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LITHIC RESOURCES OF THE NORTH CAROLINA COASTAL PLAIN: PREHISTORIC ACQUISITION AND UTILIZATION PATTERNS

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The Coastal Plain of North Carolina (NC) is traditionally regarded as an area that lacks stone resources of good fracture quality. Although exceptions to this assumption occur along major rivers such as the Roanoke (Phelps 1983:22), to date, no studies fully document site specific source areas or the general distribution of source areas. The existing paradigm is an assumption, an undocumented given, that the Coastal Plain lacks predictable and reliable sources of lithic raw materials. We propose that this is not the case. Presently, there are no definitive archaeological models regarding the nature of the lithic landscape (e.g., Gould 1980; Gould and Saggers 1985) for the Coastal Plain of NC. The concept of a lithic landscape provides an environmental context to frame archaeological studies related to raw material acquisition. It also describes and defines the relative availability of lithic raw materials present for use by a population(s) in any given region (Gould 1980; Butzer 1982; Gould and Saggers 1985). This lack of a definitive model is particularly apparent in terms of how the lithic landscape relates to the patterns of prehistoric raw material procurement and use.

Our goal is to develop a baseline conceptual model that explains patterns of lithic raw material availability and the local procurement patterns of Native Americans. The primary purposes of this study are, therefore, to initiate characterization of the lithic landscape in the Coastal Plain (CP) of NC and determine how ancient Native Americans may have utilized and procured lithic resources. Key to this study is recognition of general patterns in the geomorphology of the landscape, its underlying geology, and the distribution of accessible lithic raw materials that are available for utilization as sources of stone for tool production. Specific areas in three river basins will be targeted for detailed analyses of site location, geologic and geomorphic setting, knowledge of distribution of archaeological sites, and the raw material use patterns. Once developed, the model will be tested and refined, over a long-term, more comprehensive study of prehistoric lithic raw material procurement and use. At its most basic level, this research serves as a study of human response and adaptation to the natural setting.

OVERVIEW OF COASTAL PLAIN LANDSCAPE

This section presents an overview of the NC-CP as a diverse, natural landscape and focuses on the geologic and geomorphic processes that over time created and shaped it. Emerging from this discussion is recognition of the complexity of this region and its underlying geologic framework, and the vast resource potential it offered prehistoric populations. Here we include basic descriptions of the geologic setting, surface geomorphology and landform evolution, the underlying geologic framework, and the dynamic processes that generated the Coastal Plain.

The concepts of sedimentary facies and sequence stratigraphy are introduced as predictive tools used by geologists and related to potential sources for lithic raw materials.

Generation of Maps Using Geographical Information Systems (GIS)

Regional-scale maps using ArcGIS© software were constructed with Light Detecting and Ranging (LiDAR) elevation models, and geologic and geographic features data layers. Statewide integer LiDAR from the NC Department of Transportation (NCDOT) (http://www.ncdot.org/it/gis/), with a spatial resolution of 24.4 m (80 ft), was used to produce these maps. NCDOT LiDAR data was derived from the North Carolina Floodplain Mapping Program (http://www.ncfloodmaps.com/), which provides higher-resolution data as 10,000 x 10,000-foot ASCII files, with a maximum spatial resolution of 6.09 m (20-ft).

Data layers, available from the North Carolina Geological Survey (NCGS), include polygons for the published geologic map of North Carolina (NCGS 1985), physiographic provinces, and the interpreted NC Fall Zone. Statewide geographic features (e.g., river basins and county boundaries) are available at http://www.nconemap.com. The scarp layer is from Daniels and Kane (2001). The projection is North Carolina State Plane NAD 83. To explain the geologic map, the Geological Society of America provides a geologic time scale at its website (http://www.geosociety.org/science/timescale/timescl.pdf).

Geologic Setting

The NC-CP is the emerged, landward portion of the Atlantic continental shelf (Figure 2-1A), which forms the western rim of the North Atlantic Basin. The continental shelf and rise are underlain by a seaward-thickening wedge of sediment that thins westward to a feather edge along its Fall Zone boundary with Piedmont bedrock. This clastic wedge attains a maximum on land thickness of 3009 m (9,854 ft) at Cape Hatteras (Lawrence and Hoffman 1993) and includes deposits of Cretaceous through Quaternary age (Brown et al. 1972). The greatest thicknesses (7-10 km) occur offshore beneath the continental slope and rise (Drake et al. 1968).

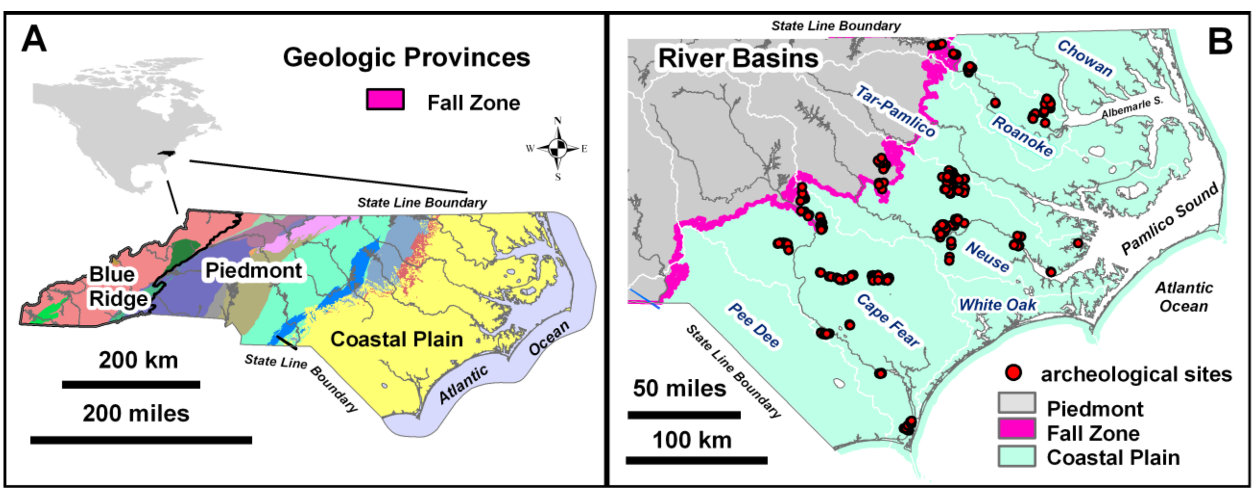


Figure 2-1. The Coastal Plain of North Carolina in the context of A) geologic provinces, and B) river basins, the Fall Zone, and archeological sites chosen for this study.

The NC Coastal Plain is mostly a relict, Plio-Pleistocene landscape characterized by a series of progressively younger scarps, or paleoshorelines, and intervening terraces that step down in elevation and age towards the coast (Figure 2-2) and into river basins (Figure 2-3). This is traditionally called stairstep topography. Seven river basins dissect the CP (Figure 2-1B) so that its low-relief, flat, eastward-dipping coastwise terraces are separated by incised valleys with terraced borders (see Colquhoun 1966). Incised valleys are commonly filled and buried on the continental shelf. Glacioeustatic changes in sea level in the Late Tertiary and Quaternary (~ the past 5 Ma) drove the marine transgressive-regressive (T-R) cycles that sculpted this landscape. The surficial deposits that underlie the relict landscape include a complex assemblage of marine, barrier island, estuarine, fluvial and other Coastal Plain deposits.

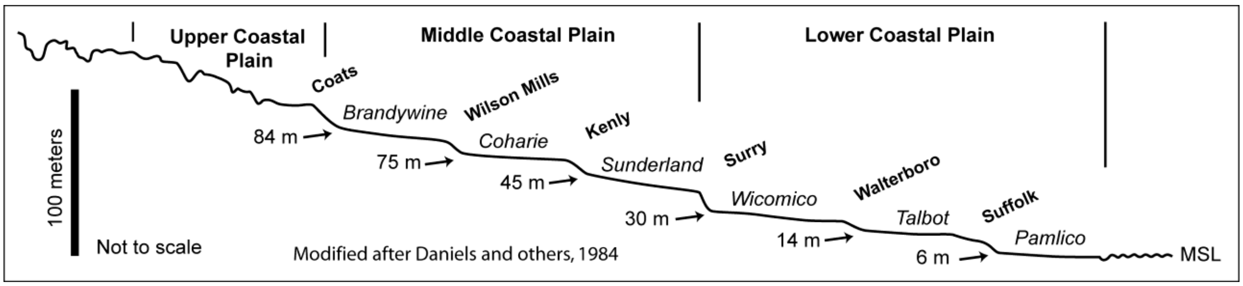


Figure 2-2. Stairstep topography (dip-parallel cross-sectional view) as depicted by a series of marine terraces that step down to the coast across interfluves in a ramp setting, between incised valleys.

Figure 2-3 shows geomorphic terminology applied to landscape position. River basin boundaries follow the highest point of land between basins (the drainage divides). Interfluves are high elevation flat areas that form (mostly) non-depositional surfaces and the divides between incised valleys (terraced drainages) (see Schumm 1993). On the Coastal Plain, interfluves correspond to the marine terraces that step down to the coast (Figure 2-2). The term ramp, derived from sequence stratigraphy terminology, refers to broad flat regions of a continental shelf, and is used interchangeably with marine terrace. Incised valleys truncate formerly extensive marine terraces. Fluvial and estuarine terraces occur in the incised valleys.

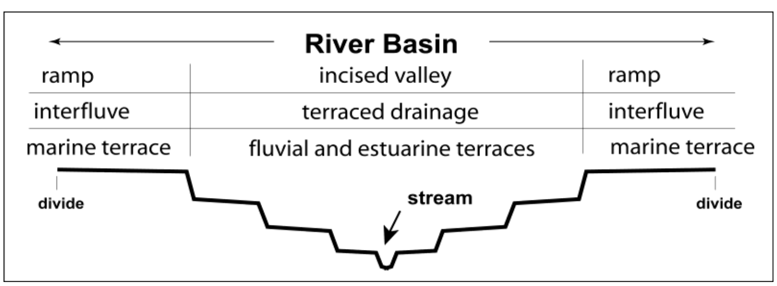


Figure 2-3. Sketch (orthogonal cross sectional view) through a river basin that shows stairstep topography from the top of an interfluve to the stream at the base of a terraced drainage. Also shown are geomorphic configurations for incised valley and ramps (sequence stratigraphy terminology), and marine, estuarine and fluvial terraces.

In the Fall Zone (Figure 2-1B), dissection of the Coastal Plain's clastic wedge is extensive, forming a zone of disconnected sedimentary outliers that overlie bedrock or saprolite (weathered bedrock). In this zone, outliers, some of which are pre-Pliocene in age, are restricted to upland interfluves, with bedrock exposed in adjacent streams. Terraces and alluvium typically border drainages and may extend upstream into the Piedmont along drainages or river valleys. Potential lithic sources in a Coastal Plain setting are: 1) *in situ* upstream bedrock, 2) upstream sedimentary outliers, 3) downstream sedimentary formations, 3) and reworked alluvium.

The archaeological sites examined here occur in the Cape Fear, Neuse and Roanoke River Basins (Figure 2-1B). Maps of the Coastal Plain show the distribution of sites in the context of surficial geomorphic features (Figure 2-4); scarps, terraces, and incised valleys, and the relative ages of the deposits (Figure 2-5). These maps are based on: 1) LiDAR elevation models, 2) named scarps (e.g., Daniels et al. 1984), 3) unpublished stratigraphic investigations by NC Geological Survey, and 4) correlative units in adjacent Virginia (Mixon et al. 1989). The following sections explain how the geomorphic conceptual model (Farrell et al. 2003) was developed for the landscape shown in these maps.

Previous Work – Surficial Geology

Traditionally, geologic maps of the Atlantic Coastal Plain are products that integrate surface landforms and subsurface stratigraphy. Early workers subdivided the Atlantic Coastal Plain into ocean-facing scarps and marine terraces (e.g., Johnson 1904; Clark et al. 1912; Cooke 1931, 1935; Flint 1940). Shattuck (1901) established the concept of a terrace formation (a flat, seaward thickening wedge of marine sediment that pinches out at the toe of a landward, wave-cut scarp). Several sources (e.g., Oaks and Dubar 1974) provide historical summaries of the terrace formation concept, its nomenclature and application. Clark and Miller (1906) inferred an emergent-submergent cycle for each maximum sea level elevation, or highstand, marked by a scarp. Glacioeustatic sea level fluctuations provided the mechanism for these cycles.

In landmark studies in eastern Virginia, Oaks and Coch (1973) recommended abandoning the terrace formation concept, recognizing that relict landforms were underlain by a complex assemblage of sedimentary deposits, or facies. They retained the idea of an unconformity-bounded unit associated with marine highstands, but included the possibility of relict coeval barrier, backbarrier, estuarine and fluvial facies preserved in more landward (and subsurface) positions. Their work also expanded the concept of a scarp from a simple wave-cut cliff to a potentially complex paleoshoreline associated with a variety of geologic environments.

With a few exceptions (Daniels et al. 1966a, 1966b, 1977a, 1977b, 1978; Oaks and Dubar 1974; Owens 1989) the shallow, post-Miocene geologic framework of eastern North Carolina is poorly known. Surficial maps based on soils morphology are available (Daniels et al. 1984, 1999; Mew et al. 2002), but do not show traditionally defined geologic map units. The geologic map of NC (NCGS 1985) mostly does not show surficial Pliocene and Pleistocene formations for the Coastal Plain. The map does show the older, underlying subcrops (Figure 2-6) that are mostly independent from surficial features. For example, surficial units east of the Suffolk Scarp are grouped as "Quaternery – Surficial Deposits - Undivided".

Formalized stratigraphic units in NC include the Pliocene Yorktown and Duplin Formations, and the Pleistocene James City, Flanner Beach, and Waccamaw Formations. The map extent and ages of these units relative to relict landforms is poorly known. These units are commonly differentiated using fossil assemblages. A web site provides historical context and citations for formal stratigraphic names (http://ngmdb.usgs.gov/Geolex/geolex_qs.html). The recent lowering of the base of the Pleistocene Epoch to correspond with that of the Quaternary System boundary (the Gelasian Global Stratotype Section and Point) so that it is at 2.58 Ma rather than the previous 1.8 Ma (Gibbard et al. 2010) impacts the local stratigraphic nomenclature significantly.

