Quarries, Procurement, and the Carolina Sandhills: A Multidisciplinary Lithic Sourcing Study.

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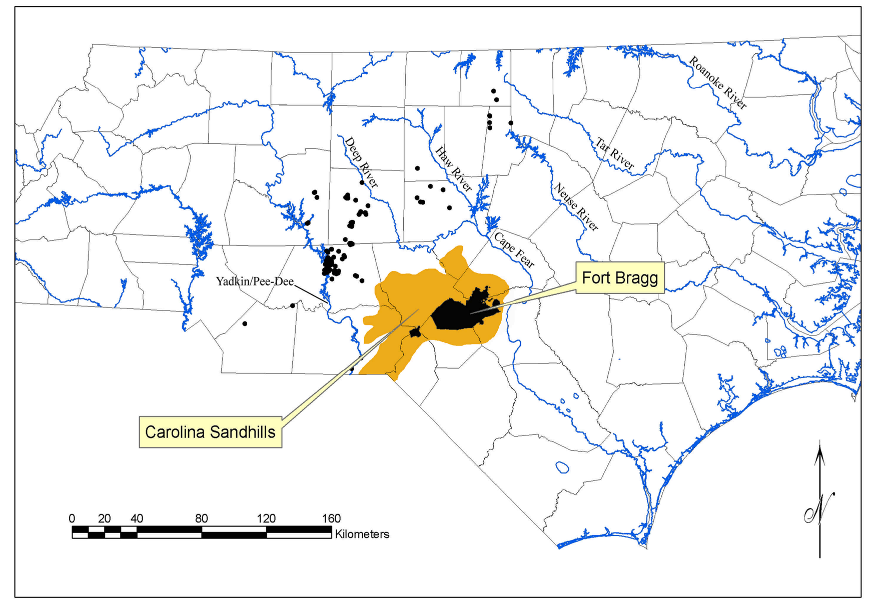
INTRODUCTION

Throughout prehistory in the Sandhills, metavolcanic stone played an important role in regional cultures. From Late Paleoindian through Early Woodland times, the majority of diagnostic projectile points were manufactured from some variety of metavolcanic material. The heavy reliance on metavolcanic stone, especially during the Archaic period, suggests a strong and persistent link between the Sandhills and the Carolina slate belt where numerous metavolcanic quarries have been documented. Beyond this simple assertion however, there is much to learn about procurement patterns developed over time.

Understanding procurement of metavolcanic stone by prehistoric hunters and gatherers is of particular importance for interpreting the archaeology of the Sandhills, and consequently, for evaluating the significance of archaeological sites at Fort Bragg. Differential selection of metavolcanic sources may reflect technological choices characteristic of distinct cultures. Daniel (1998) has advanced this argument for a highly selective Early Archaic practice focused on high quality aphyric rhyolite. Little is known, however, about the relationship between Mid to Late-Holocene lithic technology and metavolcanic procurement. With significant changes in tool production and curation, procurement patterns may be quite distinct. Even within the Early Holocene, there is significant use of quartz and potentially multiple kinds of metavolcanic stone.

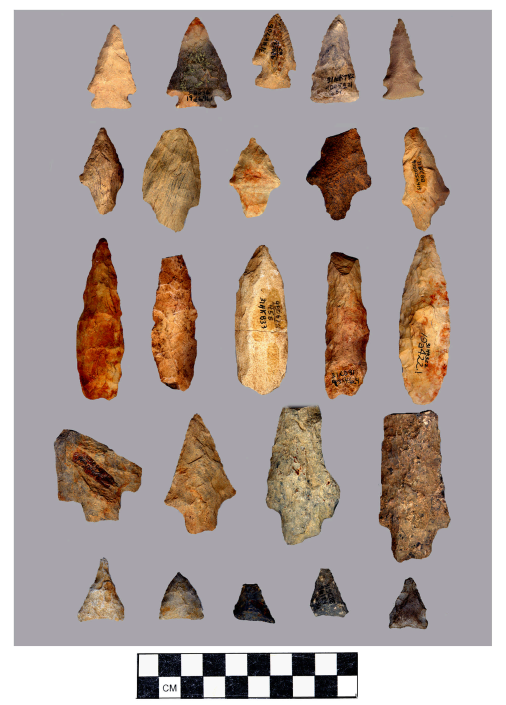
In addition to technology-based selection, prehistoric procurement of metavolcanic stone may reflect significant adjustments in mobility patterns through time. Such change could occur at multiple levels: at the scale of quarry selection within the southern Uwharries or at a larger panregional scale inclusive of the interior Coastal Plain and eastern Piedmont. Given potential demographic changes, shifts in residential versus logistic mobility, and patterns of interregional interaction, subtle to stark differences in metavolcanic stone procurement may be apparent.

