Chapter 1

Introduction

Jeffrey D. Irwin and Vincas P. Steponaitis

The archaeology of prehistoric hunter-gatherers in the Sandhills of North Carolina requires a fundamental understanding of how stone from the Appalachian Piedmont was acquired and utilized by prehistoric peoples. A significant body of data on thousands of archaeological sites or isolates continues to accumulate through the management of cultural resources at Fort Bragg, an Army installation of some 65,000 ha in the Sandhills. Stone tools and debris made from Piedmont material, particularly from the Carolina Slate Belt, constitute a large percentage of these assemblages, elevating questions of how prehistoric groups provisioned themselves with tool stone and organized stone-based technology to the fore of research. Stone from the Carolina Slate Belt was procured, used, and transported over hundreds of kilometers throughout the record of human history extending from the Paleoindian to Late Woodland periods. This study is intended to establish a scientific process for determining the original provenance of such artifacts, that is, for connecting the artifacts to their original geological sources.

This study has two primary objectives: first, to evaluate chemical and mineralogical techniques for differentiating quarries, and second, to apply these techniques in determining the sources of stone tools from Fort Bragg. Systematic characterization of stone samples from known quarries is a necessary first step before the basic problem of source differentiation can be addressed. The bulk of the analyses reported here are directed towards characterizing quarries in the Carolina Slate Belt and exploring ways to distinguish those quarries. The second question of sourcing artifacts is addressed through a case study using artifacts from Fort Bragg.

While studies of volcanic rock and Carolina Slate Belt materials exist, previous studies have been relatively limited in geographical scale and methodological scope. Our project was therefore designed to move beyond these limitations by sampling a broader range of quarries and using a greater variety of analytical techniques. In the present study, three lines of compositional evidence were brought to bear on the problem of distinguishing quarries. The mineralogy of all samples was assessed through petrographic analysis of thin sections. In addition, elemental composition was measured using neutron activation analysis, x-ray fluorescence, and inductively coupled plasma mass spectrometry. Finally, neodymium isotope ratios were measured with a mass spectrometer. Using this range of methods allowed us to assess their relative efficacy in determining geological sources. It also allowed us to identify these sources with greater precision and confidence than could be achieved with any single method by itself.

Although our immediate focus is to identify the sources of stone used in making tools, this study is ultimately driven by research questions about the adaptations and social organization of prehistoric people. Assuming direct procurement of stone by hunter-gatherers who used or moved through the Sandhills, knowledge of tool-stone sources will ultimately facilitate modeling of the "mobility scale" (Binford 1979:261) or territorial mobility (Kelly 1992) of hunter-gatherer settlement systems. Modeling of stone procurement and conveyance from within the Carolina Slate Belt should allow for refinement of existing settlement models (e.g., Anderson and Hanson 1988; Daniel 1994b, 1998), if not construction of new ones (Irwin and Moore 2003; Moore and Irwin 2002, 2004). By recognizing patterns of movement across the landscape, we may detect evidence of the settlement range or "foraging territories" (Jones et al. 2003) formed by mobile groups. Furthermore, by characterizing and sourcing tool stone, we may eventually gain knowledge of how raw material selection and treatment relate to concepts of the relative costs of procurement, raw material quality or reliability, and curation—issues integral to technological organization (Andrefsky 1994; Bamforth 1986, 1991).

The implications of this study for North Carolina archaeology are significant. Most fundamentally, identifying the sources of tool stone creates a context for interpreting artifacts recovered through archaeological investigations. Current identification of Carolina Slate Belt material at the artifact level is generic. The ability to source lithic artifacts more precisely would make use of a significant body of data that is otherwise restricted to functional meaning. By allowing issues of mobility, territory, and technological organization to be addressed regionally, tool-stone provenance research will enable the modeling of ancient cultural practices and adaptations as well as a more informed evaluation of archaeological resources.