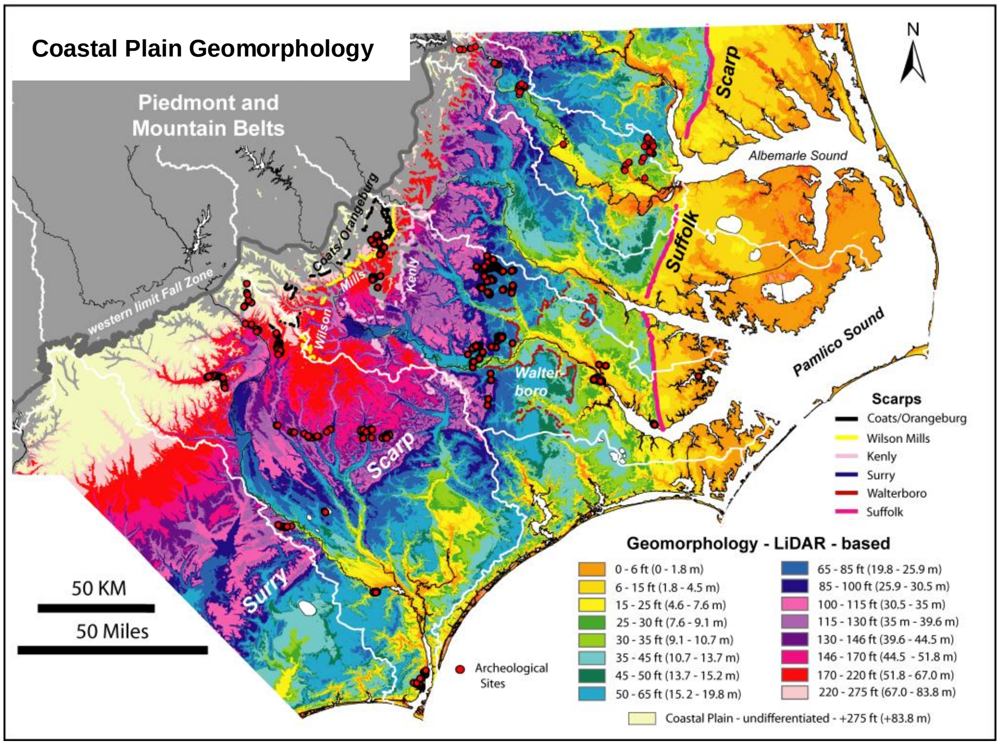


Figure 2-4. Geomorphology of the Coastal Plain of North Carolina, derived from a LiDAR-based elevation model. Scarp terminology and extents from Daniels and Kane (2001) and Daniels et al. (1984).

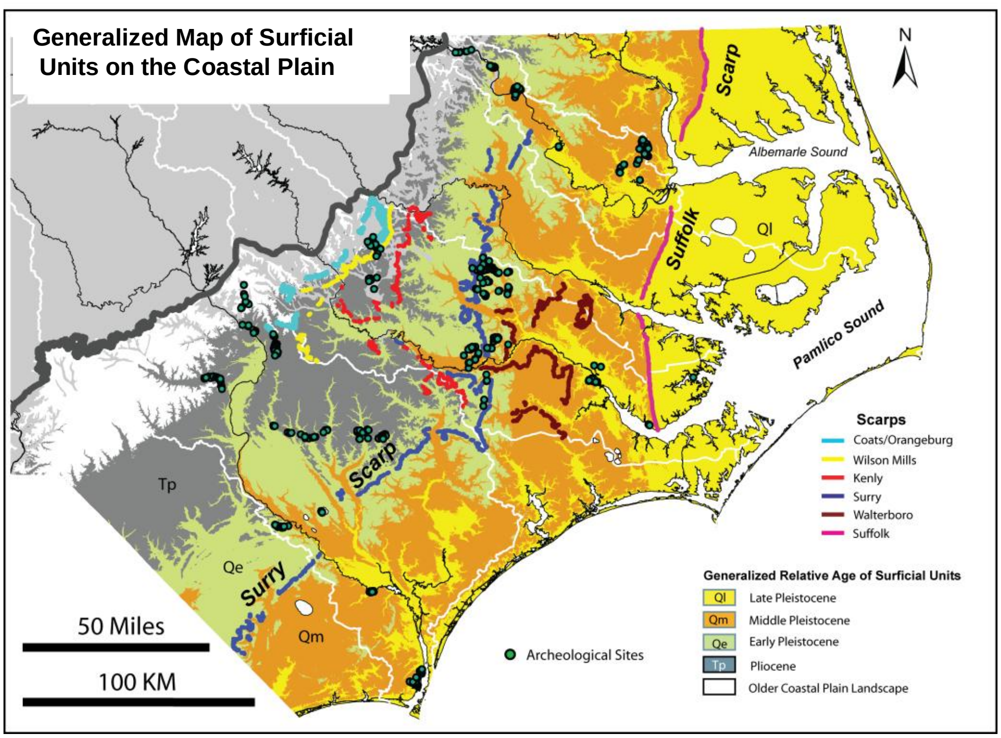


Figure 2-5. Map of surficial units showing approximate distribution of Pleistocene, Pliocene and older Coastal Plain deposits, derived from a LiDAR elevation model.

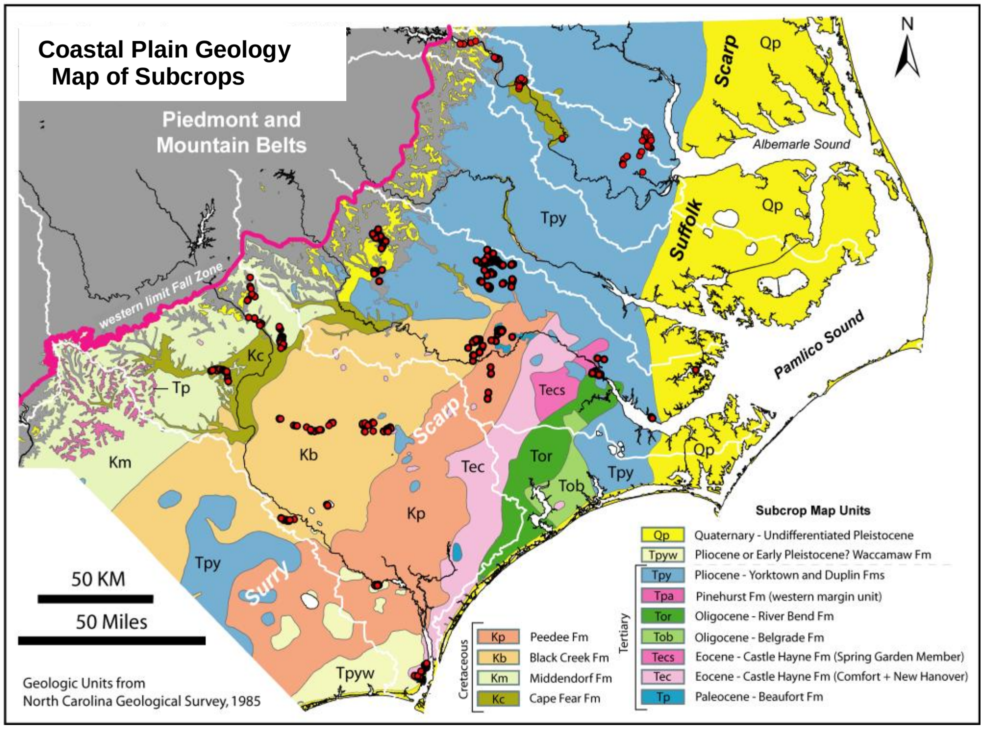


Figure 2-6. Geologic Map of North Carolina (NCGS, 1985) shows subcrop formations that underlie unmapped surficial geologic units.

Ongoing research, initiated by Riggs et al. (1992), and collaborative between the U.S. Geological Survey, NCGS, and East Carolina University, intends to integrate stratigraphy, map units, ages, marine isotope stages, and glacioeustatic sea level oscillations for Quaternary deposits (e.g., Wehmiller et al. 2010; Mallinson et al. 2005, 2007, 2010; Culver et al. 2008, 2011). Unpublished, regional-scale cross sections are in preparation (Farrell et al. 2008) for areas east of the Suffolk Scarp and the Outer Banks. To date, Parham (2009) provides the most comprehensive regional treatment of Late Pleistocene stratigraphy in this area.

Stratigraphic Concepts

Two components of a modern stratigraphic analysis - facies analysis and sequence stratigraphy - are defined here. From a geologic perspective, lithic raw materials of the CP are process-generated and facies-controlled, and are commonly concentrated along surfaces defined in a sequence stratigraphic context. Sequence stratigraphy is a recent paradigm shift for classic stratigraphers, and is considered a major revolution in geology (Miall 1995; Catuneanu 2006). Familiarity with these concepts helps describe and interpret landscape positions for archaeological studies, and predict the geologic occurrence of potential lithic sources. The Society for Sedimentary Geology (SEPM) provides examples of on-line resources to better understand sedimentary facies, dynamic stratigraphic processes, and sequence stratigraphy (http:// http://www.sepmstrata.org/).

Depositional environments, processes, landforms, and sedimentary facies are interrelated. A facies is a lithologically distinct body of rock or sediment, with geometry and internal characteristics that reflect the processes that acted together to form a deposit in a specific sedimentary environment (Krumbein and Sloss 1963). A facies is defined by a geomorphic form and its bounding surfaces and is a geometrical component of an evolving landscape (Farrell 2001). An example of a facies is a ribbon-shaped, crossbedded sand, that formed in a fluvial environment, during the channel migration process (see Farrell 2001:137). Facies, their geometries, and their stacking arrangement in the rock record, form the architectural elements of a sedimentary deposit.

Catuneanu (2006) provides definitions that are useful in linking facies with sequence stratigraphy. Facies analysis is a fundamental sedimentological method of characterizing bodies of rock with unique lithologic, physical and biological attributes relative to all adjacent deposits. A depositional system is the product of sedimentation in a particular depositional environment and includes the three-dimensional assemblage, or architecture, of strata whose geometry and facies lead to the interpretation of a specific paleo-depositional environment. Depositional systems refer to products (bodies of rock in the stratigraphic record), whereas depositional environments refer to active processes in modern areas of sediment accumulation.

The Coastal Plain clastic wedge is constructed from a series of depositional systems ranging in age from Cretaceous to Holocene. Many texts catalog depositional environments and describe facies models for a broad spectrum of depositional systems (e.g., Walker and James 2001; Reading 1996). Facies models are tools that help predict the spatial distribution of facies and their attributes in each depositional system. Catuneanu (2006:19) provides an example of a classification of depositional environments, based on the relative contributions of nonmarine and marine processes. For Coastal Plain settings, knowledge of facies models, sedimentary processes, and depositional systems provides bases for establishing geologically meaningful descriptions of the natural landscape, and predicting potential sources for lithic materials.

Sequence stratigraphy focuses on analyzing changes in facies, the geometric character of strata, and the identification of key surfaces to determine the chronological order of basin filling and erosional events; it emphasizes facies relationships and stratal architecture within a chronological framework (Catuneanu et al. 2009; Van Wagoner et al. 1990). Sequence stratigraphy includes the analysis of the sedimentary response and cyclic sedimentation patterns that emerge in response to base level changes, variations in sediment supply, and accommodation space, which is space available for sediment to accumulate (Posamentier and Allen 1999). Base level is controlled by an interplay between sea level oscillation and tectonism (uplift and subsidence), which creates accommodation. This interplay may be complex.

Facies models in the context of a sequence stratigraphic framework are useful as predictor tools. Dalrymple (1992:209) provides an example of a facies model that is relevant to identifying potential lithic sources on the southeast Atlantic Coastal Plain. This conceptual model is a hypothetical, coast-parallel, two-dimensional (2D), geologic cross section based on actual field data (Figure 2-7). It shows the predicted architecture of fluvial, estuarine and marine facies, and their bounding surfaces in a transgressive (sea level rising) system. Facies with gravel-sized clasts, the potential raw material for lithic assemblages, are generally associated with high energy current, wave, or storm conditions. Gravel, a size-grade classification term (> 2 mm diameter, after Wentworth (1922), includes granule-, pebble-, cobble- and boulder-sized clasts. Clasts are sedimentary particles. Gravel tends to be associated with fluvial and estuarine channels, tidal inlets, and along erosion surfaces such facies boundaries, transgressive surfaces, and unconformities.

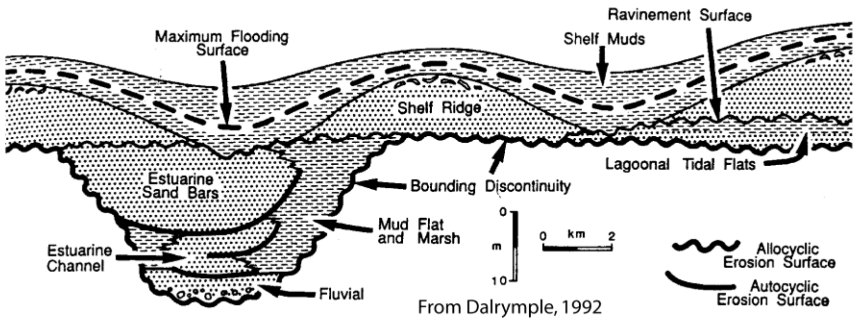


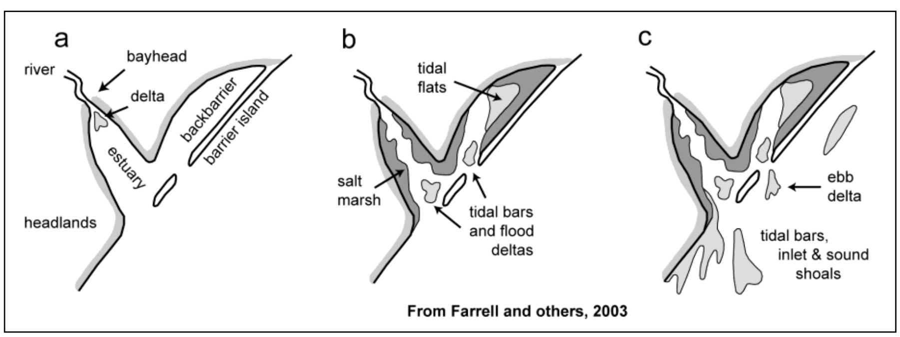
Figure 2-7. Example of a facies model that shows a hypothetical cross section parallel to a coast such as North Carolina's Outer Banks. The section shows the architecture and scale of sedimentary facies and bounding surfaces. Gravel-sized clasts may be preserved in fluvial and estuarine channel facies, and along bounding discontinuities.

Surface Geomorphology and Landform Evolution

The Coastal Plain is mantled by Holocene (modern <10,000 years old), relict Pleistocene (>10,000 – 2.58 Ma), and older relict features that are Pliocene (2.58 – 4.8 Ma) and possibly older. The Holocene rise in sea level is flooding river valleys and the interfluves between them. This section explains how a relict, dissected, Plio-Pleistocene landscape is divided into a series of progressively younger, depositional systems and their landform elements. The geomorphic configuration of the landscape, combined with the distribution of map units, provide bases for subdividing or compartmentalizing the Coastal Plain to define lithic landscapes.