With these kinds of questions in mind, the Fort Bragg Cultural Resources Program has launched an intensive, multidisciplinary sourcing study of metavolcanic stone. Fort Bragg archaeologists, together with archaeologists from CERL and UNC- Chapel Hill, have teamed up with geologists from UNC-Chapel Hill and N.C. State University. The first phase of this project is geared towards understanding variability of metavolcanic stone at the quarry level. Basic methods of this initial phase are outlined here. Ultimately, knowledge gained from this study will assist interpretation of the archaeological record of the Sandhills, allowing an informed assessment of the significance of archaeological sites. In a region with extreme preservation bias and an archaeological record dominated by the lithic residue of hunters and gatherers, the study of stone procurement is an important step towards modeling prehistoric settlement, interaction, and technological organization.

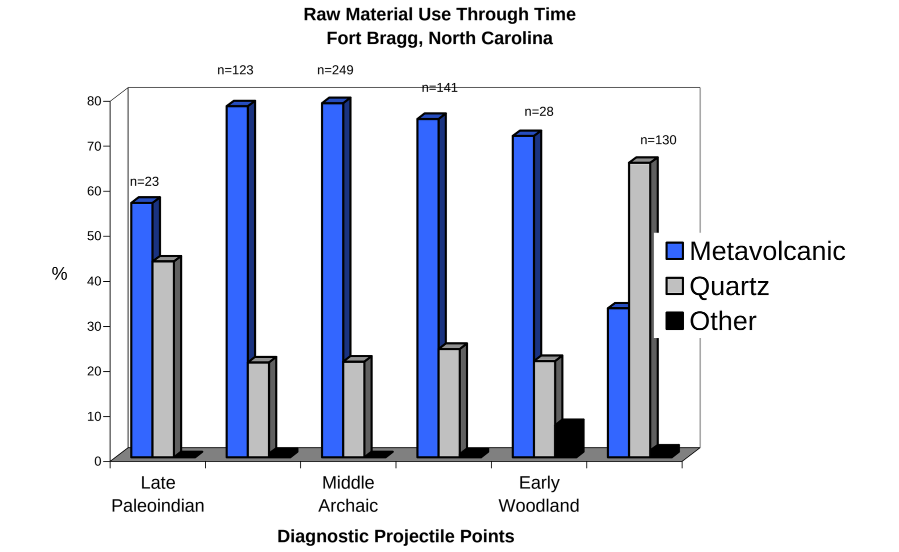


• Quarries

Fort Bragg is situated firmly in the North Carolina Sandhills of the Upper Coastal Plain of North Carolina. The Sandhills constitutes a narrow physiographic zone situated between the Piedmont and Coastal Plain. Characterized by hilly topography of broad interfluves and off-shooting toeslopes and finger ridges framed within a dendritic stream system, the defining elements for this area are the xeric sandy soils and the longleaf pine forest (Bartlett 1967; Russo et al. 1997). The xeric, acidic sands largely dictate the dominant pine forest with variable scrub oak mid-story and wiregrass ground cover. A moisture and nutrient gradient exists with elevation change as the upland pine forest gives way to dense hardwood and shrub vegetation around and within streams, seeps, bogs and pocosins. Since the Sandhills are comprised of ancient marine sediments, the region is considered to be stone poor. Although use of local quartz greatly enhanced and supplemented prehistoric stone tool manufacture, the vast majority of tool stone had to be acquired from outcrops and quarries more than 50 miles to the west in the Uwharrie National Forest and Morrow Mountain State Park.

