yabba samples are grouped as Chemical Group 2 and Petrographic Group 5 supports the possibility that there are potential sub groups that are captured using qualitative and semi-quantitative techniques like ceramic petrography and point-counting that are not statistically significant from the larger group. This might indicate variation in the recipes employed by the potters or the sources the potters used.

Turning back to the question of relative provenance, whether or not archaeological ceramics recovered from the south coast were made using the same recipe as archaeological ceramics recovered from the north coast, an analysis of compositional groups and their distribution across the island is telling (Table 4). Samples identified as Petrographic Groups 2 and 3 were recovered from each of the archaeological sites in the study area. Samples identified as Chemical Groups 1 and 2 were also recovered from each of the historic period sites. Each of these groups does have some degree of variation.

To combine the different analyses as a measure of further precaution, we still find similar distributions. Samples identified as Chemical Group 1 and Petrographic Group 2 were recovered from the north coast (Drax Hall, Seville); central (Juan de Bollas and King’s House) and the south coast (Naval Dockyard and St. Peter’s Church). These samples were glazed Yabbas and similar to those that Cecil Baugh described as being made on Mountain View Road. The fact that there were none found in Thetford is a function of their low abundance in the overall assemblage of that excavation’s collection. Samples identified as Chemical Group 2 and Petrographic Group 3 were recovered from all seven historic period sites sampled and the control sample from Munchie’s houseyard.

These samples were slipped and burnished Yabbas and are similar to those described by Edward Long, Hans Sloane and Roderick Ebanks.

We actually anticipated finding a considerable amount of variation in the pottery. This came from my visual inspection of the pieces and from what the previously published studies on analogous pottery on other islands were. Essentially the results of both the petrographic description and INAA confirm that pots recovered archaeologically from the sites located on the north coast appear to be made using the same ceramic recipe as pottery recovered from the south coast and the central part of the island. In addition, it appears that the recipe employed by Munchie, at least in the case of two samples, is similar to the recipe used in the eighteenth century for slipped and burnished ceramics.

Conclusion

While these results do not necessarily indicate an island-wide system of distribution, the scale of production is certainly larger than we had anticipated. Many archaeologists studying colonowares in the South East have argued that these ceramics made by enslaved women during their free time were for their own use or the use by others in the slave village. We would like to highlight the point that most believed, because of the fragility of ceramics and because of the assumption of the kinds of industry the enslaved could undertake, that the manufacture and the distribution of colonoware would be local. This is derived from a sound logic based on the facts that Yabbas could not easily be transported between parishes and that potters could not produce enough to meet a regional demand. Rather, what we see are ceramics made by different potteries but recovered from sites on the north and the south coast. Coupled with the documentary record, we can use this information to infer a trade in ceramic materials between both coasts with little to no facilitation by the planting class. Not only does this give us a venue into understanding enslaved craft production, it also gives us an ability to evaluate and track the flow of commodities with the enslaved's own economic system. The pots that were in Seville and St Peter's Church were not in-and-of themselves mobile, nor was there a natural conservancy in their use. They were moved by people who were, in many cases, enslaved, and their mobility, at least in legislative terms, circumscribed.

In Jamaica, the partial nature of the documentary record leaves much room for the interpretation of internal market exchange and pottery production. More so, the ethnographic evidence of contemporary potters in the Caribbean producing analogous ceramics point to small-scale production but an unstable market and an early twentieth century crash in the demand for pottery. While suggestive, hints about the scale of pottery production and distribution can be gleaned from oral histories of Munchie and others. Archaeological evidence indicates that ceramic production of Yabbas, though highly variable was focused in a limited number of locations for three centuries. Note that we do not indicate an exact provenance for the production of the ceramics. We do not know necessarily where they were made, we only have a good idea that ethnographic examples retrieved from Munchie's house yard have the same chemical constituency as Petrographic Group 3 and Chemical Group 2. The analysis described above gives us an answer, though partial, about the extent of commodity flow. To speculate from this set of archaeological data, our understanding of commodity flow has an enormous impact on our understanding of Jamaica's economy as a whole.

We are also left with some unresolved and some archaeologically unanswerable questions. Was the clay traded across the island or the pottery? Were the potters afforded the same kind of mobility to hawk their wares or was this an activity monopolized by the higglers of Jamaica? How do we explain the innovations responsible for the production of glazed Yabbas? How also do we account for the demise of the industry that made "old-time 'yabba'" with the introduction of tin and aluminum crockery?

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