The modern NC Coastal Plain (Figure 2-4) includes a set of barrier islands (the Outer Banks) that separate the Atlantic Ocean from backbarrier sounds (Albemarle and Pamlico Sounds). Rivers, such as the Cape Fear, Neuse, and Roanoke, have funnel-shaped estuaries near their mouths. These and other landforms associated with a Holocene, embayed coast are summarized in Figure 2-8 (Farrell et al. 2003). At the head of each estuary is the bayhead and its delta (Figure 2-8a); this may occur as a subaqueous feature, a tidal flat, or a vegetated marsh or wetland. Landward of the bayhead, the rivers tend to be incised into their floodplains and older terraces. At the bayhead, the river changes its form from pipe-shaped conduit to funnel-shaped estuary. Similar, relict landform patterns are repeated in the older landscapes.

Figure 2-8. Landforms associated with the Holocene embayed coastline, and other relict marine highstand positions (map view). From Farrell et al., 2003.



Elevation patterns suggest that the Coastal Plain landscape consists of a series of downstepping, paleo-coastlines with associated nested, embayed paleovalleys. Figure 2-9 is a simple conceptual model that shows a series of unconformity-bounded units, or depositional systems, that step downward to the coast and into an incised valley.

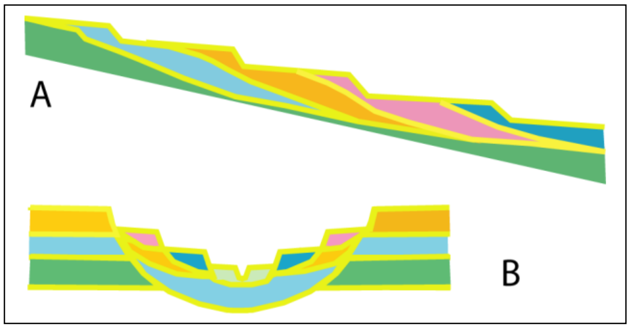


Figure 2-9. Conceptual model that shows stratigraphic architecture of a series of depositional systems, preserved in the geologic record as unconformity bounded units. A. Dip parallel section beneath coast-facing marine terraces. B. Orthogonal cross section through an incised valley.

To subdivide the Coastal Plain into unconformity-bounded units, the first task is to identify the marine (ocean facing) wave-cut scarps that mark highstand positions in relative sea level. Highstands may be marked by four coeval shorelines at the same elevation (Figure 2-8a): 1) an oceanside, coast-parallel marine shoreline; 2) a backbarrier shoreline on the leeward side of a barrier; 3) a shoreline on the headland side of a backbarrier sound, lagoon, tidal flat or salt marsh; and 4) a wave-cut scarp that extends upstream along the borders of estuaries. Figure 2-10 shows generalized shoreline features in cross section. Slope and toe elevation may vary along the extent of a shoreline. Identifying the best-fit elevation to explain all of these features is the key to defining a highstand position in relative sea level.

For each highstand position, elevation helps define smaller-scale landforms distributed along the paleoshoreline, such as those associated with estuaries and backbarrier environs (Figure 2-8b), and open shoreline (Figure 2-8c). Salt and freshwater wetland flats may border the estuary and the river channel. Landward of the bayhead, fluvial terraces mantled by wetland flats rise in elevation upstream along the drainage.

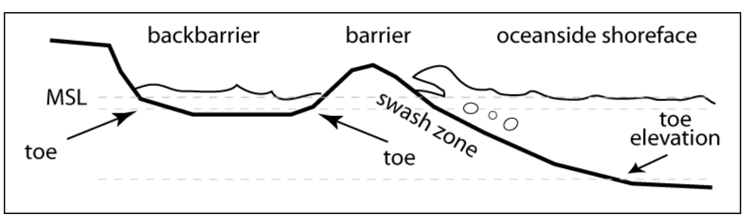


Figure 2-10. Variations in toe elevation at a marine highstand (cross sectional view) in relative sea level.

Assumptions for Stratigraphic Model

The stratigraphic model developed for southeast Virginia from a geomorphic analysis and targeted subsurface studies (e.g., Johnson and Berquist 1989; Mixon et al. 1989), applies south of the border in NC (see Figure 2-11). The model, used to help generate Figures 2-4 and 2-5, relates a series of unconformity-bounded, T-R cycles to regional landscape features and elevation. Each T-R cycle includes both paleovalley and interfluve deposits. The model (see Farrell et al. 2003) assumes that: 1) field data support development of regional relative sea level curves; 2) the shape of relative sea level curves is controlled primarily by glacial eustasy, recognizing that local sediment supply and subsidence affect landforms and differential facies thicknesses; 3) glacial eustasy affected large map extents; 4) successive highstand deposits step down to the coast; 5) unconformity-bounded T-R units are associated with sea level events; and 6) the distribution of strata related to sea level events requires confirmation via subsurface analysis at key localities. This mapping method does not provide absolute sea levels and ignores isostatic rebound.

Dynamic Processes and Lithic Resources

Our position is that, from a geologic perspective, the Coastal Plain is a dynamic, complex terrain, with great potential to yield a variable lithic landscape for human use. In this section, we explore typical associations between landscape position, dynamic geologic processes, gravel-sized clasts, and potential lithic resources. The discussion is specific for the mid-Atlantic Coastal Plain, which is part of a passive continental margin, and is based on the geomorphic and stratigraphic features preserved in that region. See Catuneanu (2006) for further information on the dynamic processes of landscape and basin evolution.

As relative sea level rises and transgresses across a Coastal Plain landscape, sedimentary environments and facies migrate landward, accompanied by an upward deepening of facies that culminates in a surface or zone of maximum flooding (Cattaneo and Steel 2003:187). As the shoreface migrates (Figure 2-10), the landscape is eroded, and a basal unconformity, or ravinement surface, is generated to mark this event. During transgressions and near highstands of sea level, sediment fills in accommodation (space) on the shelf, in estuaries and sounds, in backbarrier areas, and in the contiguous fluvial systems, provided that sediment and accommodation are available. Upstream areas are commonly incised throughout a transgression and may act as regions of sediment bypass. If the rate of sea level rise decreases relative to the rate of sediment supply, then the shoreline regresses, and progrades or migrates seaward. This process may construct a series of beach ridges that are preserved on a marine terrace. Commonly, relict topography indicates that shoreline landforms are abruptly abandoned when relative sea level falls. During falling stages in sea level or at lowstands, rivers may incise and deeply erode into terraces, valleys and subcrop formations.

Sediment deposited during T-R cycles includes mud, sand, and gravel-sized clasts. Climate and tectonic events, such as uplift in source areas and subsidence in basins, impact the relative volume of coarser grained sediment available for dispersal in a river basin or along a coast. Tectonic events affect stream slope and the amount of accommodation (space) available for infill. Some of the older and higher, coastwise terraces near the Fall Zone are mantled with near-surface, areally extensive gravel facies that may have formed as rivers and coastal zones responded to climatic, sea level, and/or tectonic events. Similar gravel facies are not common in the surficial Pliocene and Pleistocene deposits of lower elevation coastal terraces.

Cobble-sized clasts are concentrated in depositional environments associated with high-energy stream power, wave and storm energy. Incised valleys, with their terraced borders, are common sources for gravel-sized clasts. Large rock fragments may be eroded from upstream crystalline bedrock or indurated sedimentary outcrops. Coarser clasts may also be eroded from terrace deposits or geologic formations that are exposed along streams. As these clasts are transported downstream, they are broken, abraded, rounded, and redeposited. Clast size decreases in a downstream direction. In drainages, modern environments with gravel include channel floors (thalwegs), active bars, and swash-zone beaches along rivers and estuaries. On the open coast, modern gravels may be concentrated in swash zone beaches (Figure 2-10), in tidal inlets, and on overwash fans on barrier islands. Gravel beds that are components of surficial or subcrop formations may be exposed and eroded from headlands, from subaerial outcrops, or from subaqueous outcrops in channels or in the shoreface (see Figure 2-10). Reworked gravel may be redeposited onto beaches and bars, especially in response to storm events.

Gravel lags commonly overlie geologic contacts such as unconformities, transgressive or ravinement surfaces, or facies contacts. The erosive and transporting power of stream flow may concentrate gravel-sized clasts in channel thalwegs (deepest part of channel). As thalwegs migrate, the gravel pavement migrates and expands in area, and the basal gravel becomes buried by a channel, bar, or inlet fill. Transgressive surfaces may occur at the bases of estuarine and marine facies. At the leading edge of the transgression, wave and storm energy is concentrated on the beach, shoreface and shallow shelf. This erosive power, accompanied by the landward migration of the shoreface over time, erodes and reworks pre-existing deposits. Surfaces interpreted as unconformities that separate formations commonly originate as transgressive surfaces or are associated with fluvial incision, or are subaerial surfaces of erosion. Gravel-sized clasts originating in older, pre-existing deposits are reconcentrated as lags at the base of the next younger T-R cycle. Near sediment source areas (Fall Zone), gravel-rich facies are common on upland coastwise terraces.

In summary, the Plio-Pleistocene landscape of the Coastal Plain consists of a series of downstepping marine-facing terraces that are truncated by incised valleys with terraced borders (Figure 2-9). In valley settings, gravel occurs: 1) upstream near exposures of bedrock; 2) in bars along modern streams, 3) in channel facies that underlie valley terraces, and 4) along unconformities. On interfluves, coast-facing terraces (Figure 2-9A) typically include gravels along unconformities and ravinement surfaces, or buried in fluvial, estuarine, or inlet channel-fill facies, or other high energy facies. Proximal to the sediment source, the Fall Zone, gravel facies with potentially significant thicknesses and large areal extents occur in the shallow subsurface beneath upland terraces. Surficial units further east do not include comparable gravel deposits. Stream and wave erosion, however, may erode and expose buried gravels to produce localized, long-standing outcrops, also useful as potential lithic sources.

LITHIC RESOURCES AND THE GEOLOGIC FRAMEWORK

Here potential lithic sources are examined in the context of subcrop formations (Figure 2-6), geomorphology, and surficial map units (Figures 2-4 and 2-5). A regional scale overview is presented first. Then, the Cape Fear, Neuse and Roanoke river basins are examined in detail. The subcrop formations in Figure 2-6 are based on NCGS (1985). The map is not current, but is a starting point for integration. Through the scientific process, more recent studies (e.g., Horton and Zullo 1991) provide bases for reinterpreting and revising this map. Citations documenting formalized stratigraphic nomenclature are provided at the U.S. Geological Survey's website (http://ngmdb.usgs.gov/Geolex/geolex_qs.html). Conceptual models for geomorphology (Figure 2-4) and surficial units (Figure 2-5) are based on: 1) correlation charts (Ramsey 1992; Krantz 1991) and maps (Mixon et al. 1989), 2) interpreted LiDAR elevation models, and 3) unpublished

Series	Subseries, Stages	Age (MA)	Alloformations and Extent				
			Virginia Coastal Plain Berquist, 2007, pers. comm. Revised after Mixon et al, 1989		Virginia Map Extent Geomorphic Features		
			Formations	Members	Elevation - Surface		Scarp Toe
					Ft	Meters	"Highstand"
Holocene							
Pleistocene	Late		Tabb Fm	Poquoson Mbr.	6 -10 ft	1.8 - 3.3 m	10 ft/ 3.3 m
				Lynnhaven Mbr.	10 -18 ft	3.3 - 5.5 m	18 ft/ 5.5 m
		0.12		Sedgefield Mbr.	18 -28 ft	5.5 - 8.5 m	28 ft/8.5 m
	Middle		Shirley Fm		28 - 48 ft	8.5 - 14.6 m	48 ft/14.6 m
		0.78	Chuckatuck Fm		48 - 55 ft	14.6 - 16.8 m	55 ft/16.8 m
	Early		Charles City Fm		55 - 70 ft	16.8 - 21.3 m	70 ft/21.3 m
			Windsor Fm		70 - 95 ft	21.3 - 29.0 m	95 ft/29.0 m
			Moorings Unit	barrier/beach	95 - 125 ft	29.0 - 38.1 m	115 ft/35 m
		1.80		backbarrier	95? - 115 ft	29.0? - 35.0 m	115 ft/35 m
Pliocene			Bacons Castle Fm	Barhamsville Varina Grove	115 - 170 ft	35.0 - 51.8 m	170 ft/51.8 m
			Chowan River Fm				

Figure 2-11. Chart showing relative ages and map units for Virginia's Coastal Plain Map (Mixon et al., 1989). This diagram does not incorporate revisions to the Pleistocene proposed by Gibbard et al. (2010).

subsurface studies by the NCGS. Figure 2-2 shows nomenclature (Daniels and Gamble 1974; Daniels et al. 1966a) for scarps and terraces. Figure 2-11 compiles surficial units in adjacent Virginia, their respective relative ages, and elevation of surface expression.

Regional Subcrop Geology

The subcrop formations (Figure 2-6) that underlie the surficial Pliocene and Pleistocene units mostly predate the incised paleovalleys and relict coastal terraces that form the modern Coastal Plain landscape. Generally, the subcrop formations dip and thicken eastward as older units are replaced by progressively younger units. Subcrop units are intercepted in boreholes and are exposed beneath the surficial units along streams, in pits and mines, and in other man-made and natural outcrops. A dramatic change in map patterns, that may be fault controlled, occurs along the Neuse River and its upper tributaries.

North of the Neuse, relatively younger subcrop units are exposed closer to the ground surface. West of the Suffolk Scarp is the areally extensive Pliocene-age, Yorktown/Duplin Formation; its actual extent is poorly known. Outcrops of the Cretaceous Cape Fear Formation occur along upstream reaches of the Roanoke River. East of the Suffolk Scarp, the region is mapped as undifferentiated Pleistocene, and includes the thickest Pleistocene section (>60 m). The Yorktown and Pleistocene units overlie the Miocene Pungo River Formation (not shown) which is mined for phosphate at Aurora, NC.

South of the Neuse, relatively older subcrop units are exposed near the ground surface, and lithologic materials are more diverse. Shallow subcrops include the Cretaceous Cape Fear, Middendorf, Black Creek and Peedee Formations (NCGS 1985). The stratigraphy of Cretaceous units is currently under revision by the U.S. Geological Survey, but the new units are not yet mapped and are not discussed here. For simplicity, we use here the former terminology shown in Figure 2-6. Subcrop belts of the Paleocene-age Beaufort, the Eocene Castle Hayne, and the Oligocene River Bend and Belgrade Formations successively overlie the Peedee. The Yorktown/Duplin and Pleistocene Waccamaw Formations form the youngest subcrops. Near the Fall Zone, the Pinehurst Formation, of enigmatic age, overlies the Middendorf and other units.

