Exploratory Steatite Source Characterization in the Long Island Sound Watershed

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Mark Stephenson Tweedie

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Abstract of the Thesis

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For as long as humans have incorporated stone into their material culture, they have used cooperative strategies (i.e., exchange networks) to mitigate the uneven distribution of available resources on the landscape. The procurement, transport, and selective distribution of lithic materials are thus uniquely human social institutions. One of the few ways to examine the limited evidence for this behavior in the archaeological record is through the geochemical characterization of artifacts and their potential source areas. Steatite cooking vessels recovered on the outer coastal plain of Long Island, New York, are unique in that their acquisition required water-borne transportation from quarries in Connecticut, Massachusetts, or Rhode Island. This research project employs techniques of material source characterization to examine the geographic context for steatite vessel exchange in a discrete study area, the Long Island Sound Watershed. Energy Dispersive X-Ray Fluorescence (EDXRF) was performed with a Bruker Tracer III-V hand-held/portable X-Ray Fluorescence (HHpXRF) unit on steatite artifacts from Long Island archaeological sites, in conjunction with samples collected from prehistoric steatite quarries, historic mines, and geological source areas. From these preliminary data, long-held assumptions about the structure of steatite utilization in Northeastern prehistory can begin to be addressed. Ultimately, this research attempts to establish what geological outcrops were the source(s) for the vessels found on Long Island, and what watershed corridors were the physical conduits for prehistoric trade. EDXRF data suggests that steatite vessels and smoking pipes transported to Eastern Long Island, New York came primarily from two source areas in Rhode Island: the Oaklawn and Ochee Springs quarries.

I dedicate this research project to my Mother,
Donna Stephenson Tweedie.
You are truly missed.

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Acknowledgments

This project began in the summer of 2008, at the Data Recovery Project for the Skunk Lane Trust Property in Peconic, New York. At this idyllic, bay-front setting, under the cool shade of mature oak and hickory trees, the Institute for Long Island Archaeology was excavating a prehistoric village when twenty-five fragments of what appeared to be a single steatite vessel was recovered. My excitement could not be contained by this discovery, as my interest in Long Island archaeology was inseparable from my fascination with steatite vessel technology. No other artifact class seemed to achieve an equivalent level of prestige to the prehistoric peoples of Long Island. Therefore, any chances to better understand its economic, geographic, and social context are invaluable contributions to the prehistory of Southern New England. Hence when beginning with the Master's program at Stony Brook University, I was elated when my Thesis Advisor at the time, Dr. David Bernstein, suggested that I pursue the challenging task of conducting sourcing analyses on steatite vessels from Long Island.

Artifact source characterization endeavors are interdisciplinary experiments that require the expertise of many different academic specialties. Archaeometric research projects of this nature could never be accomplished by a single person; they are always a product of collaborative efforts. A multitude of enthusiastic archaeologists, geologists, chemists, and museum curators were instrumental in helping facilitate this research. My tremendous appreciation for their assistance cannot be overemphasized; specifically I would like to thank my Advisors David J. Bernstein and John Shea (who took over after Prof. Bernstein retired), as well as E. Troy Rasbury, Nina Versaggi, Joseph Waller, Nicholas Bellantoni, Cheri Collins, William Turnbaugh, Dick Boisvert, Bruce Bailey, Katherine Aubrecht, Daria Merwin, Joseph Boo, Steven Jaret, Amy Folk and the Oysterponds Historical Society. In addition, I would like to thank all my family and friends for their endless support and encouragement over the years.

One of the most critical, but time consuming aspects of this investigation was acquiring the artifact and quarry sample base, and in turn regularly communicating with several outside researchers. In the early stages of my research I came in contact with Dr. Brad Van Gosen, the Talc Specialist for the United States Geological Survey whose focus is the study of ultramafic bedrock exposures that support talc formation. His keen interest in my research project facilitated a series of correspondence that were critical in helping me understand the many geological contexts in which steatite could be derived; and also that detailed analysis of existing geological maps from the study area were essential to tracking down known and unknown quarry locations, to gauge the potential for lost sourcing information from both historic period steatite quarrying and modern urban development.

The vast majority of the sample base included in the present study was graciously provided by Dr. William Turnbaugh of Brown University, Amy Folk of Oysterponds Historical Society, Dr. Nicholas Bellantoni of the University of Connecticut, Cheri Collins of the Connecticut State Museum of Natural History, New Hampshire State Archaeologist Dr. Richard Boisvert, and most especially Joseph Waller of Public Archaeology Laboratory, Inc. Without their support and willingness to share numerous steatite samples, this study would not have been possible.

Dr. E. Troy Rasbury performed a small portion of this thesis research between 9/21/12-9/24/12 at Beamline X26A, National Synchrotron Light Source (NSLS), Brookhaven National Laboratory. X26A is supported by the Department OF Energy (DOE), Geosciences (DE-FG02-92ER14244 to the University of Chicago-CARS). Use of the NSLS was supported by DOE under Contract No. DE-AC02-98CH10886.

Chapter 1. Introduction

"Society is indeed a contract…nothing better than a partnership and agreement in a trade of pepper and coffee." - Edmund Burke (1790)

The procurement and transport of raw materials, with the intention of bringing items over long distances to acquire different products, are uniquely human behaviors facilitated by cooperative mechanisms of exchange. The social mechanisms responsible for trade and exchange are difficult to elucidate from the archaeological record. Thus it is non-perishable raw materials (e.g., lithics) transported by humans that best reflect these behaviors, and in turn, delineate the boundaries of social interaction in prehistory.

Trade in the modern sense refers to large-scale exchange between different nations. Exchange and trade in prehistory, however, are considered identical activities undertaken in varying social contexts. The most common form of prehistoric exchange, dyadic exchange, was likely practiced on a person to person basis (Braswell and Glascock 2002). This social networking process typically transports items in a down-the-line pattern through individual and group interactions between spatially adjacent communities (Wholey 2011b). Exchange systems can also be facilitated with procurement strategies that circumvent neighboring communities by "targeted direct access" of source locations (ibid: 119), and through elite or market-based redistribution networks (Braswell and Glascock 2002).

Inter-regional trade of lithic materials in the Northeastern United States, and specifically Southern New England, was an interactive process that likely extended back into the Late Pleistocene. Riverine corridors and glacial embayments, such as the Long Island Sound, would have been the primary conduits for lithic procurement, transport, and exchange throughout the prehistoric period. The glaciated Northeast contained a wide range of available lithic materials for both flaked and ground stone tool manufacture (Calogero 2002). One of the lithic types used in ground stone tool manufacture, steatite, was carved into hollow cooking vessels (Figure 1.1) for both domestic and ceremonial activities practiced across Eastern North America.

The long distance exchange of steatite containers began around 4,500 B.P., and by 3,500 B.P., was present in habitation sites and burial complexes from Louisiana to New England (Truncer 2004b). Exchange networks centered on the transport of steatite bowls served as a natural catalyst for inter-regional social interaction and increased sedentism, in addition to improving the thermodynamic efficiency of food-processing technology (Hayden 1998, Hill 2012, Hubbard 2006, Sassaman 1995). The labor involved in the procurement and manufacture of heavy stone containers, and the economic demand to transport them long distances along riverine corridors and over large bodies of water (e.g., Long Island Sound) suggests that steatite vessels had high overall transport costs. The limited dimensions of steatite outcrops in New England (Chidester 1964), also implies that source areas were highly susceptible to anthropogenic depletion (Amick 2007). Therefore, steatite's geological rarity, thermodynamic efficiency, high transport costs, and socio-political functions suggest these objects had an elevated status. Furthermore, the distance those artifacts potentially traveled from their geological source, prior to their deposition in the archaeological record, exemplifies the multifarious role of steatite bowls in Northeastern prehistory (Elliot 1980, Gibson 1996, Luckenbach et al. 1975, Hubbard 2006, Holland et al. 1981, Seeman 1981).

In Southern New England, the abrupt spike in the manufacture and distribution of steatite cooking vessels between 3,600-2,500 years ago raises questions about what procurement-transport strategies would have facilitated exchange networks over long distances. No other artifact class appeared with such sudden intensity, and subsequently became a ubiquitous material trait across regions far removed from quarry sources (Truncer 2004b). The high frequency with which steatite vessels occur in coastal and interior areas (e.g., New York, Louisiana) relative to areas in close proximity to quarried outcrops (Elliot 1980, Truncer 2004b: 21-23, Gibson 1996) is an intriguing inter-regional pattern that deserves further study. One of the few ways to examine the limited evidence for this behavior in the archaeological record is through the geochemical characterization of artifacts and their potential source areas.

The geographically isolated setting of Long Island, New York, and its total lack of steatite outcrops, is an ideal study area for researching this pattern. It has long been speculated that containers of steatite had been brought to the outer coastal plain from quarries in New England by water-borne transport (Bullen and Howell 1943, Merwin 2003, Ritchie 1959). Stone vessels recovered on Long Island archaeological sites are thus prime candidates for inter-regional provenance studies.

This sourcing project attempts to provide baseline geochemical data, in the form of tracer elements, which will address two research questions. What were the geological source(s) of steatite artifacts found on Long Island, and what watershed corridors were the geographic conduits for exchange? Source determinations will allow for the testing of hypotheses about the structure of steatite trade networks between Long Island and New England. Because the archaeological steatite samples and geological sources are separated by the Long Island Sound, this project will also shed new light on water-borne exchange networks in North American prehistory. An archaeometric study of this kind has the potential to address several related inquiries that draw from the original research questions above: Was there a single, primary source for steatite artifacts found on Long Island? How, if at all, does the source variation change over time? Would each artifact be quarried from the least distance possible?

Based on down-the-line or dyadic exchange models for the anthropogenic transport of lithic materials (Braswell and Glascock 2002, Wholey 2011b), steatite quarried for cooking vessels recovered on Eastern Long Island would most likely be derived from the nearest available sources. In effect, it is expected that in a dyadic trading system, the average straight line distance between an artifact and its raw material source will be the least compared to other source areas (see Chapter 6). Therefore, one predicts that quarries situated along watershed corridors leading to the Long Island Sound through the Connecticut River Valley will be the predominate source of finished steatite vessels for prehistoric groups on Long Island.

In order to test these hypotheses, this study uses Energy Dispersive X-Ray Fluorescence (EDXRF) to determine the provenance of steatite artifacts from Long Island, New York and the geochemical signature for source areas in Connecticut, Massachusetts, New Hampshire, New York, Pennsylvania, and Rhode Island. In addition, Synchrotron-based X-Ray Fluorescence (S-XRF) spectra for two steatite samples from Connecticut and Rhode Island were generated at the National Synchrotron Light Source, Brookhaven National Laboratory. As many sourcing studies have shown, combined approaches that incorporate multiple analytic techniques allow for a more replicable and statistically powerful method of geochemical data acquisition (Arnold et al. 2007, James and Carlson 2005, Jones et al. 2007, Santi et al. 2009, Speakman and Neff 2005).

In total, 103 steatite samples were included in the EDXRF study. Ninety-six samples collected from seventeen discrete steatite sources in New England, and one source area in the Mid-Atlantic. In addition, five steatite vessels and two smoking pipes recovered on Eastern Long Island were analyzed with EDXRF.

Chapter 2. Background

The prehistoric use of steatite (soapstone) for cooking vessels, smoking pipes, atlatl weights, net sinkers, and various decorative objects has been recorded on archaeological sites from throughout the Long Island Sound watershed. The hollow cooking vessel (Figure 1.1), whether found in a habitation, interment, or quarry context, comprises the vast majority of steatite artifacts recovered. Determining the various function(s) of steatite containers, extrapolating their methods of procurement, and tracing an artifact's chemical composition to specific geological sources have been stimulating topics of Eastern North American archaeological research since the late nineteenth century (Allen et al. 1975, Bullen and Howell 1943, Bushnell 1939, Dixon 1987, Hart et al. 2008, Holland et al. 1981, Holmes 1890, 1892, 1893, Howes 1944, Hubbard 2006, Klein 1997, Luckenbach et al. 1975, Putnam 1880, Reynolds 1879, Turnbaugh et al.1984, Truncer et al. 1998, Truncer 2004b, Waller 2006, Witthoft 1953).

Steatite (soapstone) is a broad category of exceptionally soft lithic materials characterized by high talc content. The dominant presence of talc, one of the few minerals to have the lowest possible value (1) on the Moh's Hardness scale (Ludman and Coch 1982), suggests that steatite is especially conducive to the manufacture of a wide range of ground stone products. The presence of talc crystals, and other fire-resistant minerals, also makes steatite one of the most efficient material solids in terms of thermal conductivity and overall heat retention (Hsieh and Chang 1936, Quintaes et al. 2002, Truncer 1991, 2004b, Tupa 2009, Virta 2000). While steatite is well-suited to producing artistic or decorative objects of nearly any desired shape, more often in New England the two physical qualities (softness, heat retention) were combined to construct cooking vessels (Figure 1.1).

Steatite is the massive variety of talc, a hydrous magnesium silicate; with widely varying percentages of ancillary mineral inclusions such as amphiboles, calcite, chlorite, kyanite, opaque minerals (magnetite), and serpentine (Allen and Pennell 1978, Bar-Yosef Mayer 2004, Hubbard 2006, Jones et al. 2007, Moffat and Butler 1986, Tupa 2009, Turnbaugh et al. 1984). Steatite (or soapstone) when recovered from an archaeological context, however, is a highly variable class of talc-bearing rocks that can include intergrades with geologically associated materials: amphibolites, chlorite, chlorite schist, pyrophyllite, and serpentinite (Becker 1976, Hubbard 2006, Rapp 2009). In the archaeological literature, steatite artifacts have been identified by a multitude of classifications, primarily based on their visible mineral constituents: "amphibole-chlorite-carbonate-talc rocks" (Allen et al. 1975), "talc-bearing schist" (Santi et al. 2009), "amphibole-talc schist" (Ritchie 1959), and "talc-dolomite-quartz-chlorite-schist" (Bullen and Howell 1943).

Geological reports are often inconsistent in their application of terminology, and in the same publication will use both steatite and soapstone interchangeably (Collins 1954, Rapp 2009). Soapstone is considered to be a slightly harder lithic material with greater compositional heterogeneity, which grades into softer, massive-grained steatite; based on a continuum of relative density, mineral inclusions, parent material, and talc content (Bachor 2011, Hubbard 2006, Wlodarski 1979). Hubbard (2006: 14) comments on this talc/inclusion gradient, as it relates to prehistoric steatite extraction, and concludes that “any rock between the ultramafic precursors and the country rock (CR) might be considered a usable soapstone grade material.”

The difficulty in properly defining the raw material used in artifact manufacture not only attests to the complex geology of New England and the Mid-Atlantic (Dincauze 1976:31, Leudtke 1993), it also emphasizes the need for more critical analysis of the presence of talcose rocks recovered from Eastern North American archaeological sites. The wide range of raw material variation observed in archaeological assemblages also implies that prehistoric peoples were selecting materials based more on qualitative properties conducive to the manufacture of specific objects (Wlodarski 1979), as opposed to seeking out and processing a discrete rock type. Pyrophyllite, for example, has a mineralogical structure very similar to steatite, but is in fact a hydrous aluminum silicate, with a nearly identical softness and soap-like texture (Rapp 2009, Virta 2000).

Venuto’s (1967: 134) petrographic analysis of Mid-Atlantic argillites provides the best analogy to describing the wide variability of a material like archaeological steatite; in that often lithic materials are “...not a single unique composition of matter, but rather a graduation of related yet distinguishable compositions.” Steatite, therefore, is most applicable as a generalized term, but is still an effective reference tool for most geologists, archaeologists, and the general public. In addition, this thesis is including source material from across Eastern North America, with material ranging from amphibole-talc-schist of Connecticut, serpentine-talc rock of Western Massachusetts, and talc-carbonate-chlorite rocks of Pennsylvania. Unless otherwise cited, “steatite” will be used as the default representation of any easily carved, talc-bearing stone found in a Southern New England archaeological context.

Steatite, in all of its variant grades, is imbued with a unique set of mineralogical qualities that make it an ideal medium for manufacturing an array of domestic (Hart et al. 2008, Sassaman 1995, Truncer 2006), ceremonial (Fowler 1966b, Ritchie 1959), artistic (Ige and Swanson 2008), architectural (Dann 1989), and industrial products (Chidester 1964, Virta 2000). However it was likely that heat retention, the most critical thermodynamic requirement for food processing (Quintaes et al. 2002), was the primary factor motivating prehistoric peoples to experiment with steatite as a raw material (Sassaman 1995, Truncer 1991, 2004b). A high melting point of 1,350-1,400 degrees Celsius (Bushnell 1939), a “low index of thermal expansion” (Tupa 2009: 13), and an exceptional resistance to fire damage allows the material to maintain prolonged, consistent temperatures (Hsieh and Chang 1936).

In Eastern North America raw nodules and perforated slabs of steatite were first used for cooking purposes as both stone-boiling material and direct-heat baking slabs in small areas of the Savannah River

Valley around 5,000 B.P (Sassaman 1995). Prehistoric peoples clearly must have recognized that when placed in liquid-filled cooking containers, steatite nodules would have maintained a noticeable resistance to breakage; as compared to the easily fractured quartz and granitic fire-cracked rocks found in abundance on archaeological sites throughout Eastern North America (Pagoulatos 1983, Sassaman 1995). Flat steatite slabs, often perforated in the center, were also actively employed and exchanged throughout Georgia and South Carolina for direct-heat cooking, typically in combination with early fiber-tempered ceramics (Sassaman 1996).

This initial period of experimentation with steatite as a raw material occurred roughly prior to the development of the first stone cooking containers (Truncer 2004b, Sassaman 1995, 1998). Carved steatite vessels, first actively employed in the Southeastern United States between roughly 5,000- 4,500 B.P. (Sassaman 2006, Truncer 2004a), and in the Northeast by 3,500 B.P. (Taché and Hart 2013), were even more versatile. Stone vessels were uniquely suited for implementation as a waterproof container for both "direct heat" and "indirect-heat moist cooking technology" (Sassaman 1995: 228, Klein 1997). These unique thermodynamic and shock resistant qualities of steatite may have prompted prehistoric peoples to widely promote the utilization of this raw material as a cooking vessel medium, and in turn the exploration for new sources throughout Eastern North America.

Historically, Euro-Americans in Eastern North America also maximized the heat retention qualities of steatite; wherein large slabs would be heated and used as bed warmers (Dann 1989). Steatite slabs also typically constituted the inner lining of fireplaces and iron-smelting kilns (ibid., Elliot 1980). Modern industrial, architectural, and artistic applications of steatite further expand upon prehistoric and historic recognition of steatite's unique physical properties (Chidester 1964, Dann 1989, Virta 2000). The fibrous mineral constituents of steatite/talc deposits that formed by regional and contact metamorphism, also tend to contain asbestos (e.g., actinolite, tremolite); fire resistant amphibole minerals used as insulation in early to mid-twentieth century architecture (Dann 1989, Van Gosen et al. 2004).

Modern steatite mining in North America, however, tends to focus its efforts on nearly pure talc mineral deposits associated with carbonate-sedimentary bedrock; as opposed to harder beds of steatite (i.e., block talc) located within typically smaller mafic and ultramafic deposits (Chidester 1964, Van Gosen et al. 2004). Interestingly, according to Truncer (2004a), only steatite derived from ultramafic rocks was ever exploited by prehistoric peoples for vessel manufacture. This supposed preference for steatite derived from ultramafic contexts has not been formally tested, but it has thus far proven to be an accurate correlation for prehistoric quarries in Eastern North America (Hubbard 2006).

Geology of Steatite

The geological formation of steatite deposits is a complex process that can derive from metasomatism, regional metamorphism, or contact metamorphism of bedrock into linear deposits called Talc Belts. Talc Belts, a term used by archaeologists (Turnbaugh and Keiffer 1979), geologists and miners (Chidester 1964), are broadly interpolated units of talc-bearing rock that circle the globe along both active and dormant subduction zones, fault lines, intrusive plutons, hydrothermal vents, and geologic contacts (Hubbard 2006). In Northeastern North America, most steatite deposits were formed as a result of the closing of the Iapetus Ocean basin that separated the North American and European plates during the Cambrian-Ordovician Period; which caused mountain building events (i.e., Taconic Orogeny), as well as the subduction and obduction of oceanic plate fragments (Dann 1989, Keppie and Ramos 1999, Krevor et al. 2009). This state of punctuated flux allowed oceanic liquids to reach hollowed cavities of the upper mantle, and their subsequent reaction to one another formed steatite, metals, and other precious ore deposits (Cox 1989, Mathez and Webster 2004).

After extended periods of inundation with chemically saturated liquids, new steatite deposits form as a secondary mineral aggregate within these oceanic fissures (Hubbard 2006). More specifically the chemical alteration resulting from the exposure of mafic, ultramafic, or siliceous dolostone bedrock to water at high temperatures ($\geq 350°C$), causes the replacement of olivine, peridote, and pyroxene minerals with serpentine or talc; also known as the reactionary process of steatization (Bachor 2009, Chidester 1964, Hubbard 2006, Ludman and Coch 1982, Mathez and Webster 2004, Truncer et al. 1998). The resulting tri-octahedral mineralogical composition of talc, perfect basal cleavage, and weak Van der Waal's bonds imbues steatite with its unique sculptural qualities and soap-like texture (Hubbard 2006).

In order for the talc-bearing deposits of Eastern North America to have even reached the modern ground surface; the obduction of oceanic plate fragments and subsequent erosion of metamorphic terranes over millions of years must have occurred (Dann 1989, Martin 1970, Williams and Talkington 1977). The gradual attrition of landscapes that were formed by the closing of the Iapetus Ocean eventually resulted in the presence of sporadic and isolated ultramafic bodies; which include steatite outcrop exposures that "mark an ancient continent-ocean interface" (Williams and Talkington 1977: 2). In Eastern North America, the geological formations are best described as a "chain of intermittent lenses" (Luckenbach et al. 1975: 57) that parallel the eastern foothills of the Appalachian Mountains.

Researchers have classified these exposures that extend from Alabama to Vermont into a pan-regional unit referred to as the Eastern North American Talc Belt (Figure 2.1). In Eastern New England, there are smaller outlier talc belts that occur in the uplands of Eastern Massachusetts, New Hampshire, and Rhode Island (Chidester 1964: 22). These characteristically small steatite exposures are not derived from the varied oceanic deposits that encompass the Iapetus Ocean Terrane, but occur within several Allochthonous Island Arc terranes (e.g., Avalon, Nashoba) with unique geological histories (Calogero 2002, Williams and Talkington 1977).

Steatite exposures suitable for use as quarry outcrops in Eastern North America occur as banded lenses, ovoid masses, ledges, or a cluster of glacially transported boulders. The pattern of exposures relates to the underlying bedrock that steatite can form within or around, and may result in a "small pod to masses several miles or tens of miles in extent" (Chidester 1964: 17). Therefore, the rates of local erosion, the size of the underlying deposit, jointing patterns, genesis of the parent rock, and the amount of steatization that occurs (i.e., replacement of various mineral constituents with talc) will determine the dimensional volume of usable lithic material for vessel manufacture.

Steatitization, as mentioned above, can be formed by different processes in different contexts, such as the metasomatic alteration of siliceous dolostones (Hubbard 2006, Truncer 2004b); wherein magnesium-rich marble or limestone's interaction with oceanic water causes the secondary formation of talc (Van Gosen USGS, pers. comm.). Similarly amphibolites, gabbro, gneiss, granofels, schist, serpentinite, and all ultramafic plutons, are equally suited to the hosting of steatite deposits (ibid.). The critical underlying factor is that steatite forms during periods of inundation from certain groups of oceanic bedrock called Ophiolites, typically Dunite, Pyroxenite, and Peridotite in New England (Calogero 2002: 92-93, Van Gosen et al. 2004: 921). These marine deposits contain either obducted or intrusive portions of the Earth's mantle that are stratigraphically associated with lenses of oceanic bedrock, called Ophiolite suites (Dann 1989, Krevor et al. 2009, Waller and Leveillee 1998, Williams and Talkington 1977). All of the previously mentioned bedrock classes that can host artifact quality steatite beds, and many other ore types in Eastern North America, typically fall within the broad category of metamorphosed Ophiolite suites (Cox 1989, Krevor et al. 2009, Mathez and Webster 2004).

Given enough time, heat, and pressure steatite can also potentially become further metamorphosed and grade into enstatite or cristobalite, through either geological or anthropogenic processes (Bar-Yosef Mayer 2004, Rapp 2009). As mentioned above steatite has a very high melting point (Bushnell 1939), as well as a "low coefficient" of thermal expansion (Truncer 1991: 49), but prolonged exposure to temperatures exceeding 900°C eventually causes the decomposition of talc crystals and transformation to a harder, less sculptural material (Bar-Yosef Mayer 2004, Hsieh and Chang 1936). Steatite deposits that never become obducted or exposed to the surface by erosion potentially continue on in this perpetual process of metamorphic transformation.

One anthropogenic example of this process comes from the Chalcolithic Period of Southwestern Asia, where steatite was crushed into a powder, mixed with water, heated, and then glazed to produce discoidal beads that served as major constituents of expansive trade networks (Bar Yosef Mayer 2004). Interestingly it was recognized that the pyrotechnology employed in bead production mimicked the metamorphic processes responsible for the formation of enstatite from steatite (ibid, Rapp 2009). Pyrotechnology in North American prehistory, however, does not appear until the onset of clay ceramic technology, and was apparently never an applied strategy for the production of steatite objects.

To date, no studies have been published that adequately address the variability in the production of the many types of steatite beads, effigies, gorgets, or pendants found in Eastern North America beyond descriptive essays (Fowler 1966b, Willoughby 1935); and it is not clear whether the material was ever intentionally modified through exposure to heat. Steatite vessels from Eastern North America, specifically those showing evidence of consistent exposure to fire, may have thus been somewhat altered or hardened into an enstatite-like material. However, it is assumed that this would have only been an unintended byproduct of repeated use over time. An unforeseen factor to be considered for the present archaeometric study, is whether or not thermal alteration of steatite vessels, by exposure to repeated heating/cooling episodes during its use-life, modifies the elemental or mineralogical composition enough to make source characterization unreliable (Glascock 2002)? Rapp (1985: 355) posits that the first and foremost variable to be determined in a successful provenance test is that "it must be established that the artifact has not undergone any chemical or physical alteration that would invalidate direct comparison of the artifact with the same material from known sources." Notably, Allen and Pennell (1978) have demonstrated through Instrumental Neutron Activation Analysis (INAA) that heavily burned steatite vessels from the Mid-Atlantic, and their associated quarrying loci, fell within a relatively specific range of Rare Earth Element (REE) abundances.

Therefore, steatite vessels that were hardened over time by intensive thermal exposure should still be viable for source characterization analyses; because the variation in the geochemical, isotopic, and mineralogical composition of steatite outcrops is considered to be more heavily influenced by the adjacent bedrock matrix (Allen et al.1978, Hubbard 2006, Truncer et al. 1998). Each discrete geological context, from which a particular steatite artifact or quarry sample is derived, will thus be reflected in the mineralogical variability, isotopic ratios, and quantitative elemental signature suite. This research project focuses on the latter, measurable variation or consistency in the frequency of major, minor, and trace elements for steatite vessels and geological source area samples.

2.1 Regional Perspectives: Geographic Origins, Chronological Debates, Functionality

The research into steatite vessel manufacture and utilization over time has echoed the progressive changes in theoretical and methodological approaches employed by archaeologists in Eastern North America. In recent years many applied approaches have culminated, many of which have incited academic debates over vessel function and chronological placement, with varying schools of thought as to the underlying social incentives (e.g., political, religious, economic) that would have spurred prehistoric steatite vessel manufacture and exchange. However, the underlying function(s) of stone vessels, their relationship to emerging ceramic technologies, and the various reasons for steatite's seemingly abrupt decline from the archaeological record around 2,000 B.P. are still inadequately understood. This section provides a very brief overview of these incremental shifts in perspective towards steatite vessels, and discusses how in certain cases theoretical platforms tend to influence the outcome of interpretations.

Descriptive reports, trait lists, and generalized essays dominated the literature for steatite quarries, and all aspects of archaeology in the late nineteenth century (Trigger 2006). William Henry Holmes (1890, 1892, 1893) and F.W. Putnam (1880) were exceptions to this rule. Some of the earliest systematic archaeological investigations in Eastern North America were undertaken by Holmes with the Smithsonian Institution, and Putnam with the Peabody Museum, on prehistoric steatite quarries in Connecticut, Virginia, Pennsylvania, and the District of Columbia (Holmes 1890, Putnam 1880, Reynolds 1879). These data were critical in forming incipient theoretical and chronological models of technological adaptations among prehistoric Native American groups (Bushnell 1939, Coe 1964, Griffin 1952, MacNeish 1952, Holmes 1892, Willoughby 1935).

Rowan and Ebeling (2008: 3) note that researchers like Holmes were "pioneers of collecting ethnographic observations," and most importantly "recognized a larger goal beyond description." Drawing from his work on numerous prehistoric quarries and lithic workshop sites in the Potomac River Valley, Holmes' detailed manuscripts reconstructed the basic *chaine operatoire* sequences for both steatite vessel manufacture (Figure 2.2) and quartzite cobble reduction (Holmes 1890, 1893). Following the meticulous works of Holmes (1890, 1892, 1893) and Putnam (1880), publications addressing steatite vessels and quarrying loci in the first half of the twentieth century, with a few notable exceptions (Bullen and Howell 1943, Bushnell 1939, Howes 1944, Parker 1920, Skinner 1908, Willoughby 1935), were limited in their overall breadth. Like Holmes, Charles C. Willoughby (1935), combined artistic renderings of steatite vessels and quarrying tools with syntheses of field research. In Willoughby's relative chronological framework for New England (i.e., Pre-Algonquian, Old Algonquian, Algonquian), the appearance of steatite vessels occurred during the early part of the latter Algonquian Period, which he understood to be the time when artifact assemblages could be convincingly associated with extant or historic indigenous groups (ibid: 119).

A decade later, Bullen and Howell (1943) modernized steatite research in Southern New England by generating the first source characterization data through mass spectrographic analysis of several quarry locations in New England, and a single vessel fragment from Massachusetts. Despite their identifying the differential presence/absence of elements in each sample, Bullen and Howell (1943) were quick to recognize the limitations of their results, which they argued were primarily due to small sample sizes, compositional heterogeneity within steatite exposures, and the relatively few elements analyzed. Source characterization studies, for steatite and any other lithic material, are plagued by these exact same methodological and sampling impediments even today. Bullen and Howell showed the potential utility of interdisciplinary scientific research in archaeological inquiry. From the mid-twentieth to the early twenty-first century onward, archaeologists employed explanatory theoretical approaches, modern excavation techniques, and statistically driven sampling methodologies, enhanced from the addition of absolute dating techniques (Goffer 1980, Trigger 2006). This epistemological shift began a period of intensive research into the geographic origins, chronology, functionality, and perceived relationship of steatite vessels to early ceramic container technology.

Geographic Origins of Steatite Vessels:

Initially, archaeologists surmised that stone cooking bowl technology had originated in the Northeastern United States and Canada, and that the diffusion of this artifact class correlated to the southward migration of Algonquian speaking groups along the Atlantic coast (Allen et al. 1978, Bushnell 1939, Fowler 1947, Laguna 1940). This hypothesis was based on correlations between archaeological and linguistic data, and has since been reevaluated and advocated by Stuart Fiedel (1987). However, this explanation has not been widely accepted. Nevertheless, the two earliest unequivocal examples of steatite usage in Eastern North America comes not from cooking vessels or boiling nodules, but carved plummets (i.e., net/fishing sinkers) dated to 7,500 B.P. in Southern Labrador. Both plummets and carved zoomorphic effigies were also found in various burial contexts along the Coast of Maine by 6,000 B.P. (Allen et al. 1978, Rapp 2009).

Ritchie (1969) proposed that steatite vessel technology was first initiated in the Southeast, and was primarily centered in the Piedmont of Georgia, the Carolinas, and Virginia. This explanation was further promoted by Turnbaugh (1975), who saw the synchronous appearance of steatite vessels and certain projectile points termed Broadspears, as further evidence of this northward trending pattern of technological transmission. Turnbaugh (1975) and others (Bourque 2008, Pagoulatos 1983, 1988) elaborate upon this theory and argue that it represented a rapid northward migration of intrusive populations; transporting new technologies (i.e., steatite bowls, broadspears) and adopting specialized settlement patterns exclusive to riverine and coastal environments. Swigart (1974: 34) compares the idiosyncratic traits of different cremation cemeteries in New England and the Mid-Atlantic, both with and without steatite vessels, and argues that the outcome was “either an amalgam of traditions arriving in this area almost simultaneously from both the north and the south or was the result of an extremely rapid northward movement…”

Steatite vessel technology is now considered to have developed independently from the different Late Archaic exchange networks and burial complexes recorded in the Southeastern, Mid-Atlantic, and Northeastern states (Dincauze 1968, Hoffman 1998, Robbins 1980, Sassaman 1999). Although Klein (1997) argues there were only two major regional production networks in Eastern North America.

Hubbard (2006: 7) aptly synthesizes Klein's (1997) unique bimodal interpretation of this widespread pattern by noting that Klein "sees the Potomac River as the demarcation line between two major regional ceremonial exchange spheres. The southern sphere was apparently driven by Poverty Point's appetite for soapstone…the northern sphere was affiliated with Great Lakes ceremonialism…" Strong (1997: 51) notes that William Ritchie previously contended a similar theory based more on ceremonial behaviors, and "felt confident enough to define the general outline of a religious system shared by Indian peoples from the Great Lakes to Long Island and south to the Potomac River."

The conspicuous similarities in vessel morphology between the two regions make it difficult to argue for or against these positions. Even more problematic are steatite vessel's seemingly simultaneous appearance (ca. 3500 B.P.) in both the Northeast and Southeastern states, when considering the few widely accepted radiocarbon dates (Taché and Hart 2013, Sassaman 2006). Although on a finer scale, Ritchie (1959) and others (Swigart 1974, Versaggi and Knapp 2000) have shown that even within New England, a morphological distinction in vessel design criteria is evident between sub-regions; as shown by the larger, thick-walled steatite vessels of central New York/Pennsylvania, and the typically thin-walled vessels found in the Long Island Sound region.

Swigart's (1974: 40-42) classification of stone vessels in Western New England, further categorizes these morphological disparities (Figure 2.3). "Susquehanna" style containers had more globular walls and unpolished exteriors; and "Orient" style vessels were more gracile and "had smooth external and internal surfaces" (ibid, Versaggi and Knapp 2000). Even though extremely large and small vessel sizes occur in both regions (Lord 1962, Mansfield 1985, Stewart 2011), this conspicuous divergence between the dominant regional vessel design does suggest independent approaches to the final stages of manufacture; but at the same time does not eliminate the possibility for external influences coming from the south (e.g., Mid-Atlantic), north (e.g., Arctic/Subarctic) or the west (e.g., Great Lakes). In addition, the quarrying methods employed by prehistoric peoples, discussed below in Chapter 2.3, were the same sequence of extraction processes between regions and throughout the globe. Anywhere steatite occurs, humans have carved it into open-mouthed cooking vessels (Figures 1.1, 2.3). This vessel design emphasizes the overwhelming difficulty in determining geographic origins, or the mechanisms of technological diffusion vs. independent invention; due to the distinct possibility for localized, idiosyncratic experimentation with steatite vessel technology.

Chronological Debates:

The chronological placement of steatite vessels in Eastern North America has been debated by several researchers (Hoffman 1998, Sassaman 1997, 1998, 1999, 2006, Taché and Hart 2013, Truncer 2004a, 2004b, 2006). Hoffman (1998) and others (Reeve and Forgacs 1997) compiled a series of 84 published radiocarbon dates for the Northeast and their respective artifactual associations; and demonstrated that the peak usage of steatite vessels in this region coincided with the end of the Terminal Archaic (ca. 3000-2700 B.P.), with additional punctuated occurrences preceding and following this period. Subsequently, Hart et al. (2008), Sassaman (2006) and Truncer (2004a, 2006) complemented this with additional radiometric datasets from throughout Eastern North America, and in many cases incorporated dates yielded from soot, lipid, and carbonized plant residues adhering to the inner and outer surfaces of steatite vessels. Despite these efforts, which also attempted to establish replicable criteria (i.e., ranking system) for evaluating the validity of dates and artifact/feature associations (Truncer 2006); Taché and Hart (2013), have critically reviewed all of the previously published radiocarbon data for early durable cooking vessels (i.e., steatite/Vinette grit-tempered ceramics) in the entire Northeast, and have rejected 38 out of the 46 published radiocarbon dates for steatite vessels.

Taché and Hart (2013) assert that now all radiometric dates must be acquired through Accelerator Mass Spectrometry (AMS) and derived from soot, lipids, or carbonized plant residues on the exterior/interior surfaces of vessels, or from charcoal within closed feature contexts. In addition, fallacious spatial associations (i.e., artifacts recovered outside of a discrete pit feature context), radiocarbon dates run on marine shell, and dates with standard deviations > 60 years are considered unacceptable data. This redefines what can be considered a reliable radiocarbon date, and complicates the interpretation of regional patterning when attempting to incorporate the half century of C14 data yielded from earlier research. However, based on Taché and Hart's (2013: 366) extremely strict dating criteria, the mean or peak usage of steatite vessel frequency in the Northeast occurred around 3,096 years B.P., still within a century of the mean derived from the rejected dates. More striking is their conclusion that "steatite vessels predate pottery by centuries," even though the authors admit "the paucity of acceptable age estimates precludes such an interpretation" (ibid.). As a result, the remainder of this thesis will attempt to adhere to Taché and Hart's (2013) limited, yet statistically hygienic chronological framework, but will not completely disregard the body of radiometric data that exists outside of their narrow criteria.

In the Southeast, Sassaman (1995) has convincingly shown that one of the earliest known applications of steatite as a cooking medium comes from the central Savannah River Valley by 5,000 B.P., in the form of minimally modified nodules and flat perforated slabs presumably used for stone boiling and direct heat baking. The adoption of more thermodynamically efficient steatite for stone boiling material also directly coincided with the development of the earliest known clay ceramics in North America; fiber-tempered pottery known as Stallings Island ware from Georgia and St. John's ware from Florida (Sassaman 1995, 1998). At roughly the same time (ca. 4,500 B.P.), and in some anomalous cases prior to this time (Sassaman 2006, Truncer 2004a), the standardized steatite vessel form was also being manufactured, exchanged, and employed in portions of the Southeast (Sassaman 1995, Truncer

2004a, 2006). All three technologies occurred together in many places, but the technological variability of combining boiling nodules, perforated slabs, and cooking containers of steatite observed in the Late Archaic of the Southeast, is not replicated in the Northeastern states.

Only one example of a non-perforated, flat steatite slab was found within a FCR roasting platform in Western Connecticut which could be considered a cooking slab like those used extensively in the Southeast (Swigart 1974: 39). A few rounded, flat slabs have also been recovered on quarry sites in Western Massachusetts, and were interpreted as suitable for direct heat baking of meat (Howes 1944). Despite the occurrence of these few examples, there is no compelling evidence for steatite usage in the study area prior to the adoption of the cooking vessel. In fact, the oldest reliably dated example of steatite in the Northeastern United States was with the vessel form, dated to 3,530±30 years B.P. from the Hunter's Home Site (Figure 2.1) in Western New York (Taché and Hart 2013). One could argue from this general lack of artifact variability in the Northeast, that the evolutionary development of steatite containers ultimately was derived from the Southeastern United States. However, the mechanisms that facilitated technological transmission or population movement in either direction can only be speculated about. Taché and Hart (2013: 363) argue that based on this uncertainty of directionality, "there is no a priori reason for the timing of these vessel technologies to be identical in the Northeast and in the Southeast."

These new dating criteria are suited to address the other chronological issues with steatite technology. Throughout the early to mid-twentieth century, stone vessels were automatically assumed to be chronological antecedents, or the logical evolutionary precursor to ceramic cooking technology. These assumptions were based on correlations derived from relative dating techniques used on early excavations and the absence of refined absolute chronologies (Coe 1964, Griffin 1952, Ritchie 1969). This linear model subsequently permeated the local archaeological publications, museum exhibits, and school curricula as a convenient narrative. When in reality the application sequence of durable container technology across Eastern North America and throughout the continent was highly varied and localized.

This disparity in technological evolution can be more easily demonstrated by comparisons to other regions of North America. For example, in the Arctic and Sub-Arctic of Canada, steatite vessels and lamps actually replaced ceramic containers (Truncer 1991). Conversely, in places like Southern California, ceramics were never adopted, and steatite vessel technology persisted for 4,000 years and well after European contact (Adams 2006, Hull et al. 2013, Klein 1997, Tupa 2009, Wlodarski 1979).

By the late twentieth and early twenty-first century, it was being argued that Coe (1964) and Ritchie (1969) were incorrect in their assertion that steatite vessels preceded ceramic containers in Eastern North America (Hoffman 1998, Sassaman 1999, 2006). The dates for early pottery and steatite vessels by this time did not support this linear evolutionary model, and it was demonstrated that grit-tempered ceramics preceded the earliest recorded dates for steatite vessels in New England by roughly 1,000 years (Brumbach 1979, Hoffman 1998, Reeve and Forgacs 1999, Sassaman 1999). Only Truncer (2006) held the opposing view that steatite was temporally prior to ceramics, based on a single radiometric date of 4910 ±75 B.P. from the Hagerman Site in Pennsylvania. Since that time the dates from early sites like Hagerman have been rejected by Taché and Hart (2013). Yet based on their reevaluation of existing radiocarbon datasets, the tide has turned back to the original hypothesis. The dates associated with stone bowls and early pottery argues for the precedence of stone bowls (ibid.). Ultimately, the shift towards increasing utilization of ceramic technology over time in temperate Eastern North America was ubiquitous; but the underlying reasons for this remain elusive. Several recent publications address this relationship between stone vessels and ceramic containers in more detail than can be addressed in this thesis (Bedard 2011, Hoffman 1998, Klein 1997, Sassaman 1995, Stewart 2011, Taché and Hart 2013).

Functionality:

In tandem with disputes over geographic origins, chronology, and evolutionary relationship to ceramic containers; were arguments over the specific function(s) of steatite vessels to prehistoric peoples. Two of the most prolific publishers on steatite vessel manufacture in Eastern North America, James Truncer and Kenneth Sassaman, were central to this now long-standing debate. Sassaman (1995, 1997, 1998, 1999, 2006), and others (Bedard 2011, Klein 1997), whose theoretical orientations lean towards a more post-processual/Marxist framework, have long argued that steatite cooking vessels served primarily as symbolic media for initiating and maintaining gender-based alliance networks. Truncer's (2006) processual-evolutionary-functionalist interpretations take a more ecological perspective towards vessels, as utilitarian mast-processing containers. Taché and Hart (2013: 367-368) synthesize this theoretical duality, in that researchers such as Sassaman think steatite "containers were used in the context of increased intersocietal contacts and emerging social differentiation to meet new needs associated with conspicuous consumption of food carried out at multigroup feasting and/or trading events…," while Truncer would argue it is the steatite vessel's "adaptive advantages in the context of new ecological conditions or subsistence strategies."

Alternative functions for steatite vessels have not been evaluated by recent researchers, beyond their use as cooking vessels or elements of grave furniture; but their diverse morphological variability and their known role in other regions justifies these speculations. For example, no one has considered the possibility of steatite vessels being used as lamps or lighting devices, which were their primary functions in the Arctic and Sub-Arctic regions of the North America (Laguna 1940). In New England their consistent presence in burial contexts that contain cremated remains and/or secondary bone bundles suggests that the vessels themselves could have been used to transport the desiccated remains of the deceased owner. In a more humorous sense, the sizes of some of the vessels from the collections at the Southold Indian Museum in Southold, NY (Stewart 2011) would have been large enough to bathe a small child. However these are unsubstantiated suppositions that cannot be advocated in any way without ethnographic parallels, which do not exist for this region, or controlled actualistic studies of vessel function (e.g., residue analyses).

Residue studies conducted on steatite artifacts in the Northeast (Hart et al. 2008, Truncer 2006), have demonstrated that vessels were primarily used for cooking. Until the work carried out by Hart et al. (2008), the only residue-based study had argued for a homogenous function for steatite vessels, focused exclusively on the processing of deciduous tree mast (Truncer 2006). Truncer's (2006) mast-processing hypothesis was based on two observations. First, that steatite vessel distribution *tends to* correlate with the distribution of oak-hickory or mast-producing forests (ibid.), and second, that the results of his residue analyses were overall inconclusive but still "compatible with mast" (Hart et al. 2008: 730).

Truncer (2006: 163) asserts that a single-purpose function for steatite vessels seems highly unlikely. Especially when considering the restricted seasonal productivity of tree mast, the generalized subsistence strategy of most hunter-gatherers, and steatite vessels apparent religious association when found in a burial context. The research carried out by Hart et al. (2008: 739) more explicitly demonstrates that steatite had a multifarious range of functions, with direct evidence for the exploitation of "grass seeds, a legume, pine resources [resin], animal flesh, and unidentified plants." Only through the application of similar residue analyses and exterior soot dating techniques (Sassaman 1997, 2006, Taché and Hart 2013, Todd and Wholey 2011, Truncer 2004b), can a region's domestic context for steatite utilization be interpreted with any confidence. Future research addressing this range of empirically measurable variables will eventually clarify the connection between form, function, and context.

Recent Academic Research:

In 2010, the Mid-Atlantic Archaeology Conference (MAAC) held in Ocean City, Maryland hosted an organized session of papers on the most recent research on steatite vessel technology in Eastern North America, which were subsequently published as a series (Bachor 2011, Bedard 2011, Stewart 2011, Todd and Wholey 2011, and Wholey 2011b). Bachor's (2011) steatite source characterization research with Hand-Held X-Ray Fluorescence (HHpXRF) on prehistoric quarries and vessels from the Susquehanna River Valley is the most relevant to the present study. Her research is treated briefly in Chapter 3. Each additional paper addressed important facets of steatite vessel research in the twenty-first century, and although the geographic focus was restricted to the Mid-Atlantic States, the data presented has a much broader applicability (Wholey 2011a).

Todd and Wholey (2011) performed actualistic studies examining the process of soot and residue formation on both experimentally manufactured steatite vessels and artifact samples; providing empirical data on the effect of domestic utilization (i.e., exposure to fire/organic substances) on vessel surfaces. The authors concluded that, while similar analyses "can reveal information related to functional usage of steatite vessels, they cannot indicate context. For example, it can be inferred that at least some steatite vessels were used in cooking, but it cannot be concluded that this was done as part of a regular domestic regime rather than reserved for special occasions" (ibid: 127). The continued application of Middle Range Theory to this unique artifact class will invariably augment these germane efforts.

Bedard (2011) and Stewart (2011) both addressed the dynamic, and often dialectic, relationship perceived to exist between steatite vessels and early clay ceramics in Eastern North American prehistory. Bedard (2011) tends to follow Sassaman (2006), in that his research presumes an inferred tension existed between steatite vessel manufacturers and groups involved in localized ceramic production; which they argue may have undercut pre-existing inter-regional exchange systems centered upon steatite vessels. The effect of this shift, in their view, would have not only modified existing gender roles within and between groups, but individuals who previously gained socio-political prestige through their role in procuring and manufacturing steatite vessels would have had their status markedly threatened. In contrast, Stewart (2011: 157) does not emphasize a dialectic relationship, but argues that "the lengthy co-existence of the two forms of containers is one argument for their use in different economic and/or social functions."