Archaeology of Fort Bragg

Our perspective on prehistoric mobility and technology originates from a seemingly marginal region. Located in the interior Coastal Plain of North Carolina, the Sandhills mark an ancient coastal dune environment that is characterized by dissected hilly topography, longleaf pine and wiregrass forest, and acidic, arid sands along ridges and side slopes. The Sandhills have been referred to historically as the "Pine Barrens," "Pine Plains," even the "Sahara of the Carolinas," pejorative terms reflecting the nutrient-poor soils and low resource abundance of the area. Despite this reputation, the unique Sandhills area was persistently used throughout prehistory, as indicated by the presence of thousands of prehistoric sites and isolated artifacts on Fort Bragg.

Archaeological survey (e.g., Benson 1998; Clement et al. 1997; Idol and Becker 2001; Ruggiero 2003) and site excavation reports (Benson 2000; Ollendorf 1999; Idol and Pullins 2001) consistently reveal an archaeological landscape with lithic and ceramic artifacts distributed across all but the highest elevated ridges of Fort Bragg. These artifacts represent limited-duration occupations and specialized activities related to hunting and gathering throughout prehistory. The low density and often low diversity of artifacts relate to fairly high mobility and small group size. As Cable and Cantley (2005:391) describe, "most sites in the region are composed of a complex and redundant array of special purpose camps, extraction loci, single nuclear family and small multiple family short-term residences." Archaeological sites range in size from a few square meters to over 3 hectares, though most sites contain unrelated, temporally disjunctive components. While artifact distributions are sparse at the landscape or site level, isolated activity areas, most commonly debris from lithic reduction episodes or the discarded remains of broken pots, can produce dense artifact concentrations with hundreds of artifacts per square meter (Benson 2000:644; Cable and Cantley 2005:396).

Archaeological sites in the Sandhills often contain stone tools or debitage made of rocks found in the Carolina Slate Belt (Figure 1.1). Artifact surfaces are often weathered, which makes the characteristics of the underlying, unaltered stone difficult to see. Even when unaltered

Figure 1.1. Selected diagnostic hafted bifaces, metavolcanic material, Fort Bragg.

surfaces are visible, the macroscopic distinctions among metavolcanic rocks are often subtle. These factors, combined with archaeologists' lack of geological training, make specific rock types hard to identify. What Abbott (2003) terms the "identification problem" has resulted in predominant use of the term "metavolcanic" as an inclusive category for material from the Slate Belt (e.g., Braley 1989; King 1992; Trinkley et al. 1996a).

Some archaeologists working at Fort Bragg have addressed variability in metavolcanic material, identifying rocks such as rhyolite and argillite "where possible" (Ollendorf 1999) or subdividing the metavolcanic category into "unidentified metavolcanic, general rhyolite, and . . . fine grained rhyolites" (Idol and Becker 2001:37). Following Daniel and Butler's (1996) work and his own 1,600-ha survey in the Uwharrie Mountains, Benson (2000) expanded on the previously defined Uwharrie-Mountain rock types, adding several categories of rhyolitic tuffs in a Fort Bragg survey. In recent years emphasis has been placed on key attributes, particularly the occurrence of flow banding and phenocrysts (e.g., Culpepper et al. 2000; Cable and Cantley 2005; Ruggiero and Grunden 2005). Given historic attention on the southern Uwharrie Mountains, there was little need to refine stone identification since the proximity of quarries precludes meaningful analysis of mobility patterns relative to stone procurement. Recent attempts to capture variation in metavolcanic material, whether at the classificatory or attribute level, are geared towards differentiating individual components or activity areas at the intrasite level (Benson 2000; Cable and Cantley 2005). Indeed, attribute-based sorting is particularly important for analysis of the number and kinds of cores being reduced at a site.

It is assumed here that most metavolcanic materials appearing archaeologically on Fort Bragg were procured in the Carolina Slate Belt and imported as flake blanks or preforms. There is substantial, albeit indirect, evidence for this supposition in the form of metavolcanic debitage. Lithic assemblages on Fort Bragg are typically dominated by flakes reflecting late-stage biface thinning. Of 15,858 pieces of metavolcanic debitage cataloged in the Fort Bragg database, 87% are classified as late-reduction, biface-thinning flakes. Metavolcanic flakes tend to be less than 2-3 cm in maximum length (see site descriptions in Idol and Pullins 2001; Cable and Cantley 2005:Table 120) and lack cortex, revealing an emphasis on reduction of prepared cores or bifaces. Additionally, among tool classes, metavolcanic material appears most frequently in projectile points. Most points dating from the Early Archaic through the Early Woodland periods are made of metavolcanic stone (Benson 2000; Culpepper et al. 2000). With the exception of prepared biface preforms, core technology in the Sandhills is based predominantly on quartz (Brannan and Irwin 2005).