Coastal Plain formations are typically composed of siliciclastic and/or bioclastic sedimentary particles, with some intervals containing concentrated plant debris (peats and lignites), glauconite, or phosphate clasts. Generally, siliciclastic units are dominated by the silicate minerals (e.g., quartz, feldspar, mica) and possibly, variegated rock fragments. Bioclastic units, which include limestones, typically include clasts composed of calcium carbonate (the allochems - fossils, pellets, oolites and intraclasts). In NC, whole and broken fossils (shells) dominate.

Along the Cape Fear River, the four Cretaceous formations are mostly siliciclastic. The Middendorf and Cape Fear include facies interpreted as fluvial channel and floodplain. Gravels that include quartz, rock fragments, and petrified wood are common in channel facies, and at their basal contacts. The overlying Black Creek may include some thin shell beds. Its basal unconformity is, at least locally, overlain by relatively thick, estuarine channel gravels. The unit also includes high energy tidal bar facies with gravel and finer-grained marine units. Gravel-sized clasts in the Black Creek include petrified logs, lignitized logs and plant debris, quartz, variegated rock fragments, slump blocks, intraclasts, and bone. Some clasts, such as logs and slump blocks, are boulder sized. The overlying Peedee is a marine shelf deposit with dark gray muds and sands; these are punctuated by thin beds (< 0.5 meters thick) that include gravel-sized shell, quartz, and rock fragments. In downdip areas, Cretaceous deposits in the subsurface include bioclastic sediment.

The Paleogene section includes Paleocene, Eocene and Oligocene formations. These dominantly marine units include siliciclastic, bioclastic, and compositionally mixed facies; concentrated glauconite and/or phosphate may be present. This section may be variably cemented with calcite and other minerals, forming plastic, friable, and brittle rocks. Marine unconformities are commonly associated with thin, cemented beds and gravel lags that include shells, quartz, phosphate, and rock fragments. Paleocene deposits locally include porcellanite, a low density (porous) siliceous rock. Oligocene strata are locally cemented with silica or dolomite, and include thin chert-like beds. The New Hanover Member of the Castle Hayne is a brittle rock that includes cobble-sized rock fragments. Rounded, quartz cobbles and other rock fragments occur in the Pinehurst.

The Waccamaw and Yorktown/Duplin are fossiliferous marine units with basal unconformities and facies that include bones, logs and wood, phosphate nodules, quartz, and reworked rock fragments. Reworking of underlying Miocene strata contributed cobble-sized phosphate nodules, variegated rock fragments, fossils and bone fragments into younger formations and onto modern beaches.

The geomorphic map (Figure 2-4) shows the general relationship between river basins, paleovalleys, and the relatively undissected interfluves between the valleys. Several of the scarps (Figures 2-2, 2-4 and 2-5) (the Coats, also known as Orangeburg, Surry, and Suffolk Scarps) are components of regionally extensive (> 500 km) ancient shorelines (Winker and

Howard 1977). The generalized distribution of Pliocene, and Early, Middle and Late Pleistocene deposits is shown in Figure 2-5. The Surry Scarp, Walterboro and Suffolk Scarps are respectively Early, Middle and Late Pleistocene landforms. Early Pleistocene deposits appear to extend westward to some of the traces of the Kenly Scarp. Late Pleistocene surficial deposits occur east of the Suffolk Scarp and beneath upstream terraces in valleys.

The Surry Scarp formed as a latest Pliocene to Early Pleistocene shoreline (Mixon et al. 1989). It is defined here as a highstand shoreline at about 31 m (possibly as high as 35 m). Its toe elevation is about 29 m (Flint 1940; Johnson et al. 1987; Daniels et al. 1984). West of the Surry Scarp is the extensively dissected Sunderland Plain. This is a Pliocene headland that predates the Surry shoreline; east of the Kenly Scarp, it is underlain by a unit equivalent to the Late Pliocene Bacons Castle Formation (Mixon et al. 1989; Ramsey 1992). Near the Surry Scarp, this Pliocene unit is overlain by a barrier island complex that is in the same stratigraphic position as the Moorings Unit in Virginia. The Moorings Unit (32-36 m) is a latest Pliocene to Early Pleistocene barrier island complex (Mixon et al. 1989) that extends southward from Moorings, Virginia to NC's Neuse River Basin. It includes barrier island sands along the Surry Scarp, and extensive backbarrier flats behind it. These units are exposed in a quarry at Fountain, NC where Early Pleistocene backbarrier foraminifera were identified (Snyder and Katrosh 1979).

East of the Surry Scarp is the Wicomico Terrace. This feature extends eastward to the Walterboro Scarp, but, it is erosionally notched along two, low, discontinuous, unnamed scarps (at ~26 m and 20 m) that face the coast and local drainages. The higher western part of the plain (at ~26-31 m) is underlain by a unit equivalent to the Windsor Formation. The Windsor is Early Pleistocene in age (1.6 to 0.7 Ma) (Krantz 1991). Below 26 m is a lower and flatter plain (at ~20-25 m), that is mantled by a unit that correlates with the Charles City Formation. The Charles City is also Early Pleistocene (Johnson and Berquist 1989; Mixon et al. 1989), but postdates the Windsor. Between 20 m and the Walterboro Scarp are surficial deposits that correlate with the Chuckatuck Formation. The Chuckatuck is Middle Pleistocene (Johnson and Berquist 1989; Mixon et al. 1989). This unnamed scarp at 20 m is, potentially, the landward updip limit of surficial, Middle Pleistocene deposits. East of it, the middle Pleistocene Walterboro Scarp, a highstand shoreline at 15 m, separates the Wicomico from the Talbot Terrace. The middle Pleistocene generated Talbot Terrace extends eastward to the Suffolk Scarp, a predominantly Late Pleistocene feature.

Surficial deposits seaward of the Suffolk Scarp are Late Pleistocene and Holocene in age. The Suffolk shoreline likely formed in Late Pleistocene time, but was likely occupied at least twice. A unit that correlates with the Shirley Formation, which is Late Middle Pleistocene in age (Johnson et al. 1987), lies between the highstand shorelines at 15 m and 10 m, but there is an additional highstand shoreline or notch at 12 m. Three T-R cycles are associated with Late Pleistocene deposits in southeast Virginia. These form the three members of the Tabb Formation. In NC, these respectively have highstand shorelines at 10, 7, and 4 meters. The Arapahoe Ridge complex, and the associated "Cherry Point Member" of the Flanner Beach Formation are likely associated with the 10 m highstand. The 7 m highstand approximately coincides with the "toe" of the Suffolk Scarp. Parham (2009) provides a discussion of Late Pleistocene stratigraphy near the Suffolk Scarp. Mallinson et al. (2007) provide additional information on the age of features associated with and east of the Suffolk Scarp.

Upper Cape Fear River Basin

Geomorphology, surficial deposits, and subcrop geology for the upper Cape Fear are shown in Figure 2-12. For this discussion, the upper Cape Fear includes the terraces and incised valleys that are landward of the Surry Scarp. These include Middle Pleistocene and older deposits. Here the Surry Scarp prominently separates upland terraces, or ramps, of the middle Coastal Plain from the Wicomico and younger marine terraces of the lower CP. Marine terraces are crosscut and dissected by an incised paleovalley complex (Figure 2-12D) that includes deposits that are Early Pleistocene and younger in age. The valley fill includes a probable Early Pleistocene longitudinal bar complex.

Generally, the archaeological sites used for this study are situated on Early Pleistocene, Pliocene and older uplands, near streams or lakes (Figure 2-12B). Subcrops that are exposed in eroding banks along the upper Cape Fear River include all four Cretaceous units and the Waccamaw Formation. All contain gravel-sized clasts. The Surry Scarp follows the unconformity that separates the Cretaceous Black Creek Formation from the overlying Peedee. The archaeological sites are clustered in several areas: 1) upstream on Pliocene and older terranes near the Fall Zone and bedrock outcrops; 2) on the middle Coastal Plain, upland Pliocene terranes along incised streams; 3) on Early Pleistocene uplands near the Cape Fear River; and 4) along a lake on an Early Pleistocene terrane. Most of these sites occur near streams that are potentially reworking Cretaceous gravels. The Cape Fear and Middendorf Formations provide fluvial channel gravels; the Black Creek Formation provides thick estuarine gravels. The base of the Waccamaw Formation contains cobbles that are exposed in cliffs along the river.

Lower Cape Fear River Basin

Geomorphology, surficial deposits, and subcrop geology for the lower Cape Fear are shown in Figure 2-13. For this discussion, the lower Cape Fear includes the terraces and incised valleys that are seaward of the Surry Scarp. These are Middle Pleistocene and younger in age, with Early Pleistocene units exposed near the Surry Scarp. East of the Surry, the landscape is flat, and incised valleys have low relief. Subcrops eroded here include the Peedee, Castle Hayne, and Waccamaw Formations. The Peedee has areally extensive thin beds with gravel-sized clasts that are exposed locally in river cliffs. Gravel derived from upstream outcrops could be transported downstream into these lower reaches. In cliffs along the Cape Fear, cobbles at the base of the Waccamaw are exposed. Near Lake Waccamaw, cobble sized rock fragments from the same unit, are concentrated, as lime dissolves, in the soil profile (< 2 m depth). Castle Hayne limestones may be exposed in streams beds that dissect the Middle Pleistocene landscape. Shoreline beaches here could concentrate clasts of sediment debris that originate in subaqueous outcrops. The archaeological sites considered here occur in two clusters near the Cape Fear River: 1) upstream near cliff banks that include Waccamaw gravels, and 2) downstream near estuarine beaches that accumulate clasts reworked from Pleistocene and possibly older strata.

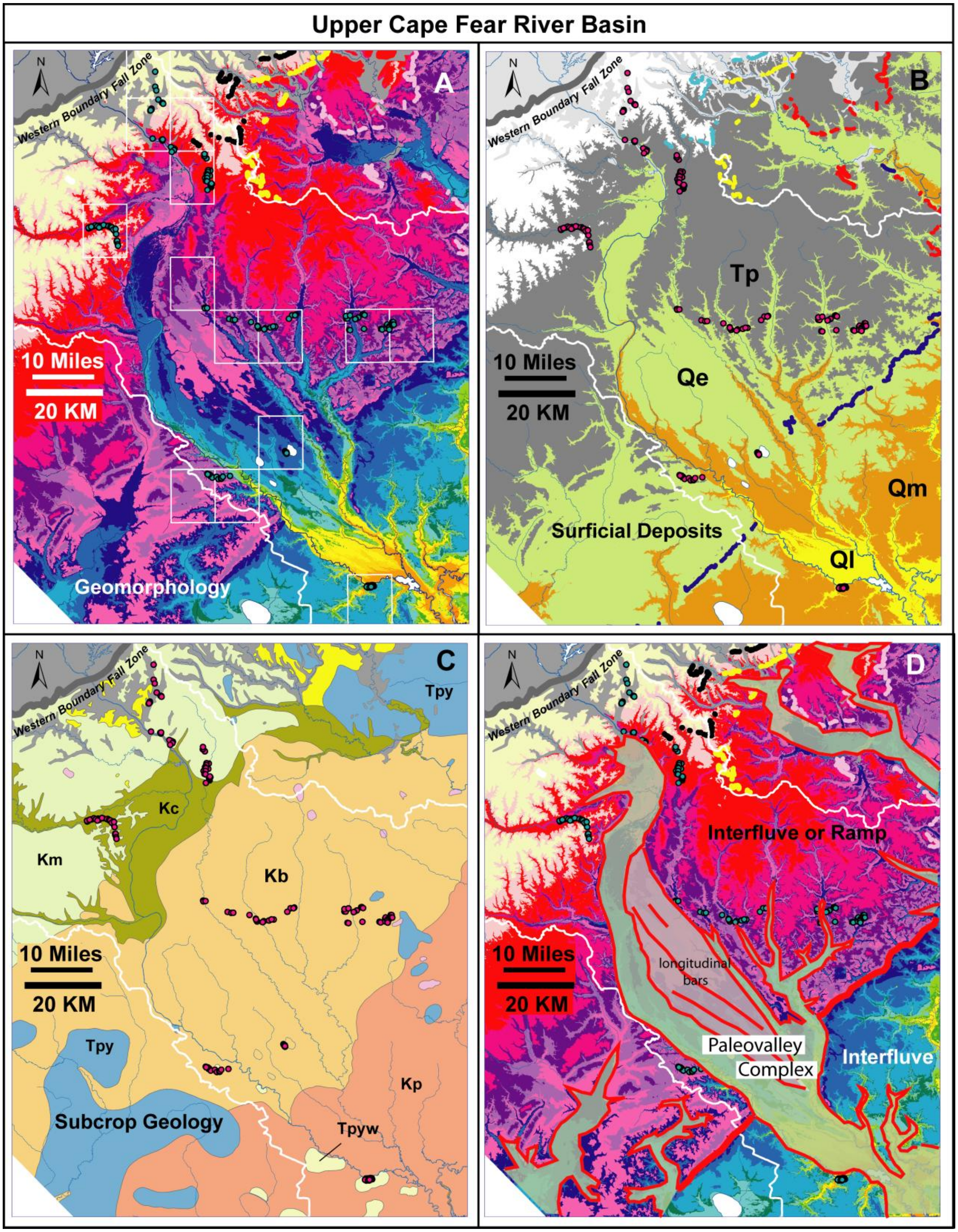


Figure 2-12. The Upper Cape Fear River Basin shows the distribution of archaeological sites in the context of: A) geomorphology, B) surficial geologic units, C) subcrop geologic units, and D) interfluves (ramps) and incised paleovalleys. Legend is included in Figure 13.