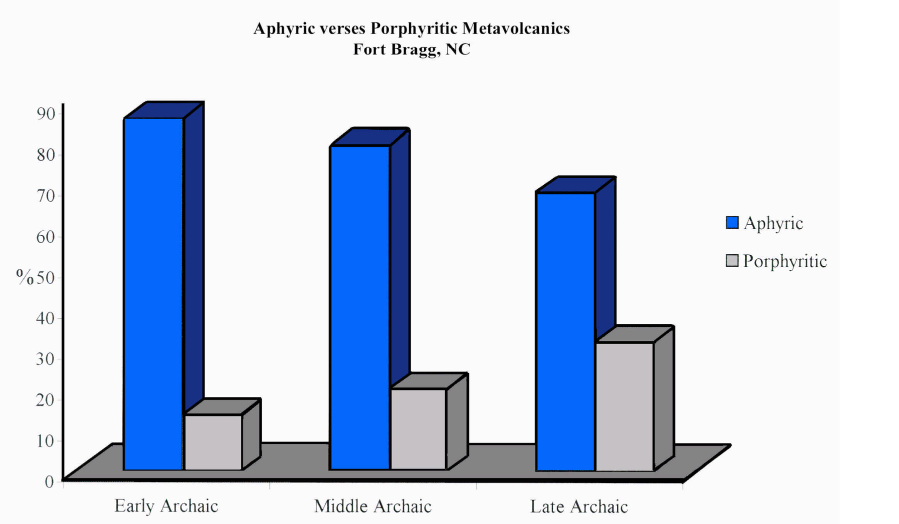


Examples of metavolcanic projectile points from Fort Bragg. From top to bottom:
Top row- Early Archaic (8000-6000 B.C.), 2nd and 3rd row- Middle Archaic Morrow Mt. and Guilford bifaces (6000-3000 B.C.), 4th row- Late Archaic (3000-1000 B.C.), and bottom row- Woodland triangular points (1000 to 1650 B.C.)



Based on the presence/absence of phenocrysts, an analysis of macroscopic variation in metavolcanic stone found at Fort Bragg has been conducted (see above). Daniel and Butler (1996) identify two types of phenocrysts (quartz and plagioclase) as significant indicators of variation among quarries in the southern Uwharries region. Among Fort Bragg projectile points, aphyric (i.e., non-porphyritic) stone dominates biface collections from the Early through Late Archaic. The high rate of occurrence of aphyric stone in the Early Archaic supports Daniel's interpretation of a preference for aphyric material. A gradual increase in the use of porphyritic stone in the Middle and Late Archaic suggests changes in metavolcanic procurement patterns.

While this simple approach to metavolcanic stone reveals at least some differences in procurement through time, this type of measure only scratches the surface of potential variability in metavolcanic material. Many of the projectile points classified as aphyric could be one of several varieties of volcanic rock recognized by archaeologists, e.g., rhyolite, felsite, tuff, etc. With this sourcing study, aimed at mineralogical and chemical variation in metavolcanic stone, we hope to refine our approach towards characterizing metavolcanics. In particular, we hope to develop a practical measure by which artifacts can be connected to source areas, if not individual quarries.