Several examples of lithic caches found in or around the Sandhills reveal the likely form of transported material. The senior author has observed six caches (all but one collected by amateurs) of metavolcanic material. Cached material includes porphyritic and aphyric metavolcanic or metasedimentary stone, and the artifacts include flake blanks as well as biface preforms (Figure 1.2). Most of these caches contain 20 or more artifacts.

Given a persistent hunting and gathering economy and residential mobility throughout most of prehistory in the Sandhills, it is reasonable to assume direct acquisition and embedded procurement within a certain mobility scale. The maximum linear distance between the Sandhills region and quarry groups sampled in this study is roughly 130 km, while many quarries are roughly 70-80 km away. While metavolcanic stone is nonlocal, the Carolina Slate Belt is certainly within the range of annual mobility practiced by modern hunter-gatherers (Kelly 1995), and so direct procurement is a reasonable assumption (Meltzer 1989). If trade in stone occurred prehistorically in the region, it probably was most important in the Middle and Late Woodland periods, when trade and long-distance contacts were evidenced in the sand burial mounds of the southern coast (Irwin 2004; Irwin et al. 1999; MacCord 1966). Indeed, metavolcanic material may have been at its most exotic when groups associated with Hanover pottery were largely confined to the Coastal Plain and were relying heavily on quartz for arrow points (Culpepper et al. 2000; Ruggiero 2003).

The possibility for local procurement of metavolcanic material redeposited or exposed by rivers in the Coastal Plain is considered real, but minor. The occasional presence of cortex on metavolcanic debris or metavolcanic cobbles or cobble fragments on Fort Bragg has led some to suggest local procurement (Benson 2000; Idol 2005; Cable and Cantley 2005). Cortex may indeed reflect reduction of locally available stream cobbles, though it should be noted that cortex must be distinguished from weathering rinds common on quarry samples. Metavolcanic cobbles (e.g., Benson 2000) found on Fort Bragg are rare and tend to be of extremely poor quality. Recent excavations along the Cape Fear River have produced evidence of local procurement and use of material occurring as float in the ancient terraces along the north side of the river near Fayetteville (Kenneth Robinson, personal communication 2001). Similar materials were included in this study.