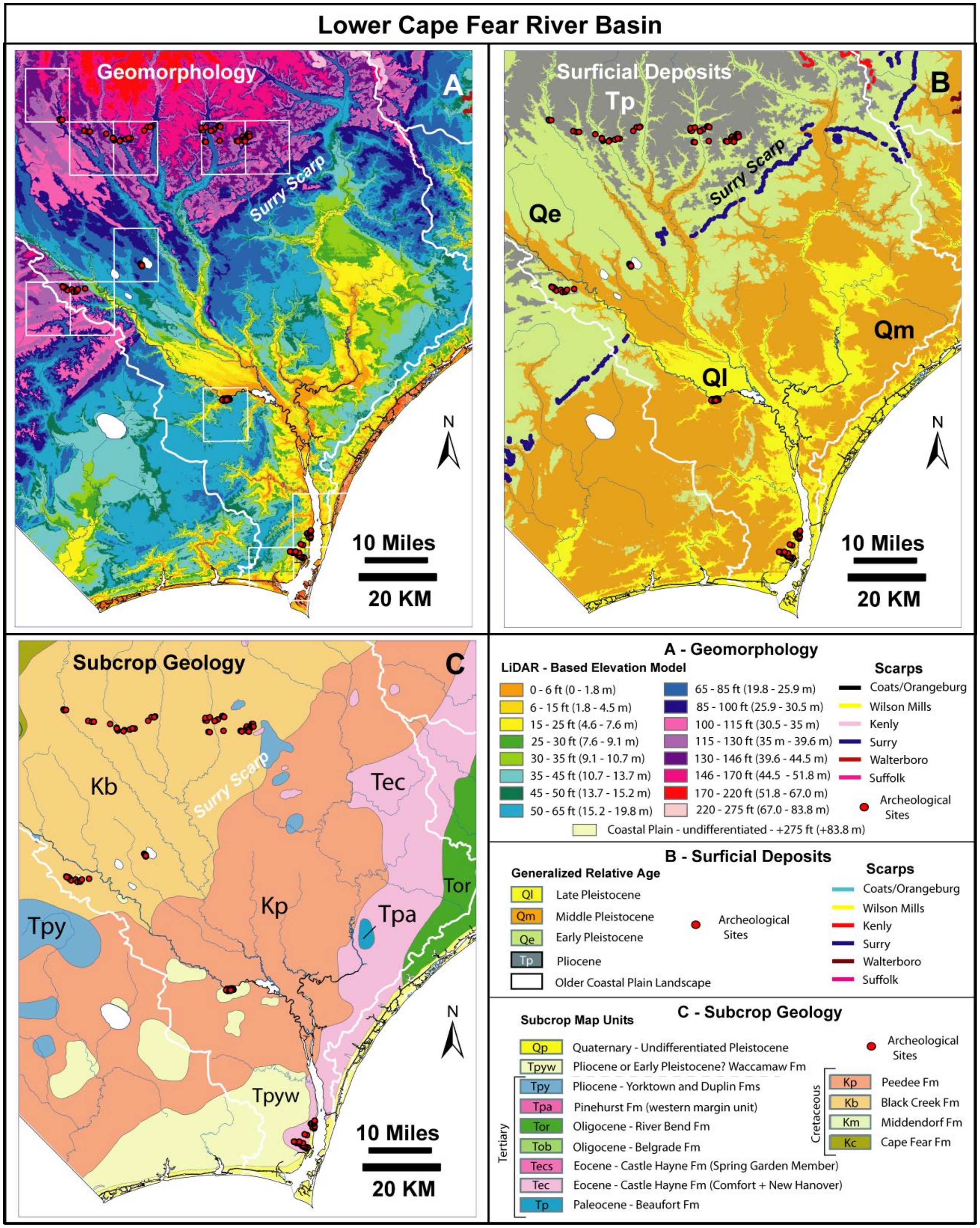


Figure 2-13. The lower Cape Fear River Basin shows the distribution of archaeological sites in the context of: A) geomorphology, B) surficial geologic units, and C) subcrop geologic units.

Middle to Upper Neuse River Basin

Geomorphology, surficial deposits, and subcrop geology for the middle to upper Neuse are shown in Figure 2-14. This discussion includes the interfluves and incised valleys near the Surry Scarp, upstream to the Fall Zone, where sites cluster in an area of crystalline bedrock and Coastal Plain outliers. In downstream areas, most sites occur along streams near the Surry Scarp.

North of Contentnea Creek, archaeological sites cluster along Little Contentnea Creek, which headwaters in the Surry Scarp area, in some cases, possibly as springs. Little Contentnea Creek was formerly an open water stream, until storms and management practices changed it into wetlands in the early 1960s. These sites sit on an Early Pleistocene landscape. The subsurface stratigraphy is well known here from boreholes (NCGS, unpublished data), but outcrops are rare. An exception is the quarry on the river basin boundary at Fountain, NC, where granodiorite bedrock is exposed at the ground surface near the upper reaches of Little Contentnea Creek. Coastal Plain formations lap up and shallow around this bedrock dome, so that a series of unconformities approaches the ground surface. In the quarry, cobble-sized quartz and rock fragments occur along the unconformity at the base of the Yorktown Formation. Above this, is a thick, high-energy shelly facies with gravel-sized clasts. The Yorktown is overlain by a probable Early Pleistocene unit with boulders and cobbles of crystalline rock along its basal unconformity. Boulders are exposed at the ground surface here. Cobbles from these unconformities are likely reworked into local stream beds.

South of Contentnea Creek, the selected archaeological sites cluster along second order streams in the Early Pleistocene landscape. West of the scarp, the landscape is more highly dissected than east of it. Some sites are located in the Middle Pleistocene and younger paleovalley. The subcrop map indicates that in this area, the trace of the Surry Scarp follows the unconformity at the base of the Peedee, and many of the sites are fairly close to this boundary. We cannot confirm if gravel occurs at the base of the Peedee. The Black Creek Formation could provide coarse clastic debris from upstream reaches of the Neuse.

Lower Neuse River Basin

Geomorphology, surficial deposits, and subcrop geology for the lower Neuse are shown in Figure 2-15. For this discussion, the lower Neuse includes terraces and incised valleys that are in the vicinity of the Walterboro Scarp and east. This region is flat with low relief and few outcrops. All sites are situated in a Late Pleistocene landscape. Most are concentrated in the region of the bayhead delta, at the head of the estuary, at the confluence of several streams. This area also corresponds with the unconformity at the base of the Oligocene formations. Limestone outcrops occur upstream from here and in tributaries. All the sites are near the banks and shoreline of the Neuse and its tributaries. New unpublished data (NCGS) suggests that the Yorktown Formation, although documented in the literature, is not exposed along the Lower Neuse; nor does it occur in the subsurface in coreholes, south of the Neuse. Outcrops of Pleistocene units with shell beds are present along the lower Neuse. Potential local sources for lithic clasts here are storm deposits on beaches, and outcrops on the Neuse and its tributaries. Clasts derived from upstream sources may also be concentrated here.

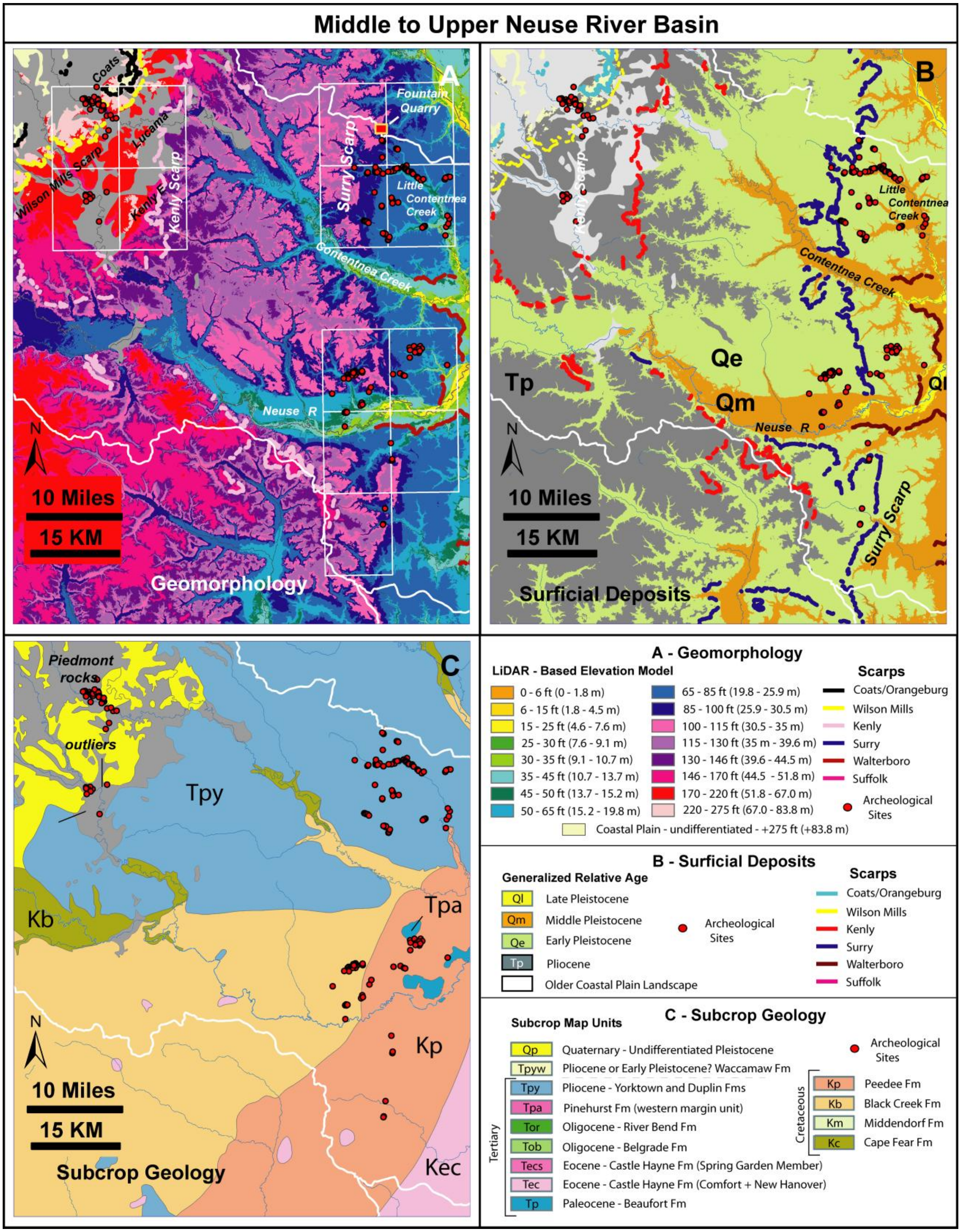


Figure 2-14. The middle to upper Neuse River Basin shows the distribution of archaeological sites in the context of: A) geomorphology, B) surficial geologic units, and C) subcrop geologic units.

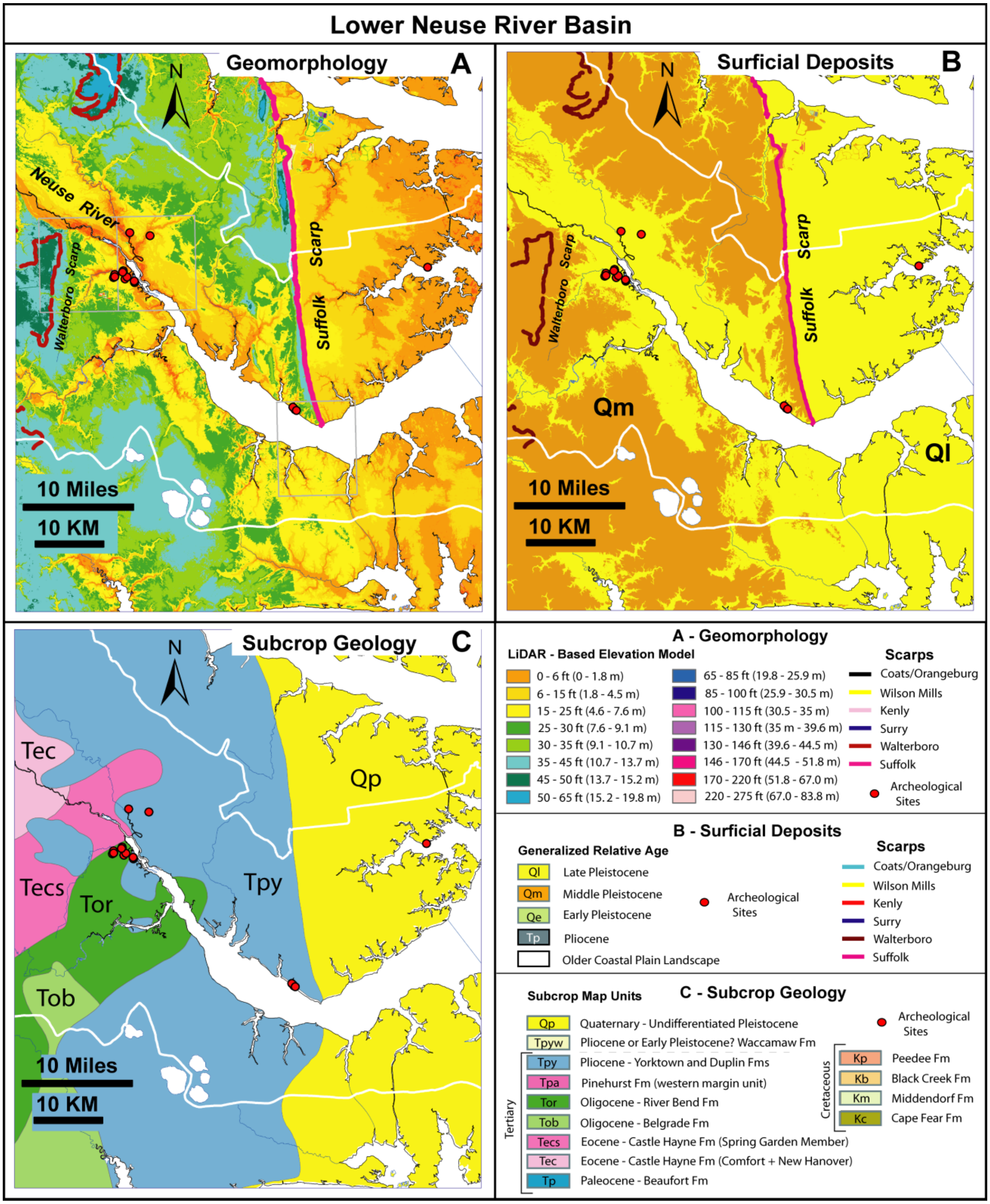


Figure 2-15. The lower Neuse River Basin shows the distribution of archaeological sites in the context of: A) geomorphology, B) surficial geologic units, and C) subcrop geologic units.

Upper Roanoke River Basin

Geomorphology, surficial deposits, and subcrop geology for the upper Roanoke are shown in Figure 2-16. For this discussion, the upper Roanoke includes the Fall Zone and terraces and incised valleys that are landward of the Surry Scarp. The archaeological sites occur in three clusters near the Roanoke River. At the upstream end, the first cluster occurs in the Fall Zone in a bedrock terrane associated with Coastal Plain outliers on uplands. Moving downstream, the second cluster occurs in an area with bedrock outcrops along streams. Here however, the Yorktown Formation overlies bedrock and its basal unconformity may be locally exposed. Also, this area marks the updip limit of Early Pleistocene units, a basal unconformity or gravelly facies may outcrop in river banks. The third cluster is downstream from exposed bedrock, with most sites occurring along the river in the Middle Pleistocene incised valley. Some occur on the Early Pleistocene landscape. The subcrop map indicates that basal Yorktown is exposed upstream from the cluster, and that the gravelly Cape Fear Formation, may be exposed along the Roanoke.