	Projectile Points			
Phenocrysts	Early Archaic	Middle Archaic	Late Archaic	*Totals*
Aphyric (Absent)	106	199	71	376
Plagioclase	3	20	16	39
Quartz	7	19	4	30
Quartz & Plagioclase	7	11	13	31
Totals	123	249	104	476

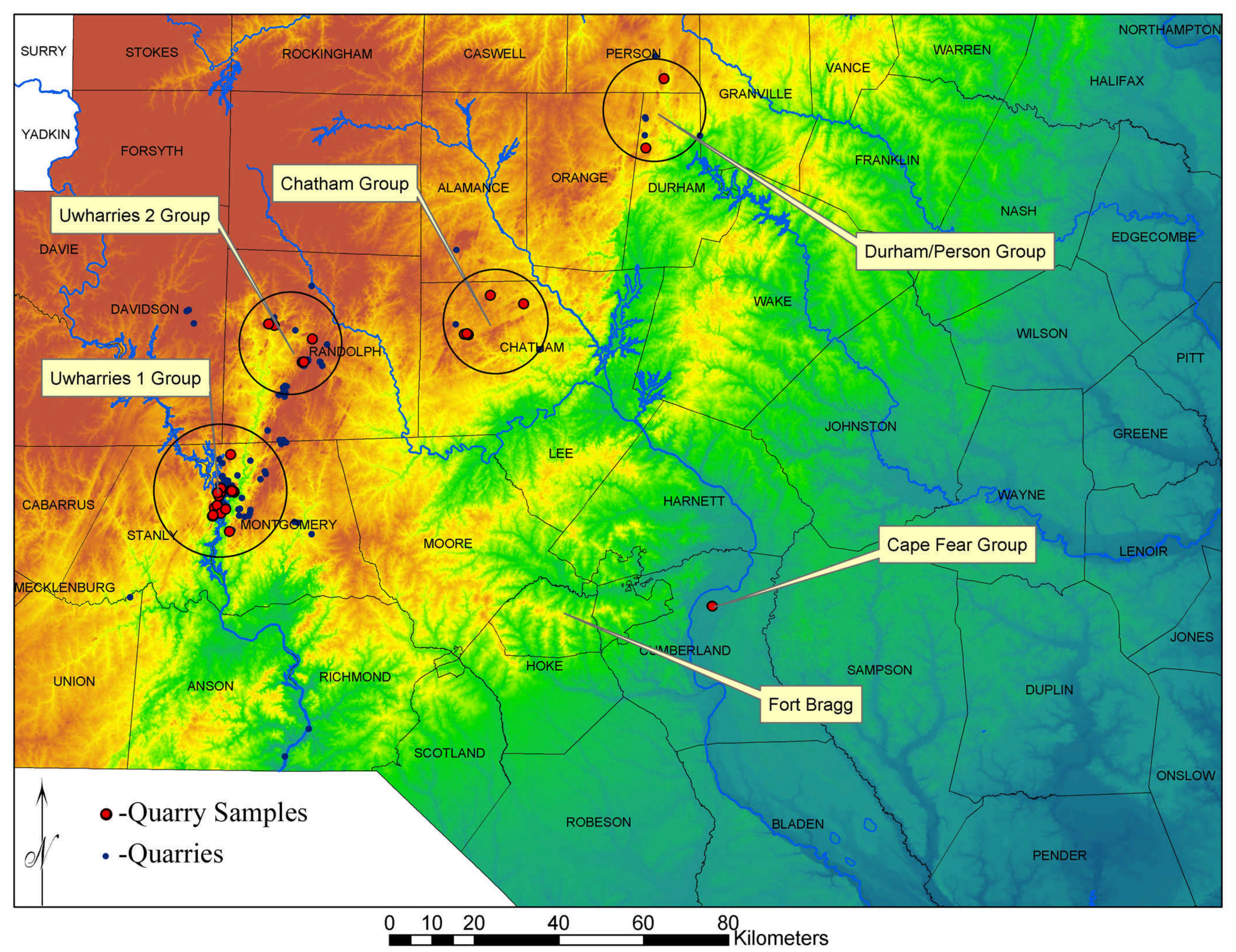
Pearson Chi-Square = 23.184, df = 6, p = .001