The Landscape Archaeology method, presented by Heather Wholey (2011b), was the most novel and comprehensive approach applied to steatite vessel technology discussed at the MAAC Conference. It is a broad-based research strategy, which incorporates datasets from multiple lines of both direct and indirect evidence (e.g., Geographic Information Systems, Bedrock Geology, Ecological Data). Her work shows certain bedrock units typically associated with steatite outcrops (i.e., serpentinite) affects the ecological landscape enough to make those environment's flora visual indices for locating new sources of raw material (see Chapter 2.3). Wholey (2011b) also argues that the way people ascribe meaning, delineate boundaries, and facilitate access to particular landscapes drives much of the variability within the archaeological record. Her landscape approach significantly allows for the incorporation of nearly every relevant variable to the study of a particular artifact class or raw material, in this case steatite source areas and steatite vessels; thus providing a solid theoretical platform to synthesize these complex data as they accrue in the future.

Source characterization studies, which are inter-disciplinary in methodology; are also uniquely suited to the Landscape approach, and address geographic and contextual variables relevant to each theoretical platform discussed above. The inter-regional transport and exchange of steatite vessels, well demonstrated in Eastern North America, is an ideal setting from which to conduct broad inter-regional studies (Hoffman 2006, Holland et al.1981, Luckenbach 1975, Truncer 2004b). Therefore, many of the social, political, economic, and ecological questions that plague steatite researchers discussed above, directly benefit from the continuing study of where, and through what geographic conduits, steatite vessels could be acquired.

2.2 Study Area, Context, and Chronology

The study area selected for this thesis project is a vast geographic region of Eastern North America in which most watershed corridors drain to the Long Island Sound. The research centers on Long Island, New York and coastal Southern New England (Figure 2.4); both of which are glacially-defined landscapes, situated near the interface of three major physiographic provinces (i.e., Coastal Plain, Piedmont, New England Highlands). However, the study area also includes eighteen steatite quarrying loci and source deposits within the states of Connecticut, Massachusetts, New Hampshire, New York, Pennsylvania, and Rhode Island (Figure 2.1, 3.7). The peripheral margins of the study area lie between the Appalachian Mountains and the Atlantic Ocean, from Francestown, NH in the north to Wissahickon Creek, just outside of Philadelphia, PA (Figure 2.1). A more detailed focus is given to the Long Island Sound area (Figure 2.4), and its watershed corridors, as they are hypothesized to be the primary exchange conduits for steatite vessel transport to Long Island, New York.

Long Island, New York (Figure 2.4) is a large segment of the Atlantic Coastal Lowlands flanked to the north and west by the New York Bight, New England Highlands, Hartford Basin, and Newark Basin (Cadwell et al. 2003, Merwin 2010, Sirkin 1995). Geologically, Long Island is a linear trending landform that consists of a "mantle of glacier-derived overburden and reworked sediments over a gently inclined strike ridge of Cretaceous sedimentary rocks" (Cadwell et al. 2003: 8). Several Terminal and Recessional Moraine sequences deposited between 24,000-18,000 years B.P. interface and truncate one another on Long Island, with two roughly parallel kame and kettle hill systems, and associated outwash plains dominating the landscape (ibid: 11, Bennington 2003, Ridge 2003, Sirkin 1995). Long Island and Long Island Sound together mark the coastal boundary between the New England and Mid-Atlantic regions of the United States, and is also the terminal boundary zone between glaciated and un-glaciated North America.

Long Island and coastal Southern New England as a whole fall within the Oak-Chestnut zone of the temperate, mast-producing forests of Eastern North America (Bernstein 2002, Snow 1980), but at a finer scale, Long Island contains a diverse mosaic of ecological units. Mixed deciduous forests, pine barrens, and cordgrass (*Spartina alterniflora*) salt marshes dominate much of the landscape; but other less common environments like Maritime Cedar Forest, Willow-Silver Maple-Box Elder Forest, Beech-Maple Forest, grass-dominated plains (i.e., former Hempstead Plains), and Red Cedar swamps highlight the variability of the island (Greller 1977). The terrestrial, estuarine, and marine habitat productivity of Long Island, and the greater Southern New England region, is in fact unparalleled by most temperate environmental settings; and incidentally some have suggested that the region's carrying capacity could support sizable hunter-gatherer-fisher populations (Nixon 2004).

The nearly 500 miles of Long Island coastline are also in close proximity to the Atlantic Ocean, major riverine corridors (e.g., Connecticut, Housatonic), and most importantly, the Long Island Sound; an east-west trending bay formed during the most recent advance of the Wisconsin Ice Sheet (Sirkin 1995). This massive watershed system connects all of these environmental nodes by a single geographic conduit (Figure 2.4). The Long Island Sound, when viewed as the nexus of an inter-regional exchange corridor, could therefore be compared to a prehistoric superhighway that would have augmented the amount of cultural exposure to outside influence on Long Island; but also likely had an equally isolating effect upon its prehistoric inhabitants. Some researchers have drawn an "analogy between the Mediterranean Sea and Long Island Sound as conduits for ancient peoples and cultures, observing that movements of prehistoric groups to and from Long Island occurred longitudinally across the sound, more often that overland from east to west" (Witek 1990: 42).

The Narragansett drainage, while not technically part of the Long Island Sound Watershed, is included in the study area because three well-known steatite quarries sampled for the present research project (i.e., Horne Hill, Ochee Springs, Oaklawn), occur along rivers and creeks that flow into this massive glacial embayment (Appendix B). Distant outlier watershed localities containing steatite deposits are also included in the present study; specifically the greater Merrimack drainage in New Hampshire, and the Schuylkill-Delaware drainage in Pennsylvania (Appendix B). Inclusion of these distant source areas is pertinent not only for teasing out broad scale inter-source geochemical variation, but also to acknowledge and account for the fact that prized commodities like steatite vessels could have been exchanged far beyond their source along a myriad of watershed transport corridors (Appendix B).

Hoffman (1998), and others (Pagoulatous 1983, 1988, Reeve and Forgacs 1999), have noted a striking distribution pattern among the known locations of steatite vessel bearing archaeological sites within Southern New England, in that there is a much greater frequency of occurrence on outer coastal and riverine areas at great distances from source regions. Typically these loci are found less than one half mile from the closest navigable body of water. The archaeological sites sampled for the present study (e.g., Skunk Lane, MPM Farm, Orient #1&2), as well as all of the sites containing steatite bowls on Long Island, occur even closer to the shore, and are each located less than 1000 feet from the closest waterway (Figure 2.4).

Conversely all of the documented steatite quarrying loci, north of the Potomac River Valley, occur either within the interior Piedmont Province that extends into the related New England Highlands

(Collins 1954) or along the Fall Zone. The Fall Zone is a 2-km wide geomorphologic boundary that separates the Piedmont/Highlands and the Coastal Plain. Extensive erosion of the Piedmont and Fall Zone, and glacial scouring in the New England Highlands, has subsequently exposed the once deeply buried metamorphic terrain in isolated outcrops and boulder deposits of varying quality and extent in the states of Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont (Chidester 1964).

There appears to be a rather conspicuous 300km gap between the recorded prehistoric steatite quarries of southeastern Pennsylvania and those of western Connecticut (Figure 2.1). Despite the fact that nineteenth century geological surveys (Britton 1882, Cozzens 1843) report that in Northeastern New Jersey and Southeastern New York, specifically Westchester County, Staten Island, Manhattan Island, and the Bronx, ultramafic bedrock outcrops with serpentinite and steatite lenses are present at several locations (Figure 2.4). Curiously, none of these areas has yet to record a single prehistoric quarry, but do contain several archaeological sites with steatite vessel fragments (Merwin 2010: 33, Ritchie 1969). A more detailed discussion of the many anomalies of steatite quarry distribution is provided in Chapter 3.2.

Prehistoric Context of Long Island, New York and Regional Steatite Chronology

Since the late seventeenth century naturalists, curiosity seekers, and farmers had been actively depleting the regions archaeological record for both recreation and economic gain. Ceci (1984) has outlined the detrimental scale of this latter practice; wherein the dense shell heaps and midden deposits, which historically lined the coastal margins of Long Island, were intensively mined for agricultural fertilizer and construction material. Afterwards in the early to mid-twentieth century, monumental landscape modifications occurred throughout coastal New York; and as a result "known sites and sensitive areas now lie below city streets, dredged landfill, railroad beds, and highways…Sandmining on Long Island since the last century to make concrete for Manhattan's skyscrapers has gouged away miles of potential archaeological resources" (ibid: 65). The rapid pace of post-World War II suburban residential development on Long Island, prior to the establishment of Cultural Resource Management regulations, potentially destroyed much of the remaining evidence. As a result, the contributions of early excavators provide an invaluable comparative reference, yet the data is predominately unprovenienced artifact assemblages that are abundant in local avocational museums and historical society collections.

Research-based archaeology did not regularly occur on Long Island, New York until the mid-twentieth century, with the works of state archaeologist William Ritchie, and his detailed excavations of the Baxter, Wading River, Jamesport, Sugar Loaf Hill, and Stony Brook sites (Ritchie 1959). Investigations at these Long Island sites, including his meticulous work at the massive Lamoka Lake site in Central New York (Ritchie 1932), helped develop the region's culture history with the concept of the

Archaic and Transitional/Terminal Archaic periods (Ritchie 1959, 1969). Ritchie's Archaic periods were subsequently adopted by archaeologists throughout Eastern North America as a suitable but limited definition for the poorly understood span of time between the Paleoindian Period (13,500 - 10,000 B.P.) and the Woodland Period (2,500 B.P. - Contact). Prior to that time archaeological investigations on Long Island, with a few notable exceptions (Parker 1920, C. Smith 1950, Solecki 1950), had been unsystematic and biased towards near-coastal settings for their extensive shell middens, burials, and village habitations (Lightfoot 1988).

Over time the prehistoric chronology of the Long Island Sound region (Table 2.1) has been gradually refined (Bernstein 2006, Dincauze 1990, Snow 1980), but most researchers still generally adhere to the classic Paleoindian-Archaic-Woodland sequence promoted by William Ritchie (1969). Although Long Island and outer coastal plain prehistory often does not conform to the temporal model of cultural progression seen in the surrounding interior mainland (Bernstein 2006). Regardless of these local variations, a brief description of each abstracted archaeological time period (Table 2.1), and a separate discussion of the role of steatite during that particular era, is necessary and essential to understanding the material context of Long Island's prehistory.

Paleoindian Period (13,500-10,000 B.P.):

The Paleoindian Period represents the time when human populations were first colonizing Eastern North America during the Late Pleistocene-Holocene transition (Table 2.1). This period is only sparsely represented on Long Island by the isolated surface collection of less than twenty fluted, lanceolate-shaped projectile points (Saxon 1973, Thieme 2003). Many researchers attributed the scarcity of Paleoindian, and also Early-Middle Archaic Period archaeological sites in the Northeast, to the punctuated fluctuation of eustatic sea levels; and argue that much of the habitable space on the coastal plain, exposed during the Late Pleistocene and Early-Middle Holocene, was gradually inundated until nearing present levels approximately 5,000 years B.P. (Merwin 2003, 2010, Stright 1995, Wyatt 1977). Long Island during the Paleoindian Period was therefore not a coastal environment, but a deeply interior portion of the coastal plain, dominated by mixed Spruce Forest and Tundra environments (Merwin 2010).

At only one location, the Port Mobil site on Staten Island, New York (Ritchie 1969), is there evidence for Paleoindian settlement in the study area core. In adjacent regions however, there is ample evidence for early settlement from terrestrial archaeological sites in Connecticut, New Jersey, and the Hudson River Valley (Jones and Forrest 2003, Merwin 2010, Thieme 2003, Wyatt 1977). Recently in response to the conspicuous paucity of early site data in Coastal New York, Merwin (2010) conducted detailed underwater investigations to the southwest of Long Island, in the submerged Hudson River channel off of Sandy Hook, New Jersey; and recovered stone artifacts from the margins of previously dredged archaeological sites that typologically date from the Late Paleoindian to the Middle Archaic Periods (Table 2.1).

Steatite in the Paleoindian Period:

Personal adornments of steatite, in the form of incised pendants or beads, have been reported from one New England Paleoindian context, the Reagan Site (Figure 2.1) in Vermont (Ritchie 1940). Initially this was considered to be early evidence of, at the very least, an awareness of steatite as a decorative sculptural medium; a plausible inference given the sheer abundance of steatite sources in the Vermont region (Chidester 1964, Truncer 2004a). A more recent critique of the data, however, has called into question the association of some the steatite beads with the site's Paleoindian component; and further suggests that, based on inconsistent wear patterns, part of the assemblage are likely modern forgeries (Robinson IV 2009).

Archaic Period (10,000-3,500 B.P.):

In the succeeding Archaic Period (Table 2.1), the material and behavioral changes hypothesized to have taken place on Long Island and across Eastern North America are generally interpreted to be incremental adaptive responses to the progressively warming climate and shifting location of ecological biomes during the Early-Middle Holocene (Thieme 2003, Wyatt 1977). Archaeologically, the characteristics of the Archaic Period are the exploitation of modern faunal and floral species, and the first adoption of ground stone tool technology (e.g., axes, adzes, bannerstones, celts). More acute was the marked shift from highly curated, fluted projectile points made from crypto-crystalline silicates (employed across the entire continent in the Paleoindian Period), to cruder notched and stemmed projectile forms made of locally available lithic material (Griffin 1952). In the study area (Figure 2.4), it is recorded as the increased exploitation of "fist-sized," glacially transported quartz and quartzite cobbles, as well as quartzite, glacial erratic boulders for lithic raw material (Bernstein and Lenardi 2008: 102). These varied changes are also often attributed, but not limited to, the incipient expansion of inter-regional trade networks and reduced settlement mobility resulting from the restriction of available territory (Bernstein 2006, Sassaman et al. 1988, Smith 1998).

The limited archaeological site data for the Early-Middle Archaic has already been noted above; the few examples of bifurcate-based and stemmed projectiles considered to be diagnostic of this period are only known from isolated artifacts found on younger sites and surface collections on Long Island. The material evidence for the following Late Archaic period (6,000-3,500 B.P.) however increases exponentially from earlier time periods (Cassedy 1999), due to the fact that the rate of eustatic sea level rise became relatively stable after this point in time (Bernstein 1993, Merwin 2010, Wyatt 1977).

Dincauze (1990: 24) notes that the archaeological record for the Late Archaic in New England exceeds all other time periods in sheer volume of collected data, and refers to this directly as "the richest time span in the archaeological record as we know it."

Large settlements were appearing on productive coastal embayment's situated along the periphery of the Long Island Sound by approximately 5,500 B.P. (Bernstein 1993, Wyatt 1977); and year-round habitation zones (Gwynne 1979), with potentially high population densities (Nixon 2004), were becoming established. Most importantly, this dense settlement pattern developed in situ, and without any compelling evidence for experimentation with horticultural practices that selectively exploited local seed-bearing flora (e.g., *Chenopodia sp*.); which comparatively was a major characteristic of Late Archaic subsistence strategies of the Southeastern and Midwestern United States (Bernstein 2006, Smith 1998). The continuous occupation of these productive coastal regions after this point in time is indicative of a shift to intensive exploitation of marine, littoral, and estuarine resources (Bernstein 2006, Nixon 2004, Tveskov 1997).

This evidence for an increased reliance on maritime resources becomes apparent on the outer coastal plain by the Late Archaic (Bourque 2008, Funk and Pfeiffer 1988, Ritchie 1969), and more explicitly so in what has been defined as a transitional sub-period, the Transitional/Terminal Archaic (3,500-2,500 B.P.). On Long Island, the oldest evidence for shell midden deposition occurs along the margins of Mount Sinai Harbor, at the Pipestave Hollow site, which has been dated to 4015±140 years B.P. (Gwynne 1979). Contemporaneous Late Archaic dates have been obtained from shell deposits in the Lower Hudson River Valley (Schaper 1989: 15-16, 1993: 27), Coastal Maine (Bourque 2008: 42), and the island of Martha's Vineyard (Ritchie 1969: 141). In tandem with the appearance of shellfish processing facilities, the construction of fishing weirs is first demonstrated at the remarkably well-preserved Boylston Street Site in downtown Boston, Massachusetts; and dated components from this unique locality range from 4,900-3,700 B.P. (Dincauze and Decima 2002).

Although it must be understood that these interpretations of the region's maritime adaptations could easily be biased by the fact that sea levels were progressively inundating the coast since the end of the Pleistocene, and had not yet fully stabilized until the end of the Late Archaic; and that earlier evidence of coastally oriented occupations, via shell middens or fishing weirs, could have become submerged (Merwin 2010, Schaper 1989). In addition, the practice of mining shell deposits in the Colonial Period (Ceci 1984), could equally be obscuring our sense of the timing and scale of early coastal subsistence activities in Southern New England. The most compelling case for coastal shellfish resources being a major component of subsistence strategies in the Northeast, prior to sea level stabilization around 5,500 B.P., comes from the Croton and Dogon Point shell middens in the Hudson River Valley; which yielded radiometric dates that are attributed to the Sixth Millennium B.P. (Brennan 1972) or the Middle Archaic

Period (Table 2.1).

Overall, the broad trends of the Archaic Period in the study area demonstrate that this was a dynamic era encompassing over 6,000 years, but with relative material continuity (Bernstein 2006); and is again defined primarily by the generalization of subsistence strategies with a growing emphasis on coastal resources, the increased variability of projectile point morphologies, the widespread adoption of ground stone tools, and the decreased mobility of Hunter-Gatherer populations leading to year-round settlements and locally indigenous burial traditions. The latter two being the critical variables in the establishment of inter-regional, exchange-based social networks (Sassaman et al. 1988), of which steatite vessels were a major constituent. All of these behaviors would have set the stage for the changes that occurred during the brief but marked cultural fluorescence of the Terminal Archaic.

Steatite in the Archaic Period:

In Northeastern North America, the oldest unequivocal example of steatite utilization in the Archaic Period comes from Southern Labrador in the form of carved plummets, or fishing line sinkers, employed around 7,500 B.P. (Allen et al. 1978: 237, Rapp 2009: 126). Beads, pendants (Fowler 1966b, Simmons 1970), zoomorphic effigies (Booth 1982, Spiess 1991, Webb 1944, Willoughby 1935: 167), and other classes of decorative objects made from steatite also appear in the Archaic-Terminal Archaic Periods of New England; but are found in such low frequencies that there is little that presently can be discussed about their procurement, manufacture, or function. One good early example comes from the Maritime Archaic Tradition of Coastal Maine (6,000-5,500 B.P.), in which plummets and effigies made of steatite have been recovered from both habitation and burial contexts (Rapp 2009, Spiess 1991). This shows that by this time steatite was being exploited for the manufacture of both utilitarian and presumably ceremonial objects.

The rare examples of other ground stone products manufactured from steatite, like bannerstones (i.e., spear-thrower counterweights), also points to ancillary extraction industries operating in the Archaic Period (Baer 1922, Dixon 1987, Fowler 1956, Ives 2003, Ritchie 1969, Robinson 1996, Spiess 1991, Staats 1991, 1993a, Truncer 1991). But again these artifacts are rarely found in dated contexts, nor are they treated in publications beyond inclusion in the vague trait list or an occasional artifact illustration. Only the Ragged Mountain Rockshelter and Quarry site in Northwestern Connecticut has yielded any compelling evidence for the manufacture of steatite bannerstones in New England; and it was at this unique multi-purpose quarrying locus that bannerstones were carved directly from the steatite and steatite schist veins present along the walls of the rockshelter (Dixon 1987, Fowler 1971).

One glaring problem with all of the published data for bannerstones is the fact that only in certain instances is the raw material ever actually noted. Even in recent publications, this critical information is often lacking (Ives 2003, Robinson 1996). As a result, it is near impossible to examine the role of steatite in this early ground stone tool industry. When it is recorded, it is apparent that the wide range of raw material utilized for bannerstones (e.g., basalt, hematite, quartzite, jasper, quartz, serpentinite, diabase, granite, micaceous shale, trap rock, chlorite, steatite), with varying grades of slate being found in the greatest frequency (Baer 1921, Fowler 1956, 1966b, Staats 1991, 1993a, 1993b), strongly argues that steatite was not the requisite medium for production of bannerstones.

The only occasional reliance upon steatite as a raw material for bannerstones, is also the case for most other ground stone tool types in Northeastern North America (e.g., celts, adzes, mortars, pestles), which were typically made from harder igneous and sedimentary materials. The stark exception to this rule is when vessels were hollowed out for food processing activities; in almost all cases in Eastern North America, these objects were made from steatite. In the far western reaches of the Appalachians however, cooking vessels were occasionally manufactured from sedimentary sandstone or other semi-apyrous rocks (Truncer 2004b). Yet steatite was still the predominant material employed in these outlier regions (ibid.), probably due to its superior thermodynamic qualities.

Steatite cooking vessel fragments first appear in very low frequency in this time period on habitation sites of the Snook Kill Phase (Ritchie 1969:136), and interestingly have also been recovered in Late Archaic burial complexes that were becoming widespread throughout New England and the Great Lakes region by approximately 4,500 B.P. (Dincauze 1990, Robbins 1980, Strong 1997, Swigart 1974). Unfortunately, despite their consistent presence, none of these particular Late Archaic interment sites have yielded steatite vessel fragments from specific dated components (Dincauze 1968). Even in the latter Terminal Archaic Period, steatite is virtually non-existent in the early Atlantic Phase of Coastal New England (Dincauze 1972), and the contemporaneous Koens-Crispin Phase of Northeastern New Jersey (Kraft 1970). Stone vessels do not appear to become a major component of regional cremation cemeteries and habitation site assemblages until after 3,300 B.P., when the Susquehanna Phase and subsequent Orient Phase traditions become established (Kraft 1970, Ritchie 1969).

The oldest published radio-carbon dated steatite vessel association in the study area core, including all of New England, significantly comes from a ceramic-bearing shell midden; the Sharp site on Fishers Island, New York (Figure 2.4), dated to the end of the Late Archaic at 3655±85 years B.P. (Funk and Pfeiffer 1988: 89, Hoffman 1998). Taché and Hart (2013) however, have recently rejected this date based on what they consider to be unreliable spatial associations, a radiometric date run on marine shell, and a standard deviation of >60 years (see Chapter 2.1). According to Taché and Hart (2013), the Hunter's Home Site in Northwestern New York State (Figure 2.1) has the oldest reliably dated steatite vessel association in the Northeast at 3,550 ±30 B.P.

Long Island contains numerous archaeological examples of the water-borne transport of finished steatite vessels into the Long Island Sound region in the Archaic Period (Ritchie 1959). Several early examples of steatite vessels also occur in comparable outlying coastal areas, including Shelter Island (Witek 1990), Nantucket (Roy 1956), Cape Cod (Fulcher 1975, Moffet 1947), and Martha's Vineyard (Chilton and Doucette 2002). It seems that once the economic conduit for steatite vessel exchange was becoming established, apparently by the Fourth Millennium B.P. (Funk and Pfeiffer 1988, Taché and Hart 2013), steatite vessels were transported extensively over the next 1500 years, eventually becoming a rare, but important component to the material culture of Long Island and coastal Southern New England.

Terminal Archaic Period (3,500-2,500 B.P.):

The Terminal Archaic Period on Long Island (Table 2.1) is discussed separately from the traditional Archaic Period, due to the seemingly rapid pace of cultural change occurring during this time (Boyd 1962, Filios 1989, Funk and Rippeteau 1977, Leveillee 1999, Ritchie 1959, Turnbaugh 1975, Witthoft 1953); as opposed to the relative material continuity of the earlier stages of the Archaic and subsequent Woodland Period (Bernstein 2006). Some have questioned the impact of this brief transition period on prehistoric life ways (ibid.); while others have vehemently argued that it should not even be viewed as a discrete cultural horizon (Cook 1976). Instead, they argue it should be considered more of a technological shift towards riverine and maritime-based economies, identified predominately by the appearance of Broadspears and/or expanding stemmed projectile points (e.g., fishtails) from Florida to Maine (ibid.). Conversely, many researchers have promoted the notion that the suite of previously unseen artifact types (e.g., Broadspears, steatite vessels, pigments, grit-tempered pottery), features (i.e., caches, elaborate burial pits, caches), and exotic raw materials (e.g., steatite, ochre, graphite) represent a "complete cultural system," that migrated from the Southeast with settlement patterns oriented towards coastal and riverine environments (Pagoulatos 1988: 85, 1983, Bourque 2008, Hoffman 1998, Ritchie 1969, Turnbaugh 1975, Witek 1988).

Throughout coastal New England, this perceived shift towards a maritime subsistence strategy is most explicitly demonstrated by shell middens, which became an intrinsic component to the archaeological record during the Terminal Archaic. These facilities were fully present by the Late Archaic Period (Bourque 2008, Funk and Pfeiffer 1988, Gwynne 1979, Ritchie 1959) and even earlier in the lower Hudson Valley (Brennan 1972, Schaper 1989, 1993). By the Terminal Archaic period however, these food processing features became ubiquitous in habitation contexts, and were often accompanied by a suite of new material traits that included fragments of exotic steatite vessels and expanding-stemmed projectile point technologies (Ritchie 1969, Turnbaugh 1975). In more interior regions of Eastern North America, the appearance of shell middens has been observed to be synchronous with the first appearance of steatite vessels (Sassaman 1995). Interestingly, Hayden (1998: 258) notes that new technologies like stone vessels, and other objects that would be conspicuously used and displayed, often only arise "when technological advances occur in subsistence procurement and food storage…" Whether these inferred behaviors represent intrusive groups displacing and/or integrating with local populations, or in situ manifestations of a pan regional spread in maritime and riverine adaptations, cannot be determined at present.

On this issue, Ritchie (1959: 10) notes that taken as a whole this "transition appears to have involved the introduction into these areas of a new complex of ideas and material objects but not to have altered the basic food gathering economy or general way of life." Despite this caveat, there is compelling evidence for expanding trade networks, increasing sedentism, and the adoption of new interment practices, which characterize a short, but unique time period in the Long Island Sound region (Boyd 1962, Hoffman 2006, Hubbard 2006, Leveillee 1999, Nixon 2004, Pagoulatos 1988, Ritchie 1959, Strong 1997, Turnbaugh 1975, Tveskov 1997). The Terminal Archaic on Long Island and the study area core is thus characterized primarily by a range of archaeological signatures that are distinct from any prior or succeeding material culture patterns (Boyd 1962). The most critical material element of this time period was the full integration of steatite containers into the regions subsistence strategies, exchange networks, and social systems; as these objects are only sparsely present in Late Archaic components (Ritchie 1969).

Steatite in the Terminal Archaic Period:

Steatite vessels, which are widely known as the single most diagnostic material trait of the Terminal Archaic in coastal New England, typically occur within the shell middens and burial complexes of the last two stages of this period; the Susquehanna (3,300-3,000 B.P.) and Orient (3,000-2,500 B.P.) cultural phases (Dincauze 1972, Kraft 1970, Ritchie 1969, Swigart 1974). Associated toolkits typical of both Susquehanna and Orient components are characterized by similar frequencies of broad-bladed spears, expanding-stemmed projectile points, perforated bannerstones, drills, two-holed gorgets, net sinkers, graphite and ochre paintstones, coarse grit-tempered ceramics, and the absence of stone scrapers (Boyd 1962, Ritchie 1969, Snow 1980, Tuck 1978, Witthoft 1953). The peak in steatite vessel frequency in the study area occurred during the Orient Phase (3,000-2,500 B.P.); and this coincided directly with a period of elaborate burial ceremonialism and inter-regional economic exchange that had been emerging since the Late Archaic (Ritchie 1969: 175-178, Dincauze 1968, Hoffman 1998, Leveillee 1999, Simmons 1970, Taché and Hart 2013).

Although Table 2.1 depicts the Terminal Archaic as beginning in roughly 3,500 B.P., all the radiometric dates for known domestic and burial sites on Long Island cluster tightly around 3000-2700 B.P., and are referred to locally as the Orient Burial Complex (Bernstein et al. 2010, Hoffman 1998, Ritchie 1959, 1969). Analogous sites to the Orient Complex of Long Island are found in regions directly adjacent (i.e., New Jersey, Connecticut, Rhode Island), but extend this time range only slightly (Hoffman 1998, Kraft 1970, Simmons 1970, Swigart 1974). From these data, and based on identical date ranges for both interment complexes and associated habitation loci, it was recognized for a time that “the Orient complex is the most completely dated archaeological manifestation in the Northeast” (Ritchie 1959: 74).

Due to their grand scale and novel complexity, Eastern Long Island’s hilltop burial sites of the Orient Phase (see Chapter 3.3), and their associated steatite vessels (Figures 1.1, 3.18-3.19), have thus become the archetypal expression of Terminal Archaic culture in Southern New England (Strong 1997). Terminal Archaic burial complexes as archaeological units however, are found throughout Eastern North America, and commonly incorporated steatite vessels into massive interment features, ochre deposits, and artifact caches (Bourque 2008, Dincauze 1968, Gibson 1996, Klein 1997, Latham 1953, Ritchie 1959, 1969, Simmons 1970, Witthoft 1953). In some cases, anywhere from one to fifty complete or intentionally broken vessels would be systematically deposited as exotic grave furniture (Boyd 1962, Latham 1953, Ritchie 1959: 74-77). Conversely on contemporary habitation sites, it is broken and incomplete vessel fragments that are recovered in much greater frequency (Ritchie 1959, Truncer 2004b: 107, Witthoft 1953), and especially so at quarrying loci (Russell 1997). Suggesting that broken pieces of vessels were regularly transported off site and/or reconstituted into smaller utilitarian objects like grooved net sinkers or decorative items like beads and gorgets (Bourque 2008, Fowler 1966b, Howes 1944, Swigart 1974, Witthoft 1953).

The frequency of steatite vessels occurring in both burial and domestic contexts in the Terminal Archaic Period contrasts sharply with how ceramics of the period were used, which are typically found on habitation loci (Hoffman 1998, Stewart 2011). Ceramics, as mentioned above, were developed in tandem with stone containers, and the developments of both technologies were the key elements in what Smith (1988) has defined as the “Container Revolution” in Eastern North American prehistory. The production and distribution of both stone and ceramic vessels are understood as explicit indices of changing life ways, settlement patterns, and subsistence strategies among prehistoric peoples around the globe. However it is the special treatment of steatite vessels in prehistoric Southern New England that illustrates that at this time steatite was coveted for both its symbolic and thermodynamic qualities. Therefore, steatite vessels used in the Terminal Archaic Period can be subsumed under Hayden’s (1998) concept of both practical and prestige-based technologies.

Woodland Period (2,500-350 B.P.):

Following the Terminal Archaic, the Woodland Period in Southern New England is broadly defined by the increasing frequency and variability of ceramic container technology, a marked shift away from the elaborate burial ceremonialism of the preceding period (Dincauze 1990), and towards either a more agricultural or maritime economy depending upon a groups proximity to the coast (Bernstein 2002). In the discussion of the Late Archaic, it was emphasized that in the study area the shift in subsistence strategies towards coastal resources was a ubiquitous shift that persisted until European Contact (ibid.). Decades of archaeological research on the Southern New England coast have confirmed the overwhelming lack of compelling evidence for the cultivation of locally domesticated species (*Chenopodia sp.*) or tropical domesticates (*Zea maize*); excepting the few anomalous examples of the latter derived from Late Woodland contexts (Bernstein 1993, Ceci 1990). As mentioned previously though, Long Island's archaeological record does not fit the regional model for interior Mid-Atlantic or Southern New England prehistory, especially during the Woodland period (Bernstein 2006).

Durable Cooking Containers (Steatite, Clay) in the Woodland Period:

The material culture of the Woodland Period (Table 2.1) is traditionally associated with triangular projectile points, the proliferation of clay pottery, and the abandonment of steatite vessels (Griffin 1952, Lavin 1998, Ritchie 1969). But (as mentioned above) mounting evidence from dated habitation loci in New England has shown that experimentation with both container technologies began in relative tandem in the Late Archaic (Boyd 1962, Fiedel 2001, Hoffman 1998, Ritchie 1959). Numerous radiocarbon assays yielded from early ceramic-bearing sites in Connecticut, Massachusetts and Maine have been dated from 4,500-3,600 B.P., and suggest that pottery preceded the oldest recorded dates for steatite vessels in Southern New England by 1000 years (Hoffman 1998, Reeve and Forgacs 1999, Sassaman 1998). However, if Taché and Hart's (2013) recent chronometric arguments to the contrary are adopted (see Chapter 2.1), than 83% of all published dates for ceramics in New England must also be rejected, and ceramics do not unequivocally appear in the Northeast until 3,110 ±20 B.P., from the Batiscan site in the Saint Lawrence River Valley of Canada (Taché and Hart 2013). These methodological revisions bring the interpretations of chronometric relationships of durable container technology in Eastern North America full circle, with two prominent research publications now arguing for the temporal priority of steatite over ceramic technology (Truncer 2006, Taché and Hart 2013). As mentioned in Chapter 2.1 though, the chronological and contextual overlap of steatite vessels and early ceramics is a complex and ongoing controversy that cannot be adequately resolved. Yet considerable effort has been undertaken to address this dynamic relationship (Bedard 2011, Hoffman 1998, Klein 1997, Sassaman 1995, Stewart 2011, Taché and Hart 2013).

One element to reference that is critical to outlining inter-regional variability and the technological interfacing of steatite and ceramics in the Terminal Archaic-Early Woodland transition; is the rare presence of clay containers that were shaped and/or carved into the form of stone vessels, and ceramic vessels that were occasionally tempered with crushed steatite fragments (Bedard 2011, Brumbach

1979, Klein 1997, Ritchie 1959). Only two examples of ceramic copies of steatite vessels are known from the study area core, and both come from Eastern Long Island, at the Jamesport and Sugar Loaf Hill burial sites (Ritchie 1959). Beyond this, little else is known about these extremely rare vessel types in Southern New England. However ceramic copies of stone bowls, often tempered with steatite, are relatively abundant in the adjacent Mid-Atlantic region, and are typologically identified as the Marcey Creek Plain type (Klein 1997, Kraft 1970).

The practice of utilizing steatite for ceramic temper is also conspicuously prevalent south of the study area core, and in some cases, the temper has been observed to be crushed fragments of broken steatite vessels (Brumbach 1979: 24, Kraft 1970: 12). Yet in all of New England, only a few sites have definitively encountered steatite-tempered ceramics (Hoffman 1998); the Schuylerville Site in the Hudson Valley of New York (Brumbach 1979: 21-22), the Smyth Site in New Hampshire (Winter 1975: 7) and the Casley Site in Massachusetts (Nassaney 1999: 229), with a total recovery of eleven sherds between the three sites. The reasons for this extremely low frequency are poorly understood, but it might also simply reflect the lack of recognition of steatite temper by excavators. Most ceramic fragments in New England are classified under the vague designation of grit-tempered, and could represent a myriad of lithic types available in the glaciated Northeast.

A growing body of data suggests that the utilization of steatite cooking vessels persisted intermittently well after the Terminal Archaic and into the Woodland Period in New England and New York (Funk and Hoffman 1998, Ritchie 1969, Versaggi and Knapp 2000). On Long Island, two steatite fragments recovered from the Henry Lloyd Manor site (Silver 1991: 111, 145) provides tentative evidence for the continued use of steatite vessels into the Woodland Period. However, Henry Lloyd Manor is a complex, multi-component shell deposit with extensive disturbance from horizontal movement, bioturbation, and house construction in the eighteenth century (ibid.). The two steatite vessel fragments are also not treated directly in Silver's (1991) synthesis; and steatite is only briefly mentioned as occurring within the presumably oldest and youngest strata of the Woodland Period midden.

Two Early Woodland Period sites associated with Ritchie's Meadowood Phase for Central New York, Morrow and Oberlander No. 2, contained an unspecified number of steatite vessel fragments in the fill of several features (Ritchie 1969: 190-191). However, Ritchie does not elaborate upon this unexpected occurrence. Recently, increasing numbers of steatite vessel fragments are being recovered from dated Early Woodland contexts (2,500-2,000 B.P.): the Timothy Stevens and 294A-25-2 sites in Connecticut, the Lucy Vincent Beach site in coastal Massachusetts (Martha's Vineyard), and the Grouse Bluff, Southside Treatment Plant, and Broome Tech sites in Central New York (Hoffman 1998: 66-67, Versaggi and Knapp 2000).

The latter two sites, the Southside Treatment Plant and the Broome Tech sites, have produced sizable assemblages of steatite vessel fragments in securely dated Early Woodland contexts in spatial association with expanding stemmed (i.e., fishtail) projectile points typical of the preceding Terminal Archaic period (Versaggi and Knapp 2000). However these data are not anomalous, but represent the growing recognition that regional chronologies based on typology (Ritchie 1969), often do not "recognize regional deviations from these normative models. By not factoring in the potential for different temporal trajectories within subregions of the Northeast, many important social, political, and economic patterns are masked and missed" (Versaggi and Knapp 2000: 2). An example of this issue also occurs in the subsequent Middle Woodland (2,000-1,000 B.P.), where Ritchie (1969: 227) records the presence of steatite sherds in several Middlesex (Hopewell) earthworks in Western New York. Once again, tethered to his own regional sequence, Ritchie interpreted the presence of steatite in these contexts to be merely the "fortuitous inclusion of more ancient cultural debris" (ibid.). The problems of typological ambiguity are much deeper issues within Northeastern archaeology (Filios 1989); and as new evidence is recovered, like the compelling data from Central New York (Versaggi and Knapp 2000), regional sequences must account for these idiosyncratic patterns. From these limited data it is apparent that, despite the typological arguments to the contrary, stone vessels appear to be extant in both Early and Middle Woodland archaeological components in the Northeast (Hoffman 1998, Versaggi and Knapp 2000).

The material evidence for Late Woodland (1,000-350 B.P.) and even Contact Period steatite vessel utilization in coastal Southern New England, while mentioned briefly in earlier essays and colonial records (Bushnell 1939, Holmes 1893, MacNeish 1952, Meltzer and Dunnell 1992, Saville 1919), is only recently being noted in archaeological publications (Bernstein et al. 1996a, Bernstein et al. 2009, Funk and Pfeiffer 1988, Hoffman 1998, Leveillee and Harrison 1996). Bernstein et al. (2009: 52) emphasize that although "radiocarbon dates (from soot adhering to vessels or from closely associated charcoal) for steatite run continuously from 3700 to 2700 B.P…There appears to be a break in steatite use after 2300 B.P., following which a number of younger dates suggests a separate late horizon for steatite vessels." Surprisingly, little attention has been paid to this late horizon of steatite vessel utilization, as the majority of research has been devoted to determining the timing of the earliest onset of vessel manufacture, and whether or not that preceded the first production of ceramics (Hoffman 1998, Sassaman 1997, 2006, Taché and Hart 2013, Truncer 2006).

Three archaeological sites in the greater study area have recovered persuasive evidence for the utilization (or intentional recycling) of steatite vessels in the Late Woodland: Point Judith Upper Pond, Christiana Steatite Quarry, and MPM Farm (Locus A). A fourth site, Skunk Lane (Figure 2.4), could tentatively be included in this list based on a vessel fragment found in association with a hearth feature dated to 330±40 years B.P. However, the dating issues with that particular feature are problematic, and are discussed in Chapter 3.3.

The Point Judith Upper Pond site, a sizable village occupation in coastal Rhode Island, significantly encountered a large pit feature securely dated to 480±110 years B.P., and among the contents recovered were canine teeth and steatite vessel fragments (Leveillee and Harrison 1996). The Christiana Quarry in Pennsylvania, one of the most intensively exploited steatite sources in the Mid-Atlantic (Wholey 2011b), yielded a quarry component feature with a contemporary radiometric date of 310±65 years B.P. (Truncer 2006). However, neither of the latter two publications specifically mentions the anomalous nature of these finds, and thus it is exclusively this author's speculation that these data may reflect Late Woodland era steatite vessel utilization.

The last well-dated example of this late horizon occurs on Long Island, at the MPM Farm Site in Water Mill, New York (Figure 2.4). Analogous to the discoveries from Point Judith Upper Pond, at MPM Farm excavators recovered a large steatite vessel fragment (Figure 3.17) within a clay-lined pit dating to approximately A.D. 1150, well within the Late Woodland Period (Bernstein et al. 1996a). These unique discoveries of steatite fragments in dated Late Woodland feature contexts are highly significant to the present study, as well as our understanding of Eastern North American prehistory; and allows for tentative comparisons of chronological changes, or continuity, of steatite vessel utilization.

Overall, the widespread increase of ceramic usage and decrease in steatite vessel exchange during the Woodland Period already mentioned above, suggests shifts in resource procurement and transport patterns away from long established exchange networks, whose underlying catalyst(s) may never be known (Bedard 2011, Fiedel 2001, Hoffman 1998, Sassaman 1995). The only tangible evidence for longer term continuity of steatite vessel use come from the rare, well-dated archaeological contexts like that of Broome Tech (Versaggi and Knapp 2000), MPM Farm (Bernstein et al. 1996a), and Point Judith Upper Pond in Rhode Island (Leveillee and Harrison 1996). Despite the fact that these three sites contain radiometric dates with standard deviations of >60 years (Taché and Hart 2013); the vessel fragments were nonetheless recovered in closed feature contexts or discrete A-horizons, and suggest that stone vessels still held a limited role within Early-Late Woodland communities in the Northeast.

Of course, these few atypical Late Woodland cases could feasibly represent site disturbance mixing discrete components. It is equally conceivable that they reflect localized practices of recycling broken vessel fragments for raw material (Swigart 1974). Third, the presence of steatite in later components may have been a form of technological nostalgia (e.g., passing down of heirloom objects), reinforcing prestige among individuals long after the exchange and domestic use of steatite vessels had ceased (Hayden 1998, Lillios 1999). These phenomena, and the more recent trend towards production of tobacco pipes, at the very least demonstrates that Woodland Era peoples were still including steatite outcrops within their overall resource procurement strategies, and that vessel production (or recycling) may have embodied a minor ancillary facet in this economic sphere.

Smoking Pipes in the Woodland Period:

Initially, the Woodland era production and trajectory of stone smoking pipes was not intended to be a focal point of the present research. However, while in the process of acquiring the two reconstructed steatite vessels and a rim fragment from the Oysterponds Historical Society (Figures 1.1, 3.18-3.19), the staff offered to loan out two steatite pipes recovered from Orient, NY (Figure 3.20) to be included in the present sourcing study. It seemed warranted to consider these additional lines of evidence to account for the continued reliance upon steatite as a raw material resource after the Terminal Archaic.

Throughout Eastern North America in the Early Woodland Period (Table 2.1), smoking pipes, occasionally made of steatite, appear at the time of the earliest archaeological evidence for tobacco use (Rafferty 2006). For the most part, it is the basic tube shape that represents the earliest form of pipe style, and was the only type to be utilized consistently across the continent (West 1934). This general trend is shown to be accurate at least for Eastern North America, wherein the oldest known pipes from the Late Archaic Eva site in Tennessee conform to the general tube shape (Lewis and Lewis 1961). It was not until the Middle Woodland period did the more elaborately carved effigy, elbow, platform, and monitor pipe styles fully develop in the east (Rafferty 2004). Ritchie (1969: 253) observed that the "evolution [of pipe styles] can be readily traced through progressively more angular forms, until the virtually right-angle pipe of the latest stage is achieved." This description not only applies to New York, but it accurately synthesizes the spectrum of North American pipe style trends over time.

Malleable stones, especially steatite or chlorite schist, were commonly employed for constructing the elaborate platform pipes of the Middle Woodland period (Seeman 1981). However, like bannerstones mentioned above, in Eastern North America smoking pipes were manufactured from a wide range of raw material types including wood, clay, stone (e.g. chlorite schist, Catlinite pipestone, claystone, argillite, steatite), and potentially the tobacco leaves themselves (Emerson et al. 2013, Fowler 1966b, West 1934). This variability stands in sharp contrast to smoking complexes of the Southern California region, where nearly every pipe recovered was carved from steatite (Tupa 2009).

Determining the source(s) of the raw material used to manufacture smoking pipes has the unique potential to not only reveal the extent of wide-ranging communication networks (Seeman 1981) and social institutions (Kuhn and Sempkowski 2001), but also to shed light on lithic procurement strategies that are wholly separate from subsistence-based quarrying (see Chapter 6). The results of sourcing experiments on stone smoking pipes have, for example, presented evidence for the existence of Hopewell ceremonial exchange networks extending into the study area (Seeman 1981). For example the Oaklawn Quarry in Rhode Island has revealed extensive evidence for tubular, elbow, and platform style pipe production (Dunn 1945), and has yielded a radiometric date of 731 A.D. (Fowler 1967), well within the Middle Woodland peak of formal smoking pipe exchange in North America (Seeman 1981). Yet, controversy has surrounded the Middle Woodland pipe making industry of the Oaklawn Quarry, ever since the recovery of a steatite platform pipe from Mound-2 of the Caitlin Site (Figure 2.1) in the State of Indiana (Seeman 1981, Turnbaugh and Keifer 1979). Seeman (1981) claimed that the platform pipe from Mound-2 was likely constructed of steatite from the Oaklawn Quarry in Rhode Island, based on the similarity of Rare-Earth Element (REE) abundance curves generated by Holland et al. (1981). Although this is difficult to accept at face value, it is certainly not impossible. Several unfinished pipe blanks from the Oaklawn Quarry, and also from the nearby steatite processing site RI 2050, were clearly abandoned in the early stages of manufacturing nearly identical platform-type smoking pipe designs (Dunn 1945, Fowler 1967, Waller and Leveillee 1998). Waller and Leveillee (1998: 28) later made the contention that it is feasible "pipes from that of the Oaklawn quarry …were being manufactured for a long distance exchange network of artifacts and information that extended from the Northeast to the Ohio River Valley."

However, this type of wide ranging correlation cannot be adequately addressed with the recovery of a single artifact, and that the steatite source could have easily come from many other unanalyzed sources (Seeman 1981). Additionally, the use of Rare-Earth Element abundance curves as a method for discriminating between steatite source locations has since been shown to be less reliable than previously contended (Bishop and Canouts 1993, Hubbard 2006, Moffat and Butler 1986, Jones et al. 2007, Truncer et al. 1998). Regardless, the presence of steatite platform and tubular pipes throughout Southern New England (Fowler 1966b) that are morphologically identical to those ranging from the Midwest to the Southeast, are intriguing occurrences, that can reveal changes in the economy of inter-regional steatite exchange over time.