Lower Roanoke River Basin

Geomorphology, surficial deposits, and subcrop geology for the lower Roanoke are shown in Figure 2-17. For this discussion, the lower Roanoke includes terraces and incised valleys, seaward of the Surry Scarp. This area is low relief with few outcrops. The subcrop map shows that the Yorktown is areally extensive, with its basal unconformity exposed along the Roanoke. One site is located in the Late Pleistocene valley complex, near this unconformity, along the river. Other sites are not near the Roanoke River. Many cluster near the drainage divide along the northeast border of the Roanoke Basin, possibly associated with stream headwaters, upland pocosins, or Carolina Bays. Other sites occur in Late Pleistocene incised valley, or on Middle Pleistocene upland terraces. Except for stream banks, river bars, and beaches, local sources for large clasts suitable as raw material are likely not available locally.

PREVIOUS ARCHAEOLOGICAL RESEARCH

Within the Coastal Plain region of NC, very little research has focused on documenting lithic sources or resource acquisition and prehistoric procurement patterns. This is not the case in adjoining regions, where more specific research addresses lithic raw material procurement and distribution in terms of prehistoric settlement patterns in South Carolina (Blanton 1983; Blanton et al. 1986; Sassaman et al. 1988; Anderson and Hanson 1988; Blanton and Sassaman 1989; Tippett 1992; Cable et al. 1996) and northward in the Middle Atlantic Region (Gardner 1979; Geier 1990; Stewart 1989).

Chert and quartzite quarries are recorded along the Fall Zone in Virginia (McAvoy 1992). Allendale chert quarries are recorded in the Coastal Plain of South Carolina (Goodyear and Charles 1984). Quartzite quarries occur in the Coastal Plain of South Carolina in the lower Santee River valley (Charles 1981; Anderson et al. 1982; Goodyear and Charles 1984) and also in the Savannah River valley (Goodyear and Charles 1984). A short distance west of the NC-CP, Lautzenheiser et al. (1996) record a chert quarry (Piedmont Chert) in the eastern Piedmont (Lee County). A source of jasper (Montgomery County Agate) is recorded in the Uwharrie Mountains in Montgomery County (Abbott 1996; Abbott and Harmon 1998). To date, however, chert or jasper quarries are not described in detail in the NC-CP.

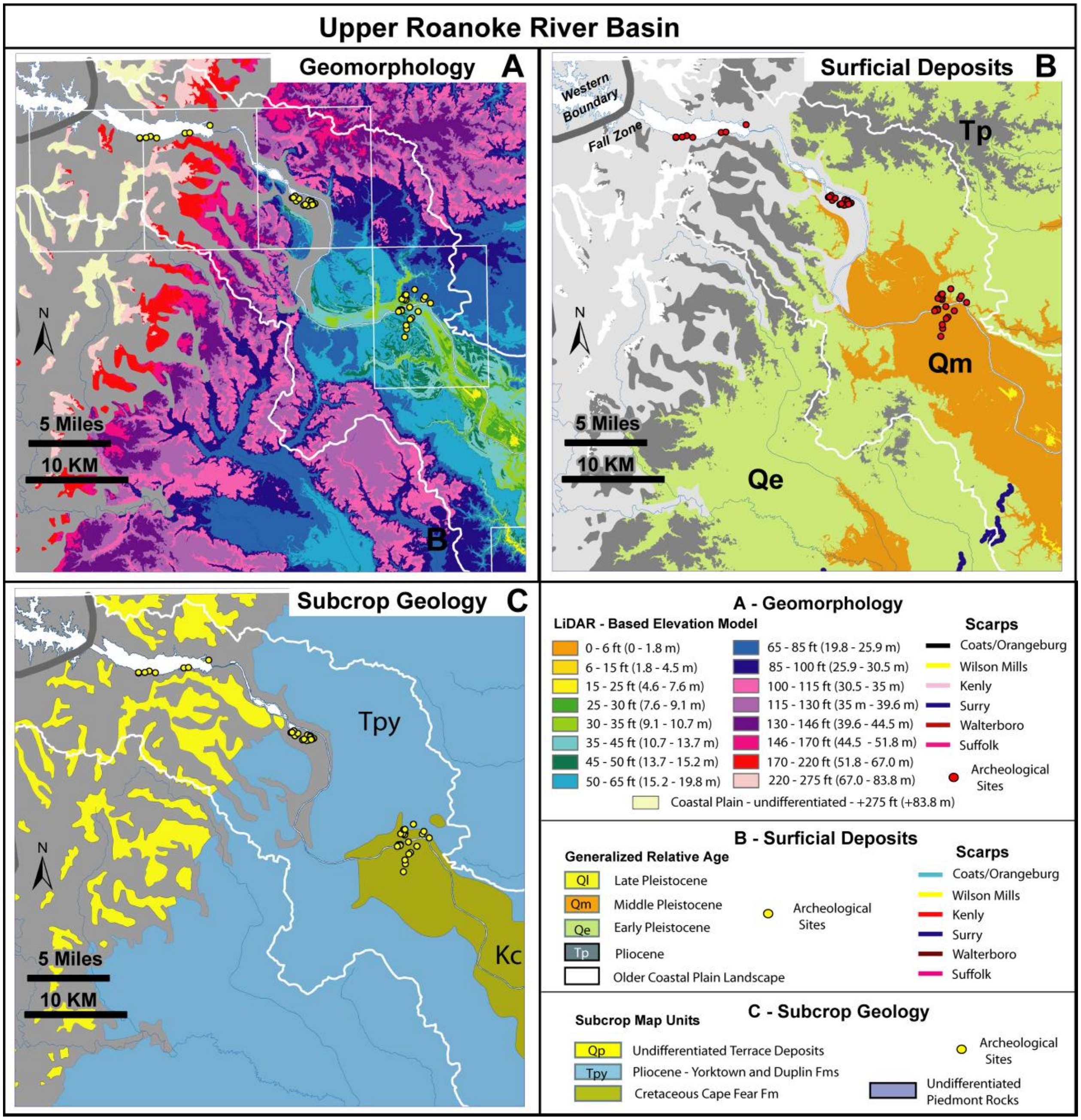


Figure 2-16. The upper Roanoke River Basin shows the distribution of archaeological sites in the context of: A) geomorphology, B) surficial geologic units, and C) subcrop geologic units.

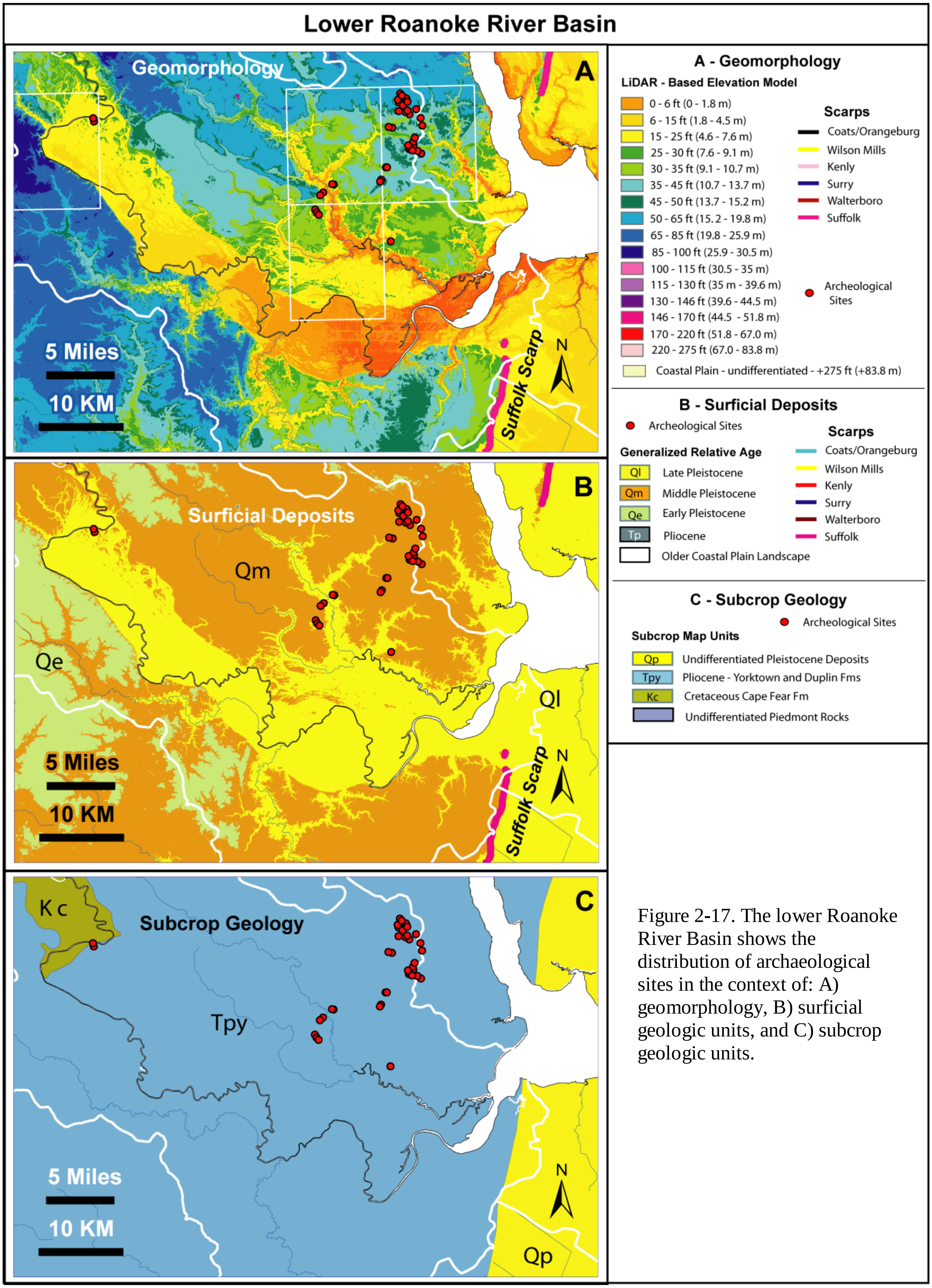


Figure 2-17. The lower Roanoke River Basin shows the distribution of archaeological sites in the context of: A) geomorphology, B) surficial geologic units, and C) subcrop geologic units.

Most of the earlier discussion regarding lithic raw material acquisition in the NC-CP focused on its function within an inferred Paleo-Indian settlement model. Phelps (1983:21-22) discussed the Dismal Swamp model according to Gardner (1979:14-15). In this model, Gardner suggested that the Williamson quarry site in Virginia served as a primary source for chert which occurred at sites along the western margin of the Dismal Swamp. This model was based on the central quarry theory proposed by Gardner (1974) for the Flint Run Complex in which settlement and mobility is tethered to large, primary sources of high-quality raw materials. According to Phelps (1983:21), “Given the range of locally available materials from which the Paleo-Indian artifacts (projectile points, scrapers) found in the Coastal Plain have been produced (quartz, quartzite, slate, rhyolite, chert, jasper), the central ‘quarry’ organization seems inappropriate and trade between territories may just as readily explain the presence of chert from particular sources”.

Gardner (1979) observed a general lack of sites within the Coastal Plain, which suggested the lack of naturally occurring raw material sources within the region. Gardner noted the Roanoke River basin as an exception to this trend. Phelps responded to this issue and stated that, “all of the rivers with Mountain and Piedmont headwaters probably carried considerable loads of pebbles and cobbles downstream from their source (1983:22).” In the final analysis, the exploitation of subsistence resources rather than the location of lithic resources more likely dictated Paleo-Indian settlement (Phelps 1983:22). A key element in his discussion was the acknowledgement of the important role served by river-borne gravel and cobbles as primary sources of lithic raw material within the Coastal Plain. Phelps also suggested that Paleo-Indian territorial ranges could have extended 130 miles or more from known quarries in the Carolina Slate Belt of the Piedmont Region of NC. Similar issues related to Early Archaic ranges were addressed by Anderson and Hanson (1988) and Daniel (1994, 1996).

As a part of the Uwharrie-Allendale settlement model, Daniel (1994) suggests that sources of raw material were the geographical basis for Early Archaic adaptation. His model is based on sources of metavolcanics from the Uwharrie Mountains of NC and sources of chert from the Allendale quarries in the Coastal Plain of South Carolina along the Savannah River (Goodyear and Charles 1984). According to Daniel (1994:245), “At some point during the Early Holocene, hunter-gatherer groups coalesced around the Uwharrie and Allendale sources forming at least two regions.” Aggregation of the two regions occurred in areas between the two ranges, such as the Fall Zone along the Upper Congaree River valley. As a result, band ranges cut across several major drainages rather than remaining confined to specific drainages as proposed by the band-macroband model of Anderson and Hanson (1988). According to Daniel (1994:257), “Although most lithic demands were satisfied at the Uwharrie and Allendale sources, stone supplies were also supplemented while moving within each region by exploiting secondary cobble sources and lesser quality outlying bedrock outcrops.” He refers to these sources as “expedient quarries”, dispersed across the landscape (1994:257). Use of these types of sources were likely embedded in normal subsistence activities, and allowed groups to extend the time and distance traveled away from the primary quarries prior to a scheduled return to the Uwharrie or Allendale sources (Daniel 1994:257).

McReynolds (2005:24) notes an increase in quartz use over time within the Coastal Plain. In her study of projectile point distribution, she observes that for the NC-CP, “metavolcanic stone appears to gradually diminish in importance relative to quartz, which was presumably locally available in the form of riverbed cobbles (2005:24).” She also notes the relatively low frequency of chert in the NC-CP and suggests that the sources of Allendale Chert in South Carolina (Goodyear and Charles 1984) were not regularly used by groups in NC.

Cooke (2000:11) notes that the northern Coastal Plain lacks significant lithic raw material sources, except for available metavolcanic cobbles (Riverine Quaternary gravels) in riverbeds as possible sources of raw material for tool production (2000:28). He assumes, however, that most "non-local stone was procured from the Piedmont (2000:11)."

Changes in lithic raw material procurement and utilization are generally viewed as functions of group range reduction over time (Blanton 1983; Sassaman et al. 1988; Blanton and Sassaman 1989; Claggett and Cable 1982; Sassaman 1983; Anderson and Hanson 1988; Tippett 1992). In general terms, lithic raw material procurement and use patterns changed over time. Changes range from the near exclusive use of specific types of high quality metavolcanics collected over a relatively wide geographic area centered in the Piedmont region, to the use of a diverse group of materials collected from more localized (river-borne) sources (Daniel 1994; Cable et al. 1996:327; Daniel et al. 2008). This view is generally accepted and is based mainly on research conducted in the Piedmont regions of North and South Carolina. Tippett (1992) and Cable et al. (1996) addressed the implications of this model in terms of its application to the Coastal Plain. Tippett suggests that a generalized reduction of group range begins during the Middle Archaic. The evidence for this is that assemblages of this time frame and beyond include a greater diversity of inferred, poorer-quality Coastal Plain resources mixed with the inferred, higher-quality metavolcanic materials from the Piedmont (1992:111). This general trend continues over time, intensifying during the Late Archaic. It culminates in the Woodland Stage with an expedient, disposable technology based on flake tools (Blanton et al. 1986) and, in some cases, the exploitation of "cultural quarries" (Sassaman et al. 1993). Benson (2000a and 2000b) discusses cultural quarries as a type of lithic landscape in the Sandhills of NC.