SOURCING METHODOLOGY

Through the collaborative efforts of both archaeologists from Fort Bragg and geologists from UNC Chapel Hill and NC State, 50 quarry samples were selected for petrographic and geochemical analysis. These samples consist of metamorphosed volcanic flows (metadacites and meta-andesites), or "..metamorphosed volcanic-sedimentary detritus of similar composition (e.g., mudstones of water-lain ash) (Miller 2002)." Historically, these materials have collectively been called "Carolina Slate" and/or rhyolite. Although the term rhyolite is used almost universally to describe many types of metavolcanics and even metasedimentary rocks with the North Carolina Slate Belt, it is becoming apparent from working with geologists that our terminology is in serious need of refinement.
Quarry groups were divided according to geographic proximity and included the Uwharries (Uwharries 1), Uwharries/Asheboro (Uwharries 2), Chatham County (Chatham 1-3), Durham County, Person County, and Cape Fear. All samples but Cape Fear consisted of samples from the North Carolina Slate Belt. Cape Fear samples occurred as float river cobbles within the older terraces of the Cape Fear River. These samples were tested due to their proximity to Fort Bragg and archaeological evidence indicating their use by Native Americans. Samples were subjected to a suite of geological and geochemical techniques including petrography, trace/major element analysis (Instrument Neutron Activation Analysis), and neodymium/samarium isotope analysis.

Each sample was characterized mineralogically to provide a basic understanding of the variability within and between quarries. Similarly, trace element and major element analysis will provide a baseline for understanding elemental variability between quarries and between specific volcanic complexes. These data allow geochemical "fingerprinting" of metavolcanic material from the central and northern Slate Belt verses stone from the Uwharries. Following Daniel and Butler's work in 1996, these initial steps are fundamental to any future work in sourcing or for characterizing metavolcanic variability in archaeological assemblages. Finally, neodymium isotope ratios were calculated for quarry samples to define isotopic variability of individual quarries and between quarry groups.

Together, mineralogical and trace/major element data *compliment* the isotopic data in order to provide a potential "fingerprint" for individual quarries or quarry groups within the Uwharries and/or other source areas outside the Slate Belt. Recent work on felsitic lithic material from southeastern New England has demonstrated the utility of this approach for "sourcing debitage to a particular quarry site within a volcanic complex, and even to a particular ash flow within a quarry" (Brady and Coleman 1999).



An intensive search of the state site files has been undertaken to document and map all known prehistoric quarries in the state. The vast majority of these fall within the southern Uwharries and Asheboro area of North Carolina, however increasing numbers of quarries are being found in regions of the central and northern Slate Belt. Collectors or advocational archaeologists discover many of these new quarries and are key to locating undocumented quarries on private lands. Red dots indicate samples from quarry groups including: Uwharries 1, Uwharries 2, Chatham County, Durham and Person Counties and Cape Fear were taken and analyzed using traditional petrography, Instrument Neutron Activation Analysis, and Samarium/Neodymium isotope analysis.

Dense quarry debris at 31CH729 (Joe Moylan Quarry), Chatham County, NC .

Looking east over the Uwharrie National Forest from the top of Shingle Trap Mountain. Note quarry debris and boulders of plagioclase-quartz porphyritic "rhyolite".

University of North Carolina geologist, Brent Miller inspects quarry samples at 31MG117 (Wolf Den), Uwharrie National Forest.

Quarry debris from 31MG117 (Uwharrie National Forest).

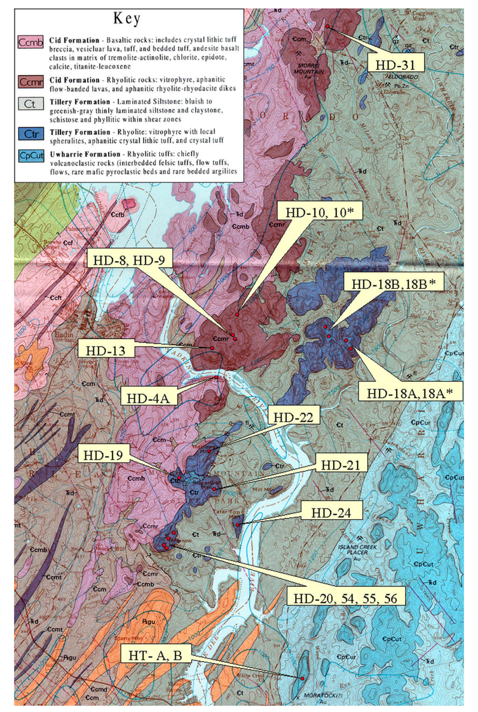


Figure 1. Quarry samples from Uwharries 1 plotted on a section of a geologic map of North Carolina (Stromquist and Henderson 1985).