Source characterization studies on smoking pipes made from steatite have also been used to indirectly trace the geographic trajectory of social institutions and the development of inter-regional diplomatic alliances (Kuhn and Sempkowski 2001). For example, Kuhn and Sempkowski (2001) employed X-ray Fluorescence (XRF) and Particle-Induced X-Ray Emission spectrometry (PIXE) to discern the timing and extent of interaction among late sixteenth to early seventeenth century Mohawk and Seneca groups. The authors proposed that the geochemical identification of exotic Mohawk pipes in Seneca assemblages from the late sixteenth century implies that diplomatic relationships were cementing, and this phenomenon supposedly represented the incipient formation of the historic League of the Iroquois. Kuhn and Sempkowski's (2001) research used sourcing data to demonstrate how objects such as steatite pipes are uniquely suited to addressing the nature of diplomatic social relations among prehistoric and historic groups.

Steatite Vessels in the Post-Contact Period:

Historic Period references to steatite vessel utilization and trade by indigenous peoples in Eastern North America is limited to only a few examples. The first, and most intriguing, is the oral history told by Swedish colonists in New Jersey, who claimed to have witnessed Native Americans boiling their meat in "greenish…grey pot stone" along with "another species of apyrous stone" (Bushnell 1939: 472, cf. Kalm 1750:343-344, Willoughby 1935). This seems to be a reference to Post-Contact stone vessel use by Native Americans, and the observed thermodynamic efficiency of a steatite-like material. Bushnell's (1939) citation of Peter Kalm's mid-eighteenth century text "Travels into North America," however, points out that by the time of Kalm's visit to the colony in 1749, stone bowls were no longer in use, and this behavior was documented orally from the memory of older individuals in the colony. Specific material types, tribal names, and other relevant behavioral patterns are not evidenced by Kalm's work, but more importantly it suggests that at the very least, stone cooking vessels were still being utilized intermittently up until the late seventeenth century in the study area. By whom and to what extent is clearly unknown, but most likely it was the Algonquian-speaking peoples of New Jersey known as the Delaware-Lenape, and apparently not the Iroquoian groups who had socio-political influence in the region (Laguna 1940, Parker 1920). Arthur C. Parker (1920:66), one of the most prolific archaeological and ethnological researchers in the Northeast, made the blunt ethnic distinction that the "Iroquois did not use steatite dishes, and fragments are found only on Algonkian and on Eskimo-like sites."

Laguna's (1940: 62, cf. Birket-Smith 1929) broad study of stone and ceramic lamps from the Arctic and throughout the globe, made a similar claim about these ethnic distinctions; "soapstone vessels are distributed from the Cree and Ojibway of Canada down to Florida, with the exception of the Iroquois." Linguistic data, also support these contentions (Whritenour 2010: 7), as recent revisions to known words of the Delaware-speaking peoples include examples for both "steatite pipe = achsinni hopoakan" and "steatite bowl = achsinni wulacans." Again these are only statements made in isolation and translated word lists, and none are elaborated upon further.

The second historic reference comes from an early account of the Ochee Springs quarry published by the Rhode Island Historical Society that reports Narragansett groups in the seventeenth century were known to be actively involved in the quarry and trade of both steatite vessels and smoking pipes to surrounding Native groups, specifically those on Long Island (Saville 1919). Saville (1919: 104-105) goes so far as to say "It is a historical fact that the Narragansetts…traded steatite vessels and pipes to the adjacent tribes…in exchange for which the Long Island Indians gave other articles, especially wampum…" These are however again unsubstantiated claims, referring to post-Contact trading systems which may not have existed in the first place, or have been practiced in the same way prehistorically. Regardless, these early references raise some interesting questions about the possible role of steatite and steatite vessels in the Woodland-Contact Period transition.

Little to no archaeological evidence for this post-Contact exchange has been recognized on Long Island; one tentative example comes from the Skunk Lane Site in Peconic New York, which contained steatite vessel fragments adjacent to a hearth feature dating to 330±40 years B.P. Curiously the sites location (Figure 2.4) was in the vicinity of a number of historic Native American settlements, including a temporary reservation established for the Corchaug peoples in 1691, before their forced removal in 1719 (Case 1884, Parker 1920). However, Skunk Lane is a multi-component prehistoric site occupied for potentially six millennia (Bernstein et al. 2009), and thus hypothetical correlations drawn between historic references and the fragmented archaeological record can inspire alternative explanations for vessel fragments occurring in terminal Late Woodland archaeological features.

Throughout North America, however, there are other isolated examples of Post-Contact steatite vessel manufacture and trade occurring among indigenous groups (Adams 2006, Hull et al. 2013, Klein 1997, Morrison 1991). For example in the nineteenth century, arctic Copper Inuit initiated a prolific but short-lived steatite vessel and Russian iron trading system, that ranged geographically from Eastern Canada to Siberia (Morrison 1991). These unique exchange networks functioned exclusive within indigenous groups, until being subverted by Euro-American traders (ibid.).

While not specifically mentioned for the Copper Inuit, anthropologists and historians have interpreted similar forms of post-contact exchange as responses to European encroachment, the disruption of traditional life ways, and to changes in material culture during the 1500s-1700s (Turnbaugh 1977). In New England, an example of this practice is known by the rapid spread of “Calumet” pipe ceremonialism in the Historic Period (ibid.). By the nineteenth century, this social complex had spread throughout North America east of the Mississippi River, and was centered on the long-distance exchange of carved pipes and decorative ornaments made of exotic “Catlinite” pipestone, claystone, and steatite (Emerson et al. 2013, Turnbaugh 1977).

Intensive Euro-American steatite quarrying took place in the historic period, most notably for grave stones and decorative architectural material (Dann 1989, Mathis 1982). Europeans also exploited steatite for the same thermodynamic properties recognized by prehistoric peoples; specifically as the fire-resistant, inner lining for iron kilns and fire places, as well as the use of flat, heated slabs for colonial bed warmers (Dann 1989, Elliot 1980). The collections of the Institute for American Indian Studies Museum and Research Center in Connecticut also contain some uniquely carved blocks of steatite, used by both Euro-Americans and historic Native American groups, as molds for the smelting of musket balls and clothing buttons (IAIS 2013).

The unique thermodynamic and chemically inert qualities of steatite are still highly prized, and active mines still exist throughout the region (Dann 1989). Steatite is still used primarily for manufacturing high-end kitchen products like counter tops, wood stoves, and cooking pans; the latter being recently discovered to be an excellent source of the essential nutritional elements Mg and Ca (Quintaes et al. 2002). Ultimately, mining of steatite deposits has become an intrinsic component to many aspects of modern life (Dann 1989), and thus the history of steatite use among humans is a complex and fascinating story.

This raises the question of what effects Euro-American, and even post-contact Native American steatite quarrying in the Historic Period, have had on the remaining evidence for prehistoric era extraction? Prehistoric steatite quarries, like the Westfield Quarry in Massachusetts and the Ochee Springs Quarry in Rhode Island for example, were recorded as being only marginally spared from these intensive activities (Dixon 1987, Fowler 1945). Thus, analogous to the mining of shell deposits on the Long Island coast (Ceci 1984); the impact of historic steatite quarrying upon our understanding of the scale of steatite vessel manufacture in prehistory is potentially massive (see Chapter 3.2).

The geographic trajectory and temporal continuity in steatite vessel quarrying and utilization in Southern New England between the end of the Late Archaic (ca. 3,600 B.P.), peak Terminal Archaic (3,000-2,700 B.P.), and the time of European Contact still remains unresolved. Although this research project is less concerned with ‘when,’ given that so few steatite artifacts have a reliable date associated with them (Taché and Hart 2013), but more with ‘where’ they were manufactured, and ‘how’ they may have reached the islands of the outer coastal plain with such frequency. The incorporation of smoking pipes (occasionally made of steatite) into post-Terminal Archaic assemblages, and the rare recovery of vessel fragments in Woodland contexts (i.e., MPM Farm, Point Judith Upper Pond, Broome Tech), points to a ubiquitous reduction in the scale of steatite vessel manufacture, and a shift in technological priorities over time. The frequency of ceramics in archaeological sites increases exponentially during this latter period; despite the fact that modern researchers have demonstrated the overall technological superiority (i.e., heat retention, fracture resistance) of steatite over ceramics, and even some metal containers (Bedard 2011, Stewart 2011, Quintaes et al. 2002, Truncer 2006, Todd and Wholey 2011).

This abrupt shift marks a significant turning point in the prehistoric technological evolution of Southern New England and Eastern North America as a whole (Sassaman 1995). It is possible these archaeological phenomena resulted from three sources, or a combination of each. First, the breakdown of established territorial boundaries and inter-regional exchange networks around 2,500 B.P., which had previously used steatite vessels as mediums for socio-political and ceremonial activities (Bedard 2011, Sassaman 1995, 2006). Second, a preferential divergence in raw material acquisition, from exogenic stone (i.e., steatite) for cooking containers, to readily available clay deposits (Hoffman 1998). Third, an overexploitation of known sources of vessel quality steatite occurred during the prehistoric period, a working hypothesis that will be addressed further in Chapter 3.2.

2.3 Geographic Context of Sampled Quarries and Quarrying Methodology

A broader discussion of the geological/ecological context of source area locations and extraction methods for steatite quarries included in this analysis is essential. Prehistoric steatite quarries in Eastern North America have been recorded by geologists, amateur excavators, and professional archaeologists since the nineteenth century (Holmes 1890, Putnam 1880, Reynolds 1879). With some notable exceptions (Dixon 1987, Neshko 1970, Truncer 2004a, Turnbaugh and Keifer 1979, Waller 2006), few modern scientific investigations have addressed the complexity with which steatite was procured and transported throughout New England.

Steatite procurement and vessel manufacture in prehistory is a unique extraction and production process that differs from any flaked-stone tool technology. Steatite artifacts are not comparable to other classes of ground stone tools (e.g., adzes, axes, mortars, pestles, or celts). Most of these are manufactured from harder igneous materials (Wright 1992). Instead, steatite artifacts fall into their own unique category of a chiseled-scraped-abraded-polished (Howes 1944) ground stone technology (CSAP-GST); a reduction strategy that could only be employed on softer lithic materials similar to and/or geologically associated with steatite (e.g., alabaster, chlorite schist, limestone, graphite, marble, pipestone, pyrophyllite, serpentinite, slate).

Within this operational framework there is much greater variation in reduction approaches than exists for flaked stone tool technology (Wright 1992: 55), and the removal of lithic material occurs grain by grain, as opposed to the fracturing off of thin layers. This allows for greater precision and control over the shape of the desired object. However, a large steatite vessel would have required a sizable quarry blank to achieve the object's design criteria. Given the high frequency of vessel breakage recorded on extraction loci (Howes 1944), the quarrying and manufacturing process could be categorized as high cost and generally wasteful of raw material.

Procurement strategies and reduction sequences for steatite vessel production can be inferred from multiple lines of evidence. The visible patterns remaining on quarried outcrops, the morphological variability of stone vessels, unfinished vessel fragments, quarry tools (Figure 2.5), and the spoil piles surrounding quarry pits composed of unworkable steatite blocks and powder lenses. From these combined data, steatite vessel extraction and manufacturing sequences can be broken into three component stages.

Exploration:

Exploration and identification of suitable raw material sources would have been the first stage. Schneider and Laporta (2008: 24) observe that the most critical variable in any bedrock quarry initiation is finding suitable jointing patterns (i.e., thickness of desired deposits between adjacent rock types) that ultimately will determine the maximum size of any manufactured products. In most cases in New England, it is an amorphous mass, a horizontal lens/ledge exposure, or a glacially transported boulder of steatite exposed on the surface. In other regions like the Mid-Atlantic, an entire landform can be composed of varying grades of steatite (Chidester 1964, Reynolds 1879: 27, Russell 1996: 43). More selective preferences in exploitation could have been employed in these locations.

While many raw material types used for stone tool manufacture occur in relatively consistent settings, steatite is found in a wide variety of bedrock contexts (e.g., serpentinite, chlorite schist, biotite schist, dolomitic limestone, marble, peridotite, hornblende gneiss, and granitic gneiss). Thus alternative identification methods may have been required to seek out new steatite deposits. One intriguing exploration strategy, which is only recently being considered, is drawn from botanical evidence.

Steatite deposits, especially those associated with serpentinite bedrock can have a toxic effect on soil quality; wherein only certain species of flora (e.g., grasses and scrub pines) can tolerate the magnesium enriched soil conditions of what have been deemed by botanists and ecologists as "Serpentine Barrens" (Dann 1989, Smith and Barnes 2008, Wholey 2011b). Prehistoric humans might have recognized this geo-botanical correlation, and that new sources of steatite could have been sought in the characteristic, savannah-like vegetation (Wholey 2011b). However, no niches of serpentine flora of any substantial size are known from the Southern New England study area. Due to the fact that most ultramafic/serpentinite deposits in this region occur as relatively small, isolated outcrops (Martin 1970). The nearest documented occurrence of substantial tracts of a Serpentine Barren landscape is located in the Piedmont of Virginia, and along the border between southeastern Pennsylvania and northeastern Maryland (Smith and Barnes 2008), conspicuously in a region containing a high density of prehistoric steatite quarries (Dann 1989, Ward and Custer 1988, Wholey 2011b).

The only known example of a small Serpentine Barren-type landscape within the immediate study area occurred historically at Todt Hill (Figure 2.4) on Staten Island, New York (Alexander n. d., Parisio 1981). Todt is a Dutch word meaning dead, in reference to early colonist's observation of "treeless rocky exposures" on the dome-like ridge overlooking the Verrazano Narrows (Staten Island Serpentinite, U.S. Geological Survey n.d.). Today the uplands of Todt Hill still contain multiple exposures of serpentinite and are typically overlain by serpentine-derived soil sequences (Parisio 1981); yet no Serpentine Barren plant communities are extant due to modern landscaping practices. Geological surveys conducted in the nineteenth century also consistently noted the presence of talc-schist and steatite lenses within the serpentinite exposures (Britton 1882, Cozzens 1843), but again no prehistoric stone bowl quarries have been reported from this area.

As mentioned many times already, steatite deposits utilized by prehistoric humans in Eastern North America occur within multiple types of parent material. A good example to consider is gneiss bedrock, which breaks down into soil types with a much higher organic content, supporting the establishment of oak-maple forests (Wholey 2011b). Understandably these "would not have been such stark, atypical landscapes as those associated with the serpentine talc-belt" (ibid: 114). The recognition of the geo-botanical correlation of Serpentine Barren vegetation and steatite outcrops certainly would have been an effective method for seeking out new quarry locations, but this was probably not the only strategy employed in prehistory.

Extraction:

Once a steatite source was recognized the qualitative properties of the raw material had to be assessed (Godoy 1985), but often the surfaces of lithic outcrops are highly weathered. Harrell and Brown (2008) have shown that steatite will gradually harden as it is exposed to the atmosphere. In these situations, quarry initiation would have required the utilization of blunt flaked and ground stone axes to first remove either the weathered lepisphere, or any impeding layers of dense host rock to expose fresh steatite deposits (Howes1944, Neshko 1970, Schneider and LaPorta 2008).

During the initial surface removal and qualitative assessment, the outcrops reaction to percussion and abrasion could have indicated when suitable material had been encountered. It has been demonstrated experimentally that steatite reduction produces only powdered dust (Del Bene and Shelley 1979: 248), due to the massive to weakly foliated grain orientation of steatite, and weak van der Waal's bonds of talc minerals (Hubbard 2006, Ludman and Coch: 50). Host rocks like Chlorite Schist or Serpentinite, are harder and more foliated, and would presumably fracture into angular fragments (Goodwin 1964). A pertinent and humorous historic analogy to this comes from Colonial New England folklore; wherein apparently during the annual tilling of agricultural fields, Euro-American farmers knew when their plow had struck soft steatite bedrock, by the distinctive muffled sound it made (Cole 2011). Prehistoric miners may have also recognized these types of visual and/or audible qualitative variations, and subsequently exploited them as guides to follow a 'vessel-quality' steatite vein until only a concave trench or pit was remaining.

This second stage of extraction required the use of chisel-like end picks (Figure 2.5), gouges, axes, and large wedges; a highly specialized suite of tools that are endemic to steatite quarrying locations (Fowler 1945: 101, Pretola 1983: 42). Putnam (1880: 274) notes that these chisel-like instruments were often manufactured from the harder rocks directly adjacent to the steatite seem, and would have "required considerable labor" to produce these single-function tools. Primarily these are combination flaked and ground stone axes, gouges, and pointed chisels (Figure 2.5) employed to carve radial trenches directly into an outcrop surface until a mushroom shaped protrusion is remaining (Figure 3.14). Historically these convex protrusions were preforms called "bosses," that would later become the convex exterior of a stone vessel (Hough 1931: 538, Mathis 1982: 97, Pretola 1983: 42). In order to remove the "boss" preform from the outcrop surface, a simple wedge was needed for increased leverage to break off the vessel blank. However, it is clear that many times this last removal stage would result in fracture of the vessel blank, and/or abandonment due to suboptimal structural qualities of the raw material, as is shown by the many remaining convex bosses at the Ochee Springs Quarry in Figure 3.14.

Reduction and Polishing:

After a successful bowl blank removal, the end picks (Figure 2.5), chisels, and gouges would again be employed to hollow out the initial bowl concavity (Figure 2.2); to reduce any excess weight for transport, and to define future vessel morphology. Final vessel reduction and polishing stages could have been performed at either the quarry site (Bullen 1940, Howes 1944) or at residential bases that served as secondary distribution centers (Waller and Leveillee 1998). Any form of generalized scraper, biface, or flaked tool with enough tensile strength was adequate for the final stages of manufacture, and were less specialized toolkits (Fowler 1945). Abrading stones, sediments, and oils could have also been used to further smooth out and polish the interior and exterior surfaces. Unfortunately some authors have managed to complicate the descriptions of later-stage finishing tools with ambiguous names like shavers, reamers, or polishers; and have assigned functions to these objects based on uncontrolled replication experiments (Fowler 1945). Nonetheless, the combination of these extraction and reduction approaches resulted in a wide array of vessel shapes and sizes (Figures 1.1, 2.3, 3.18-3.19) from small hand-sized cups (Mansfield 1985) to deep tub-like vessels (Lord 1962, Stewart 2011); ranging in weight from >1-17lb (Swigart 1974: 40), and maximum length from 8cm (Mansfield 1985:56) to 82 cm (Lord 1962:23).

Despite the extreme morphological variability recorded for steatite vessels in New England, outliers were rare, and there was an overall standardization of vessel sizes (Dixon 1987). Or at least an optimal size of the blocks to be removed from a quarry face, as has been demonstrated statistically (ibid.). This perceived standardization is also indicated by the remarkable consistency to the extraction methods used to remove suitable material for vessel manufacture, within and between regions, and is worth mentioning further.

Archaeologists have long noted the similarities between steatite quarrying methods of Eastern North America, Southern California, and worldwide (Dann 1989, Harrell and Brown 2008, Putnam 1880, Tupa 2009, Witthoft 1953). For example, historic groups in Southern California (i.e., Chumash) living in the Channels Islands, manufactured a greater diversity of vessels, pipes, and decorative objects than ever existed in Eastern North America (Wlodarski 1979: 333-335). Yet the strategies employed to extract steatite for vessels were virtually identical to those of Eastern North America. Interestingly the Chumash never adopted ceramic technology, despite their ubiquity in adjacent regions, and quarried steatite for a variety of both domestic and ceremonial items (ibid.). This artifact variability may reflect the more massive steatite outcroppings at places like San Clemente Island (Tupa 2009), as compared to the localized steatite lens and pod exposures characteristic of the New England Highlands (Chidester 1964).

In the Old World steatite was also a highly valued raw material for constructing cooking vessels, even though it was not intensively procured, manufactured, or exchanged until after the adoption of metallurgy (Bar-Yosef Mayer 2004, Becker 1976, Ige et al. 2008, Jones et al. 2007, Moffat and Butler 1986: 101, Santi et al. 2009). The employment of metal tools for the extraction of steatite, however, did not significantly digress from the way humans quarried steatite with stone tools in the Western Hemisphere. Nor did the basic vessel morphology deviate from the generally circular or ovate, wide mouthed pot with opposing lug handles (Figure 2.6). The relative similarity of methods employed between opposing ends of the North American continent, and also across the globe, suggests that the qualitative properties of the steatite were really the determining factors in quarrying methods and optimal vessel design.

A review of the literature on the methods employed at steatite quarries in Southern New England (which is limited to mostly local archaeological society publications) (Fowler 1945, 1975), reflects this tripartite system for both quarrying techniques and quarry types. Depending upon the nature of the deposit, steatite bodies can range from a lenticular bed, a ledge outcrop, a rounded/ovoid mass, or a cluster of glacially transported erratic boulders. Varying removal procedures would take place over time, and would subsequently be reflected in the remnant concavities with their adjacent spoil piles, powder lenses, and workshop areas (Dunn 1945, Howes 1944, Neshko 1970). Ward and Custer (1988) provide the only recent comprehensive study of steatite procurement strategies in the Mid-Atlantic, based not on quarrying patterns, but the actual vessels themselves as indicators of the type of manufacture process and source type (e.g., boulder or ledge outcrop). This chapter takes the opposite approach, and discusses quarrying methodology based on the visible patterns of the quarried deposits.

In Rhode Island, for example, broad horizontal exposures and ledge outcrops of steatite are inferred from the published literature. Quarry deposits at both Oaklawn and Ochee Springs are described as horizontal lenses with adjacent ledges exposed, often at an oblique angle to the modern ground surface (Dunn 1945, Dixon 1987, Fowler 1967). One of the most thoroughly excavated and mapped quarry locations, Ochee Springs in Johnston, Rhode Island (Dixon 1987, Putnam 1880, Saville 1919, Waller 2006, Willoughby 1935), is described as a broad horizontal exposure, with an adjacent ledge outcrop. Putnam (1878: 276) records that at this intensive extraction site, the “seem of steatite was formerly six to twelve feet deep” and estimates that several thousand vessels may have been quarried from this locus alone. A series of approximately 60 similar sized, convex bosses (Figure 3.14) and shallow craters hollowed out by the in-situ removal of vessel blanks are extant on the modern quarry surface (Dixon

1987, Putnam 1880, Waller 2006).

Another well studied prehistoric quarry is the Nepaug-Bakerville Quarry on Cotton Hill in Northwestern Connecticut (Figures 3.7-3.8). The Nepaug-Bakerville quarry drastically differs from Ochee Springs in both geology and resulting morphology. The Nepaug-Bakerville quarry, formed by an intrusive ultramafic exposure, contained an amorphous steatite mass of much greater horizontal and vertical dimension than occurred at Ochee Springs. The primary excavator, John Neshko (1970), argued that the Nepaug-Bakerville quarry demonstrated preferential extraction strategies that sought out specific physical attributes conducive to vessel manufacture. The western portion of the quarry revealed clear evidence of the surface removal of dense host rocks and hardened unworkable grades of steatite, to expose an artifact-quality steatite mass (Neshko 1970). The deposit was subsequently harvested in an eastward direction until a deep concavity or trench was formed, and all suitable material had been completely removed (Figure 2.7).

The result was a deep open-air pit with large adjacent debris piles (Figure 2.7). Lyent Russell (1997: 43) recorded three similar open-air pit locations on the same hill system of Cotton Mountain, with the largest concavity encompassing roughly 30 x 20 x 5 meters in dimension. This massive removal technique of very deep solitary pits or trenches has long been observed in other locations in New England and elsewhere along the Eastern North American Talc Belt (Bushnell 1939: 471, Reynolds 1879: 527, Holmes 1890: 323, Ward and Custer 1988: 34, Russell 1997: 43).

The main difference between Ochee Springs and Nepaug-Bakerville in quarrying procedure was that at the latter location, it appears that weathered surface slabs were first removed and tossed aside to access fresh raw material suitable for vessel manufacture (Harrell and Brown 2008, Neshko 1970). The result was to expose a discrete, pod-like deposit (Chidester 1964), eventually forming a single, deep open-air pit with large adjacent spoil piles (Neshko 1972). Likewise this strategy could be referred to as an open-air pit and trench method, which can be easily distinguished from other quarry types that only retain individual bowl blank removal loci along horizontal exposures, outcropping ledges, and boulders. The Nepaug-Bakerville, Cotton Hill, and Horne Hill quarries fall within this open air pit category; while Ochee Springs, Westfield, and Harwinton would fall under the latter.

The surface features observed on prehistoric quarries are a palimpsest, and reflect the most recent procurement episodes (Dixon 1987). Given enough time and a substantial horizontal and vertical deposit of quality material, the massive cone shaped open-air pit may be the end result of repeated forays to the same deposit. The perceived size disparity between the lens/ledge quarries and open-air pit quarries could also be due to historic mining activities (Dixon 1987).

The Horne Hill quarry (Figure 3.7), in spatial contrast to most open-air pit and trench quarries, extends not vertically but horizontally into a steep, precipitous slope; that after quarrying ceased, more closely resembled the entrance to a cave than a quarry trench (Fowler 1966a). Horne Hill was also the first prehistoric stone bowl quarry to yield a radiocarbon age of 2,730 +/- 120 B.P. (ibid., Hoffman 1998); from a hearth feature underlying nearly seven feet of quarry tailings and overlying another four feet of steatite debris and powder/talc dust layers (Bullen 1940, Fowler1966a). The vertical location of the hearth feature between two massive depositional episodes of steatite quarrying attests to either punctuated, large scale quarrying events, or multiple small scale forays over several thousand years.

The North Wilbraham quarry (Figure 3.7) in the Connecticut River Valley of Massachusetts was involved in the unique process of what could be referred to as the erratic reduction method, endemic to the uplands of New England. There large erratic boulders, glacially transported from their point of origin, were either reduced completely down to the ground surface, or were exploited until a lesser quality inclusion was encountered and abandoned (Fowler 1969). Even though the poor quality of the North Wilbraham material compared to other quarries has long been emphasized (Skinner 1909), it may very well be the slightly harder, impure nature of these steatite boulders that facilitated their initial transport via the Laurentide Ice Sheet. A higher quality material (i.e. composed of a greater percentage of talc) may have been more easily eroded or abraded into smaller, unsuitably sized fragments for vessel manufacture.

The resulting deeply pitted surface features (due to the massive size of some of the boulders) at North Wilbraham, is similar in shape and dimension to those observed in Nepaug-Bakerville. The only difference is that at Nepaug-Bakerville, lithic material was being carved directly from bedrock outcrops, while North Wilbraham is merely a series of concave depressions within the extant forest surface that marked the prior location of the quarried boulder (Howes 1944). Among the nine quarrying loci recorded at North Wilbraham, there is either a small portion of the boulder at the base of the depression, or there is no remaining trace of the boulder except for the adjacent spoil piles (Fowler 1969).

The erratic reduction method contrasts with to the majority of known prehistoric quarries. The difficulty in tracking down the limitless boulder deposits of New England to search for similar quarries also seems impractical. Locating the nearest potential outcrop in relation to known steatite boulder quarries could indicate the distance traveled via glaciers, and the potential bedrock source of these secondarily-deposited surface features. Until that is established the original geological context of these boulder deposits remains elusive. As mentioned in Chapter 3.1, a review of the existing geological units occurring to the north and northwest of the North Wilbraham Quarry revealed the Mount Mineral Formation; an ultramafic mélange that contains lenses of Serpentinite, Serpentinized Harzburgite, and metamorphosed Gneiss (USGS-MROSD), which are all suitable bedrock contexts for hosting steatite deposits. North Wilbraham, and other possible erratic boulder sites along the Skug River in Northeastern, Massachusetts (Wall 2003), are the only known steatite quarries that fall under this category.

Overall, the marked variability in which steatite was procured is unique among stone tool industries in New England, and is exemplified by the innovative strategies employed in locating new sources and the extraction of raw material. The specialized tool kits designed exclusively for this craft, further demonstrate the energy expended by prehistoric peoples to manufacture objects that were intended to be exchanged over long distances. The mechanisms by which finished steatite vessels were transported across the landscape and over bodies of water are discussed in Chapter 6.

Chapter 3. Methods and Materials

The application of interdisciplinary research strategies to archaeological inquiry has been greatly expanded with the inclusion of source characterization techniques to elucidate artifact provenance (Allen and Pennell 1978, Hannay 1961, Gratuze 1999, Glasscock and Neff 2003, Rapp 1985, Shackley 2002, 2008, Tupa 2009, Turnbaugh et al. 1984, Tykot 2004, Weigand et al. 1977). Without modern geochemical approaches, researchers are left with unreliable visual or petrographic methods to examine these procurement-transport patterns (Leudtke 1993). Thin-section petrography has been employed effectively by geologists for over a century (Calogero 2002: 90). The enormous scale of prehistoric exchange systems, however, cannot be adequately investigated with megascopic identification techniques alone; and thus provenance studies require a comprehensive approach that ideally measures and quantifies intra and inter-source compositional variability (Harbottle 1982, Rapp 1985, Weigand et al. 1977).

The methodologies employed for examining procurement-transport strategies and artifact provenance have improved over time; from the initial use of macro-scale mineralogical classifications to modern analytic techniques like various forms of Mass Spectrometry, X-Ray Fluorescence, and Neutron Activation Analysis (Allen et al. 1975, Calogero 2002, Durant et al. 2005, Glasscock and Neff 2003, Goffer 1980, Gratuze 1999, Farquhar and Fletcher 1984, Frankel 1969, Hannay 1961, Harbottle 1982, James et al. 2005, Rapp 1985, Rasbury et al. 2012, Shackley 2008, Sayre n.d., Turnbaugh and Keifer 1979, Turnbaugh et al. 1984, Tykot 2004, Weigand et al. 1977). Artifact source characterization was first attempted in the early eighteenth century, when researchers investigated the geological origins of the megalithic stones at Stonehenge (Rapp 1985). Chemists were also experimenting independently with archaeometric techniques at this time to determine the chemical composition of metals coins and glass objects; but it was not until the mid-nineteenth century that archaeologists, museologists, and geochemists regularly embarked on interdisciplinary collaborations in artifact source characterization (Goffer 1980: 3). Luckily for the contemporary researcher, the strategies, precision, and effectiveness of artifact sourcing studies have progressed incrementally during the last few centuries, and especially so in recent decades (Rapp 2009).

The fundamental goal of every source characterization study is the establishment of the "Provenance Postulate" (Weigand et al. 1977). The Provenance Postulate states that in order to successfully distinguish quarry locations of any rock type from one another there must be greater geochemical variation between each discrete deposit than the range of variation measured within a single outcrop (Glascock 2002, Glasscock and Neff 2003, Weigand et al. 1977). If statistically significant variation for each individual quarry cannot be ascertained, or at least within a regional set of closely spaced quarries, then there can be no attempts to match artifacts to their source location (Truncer et al. 1998, Waller 2006).

A variety of techniques can be applied to archaeological materials (Rapp 2009, Tykot 2004). Selection of an appropriate analytic technique to carry out archaeometric endeavors typically depends upon the resources available to the researcher, the questions being asked, and the range of elements one is interested in measuring. In this case, it was availability of Energy Dispersive X-Ray Fluorescence (EDXRF) units at the Stony Brook University Chemistry Department that determined the methods employed. EDXRF with hand-held, portable XRF devices (HHpXRF) has been applied with relative success to a myriad of artifactual materials, and is described below.

Hand-Held/Portable X-Ray Fluorescence (HHpXRF)

Hand-held devices employed for establishing artifact provenance have become increasingly employed by archaeologists and museum researchers in recent years (Emerson et al.2013, Frahm 2013), for the simple fact that they require virtually no sample preparation, and can be easily transported to the field, laboratory, or museum. Although most importantly, Energy Dispersive X-Ray Fluorescence analyses, with HHpXRF devices, are inarguably the least destructive of any known source characterization technique, and have been utilized with relative success on a range of archaeological materials like steatite (Bachor 2011), obsidian (Forster et al. 2011, Frahm 2013, Millhauser et al. 2011, Nazaroff et al. 2010) and ceramic artifacts (Bow 2012, Speakman et al. 2011). As a result, these techniques have been conducive to use in field studies of geological source areas and quarries, as well as private, historical society, or museum artifact collections that, understandably, will only allow minimal handling of objects and nondestructive material analyses (Bachor 2011). For the present study, the author used the Bruker Tracer III-V unit at the Stony Brook University Chemistry Department, under the supervision of Dr. Katherine Aubrecht, and a Bruker II-S at the Brooklyn College Anthropology Department under the supervision of Dr. Bruce Bailey.

As happens with the progressive implementation of any newly adopted source characterization approach, differing schools of thought emerge as to the efficacy of the technique, although seemingly none more contentious as the adoption of portable XRF technology (Frahm 2013, Shackley 2010). Several methodological critiques have recently been published that evaluate the accuracy, precision, statistical value, and overall validity of the technique (Frahm 2013, Frahm and Doonan 2013, Goodale et al.2012, Shackley 2010, Speakman et al. 2011); as well as comparing the results produced by HHpXRF with techniques like INAA (Speakman et al.2011), WDXRF (Goodale et al.2012), and Electron Microprobe Analysis (EMPA) (Frahm 2013). These positive and negative critiques however are not only necessary, but absolutely fundamental to calibrating and standardizing the methods for HHpXRF analysis, and ensuring the reproducibility of the quantitative data obtained.

Despite technological limitations (as exists with every sourcing technique), researchers have recently published compelling results demonstrating the discriminating potential for HHpXRF. Most notably among these are Millhauser et al. (2011), Nazaroff et al. (2010,) and Frahm's (2013) studies of obsidian from Mesoamerican and the Near East, and Bachor's (2011) exploratory study of steatite from the Lower Susquehanna River Valley. Bow (2012), used the same device employed in the present study, the Bruker Tracer III-V, to compare ceramics from two discrete rockshelter loci; and concluded that Bruker device's high level of precision could demonstrate statistically sound inter-site differences in ceramic sources.

Essentially the Bruker Tracer III-V unit, and all portable EDXRF devices, measures photon-electron interactions by emitting a high energy Alpha X-ray from an Ag, Rh, or Re Tube source. The Bruker Tracer III-V specifically uses an Rh Tube due to its extreme rarity in most lithic materials, but as a result cannot measure the presence of Rh in samples. During operation, the incident radiation from the Rh source strikes the sample surface, and dislodges or ejects an orbiting electron from the M-shell, K-shell or L-shell of a particular atom (Figure 3.1). Subsequently, an electron orbiting in an outer electron shell fills the vacancy created by the ejected electron (Figure 3.1). As the electron moves from one shell to another, an X-ray photon is released (i.e., fluorescence), and this energy interacts with the analyzer's detector. The emitted photons diameter in nanometers (nm) and wavelength in keV is diagnostic of a particular element. These photon data are then processed through the detector and fed directly into the CPU, where the uncalibrated data are transformed directly with Bayesian Statistics from counts per channel, to a linear spectra quantified in parts per million (ppm), also referred to as net intensity.

Bruker Tracer units have the capacity to measure concentrations of elements ranging from Na through U on a variety of raw materials (i.e., gases, powders, and solids). Sample size constraints are minimal, and single grains of sand could be analyzed individually. However, samples cannot be so large that they cannot be easily mounted on the custom plate that surrounds the IR sensor, and samples surfaces that are irregular can affect the output of the data (Frahm 2013).

General XRF theory is based on the study of photons and photon emissions, which in effect is the measure of color pattern peaks for each element present within a sample (Bailey pers. comm.). Color itself is the reflection of photons from a material solid. Thus X-Ray fluorescence is the measurement of this photon energy. When atoms are excited by emissions of X-Ray bands of radiation, the atoms are fluoresced, and reflect the wavelengths of the elements present (ibid.).

Photon wavelengths can be measured because, although they do not have a length in their direction of motion, like visible light (700-300 nm) they do have a diameter in nanometers; this quality determines how photons interact with an electron structure. Different elements reflect different color wavelengths; Rare Earth Elements for example, emit distinctive color patterns from those of transition metals or main group elements. As a result, Bruker XRF devices interfaces with software that uses

Bayesian Curve Fitting statistics to produce a linear spectra of elements, which can be used to identify discrete color peaks; for example, the color pattern or photon wavelength for the element Fe is 6.4 keV and is 40,000-1,000nm in diameter (ibid.).

Elements, that have discrete voltages and wavelength diameters, are differentially located within specific orbiting electron shells (Figure 3.1); elements ranging from Sodium to Barium occur within the K-shell orbit, while Barium through Uranium occurs within the L-shell. The distribution of elements within lithic materials are also typically located at varying depths from exterior surfaces, and the Bruker Tracer device penetrates a sample differentially to measure each element. A calibration curve for each element is applied to reflect the concentration within a sample (ibid.).

Many forms of error can invariably occur during XRF analysis, and many of the references mentioned above have outlined these problems in detail. The most common are sum peaks, wherein two photons of equal voltage are measured simultaneously by the IR sensor, and thus irregularly large peaks would be observed within the spectra. Sum peaks can also be identified by incorrect voltages indicated for a particular element. For example the element Cu has a specific voltage of 8 keV, but if the Cu peaks voltage observed in a spectrum reads 16 keV, than a sum peak of two photons has been measured. Erroneous detections from the IR sensor can result in artifact peaks of multiple types: Bremsstrahlung Scattering, Compton, Rayleigh, and Escape Peaks. General background scattering of various forms can also occur, as recent research by Bow (2012) and Frahm (2013) provide excellent syntheses of these methodological issues. Fortunately, none of the issues with sum peaks or varying degrees of backscatter radiation were observed during analysis, and the operating procedure and methods of analysis employed by the author are discussed below.

Steatite Source Characterization: History and Context

The logistical advantage in sampling steatite vessels found on Long Island, New York for studies addressing geochemical sourcing is that steatite is archaeologically durable, easily identifiable, geologically exotic to the outer coastal plain, and forms in a variety of distinct bedrock contexts. The relative durability of steatite also facilitates the ability for sourcing methods to be conducted on artifacts even if they have been extensively handled or stored in museums for over a century. Museum, private, and historical society collections could also be useful in showing patterns of geological source variation; long after their archaeological context has been destroyed.

The primary disadvantage in using any lithic material, including steatite, for geochemical sourcing is that concentrations of elements and proportion of mineral inclusions can be inconsistent within a single quarried outcrop (Bullen and Howell 1943, Hubbard 2006, Rapp 1985, 2009, Shackley 2002, 2008, Truncer et al. 1998). Intra-source variation is the constant concern in archaeological provenance research, especially for heterogeneous lithic materials (e.g., marble, rhyolite, steatite) that are common constituents of prehistoric technology (Scharlotta 2010, Shackley 2008, Truncer et al. 1998). There is a greater complexity to the mineralogical variability of steatite, as opposed to a material like obsidian; which has a homogenous composition due to rapid formation, and can be characterized with greater accuracy than most lithic types (Glasscock 2002, Gratuze 1999, Shackley 2002).

Steatite, which can occur within multiple bedrock types, often has a diverse array of trace elements whose patterns of concentration in ppm might vary erratically, or inadvertently be replicated between widely separated geographic localities; which have been observed among various lithic source deposits separated by more than 1000km (Goffer 1980: 85-86). However, Rapp (1985: 353) makes the pertinent observation that "unless two artifacts…were formed from the same rock or ore body, it would be fortuitous for them to have coincident trace-element concentrations of eight or more geochemically independent elements." Although, earlier attempts to determine individual signatures for Mid-Atlantic steatite quarries with highly precise techniques like INAA published mixed results (Glasscock 2002, Truncer et al. 1998). Regions with closely spaced stone bowl quarries revealed, in some cases, a greater compositional similarity than variability between individual outcrops, and were ultimately clustered together as geochemical-regional sets.

Similar clustering of steatite characterization data by geographic region was encountered during Waller's (2006) recent WDXRF study of eight Southern New England Steatite quarries. For example the Northwest Connecticut region, the Rhode Island region, and Southeastern Massachusetts areas showed broad inter-regional dissimilarity; yet minimal individual outcrop discrimination could be achieved (ibid.). Fortunately, this regional clustering of the geochemical data has less to do with inaccuracies with the various analytic techniques employed, and much more to do with the known fact that regions with a linear, discontinuous series of steatite outcrops, in relatively close geographic proximity, are likely the eroded remnants of a single deposit (Martin 1970).

All of these mitigating factors, including the potential for lost evidence from site looting, historic period quarrying, modern talc/asbestos mining, and urban development (Turnbaugh and Keifer 1979), make steatite in Southern New England a challenging material to confidently determine source locations. The expense of testing can limit the sample size, and therefore the ability to argue any inter-regional patterning beyond tentative geographic correlations between sourcing data and artifact provenience. Furthermore, as new characterization protocols are still being established (Jones et al. 2007), different compositional anchors are being compared to broaden the scope of elements analyzed for greater proficiency.

These issues are difficulties shared widely by most archaeometric provenance research studies. No material can be indisputably 'sourced.' Published provenance data results are ultimately a probabilistic tendency for certain elemental constituents to occur within the sample base. The goal is therefore to obtain quantitative results that are not only internally consistent, but also ultimately replicable between researchers and laboratory facilities (Frahm 2013, Harbottle 1982, Shackley 2008).

Researchers have long recognized the relevance of at least attempting to test hypotheses about the mechanisms and directionality of steatite exchange in Eastern North America. Despite the widely known challenges in steatite provenance studies discussed above, Rapp (1985: 360) contends that steatite and related "soft-stone artifacts…have proved to be amenable to provenance studies." However in order to demonstrate how this still evolving process has become a viable research strategy in the study area, and Eastern North America as a whole, a brief element of historical context is essential to understanding how attempts at steatite sourcing and material identification have developed.

Initially, a spectrographic elemental analysis of six quarries from Massachusetts and Rhode Island was conducted to attempt at distinguishing Southern New England steatite sources from one another (Bullen and Howell 1943). The authors graphical output of major, minor, and trace elements was limited to presence/absence attributes "presented in interval scale making it difficult to interpret or treat statistically" (Hubbard 2006: 24), with limited quantitative reference (e.g., major elements >20%). Bullen and Howell (1943), however, were quick to recognize the limitations of these results, which were primarily due to small sample sizes and the relatively few elements analyzed. In addition, Bullen and Howell (1943: 63) observed that "talcs are rather variable in the ground. In the space of a few feet the material can change considerably both in grain size and hardness…It would probably be necessary to test samples at regular intervals across the vein…If this were done, tracer elements within certain quantitative limits could undoubtedly be set up against which the analysis of a specimen could be checked with reasonably definite expectation that the quarry of origin could be ascertained."

Subsequently, Ritchie's (1959) extensive recovery of steatite vessels on Eastern Long Island prompted him to submit several fragments from the Stony Brook habitation site, as well as the Sugarloaf Hill and Jamesport burial sites, to geologists from the Rensselaer Polytechnic Institute (RPI) and the New York State Museum. He did this not for sourcing purposes, but rather for mineralogical analysis and geologically accurate raw material identification. Samples from the Stony Brook site were identified by Mary C. Reed, Curator of Geology at the New York State Museum, broadly as a form of amphibolites that Reed claimed "may have been locally available on Long Island in glacial drift boulders" (ibid: 36). The vessel fragments from the Sugarloaf Hill and Jamesport burial sites were examined by James R. Dunn of RPI, and based on gross mineralogy identified through the use of petrographic and binocular microscopes; samples were identified as "amphibole-talc-rock" or "talc-tremolite-schist," composed of approximately 47% talc, 52% amphiboles (i.e., tremolite, actinolite, anthophyllite), and 1% magnetite (ibid: 63).

The most ambitious program of steatite source characterization since Bullen and Howell in 1943, came in the mid-1970s; with researchers from the University of Virginia exploring the efficacy of using Instrumental Neutron Activation Analysis (INAA) to trace the geological origins of steatite artifacts from throughout the Eastern United States and Northeastern Canada (Allen et al. 1975, Holland et al. 1981, Luckenbach et al. 1975). Their works concluded that Chondrite-Normalized Rare Earth Element abundance curves were able to discriminate geological sources from one another (Allen et al. 1975). In turn, this data was employed to outline the exchange conduits by which analyzed steatite artifacts were most likely transported across the landscape (Holland et al. 1981, Luckenbach et al. 1975).

In the late 1970s and early 1980s, the use of Atomic Absorption Spectroscopy (AAS) combined with Optical Mineralogy, thin-section petrography, and megascopic characterization with a Munsell Color Chart (Turnbaugh and Keifer 1979, Turnbaugh et al. 1984) established a visual, textural, mineralogical, and elemental reference database for six New England steatite sources: Bakerville (Nepaug), Oaklawn, Ochee Springs, Westfield, Horne Hill, and North Wilbraham. Their study found that, for example, two molecular structures sodium oxide and iron oxide showed potentially discriminating quantitative signatures for each quarry location (Turnbaugh et al. 1984: 134). From these data, it was concluded that "highly significant compositional variation appears to exist among soapstones from Southern New England...and as the present study demonstrated statistically…greater geochemical variation exists between most southern New England soapstone quarries than within the individual outcrops of the region" (Turnbaugh et al. 1984: 137). However, despite the compelling results, the authors adamantly stressed the need for more comprehensive sampling strategies and further geochemical experiments in steatite source characterization, and Dr. William Turnbaugh was gracious enough to provide the first assemblage of quarry samples used for this most recent study (Appendix B).

In the late 1990s, Truncer et al. (1998) re-examined the applicability of the INAA technique on sourcing steatite from Eastern North America. Basing their strategy upon Moffat and Butler's (1986) research on sourcing Shetland steatite with INAA, Truncer et al. (1998) concluded that transition metals were the most effective source discriminating elements. Truncer et al. (1998) significantly notes that the movement of transition metals during the steatization process most accurately reflects parent material characteristics, which are essential measurement criteria to differentiate between source areas. All of the artifact samples tested from coastal New York were well out of the 90% confidence interval with any of the Mid-Atlantic steatite quarries analyzed (ibid.), arguing that New England is the expected regional source group. Currently no studies have refuted the hypothesis that transition metals are the most diagnostic elemental constituents for characterizing steatite deposits. Thus the present research focused its efforts upon detecting and measuring the concentrations of transition metals in the sample base.

Versaggi and Knapp's (2000) study using INAA built upon Truncer et al. (1998) legacy data for steatite in Eastern North America with a large sample of vessel fragments found on two Early Woodland sites in central New York. In their study, which compared artifact assemblages from the central New York-Susquehanna River watershed and the New England-Hudson/Long Island Sound watershed; Versaggi and Knapp (2000) were able to demonstrate statistically significant geochemical differences between the sources of steatite vessels used in each watershed. In effect, the authors concluded that "groups occupying central New York at this time may have established trading partnerships with groups occupying areas other than New England, while people living in the Hudson Valley and Long Island region may have partnered with groups in southern New England for their steatite" (ibid: 9).

Waller (2006) employed a laboratory-based form of XRF, Wavelength-Dispersive X-Ray Fluorescence (WDXRF), on steatite from eight quarries in Southern New England and vessel fragments from three archaeological sites in Rhode Island. Prior to conducting his analyses, Waller generated a comprehensive sample base that were the first steatite quarry assemblages collected systematically in the New England region. Most significantly, each outcrop he visited was sampled at multiple exposure points, to account for intra-source compositional variability. Interestingly, the results of Waller's (2006) study revealed an unexpected distance-to-source pattern, which refuted the underlying assumption that the nearest quarries would be the most likely source. Vessel fragments found on archaeological sites in Rhode Island, which were located in close proximity to well-known prehistoric quarries, were more geochemically similar to steatite sources from Western Connecticut (Waller 2006). Similarly anomalous procurement-transport distances have been reflected for steatite vessel exchange in other parts of the continent (Elliot 1980, Tupa 2009), which is one of the reasons why the present study included source area samples covering an even larger area surrounding coastal Long Island, from Southeastern Pennsylvania to New Hampshire (Figure 2.1).