Previous research generally suggests that Coastal Plain resources consist primarily of quartz, quartzite, chert, and sandstone. Most of these resources are assumed to occur as river gravel. These materials apparently were collected and reduced from cobble form into cores, flake tools and other tools (Cable et al. 1996). Most metavolcanic raw materials (i.e., aphanitic rhyodacite, porphyritic rhyodacite, flow-banded rhyodacite, and various tuffs) are assumed to be transported into the Coastal Plain from sources located above the Fall Zone within the Piedmont region (presumably the Carolina Slate Belt). The most frequently cited evidence for this is the preponderance of metavolcanic late-stage reduction debris (e.g., bifacial thinning flakes, retouch flakes) in assemblages collected within Coastal Plain sites (Cable et al. 1996:334). In general, most previous work recognizes the NC-CP as a "lithic poor" region. As a result, the NC-CP is an area where very little information is available on raw material sources.

METHODS FOR LITHIC ANALYSIS

The sources of the archaeological data analyzed here are published and technical reports filed at the NC Office of State Archaeology (NC-OSA) in Raleigh. Most technical reports were a part of cultural resource management projects conducted in the Coastal Plain sector of the Cape Fear, Neuse and Roanoke basins over the last 30-40 years. Also available was a set of U.S. Geological Survey, 7.5 Minute Quadrangles with site locations plotted as point data. From these sources, baseline information on raw material use was compiled and analyzed for sites in the three river basins.

The study area in each river basin was defined to include the Coastal Plain landscape between the Fall Zone and the river's respective mouth. Individual USGS quadrangle maps served as the primary sample units. All quadrangles within the three drainages were inspected for the presence of archaeological sites and for the availability of survey and analytical data. Quadrangle maps, and their accompanying data sets, were selected for analysis because of the quantity, quality and type of available data, location in the drainage, and the relative ease that the data could be imported into ArcGIS for spatial analysis.

For specific localities in selected quadrangles, site files and reports at the OSA were consulted for raw material counts and other information. The usefulness of available information at a site was evaluated using several criteria: 1) did a survey accompany site reports, 2) were site locations recorded as point data on quadrangles positioned along the drainages in question; and 3) was data collected on raw material variation for recorded sites? Based on the availability of information, forty USGS quadrangles were selected for analysis (Table 2-1). Only sites with information on the raw material of individual artifacts were considered for this study. Sites with questionable context and isolated finds of questionable context were excluded.

Raw material information was collected from a wide range of archaeological site types and dimensions. Large- and small-scale sites were given equal weight in the analysis. Information was recorded for sites adjacent to the trunk streams, in the surrounding uplands, and along auxiliary drainages. Compiled information on raw material use included 27,444 artifacts at 525 archaeological sites (Table 2-2). Sites were distributed in quadrangles positioned in upper, central and lower reaches of each river basin. These distributions served as upstream to downstream transects within the river basins from the Fall Zone to the river mouth in a sound or the Atlantic Ocean.

For each site, information recorded in a spreadsheet format included: USGS quadrangle name, UTM northing and easting, UTM zone, North American datum (1927), county, and site number. UTM coordinates were converted to North Carolina State Plane NAD 83. The following raw material types were recorded for each site, in terms of frequency and as a percent of the total lithic assemblage:

1	Quartz – includes all quartz – crystal, white vein, citrine, rose, etc.
2	Metavolcanics – includes rhyodacite/rhyolite, various tuffs, argillite, and nonspecific metavolcanics
3	Quartzite – includes orthoquartzite
4	Chert
5	Steatite
6	Sandstone
7	Other – includes chalcedony, jasper, nonspecific silicates, and nonspecific sedimentary

Fire-cracked rock was not included as a part of this study. The existing surveys at NC-OSA recorded raw materials as frequency counts only, rather than counts and weights. The case for using raw material weights as a more effective unit of measure has been discussed and implemented by Millis et al. (2005). We acknowledge that weights are better units of measure, but the data was not available. Future lithic analyses should record artifact weight as a variable.

In addition, temporal aspects of individual sites were not considered for this analysis. Studies on raw material variation and the spatial distribution of temporal diagnostics were undertaken previously by Sassaman et al. (1988); Daniel (1998); Tippett (1992); Cooke (2000); and McReynolds (2005). These studies focused on prehistoric settlement pattern over time and have provided valuable data and insights. The primary focus of the current study is a baseline examination of raw material occurrence (range of raw material variation) and the changes in the range of variation as a function of distance from the Fall Zone within each basin. In this regard,

Table 2-1. USGS Quadrangles utilized in this analysis, organized by river basin.										
Raw Materials (%)										
Quadrangle	**Dist (km)**		**Qtz**	**MV**	**Qtzite**	**Chert**	**Steatite**	**Sandst**	**Other**
	A	**B**							
A. USGS Quadrangles Cape Fear River Basin									
Fuquay-Varina	0	> 20	91.6	4.2	0	0	4.2	0	0
Lillington	0	< 20	61.2	37.7	0	0	0	0	1.1
Coats	9	< 20	23.7	76.3	0	0	0	0	0
Erwin	16	< 20	81.4	18.6	0	0	0	0	0
Manchester	17	< 20	35.3	61.4	0.8	0	0.8	0.9	0.7
Overhills	21	> 20	56.2	43.3	0.3	0	0.01	0.1	0.07
Stedman	40	< 20	64.9	35.1	0	0	0	0	0
Roseboro	55	> 20	13.7	79.9	0.7	4	0	0	1.7
Bonnetsville	62	> 20	32.2	59.2	0.9	7	0	0	0.6
Turkey	76	> 20	25.6	55.2	1.8	17.2	0	0.1	0.1
Warsaw South	84	> 20	5.1	67.1	5.8	22	0	0	0
White Lake	84	< 20	10.6	6.5	57.1	24.3	0	0.4	1.1
Abbottsburg	89	< 20	30.3	21.1	41.5	7.1	0	0	0
Elizabethtown S	93	< 20	33	41	17	9	0	0	0
Acme	131	< 20	57.1	29	13.1	0.2	0.02	0.3	0.2
Carolina Beach	166	< 20	41.1	11.4	24.9	16.6	0	0	5.9
KureBeach/Southport	177	< 20	20.1	32	22.2	23.6	0	0	2.1
B. USGS Quadrangles Neuse River Basin									
Stancils Chapel	-9	< 20	65.6	34	0.4	0	0	0	0
Kenly West	0	< 20	87.8	12	0.1	0	0	0	0.1
Fountain	29	> 20	32.7	25.6	28	0.2	0	0	13.5
Walstonburg	37	> 20	59.9	31.8	7.3	0	0	0	1
Falkland	41	> 20	44.4	29.7	15.3	0	0	0	10.3
Farmville	42	> 20	44.2	44.9	8.6	0.1	0.1	0.5	1.6
Falling Creek	54	< 20	68.7	28.9	1.6	0.3	0	0.3	0.1
Deep Run	61	< 20	67.7	0.8	30.3	1.2	0	0	0
Kinston	63	< 20	42	42.2	7.3	7.3	0	0	1.1
Pink Hill	72	> 20	37.5	22.9	33.3	2.1	0	0	4.2
Rivermont	72	< 20	15	0	71.6	6.7	0	0	6.7
Jasper	97	< 20	82.2	17.8	0	0	0	0	0
Askin	106	< 20	11.1	16.9	40	26.9	0	0	5.1
Cherry Point	141	< 20	46.4	0.2	47.3	3.2	0	0.1	2.8
C. USGS Quadrangles Roanoke River Basin									
Thelma	-16	< 20	49.8	49.2	0	0	1	0	0
Roanoke Rapids	-5	< 20	78.9	14.6	3.6	0	0	0	2.9
Weldon	6	< 20	47	0.1	9.8	16.7	0	0.2	26.2
Boones Crossroad	22	< 20	73.7	21.6	0.8	0.1	1.2	0	2.6
Palmyra	45	< 20	45.3	11.6	41.4	1	0.7	0	0
Windsor North	74	< 20	31.4	32.5	29.3	0	0	0	6.8
Windsor South	78	< 20	18	11.1	58.7	5.5	0	0	6.6
Merry Hill	84	< 20	59.6	15.6	17.4	6.7	0	0.5	0.2

A – From Fall Zone, B – From Stream Trunk, Qtz – Quartz, MV – Metavolcanic, Qtzite – Quartzite, Sandst – Sandstone.

Table 2-2. Raw Material Data, Cape Fear, Neuse, and Roanoke River Basins

Basin	Total Sites	Total Artifacts
Cape Fear	217	17,807
Neuse	214	6,024
Roanoke	94	3,613
Totals	525	27,444

the lithic assemblage is considered for study as opposed to considering only temporal diagnostics. This approach provides the best information at this time on the range of variation in raw material use, as it relates to groups of sites spread across the natural landscape.

Analytical Methods

USGS quadrangle maps functioned as sample units to define clusters of sites and measure approximate distances from the Fall Zone. The quadrangle maps were considered relative points within the drainage basins for analytical purposes. For each quadrangle, the average distance was measured in kilometers (km) from the point where the main channel of the respective river crossed the eastern edge of the Fall Zone, to the center of the quadrangle. Quadrangles, and associated data, were further subdivided into two sets: 1) quadrangles that included the primary trunk stream or areas < 20 km from the primary stream, and 2) quadrangles with central points greater than 20 km from the trunk stream and associated with uplands and auxiliary streams. The frequency distribution for raw materials was calculated for the sites within each quadrangle and was recorded in terms of distance from the eastern edge of the Fall Zone and distance from trunk stream. The data for each site was recorded as frequencies and percentages relative to the total lithics within the assemblage.

RESULTS - FREQUENCY DISTRIBUTION OF LITHIC RAW MATERIALS

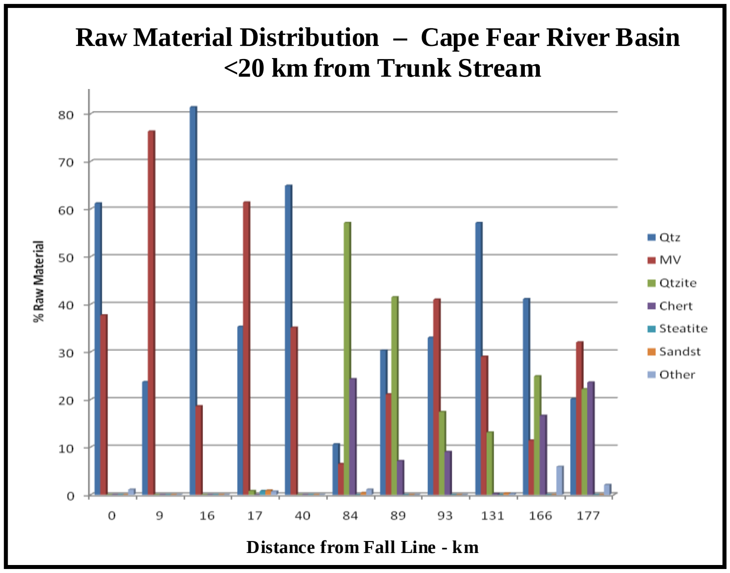
Table 2-1 presents the percent of raw material use for the lithic types listed above and relative to distance (km) from the Fall Zone and trunk stream for the three drainage basins. The data is presented in sets of frequency distribution contingency tables for each drainage basin (Tippett 1992:78). Similar to Tippett's (1992) methods, the contingency table data with basic frequency counts for each quadrangle was standardized by converting the frequency data into percentages. Once converted the percentages were transformed into a set of graphs showing proportional frequency polygons.

Cape Fear River Basin

Table 2-1A shows data compiled for the Cape Fear River basin. Twelve quads are proximal (<20 km) and six are distal (>20 km) from the trunk stream (Cape Fear River). Data for Kure Beach and Southport quadrangles were combined due to equal distance measures and similarity of physical location relative to the Fall Zone.

For proximal quadrangles, data assemblages displayed in Table 2-1A and Figure 2-18A suggest that quartz and metavolcanics dominate from the Fall Zone to 84 kilometers downstream. The other categories of raw materials remain constant or in trace proportions up to 84 km downstream. Figures 2-18A and 2-19 suggest the use of quartzite increases dramatically between 40 and 84 km from the Fall Zone, and remains relatively high downstream from this

A



B

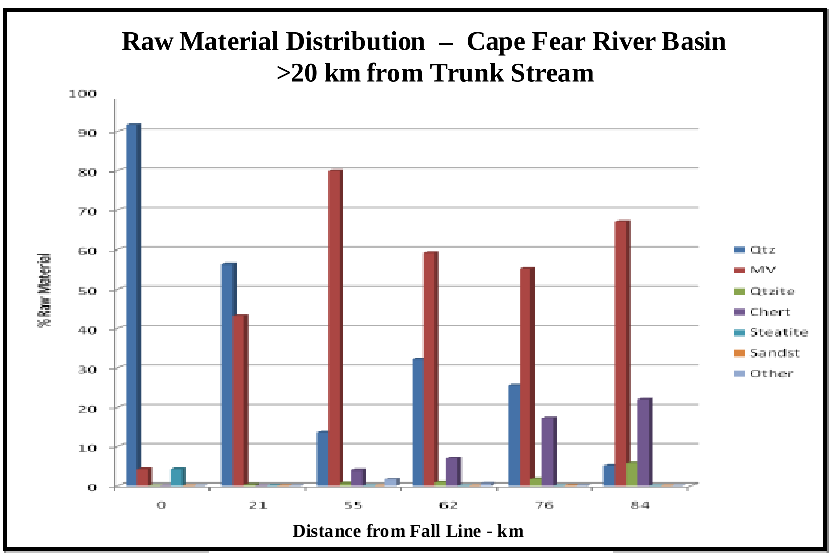


Figure 2-18. Distribution of raw materials within Cape Fear River Basin: A) < 20 km from trunk stream; B) > 20 km from trunk stream.