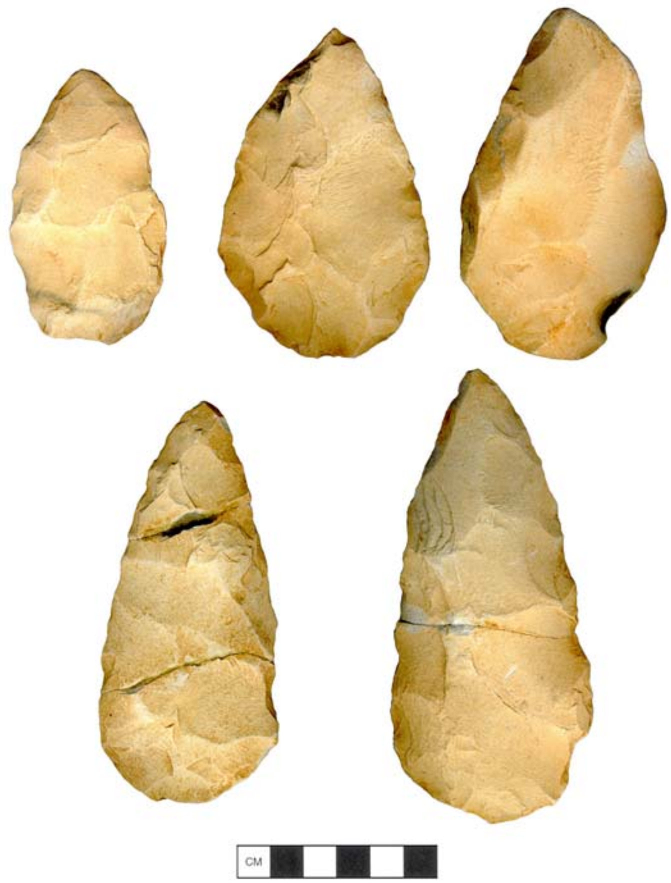

Figure 1.2. A blank and biface cache, metavolcanic material, Fort Bragg.

Sourcing Metavolcanic Rocks

This study is unique in its multidisciplinary application to a broad range within the Slate Belt, but the individual components of the tripartite methodological scheme utilized in this study (petrography, trace element analysis, isotope analysis) are not without precedent.

Although rocks of the Carolina Slate Belt have interested geologists for many years, a geoarchaeological approach to individual formations and outcrops is relatively new. The pioneering work was conducted by Daniel and Butler (1996), who documented quarry sites in the Uwharrie Mountains and characterized quarry samples macroscopically and petrographically. Daniel and Butler found important differences in groundmass texture and mineral composition upon which the current study expands. Beyond their study, however, the use of petrography in this region has been limited. Petrographic analysis is critical to understanding differences among stone raw materials and evaluating the credibility of associations based on other evidence. Hermes et al. (2001:927) note the importance of combining petrography with chemistry to distinguish among felsite, chert, and argillite as well as "varieties of look-alike felsite."

Geochemical studies of volcanic rocks have become especially important in the past two decades in southwestern regions of North America, where Jones et al. (1997:1) note that "source provenance studies of obsidian artefacts have become almost routine." In addition to obsidian, volcanic rocks such as andesite, dacite, and silicified rhyolite have been characterized using x-ray fluorescence (Dello-Russo 2004; Jones et al. 1997). In eastern North America, Bondar (2001) utilized neutron activation analysis to study metarhyolite samples from several eastern states, including North Carolina. Hermes et al. (2001) combine geochemical and petrographic analyses to evaluate the sources of rhyolites in New England. Despite the general similarity in raw material and the geochemical approach, these previous attempts to source volcanic stone vary in the techniques employed, the number of elements utilized, the statistical treatment of data, and the success of their results. The methodology remains in a formative stage and methods must be tailored to research questions and regional conditions.

Sourcing with neodymium-isotope ratios was pioneered in New England by Brady and Coleman (2000). Following previous attempts to source felsites using trace element and petrographic analyses (Hermes and Ritchie 1997), Brady and Coleman (2000:3) developed their isotopic technique to permit sourcing of artifacts to "a particular ash or lava flow within a quarry." Brady and Coleman found neodymium-isotope ratios to be an effective tool for confirming or refining previous sourcing conclusions based on visual, mineralogical, and trace-element data.

Research Design

The present study was conducted in two phases. In Phase 1, our goal was to characterize the compositional variation of quarries and evaluate potential for discrimination of metavolcanic rocks that would have been used by the prehistoric inhabitants of the Fort Bragg area. We collected 50 rock samples from 19 quarry sites in the North Carolina Piedmont and one site in the Coastal Plain. These samples were characterized by means of petrographic analysis (to provide data on mineralogy), neutron activation analysis (to provide data on a wide range of major and trace elements), and conventional mass spectrometry (to measure neodymium isotope ratios). In Phase 2, the study was expanded to include an additional 30 samples—21 rock fragments from quarries and 9 artifacts from Fort Bragg—bringing the total to 80. The new samples were studied using the same three techniques as in Phase 1. In addition, all 80 samples were examined with two more techniques: x-ray fluorescence spectrometry (to provide data on the lighter major elements that cannot be detected with neutron activation) and inductively coupled plasma mass spectrometry (to provide data on all the rare-earth elements).