Waller's (2006) emphasis on New England steatite sources, and his approach to the treatment and graphical display of generated XRF data with logarithmically transformed biplots, is the general model upon which this study presents its own results. Mr. Waller also graciously provided the bulk of the present sample database. He provided securely provenienced geological samples from the Nepaug-Bakerville, Cotton Hill, East Litchfield, Harwinton, Ragged Mountain, Jenkins Hill, Petersham, Ochee Springs, and Oaklawn quarries (Appendix B).

Subsequently, varying techniques have been applied to archaeological steatite throughout the globe and include: Electron Microprobe Analysis (EMPA) (Ige and Swanson 2008), Radiochemical Neutron Activation Analysis (RNAA), Thermal Ionization Mass Spectrometry (TIMS), and Quadrupole ICP-MS (Jones et al. 2007), Laser Ablation-Inductively Coupled-Mass Spectrometry (Tupa 2009), Infrared/Near Infrared Reflectance Spectroscopy (VNIRS) (Hubbard 2006), and a four-pronged approach of combining an Optical Polarizing Microscope, X-Ray Diffraction (XRD), Inductively Coupled Plasma-

Optical Emission Spectrometry, and Inductively Coupled Plasma-Mass Spectrometry (Santi et al.2009). Each admirable attempt revealed positive results, but as seems to be the case for any and every published sourcing study, the authors conceded with the default statement regarding statistical issues in sample size, and the overall difficulty in accurately determining the elemental variation within and between source locations. Clearly there is no consensus as to the optimal technique or combination of techniques for sourcing steatite artifacts; nevertheless each new experiment lays the groundwork for better modeling of regional procurement and vessel exchange mechanisms.

Most recently, Bachor (2011) has shown promising results with HHpXRF on both steatite artifacts and the in-situ analysis of geological sources from the lower Susquehanna and Delaware River Valleys. Her analyses used an Innova brand device; and rather analogous to the results obtained by the author, was able to differentially identify a number of transition metals and trace elements (ibid). Bachor's (2011) research was part of the symposium on steatite at the 2010 MAAC conference mentioned in Chapter 2.1; and her selection of HHpXRF partially influenced the decision to employ the Bruker Tracer III-V for the present study.

S-XRF: Beamline X26A, National Synchrotron Light Source, Brookhaven National Laboratory Blind-Test (n=2): Bakerville and Ochee Springs Source Areas

Prior to conducting EDXRF analyses at Stony Brook University, a preliminary elemental spectra of two selected steatite quarry samples was generated by Synchrotron X-Ray Fluorescence (S-XRF) with the X26A Beamline at the National Synchrotron Light Source (NSLS), Brookhaven National Laboratory by E. Troy Rasbury in 2012 (Figure 3.2). Even though source discriminating elemental data already exists for the steatite quarries (Turnbaugh et al. 1984, Waller 2006), it was thought to be prudent to conduct a blind test pilot experiment to measure, with the high precision of the National Synchrotron Light Source, for significant geochemical differences between two geographically distant steatite source locations that occur in discrete formations of widely different ages. The Nepaug-Bakerville Quarry, derived from an Ordovician age ultramafic pluton within a schist-granite interface, and the Ochee Springs Quarry, which occurs within Late Proterozoic epidote-biotite schist (Appendix B); were selected for this initial S-XRF analysis due to the simple fact that they are widely separated geographically, occur within discrete tectonostratigraphic terranes (i.e., Iapetus vs. Avalon Terranes), and are the two most thoroughly studied prehistoric quarry locations in Southern New England (Dixon 1987, Neshko 1970, Putnam 1880, Russell1997, Turnbaugh and Keifer 1979, Turnbaugh et al. 1984, Waller 2006).

The X26A Beamline performs Synchrotron-based trace element analysis with 10 detectors scanning across the sample surface at a 10 micron step, with a scan rate of 0.1 microns per second (Rasbury pers. comm.). The photon energy wavelength data from each sample were then measured and separated with a Wavelength Dispersive Spectrometer, and then processed by Multi-Channel Analysis (MCA) to provide major, minor, and trace elemental counts in ppm, the spectra results are logarithmically transformed and displayed in Figure 3.2. At the onset it was apparent that certain elements, and proportions of elements, were conspicuously present or absent between the two sources; results which if consistently represented through additional analyses, may have critical diagnostic value. Significantly, the Ochee Springs quarry contained high levels of Cr and Ni in comparison to Nepaug-Bakerville, a discriminating pattern that was also reflected in the author's EDXRF analyses.

The MCA results of the Synchrotron-XRF analyses also showed relative similarity in the overlapped profiles of the two elemental spectra (Figure 3.2). This similarity however is expected, due to the fact that both specimens were talc-bearing rocks derived from altered schist's that underwent the metamorphic process of steatization. At the same time, potentially significant quantitative differences between the elemental peaks are clearly demonstrated between the two samples, with four of the disparate and prominent peaks labeled in Figure 3.2.

These preliminary data from only two samples do not provide much statistical value to the present study. Of utmost importance however, the results of this "blind" analysis confirmed that steatite, at least on a regional scale due to similar formation histories (Martin 1970, Truncer et al. 1998) and deriving from discrete tectonostratigraphic terranes (Appendix B), can be grossly discriminated from one another through source characterization techniques. Cr and Ni were shown to be highly discriminating elements from the S-XRF analyses conducted (Figure 3.2). Therefore, these two tracer elements (Cr, Ni) are the most useful for making source-determinations of steatite artifacts.

The X26A Beamline also generated synchrotron-based X-ray microfluorescence mapping images, shown in Figures 3.3-3.4. Rapid Fly Scan analyses of both samples provided what is essentially a visual compositional map of the distribution of certain elements across the rock surface for Al, Ca, Cr, Fe, Mn, Rb, V, Ni, Si, and Ti. The color scale gradient denotes increasing concentrations from dark to light, lowest to highest. These data show element localization and spatial associations between various elements within the steatite matrix (Rasbury et al. 2012, Wilson et al. 2012), and can potentially provide insight into what elemental bi-plot comparisons would be reflective of source discrimination. For example, note that for both samples, Cr and Ni occur spatially adjacent to one another (Figures 3.3-3.4).

HHpXRF: Bruker Tracer III-V, Chemistry Department, Stony Brook University

All 103 of the quarry, source area, and artifact samples included in the present study were analyzed by the author with a Bruker Tracer III-V portable HHpXRF device at the Stony Brook University Chemistry Department (Figure 3.5), under the supervision of Dr. Katherine Aubrecht. Energy Dispersive X-Ray Fluorescence (EDXRF) was selected as a non-destructive method to provide baseline elemental data for the entire study, which will then be used to narrow the focus of future analyses with more comprehensive sourcing techniques (e.g., LA-ICP-MS, TIMS). The operating procedure for the Bruker Tracer III-V was straightforward, and the methodology was consistent for both quarry samples and artifacts.

Fortunately, since the experiments were conducted in the laboratory, the device could be securely mounted on a custom stand and remained stable during the entire analysis of each sample (Figure 3.5). Standard measurement protocols for HHpXRF devices entails that samples should be placed at a 90 degree angle to the Incident Radiation (IR) sensor, and kept in place for the duration of each timed assay. The steatite artifact sample shown above from MPM Farm (Figures 3.5, 3.17) had flat enough surfaces that no sample preparation was necessary prior to analysis. However most quarry and source area samples from the present study often still retained sediments from their original context (Figure 3.13), and were prepared by dry brush cleaning. Most quarry samples, and one artifact sample from the Skunk Lane site, was also cut with a Jaret band saw in the Stony Brook Geosciences department, to allow the Bruker Tracer device to analyze both freshly cut and cleaned natural surfaces of steatite.

Bruker Tracer devices in general are more versatile when compared to other HHpXRF units, and also bench-top laboratory XRF machines, in that the researcher has complete control over each measurement setting (e.g., filter voltage, current selection). For example, most other XRF devices have predetermined output settings that do not easily allow the researchers to manually select peaks based on patterning observed in a linear spectrum. This default setting configuration for non-Bruker XRF devices gives the majority of the analytic observational power to the CPU. Bailey (2013 pers. comm.) makes the point that no computer can replace the pattern recognition, or Bayesian Inference, of the human brain; which is specifically why Bruker devices are designed to display statistically reliable linear spectra for direct visual analysis (Figure 3.6).

During operation, the Bruker Tracer III-V is first mounted and secured on the custom stand (Figure 3.5). The device then connects to an HP laptop containing three software programs that interface with the Bruker Tracer unit to set the voltage parameters, run the EDXRF assays, statistically integrate the spectra peaks, and then calibrate the data in net intensity (e.g., ppm): X-Ray OPS, S1PXRF, and ARTAX. X-Ray OPS software is required prior to running analyses to set the voltage parameters in keV for each timed assay, based on the color-coded filter selected. The S1PXRF program directly collects the raw data during operation as the Bruker Tracer III-V measures the photon wavelengths emitted from each sample, and then converts the raw output to uncalibrated spectra (Figure 3.6). After each timed assay, the spectra generated with S1PXRF could be reviewed manually for identifying specific peaks, and the teasing out of erratic elemental signatures resulting from backscatter radiation, or other phenomena that cause unreliable wavelength measurements (Bow 2012, Frahm 2013). Afterwards, the data is exported from S1PXRF, to be statistically analyzed and calibrated with a third software program ARTAX. ARTAX software is the critical final step to obtaining reliable, and especially replicable quantitative results. It automatically integrates the selected spectra peaks with Bayesian Curve-Fitting Statistics, and provides elemental concentrations expressed as net intensity, or parts-per-million (ppm). The final output in ppm can then be directly uploaded into an Excel spreadsheet for further analysis and graphical display.

Consulting with both Dr. Aubrecht and Dr. Rasbury on data quantification for this research study led the author to question the statistical accuracy of presenting elemental data generated by HHpXRF in average net intensity in ppm (Tables 4.4-4.4), and to instead calculate average ratios of measured elements (Table 4.5). Statistically, average ratios have a lower standard error percentage and are less affected by outliers, and provide much greater quantitative discriminating power in provenance research (Goffer 1980, Rasbury pers. comm.). Dr. Bruce Bailey also argues that for HHpXRF analysis of heterogeneous lithic materials, ratios are the best data output on which to perform quantitative and semi-quantitative analyses. Analogous to the limitations of calculating the average net intensity in ppm though, it is difficult to determine whether the average ratio-based approach is only internally consistent, or if these data are also replicable. However, most archaeometric sourcing studies still publish their elemental data in ppm (Truncer et al. 1998, Tupa 2009), and only a few researchers have expressed data in terms of ratios (Santi et al. 2009).

An alternative method for presenting the results of EDXRF analyses is to logarithmically transform (log10) the ppm data when generating bi-plot comparisons (Figures 5.1-5.7). As mentioned in Chapter 3, Waller (2006) has successfully demonstrated that bi-plots of logarithmically transformed ppm data can be employed to characterize source regions and make source-determinations of steatite artifacts. The S-XRF results displayed in Figure 3.2 were also logarithmically transformed data. Therefore Waller's (2006) logarithmic approach, which is appropriate for analyzing XRF-based geochemical data, will be the primary model followed for the present study.

Data Collection Methods

In the first experiment with the Bruker Tracer III-V, a subset of eight source area and two artifact samples (n=10) were selected to determine the optimal assay strategy, filter settings, and voltage parameters for obtaining reliable elemental data. Each selected sample received XRF assays three times on different surface loci (e.g., cut/natural surfaces) for 180 seconds, for a total of 540 seconds or nine minutes per sample. Nine minutes far exceeds the assay time for most published HHpXRF studies; as Frahm (2013), for example, has obtained reliable results with HHpXRF scanning samples of obsidian for only 300 seconds, under intentionally suboptimal conditions. However, steatite is a much more heterogeneous material than obsidian, and thus scanning the samples three times on different surface loci, for 180 seconds each, was considered to be the optimal protocol for obtaining reliable data throughout the present study. All ten of the selected samples received separate assays for 540 seconds, with each of the different color-coded filters (i.e., blue, green, red, yellow) designed for the Bruker Tracer III-V.

The filters are manually inserted between the IR sensor and the sample surface, prior to each timed assay, and are intended to measure different ranges of elements. Each new filter required changes to the voltage parameters with the X-Ray OPS software, in order to modify the rates of photon emission. For example the blue filter sets to 15-20 keV with a 60 micron step. However the blue filter is unique, in that it uses a Bruker vacuum system to slow photon emissions further, and is designed to measure lighter elements. The Bruker vacuum system was developed by Dr. Bruce Bailey, in partnership with NASA, to enhance the precision of the Tracers sensitivity and resolution. The vacuum essentially removes the air during a timed assay, and stops silica photons from escaping through the IR sensor; and by doing so increases the sensitivity of the Bruker Tracer III-V unit by a factor of 10 (Bailey pers. comm.).

In contrast the green filter, which sets to 40 keV, does not employ a Bruker Vacuum, and cannot measure elements <18keV. As a result, the green filter is better suited for measuring heavier elements like Rb, Sr, Y, Zr, and Nb. However in the experimental phase, these Mid-Z Heavy elements were also differentially detected during the timed assays with each of the other color-coded filters.

The red, green, and yellow filters all detected similar ranges of elements in the experimentation phases; yet the spectra generated in these test runs did not provide consistent data. The less abundant elements like Rb, Sr, and Nb, typically could not be discriminated as specific peaks in the linear spectra from backscatter radiation. As the output of tests performed under these parameters displayed extreme noise, outside of the prominent Cr, Fe, Ni, and Zn peak pattern observed on all spectra.

After the initial experiment assaying ten selected steatite samples with each color-coded filter concluded. It was determined that the blue filter tests did not encounter the issues of backscatter radiation that were observed with the other filters. One important observation from the initial EDXRF experiments with the blue filter were the geochemical similarity between the Skunk Lane vessel and the Oaklawn quarry in Rhode Island; a tentative source determination replicated with each subsequent assay. Thus it was decided that the blue filter, which is the only filter to incorporate the Bruker vacuum system to slow the photon emissions, maximize sensitivity, and allow the measurement of lighter elements, was the optimal parameter for analysis.

Following the experimentation phase, the entire steatite artifact (n=7) and source area (n=96) sample base was analyzed under these parameters. Each steatite sample was assayed three times, again for 180 seconds or three minutes each (i.e., 540 seconds total per sample), and was differentially successful in discriminating peaks for eleven transition metals (Cr, Co, Cu, Fe, Mn, Ni, Ti, V, Y, Zn, Zr), two alkaline earth metals (Ca, Sr), two alkali metals (K, Rb) and one metalloid (As) (Tables 4.1-4.5).

These data were then exported to ARTAX for final calibration and peak integration with Bayesian Curve-Fitting statistics.

Afterwards the data was exported to an Excel spreadsheet for basic statistical analysis and graphical display (Figures 5.1-5.7). The ARTAX data was converted in Excel, from the calibrated output as average net intensity in ppm (Tables 4.1-4.4), to average ratios (Table 4.5) and logarithmically transformed (log10) ppm data (Figures 5.1-5.7). Significantly, the outcomes of these EDXRF tests were consistent with the experiments conducted by Dr. Rasbury (see above) and Dr. Bailey (see below). In all three experiments, both Cr and Ni were found to have the greatest quantitative differences in spectra peaks between source areas and artifact samples.

The results of EDXRF analyses conducted by the author are discussed further in Chapters 4-5. Tables 4.1-4.4 show the average ppm data for all of the artifact and source area samples. Table 4.5 provides the average ratios compared to the average net intensity (ppm). Figures 5.1-5.7 reveal the geochemical relationships of the sample base with logarithmically transformed bi-plots of the ppm data.

HHpXRF: Bruker Tracer II-V, Anthropology Department, Brooklyn College

Soon after conducting the EDXRF analyses at Stony Brook University, the author participated in the 2013 XRF workshop at Brooklyn College run by Dr. Bruce Bailey. Dr. Bailey is one of the seminal designers of the Bruker Tracer brand of HHpXRF devices, and during the workshop, he allowed participants to provide stone, metal, and soils samples for EDXRF analyses. From these additional assays a comparative elemental spectra of two selected steatite quarry samples from the Jay Waller collection was generated. This latter experiment was an independent verification of the results obtained by Dr. Rasbury at Brookhaven National Laboratory and the author at the Chemistry Department at Stony Brook University. As it was expected that significant geochemical differences should be identifiable between geographically distant steatite source locations, and also those that occur in discrete formations of widely different ages.

The Harwinton Quarry, derived from an Ordovician age ultramafic pluton intruding into Rowe schist (Figures 3.8-3.9), and the Oaklawn Quarry which occurs within the Late Proterozoic Blackstone group of epidote-biotite schists (Appendix B); were selected for this secondary EDXRF analysis for the same reasons as the Ochee Springs and Nepaug-Bakerville. They are widely separated geographically, were formed in different time periods (Ordovician vs. Devonian), and occur within discrete tectonostratigraphic terranes (i.e., Iapetus vs. Avalonian). Using a Bruker Tracer II-V device, Dr. Bailey overlapped the XRF spectra for the two samples from the Harwinton (CT) and Oaklawn (RI) quarries, and significantly demonstrated that transition metals Cr and Ni showed the greatest dissimilarity or quantitative distance between spectra peaks.

3.1 Steatite Source Areas by State

Eighteen steatite source areas from the States of Connecticut, Massachusetts, New Hampshire, New York, Pennsylvania, and Rhode Island were sampled for EDXRF analyses. However, not all of the samples came from prehistoric quarries. For example, five quarries were only known to have been exploited by Euro-Americans in the Historic Period (Soapstone Mountain, Jenkins Hill, Petersham, Francestown, Wissahickon); while one source (Clove Lakes Park, Staten Island, NY) has no historic or archaeological record for past mining activities. In total, ninety-six source area samples were acquired for source characterization and comparison with the five steatite vessels and two smoking pipes from Long Island (see Chapter 3.3).

Connecticut: Nepaug-Bakerville (n=7), Cotton Hill Quarry Pits 1&2 (n=4) and Ledge (n=5)

Four discrete steatite sources, intensively exploited by prehistoric peoples, are located on Cotton Hill in Northwestern Connecticut, near the Village of Bakerville (Figures 3.7-3.8). These include the Nepaug-Bakerville Quarry, the neighboring Cotton Hill Quarry Pits 1 & 2, and an associated ledge outcrop. Neshko (1970) and Russell (1997) have conducted extensive archaeological excavations of at least three of Cotton Hill's prehistoric steatite quarries. The specific open pit-style extraction methodology recorded for the Nepaug-Bakerville Quarry, and similar quarrying loci in New England, is discussed further in Chapter 2.3.

Geologically, Cotton Hill is comprised of both schist and granite bedrock, with a series of ultramafic plutons cross-cutting into both rock types in a sinuous belt trending from southwest to northeast (Figure 3.8). Geographically it is a broad upland ridge, situated at the juncture between the Naugatuck and Farmington River watersheds (Appendix B). The Nepaug-Bakerville Quarry is located at the altered margins of where these intrusive ultramafic rocks outcrop at the surface, just south of where Nonewaug Granite and Rowe Schist interface (Figure 3.8). The associated Cotton Hill Quarry Pits 1 & 2, and the adjacent ledge outcrop, occurs along the margins of similar ultramafic rocks, shown to the northeast of Nepaug-Bakerville (Figure 3.8).

This particular zone of prehistoric quarrying uniquely lies on a hill system that drains into two different watersheds; the Naugatuck River that leads to the Housatonic River Valley, and the Farmington River that flows into the Connecticut River Valley (Appendix B). Both watershed corridors could have been employed to transport finished and partially finished steatite vessels to the Long Island Sound area. The dense clustering of large quarried pits and usable ledges on a single hill system, also suggests that this could have been one of the most intensively exploited source regions in New England (Neshko 1970, Russell 1997); and thus could have provided large quantities of steatite resources to prehistoric groups over a wider geographic area than most quarry locations included in the present study. However, that is also assuming that watershed corridors were the preferred exchange conduits, and not the myriad of potential overland routes.

Seven geological samples from the Nepaug-Bakerville Quarry were included in the present study. One of which was provided by William Turnbaugh of Brown University, from his original collection and analysis of six prehistoric steatite quarries from throughout Southern New England. Significantly, this sample was used in his seminal sourcing studies that formed the baseline for all future steatite source characterization research in the Northeast (Turnbaugh and Keifer 1979, Turnbaugh et al. 1984). Turnbaugh et al. (1984: 135) describes the mineralogical composition of steatite from Nepaug-Bakerville as a nonfoliated matrix fabric, primarily composed of talc (33%), chlorite (28%), anthophyllite (25%), and quartz (9%).

Connecticut: Harwinton Quarry (n=10)

The Harwinton Steatite Quarry, located in the Town of Harwinton in Northwestern Connecticut, is situated on an upland ridge due south of Lake Harwinton (Figures 3.7-3.9). Little is known about the prehistoric use of the Harwinton Quarry; as no publications exist that directly discuss its utilization or archaeological context. Only Waller (2006) has published on this source area, in his WDXRF study of Southern New England steatite mentioned in Chapter 3. As a result, most of what can be said about the Harwinton quarry is drawn from its geography and geological context. The closest water body, Lake Harwinton, feeds directly into Catlin Brook, a tributary stream of the Naugatuck River, which flows into the Housatonic Valley (Appendix B). The Harwinton Quarry is one of three Connecticut source areas situated in the Housatonic watershed; which includes the Nepaug-Bakerville quarry to the northeast, and East Litchfield to the southwest (Appendix B).

The steatite deposits at Harwinton, analogous to those from throughout Northwestern Connecticut (Figures 3.7-3.9), are derived from a linear series of metamorphosed, intrusive ultramafic rocks; which occur on the surface as either "discontinuous lens shaped bodies" (Martin 1970: 44) or as a "small altered ultramafic pod" (Scott 1974: 29). The quarry loci are oriented in a southwest-northeast trending axis within local granite and schist deposits (Martin 1970), as are clearly shown in Figures 3.8-3.9. The Harwinton exposure quarried by prehistoric peoples occurs exclusively within Ordovician age ultramafic rocks that intrude into Rowe Schist (Figures 3.8-3.9). The United States Geological Survey Mineral Resources Online Spatial Data (USGS-MROSD) refers to these areas of metamorphosed ultramafic rock as detached fragments of Iapetus Ocean Terrane, obducted to the surface during the Ordovician or prior.

Although the region's steatite-bearing deposits are presently discontinuous (Figures 3.8-3.9), the fact that they "occur in a linear pattern parallel to the strike of the adjacent rocks suggests that they may have once been continuous bodies, the separation resulting from deformation" (Martin 1970: 44). Figures

3.8-3.9 show that the location of the Harwinton Quarry correlates perfectly to the mapped location of a discrete ultramafic pod, depicted on the 1970 Geological Map of the Torrington Quadrangle (Figure 3.9) and the 1996 Generalized Bedrock Geologic Map of Connecticut, Torrington Quadrangle (Figure 3.8).

All of the samples included from this quarry were provided by Jay Waller; who conducted a detailed surface collection of steatite at Harwinton, and several source areas in Southern New England for his sourcing study using WDXRF (Waller 2006). Waller's assemblage from Harwinton was sampled systematically, along multiple points at each outcrop exposure, to account for the wide range of compositional variability extant within relatively heterogeneous steatite deposits. However, if Martin's (1970: 44) contention that the region's ultramafic belts were originally a single continuous deposit is accurate, then this would have implications for the ability to perform source characterization analyses. Researchers must then decide whether the goal should be the geochemical fingerprinting of individual outcrops, or the broad characterization of regional units. The results obtained from past steatite sourcing endeavors in Eastern North America, which tend to reflect regional clustering due to shared geological histories, would suggest the latter approach (Luckenbach et al. 1975, Truncer et al. 1998, Waller 2006).

Connecticut: Beckwith Brook Quarry (n=2)

The Beckwith Brook Quarry, located within the Nepaug State Forest in the Town of New Hartford, is located on a small ridge overlooking Beckwith Brook, a small tributary stream of the Nepaug River, which flows to the Farmington-Connecticut River drainages (Appendix B). The steatite deposit here is derived from the same series of ultramafic rocks that characterize the region (3.11), and are recorded as obducted remnants of Iapetus Ocean Terrane (USGS-MROSD). As with the Harwinton and East Litchfield quarries, no archaeological investigations have been published on these loci, and only a Connecticut State Archaeological Site Inventory form records the location with little contextual data.

Stanley (1964: 41) describes the lithic material at Beckwith Brook, often occurring within serpentine and kyanite schist, as "talc-chlorite schist [which] varies in composition from a steatite to an epidote-pyroxene-hornblende gneiss, which locally could be called amphibolites." The Geological Map of the Collinsville Quadrangle (Stanley 1964) shows that twenty-four additional surface deposits of talcose rock and/or amphibolites occur within a short distance to the Beckwith Brook Quarry, and the map key notes that most of these delineated outcrops contained historic prospect pits (Figure 3.11). The Beckwith Brook Quarry, analogous to the Harwinton Quarry mentioned above, occurs exclusively within ultramafic rocks that intrude into Rowe Schist; locally this is referred to as the Slashers Ledge Formation (Stanley 1964), and associated rocks are considered to be of Ordovician age (USGS-MROSD).

Only two samples from Beckwith Brook were included in the present study. Two very small unfinished bowl fragments recovered from the quarry area by Mr. Frank Jones sometime prior to 1950

(Figure 3.10). These artifacts were loaned to the author by Connecticut State Archaeologist Nicholas Bellantoni from the artifact collections at the University of Connecticut at Storrs. This assemblage is certainly limited in sample size, but is significant because it includes actual unfinished steatite artifacts, not geological samples, which were presumably quarried from the Beckwith Brook exposure.

Connecticut: East Litchfield Quarry Pit 1 & 2 (n=7)

The East Litchfield quarry (Figure 3.7) is located in Northwestern Connecticut in the Town of Harwinton. The quarry pit complex at East Litchfield is situated on a small terrace overlooking Spruce Brook, a tertiary stream that flows into the Naugatuck-Housatonic Watershed system (Appendix B). The steatite deposit is of Lower Ordovician age Iapetus Ocean Terrane (USGS-MROSD), and occurs as an unmapped mass near the interface of Ratlum Mountain Schist and Rowe Schist. As mentioned above, no publications could be located that discuss the prehistoric extraction of steatite at East Litchfield. Only a Connecticut State Archaeological Site Inventory Form with GPS coordinates and photographic evidence collected by Jay Waller demonstrated that stone vessels were quarried at this location. All of the examples (n=7) from this quarry were geological samples collected by Waller.

Connecticut: Ragged Mountain Quarry (n=5)

The final steatite quarry included in the present study that derives from the Northwestern Connecticut region (Figure 3.7) is the Ragged Mountain Quarry and Rockshelter. The Ragged Mountain Quarry is located outside the village of Barkhamsted in the People's State Forest, within the greater Farmington-Connecticut River watershed (Appendix B). Ragged Mountain formed within the greater Iapetus Ocean Terrane, and occurs as an unmapped steatite lens or ledge, within the Cambrian age, Hoosac Schist (USGS-MROSD).

Today the quarry and associated rockshelter is a protected archaeological site on the National Register of Historic Places. The Ragged Mountain Quarry is unique in that it is the only known stone bowl quarry, apart from the Blue Mountain Soapstone Quarry in North Carolina (Mathis 1982), with an associated rockshelter habitation component. Ragged Mountain is also the only steatite quarry in the region with direct evidence for the manufacture of another class of ground stone tools, atlatl or spear-thrower counterweights called bannerstones (Dixon 1987, Fowler 1971).

The steatite deposit at Ragged Mountain is described as an exposed lens or ledge outcrop that juts out oblique to the modern ground surface; and the quarry area itself served as part of a rockshelter habitation zone. William Fowler (1971: 11) who served as the primary excavator of this site, along with Irving Rouse, describes the location as "an abrupt impressive mass of granitic ledges. At their base is a rock shelter 75 feet long with an overhang of about 11 feet at the deepest point. But what makes this shelter unique is the fact that once it contained workable veins of steatite that have since been quarried away, leaving nothing but small outcrops, here and there, of poor grade steatite schist." Due to the protected status of the site, and the limited amount of remaining quarry material, all of the examples (n=5) acquired from this quarry were very small geological samples collected by Jay Waller.

Connecticut: Soapstone Mountain Historic Quarry (n=5)

The Soapstone Mountain Historic Quarry, located in north-central Connecticut in the Town of Somers, is an upland monadnock overlooking the Scantic and Hockanum River Watersheds, both of which flow westward into the Connecticut River Valley (Appendix B). The steatite deposits mined on the mountains eastern face, are described as an "anthophyllite-chlorite-calcite-talc-rock," derived from "retrogressive metamorphism…along a fracture or shear zone…" of Metagabbroic Amphibolites occurring within Glastonbury Gneiss; which are metamorphosed intrusive components of the greater Middletown Formation (Collins 1954: 37). The Middletown Formation, like many of the geological zones mentioned above for the Northwestern Connecticut region, is described as a remnant of Iapetus Ocean Terrane of Middle Ordovician age (USGS-MROSD).

Petrographic analysis by Collins (1954: 21) has shown that the mineralogical composition of the material from Soapstone Mountain is unique when compared to the six prehistoric quarries analyzed by Turnbaugh et al. (1984: 21); in that it is comprised of approximately 60% anthophyllite, with only 15% of the fabric being composed of talc. The two steatite deposits occur as a sinuous lens or vein roughly two feet wide, and an amorphous mass roughly 50 feet wide; with both locations quarried in the Historic Period "as early as 1842…the last attempt being made in the 1890's. The small size and poor quality of the deposit make any future venture unlikely" (Collins 1954: 19-20). As is the case for the historic steatite quarries included in the present study (e.g., Petersham, Jenkins, Francestown, Wissahickon), it is unknown, or still unclear, whether or not people exploited this deposit for stone vessel manufacture.

The raw material from Soapstone Mountain utilized in the present study was provided by Cheri Collins, Program Coordinator and Collections Manager of the Connecticut State Museum of Natural History at the University of Connecticut at Storrs. In 2009, Cheri collected several large blocks of lustrous yellow-green and dark green fibrous steatite from the source location in Somers. In 2010, five samples were removed from the blocks by the author following the annual Soapstone Carving Workshop hosted by Cheri Collins, and held at the Connecticut State Museum of Natural History.

Massachusetts: Horne Hill Quarry (n=1)

One of the best known prehistoric steatite quarries in New England is the Horne Hill quarry (Fowler 1966a), located in south central Massachusetts near the village of Bramanville. It is situated on the slope of a steep precipitous cliff overlooking Singletary Pond directly to the east, which flows northeast to the Blackstone River, and eventually encounters the Narragansett Bay watershed system (Appendix B). The deposit of steatite at Horne Hill is the first quarry discussed so far that occurs, not within the Iapetus Ocean Terrane of Western New England, but within a gneiss/schist complex of the Allochthonous Nashoba Terrane (USGS-MROSD). The Nashoba Terrane is an Ordovician or Late Proterozoic age island arc that is flanked by the Avalonian Terrane to the east, and the Iapetus Ocean and Island Arc terranes (i.e., Central Maine & Massabesic-Merrimack) located to the west (Calogero 2002).

Due to the steep nature of the surrounding topography, the Horne Hill quarry was mined horizontally into the hillside, and today resembles to the entrance to a cave (Fowler 1966a). As opposed to the vertically mined, open pit quarries observed on other extraction loci. Excavation of Horne Hill by William Fowler (1966) revealed a hearth feature dating to 2,730 ± 120 B.P. (ibid., Hoffman 1998). Taché and Hart (2013) challenged this date, based on what they consider to be an unreliable spatial association (a lack of steatite within the feature). However the hearth feature was encountered directly overlying nearly seven feet of quarry tailings, and underlying another four feet of similar steatite debris, observations that speak to the dates validity (Fowler 1966a).

Turnbaugh et al. (1984: 135), who included Horne Hill in his sourcing study of New England steatite quarries, describes the mineralogical composition of steatite from Horne Hill as both a foliated and nonfoliated matrix fabric, primarily composed of talc (47%), chlorite (31%), magnetite (7%), serpentine (4%), calcite (3%), and quartz (3%). A single hand specimen from this location, provided by William Turnbaugh, was able to be included in the present study. Because this quarry is represented by only a single sample, results obtained through source characterization analyses have to be treated cautiously.

Massachusetts: Westfield Quarry (n=1)

The Westfield quarry, located in Southwestern Massachusetts outside the Village of Russell, was heavily exploited by indigenous people for stone bowl manufacture (Fowler 1945, Howes 1944). It is situated on a steep knoll overlooking an historic Native American travel corridor that follows the Little River watershed west to the Housatonic River Valley (Howes 1944). Similar to the Nepaug-Bakerville quarry, there was a secondary transport corridor available; the adjacent Westfield River, which flows east to the Connecticut River Valley (Appendix B). According to the USGS Mineral Resources On-Line Spatial Data (USGS-MROSD), steatite from the Westfield area occurs as intrusions of Serpentine-Talc Rock, within the Middle Ordovician Cobble Mountain Formation of coarse grained aluminous schist. Turnbaugh et al. (1984: 135) describes the mineralogical composition of steatite from Westfield as a nonfoliated matrix fabric, primarily composed of talc (28%), tremolite (25%), chlorite (22%), biotite

(20%), and quartz (4%).

Howes (1944: 49) provides the clearest synthesis of the Westfield quarrying locus, describing the deposit as a “natural ledge outcropping of serpentine that probably had several veins of different grades of soapstone…one contained certain elements that make it coarse and hard, and is characterized by a cleavage that would cause breakage while being worked; another is of a dense and fine-grained texture that makes it ideal to work; and the third is of a fibrous nature.” It was noted that all three types of veins were exploited at Westfield for stone bowls. This suggests that even within a heterogeneous steatite deposit, the wide range of the raw material available was still considered suitable for attempts at vessel manufacture. Unfortunately, the true scale of these endeavors at Westfield has been obscured by a deep, flooded pit remaining from the abandoned historic Atwater quarry (Fowler 1945, Howes 1944). What was left of the prehistoric quarry is now only a ledge outcrop roughly six feet wide by twenty feet long (Howes 1944: 50).

The Westfield locus is only one of two recorded stone bowl quarries in Western Massachusetts, despite the scores of known steatite sources from the foothills of the Berkshire Mountains, and the uplands surrounding the Quabbin Reservoir (Howes 1944). What is most unusual is that no other researcher has acknowledged the fact that the numerous Historic Period serpentine and soapstone quarries known to have existed in Western Massachusetts and Vermont, may account for this paucity of recorded prehistoric extraction loci in New England. Because this quarry is represented by only a single sample, results obtained through source characterization analyses have to be treated cautiously.

Massachusetts: North Wilbraham (n=1)

The North Wilbraham quarry differs from the stone bowl quarries examined by the present study, in that it was not an in situ exploitation of bedrock veins, masses, lenticular beds, or ledges in the New England Highlands. Rather it was a series of nine glacially-transported boulders deposited on the eastern flank of the Connecticut River Valley (Fowler 1969, Howes 1944, Skinner 1909). Excavation determined that most of the boulders had been completely quarried away, with only small fragments remaining at the base of the quarry pits. Some of the extant depressions reveal that the former boulders “might have run from six to twenty-five or more feet long, with visible depths of from four to ten feet” (Howes 1944: 53). Turnbaugh et al. (1984: 135) describes the mineralogical composition of steatite from North Wilbraham as a nonfoliated matrix fabric with a very coarse texture, primarily composed of chlorite (35%), talc (30%), opaque minerals (22%), tremolite (8%), anthophyllite (2%), and quartz (%).

The poor quality of the North Wilbraham material compared to other quarries has long been emphasized (Skinner 1909), thus it may well be the slightly harder, impure nature of these steatite boulders that facilitated their initial transport via the Laurentide Ice Sheet. A higher quality material with greater talc content may have been more easily eroded or abraded into smaller, unsuitably sized fragments for vessel manufacture (Hubbard 2006). Nevertheless, the question that has remained unanswered is where in Massachusetts or Vermont were these boulders removed from their bedrock source by glacial scouring and plucking?

A systematic review of the existing geological units occurring to the north of the North Wilbraham Quarry, revealed the Mount Mineral Formation in Pelham, Massachusetts; near where Howes (1944: 52) tentatively claimed that the boulders were most likely derived. The Mount Mineral Formation, which flanks the western portion of the Quabbin Reservoir, is described as an ultramafic mélange dating to the Proterozoic Period; and according to the USGS Mineral Resources On-Line Spatial Data, contains lenses of Amphibolites, Serpentinite, Serpentinized Harzburgite with abundant Anthophylitte, and metamorphosed Gneiss, all of which are suitable bedrock units for hosting steatite deposits. Similar to Horne Hill and Westfield quarries, only a single fragment from this location, part of the William Turnbaugh collection, was included in the present study.

Massachusetts: Jenkins Hill Historic Quarry (n=5)

The Jenkins Hill Quarry in Andover, Essex County, Massachusetts, also known as the Blue Soapstone Quarry, was mined commercially for a short time from 1830-1840, and is referred to as a lenticular bed of steatite in hornblende gneiss. A local geologist (Wall 2003) claims that glacially transported boulders near Jenkins Hill, and other steatite sources in the Andover region of the Skug River Valley were exploited by prehistoric peoples; however, the evidence for this has not been verified archaeologically. The Jenkins quarry today is located within the Harold Parker State Forest, along the Skug-Ipswich River watershed system (Appendix B).

This is the second steatite quarry included in the present archaeometric study that occurs within a portion of the sinuous Nashoba geologic terrane, an Allochthonous Island Arc of Ordovician age or older that flanks three overlapping Iapetus Ocean/Island Arc terranes to the west (Calogero 2002). Petrographic analysis of the quarry material reveals that it is composed primarily of chlorite, actinolite, and talc minerals; and according to Wall et al. (2004: C3-7) the steatite deposits of Essex County are "not thought to be of ultramafic origin but fall into the categories of highly altered metavolcanic and altered igneous rocks…associated with hydrothermal venting…" All of the examples (n=5) acquired from this historic period quarry site were raw geological samples provided by Jay Waller.

Massachusetts: Petersham Historic Quarry (n=6)

The Petersham Quarry (Figure 3.7) occurs on an upland dome at the northeastern boundary of the Quabbin Reservoir, within the Chicopee-Connecticut River watershed system (Appendix B). The

Petersham Quarry was mined briefly during the historic period from 1878-1882, and was rapidly exhausted, with only two small exposures of "talcose chloritic schist" or "chloritic soapstone" remaining (Chute 1969: 37-38). Chute (1969) notes that the mined deposit was originally two ovoid masses, roughly 50x150x30 feet and 80x35x15 feet in dimension, within a formation of Monson Gneiss known locally as Soapstone Hill. The Monson Gneiss is referred to as a "layered to massive" deposit of intrusive, altered igneous rocks (e.g., biotite gneiss, amphibolites) of Ordovician, Cambrian, or Proterozoic age (USGS-MROSD). These deposits and the surrounding formations occur within the greater Massabesic-Merrimack geologic terrane that formed an eastern Iapetus Ocean-Island Arc interface (Calogero 2002).

As is the case for several of the historically exploited steatite quarries included in the present study (e.g., Soapstone Mountain, Francestown, Jenkins Hill), it is unclear whether this deposit was ever utilized for vessel manufacture during the prehistoric period. The description of the quarry as being virtually depleted by the late nineteenth century (Chute 1969) precludes the ability to demonstrate either scenario. All of the examples (n=6) acquired from this historic period quarry site were again raw geological samples provided by Jay Waller.

New Hampshire: Francestown Historic Quarry (n=5)

In the uplands of the Piscataquog-Merrimack Watershed in South Central New Hampshire, the Francestown Soapstone Quarry was mined extensively in the late eighteenth century, until it was virtually exhausted by the early twentieth century (Green 1970). Prized historically for its high quality, it is described as a lenticular body of steatite roughly 400 feet long by 100 feet wide, formed by the regional metamorphism of argillaceous dolomite (Green 1970: 57). Green (1970: 58) further elaborates that the "soapstone was derived from a lime-silicate rock by hydrothermal alteration" (Green 1970: 58). The metamorphosed host bodies, pelitic schist and granofels are a component of the Upper to Middle Silurian, Francestown Formation; and are situated within the Central Maine Terrane (USGS-MROSD). However, the Middle to Late Silurian date associated with this unit argues that the steatite deposit in this case postdates the "Late Ordovician demise of the Iapetus Ocean," and thus may have been formed by hydrothermal process associated with the later Rheic Ocean that separated the Laurentian and Gondwana plates (Keppie and Ramos 1999: 273).

Similar to many of the quarries and source areas included in the present study, it is unknown if prehistoric peoples ever mined this deposit. The steatite from Francestown is also clearly located at a greater distance to Long Island, New York than most other source areas, and was unlikely to be the primary or even secondary source for artifacts found on Long Island. Nevertheless, its unique diagenesis and elemental signature may clarify the inter-regional compositional variability in steatite deposits of

Eastern North America. Five sections were removed from a large tabular block of Francestown steatite by the author (which up until that time had been the favorite paper weight of New Hampshire State Archaeologist Richard Boisvert).

New York: Clove Lakes Serpentinite Source Area (n=10)

Serpentinite is one of the most common bedrock contexts in which artifact quality steatite deposits can form (Dann 1989). The bedrock of Staten Island, New York is characterized by the largest deposit of Lower Ordovician serpentinite in the Coastal New York region (Figures 2.3, 3.12). Outcrops are also located in Hoboken, New Jersey, Manhattan Island, Bronx County, and Westchester County (USGS-MROSD). Further research found historic geological surveys of New York City that consistently recorded the presence of steatite lenses within the serpentinite exposures of Staten Island and Manhattan Island (Britton 1882, Cozzens 1843).

Numerous archaeological sites on Staten Island, and throughout the New York Bight, have recorded the presence of steatite vessels (Merwin 2010). Decorative objects referred to as two-holed gorgets, fashioned from "fibrous serpentine," have also been found on the Schurz and Weir Creek sites of Bronx County; and both were considered to be visually and texturally reminiscent of serpentinite from Staten Island (Lopez 1955: 108, Skinner 1919: 63). No steatite vessel, gorget, or smoking pipe quarries have ever been recorded from this region. Recognizing this anomalous pattern, the author explored whether past mining or modern urban development on Staten Island may have destroyed traces of this industry. Source characterization has the potential to reveal evidence for this occurring, but only if artifacts sampled for this study matched the geochemical signature of serpentinite from Staten Island. In 2012, the author collected 25 serpentinite samples from a surface exposure at the apex of Todt Hill in Clove Lakes Park, Staten Island, and randomly selected 10 for EDXRF analyses.

Pennsylvania: Wissahickon Valley Steatite Source Area (n=10)

In southeastern Pennsylvania, near the western border of the City of Philadelphia, and situated within the Schuylkill-Delaware Watershed system (Appendix B), the Wissahickon Valley Park contains two sinuous lenses of ultramafic rocks that includes "serpentinite, steatite, and other products of alteration of peridotites and pyroxenites" (USGS-MROSD). These deposits are exposed within a host of Garnet bearing-Mica Schist, Hornblende, and Mafic Gniess that comprise the Lower Paleozoic Wissahickon Formation (ibid.). Morgan (1977: 42-44) describes these outcrops as an ultramafic mélange in the form of "isolated lenses and pods in the Wissahickon Formation…with underlying schists… extensively replaced by talc-carbonate-chlorite assemblages."

Dann (1989) proposed that the Wissahickon Valley steatite was quarried in late prehistory by the

Delaware-Lenape for smoking pipe manufacture (Dann 1989), and Terminal Archaic sites containing vessels and numerous steatite beads, have been located within the Wissahickon-Schuylkill drainage system (Boyd 1962, Witthoft 1953). However, no published records attest to the former assertion directly, and so it is wholly unknown if these two steatite deposits were ever exploited in prehistory. Nor could the author find any direct references to historic mining at Wissahickon. Goodwin (1964: 119) noted conspicuous horizontal depressions cut into the primary steatite exposure, and large angular blocks that appeared to have been discarded in the adjacent creek bed. These surface features were posited to be evidence of Colonial or Historic Period quarrying at this location.

The Wissahickon Creek steatite deposit is included in the present study even though it is not expected that artifacts from Long Island would be derived from these distant sources. The Wissahickon source area is one of the most northeasterly surface exposures of ultramafic-serpentinite bedrock in the entire Mid-Atlantic region (Smith and Barnes 2008). In addition, it is the closest known suitable outcrop for prehistoric quarrying to the study area, aside from Staten Island and the New York Bight (see above), south of the Northwestern Connecticut region (Figure 2.1). This lack of steatite deposits northeast of Wissahickon Creek is partly due to the fact that the ultramafic deposits of the greater Wissahickon Formation dip below Mesozoic age bedrock as they extend northeastward through New Jersey (Chidester 1964: 45). Ten highly variable fragments of steatite, and associated garnet-bearing Mica schist, was collected from the Wissahickon source area by the author in 2012, immediately adjacent to, and down slope from the two mapped outcrop locations (Figure 3.13).

Rhode Island: Ochee Springs Quarry (n=5)

In central Rhode Island, the Ochee Springs Quarry in the Town of Johnston (Figures 3.7, 3.14), is one of the first recorded prehistoric steatite quarries in Eastern North America (Putnam 1880). It is also the most extensively studied stone bowl manufacturing loci in the entire Northeast (Dixon 1987, Putnam 1880, Saville 1919, Turnbaugh et al. 1984, Waller 2006, Willoughby 1935). The method of stone bowl quarrying that occurred at Ochee Springs, described as the in situ removal of bowl blank clusters over large horizontal lenses and ledges, is discussed further in Chapter 2.3.

In addition to the high quality mineral spring roughly 100 yards to the west of the quarry that bears the same name (Putnam 1880); the nearest watershed transport corridor to the Ochee Springs Quarry is Mussey Brook, a low ranking stream which flows directly into Narragansett Bay (Appendix B). The steatite deposit at Ochee Springs occurs as an unmapped lens, within the aptly named Mussey Brook Schist (Dixon 1987). Mussey Brook Schist is part of the Late Proterozoic age Blackstone Group, a greenstone belt located within the Avalon Terrane (USGS-MROSD); which is recorded as containing small bodies of lenticular talc deposits (Chidester 1964: 45). The steatites within the Blackstone group of

Rhode Island are outliers to the primary Talc Belt of Eastern North America (Figure 2.1), as "the main belt of ultramafic rocks trends about north in a well-defined zone … but a few scattered bodies of ultramafic rock are found to the east in a poorly defined belt that extends through eastern Connecticut, Rhode Island, eastern Massachusetts, New Hampshire, and Maine" (Chidester 1964: 22).