Compositional groups indicated by Instrument Neutron Activation Analysis

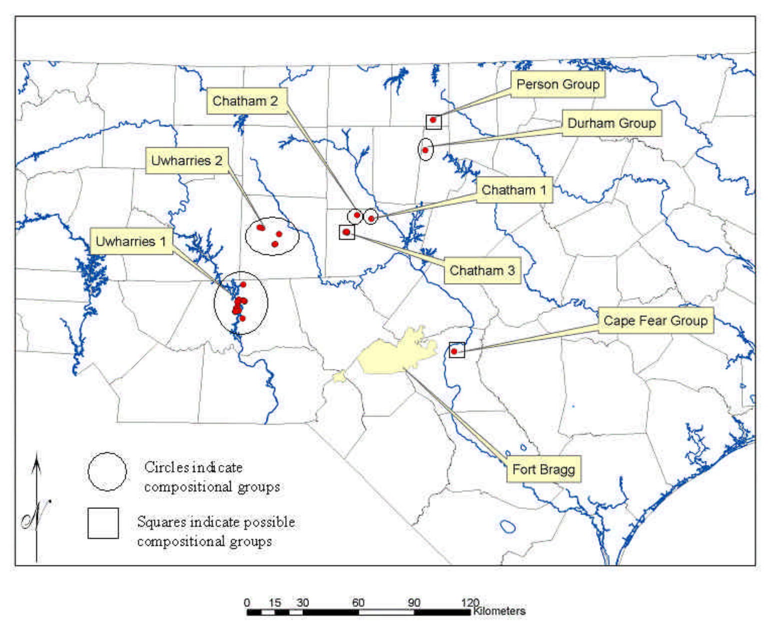


Figure 2. This map shows compositional groups for quarries and quarry groups as indicated by Instrument Neutron Activation Analysis. Compositional groups indicated by INAA are circled and possible compositional groups are indicated with a square.

Compositional groups indicated by Samarium/Neodymium isotope analysis

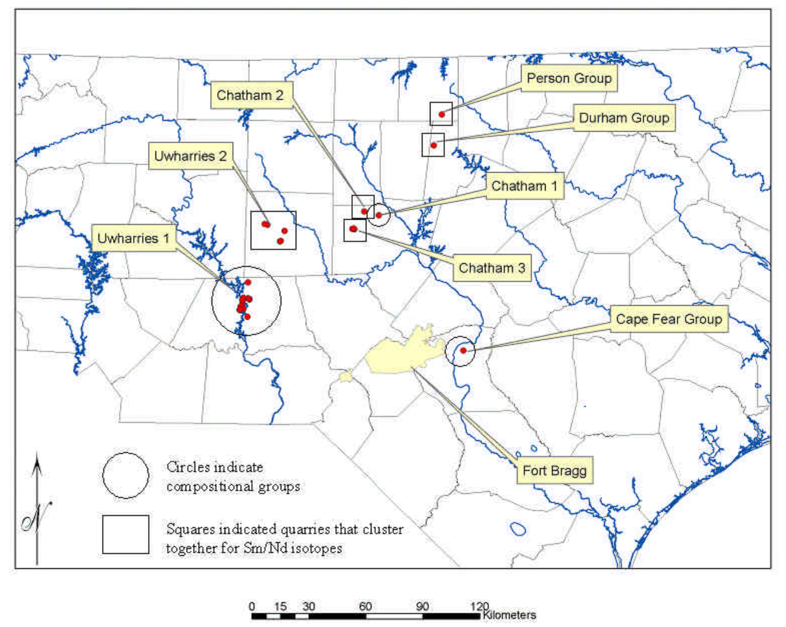


Figure 3. This map shows compositional groups indicated by Samarium/Neodymium isotope analysis. Quarries or quarry groups that were clearly discriminated by isotope analysis are circled. Squares indicate quarries or quarry groups that cluster together for Samarium/Neodymium isotope (see Figure 4) and are therefore not readily distinguishable from one another. Other geochemical signatures, such as that provided by INAA (Figure 2) may further delineate these groups when combined with isotopic data.