For the purposes of sampling and analysis, our rock specimens were grouped into *quarry zones* based on considerations of geography, geology, and sample size. Ideally, each zone was defined to encompass quarries that formed a discrete geographical cluster, corresponded to a single geological formation (or mapped rock unit), and together produced at least six samples. The 12 zones so defined were named as follows: Uwharries Eastern, Uwharries Western, Uwharries Southern, Uwharries Southeastern, Uwharries Asheboro, Chatham Pittsboro, Chatham Silk Hope, Chatham Siler City, Orange County, Durham County, Person County, and Cumberland County (Figure 1.3, Table 1.1). In the end, two of these zones deviated from our ideal criteria. Only four samples were collected from the Chatham Siler City zone, primarily because the original quarries targeted in this area could not be relocated, and the Uwharries Asheboro zone combined samples from two different, but closely related, geological formations.

In order to directly assess the ability of our techniques to match artifacts with geological sources, the Phase 2 samples also included nine projectile points from sites on Fort Bragg. These

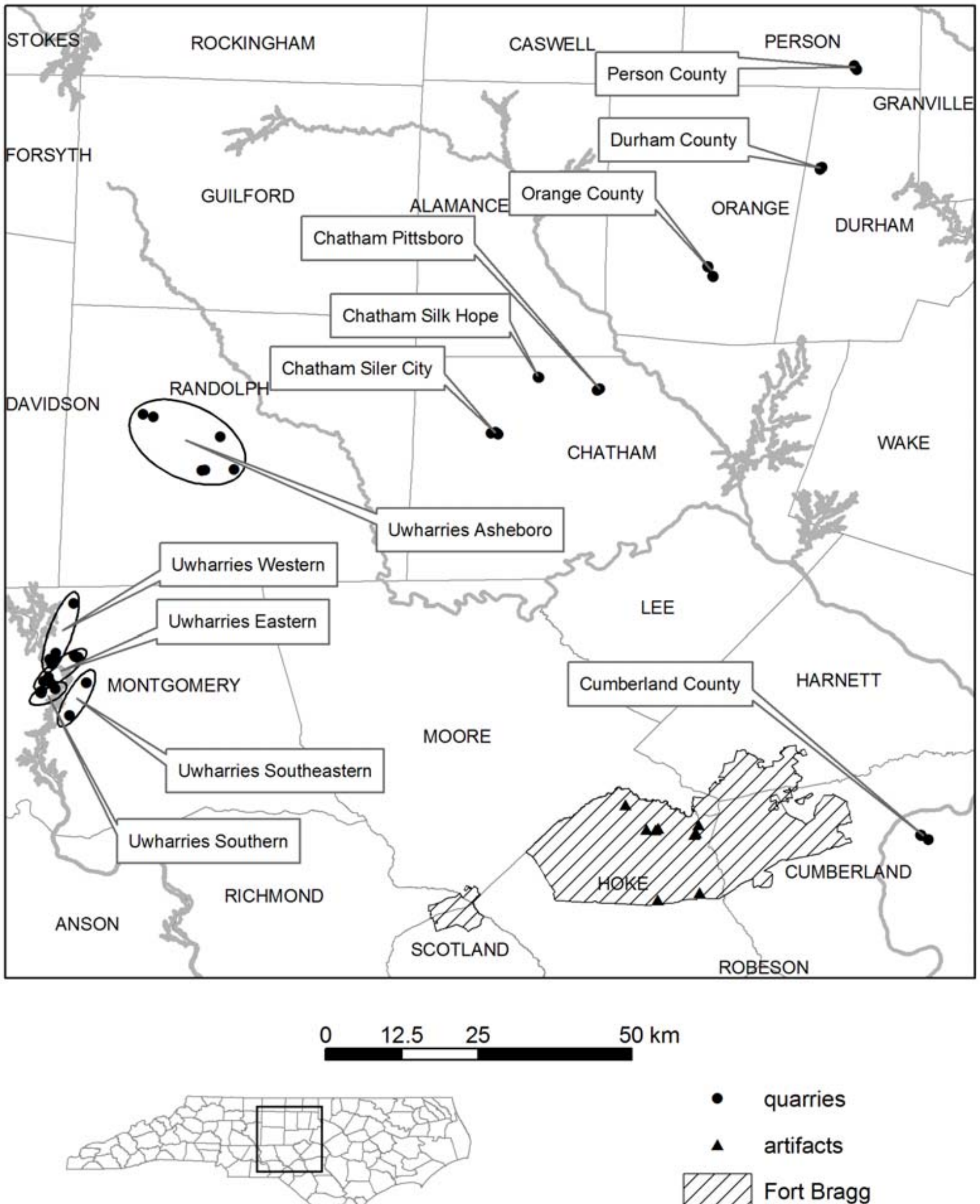

Figure 1.3. The geographic distribution of quarries, quarry zones, and artifacts used in this study.

artifacts were chosen according to three criteria. First, all were made of metavolcanic rock visually consistent with the quarry samples. Second, all belonged to a single type associated with a discrete chronological period, specifically Savannah River Stemmed points made in Late Archaic times (ca. 3000-1000 BC). And third, all were large enough to produce enough material for the various analytical techniques employed.

For the sake of consistency and clarity, our rock and artifact specimens are individually designated throughout this volume with numbers having the prefix "FBL" (for Fort Bragg lithics). Specimens FBL001 through FBL050 were analyzed in Phase 1; specimens FBL051 through FBL080 were added in Phase 2. All specimens are described in detail in Appendix A.

Table 1.1. Distribution of Quarry Samples, Phases 1 and 2.

Sample Category: Quarry Zone or Locality	Geologic Formation[a]	Mapped Rock Type[b]	Phase 1[c] (n)	Phase 2[d] (n)
Quarry samples:				
Uwharries Eastern	Tillery	felsic metavolcanic rock	7	0