Turnbaugh et al. (1984: 135), who included Ochee Springs in their early source characterization studies of Southern New England, describes the mineralogical composition of steatite from Ochee Springs as a nonfoliated matrix fabric, primarily composed of talc (43%), calcite (30%), magnetite (18%), chlorite (4%), and quartz (3%). Since the early twentieth century, the Ochee Springs quarry has been a protected archaeological site (Willoughby 1935), and today is on the National Register of Historic Places. As a result only small hand samples, collected by William Turnbaugh (n=1) and Jay Waller (n=4), were included in the present archaeometric study.

Rhode Island: Oaklawn Quarry (n=10)

The Oaklawn site in Cranston, Rhode Island, is the final quarry included in this source characterization study, and is considered by some to be one of the most intensively exploited stone vessel manufacturing loci in the Northeast (Turnbaugh et al. 1984: 130). In addition to intensive vessel manufacture, this deposit was quarried in later prehistory for platform, elbow, and tubular pipe production (Fowler 1967, Seeman 1981). Mining did occur in the mid-nineteenth century at this locality and reportedly "talc taken from Oaklawn quarry about 100 years ago brought a high price in New York" (Dunn 1945: 49, cf. Fowler 1967).

The Oaklawn Quarry is situated near Furnace Brook, which flows in a complex stream network to Meshantic Brook, and then to the Patuxet River before reaching the north branch of Narragansett Bay (Appendix B). The steatite deposit, like Ochee Springs, occurs within the Esmond-Deham zone of the Avalon Terrane, in the portion of the local greenstone belt called the Blackstone Group (USGS-MROSD). The USGS Mineral Resources On-Line Spatial Data also report that this particular portion of the Blackstone Group is composed of Marble with layered Actinolite, Chlorite, Epidote, Muscovite, and Biotite Schist of a younger Devonian age; and specifically mentions the presence of "Ovoid clots of mafic talc minerals."

Fowler (1967: 2) describes the Oaklawn quarry as a layered outcrop with extensive mineral inclusions and lenses of "asbestos, actinolite, striated crystals, serpentine, quartz and small garnets…These tend to make steatite stock difficult to work when they occur in excess. Chlorite, a companion outcrop with steatite, is less subjected to such contamination and impairment of its workable qualities…Most bowls were pecked out of steatite with only a few from chlorite, while for pipes there seems to have been a preference for chlorite." Turnbaugh et al. (1984: 135) describes the mineralogical composition of steatite he collected from Oaklawn as a fine-textured, nonfoliated matrix, composed of talc (40%), chlorite (21%), magnetite (15%), tremolite (11%), quartz (6%), and serpentine (5%). Eight geological samples, including associated actinolite fragments, from the Oaklawn Quarry were included in the present study. Three of these were provided by William Turnbaugh, derived from his original collection and analysis of prehistoric steatite quarries from throughout Southern New England (Turnbaugh and Keifer 1979, Turnbaugh et al. 1984). The remainder of the sample base (n=7) was again provided by Jay Waller.

3.2 Problems with Sampling: Historic Mining and Prehistoric Resource Depletion

The primary research question for this research project is what steatite outcrops were the sources for steatite artifacts found on archaeological sites on Long Island? Answering this simple question requires highly complex analytic techniques and a comprehensive approach to organizing these data. For example, how do we model past exchange systems when so much of the archaeological record has been mined away, looted, or destroyed by urban/suburban development? Can we quantify the geospatial scale of missing or lost information, if artifact sourcing analyses suggest a number of unidentified sources? These are important questions to address before the modeling of steatite exchange systems in any region can occur, and thus all potential source areas must be identified in their geological context and thoroughly examined for geochemical variability. Subsequently, any material transport models proposed (Chapter 6) must account for the potential of unidentified sources producing anomalous results from the sourcing data. As the unidentified sources may again reflect the inferred loss of quarry evidence by prehistoric and historic mining, looting, and land development.

It is unfortunate that the archaeological and geological context for many prehistoric quarries in Southern New England will likely never be known. Many of the documented quarries recorded in late nineteenth and early twentieth century are no longer in existence (Putnam 1880, Willoughby 1935). This is due in part to archaeological looting and late twentieth century urban and suburban development (Turnbaugh and Keifer 1979), but also extensive Euro-American quarrying industries that continue to the present day (Dann 1989). Five steatite source deposits included in the present study, Soapstone Mountain, Wissahickon, Petersham, Jenkins Hill, and Francestown, may have been exploited for cooking vessels in prehistory. However each were heavily mined in the Historic Period, and these recent activities may have obliterated any traces of prehistoric quarrying. If direct provenance correlations with prehistoric artifacts could be ascertained for any of these localities, it would be compelling evidence for understanding historic quarrying activities effect on our interpretations of prehistoric vessel procurement and manufacture.

Westfield and Ochee Springs, as mentioned above, are well-documented prehistoric quarry locations, but our interpretations of these extraction loci are limited due to the fact that they were only marginally spared by historic mining activities (Dixon 1987, Fowler 1945, Howes 1944). For example, at Westfield in western Massachusetts, the Atwater quarry was subject to intensive marble, Verde antique, and serpentine quarrying from 1896-1946 (Fowler 1945, Howes 1944). Unrecorded and lesser-known prehistoric quarries were also heavily mined, looted and/or destroyed by the middle of the twentieth century; and no remaining material evidence exists, besides the often unprovenienced collections of vessels stored in museums, mining company offices (Dann 1989), and historical society collections.

However, another issue to consider is the consistent reference to the small size of New England steatite deposits, and the near-total depletion of suitable raw material at prehistoric quarries prior to the Historic Period (Chidester 1964, Dunn 1945, Fowler 1945, 1966, 1967, 1969, 1971, Green 1970, Martin 1970, Neshko 1970, Putnam 1880). This observation raises the question of why steatite vessel manufacture may have had such an abrupt ascension and termination in the archaeological record. Putnam (1880: 275) notes that at Ochee Springs most of the "bed of steatite had been excavated its full width, and nearly all its length and depth…" by prehistoric peoples prior to Historic Period mining. Dunn (1945: 49) shows that at the Oaklawn quarry, it was difficult to determine whether the outcrop "was in a ledge or banded formation…for there only remains exposed what appears to be a small part of the original outcrop." Fowler (1971, 1951: 3) also mentions that at the Ragged Mountain Quarry and Rockshelter, several grades of steatite occurred, "the best veins of which have long since been worked away, leaving nothing exposed but low grade steatite schist."

It seems the abandonment of these locations for stone bowl or pipe manufacture was inevitable, as Amick (2007) points out that, relatively shallow and geographically restricted lithic deposits are highly subject to depletion. The anthropological significance of this pattern is monumental, and these unique data could provide insight into the variability in panhuman responses to lithic resource depletion. In this hypothetical case, exotic lithic materials highly prized for food processing, alliance building, and/or burial activities exploited to the point where exchange systems based on whole steatite vessels were no longer viable.

Incipient craft specialization, as a result of widespread regional demand for domestic cooking containers and exotic grave goods, could have also arguably been an influential factor in the depletion of steatite resources. Wright (2008: 30) considers the adoption of ground stone technology in general to be a form of craft specialization, as it often coincided with periods of subsistence intensification and increased inter-regional interaction. Steatite vessel production, when viewed from quarrying techniques, the specialization of quarry tools, and the standardization of vessel design protocols (Truncer 2004a: 25), could fit the criteria for an incipient form of craft specialization (Johnson 1996: 163) centered on a prestige-based lithic technology (Hayden 1998). However, an important distinction to make in this case is that this pattern would not imply occupational specialization, but more likely as a seasonal craft that involved groups of proficient steatite carvers and their apprentices.

The most thorough analysis of any steatite quarry, and the best evidence for vessel production as a form of craft specialization, comes from Ochee Springs in Rhode Island. Dixon (1987) performed a statistical analysis of the dimensions of the remaining vessel concavities and their spatial orientation to one another; from these data, he was able to demonstrate that there was a standardized range of vessel blank dimensions that also revealed discrete clustering patterns along the quarry surface. This phenomenon suggests intensive, coordinated episodes of steatite quarrying. If this pattern proved to be consistent with other Southern New England quarries, it could indicate that the intensification of procurement and reduction strategies for regional exportation resulted in the exhaustion of vessel quality steatite deposits. What then would have been the catalysts for a potentially unsustainable intensification in vessel manufacture? One possible explanation is the frequent deposition of large numbers of vessels into burial contexts during the Terminal Archaic Period (3,500-2,500 B.P.), which would have placed greater demands on vessel manufacture, and greater stress upon the region's limited steatite resources.

The standardization of vessel blank size recorded at Ochee Springs (Dixon 1987) may also reflect issues of local inhabitants controlling access to source areas or placing limitations on the amount of raw material that groups could extract. For example, why are there convex bosses (unfinished bowl blanks) remaining on the surface of prehistoric quarries (Figure 3.14)? It is possible that the remaining bosses were intended to be removed at a later date, or the bosses reflect that the threshold of useable raw material for a particular quarry source had been reached. However, it is impossible to know if other social constructs, such as conservation practices, ritual behaviors, and power constraints may be responsible for the extant surface patterns visible at quarry loci.

Truncer (2004a) argues that the steatite used by prehistoric peoples was exclusively derived from deposits associated with ultramafic bedrock exposures; and although ultramafic rock comprises a large percentage of the Earth's Mantle, their distribution on the surface is extremely rare and highly localized (Van Gosen, pers. comm.). Geologists working in Western New England have long noted the diminutive size of these deposits, and that most of the "altered ultrabasic bodies are too small to be of commercial use, although the latter may have been used by Indians" (Martin 1970). Elliot (1980) notes that for the Wallace Reservoir in Georgia, many more steatite exposures suitable for stone bowl quarrying existed in his research study area than had been recorded and mapped by prior geological surveys. He also notes that existing geological maps only reflect economically viable locations for historic and modern mining prospect pits. Numerous additional steatite exposures of limited dimension, some of which may have been exploited in prehistory, potentially lie unmapped across the Eastern North American Talc Belt (Figure 2.1).

Despite these limitations, basic inferences drawn from quarry distribution patterning can be illustrated through analysis of the widespread archaeological manifestations of steatite manufacture in Eastern North America (Truncer 2004b). Additional lines of evidence for this pattern can be found by reviewing interdisciplinary sources like nineteenth and twentieth century geological maps, the USGS Mineral Resources On-Line Spatial Data (MROSD), and from prior source characterization analyses (Truncer et al. 1998, Waller 2006). For example, the likelihood that steatite artifacts found on Long Island were quarried from outside of the Southern New England region is arguably low. And while this assertion has been verified through extant sourcing data (Truncer et al. 1998), this pattern can be elucidated from the fact that an approximately 300 km gap exists between the known prehistoric steatite quarries of Southeastern Pennsylvania and those of Northwestern Connecticut (Figure 2.1).

This distributional bias in recorded extraction loci could be augmented by the lack of any known steatite quarries in the heavily modified landscapes of northeastern New Jersey, the western Boroughs of New York City (e.g., Staten Island, Manhattan Island, Bronx), and Westchester County (Figure 2.4). These urban regions have early geological documentation of suitable ultramafic serpentinite and marble deposits that hosted steatite or talc exposures (Britton 1882, Cozzens 1843). Unfortunately, the modern anthropogenic environment of the New York Bight region may have forever obscured any traces of local steatite vessel manufacture. To test this hypothesis, and to sample the geochemical and geographic gap between sources in Pennsylvania and Connecticut, the author collected serpentinite from Clove Lakes Park in Staten Island for the present sourcing study.

The State of Vermont contains a greater density of historically mined steatite deposits than most other states in New England (Chidester 1964, Dann 1989, Truncer 2004b), yet in this area there is a total lack of recorded prehistoric quarries. Only one source, William Henry Holmes, addresses this issue (Meltzer and Dunnell 1992: 106) and makes the brief claim that prehistoric steatite quarries existed in "innumerable places in Vermont, New Hampshire… [and] New Jersey…and many of the quarries originally worked by the Indians have been reopened for commercial purposes, and the traces of the ancient operations thereby partially or entirely obliterated." Despite considerable effort to obtain publications pertaining to stone bowl quarries existing in Vermont, as well as New Hampshire and New Jersey, not a single reference that corroborates Holmes' statements could be located.

Regardless of the various reasons for the anomalous distribution patterns of steatite vessel quarries, their seemingly abrupt abandonment by 2,000 B.P. are also poorly understood variables in a much broader and nuanced prehistoric pattern. Few researchers have addressed what caused the overall shift (Sassaman 1995); only that steatite was predominately replaced and/or absorbed by locally derived ceramic technologies (Ritchie 1969). But it remains uncertain if this change was due to an inflated transport cost of steatite resulting from material scarcity, the ease of clay procurement, or the breakdown of alliance networks centered on steatite vessel exchange (Sassaman 1995). No hypotheses have been presented thus far that considered the former possibility of material depletion, or scarcity offsetting hypothetical "market" values.

Again, steatite deposits of Southern New England are recorded as being shallow and diffuse (Martin 1970, Wall 2003). Therefore, by definition steatite extraction loci are highly subject to resource depletion (Amick 2007). This implies that the economic advantage of those groups in close proximity to steatite quarries was limited and inevitably temporary. This limited supply of steatite may have been a major variable in why stone bowls had such a rapid onset and termination in the archaeological record.

So at this point we are still left with the question, was the rapid abandonment of steatite vessel technology the result of inflated/deflated exchange values offsetting transport costs? Or was it a shift in human selective preferences, intensive craft specialization, a breakdown of religious systems and alliance networks, or a unique case of resource depletion? One could use a more modern economic analogy to incorporate some of these ideas and attempt to explain the decline of this prehistoric industry: during the nineteenth century, the Middlefield Freestone Companies' quarry in Massachusetts, like many other historic steatite quarries in New England (Dann 1989: 76), was abandoned solely because the *transport costs exceeded the market value* of the final product (Massachusetts Historical Commission 1982: 6). From this analogy, it could be postulated that in prehistory the perceived values of steatite vessels were potentially affected from either an inferred scarcity or from the incorporation of less costly materials that could be acquired with less effort (i.e., clay for ceramics).

3.3 Sampled Long Island Archaeological Sites with Steatite Vessels

Skunk Lane Site (n=25)

The primary catalyst prompting the present thesis research was in July of 2008 when twenty-five steatite fragments, interpreted as coming from a single cooking vessel, were recovered from the data recovery project for the Skunk Lane site in Peconic, New York (Figures 3.15-3.16). The Skunk Lane Site (Figure 2.4), situated on an outwash terrace overlooking Peconic Bay in Eastern Long Island, is only part of a much larger occupation zone of artifactual material and features characteristic of the Late Archaic through Late Woodland cultural phases (6,000-330 B.P.). The data recovered from the Skunk Lane site is significant in that this was the largest systematic archaeological excavation of a prehistoric habitation zone conducted on the North Fork of Long Island (Bernstein et al. 2009).

The southern coast of Long Island's North Fork, cross-cut by several creeks, wetlands, and tidal estuaries overlooking Peconic Bay (Figure 2.4), was a productive and densely settled region of Long Island throughout the prehistoric era (ibid.). The Skunk Lane site is situated at the very center of this peninsula's southern coastline, bounded to the east and west by productive marshlands, and encompasses the basal portion of Little Hog Neck, a wide tapering spit jutting southward into Peconic Bay. Skunk Lane also lies within one mile of at least seven known prehistoric villages and burial deposits recorded in the early twentieth century (ibid., Parker 1920); as well as being directly adjacent to a temporary tribal reservation (ca. 1691-1719) for the historic Corchaug population (Case-Southold Town Records 1884).

The New York State Museum database of known prehistoric site locations, in combination with Suffolk County Archaeological Association records, delineates a nearly continuous zone of prehistoric habitation extending along the entire southern coast of the North Fork. From these data the "high density of reported finds indicates that the indented shoreline...was heavily utilized by prehistoric peoples" (Bernstein et al. 2009: 9). Thus, it is likely that the Skunk Lane assemblage was merely an extension of one or more of these previously identified archaeological sites, and falls within the center of this district or landscape of intensive prehistoric habitation and Historic Period indigenous communities.

The data recovery excavation strategy was initially systematic, with the excavation of large blocks of 1x1 meter units, but was eventually modified to conform to the footprint of the residential structure proposed to be built on the property (Figure 3.15). Broad horizontal areas of undisturbed subsoil were subsequently exposed with a backhoe to reveal intra-site horizontal relationships between features and artifact clusters (Figure 3.15). Perpendicular, one meter wide trenches were then excavated across the full diameter of the backhoe trench (Figure 3.15). From these combined efforts ten features, two of which yielded radiometric dates from the Late Woodland Period (330 ± 40 years B.P. from Feature 5; and 1150 ± 130 years B.P. from Feature 8) and 8,324 artifacts were recovered.

Besides the two pit features encountered that date to the Late Woodland, and the few examples of temporally diagnostic projectile point styles and ceramic designs (ibid), the majority of the artifact assemblage is highly redundant and occurs in unstratified, but spatially adjacent depositional contexts. This pattern is archetypal of the Southern New England region's multi-component coastal habitation loci (Brennan 1972, Lightfoot et al. 1987, Rothschild and Lavin 1977). The result is archaeological deposits that are horizontally stratified, and so the relative dating of vertically discrete components is nearly impossible. The standardization of the reduction strategies in quartz stone tool manufacture, evident in all post-10,000 B.P. archaeological components, only adds to this interpretive confusion; but at the same time classically exhibits aspects of what Bernstein (2006) has identified as "Long-Term Continuity" for sites situated along productive coastal environments of Southern New England. Thus without the presence of many datable features, it is difficult to determine Skunk Lane's full chronological placement.

The rare recovery of a sizable steatite assemblage, especially on a habitation site, allowed for a more critical analysis of the role of stone vessels in the Long Island Sound region. The majority of fragments (n=18) were excavated from the northern periphery of the site (Figure 3.15) from an undisturbed B2 outwash subsoil, while the remainder (n=7) were situated in the overlying plowzone. The vessel fragments were distributed across a 3x4m area from seven 1x1m excavation units in excessively-drained, sandy soils typical of glacial outwash plains in Suffolk County, New York. The majority of the vessel recovery was sizable body fragments and three rim fragments, two of which exhibit transverse notching perpendicular to the rim edge (Figure 3.16). No lug handles were observed on any of the body or rim sherds, but the vessel was heavily fractured, and many sections were not recovered. However, several of the larger body and rim sherds could be refit together, and from this partial reconstruction it was evident that the vessel was an elongated, oval or trough-shaped container, comparable to the vessel from the Orient #2 site depicted in Figure 1.1.

A single body fragment from this vessel was encountered directly adjacent to a small hearth (Feature 5); identified as a stained hollow form pit containing quartz debitage, fire-cracked rocks, and two small samples of charcoal. The first of which yielded an AMS date of 330 ± 40 years B.P. or cal 2σ A.D. 1450-1650 (Beta-252888); however the second sample contained a high percentage of post-modern carbon, and thus yielded a post-1950 date (Beta-254590), potentially deriving from tree root disturbance observed throughout the Skunk Lane Site (Bernstein et al. 2009: 25). Presently, it cannot be confirmed that the feature was in temporal association with the steatite fragment, or if the pit was intrusive into the B2 subsoil containing the steatite vessel fragments; as such, the potentially spurious spatial correlation and post-modern contamination of one of the two dated samples cannot be accepted as chronometrically hygienic data (Taché and Hart 2013).

Additionally, the majority of the steatite vessel fragments were dispersed for several meters to the west of Feature 5, and even though fragments were recorded in a small area only 3x4 meters in extent (Figure 3.15), the sherds still undoubtedly underwent a significant amount of post-depositional movement from bioturbation and soil truncation from historic agricultural practices. Also, recently it has been argued that in the Glaciated Northeast, pedogenic processes tend to concentrate larger artifacts at the upper portions of soil horizons as they mature over time (Cremeens 2003: 58). Thus the proximity of the steatite fragment to the pit feature may very well be circumstantial and only a serendipitous juxtaposition. If the vessel was temporally associated with Feature 5; it would be an example of very recent use of steatite on Long Island.

Unfortunately, it is not possible to further test the validity of its chronological association because the site was excavated in a CRM context, and the remainder of the site location has already been destroyed by residential development. Only with the presence of datable soot or carbonized plant residues adhering to the artifacts interior/exterior surfaces (Sassaman 1997, Taché and Hart 2013), or the presence of other diagnostic artifacts, could the association of Feature 5 and the steatite vessel be convincingly rectified. Unfortunately from field and laboratory observation, the Skunk Lane steatite vessel fragments show no visible traces of soot or interior cooking residues.

However both dentate-stamped and undecorated grit-tempered pottery fragments, and three narrow triangular quartz projectile points, were recovered within each of the excavation units and levels that contained the steatite vessel fragments (Bernstein et al. 2009). The presence of typically Woodland Period artifacts in the same levels as the steatite fragments is thus tentatively supportive of the chronological association with Feature 5. However, it must be explicitly restated that generalized correlations between projectile point morphology and specific time periods, outside of closed feature contexts, are becoming increasingly less reliable as heuristic tools for elucidating chronology or affiliation (Filios 1989, Lenardi and Merwin 2010). More pertinent to the present study however, is not the vessels temporal placement, but the fact that the large size of the Skunk Lane steatite assemblage prompted the research potential for thesis work in geochemical source characterization.

MPM Farm Site (n=1)

The second of only two archaeological sites excavated by the Institute for Long Island Archaeology to recover steatite vessel fragments, MPM Farm, is located on the South Fork of Long Island in the village of Water Mill. The MPM Farm Site (Figure 2.4) is not a multi-component residential base as observed at Skunk lane, but is instead interpreted as a special-purpose resource extraction site comprised of two discrete loci (Locus A and B). First and foremost, Locus A is a stratified cooking feature with a twenty centimeter thick shell midden overlying a meter deep, clay-lined pit. The pit is radiocarbon dated to approximately 1150 A.D., and it contains a wide diversity of floral, faunal, and lithic artifacts. Locus B is a small, non-diagnostic scatter of quartz lithic debitage (Bernstein et al. 1996a).

Both of these single-component cultural deposits at MPM Farm were identified by an intensive shovel test pit survey; which prompted the urgent need for a Stage 2 site evaluation to further delineate the horizontal and vertical extent of these two deposits (ibid.). Fifteen additional shovel test pits were placed in the vicinity of both loci, in combination with four contiguous 1x1meter excavation units in Locus A to examine the structure and contents of the pit feature; and a single 1x1 meter unit in the central portion of Locus B's quartz lithic scatter (ibid.). The Stage 2 fieldwork ended up being the full extent of investigation prior to the site's eventual destruction by residential development. From these limited excavations, however, it was clear that the majority of the prehistoric material had been mitigated, and thus no further investigations were actually warranted (ibid.). The information gained from this site evaluation was comprehensive enough to generate a significant body of subsistence and technological data on the life ways of the prehistoric inhabitants of the South Fork of Long Island.

Similar to the pattern of prehistoric landscape-use seen at Skunk Lane and on the North Fork, the MPM Farm site also lies within a nearly unbroken zone of recorded archaeological sites that surrounds the entirety of Mecox Bay (Figure 2.4). That being the case, it is of great significance to have discovered such spatially and temporally discrete deposits as those observed at MPM Farm. That the site location has been fully destroyed by residential development underscores the importance of further analyzing this rare data set.

The MPM Farm prehistoric loci were discovered at the center of a small peninsula overlooking Burnett Creek, a tidal estuary that flows eastward into the greater Mecox Bay (Figure 2.4). Mecox Bay, a shallow outwash plain watershed system, is one of several large coastal ponds lining the South Fork of Long Island, which have been intermittently breached by waters of the Atlantic Ocean (Southampton Marine Resources and Protections Plan 2001). Both the influx of water from the Atlantic Ocean, and/or the cutting off of this water flow by sediment accumulation and dune formation, could have caused marked changes in the salinity levels of this watershed over time (ibid.); shifting the availability of various food resources, and also potentially affecting the desirability of this location for prehistoric peoples to settle.

These environmental fluctuations are still occurring today, and both the predominance of large oyster-*Crassostrea virginica* in the shell midden of Locus A and the historic record of shellfish harvesting in Mecox Bay, attests to the prior favorable habitat for oyster beds (Bernstein et al. 1996a, Southampton Marine Resources and Protections Plan 2001). They have subsequently become more suitable for Soft-Shell Clam-*Mya arenaria* populations to flourish. These cyclical formation processes based on the salinity level, rates of silt deposition, and substrate characteristics occur throughout the development of salt marshes in Northeastern North America, and are often reflected in the region's shell midden variability (Braun 1974). Regardless, this unique geographic setting would have still provided an abundant but variable suite of marine, estuarine, and terrestrial resources for prehistoric inhabitants to exploit, and this is clearly evidenced by the faunal and floral diversity observed in the contents of the pit feature in Locus A.

The overlying shell spread in Locus A was composed predominantly of tightly packed oyster shells (*Crassostrea virginica*), some of which reached 15 centimeters in length, quartz debitage, fire-cracked rock fragments, shell-tempered ceramics, charcoal, a possible squirrel femur, unidentified fish vertebrae, and at the basal level small numbers of soft shell (*Mya arenaria*), hard shell (*Mercenaria mercenaria*), and surf clams (*Spisula solidissima*) (ibid.). Within the sandy, stratified portion of the pit feature, excavators encountered body fragments of both shell and grit-tempered ceramics, large decorated rim fragments of Windsor-Brushed and Cord Wrapped Stick impressed vessels (Figure 3.17), quartz triangular bifacial tools, quartz cores, quartz debitage, fire-cracked rock fragments, charcoal, unidentified burned bone, charred hickory nuts, numerous blueberry (*Vaccinium sp.*) seeds, and most unexpectedly, a thick body fragment from a large steatite vessel (ibid.).

In terms of regional chronologies, the presence of a steatite vessel fragment (Figure 3.17) in a

Woodland Period component would represent an anomalous development (Ritchie 1969), and many archaeologists would be quick to argue that the presence of steatite is merely the result of a form of site disturbance. Yet the discreteness of the archaeological deposits at MPM Farm, as opposed to Skunk Lane, precludes the likelihood that the steatite was only secondarily deposited by the excavation of the pit feature; as intensive shovel test pitting of the property showed no other material traces of previous occupation adjacent to or in the general vicinity of the two loci (Bernstein et al. 1996a). Based on the presence of diagnostic pottery, as well as two radiometric samples taken from the upper (760 ±70 years B.P., Beta-93015) and lower levels of the pit feature (850 ±70 years B.P., Beta-93016), it can be confidently argued that this site was occupied during the Late Woodland Period (ibid.).

As seen in the Skunk Lane assemblage discussed above, and from analogous sites like Point Judith Upper Pond in coastal Rhode Island (Leveillee and Harrison 1996), the unanticipated presence of steatite recovered from Woodland contexts challenges the traditional chronological sequence of the region (Versaggi and Knapp 2000). The paradigm which still argues that steatite vessel usage and exchange was abandoned by the Early Woodland, and fully replaced by local ceramic technologies with no inter-regional variation (Lavin 1998, Ritchie 1969, Versaggi and Knapp 2000). Additionally, the contents of the clay-lined pit feature found at the MPM Farm Site also reveal a unique co-occurrence between steatite vessels, shell-tempered ceramics, and Windsor brushed ceramics (Figure 3.17); which are each considered to be chronologically distinct archaeological manifestations, separated by close to a millennium or more (Lavin 1998).

Steatite from the Woodland Period is thus again an intriguing development (see Chapter 2.2). The potential significance of steatite recovered from post-Terminal Archaic Period sites should not be ignored as merely statistical noise (Bernstein et al. 1996a, Bernstein et al. 2009, Leveillee and Harrison 1996, Versaggi and Knapp 2000). Yet it must be acknowledged that the recovery of Late Woodland steatite artifacts might represent, not a persisting procurement and exchange system centered upon stone cooking vessels, but possibly an idiosyncratic form of technological nostalgia (i.e., heirloom objects), or a source of raw material being exploited by recycling broken vessel fragments into new objects like boiling stones, ceramic temper, smoking pipes, gorgets, or net sinkers (Amick 2007, Bourque 2008, Brumbach 1979, Kraft 1970, Lillios 1999, Hayden 1998, Hoffman 1998, Witthoft 1953). From these notions it is plausible that the inferred "symbolic value frequently added to archaic items" (Brasser 1978: 87), and social prestige associated with objects like steatite vessels in earlier periods (Sassaman 2006), may have simply been perpetuated by families passing down vessels, and possibly even vessel fragments, over generations into the Woodland or Contact periods. In the example from MPM Farm, which has two small grooves along its lateral margins and, based on the inferred function of Locus A as a food processing facility for marine resources, the latter alternative of a net sinker is a plausible interpretation.

Orient # 1&2 Burial Complex (n=3)

Two sites excavated in Orient, NY during the late 1930s by Roy Latham (1953), and later examined by William Ritchie (1959), contained massive hilltop burial deposits that became the archetypal model for the late Terminal Archaic period in Southern New England (Ritchie 1959, 1969). At these interment loci, most prominently at Orient #2 (Figure 2.4), were large, oval stained pit features, one measuring 30x20x5 feet in dimension, and contained multiple secondary burial pits, hearths mixed with charred human and animal bone, deposits of powdered red ochre, and artifact caches placed meticulously in the central and peripheral margins (Latham, n. d.). Among these spatially oriented pits and caches were large numbers of steatite vessels. Often these were whole vessels intentionally broken in two pieces and stacked upon one another, referred to as "steatite tiers," and also vessels with indirectly punctured bases (Figures 1.1, 3.18); occasionally these "killed" containers were inverted over one another at the floor of the large interment pits (ibid.).

The practice of the intentional breakage of an object, frequently referred to as being "killed," occurs consistently on stone vessels and other artifacts found in Late-Terminal Archaic burial features in Eastern North America (Boyd 1962, Hoffman 2006, Leveillee 1999, Ritchie 1959, 1969, Swigart 1974, Witthoft 1953); but this is also a distinctive behavior observed on ground stone tools in ceremonial contexts throughout the world (Adams 2008). In conjunction with these striking panhuman traits of ritually destroying precious objects, is the incorporation of red ochre deposits. Ochre is an iron-based pigment that has been utilized by modern humans in both ceremonial and interment contexts since the Middle Paleolithic (Strong 1997: 50, B. Smith 1950), and its use among indigenous peoples persisted into the nineteenth century in North America (Strong 1997, Robbins 1956). Yet the Terminal Archaic usage of ochre on Long Island is exceptional, and deserves further discussion.

Ochre lenses and deposits of a bewildering contextual variety were observed by the excavators of Orient #1 & 2, the Sugar Loaf Hill, and Jamesport burial sites (Latham n.d., Ritchie 1959), but this pattern is also recorded from numerous Late to Transitional Archaic mortuary features found in Southern New England (Dincauze 1968, Leveillee 1999, Lord 1962, Ritchie 1969, Simmons 1970, Taylor 2006, Winter 2006). At Orient #2 alone, dense lenses of the crushed red powder were spread over large horizontal areas, amorphous pockets of ochre bounded caches of artifacts, three masses of the red pigment were arranged in a triangle, and small foot-wide rings of ocher were encountered, with outer bands measuring only a few inches wide and encapsulating deposits of charcoal-bone crematory mixtures. All of which are considered symbolic expressions of diverse mortuary practices, that at present can only be interpreted in the most cursory fashion (Latham n.d., Ritchie 1969, Simmons 1970, Strong 1997).

Pigments derived from ochre and graphite are so consistently incorporated into these features, that some have suggested ochre and graphite were actively procured and traded as a processed commodity

(Leveillee 2003), and that they were critical material components to Late-Transitional Archaic burial protocols (Hoffman 2006). These practices preceded the use of steatite vessels, as most early Transitional Archaic sites lack steatite (Dincauze 1968, Leveillee 1999, Taylor 2006, Winter 2006), and only in later Terminal Archaic contexts does steatite become a primary constituent of imported ceremonial items used in burial sites. Long ago it was argued by Roy Latham that the Arkose-Hematite concretions found in abundance on Long Island beaches, erroneously referred to by locals as Indian Paint pots, were not the source of red pigment at the Orient sites; but the ochre used in burial sites was imported to the region along the same channels as steatite and graphite (Ritchie 1969). Hoffman (2006: 97) has demonstrated that this interpretation may be accurate, and that these materials were actively procured in Massachusetts for wider exchange in Southern New England.

The Orient #1 locus (Figure 2.4) contained four primary pit features, the largest occurring with three discrete caches of grave offerings "…one in the center and one each at the north and south ends. The two inverted stone vessels and the gorget were in the center cache" (ibid.); each additional pit feature retained a consistent suite of artifact types (i.e., quartz fishtail points, quartz unifacial cores, quartz debitage, pestles, argillite drills, graphite/ochre paintstones, celts, and lumps of raw clay). Interestingly, all of the celts were recovered a foot or more above each grave cache, and the predominate fishtail projectile points were "neatly arranged…in small groups two to four points high, laid down carefully with tips all pointing in the same direction or spread out in one or more rows with the tips on a level line and all in the same direction" (ibid.).

At Orient #2 less than a mile to the east (Figure 2.4), Latham encountered the largest single Terminal Archaic burial feature know from the entire New England region. Within and underlying this colossal 20x30x5 foot ochre-stained deposit, Latham encountered 33 caches of artifacts, three large crematory hearths, three masses of ochre pigment arranged in a triangle, an uncremated burial bundle with a steatite vessel fragment laid upon the skull, a perforated bannerstone, gouges, a cooking hearth with three large stones supporting the only unbroken steatite vessel, two-holed gorgets of steatite and slate, large spear points including a bi-notched chert knife, graphite paintstones, and approximately 48 steatite vessels interspersed throughout the pits, caches, and hearths (ibid.). One of the killed vessels from the Orient #2 burial pit, which is included in the present study (Figure 1.1; Appendix C), is the only known example recovered on Long Island, New York to show any clear signs of symbolic decoration, with a continuous row of V-shaped incisions lining the exterior rim. Many other vessels from Orient #1 and 2 were "transversely notched on the rims" (ibid.), and as shown in Figure 3.16, rim fragments from the Skunk Lane Site retained similar evidence of transverse notching. It is unclear if this rim notching practice, consistently observed on vessel fragments from the Northeast, was related to functionality, or if it served a decorative purpose (Versaggi and Knapp 2000: 5).

Situated at the terminus of the North Fork of Long Island (Figure 2.4), the Orient #1&2 burial sites directly overlook the Long Island Sound; and the dome-like glacial kame deposits, that formed the Browns Hills section of the Roanoke Point Recessional Moraine (Bennington 2003), would have dominated the landscape of the Orient Peninsula. Latham significantly records that the burial features, at both site locations, were only present in the western slopes of the hilltop that contained deep, Aeolian sand deposits formed by post-glacial winds, and completely avoided areas of compact till directly to the east of the apex. Specifically at Orient #2, Latham (n. d.) notes that "east and the south of the summit the soil is packed hard with gravel and cobbles and no pits were located there. Drift sands… had piled up on the west slope to a depth of five to eight feet and the big pit was dug through this sand down to the underlying glacial formation where the crematories were started and the grave deposits cached on or near the pit floor in soft quartz sand…" Thorson and Tryon (2003: 61) remark that in the glaciated Northeast, many well-preserved and deeply buried archaeological sites occur within analogous "west-facing bluff-top settings" which were natural collects for post-glacial, wind-blown sediment.

The artifact variability, feature diversity, site selection criteria, and human agency that would have precipitated the construction of these elaborate ceremonial facilities is found on only a few other locations in coastal Southern New England (Dincauze 1968, Leveillee 1999, Ritchie 1959, Robbins 1963, Simmons 1970). For the present study the author was able to have access to two complete steatite vessels (Figures 1.1, 3.18) and a single rim fragment (Figure 3.19) collected at the Orient #1&2 Burial Complexes (Vessel Metric Attributes see Appendix C). The trough-shaped vessel shown in Figure 1.1 was found on the Orient #2 location, based on the presence of exterior design modification noted by Latham (n.d.). The flat vessel (Figure 3.18) and the vessel rim fragment (Figure 3.19) however, could have come from either of the two interment loci. As a result the latter two artifacts are given the site designation of Orient #1/2. All three artifacts come from the Latham Collection, with the Oysterponds Historical Society providing all of the samples.

Steatite Smoking Pipes, Latham Collection, Unknown Site Location, Orient, NY (n=2)

Two steatite smoking pipes excavated from an unknown site location in Orient, NY during the late 1930s by Roy Latham were also included in the present study (Figure 3.20). Despite the lack of provenience data, these pipes have the potential to aid in understanding the variability in raw material exploited between artifact classes. The non-decorated pipe, depicted on the left in Figure 3.20, is an obliquely angled elbow pipe that has been smoothed on both the interior and exterior surfaces. The edge-decorated pipe, shown on the right, has been notched along the lateral margins of the tube-shaped design, with a smoothed interior bowl cavity. Both pipes were fractured in multiple places, thus recording metric attributes was uninformative.

Chapter 4. EDXRF Results

It is intended that the results obtained through EDXRF and S-XRF source characterization analyses be viewed as exploratory data intended to identify discriminating tracer elements, from which a baseline can be drawn for more detailed analyses in the future. One of the major limitations of these EDXRF experiments is that the author could not calibrate the Bruker Tracer III-V device with a geological standard. There is no geological standard that is known to be appropriate for calibrating source characterization data from steatites. As a result, the data obtained from the author's EDXRF experiments is more qualitative or semi-quantitative in nature. It is also certain that the results of the present study are limited in terms of sample sizes (Hubbard 2006, Shackely 2008), and the number of elements that were reliably detected, when compared to similar studies that employ techniques like INAA (Truncer et al. 1998, Versaggi and Knapp 2000).

For archaeologists, the success with which HHpXRF devices can be used for making source-determinations outweighs any limitations of the data. As studies employing non-destructive sourcing methods are the only conditions in which most museums and artifact repositories will loan out their collections. For example, the two restored steatite vessels (Figure 1.1, 3.18) loaned to the author by the Oysterponds Historical Society in Orient, NY could not have been geochemically assayed by any other means without removing sections from exterior surfaces. Therefore EDXRF data generated through HHpXRF devices is likely to become the standard method by which source-determinations can be made for artifacts like whole steatite vessels; and so further experimentation with these non-destructive sourcing techniques is both worthwhile and necessary.

The results of the EDXRF analyses obtained for this project produced a compelling body of geochemical data (Tables 4.1-4.5; Appendix A). From the onset, it was understood that the detection of transition metals would provide the most useful source characterization data for Eastern North American steatites (Truncer et al. 1998). The consistent identification of transition metals Cr and Ni as discriminating tracer elements in the sample base was a highly significant outcome. The fact that these baseline results were independently verified by both the S-XRF analyses conducted by Dr. Rasbury, and EDXRF analyses conducted by Dr. Bruce Bailey (Chapter 3), bolsters the interpretation that source-determinations can be proposed. Two-tailed t-tests show the obtained elemental data for Cr and Ni are statistically significant at the $p < .001$ level; and all of the artifact samples tested from Long Island, New York were well within the 90% confidence interval with the two steatite quarries analyzed from Rhode Island.

Chapter 5. Analysis

During EDXRF analyses, each source area and artifact sample produced discernible variation in the detection of trace elements and transition metals. For example, surface irregularities clearly affected the reliability of the spectra generated through EDXRF. The two small bowl fragments from the Beckwith Brook quarry (Figure 3.10) could not be cut to make flat sections, thus only the convex basal portions could be scanned. When attempts were made to scan the concave face, which left a 2cm gap between the sample and the IR sensor, the linear spectra generated was visibly erratic and heavily scattered.

Frahm (2013) addresses the methodological problems of dealing with surface irregularities on samples when performing HHpXRF analyses and his solution was to emphasize the detection of Mid-Z heavy elements like Sr and Rb. However, as discussed in Chapter 3, Mid-Z heavy elements were differentially detected in the steatite sample base (Tables 4.1-4.5). They may have been present in trace quantities, but did not always result in a discrete color peak in the XRF spectra. It is important to reiterate that only elements that produced a clear peak in the linear spectra (Figure 3.6) were selected for analyses (Figures 5.1-5.7; Tables 4.1-4.5). Other elements were present in each sample, but the lab director Dr. Katherine Aubrecht said that only elements with unambiguous peaks in the XRF spectra could be considered quantitatively reliable data.

A second issue with EDXRF assays was that fact that the elements detected on weathered surfaces of quarry samples were sometimes inconsistent with freshly cut surfaces. For the North Wilbraham quarry sample, the trace element Vanadium was only detected on cut surfaces, but was completely lacking on the weathered surface. In contrast, the sample from the Westfield quarry detected the presence of K and Y on weathered exterior surfaces, and not on freshly cut surfaces. Inconsistencies like this challenge the efficacy of performing in-situ EDXRF analyses at weathered steatite outcrops, as Bachor (2011) has done for quarry sources in the Susquehanna River Watershed.

Although the differential presence/absence of various elements is to be expected, Waller (2006) and Bachor (2011) have shown that these data are still useful in characterizing quarries and source-matching artifacts. For example, the Westfield quarry was unique among New England quarries, in that it was the only source area to contain the element K, and a high concentration of Ca. Westfield also stood out, in that it contained the highest concentration of Rb and Y of any source area that was examined with EDXRF. Based on those data alone, the Westfield quarry could be eliminated from being a possible source for the sampled artifacts from Long Island. However, the Westfield source area was assayed with only a single specimen; and thus the interpretation of these EDXRF results is heavily limited by sample size constraints.

Overall the data collected by HHpXRF suggest there is inter-source variability between quarry loci, and more explicitly so between source regions. To best illustrate the discriminating utility of this approach, biplots of logarithmically transformed trace element data were generated and are shown in Figures 5.1-5.7. Table's 4.1-4.4 and Appendix A show the results of EDXRF analysis, and are organized by average net intensity in ppm. Table 4.5 shows the average ratios compared to the average ppm for each individual sample. It appears that average ratios better account for the wide variability observed in certain samples that would cause higher standard error percentages when using average net intensity (ppm). However, logarithmic bi-plots and ratio bi-plots produced very similar outcomes; therefore the graphical display of all EDXRF data utilized only logarithmic transformations, following the model used by Waller's (2006) WDXRF study of steatite from this region.

Connecticut:

There was considerable geochemical variation among the steatite sources from Northwestern Connecticut (Table 4.2). It was assumed that the EDXRF data for these seven source areas would cluster together as a regional unit, due to the linear orientation of the talc-bearing belt of ultramafic rocks (Figures 3.8-3.9). However these source areas revealed a high degree of variability between discrete outcrops (Figures 5.1-5.7). This was an unexpected outcome, as the Northwestern Connecticut series have been described by some geologists as the eroded remnants of a single deposit (Martin 1970).

The Harwinton quarry (Figures 3.7-3.9) contained the lowest concentration of Ni among the Northwestern Connecticut quarry series, which corroborates well with Waller's (2006) analyses with WDXRF. Arsenic (As), a metalloid found in only a few other sampled source areas outside of Connecticut (i.e., Jenkins Hill, North Wilbraham, Oaklawn, Ochee Springs, Wissahickon), was present in high concentrations at Harwinton (Figure 5.2-5.3; Table 4.5). Harwinton also differed from the surrounding Northwestern Connecticut sources in that it contained the element Rb. Mid-Z heavy elements, specifically Rb and Sr, were primarily present in sources from Massachusetts (Horne Hill, Jenkins Hill, Petersham, Westfield), Rhode Island (Oaklawn, Ochee Springs), New Hampshire (Francestown), and Pennsylvania (Wissahickon). From each of the bi-plots generated in Figures 5.1-5.7, it appears that the Harwinton quarry would not have been the source for any of the artifacts sampled from Long Island, New York.

The Beckwith Brook Quarry was distinctive in that it contained the highest concentration of Ni among all of the quarries from Northwestern Connecticut. However, this source area is only represented by two artifact specimens (Figure 3.10), and the results are heavily limited by samples size issues. Therefore, this source region was not treated statistically or depicted in logarithmic biplots shown in Figures 5.1-5.7.

The Cotton Hill Quarry Pits 1 &2 and the associated ledge outcrop (Figure 3.8) were clearly geochemically associated, as they plotted adjacent to one another in all logarithmically transformed biplots shown in Figures 5.1-5.2, 5.5-5.7. These quarry loci conspicuously contained the highest concentration of Cr, but completely lacked Co and Mn, which were elements consistently detected in all other samples. By the stark lack of Co and Mn, it can be argued that this particular cluster of quarries can be eliminated as a possible source for artifacts deposited on Long Island. The Nepaug-Bakerville quarry, which was one of the most intensively utilized steatite sources in New England (Neshko 1970), was also not geochemically represented in the sampled artifact base from Long Island, New York.

The Ragged Mountain quarry and rockshelter had a rather unique geochemical signature when compared to the other sources areas in the Northwestern Connecticut series (Figure 3.7). This is partly due to the fact that Ragged Mountain contained a very low concentration of Cr (Table 4.2). In addition, the Ragged Mountain quarry was formed in Hoosac Schist that dates to the Late Cambrian period, as opposed to the other Northwestern Connecticut quarries that were formed during the Ordovician Period.

The Soapstone Mountain Historic Quarry had the most distinctive elemental output of all the sampled sources from Connecticut, due to its conspicuously low levels of both Cr and Ni (Table 4.2). These were so low that the source area could not be plotted in Figure 5.1 that depicts a biplot of logarithmically transformed EDXRF data for elements Cr and Ni. Based on these data alone, it is quite probable that none of the samples derived from Soapstone Mountain would match with artifacts recovered on Long Island.

Massachusetts:

Steatite samples from three well-known prehistoric quarries in Southern Massachusetts (Westfield, Horne Hill, North Wilbraham) were unfortunately the most poorly represented sources areas in the sample base. Only a single specimen from each location could be obtained (Appendix B). As a result, sample size issues heavily limit their statistical value in this EDXRF study. Figures 5.1, 5.4-5.7 only present the EDXRF data from sources areas with five or more samples, and so the three quarries noted above are not depicted due to their minimal representation in the sample base. The North Wilbraham quarry is shown in Figures 5.2-5.3 because it was one of the few source area samples that contained As.

In future sourcing endeavors, these three heavily utilized quarries must be more thoroughly sampled before any source-determinations can be put forth. Unfortunately two of these quarries, North Wilbraham and Horne Hill, are no longer extant and have been destroyed by residential development. Local museums and artifact repositories will then be necessary to obtain more samples from these two quarry loci.

The two steatite quarries in Massachusetts that were only known to have been mined by Euro-

Americans in the Historic Period (i.e., Petersham, Jenkins Hill) were well represented in the sample base. Neither source area could be matched to the sampled artifacts from Long Island. The Petersham quarry did plot close to several artifacts in Figures 5.4-5.7. However, the Petersham source contained a high concentration of Sr, and therefore is unlikely to be the source for any of the sampled artifacts. This outcome was expected for both Jenkins Hill and Petersham, based on the lack of evidence for prehistoric extraction at these loci, and their high distance to source ranks depicted in Table 6.1.