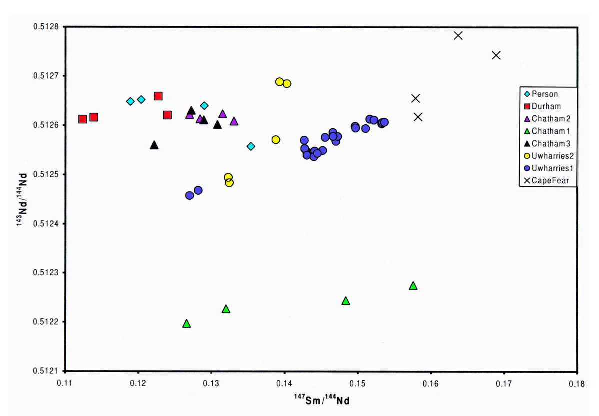


Figure 4. Neodymium isotopic composition of all quarry samples, categorized according to quarry group (Miller 2002).

This diagram graphically depicts the isotopic ratios of quarry samples used in our analysis. Radioactive isotope 147 Samarium divided by a stable reference isotope 144 Neodymium are plotted on the X-axis verses stable daughter isotope 143 Neodymium divided by the reference isotope 144 Neodymium on the Y-axis. Quarry groups clearly discriminated by their isotopic composition of Neodymium are Uwharries 1 (blue), Chatham 1 (green), and Cape Fear (X). Other quarry groups cluster together in the upper left-hand corner of the plot.

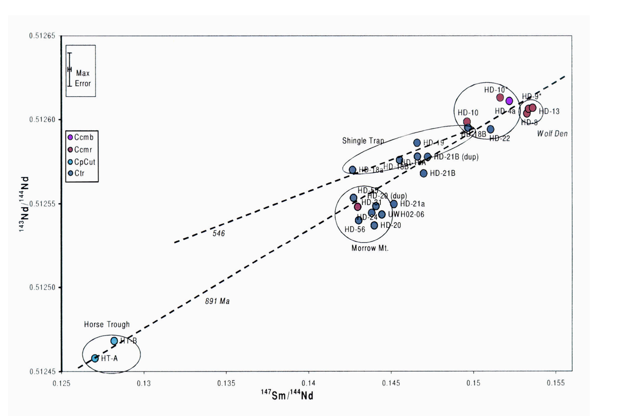


Figure 5. Neodymium isotopic composition of quarry samples from group Uwharries 1, categorized according to geologic map unit (see Figure 1) (Miller 2002).

This diagram shows just the Uwharrie 1 quarry samples plotted for Neodymium isotope ratios. Samples are color coded to represent geologic map units. In this case Uwharrie 1, samples show good distinction and cluster together based on Neodymium ratios and geologic units. The lines going through the clusters indicate age of rocks since crystallization of source magma. Since the geologic age of these rock units are between 540 and 580 ma it is likely that the slope produced by the suite of quarry samples depicted here reflect the time-integrated effects of geologic events in the source rock for these samples prior to melting and eruption. Since the slope of the line is proportional to how long the original radioactive isotope (147 Samarium) has been producing 143 Neodymium, the slope is proportional to the rocks age. Since we know the 891 ma line in incorrect for the age of these rock we know that there were significant differences between samples in their initial magmatic sources and therefore differences in their initial isotopes. This is important for archaeologists because it means that we can use these isotopes to "fingerprint" artifacts to source regions within the Uwharries and perhaps to individual quarries (Miller 2002).