Uwharries Western	Cid	felsic metavolcanic rock, mafic metavolcanic rock	7	0
Uwharries Southern	Tillery	felsic metavolcanic rock, metamudstone and meta-argillite	5	0
Uwharries Asheboro	Tillery, Uwharrie	felsic metavolcanic rock, mafic metavolcanic rock, metamudstone and meta-argillite	5	1
Uwharries Southeastern	Uwharrie	felsic metavolcanic rock	2	4
Chatham Pittsboro		metamudstone and meta-argillite	4	2
Chatham Silk Hope		intermediate metavolcanic rock	4	2
Chatham Siler City		metamudstone and meta-argillite	4	0
Orange County		felsic metavolcanic rock, metamorphosed gabbro and diorite[e]	0	6
Durham County		felsic metavolcanic rock	4	2
Person County		felsic metavolcanic rock	4	2
Cumberland County			4	2
Artifact samples:				
Fort Bragg			0	9
			50	30

[a] This column contains entries only for quarries that fall within named geological formations (North Carolina Geological Survey 1985).
[b] For quarry samples, this column contains the dominant rock type as indicated on the state geologic map (North Carolina Geological Survey 1985).
[c] Specimens FBL001-FBL050.
[d] Specimens FBL051-FBL080.
[e] Although one of the quarries in this zone is mapped in the "metamorphosed gabbro and diorite" unit (North Carolina Geological Survey 1985), the results of our analyses suggest that the sampled rocks are actually felsic metavolcanics, the discrepancy being the result of a mapping error.

The geological background, the quarry reconnaissance, and the analytical results of this study are described in the pages that follow. In Chapter 2, John Rogers provides a general overview of the geology of the Carolina Slate Belt and surrounding regions. Chapter 3, by Jeffrey Irwin and Christopher Moore, describes the quarries from which the rock samples were obtained, as well as the artifacts from Fort Bragg that were used in this study. Chapters 4-6 report on the various characterization studies that were done on these items: Edward Stoddard describes the petrography, Michael Glascock and Robert Speakman present and analyze the element data, and Drew Coleman and Brent Miller discuss the neodymium isotope geochemistry. Chapter 7 presents the overall conclusions, in which Vincas Steponaitis, Jeffrey Irwin, and John Rogers synthesize the results, evaluate the methods, and point to directions for future research. Finally, details of the analytical methods and all the raw data are gathered in a series of appendices at the end.