New Hampshire:

The Francestown quarry, which was only known to have been exploited by historic Euro-Americans, does not appear to be geochemically represented within the sampled artifacts from Long Island, New York (Figures 5.1, 5.4-5.7; Table 4.3). Given the fact that the Francestown quarry had the second to highest distance to source rank in Table 6.1 and EDXRF assays detected concentrations of Rb, Sr, and Y not seen in any artifact samples, this outcome was heavily anticipated. This result correlates well with the archaeological record, in that very few sites in the State of New Hampshire have recorded the presence of steatite vessels (Willoughby 1935). In addition, the Late Silurian date for the Francestown formation noted in Chapter 3.1 differs from most of the other source areas sampled, which were typically formed during the Late Proterozoic-Late Ordovician Periods.

New York:

The EDXRF data suggest that the Cloves Lakes serpentinite deposit in Staten Island, New York (Figures 5.1, 5.4-5.7; Table 4.3) can be eliminated as a possible source region for the sampled artifacts from Long Island (Figure 4). However, Figure 5.1 shows that the Orient #1/2 rim fragment (Figure 3.19) plots about halfway between Clove Lakes and the Oaklawn quarry in Rhode Island. Yet the artifact sample and the Oaklawn quarry contained a prominent peak for the metalloid As, while the Clove Lakes was lacking in As; therefore, the rim fragment likely derives from Oaklawn (Figures 5.2-5.3).

Pennsylvania:

The linear spectra for the Wissahickon source area showed the greatest range of elements measured, and is the only sampled source to reveal specific peaks for all elements depicted in Table 4.5. In addition, the element Zr was measured only in the Wissahickon sample. Based on elemental variability Wissahickon can be eliminated as a possible source for the vessels or pipes sampled from Long Island.

What is most interesting about the data from Wissahickon is how it consistently plotted close to the Oaklawn source in Rhode Island (Figures 5.1-5.7). Clearly the spectra from the two source areas are highly distinct, and several elements not detected in Oaklawn samples were present in high concentrations at Wissahickon (Table 4.5). However, these EDXRF data show that similar concentrations of certain elements can be replicated between far distant sources, as noted in Chapter 3 (Goffer 1980: 85-86). The recognition of this issue emphasizes the need for inter-regional sourcing studies to compare all of the geochemical data obtained before attempting to make source determinations of artifacts.

Rhode Island and Eastern Long Island Artifacts:

It is significant to note that the seven artifact samples tend to cluster together in logarithmic biplots (Figures 5.1-5.4). This is highly suggestive that the artifacts sampled for this research project derived from a single source or source region. However, this was not always the case as some biplots were more scattered, while others showed two clusters and outliers (Figures 5.5-5.7). As a result, future examination of these data should incorporate cluster and discriminant analyses to support or refute these preliminary source determinations.

Nevertheless, the seven artifact samples tend to plot closely with two source areas: the Oaklawn or the Ochee Springs quarry in Rhode Island. When average ratios are compared with similar element biplots, the same outcome is achieved. As mentioned above, two-tailed t-tests show the obtained elemental data, specifically for Cr and Ni, are significant at the $p < .001$ level; and each of the artifact samples tested from Long Island were well within the 90% confidence interval with the two steatite quarries analyzed from Rhode Island.

Prior to EDXRF analyses, one of the Skunk Lane vessel fragments (Figure 3.16) was cut with a Jaret bandsaw to assay both exterior and freshly cut surfaces. This was the only artifact sample to be subject to the removal of sections, all other artifacts were assayed on exterior surfaces. As mentioned above, the quarry sample from North Wilbraham revealed the presence of V only on freshly cut surfaces and not on weathered exterior surfaces. The Skunk Lane sample showed no variation in elements detected, or their range, between the cut and exterior surfaces.

One possible reason for this is rapid deposition in the archaeological record after quarrying limited the artifacts exposure to atmospheric weathering. None of the sampled vessels and vessel fragments reveals any visible evidence of exterior weathering. The realization of this fact is highly significant to the study, as it shows non-destructive EDXRF of only exterior vessel surfaces detects the same signature as on cut surfaces. Most importantly, these results suggest that future sourcing studies do not need to damage artifacts to achieve greater geochemical resolution.

The Skunk Lane vessel, like the remainder of the artifact sample base, tends to plot closest to the Oaklawn or the Ochee Springs quarries in Rhode Island (Figure 5.1, 5.7), except for Figure 5.4, which depicts the biplot data for Ca and Co. Interestingly, it was evident during the first EDXRF experiments with each color-coded filter noted in Chapter 3, that the Skunk Lane sample was geochemically similar to the Oaklawn source. Further analyses only confirmed these initial observations.

The presence of the metalloid Arsenic (As) was detected during EDXRF analyses in six source area and three artifact samples (Table 4.5). The rim fragment from Orient #1/2 (Figure 3.19) and the two smoking pipes (Figure 3.20) included in the study contained similar concentrations of As. When these data were logarithmically transformed and plotted against both Cr and Co for source areas containing As (Figures 5.2-5.3), some interesting conjectures could be made. For example, Figures 5.1 (Cr/Ni) and Figure 5.2 (As/Cr) both show that the steatite Elbow Pipe (Figure 3.20, left) plots very close to the Ochee Springs quarry of Rhode Island. It is important to note that the manufacture of smoking pipes at Ochee Springs has not been demonstrated archaeologically (Dixon 1987), and this would be the first indirect evidence for this practice.

The decorated Tube Pipe (Figure 3.20, right) plots close to both the Oaklawn Quarry and Wissahickon source area (Figures 5.1-5.2). Since the Wissahickon samples contained a highly distinctive spectrum that detected multiple elements not identified in any other sample, it can again be eliminated as a possible source for the Tube Pipe, or any sampled artifact for that matter. It could more convincingly be argued that the decorated Tube Pipe derives from Oaklawn. Given the well-known fact that the manufacture of various types of smoking pipes has been demonstrated at the Oaklawn quarry in Rhode Island (Fowler 1967, Waller and Leveillee 1998), these bi-plot comparisons may have some merit. The consistent plotting of the smoking pipes within Rhode Island steatite sources are thus compelling data.

However, for the Orient #1/2 vessel rim fragment (Figure 3.19) elemental bi-plots produced varying results. In Figure 5.2 comparing As/Cr, the artifact plots half way between Oaklawn and the historic Jenkins Hill quarry of Northeastern Massachusetts. Although, when As/Co (Figure 5.3) are plotted against each other, the Orient #1/2 rim fragment much more closely matches the Oaklawn source. In Figure 5.1 using Cr/Ni, the same artifact sample plots close to both Oaklawn and the Clove Lakes source area in Staten Island, NY. However when the concentrations of Cr and Ni are compared to other elements present with the two source areas (Table 4.5), the Oaklawn quarry shows the greatest geochemical similarity to the vessel fragment.

Once again it appears that Cr and Ni have great potential in making source-determinations among Southern New England steatites, as long as additional lines of comparison are employed. Tupa's (2009) Masters research using LA-ICP-MS to characterize steatite from the Channel Island's of Southern California made a similar conclusion that often the comparison of two particular elements held the greatest utility in making source-determinations of artifacts. Her study concluded that As, when plotted against the transition metal Co, could reliably identify the likely source from which a particular artifact was derived. Therefore, the present EDXRF study's emphasis upon Cr and Ni, as well as As, Ca, Co, Cu, and Zn, as a baseline from which to compare other elemental relationships is warranted.

Chapter 6. Discussion and Conclusions

Data obtained through source characterization efforts can identify the source or source region from which a particular artifact is derived. They also allow us to "assess transport cost by establishing artefact provenance (based on compositional similarity) and recording the distance between the location of the artefact and its source" (Truncer et al. 1998:28, 1991). Source determinations can illustrate the geographic trajectory of an exchange-based economy between prehistoric peoples on Long Island and groups located along the geographic conduits of the Talc Belt. Down-the-line or dyadic exchange models for the anthropogenic transport of lithic materials (Braswell and Glascock 2002, Wholey 2011b) predict that steatite quarried for cooking vessels recovered on Eastern Long Island should come from the nearest sources. The average straight line distance between an artifact and its raw material source are thus expected be the least compared to other source areas (Table 6.1).

Is there evidence that steatite vessels found on Long Island were produced locally? Steatite boulders or cobbles on Long Island are virtually unknown, or are exceedingly rare. These would not have been adequate sources to independently produce steatite objects beyond small beads or pendants for personal adornment. Nor could their rare presence account for the frequency of vessel recovery on the outer coastal plain (Hoffman 1998, Truncer 2004b). Steatite's softness also precludes the likelihood of long distance glacial transport (Hubbard 2006: 9), aside from the possibility of ice-rafted boulders (Bullen and Howell 1943: 62) or fragments caught within the ablation zone of an ice sheet. Even if a large enough block of steatite for vessel manufacture had reached the shores of Long Island, it would have hardened considerably due to prolonged exposure to the atmosphere (Harrell and Brown 2008). No compelling evidence for local vessel manufacture has been recorded so far on Long Island, and only finished vessels have ever been found on the outer coastal plain of Southern New England (Fulcher 1974, Funk and Pfeiffer 1988, Moffett 1947, Ritchie 1959, Roy 1956).

The use of watercraft preceded the Late-Terminal Archaic importation of finished steatite vessels to the outer coastal plain (Dixon 1999, Merwin 2003). However, when steatite vessels became an increasingly common artifact class in Southern New England by roughly 3,500 B.P., watershed corridors would have much better facilitated the exchange of heavy stone containers. In addition, overland routes used for transporting other lithic materials (e.g., chert, rhyolite) from New England to Coastal New York may have been less tenable. Water-borne transport might have been the mechanism for the exchange of steatite vessels and all lithic types from the onset. However, the necessity for these modes of inter-regional travel would have become critical after this point in time. This conjecture has led the author to argue that watershed corridors spatially associated with quarried outcrops might have been central to the effective transport of steatite vessels, and not overland routes. The Long Island Sound watershed connects all of these geological and archaeological nodes. It is proposed to be the primary conduit for steatite artifact exchange in the study area (Figure 2.4). The geographic context of this study is therefore structured around an investigation of steatite procurement and transport in this massive watershed system.

Watershed corridors could have been the most efficient means of transporting steatite vessels in Southern New England. For example, the distance between Northwestern Connecticut and Eastern Long Island using overland routes to circumnavigate the New York Bight (≈265 kilometers in a straight line overland path) versus a straight line path overlying watershed corridors (≈108 kilometers) is considerably longer. As a result, it was important to identify each of the potential watershed corridors that could have been utilized for this process. Each of the source areas and their potential drainage pathways could have led prehistoric groups to the Long Island Sound (Appendix B). In addition, average straight line distances were calculated between source regions like the Northwestern Connecticut series of quarries and the four archaeological sites included in the present study, and from these data, each source region could be ranked by their likelihood for being the source of steatite artifacts on Eastern Long Island (Table 6.1).

Table 6.1 shows that the quarries in Western Connecticut situated along watershed corridors of the Connecticut River are ranked as the most likely source region for steatite vessels found on Eastern Long Island. However, the Rhode Island series associated with the Narragansett Bay watershed rank second in terms of straight line distance-to-source. Therefore, it is possible that steatite vessels on Long Island came from Southern New England sources in Connecticut or Rhode Island. More distant sources decrease in likelihood as follows: Massachusetts (Rank 3-4, 6-7), Staten Island, NY (Rank 5), New Hampshire (Rank 8), and Southeastern Pennsylvania (Rank 9).

The similar ranking of Western Connecticut and Rhode Island quarries raises questions such as what would have been the differences between transporting steatite vessels from these two source regions. Straight-line distance measures ignore the nuances of topography and the course of watershed corridors (Ward 1974), which would have been major transport cost factors leading from upland steatite outcrops to the mouth of the Connecticut River and Narragansett Bay (Figures 2.4). When an approximate path overlying watershed corridors (not straight-line distance) is calculated, both the Connecticut (115km) and Rhode Island series (126km) have similar distances to Eastern Long Island. Yet each directional path would have posed challenges to prehistoric peoples.

The crossing of the Long Island Sound from the Connecticut River mouth is a rather short distance from the terminus of Long Island's North Fork at Orient Point (15km), when compared to the distance to the same point from Narragansett Bay (72km). Could other environmental factors such as prevailing surface currents affect the transport cost of cross-sound trade? Eastern Long Island Sound and surrounding watersheds (e.g., Block Island Sound) have complicated surface currents. The narrow water body known as Plum Gut, which separates the tip of Long Island (Orient Point) from Plum Island, is well-known for erratic surface currents that make travel between these landforms difficult. These currents, which are oriented around buried moraine sediments, do not flow in linear patterns, but rather in vortices (Signell et al., n.d.). Prehistoric peoples transporting steatite vessels across the Long Island Sound would have had to traverse areas like Plum Gut to reach Eastern Long Island; and so whether groups were traveling from the Connecticut River mouth or Narragansett Bay, each would have had to learn to cope with these erratic current patterns.

Other external factors affecting the exchange of steatite vessels in the Long Island Sound watershed could have been seasonal wind patterns, or the occasional presence of winter ice blocking access to portions of the Long Island coastline. Without direct experimentation at different times of the year, it is impossible to argue what effect environmental variables such as surface currents and wind patterns would have had on canoe-based water-borne transport between the two regions. These are important considerations for comparing different models of steatite transport in the Long Island Sound Watershed.

What local resources could have been exported in exchange for steatite bowls? No classes of artifacts recovered on Long Island archaeological sites are considered endemic, nor are there many raw materials available that could not have been found elsewhere in Southern New England. As a result, it is difficult to identify any specific resource(s) or tool technology for export from Long Island. One previously unconsidered possibility is that prepared cores of quartz were suitable commodities for inter-regional exchange.

Quartz, the ubiquitous lithic material utilized for flaked stone tools found on Long Island, is the only raw material available on the outer coastal plain that occurs in near inexhaustible quantities (Bernstein 2006, Bernstein and Lenardi 2008). Quartz is also relatively abundant on sites throughout the narrow coastal plain of Connecticut, Rhode Island, and Southeastern Massachusetts (Lavin 1988). North and west of the coastal plain, however, this is not the case. Quartz veins in the uplands of New England and Central New York State are highly localized, and cobbles of adequate size and semi-elastic quality are difficult to locate (Boudreau 1981: 24-25, Gramly 1981: 90).

Archaeological sites on Eastern Long Island, including the Skunk Lane site (Figure 2.4), often contain numerous prepared cores of quartz (Figure 6.1). In addition, dense caches of these artifacts have been encountered periodically on the North Fork of Long Island (Latham 1978: 86). Locally these artifacts are referred to as “turtleback” cores, due to the removal of cortex from a single face of the cobble to reduce excess weight prior to transport. These unifacial core types were a major innovation in systematizing the process of quartz tool manufacture, and have a remarkable level of standardization of size and quality (Bernstein and Lenardi 2008).

Archaeologists in New England typically underrate quartz as a low-quality lithic material (Gramly 1981: 86), and presume that prehistoric groups would only utilize quartz if no other material were available. As a result of this assumption, the procurement of quartz cobbles on Long Island has only been examined with intra-regional models of transport (Bernstein et al. 1996b). The uneven distribution of quartz cobbles in the uplands of New England, aside from localized glacial outwash and moraine deposits (Ritchie 1981: 102), suggests that the latter model of exclusively intra-regional transport of quartz cores may require revision. A *Cores For Vessels* model of exchange (Figure 6.2) proposes groups living in the uplands of New England could have relied on prepared unifacial cores as reliable sources for knappable quartz, while providing coastal groups on Long Island with finished steatite vessels.

The vast coastal and terrestrial resources available to prehistoric groups living on Long Island (Nixon 2004, Tveskov 1997), suggest that floral or faunal materials may have also been abundant enough to serves as reliable exchange commodities to acquire steatite vessels. Locally obtained littoral (e.g., shellfish) and marine (e.g., fish, sea mammals) resources of Long Island, if processed adequately, could have provided an adequate surplus of organic exchange commodities. New England groups situated close to quarried outcrops could have equally relied on this *Lithics For Organics* exchange model in a similar transport pattern delineated in Figure 6.2, in which steatite resources could be utilized as a tradable commodity for obtaining organic food stores and other raw materials.

A prime example of this *Lithics For Organics* model of steatite exchange comes from the Terminal Archaic Poverty Point Site in Northeastern Louisiana (Gibson 1996, Smith 1976). Poverty Point (Figure 2.1), located far to the west of Appalachian source areas (≈495km) in Georgia and Alabama, retains the highest recovery of steatite vessels in all of Eastern North America, currently numbering over 6,000 vessels (Truncer 2004b, Webb 1944). Poverty Point was virtually devoid of local lithic resources of any kind, yet it was situated in a highly productive riverine environment of the Lower Mississippi River Valley; and it is argued that groups living in and around Poverty Point were able to facilitate the acquisition of steatite vessels by exporting organic commodities (Gibson 1996). The *Lithics For Organics* versus the *Cores For Vessels* model, could both explain the high frequency of steatite vessels in regions located at great distances to quarries.

Several regions like Louisiana that are outliers to the Talc Belt (e.g., Coastal New York, Florida, Ohio), have conspicuously high steatite artifact recoveries relative to areas in closer proximity to quarried outcrops (Hubbard 2006, Truncer 2004b). The material evidence for this trend of *increasing vessel frequency with increasing distance to geological sources* is underscored locally by the fact that New York has a higher frequency of steatite artifacts recovered than any of the states containing prehistoric stone bowl quarries included in the present study. Suffolk County alone, which comprises all of Eastern Long Island, contains the highest density of steatite artifacts recovered from any county in New York State (Truncer 2004b: 30). All of which implies that there was a strong incentive in coastal Southern New England, and throughout Eastern North America, to import and export these exotic commodities over long distances (Gibson 1996, Klein 1997).

These hypothesized steatite exchange networks were not simply a technological diffusion of new methods for food processing. Clearly, there was a widespread social demand as well as an economic demand for these stone containers. Otherwise, their role in both habitation sites and burial practices of the Terminal Archaic would not have been so prominent. The Susquehanna Burial Complexes of Eastern Massachusetts (Dincauze 1968, Robbins 1963, 1980, Swigart 1974, Taylor 2006, Winter 2006) and the Orient Burial Complexes of coastal Southern New England (Ritchie 1959, 1969, Simmons 1970) are often defined as discrete from preceding Late Archaic traditions, due to the ubiquity of steatite vessels.

The social context of these dynamic exchange networks lends more insight into steatite's unique procurement-transport strategies. For places like Southern California, archaeological and ethnographic data suggest indigenous groups with local steatite sources instead tended to acquire finished vessels from more distant geographic sources (Elliot 1980, Tupa 2009). In Southern New England, Waller's (2006) WDXRF study revealed that steatite artifacts found in close proximity to quarries in Rhode Island, were actually derived from sources in Northwestern Connecticut. Versaggi and Knapp's (2000) INAA analysis of steatite from Central New York State also demonstrated that the nearest available sources were not represented (i.e., Southeastern Pennsylvania), and that more distant quarries in Maryland were the likely source area.

What could account for this pattern? Why would groups ignore local sources to acquire the same material from a greater distance? A sourcing project conducted by Whitaker et al. (2008) provides one possible explanation. Whitaker et al. (2008) used Laser-Ablation ICP-MS to compare obsidian distribution patterns in California with linguistic data; and demonstrates that obsidian exchange systems were operated exclusively within discrete linguistic boundaries, at the expense of ignoring locally available obsidian sources. Linguistic boundaries are near impossible to trace back into prehistory, and so it would be misleading to make similar comparisons in Southern New England, but socially defined variables like these must be further considered to better understand these anomalous patterns.

This suggests that counterintuitive exchange patterns for objects like steatite vessels may actually be the rule and not the exception. But what other factors could be responsible for this unexpected trend? Based on ethnographic parallels derived from the Eastern Shoshone of Wyoming, these seeming anomalies could be derived from gender-based inheritance practices. For example, Adams (2006: 535) notes among the Eastern Shoshone, informants have told ethnographers that steatite vessels were strictly familial property, heirlooms, which were not ever traded between or within groups. More specifically, the daughters of a family inherited stone vessels, and only in the absence of daughters would a son acquire one (ibid.). Morrison (1991) also showed that the historic Copper Inuit similarly retained the use of steatite vessels as non-traded heirloom items, long after the active exchange for those objects had ceased. Behaviors such as these may reflect an identity issue, and could explain why sherds from broken vessels continue to surface on sites well after the use of clay pots became ubiquitous.

These varying ethnographic examples suggest dyadic networks of prehistoric exchange were only one means by which to acquire steatite vessels in Southern New England. An alternative hypothesis is that the entire process of steatite acquisition and vessel manufacture was carried out by each individual cultural group (Wholey 2011b). Witthoft (1953) suggested this early on for distribution patterns observed in the Susquehanna River Valley. Based on the general lack of steatite-bearing habitation sites near the Pennsylvania quarries, he argues the "people who quarried the soapstone did not live here, but only stayed long enough to dig out and shape up the soapstone…" (ibid: 14). A procurement strategy such as this would potentially account for more intra-familial distribution patterns of steatite vessels.

Past interpretations of these inferred trading systems may be too simplistic, and the emphasis on using modern economic concepts and terminology to explain the nature of material exchange has hindered the development of alternative models (Brose 1990). Based on the ethnographic analogies for steatite vessel exchange in North America, one could argue that the geographic trajectory of steatite vessels in the Long Island Sound Watershed reflects individual transport of inherited goods or heirlooms. As prehistoric peoples in Southern New England would have integrated through inter-marriage, steatite vessels may have then traveled with the individual owner of each vessel. Therefore, the distribution of finished steatite bowls may have no association with inter-regional economic exchange of exotic commodities, but instead are archaeological signatures of familial movements and integration over time.

Wholey (2011b: 119) proposed a similar steatite exchange model for the Susquehanna watershed, arguing that prehistoric peoples "may have been in involved in entrepreneurial activities that involved targeted direct access procurement rather than in a down-the line system involving limited interactions and territorial object hoarding." Given the recorded context of steatite vessels in elaborate burial features, and their presumed role in conspicuous consumption events (Taché and Hart 2013), it could be suggested that steatite acquisition was part of a larger ceremonial or economically driven pilgrimage, incorporating long distance travel to quarry locations. However it is difficult to do anything but develop multiple working hypotheses about these complex prehistoric patterns for indigenous steatite vessel procurement and trade in Eastern North America.

Pipestone quarries in the Proto-Historic Period of the Midwestern United States (Figure 2.1) provide an additional ethnographic analogy to Wholey's (2011b) targeted direct-access hypothesis in that the locations for acquiring the highly sought after raw material for pipe production were considered neutral territorial zones, accessible to groups from distant regions. For example, a Catlinite (i.e., Pipestone) quarry in Wisconsin was historically observed to be "a place of asylum where even enemies mingled" (Springer 1981: 221). The anthropological implications of this type of historic phenomenon show that the importance of acquiring ceremonial or prestige-based items made from rare lithic materials (Emerson et al. 2013, Hayden 1998), may have transcended inter-group conflicts and territorial boundaries.

The latter possibility is plausible, but from a purely economic standpoint unlikely to be a viable procurement strategy for steatite vessels in Southern New England. Especially because protection and controlled access to regionally demanded lithic resources directly increases the economic returns on establishing and maintaining strict territorial boundaries (Alvard 1998). The actual (or perceived) scarcity of rare lithic resources like steatite often correlates to their inflated values (Andrefsky 1994). Groups with steatite outcrops within their territory would benefit from protecting those resources or the routes to those resources (i.e., watershed corridors), and actively managing their exchange networks.

Hypotheses about the dynamics of prehistoric steatite procurement and exchange in the Long Island Sound watershed can only be tested through the analysis of economic, geographic, and geological variables. The results of sourcing research endeavors are one of the only methods to model what geographic locations were involved in this process, and the extent to which certain quarries were the beneficiaries of exchange with groups on Long Island. The most plausible scenarios for steatite vessel procurement involved the dyadic (Braswell and Glascock 2002), or down-the-line (Wholey 2011b) exchange of locally available materials (e.g., *cores for vessels, lithics for organics*) between relatively equal groups (e.g., groups with items of value for trade) and individuals from Long Island and New England.

This economic perspective is supported by the fact that during the Late Archaic Period in Eastern North America, and possibly even earlier, established territorial ranges had already been delineated (Bernstein 2006, Bourque 2008, Sassaman 1996). If this regional model is accurate, than the acquisition of steatite likely required the reciprocal solicitation of primary manufacturers, and/or the secondary gateway communities (Hirth 1978), situated along the mouths of major watersheds that flow into the Long Island Sound (e.g., Housatonic River, Connecticut River). As previously discussed, the Long Island Sound would have provided an unrestricted conduit for access to hundreds of miles of coastline and facilitated interaction between a myriad of territorially distinct communities.

Several lithic material types recovered from Long Island archaeological sites were potentially procured through similar external outlets; argillite from New Jersey; yellow jasper from New Jersey, Pennsylvania, or Staten Island, NY; siliceous cherts from the Hudson River Valley; and rhyolites from Southern New England or Pennsylvania (Nadeau 2006). It has been recently documented that most of these lithic types could have been just as easily found in till exposures, moraines, and cobble strewn beaches that are characteristic of Long Island's glacial topography (Keegan 2013). Still the frequency of non-quartz lithic artifacts within Long Island site assemblages rarely exceeds 1%, with quartz comprising the remaining 99% of flaked stone tools and debitage (Bernstein and Lenardi 2008). Their consistently sparse recovery rate alludes to the overwhelming difficulty in determining whether non-quartz lithics were obtained locally or through some form of territorial exchange (Keegan 2013, Nadeau 2006). A similar application of sourcing techniques to these presumably exogenic lithic types would expand upon this hypothesis of material exchange across and along the coastal margins of the Long Island Sound.

For prehistoric Long Islanders, steatite vessel acquisition could have been at the very core of widespread regional interaction, especially during the Terminal Archaic. Steatite was the one raw material that unequivocally held both domestic and religious significance in the region (Hoffman 1998). The predominance of steatite vessels occurring within Susquehanna and Orient Phase burial complexes also reflects an inexplicable association of steatite with the interment of the deceased (Ritchie 1969, Swigart 1974). The increase in burial ceremonialism in the Late Archaic and tapering off by the Middle Woodland period is documented throughout Southern New England (Dincauze 1968, Ritchie 1969). The decrease in elaborate burial features on Long Island after the Terminal Archaic Period (2,500 B.P.) also seems to directly coincide with the decrease in the frequency of steatite vessel utilization. The extent to which evolving cultural belief systems, resource depletion, innovative new vessel technologies, or economic shifts in procurement strategies were responsible for this decrease in steatite exchange is still nearly impossible to determine from current evidence.

The preliminary recognition of patterning derived through the results of source characterization is the only viable method by which regional exchange and social interaction models can be evaluated and tested. So far, the data that have been obtained through EDXRF analyses does not appear to challenge distance decay models. The region with the second lowest distance to source rank noted in Table 6.1, Western Rhode Island (i.e., Oaklawn, Ochee Springs), was found to be the closest match for the Long Island artifacts.

Conclusion

As is often the case for archaeometric research endeavors, the results from the present study are compelling, yet inherently limited by statistical issues of sample sizes, the number of elements that could be reliably detected, and the time available for analyses. Therefore all interpretations and conclusions drawn are invariably preliminary, and will require the further analysis of both geological source area specimens and artifacts from throughout Southern New England. Nonetheless, it was concluded that transition metals Cr and Ni are the most reliable tracer elements at the $p < .001$ level for discriminating between quarries and for making source determinations of steatite artifacts.

The author's EDXRF analyses of all 103 steatite samples with a Bruker Tracer III-V, Dr. Bruce Bailey's EDXRF assay of two samples from Harwinton (CT) and Oaklawn (RI), and Dr. Troy Rasbury's

S-XRF analysis of two samples from Nepaug-Bakerville (CT) and Ochee Springs (RI) at the National Synchrotron Light Source each independently verified that spectra peaks for Cr and Ni revealed the greatest quantitative differences between source areas. That these elements consistently occurred as prominent spectra peaks within all samples is reason alone to incorporate them into more detailed analyses. What is of utmost importance is that Cr and Ni were shown to be discriminating variables between three different XRF-based source characterization devices, and that these results were independently verified among three different laboratory settings. All of this indicates that the use of these tracer elements for future sourcing of steatite produces both reliable and replicable data.

The author's original hypothesis was not supported by the geochemical data. As it could not be concluded with confidence that the source of steatite vessels from Long Island, New York were derived from quarries situated along the Connecticut River watershed (Rank 1). The null hypothesis, that all of the quarries sampled would be equally distributed among the artifact sourcing results, is also rejected. Instead it appears that the Rhode Island quarry series (Oaklawn, Ochee Springs), which occur within the Narragansett Bay watershed (Rank 2), was the likely source for all the artifacts assayed by the author with EDXRF (Figures 5.1-5.7).

Overall the bodies of data obtained through EDXRF source characterization for this thesis project have the potential to provide a solid baseline for future analyses. In addition, the background research conducted for this thesis has revealed the geological context of steatite quarries, as well as a better understanding of the anomalous patterns of steatite quarry distribution. The direct experimentation on samples collected from geological source areas and archaeological sites on Long Island, suggests that the artifact samples subject to EDXRF assays were well within the 90% confidence interval with the two steatite quarries analyzed from Rhode Island. Therefore, an archaeometric study of this scope has the potential to not only propose models of steatite exchange based on source-determinations for steatite artifacts, but also to address several related inquiries that draw from the original research questions:

1. Was there a single, primary source for steatite vessels found on Long Island?
2. Would each example be quarried from the least distance possible?
3. Is there any evidence that historically mined steatite deposits destroyed evidence of prehistoric vessel and smoking pipe industries?
4. How, if at all, does the source variation observed change over time?
5. Does the sourcing data provide any insight into the author's ancillary hypothesis concerning the prehistoric depletion of vessel-quality steatite deposits?

From these preliminary data, it can again be proposed that steatite vessels and smoking pipes transported to Eastern Long Island, New York came primarily from the two source areas in Rhode Island:

the Oaklawn and Ochee Springs quarries. The EDXRF results also determined that the sampled artifacts were not quarried from closer sources from the Connecticut River watershed (Table 6.1). While this does not outright refute distance decay models, it does correlate well to other steatite exchange systems in North America.

It also does not appear that any of the quarries included in the study that were known only for Historic Period mining by Euro-Americans (i.e., Francestown, Jenkins Hill, Petersham, Soapstone Mountain, Wissahickon) were geochemically represented in the artifact sample base. However, the EDXRF study only included seven artifact samples from Long Island. Therefore at this point it is still impossible to estimate the impact of historic mining on the known distribution of quarry areas.

Given that the artifact samples from Long Island were recovered from sites with radiometric dates for both the Terminal Archaic (Orient #1&2) and Woodland Periods (Skunk Lane, MPM Farm), it does not appear that the source variation changed over time. If the source region of Rhode Island was consistent through time, as the results suggest, there would not appear to be any stress related to the prehistoric depletion of steatite sources, at least for those groups living on Long Island. It would be expected that source areas would shift drastically over time if available quarries were becoming scarce or depleted. This was not found in the data analyzed for this thesis. However, this explanation for the widespread abandonment of steatite vessel exchange after 2,500 B.P. is still a working hypothesis, and deserves future consideration as more evidence is gathered.

These are only a few of the variables that can be addressed by this type of interdisciplinary study; even more questions will naturally result from future sourcing experiments. The greater purpose of this study should not be understood as simply attempting to geochemically connect-the-dots on a hypothesized prehistoric landscape. Instead, the results should be treated as behaviorally significant data pertaining to a complex system of interregional communication, wherein steatite vessels may have served as the primary medium for the building of inter-group alliances, advancing the thermodynamic efficiency of cooking technology, and facilitating the ritualized component of elaborate interment activities.

Future considerations

It is expected that the results of the author's EDXRF study will be met with heavy skepticism based on samples sizes alone. Shackley (2002) and Hubbard (2006) have vehemently argued that the minimum sample size for sourcing experiments, of any lithic material type, should number in the 150-200 range to obtain statistically significant results. Nonetheless the replication of spectra patterning for Cr/Ni between three different XRF tests, lends credence to the interpretation of these data.

Therefore, it is the author's intention to bolster these preliminary results by performing additional statistical tests (i.e., cluster analyses, discriminant analyses), and conducting further analyses at the

Facility for Isotope Research and Student Training (FIRST) laboratory at Stony Brook University. Dr. Troy Rasbury, who performed the initial S-XRF analyses for this study at the National Synchrotron Light Source, has from the incipient stages of this research project been enthusiastic about the prospect of eventually analyzing steatite samples at the FIRST laboratory with Laser Ablation-Inductively Coupled-Mass Spectrometry (LA-ICP-MS) for more detailed trace elemental data, and with Thermal Ionization Mass Spectrometry (TIMS) to precisely measure the isotopic ratios within those elements. Ideally, these and other researchers' data could be incorporated as an addendum to the present study, and ultimately built upon to establish a reference or legacy database (Boulanger 2013) with which to compare more geochemically analyzed samples in the future.

Figures

Figure 1.1 Decorated Steatite Vessel from the Latham Collection (Oysterponds Historical Society), Orient # 2 Burial Complex.

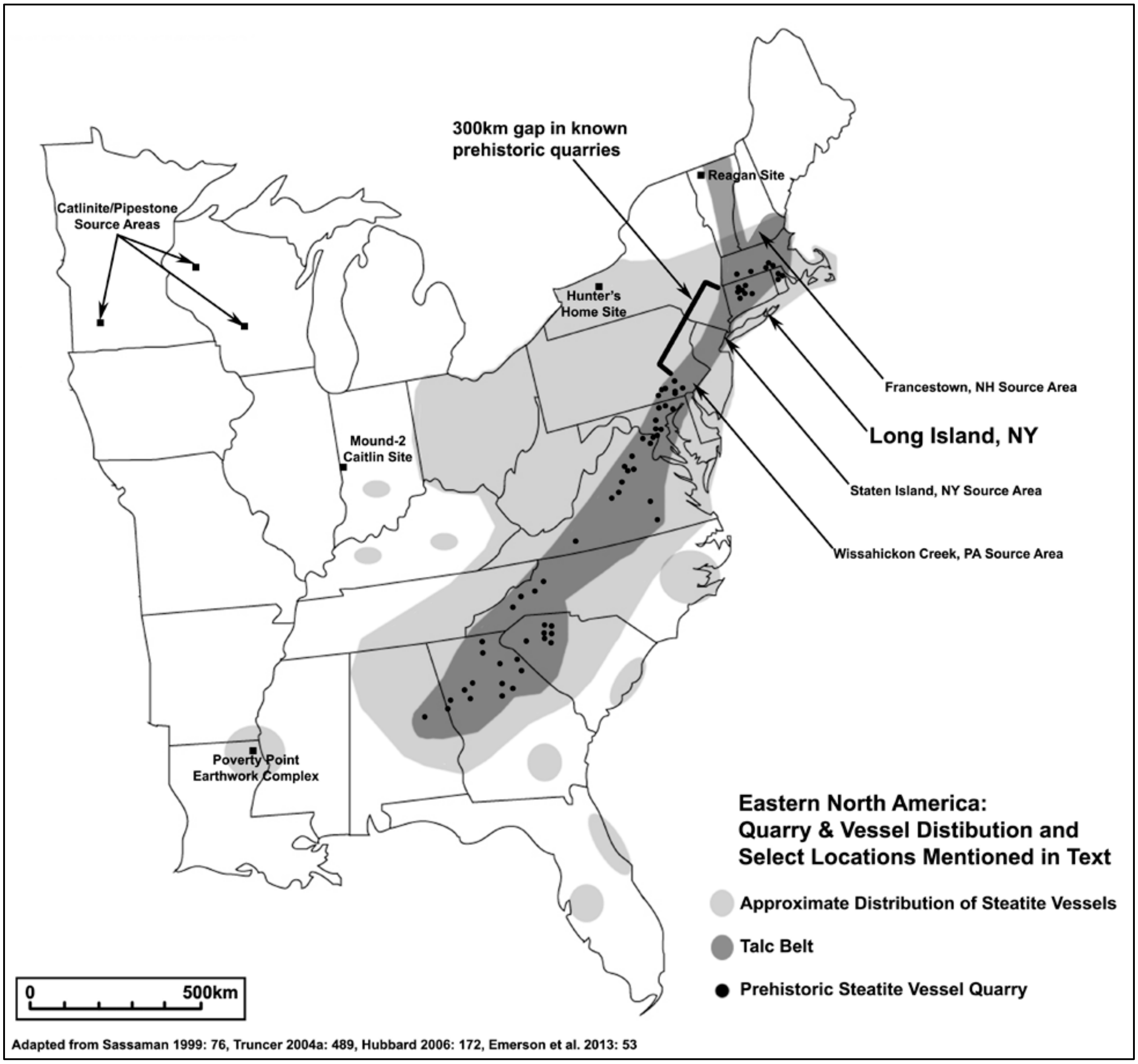

Figure 2.1 Eastern North America, archaeological sites and locations mentioned in text.

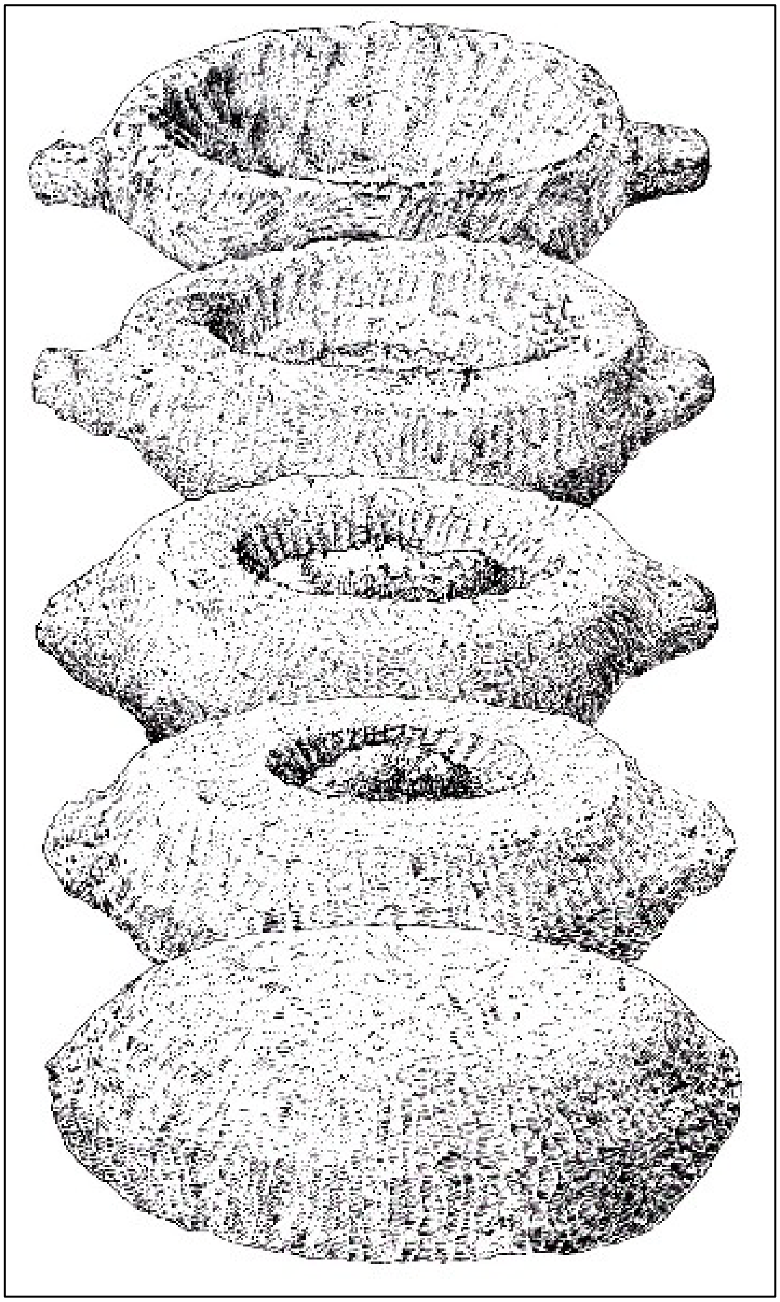

Figure 2.2 Holmes' reduction sequence of a steatite bowl blank (after Meltzer and Dunnell 1992: Plate LXXVII).

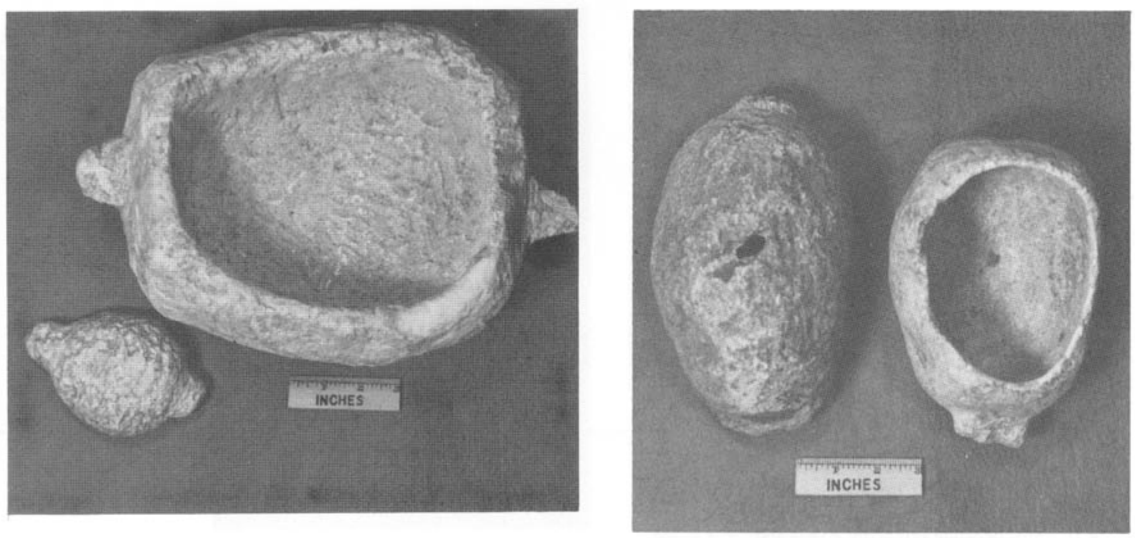

Plate 19 2 Susquehanna-related Soapstone Bowls

Plate 23 2 Orient-related Bowls

Figure 2.3 Inter-regional variation of vessel morphology in New England (after Swigart 1974: 19-20).

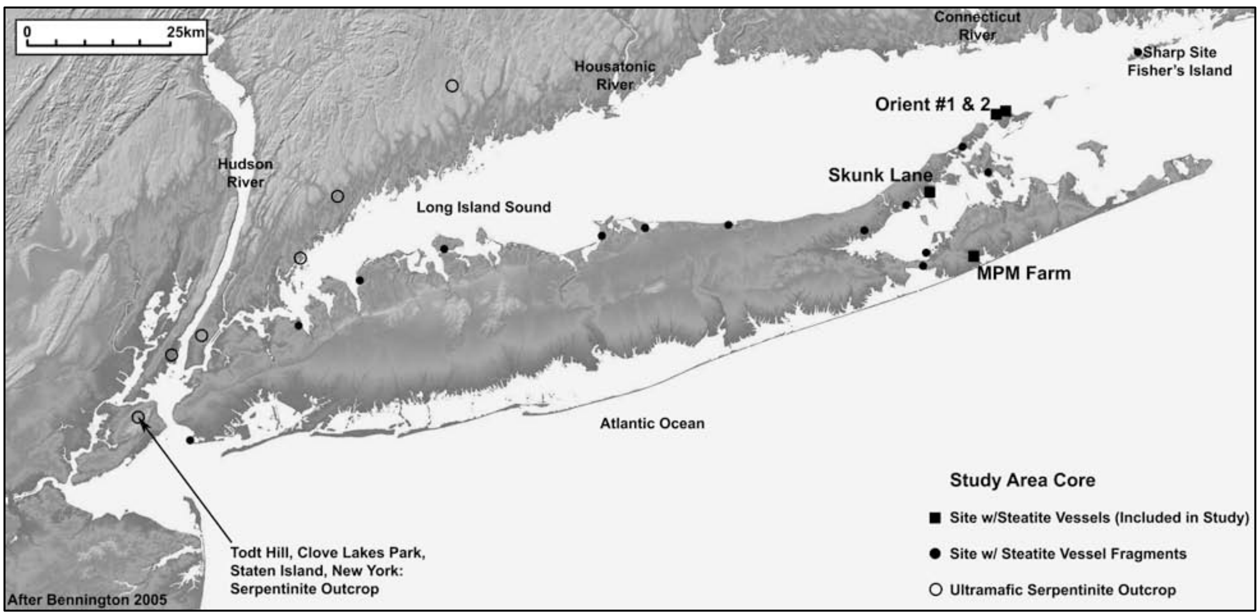

Figure 2.4 Study area core, archaeological sites, and locations mentioned in text (after Bennington 2005).

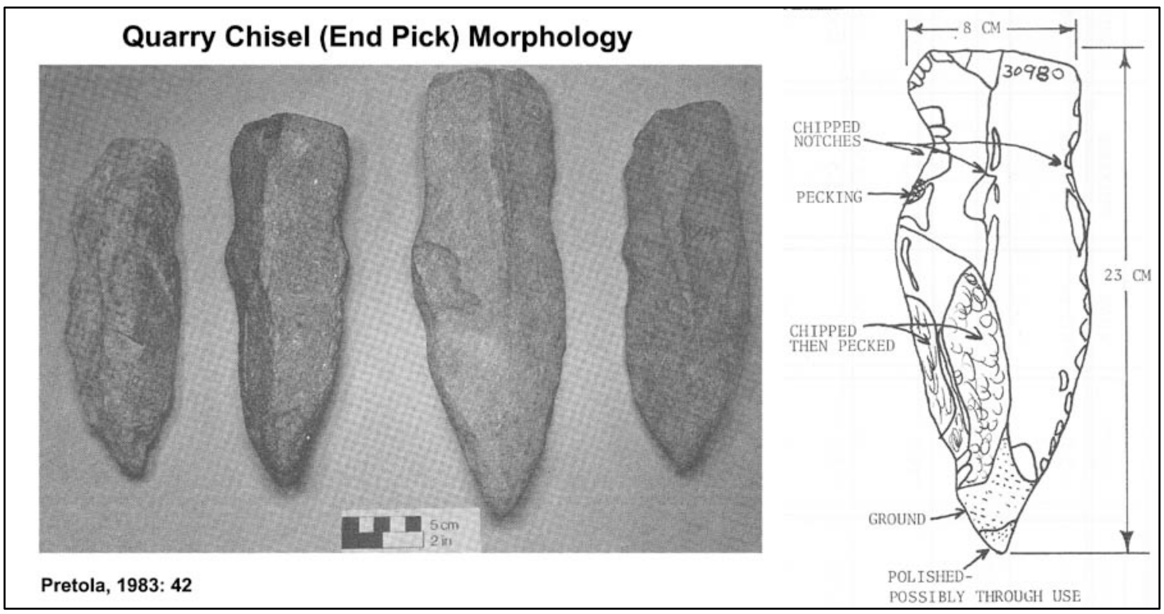

Figure 2.5 Steatite Quarry End Picks/Chisels.