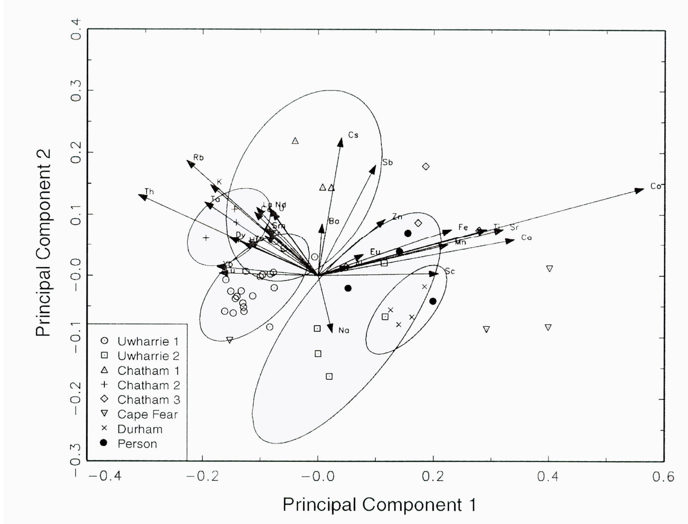


Figure 6. Principal Components Analysis of 29 elements data from Neutron Activation revealed a clear discrimination between Uwharrie I group material and all other material studied. Compared to the 21 samples from Uwharrie I, all but 1 of the other samples "have less than 1% probability of membership in the Uwharrie 1 reference group" (Speakman and Glascock 2002). Certain groups appear to be relatively homogenous chemically while others appear heterogeneous.

RESULTS

The first phase of this project was intended to establish a significant foundation for future work. The knowledge gained from this study will guide analyses of archaeological specimens from Fort Bragg in Phase II of this research.

Final petrographic descriptions and mineralogical analysis awaits additional geochemistry but already we have been able to refine rock types and descriptions of samples well beyond generic classification of slate belt metavolcanic and metasedimentary facies. Samarium-Neodymium isotope analysis has identified clear distinctions between quarry clusters Uwharrie 1 (n = 21), Cape Fear (n = 4), and Chatham 1 (n = 4). Other quarry groups cluster together for Samarium-Neodymium but may be further delineated using other geochemical signatures (Miller 2000). Instrument Neutron Activation Analysis has identified five clear compositional groups and three possible groups. These include Uwharries 1 (n = 21), Uwharries 2 (n = 5), Chatham 1 (n = 4), Chatham 2 (n = 4), and Durham (n = 4). Cape Fear samples, the Chatham 3 group, and Person County exhibit heterogeneous geochemical signatures and may indicate multiple compositional groups or subgroups at these locations (Speakman and Glascock 2002). Given small sample size for each group, additional testing of these quarries my provide evidence of definitive compositional groups.

Application of sophisticated geochemical techniques has given us for the first time a real understanding of the variability of metavolcanic stone within various regions of the North Carolina Slate Belt and Coastal Plain. Although much work remains to be done in the chemical and mineralogical characterization of quarries, the foundation for future sourcing research has been laid. Results of this initial phase of work, though preliminary, suggest the possibility to distinguish quarry groups based on one or a combination of the techniques employed. In particular, Sm-Nd ratios from several quarry groups appear distinct enough to potentially provide a comparative measure for artifact sourcing to the quarry group level. Therefore, Phase II of our research will utilize actual artifacts for analyses and will focus on diagnostic projectile points to establish chronological control of the variability being explored.

Such refined sourcing would be revolutionary for archaeologists interested in tracing hunter-gatherer settlement systems, corridors of movement, trade networks, and technological organization. Even less precise sourcing to general regions, outcrops, or quarry groups would be extremely informative given the known or inferred settlement ranges of ethnographically recorded hunting societies. Finally, work will continue at Fort Bragg to document and characterize the archaeological and mineralogical variability of lithic assemblages including the production of a comprehensive digital database of quarry and artifact thin-sections, mineralogical descriptions, and geochemical results.