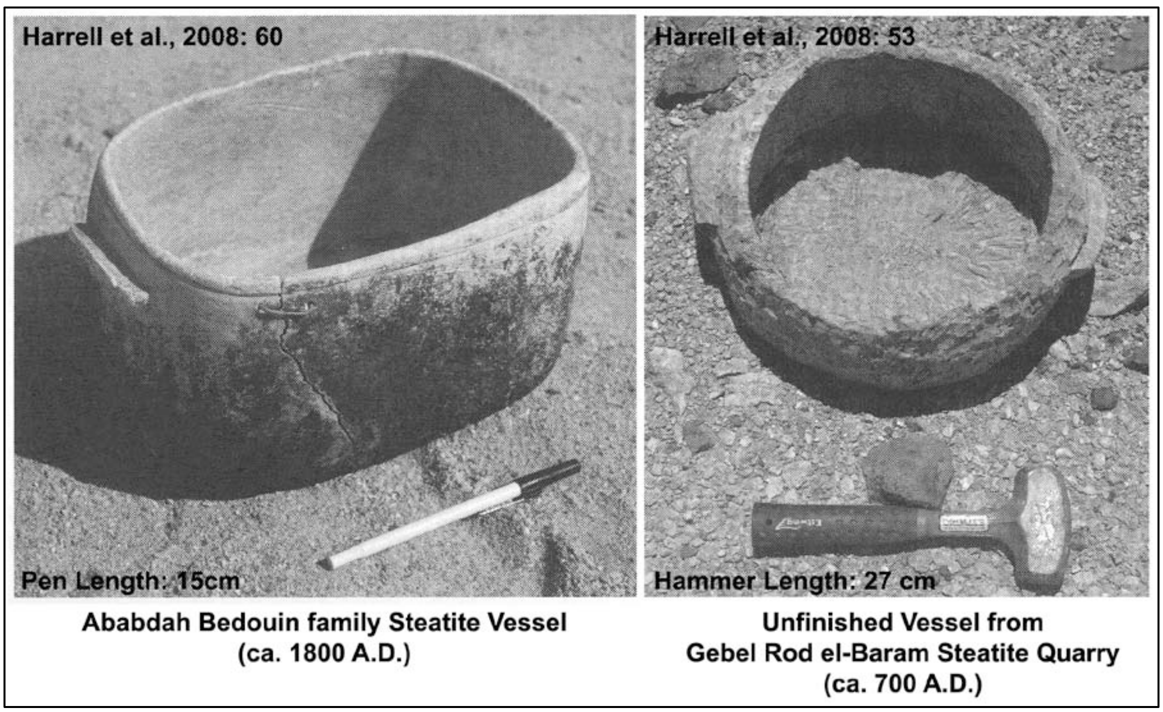

Figure 2.6 Middle-Eastern Steatite Vessel Morphology (after Harrell et al. 2008: 60).

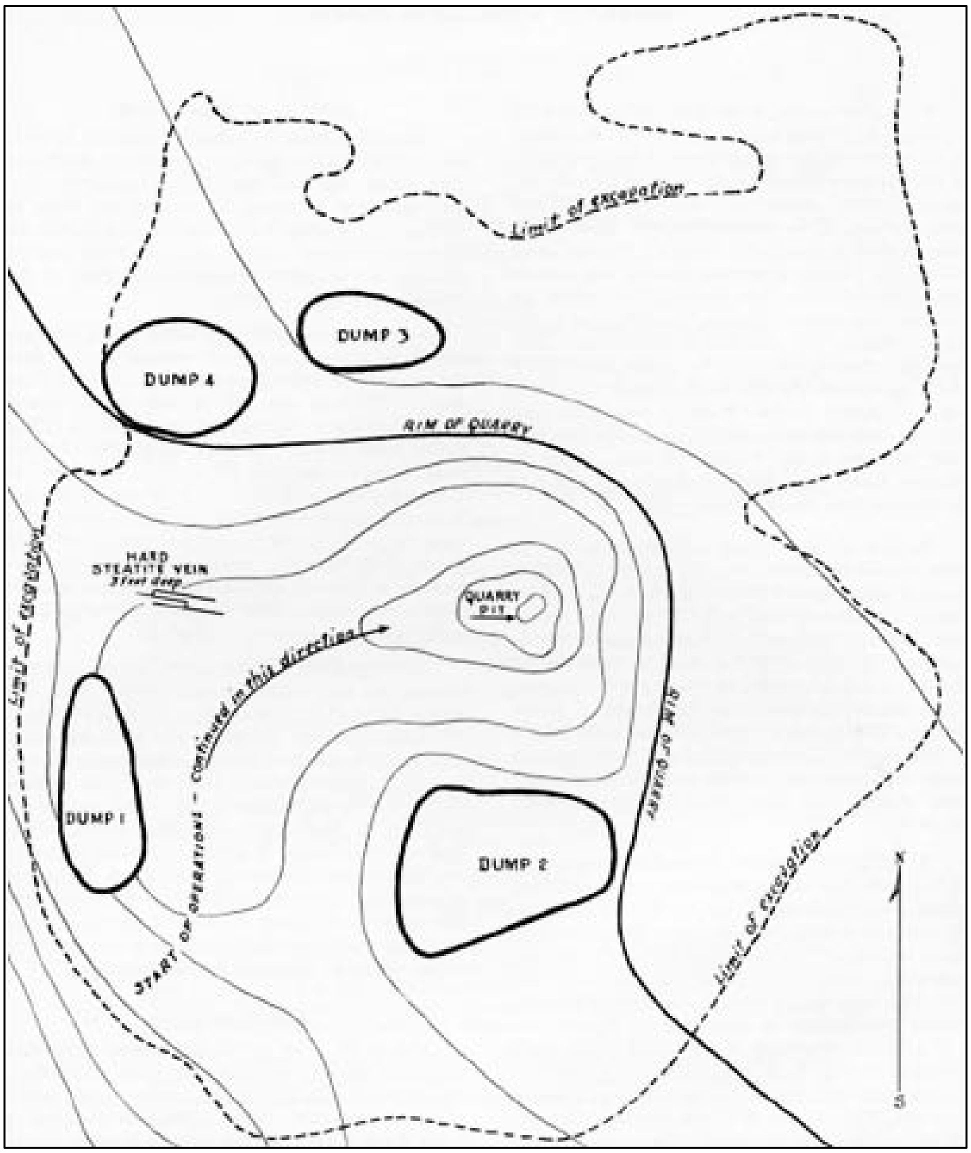

Figure 2.7 Quarry extraction pattern observed at the Bakerville-Nepaug Quarry (after Neshko 1970: 2).

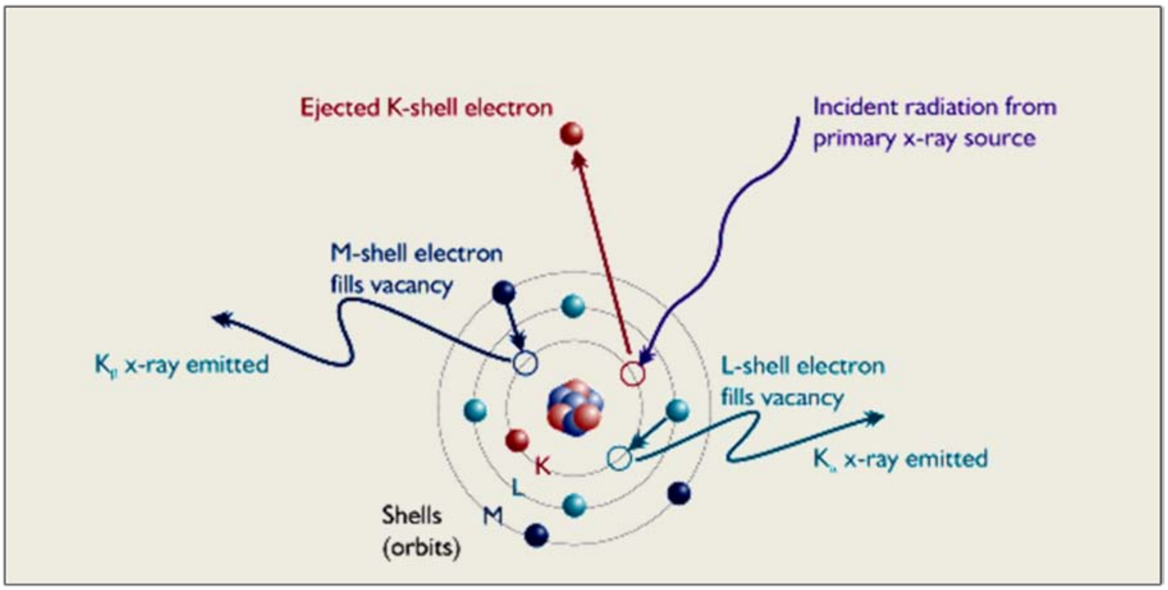

Figure 3.1 Schematic model of X-Ray Fluorescence of atoms (after Palmer n.d.).

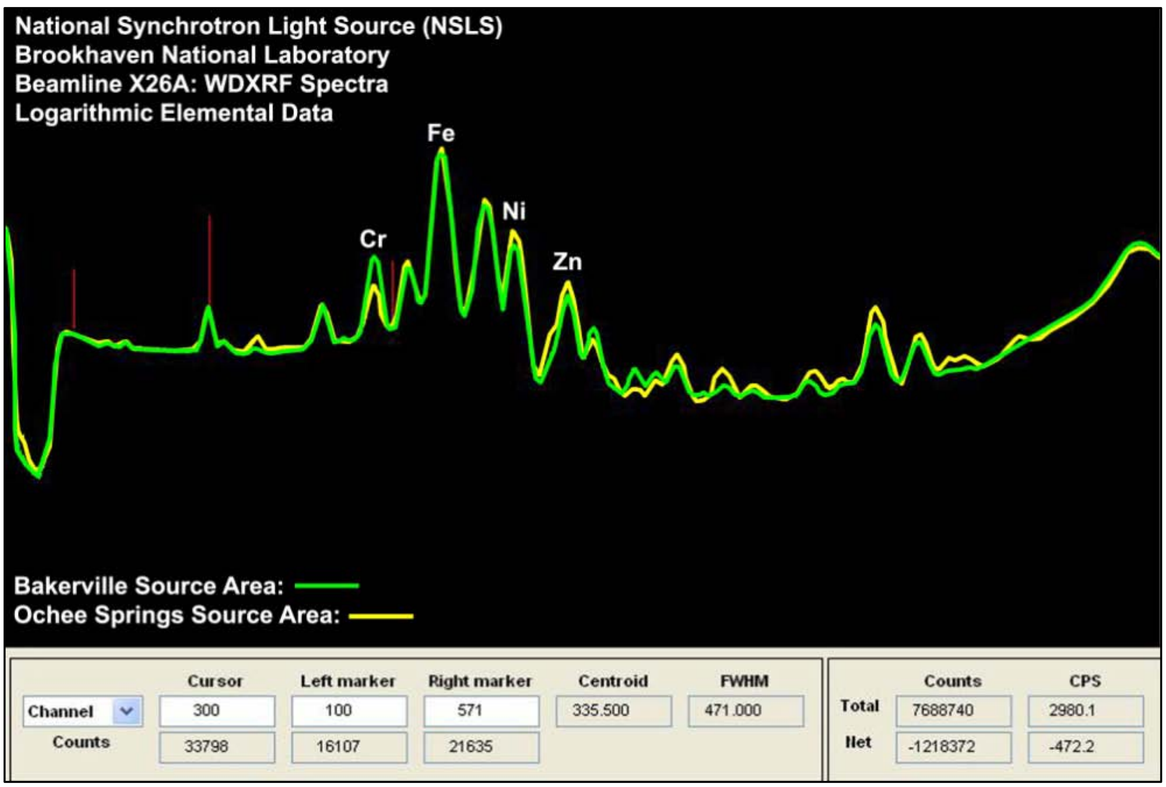

Figure 3.2 Synchrotron XRF (S-XRF) spectra generated for Nepaug-Bakerville and Ochee Springs Quarries.

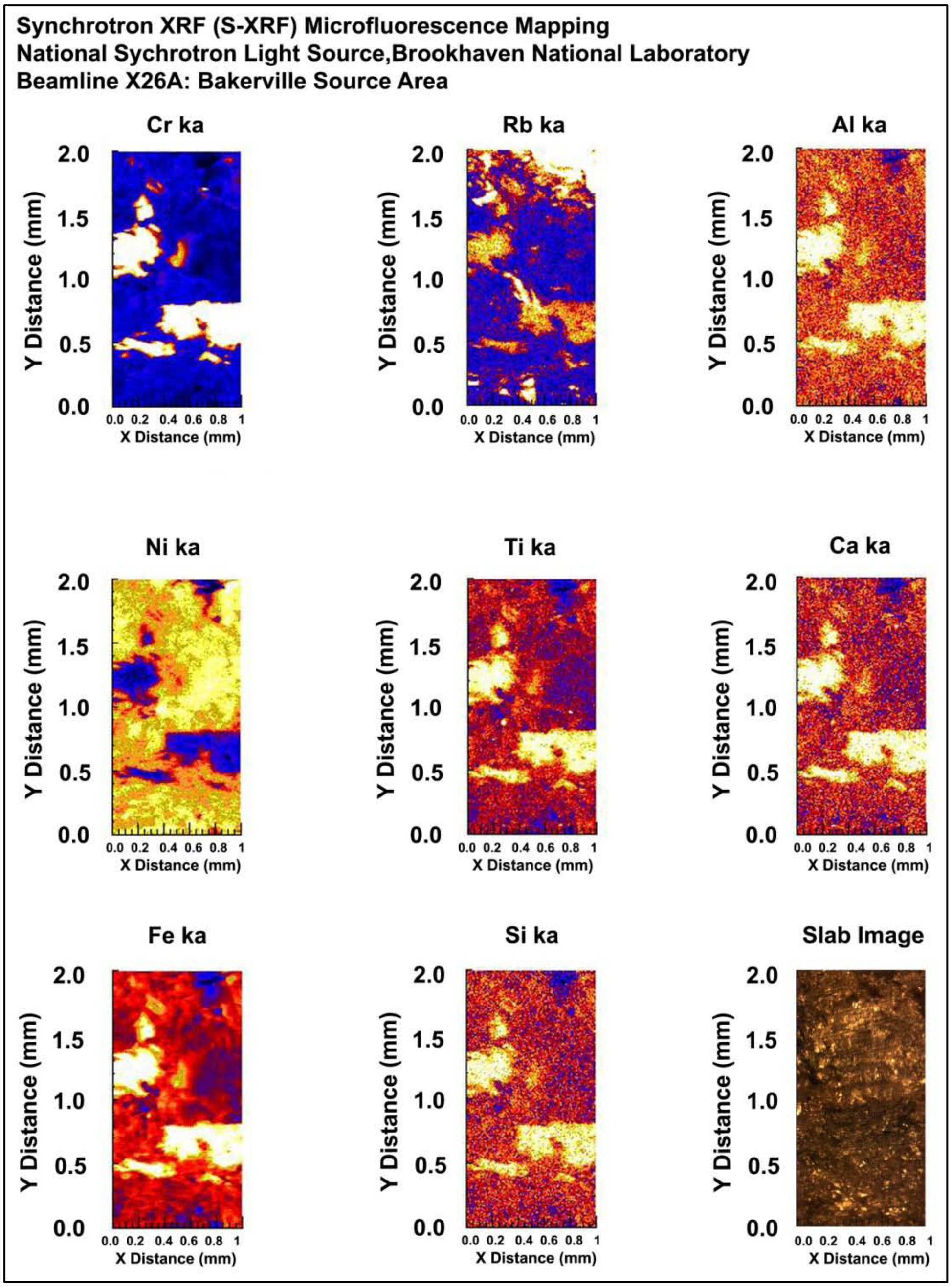

Figure 3.3 Microflourescence Mapping, Nepaug-Bakerville.

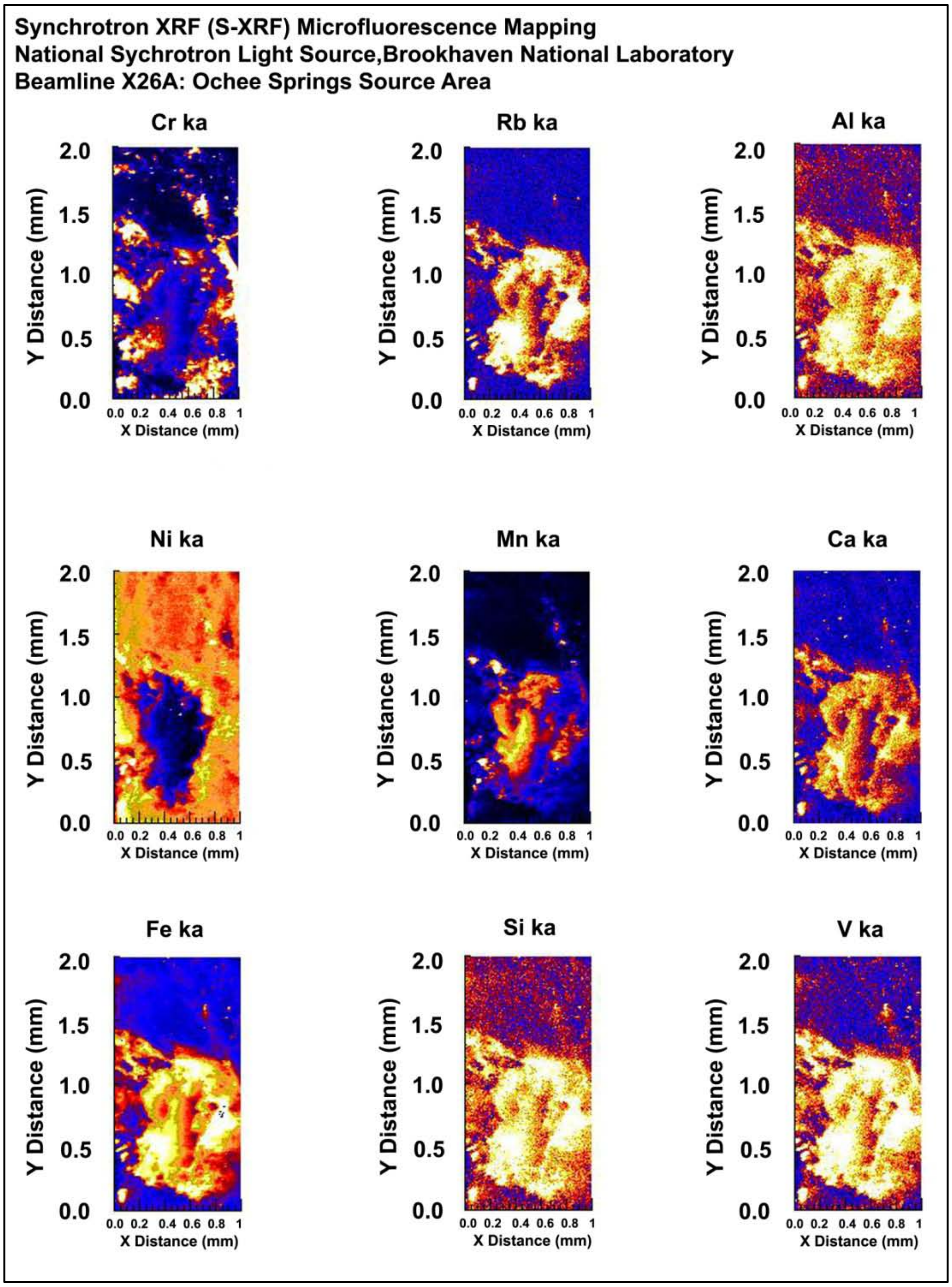

Figure 3.4 Microflourescence Mapping, Ochee Springs.

Figure 3.5 Bruker Tracer III-V with steatite vessel fragment from MPM Farm Site.

Figure 3.6 Uncalibrated EDXRF spectra generated by S1PXRF with the Bruker Tracer III-V unit, Skunk Lane site.

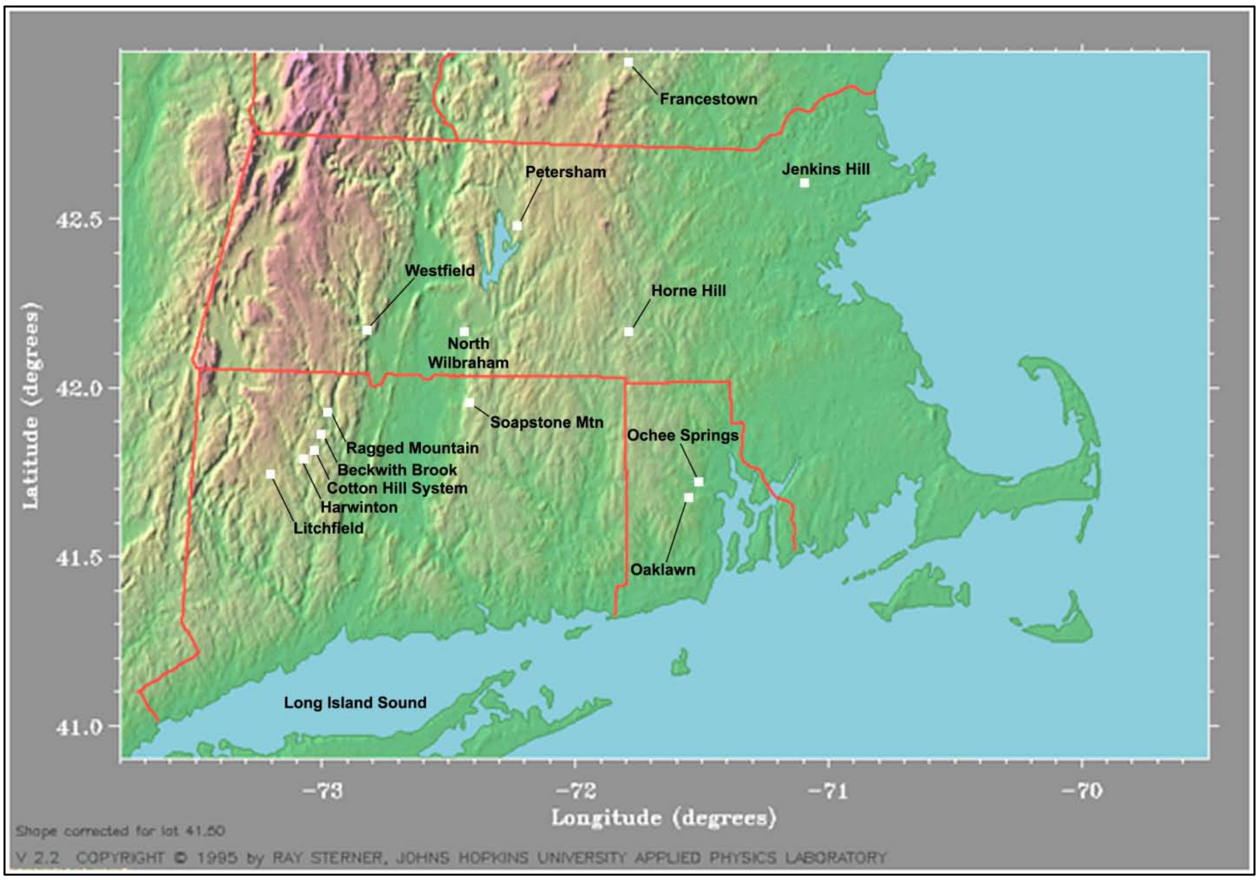

Figure 3.7 Prehistoric and historic steatite quarries of Southern New England sampled for EDXRF source characterization, only the Wissahickon Valley, PA source area is not shown (after Sterner 1995).

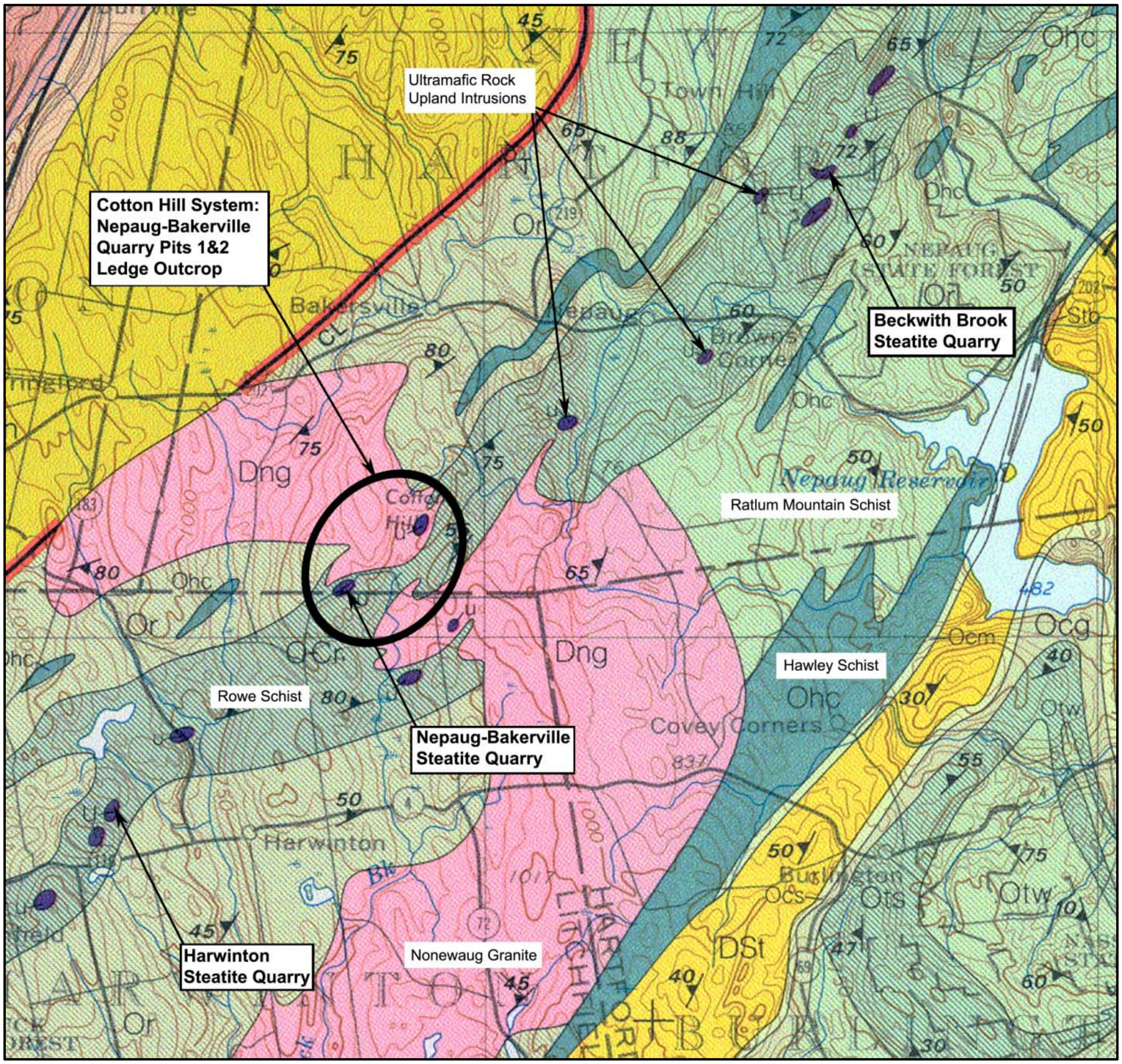

Figure 3.8 Harwinton Quarry (bottom left), Cotton Hill System (center left), and Beckwith Brook Quarry (top right), shown in geological context with associated bedrock units labeled (after Generalized Bedrock Map of Connecticut 1996, Torrington Quadrangle).

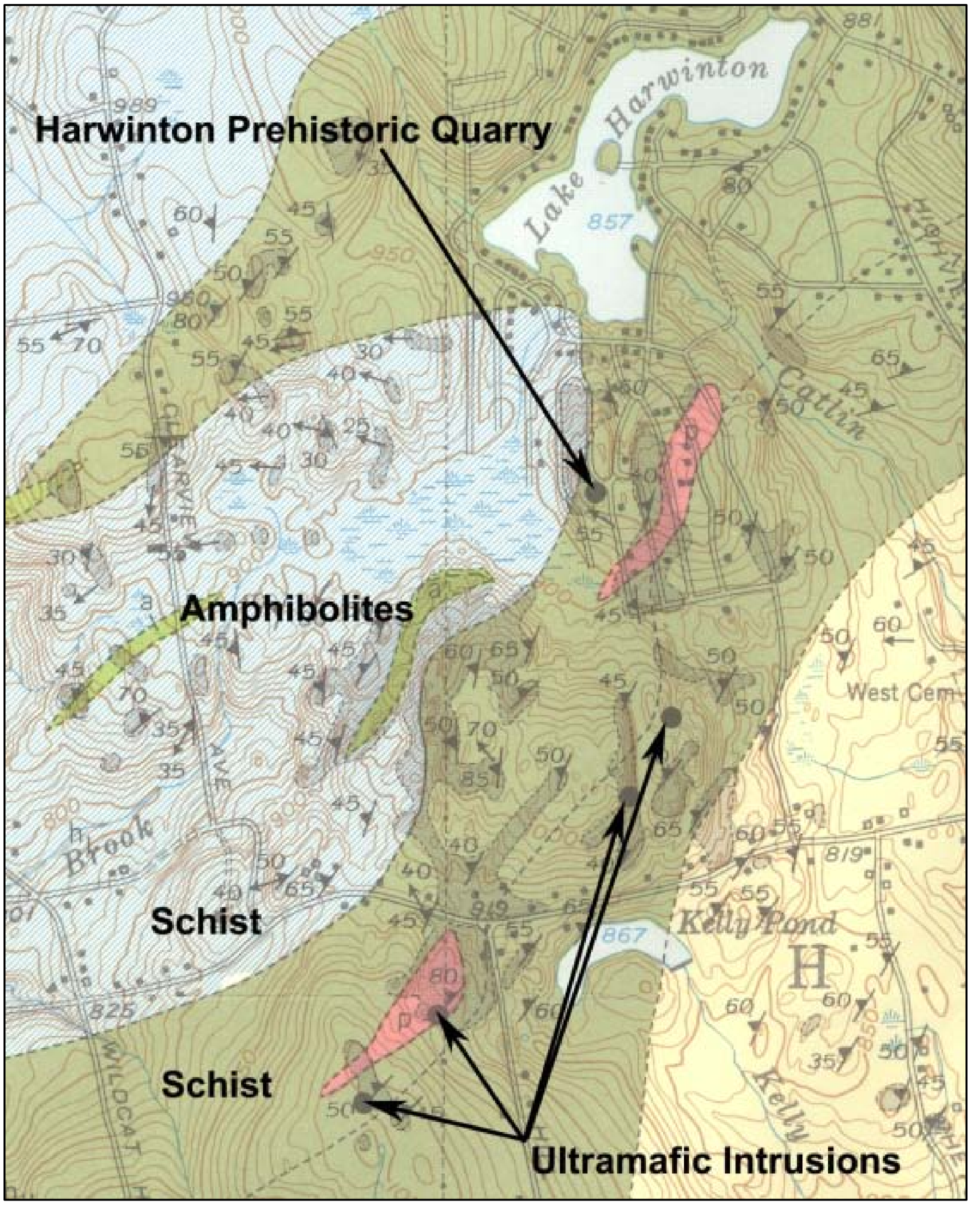

Figure 3.9 Harwinton Quarry (after Martin 1970, Geological Map, Torrington Quadrangle).

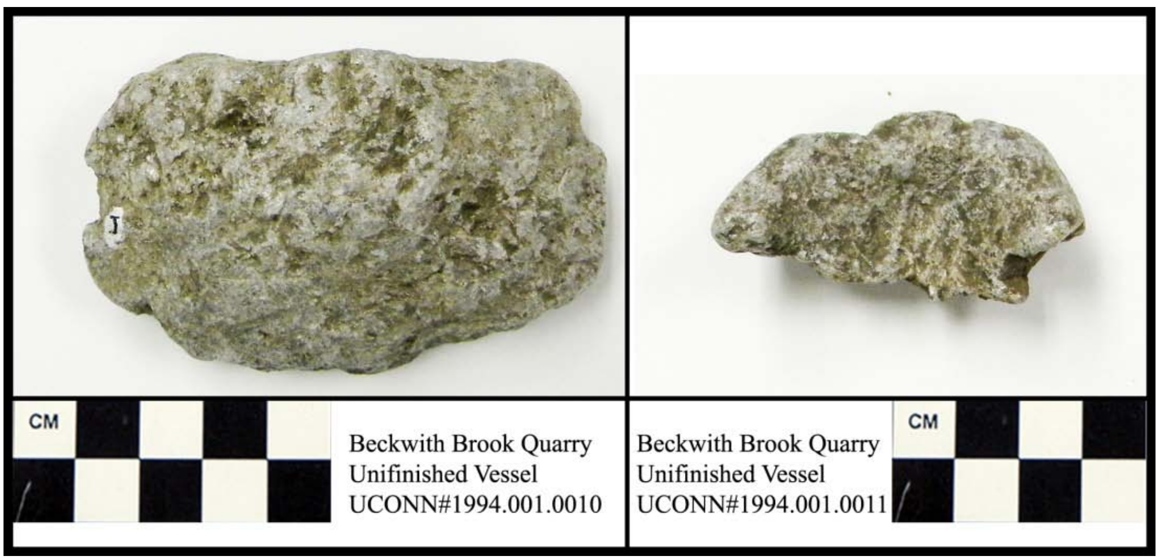

Figure 3.10 Steatite Bowl Fragments from Beckwith Brook Quarry.

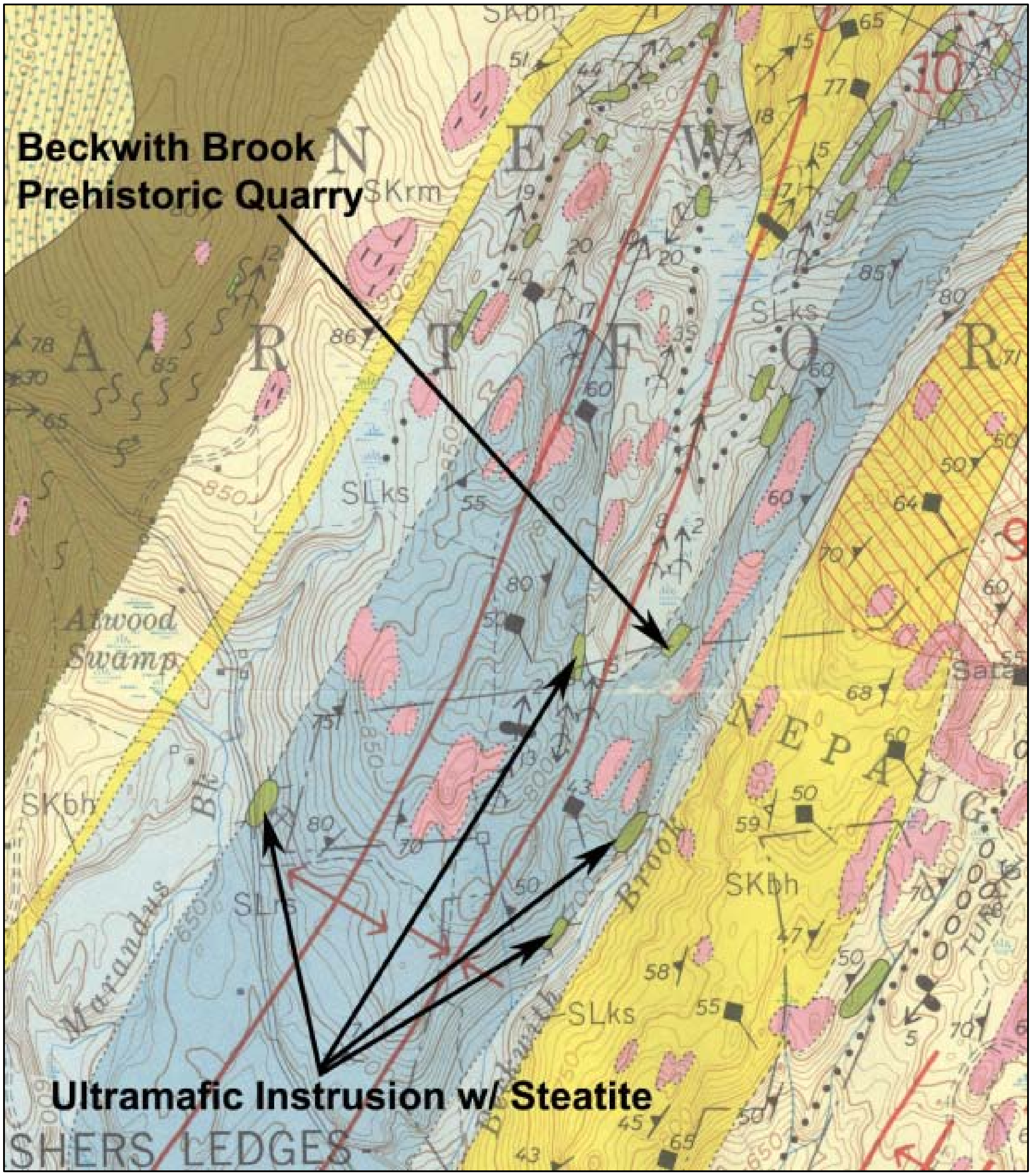

Figure 3.11 Beckwith Brook Quarry (Stanley 1964), Geological Map, Collinsville Quadrangle.

Figure 3.12 Serpentinite deposit (shown in dark green) from Staten Island, NY (after USGS-MROSD).

Figure 3.13 Steatite sample collected by the author from Wissahickon Creek Source Area.

Figure 3.14 In-situ, unfinished bowls (e.g., bosses) and craters from the Ochee Springs Quarry (Photographs by Waller 2006).

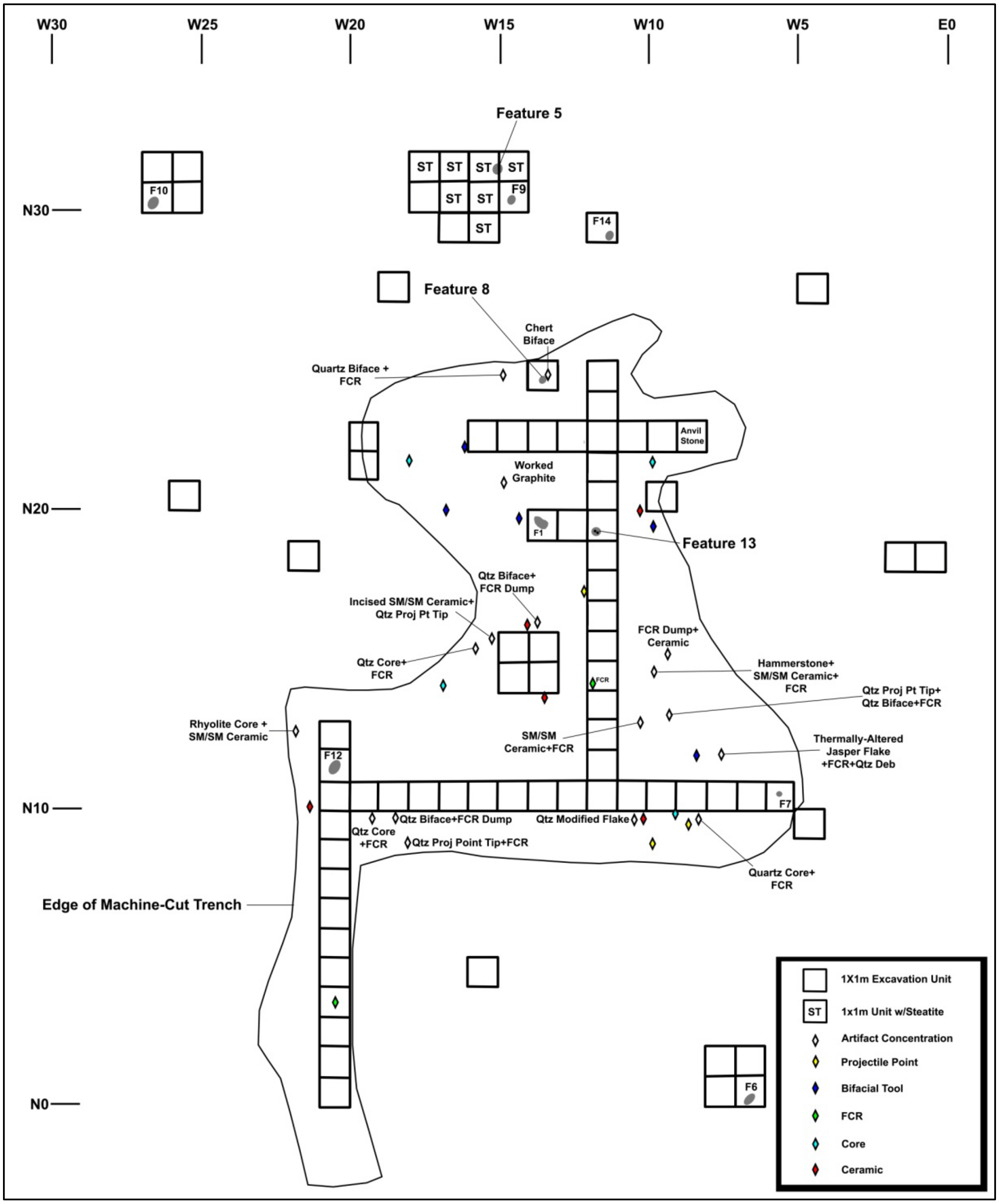

Figure 3.15 Skunk Lane Site excavations.

Figure 3.16 Steatite vessel rim (left) and body (right) fragments from the Skunk Lane Site.

Figure 3.17 Grit and Shell-Tempered Ceramics (top row) and Steatite (bottom row) from Locus A at the MPM Farm Site.

Figure 3.18 Flat-Bottomed Steatite Vessel from the Latham Collection (Oysterponds Historical Society), Orient #1/2 Burial Complex.

Figure 3.19 Rim Fragment of Steatite Vessel from the Latham Collection (Oysterponds Historical Society), Orient #1/2 Burial Complex.

Figure 3.20 Steatite Smoking Pipes, Latham Collection, Oysterponds Historical Society.

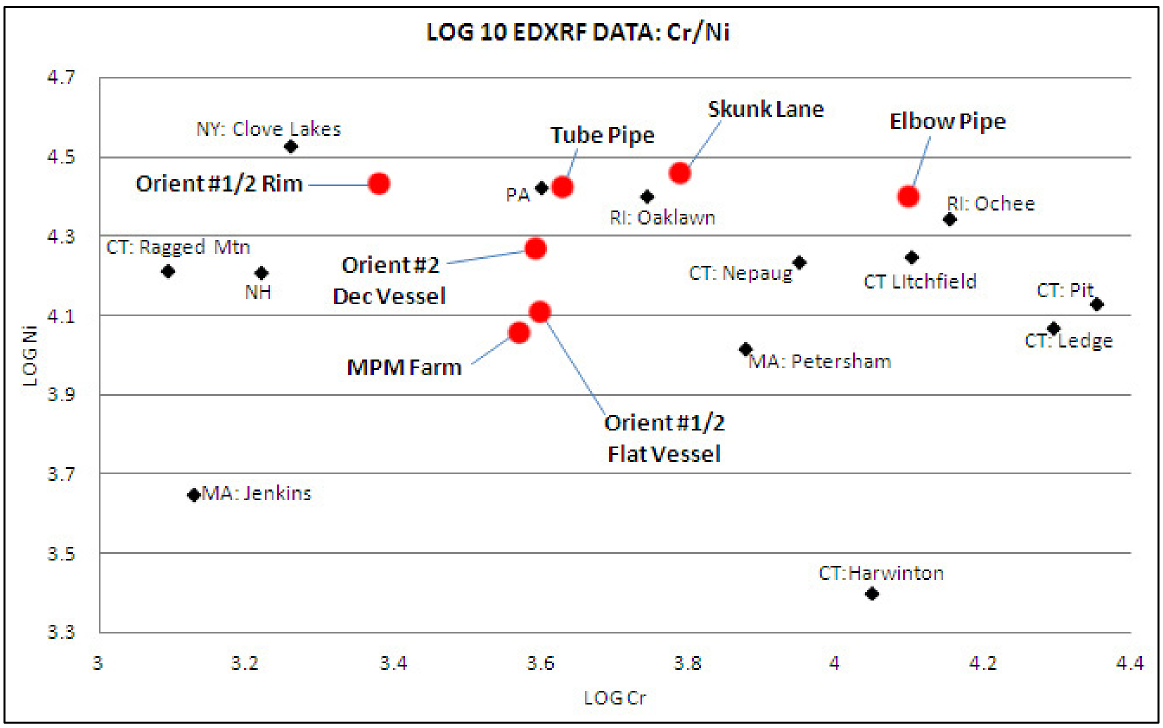

Figure 5.1 Log10 EDXRF biplot for Cr/Ni

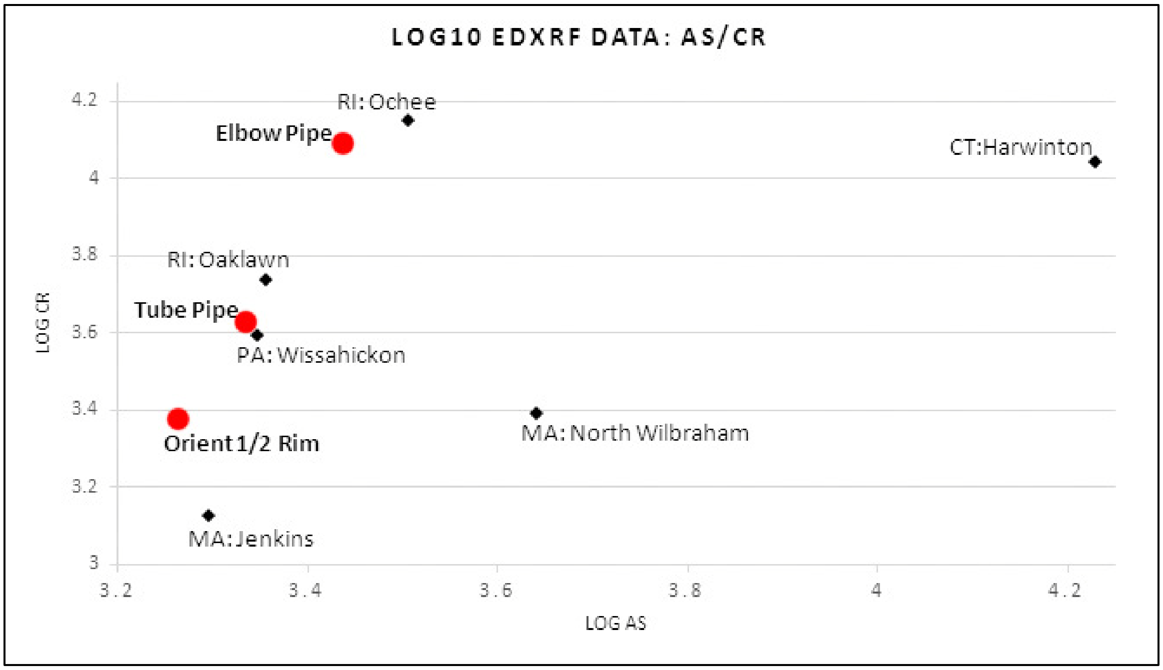

Figure 5.2 Log10 EDXRF biplot for As/Cr

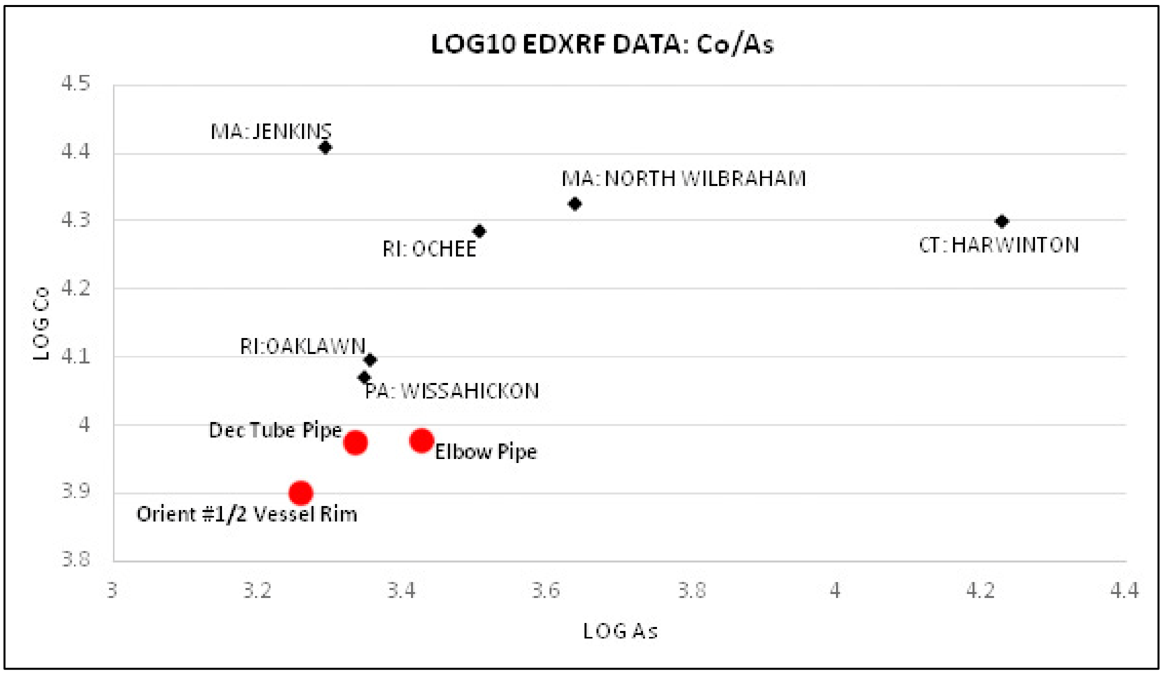

Figure 5.3 Log10 EDXRF biplot for Co/As

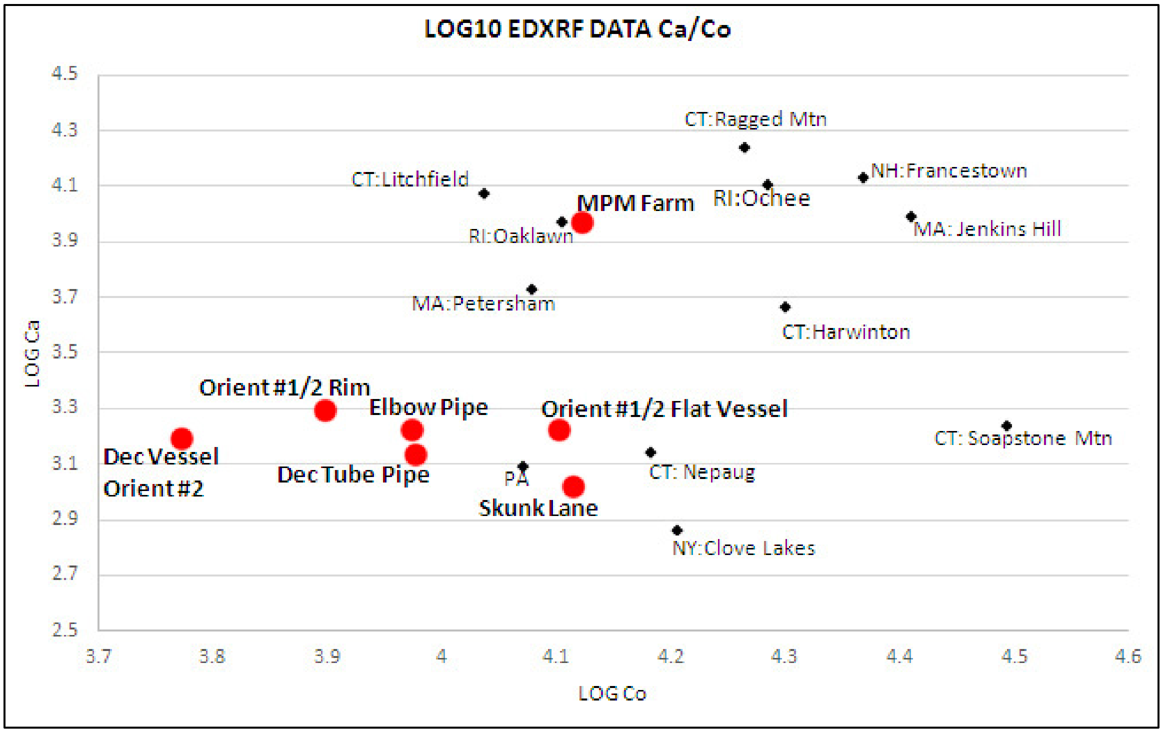

Figure 5.4 Log10 EDXRF biplot for Ca/Co

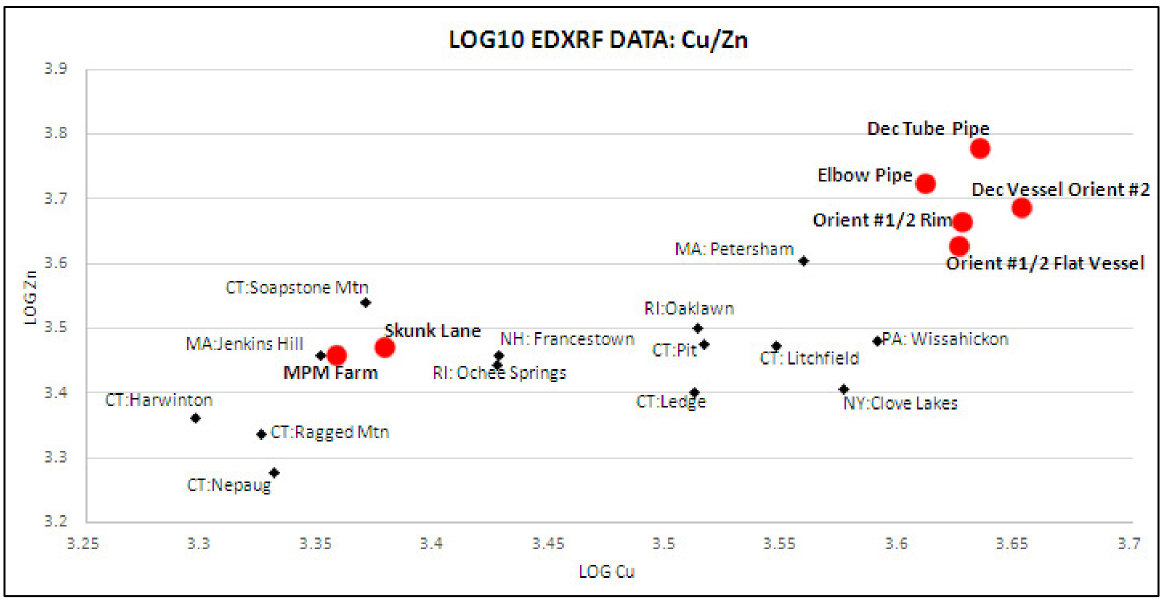

Figure 5.5 Log10 EDXRF biplot for Cu/Zn

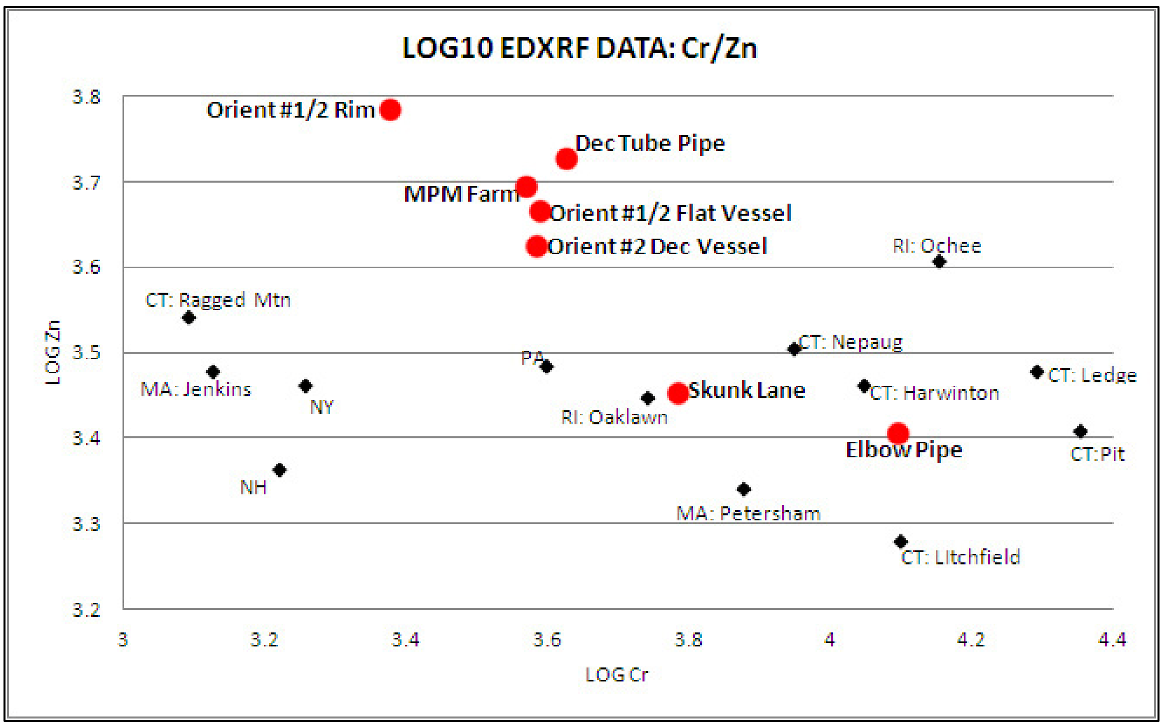

Figure 5.6 Log10 EDXRF biplot for Cr/Zn

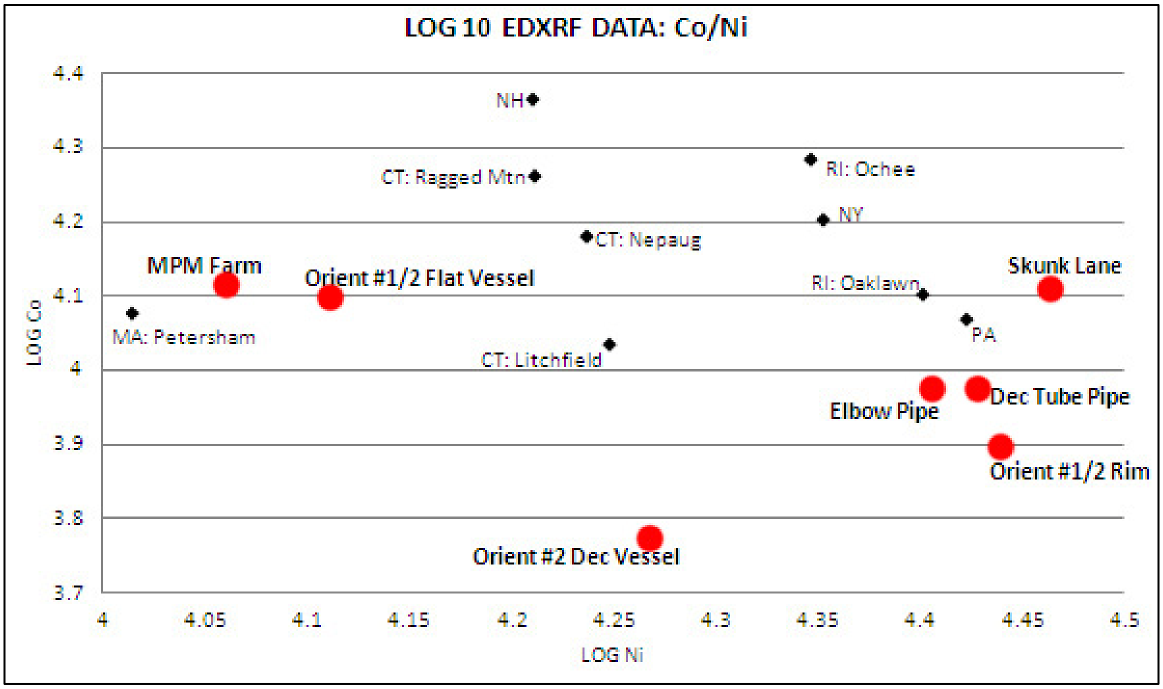

Figure 5.7 Log10 EDXRF biplot for Co/Ni

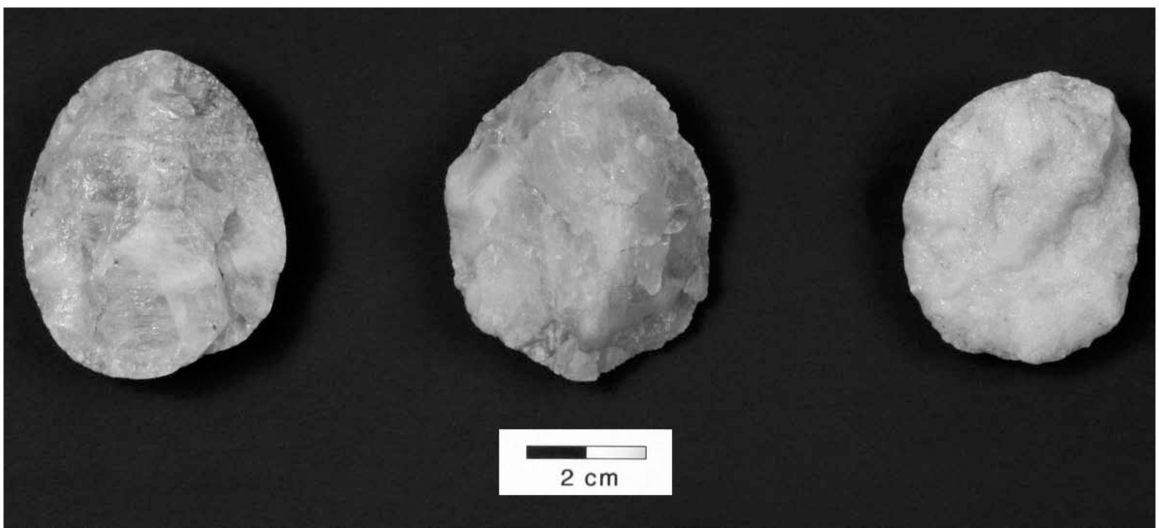

Figure 6.1 Three prepared quartz turtleback cores from N12/W21, Skunk Lane Site.

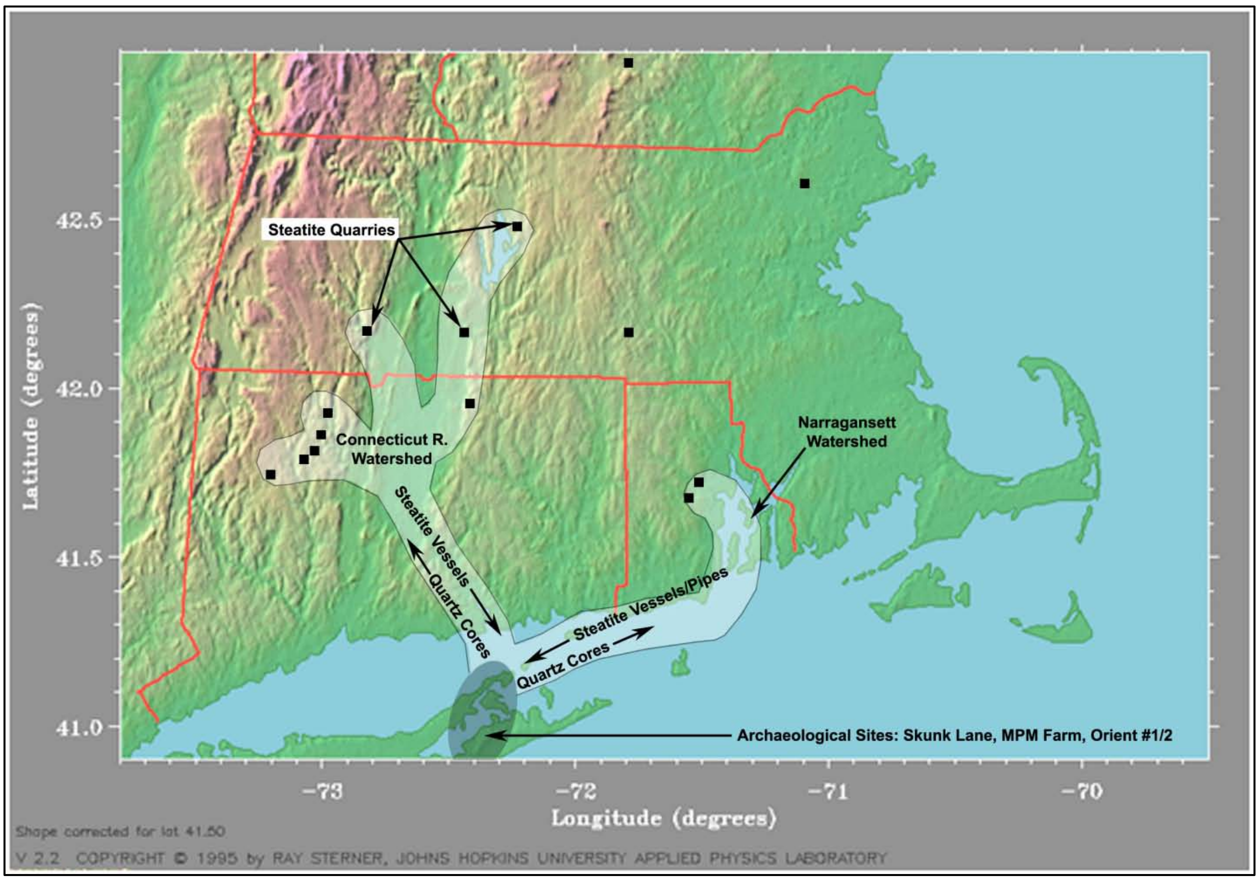

Figure 6.2 Proposed Model for Steatite Vessel Exchange from two high ranking watersheds (Table 6.1), Connecticut River (Rank 1) and Narragansett Bay (Rank 2).

Tables

Table 2.1 Prehistoric Chronology for Long Island Sound Watershed (after Bernstein 2006, Bernstein et al. 2009, Merwin 2010).

Cultural/Geological Period	*Uncalibrated Dates*	*Trends*
Late Woodland (Late Holocene)	1000 - 500 B.P.	agriculture in mainland river valleys; intensive use of maritime resources in coastal margins; shift from cremation to ossuary type burials; triangular projectile points
Middle Woodland (Late Holocene)	2000 - 1000 B.P.	diversification of pottery styles; stone/ceramic smoking pipes; variety of projectile point forms
Early Woodland (Late Holocene)	2500 - 2000 B.P.	mainland experimentation with horticulture; marked decrease in number of archaeological sites; contracting stemmed projectile points
Terminal Archaic (Late Holocene)	3500 - 2500 B.P.	elaborate burial ritual; wide ranging exchange networks; peak usage of steatite vessels; small stemmed, broad-bladed, and fishtail projectile points
Late Archaic (Mid-Holocene)	6000 - 3500 B.P.	marked increase in number of archaeological sites; shell middens/fishing weirs first appear; early pottery; projectile points include side-notched and straight-stemmed
Middle Archaic (Mid-Holocene)	8000 - 6000 B.P.	modern flora and fauna; ground stone tools (e.g., bannerstones, plummets); projectile points include stemmed and side-notched
Early Archaic (Early Holocene)	10,000 - 8000 B.P.	climatic warming; projectile points include bifurcate base and stemmed
Paleoindian (Late Pleistocene)	13,500 - 10,000 B.P.	end of Late Pleistocene; first human colonization of region; fluted, lanceolate projectile points

Table 4.1 Average Net Intensity (ppm) for Steatite Artifacts from Long Island, New York

Eastern Long Island Steatite Vessels (n=5) and Smoking Pipes (n=2)							
Element	**Skunk Lane Vessel**	**MPM Farm Vessel**	**Orient #2 Decorated Vessel**	**Orient #1/2 Flat Vessel**	**Orient #1/2 Rim**	**Elbow Pipe**	**Tube Pipe**
As	0	0	0	0	1827	2709	2153
Ca	1030	9776	1551	1723	1981	1696	1355
Co	13044	13190	5906	12677	7893	9441	9476
Cr	6119	3710	3883	3922	2384	12450	4229
Cu	2383	2268	4484	4215	4220	4075	4307
Fe	365750	404629	242788	418989	273793	302924	296900
K	0	0	0	0	0	0	0
Mn	7605	9312	2604	6315	4293	3662	4201
Ni	29074	11488	18550	12926	27437	25413	26806
Rb	4730	0	0	0	0	0	0
Sr	0	0	0	3966	0	0	0
Ti	6999	6903	8324	7864	7458	4800	4959
V	0	0	0	0	0	0	0
Y	0	0	0	0	0	0	0
Zn	2933	2860	4936	4456	4646	5344	6109
Zr	0	0	0	0	0	0	0

Table 4.2 Average Net Intensity (ppm) for Steatite Source Areas by State - Connecticut

Connecticut								
Element	**Beckwith Brook (n=2)**	**Cotton Hill Ledge (n=5)**	**Cotton Hill Pits 1&2 (n=4)**	**Harwinton (n=10)**	**Litchfield (n=7)**	**Nepaug-Bakerville (n=6)**	**Ragged Mountain (n=5)**	**Soapstone Mountain (n=2)**
As	0	0	0	16896	0	0	0	0
Ca	1696	3223	711	4651	11882	1396	17403	1760
Co	16591	0	0	19979	10880	15211	18352	31134
Cr	6142	19616	22497	11115	12592	8863	1233	171
Cu	2471	3246	3274	1979	3519	2140	2111	2341
Fe	411077	414114	44910	492130	335329	387364	449761	633990
K	0	0	0	0	0	0	0	0
Mn	17965	0	0	29775	10456	13448	22018	44600
Ni	22467	11708	13451	2513	17700	17230	16276	21
Rb	0	0	0	5043	0	0	0	6360
Sr	0	0	0	0	0	0	0	0
Ti	5996	5281	5596	4663	5062	5669	5616	8637
V	0	0	0	0	0	0	0	0
Y	0	0	0	0	0	0	0	0
Zn	2862	2532	3003	2309	2999	1901	2187	3485
Zr	0	0	0	0	0	0	0	0

Table 4.3 Average Net Intensity (ppm) for Steatite Source Areas by State – Massachusetts, New Hampshire, & New York

	Massachusetts					New Hampshire	New York
Element	**Horne Hill (n=1)**	**Jenkins Hill (n=5)**	**North Wilbraham (n=1)**	**Petersham (n=6)**	**Westfield (n=1)**	**Francestown (n=5)**	**Clove Lakes (n=10)**
As	0	1969	4360	0	0	0	0
Ca	563	9853	4338	5436	23621	13662	737
Co	21352	25708	21225	11973	11601	23367	16065
Cr	13244	1340	2469	7515	6268	1657	1813
Cu	2220	2240	2306	3612	2346	2673	3760
Fe	478205	618800	525964	393031	353575	562445	450660
K	0	0	0	0	9848	0	0
Mn	24842	28995	21458	8256	7724	26436	16178
Ni	18124	4476	11984	10338	22299	16211	33927
Rb	4608	5789	0	0	12002	4796	0
Sr	3034	0	0	5291	0	3740	0
Ti	5140	8153	6365	5126	4974	8353	4560
V	0	0	1171	0	0	0	0
Y	1080	0	0	0	2314	1058	0
Zn	2452	2890	4264	4040	3093	2889	2558
Zr	0	0	0	0	0	0	0

Table 4.4 Average Net Intensity (ppm) for Steatite Source Areas by State – Rhode Island & Pennsylvania

	Rhode Island		Pennsylvania
Element	**Oaklawn (n=9)**	**Ochee Springs (n=7)**	**Wissahickon (n=10)**
As	2261	3200	2221
Ca	9411	12938	1254
Co	12743	19280	11785
Cr	5520	14243	3964
Cu	3256	2668	3889
Fe	353777	485170	330883
K	0	0	3181
Mn	11515	20501	9857
Ni	25213	22191	26433
Rb	4685	3991	4989
Sr	0	4822	5000
Ti	6271	4840	7428
V	0	0	1800
Y	0	0	1372
Zn	3193	2797	3051
Zr	0	0	1949

Table 4.5 Average Net Intensity (top) and Average Ratios (bottom) for Artifact and Source Area Samples

Artifact Sample	As	Ca	Co	Cr	Cu	Fe	K	Mn	Ni	Rb	Sr	Ti	V	Y	Zn	Zr
Skunk Lane	0	1030	13044	6119	2383	365750	0	7605	29074	4730	0	6999	0	0	2993	0
		.0024	.0294	.0125	.0055	.8294		.0168	.0691	.0108		.0165			.0069	
MPM Farm	0	9776	13190	3710	2268	404629	0	9312	11488	0	0	6903	0	0	2860	0
		.0180	.0282	.0078	.0048	.8720		.0197	.0247			.0150			.0031	
Orient #2 Dec Vessel	0	1551	5906	3883	4484	242788	0	2604	18550	0	0	8324	0	0	4936	0
		.0053	.0201	.0132	.0153	.828		.0087	.0637			.0284			.0168	
OBC #1/2 Flat Vessel	0	1723	12677	3922	4215	418989	0	6315	12926	0	3966	7864	0	0	4456	0
		.0036	.0265	.0082	.0088	.87		.0132	.0270		.0083	.0164			.0093	
OBC #1/2 Rim	1827	1981	7893	2384	4220	273793	0	4293	27437	0	0	7458	0	0	4646	0
	.0054	.0058	.0234	.0070	.0125	.8150		.0127	.0816			.0222			.0138	
Tube Pipe	2153	1355	9476	4229	4307	296900	0	4201	26806	0	0	4959	0	0	6109	0
	.0059	.0037	.0262	.0117	.0119	.8235		.0116	.0743			.0137			.0169	
Elbow Pipe	2709	1696	9441	12450	4075	302924	0	3662	25413	0	0	4800	0	0	5344	0
	.0071	.0045	.0253	.0334	.0109	.8131		.0098	.0682			.0128			.0143	
Source Area	**As**	**Ca**	**Co**	**Cr**	**Cu**	**Fe**	**K**	**Mn**	**Ni**	**Rb**	**Sr**	**Ti**	**V**	**Y**	**Zn**	**Zr**
Connecticut																
Beckwith	0	1696	16591	6142	2471	411077	0	17965	22467	0	0	5996	0	0	2862	0
		.0036	.0334	.0134	.0053	.8429		.0338	.0479			.0132			.0062	
CH Ledge	0	3223	0	19616	3246	414114	0	0	11708	0	0	5281	0	0	2532	0
		.0070		.0426	.0070	.9000			.0254			.0114			.0055	
CH Pit 1&2	0	711	0	22497	3274	449910	0	0	13451	0	0	5596	0	0	3003	0
		.0115		.0421	.0066	.9023			.0290			.0120			.0061	
Harwinton	16896	4651	19979	11115	1979	492130	0	29775	2513	5043	0	4663	0	0	2309	0
	.0285	.0078	.0338	.0188	.0033	.8326		.0503	.00425	.0085		.0078			.0039	
Litchfield	0	11882	10880	12592	3519	335329	0	10456	17700	0	0	5062	0	0	2999	0
		.0289	.0265	.0306	.0085	.8170		.0254	.0431			.0123			.0073	
Nepaug-Bakerville	0	1396	15211	8863	2140	387364	0	13448	17230	0	0	5669	0	0	1901	0
		.0030	.0335	.0195	.0047	.8546		.0296	.0380			.0125			.0041	
Ragged Mtn	0	17403	18352	1233	2111	449761	0	22018	16276	0	0	5616	0	0	2187	0
		.0325	.0343	.0023	.0039	.8407		.0411	.0304			.0104			.0040	
SoapstneMtn	0	1760	31134	171	2341	633990	0	44600	21	6360	0	8637	0	0	3485	0
		.0024	.0425	.0002	.0031	.8655		.0608	.00002	.0222		.0117			.0047	
Massachusetts																
Horne Hill	0	563	21352	13244	2220	478205	0	24842	18124	4608	3034	5140	0	1080	2452	0
		.0012	.0355	.0206	.0043	.8253		.0366	.0417	.0081	.0066	.0113	0	.0024	.0049	0
Jenkins	1969	9853	25708	1340	2240	618800	0	28995	4476	5789	0	8153	0	0	2890	0
	.0027	.0138	.0361	.0018	.0031	.8712		.0408	.0063	.0081		.0114			.0040	
N.Wilbraham	4360	4338	21225	2469	2306	525964	0	21458	11984	0	0	6365	1171	0	4264	0
	.0072	.0071	.0352	.0040	.0038	.8723		.0355	.0198			.0105	.0019		.0070	
Petersham	0	5436	11973	7515	3612	393031	0	8256	10338	0	5291	5126	0	0	4040	0
		.0119	.0263	.0165	.0079	.8645		.0181	.0227		.0116	.0112			.0088	
Westfield	0	23621	11601	6268	2346	352575	9848	7724	22299	12002	0	4974	0	2314	3093	0
		.0519	.0255	.0137	.0051	.7755	.021	.0169	.0490	.0264		.0109		.0050	.0068	
New Hampshire																
Francestown	0	13662	23367	1657	2673	562445	0	26436	16211	4796	3740	8353	0	1058	2889	0
		.0204	.0350	.0024	.0040	.8428		.0396	.0242	.0071	.0056	.0128		.0015	.0043	
New York																
Clove Lakes	0	737	16065	1813	3760	450660	0	16178	33927	0	0	4560	0	0	2558	0
		.0013	.0302	.0034	.0070	.8498		.0305	.0639			.0085			.0048	
Pennsylvania																
Wissahickon	2221	1254	11785	3964	3889	330883	3181	9857	26433	4989	5000	7428	1800	1372	3051	1949
	.0056	.0031	.0297	.0099	.0098	.8345	.008	.0248	.0666	.0125	.0126	.0187	.0045	.0034	.0076	.0049
Rhode Island																
Oaklawn	2261	9411	12743	5520	3256	353777	0	11515	25213	4685	0	6271	0	0	3193	0
	.0052	.0218	.0295	.0128	3256	.8215		.0267	.0585	.0108		.0145			.0074	
Ochee Springs	3200	12938	19280	14243	2668	485170	0	20501	22191	3991	4822	4840	0	0	2797	0
	.0053	.0216	.0323	.0238	.0044	.8131		.0343	.0371	.0066	.0080	.0081			.0046	

Table 6.1 Source Area Ranking

Quarry Series	Average Straight Line Distance to Sampled Archaeological Sites on Eastern Long Island	Source Area Rank
Western Connecticut (Harwinton, E. Litchfield, Cotton Hill Quarries, Beckwith Brook, Ragged Mtn, Soapstone Mtn)	108km	1
Western Rhode Island (Oaklawn, Ochee Springs)	114km	2
Southwestern Massachusetts (Westfield, North Wilbraham)	124km	3
Southeastern Massachusetts (Horne Hill)	137km	4
New York Bight/Staten Island (Clove Lakes Park)	154km	5
North Central Massachusetts (Petersham)	164km	6
Northeastern Massachusetts (Jenkins Hill)	207km	7
South Central New Hampshire (Francestown)	224km	8
Southeastern Pennsylvania (Wissahickon)	262km	9

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Appendix A: EDXRF Data

Artifact/Quarry Sample: Mean (ppm)/ ±St. Dev	As	Ca	Co	Cr	Cu	Fe	K	Mn	Ni	Rb	Sr	Ti	V	Y	Zn	Zr
Skunk Lane 1	0	1030 ±626	13044 ±3134	6119 ±6101	2383 ±66	365750 ±76340	0	7605 ±2895	29073 ±6144	4730 ±362	0	6999 ±1142	0	0	2993 ±210	0
MPM Farm 1	0	9775 ±1544	13190 ±2817	3709 ±923	2268 ±109	404629 ±36910	0	9312 ±3146	11488 ±1354	0	0	6903 ±991	0	0	2859 ±124	0
Orient #2 Vessel	0	1550 ±126	5905 ±506	3883 ±265	4484 ±130	242788 ±18463	0	2603 ±945	18550 ±2447	0	0	8324 ±415	0	0	4936 ±281	0
Orient #1/2 Flat Vessel	0	1723 ±111	12676 ±2725	3921 ±1188	4215 ±419	418989 ±79837	0	6315 ±2206	12925 ±7257	0	3966 ±829	7863 ±243	0	0	4455 ±188	0
Orient #1/2 Rim Fragment	1826 ±616	1980 ±157	7893 ±922	2384 ±198	4219 ±95	273792 ±28803	0	4292 ±1494	27437 ±1454	0	0	7458 ±307	0	0	4645 ±99	0
Dec Tube Pipe	2153 ±430	1355 ±109	9476 ±221	4229 ±107	4307 ±83	296900 ±267	0	4201 ±69	26806 ±289	0	0	4959 ±162	0	0	6109 ±174	0
Elbow Pipe	2709 ±359	1696 ±178	9441 ±1802	12450 ±3953	4075 ±150	302924 ±48237	0	3662 ±604	25413 ±2175	0	0	4800 ±440	0	0	5344 ±287	0
Beckwith Brook (CT)	0	1696 ±257	16591 ±5101	6142 ±1637	2471 ±217	411077 ±83170	0	17965 ±12146	22467 ±898	0	0	5996 ±1428	0	0	2862 ±455	0
CH Ledge (CT)	0	3223 ±2097	0	19616 ±18753	3246 ±564	414114 ±74674	0	0	11708 ±5362	0	0	5281 ±1375	0	0	2532 ±942	0
CH Pit #1 & 2 (CT)	0	711 ±176	0	22497 ±24673	3274 ±559	449910 ±87051	0	0	13451 ±3878	0	0	5596 ±1631	0	0	3003 ±658	0
Clove Lakes (NY)	0	737 ±129	16065 ±4833	1813 ±3436	3760 ±378	450660 ±62755	0	16178 ±8571	33927 ±8429	0	0	4560 ±800	0	0	2558 ±896	0
Francestown (NH)	0	13662 ±9373	23367 ±4064	1657 ±1138	2673 ±567	562445 ±61606	0	26436 ±8304	16211 ±14798	4796 ±815	3740 ±932	8353 ±1796	0	1058 ±506	2889 ±749	0

Artifact/Quarry Sample: Mean (ppm)/ ±St. Dev	As	Ca	Co	Cr	Cu	Fe	K	Mn	Ni	Rb	Sr	Ti	V	Y	Zn	Zr
Harwinton (CT)	16896 ±15575	4651 ±4847	19979 ±7926	11115 ±11648	1979 ±293	492130 ±93376	0	29775 ±37116	2513 ±1998	5043 ±777	0	4663 ±1670	0	0	2309 ±593	0
Horne Hill (MA)	0	563 ±270	21352 ±10318	13244 ±8905	2220 ±242	478205 ±172536	0	24842 ±20995	18124 ±12433	4608 ±1346	3034 ±1452	0	0	1080 ±709	2452 ±504	0
Jenkins Hill (MA)	1969 ±488	9853 ±3292	25708 ±6486	1340 ±460	2240 ±391	618800 ±57392	0	28995 ±15864	4476 ±1210	5789 ±536	0	8153 ±2199	0	0	2890 ±383	0
Litchfield\ (CT)	0	11882 ±13982	10880 ±5286	12592 ±10619	3519 ±570	335329 ±96648	0	10456 ±4114	17700 ±3701	0	0	5062 ±1010	0	0	2999 ±888	0
Nepaug (CT)	0	1396 ±443	15211 ±2696	8863 ±6492	2140 ±238	387364 ±69082	0	13448 ±4119	17230 ±9805	0	0	5669 ±645	0	0	1901 ±288	0
N. Wilbraham (MA)	4360 ±3743	4338 ±2693	21225 ±4289	2469 ±834	2306 ±110	525964 ±73441	0	21458 ±10123	11984 ±4796	0	0	6365 ±721	1171 ±477	0	4264 ±2568	0
Oaklawn (RI)	2261 ±460	9411 ±18600	12743 ±3252	5520 ±4710	3256 ±802	353777 ±67844	0	11515 ±6875	25213 ±6577	4685 ±192	0	6271 ±1157	0	0	3193 ±823	0
Ochee Springs (RI)	3200 ±2818	12938 ±19277	19280 ±4548	14243 ±17333	2668 ±285	485170 ±69908	0	20501 ±9671	22191 ±7012	3991 ±729	4822 ±3491	4840 ±1739	0	0	2797 ±1246	0
Petersham (MA)	0	5436 ±5219	11973 ±3031	7515 ±1777	3612 ±607	393031 ±44492	0	8256 ±4585	10338 ±1152	0	5291 ±1017	5126 ±788	0	0	4040 ±579	0
Ragged Mtn (CT)	0	17403 ±11016	18352 ±4915	1233 ±630	2111 ±144	449761 ±82880	0	22018 ±8630	16276 ±4956	0	0	5616 ±569	0	0	2187 ±253	0
Soapstone Mtn (CT)	0	1760 ±1915	31134 ±7043	171 ±206	2341 ±646	633990 ±64599	0	44600 ±21091	21 ±59	6360 ±691	0	8637 ±5851	0	0	3485 ±656	0
Westfield (MA)	0	23621 ±15141	11601 ±1180	6268 ±2519	2346 ±319	352575 ±25995	9848 ±5468	7724 ±1142	22299 ±3325	12002 ±6491	0	4974 ±247	0	2314 ±98	3093 ±339	0
Wissahickon (PA)	2221 ±306	1254 ±816	11785 ±6541	3964 ±2173	3889 ±557	330883 ±13191	3181 ±91	9857 ±11659	26433 ±12546	4989 ±917	5000 ±1356	7428 ±547	1800 ±663	1372 ±550	3051 ±784	1949 ±195

Appendix B

Steatite Quarry/ Source Area	Geological Context/ Tectonostratigraphic Terrane	Quarry Location	Exchange Conduit - Watershed to L.I. Sound	N	Sample Provider
Bakerville (Nepaug)	Ultramafic intrusion near interface of Nonewaug Granite & Rowe Schist (Ordovician or Older) Iapetus Ocean Terrane	Bakerville, CT	Rock Brook- Naugatuck R.- Housatonic R. - or - Farmington R.- Connecticut R.	6	W. Turnbaugh (n=1) J. Waller (n=5)
Cotton Hill - Ledge	Ultramafic intrusion within Nonewaug Granite (Ordovician or Older) Iapetus Ocean Terrane	Bakerville, CT	Rock Brook- Naugatuck R.- Housatonic R. - or - Farmington R.- Connecticut R	5	J. Waller
Cotton Hill- **Quarry Pit 1&2**	Ultramafic intrusion within Nonewaug Granite (Ordovician or Older) Iapetus Ocean Terrane	Bakerville, CT	Rock Brook- Naugatuck R.- Housatonic R. - or - Farmington R.- Connecticut R	4	J. Waller
Beckwith Brook	Ultramafic intrusion within Rowe Schist (Ordovician or Older) Iapetus Ocean Terrane	New Hartford, CT	Beckwith Br. - Nepaug R. - Farmington R. - Connecticut R.	2	N. Bellantoni
East Litchfield- **Quarry Pit 1&2**	Ultramafic intrusion at interface of Rowe Schist and Ratlum Mountain Schist (Lower Ordovician/Cambrian) Iapetus Ocean Terrane	East Litchfield, CT	Spruce Brook- Naugatuck R.- Housatonic R.	7	J. Waller
Harwinton	Ultramafic intrusion within Rowe Schist (Ordovician or Older) Iapetus Ocean Terrane	Harwinton, CT	Lake Harwinton/Catlin Brook- Leadmine Brook - Naugatuck R. - Housatonic R.	10	J. Waller
Ragged Mountain	Ultramafic intrusion within Hoosac Schist (Cambrian) Iapetus Ocean Terrane	Peoples State Forest, CT	Farmington R.- Connecticut R.	5	J. Waller
Soapstone Mountain (Colonial)	Steatite Mass derived from Massive Mafic Rock within Glastonbury Gneiss of Middletown Formation (Middle Ordovician) Iapetus Ocean Terrane	Somersville CT	Broad Brook – Scantic R. – Connecticut R. – or - Hockanum R. - Connecticut R.	2	C. Collins

Steatite Quarry/ Source Area	Geological Context/ Tectonostratigraphic Terrane	Quarry Location	Coastal Exchange Conduit - Watershed to L.I. Sound	N	Sample Provider
Clove Lakes Serpentinite	Upland serpentinite deposit, unknown if used prehistorically or historically. (Lower Ordovician) Iapetus Ocean Terrane	Staten Island, NY	Arthur Kill/Hudson R.- East R. - or - Atlantic Ocean	10	M. Tweedie
Horne Hill	Steatite Mass within the Nashoba Formation complex of Schist and Gneiss. (Ordovician or Proterozoic Z) Radiocarbon date of hearth feature within quarry debris: 2730 ± 120 B.P. Nashoba Terrane	Sutton, MA	Singletary Pond- Blackstone R.- Narragansett Bay	1	W. Turnbaugh
Jenkins (Colonial)	Steatite Bed within Hornblende Gneiss, (Ordovician or Proterozoic Z) Nashoba Terrane-Boxford Formation	Andover, MA	Skug R.- Ipswich R.- Atlantic Ocean	5	J. Waller
N. Wilbraham	Glacially transported steatite boulders of unknown geological context; possible source: Mount Mineral Formation with lenses of Serpentinized Harzburgite (Proterozoic Z) Terrane Unknown	Wilbraham, MA	Connecticut R.	1	W. Turnbaugh
Petersham (Colonial)	Two Ovoid Masses of Steatite within Monson Gniess (Ordovician or Older) Massabesic-Merrimack Terrane	Petersham, MA	Chicopee R.- Connecticut R.	6	J. Waller
Westfield	Steatite lenses (Serpentine-Talc Rock) within Cobble Mountain Formation (Middle Ordovician) Iapetus Ocean Terrane	Westfield, MA	Westfield R. or Little R. – Westfield R.- Connecticut R.	1	W. Turnbaugh
Oaklawn	Steatite lens with Actinolite, within greater Blackstone Group, primarily composed of Epidote and Biotite Schist. Mentions: “Ovoid clots of mafic talc minerals” (Devonian) Radiocarbon date of hearth in association with pipe quarrying debris: 731 A.D. Avalonian Terrane, Esmond-Dedham Zone	Cranston, RI	Furnace Brook - Meshanticut Brook - Pawtuxet R.- Narragansett Bay	9	W. Turnbaugh (n=3) J. Waller (n=6)

Steatite Quarry	Geological Context/ Tectonostratigraphic Terrane	Quarry Location	Exchange Conduit - Watershed to L.I. Sound	N	Sample Provider
Ochee Springs	Steatite lens within Mussey Brook Schist, part of greater Blackstone Group (Late Proterozoic) Avalonian Terrane, Esmond-Dedham Zone	Johnston, RI	Mussey Brook – Narragansett Bay- Long Island Sound	7	W. Turnbaugh (n=1) J. Waller (n=6)
Francestown (Historic)	Steatite Bed within Small Falls Formation of Pelitic Schist and Granofels, locally mapped as Francestown formation (Upper to Middle Silurian) Central Maine Terrane	Francestown NH	Piscataquog R.- Merrimack R.- Atlantic Ocean – Long Island Sound	5	D. Boisvert
Wissahickon Source Area	Steatite Lenses from Wissahickon Formation of predominately Mica Schist, Hornblende Gneiss, and Mafic Gneiss (Lower Paleozoic) Iapetus Ocean Terrane	Manayunk PA	Wissahickon Creek- Schuylkill R.- Delaware R.- Atlantic Ocean	10	M. Tweedie
Domestic & Burial Sites w/Steatite	**Site Description and Context**	**Site Location**	**Nearest Watershed**	**N**	**Sample Provider**
Skunk Lane	Domestic village site with 25 steatite bowl fragments recovered from B2 subsoil, adjacent to Late Woodland artifacts, and C14 dated hearth feature ca. A.D. 1650. Chronological association with feature still unclear, site destroyed.	Peconic, NY	Adjacent to Peconic Bay	25	I.L.I.A. Collections
MPM Farm	Single vessel fragment recovered within securely dated, Late Woodland, clay-lined pit feature: A.D. 1150.	Hayground, NY	Burnett Creek- Mecox Bay- Atlantic Ocean	1	I.L.I.A. Collections
Orient #2	Decorated Steatite Vessel from Hilltop Burial Complex #2 Radiocarbon date on charcoal: 2944 B.P.	Orient, NY	Adjacent to Long Island Sound	1	Oysterponds Historical Society
Orient # 1/2	Two Steatite Vessels from Hilltop Burial Complex	Orient, NY	Adjacent to Long Island Sound	2	Oysterponds Historical Society
Unknown Site Orient, NY	Two Steatite Smoking Pipes (Unknown Archaeological Context)	Orient, NY	Adjacent to Long Island Sound	2	Oysterponds Historical Society

Appendix C: Metric Attributes of Sampled Steatite Vessels

Vessel	Maximum Length (L)	Maximum Width (W)	Maximum Vessel Height (HGT)	Max/Min Rim Thickness (TH)	Inner Rim Diameter L/W (RDI)	Depths of Use Surface (DPTH)	Liquid Volumetric Capacity (LVC)
Decorated Vessel Orient #2 Site (Figure 1)	34cm	14.2cm	7.3cm	Max:11mm Min: 3mm	L: 27.5cm W: 12cm	d1: 5.2 d2: 4.7cm d3: 3.1cl (at 17cm)	768ml
Non-Decorated Flat Bottomed Vessel Orient #1/2 Site (Figure 3.18)	31cm	18.3cm	5.7cm	Max: 8mm Min: 3mm	L: 22cm W: 16.5cm	d1: 3cm d2: 4.1cm d3: 3cm (15.5cm)	962ml
Non-Decorated Vessel (Rim) Orient #1/2 Site (Figure 3.19)	n/a	n/a	n/a	Max:11mm Min:10mm	n/a	n/a	n/a
Skunk Lane Site Vessel (Figure 3.16)	n/a	n/a	n/a	Max:11mm Min:8mm	n/a	n/a	n/a
MPM Farm Site Vessel (Figure 3.17)	n/a	n/a	n/a	Body Fragment Max: 19mm	n/a	n/a	n/a