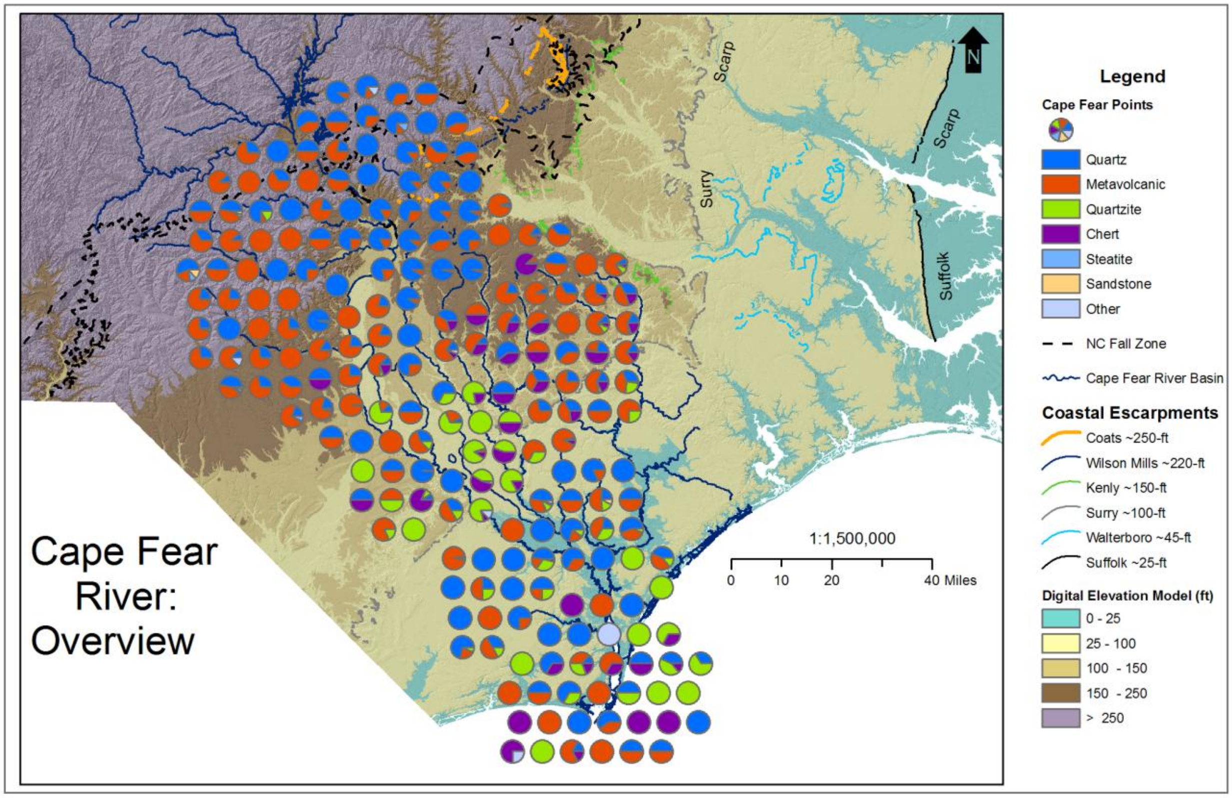


Figure 2-19. Diagrammatic view of Cape Fear River basin archaeological site locations. NOTE: Point locations for sites are exaggerated in size to show the relative percentages of material type (see legend), and are not to scale, nor in their proper spatial location.

area to the river mouth near Wilmington. Chert also spikes between 40 and 84 km from the Fall Zone, although relatively less than quartzite. The diversity of assemblages appears to increase downstream from 84 km. Overall, quartz and metavolcanics dominate.

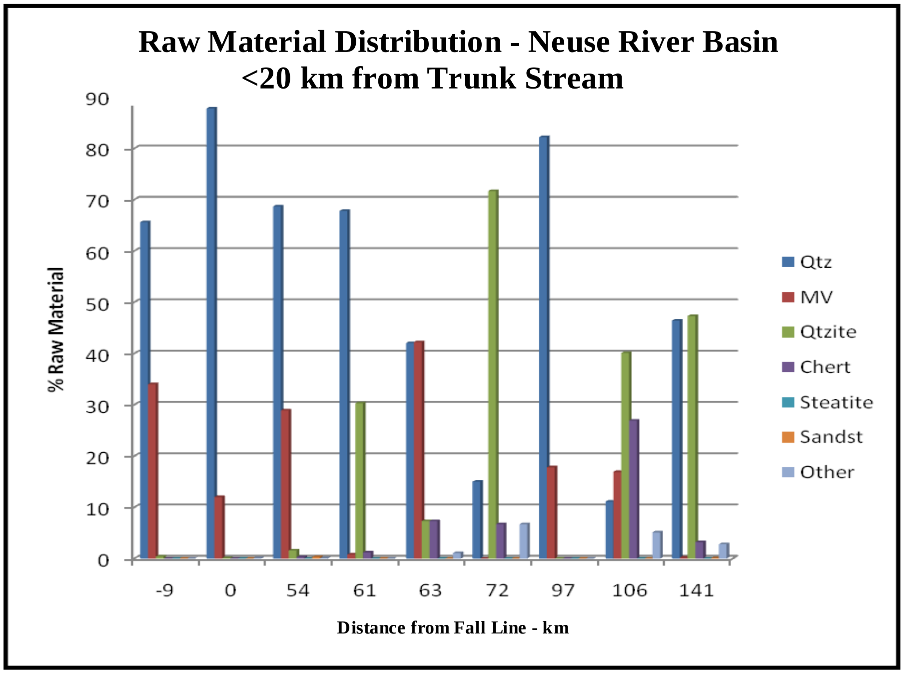
For distal quadrangles, Table 2-1A and Figure 2-18B suggest that quartz dominates from the edge of the Fall Zone to an area between 21 and 55 km from the Fall Zone, where metavolcanics dominate. East of here, on uplands and auxiliary streams, however, chert and quartzite gradually increase as a function of distance from the Fall Zone.

Neuse River Basin

Table 2-1B shows data compiled for the Neuse River Basin. Nine quads are proximal (<20 km) and five are distal (>20 km) to the trunk stream (Neuse River). The center of the Stancils Chapel quadrangle is located within the Fall Zone, about 9 km west of its inferred eastern edge. The contingency table data is presented in Table 2-1B. Figure 2-20 shows the graphic display of the proportional frequency polygons.

For proximal quads, data assemblages displayed in Table 2-1B and Figure 2-20A are similar to those displayed in Figure 2-18 for the Cape Fear basin. Figure 2-21A shows that quartz and metavolcanics dominate in the upper Neuse basin between 9 km upstream from the eastern edge

A



B

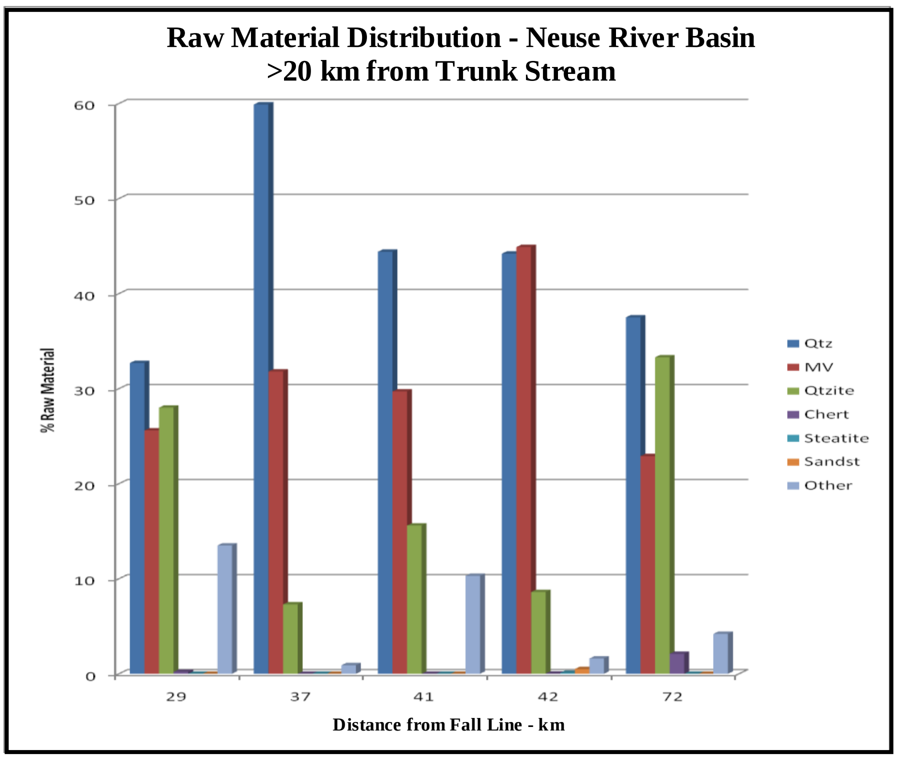
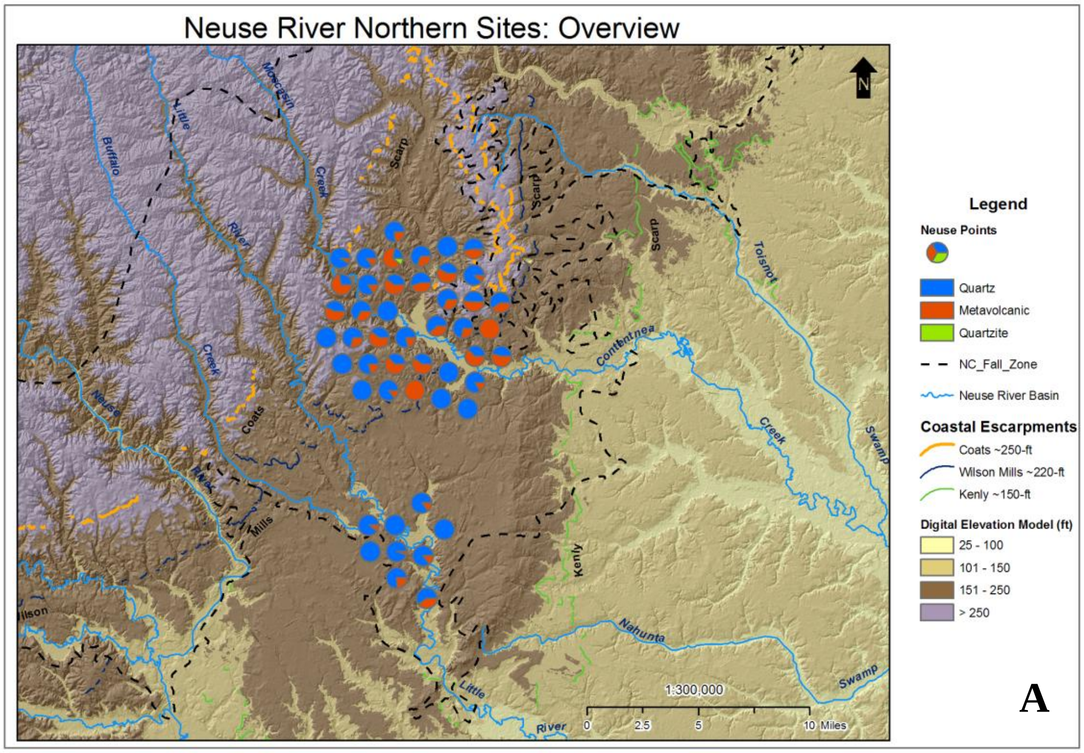


Figure 2-20. Distribution of raw materials in the Neuse River Basin: A) <20 km from trunk stream, and B) >20 km from trunk stream.



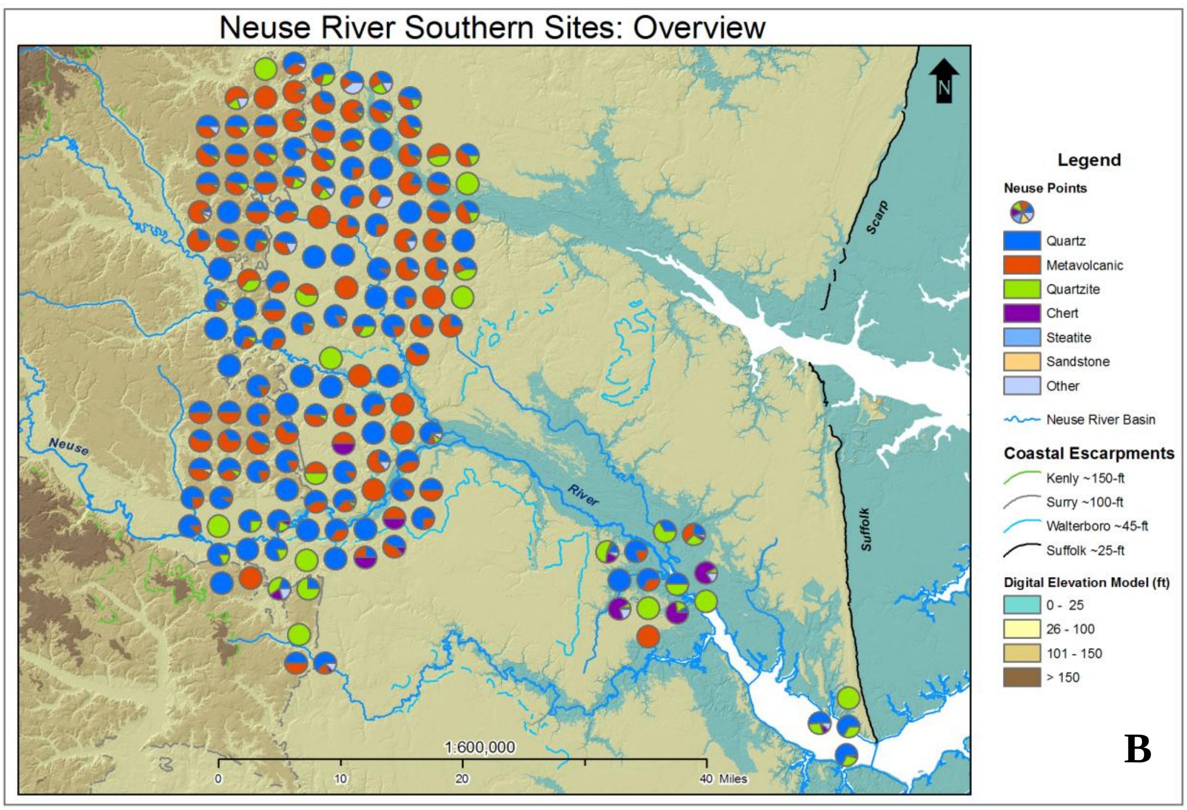


Figure 2-21. Diagrammatic view of Neuse River Basin archaeological site locations. NOTE: Point locations for sites are exaggerated in size to show the relative percentages of material type (see legend), and are not to scale, nor in their proper spatial location. A. Northern sites – overview. B. Southern sites – overview.

of the Fall Zone to about 61 km downstream. The other categories of raw materials remain constant or in trace proportions, with the exception of a small increase in quartzite at 54 km. The use of quartzite increases dramatically between 54 to 61 km from the Fall Zone and maintains relatively higher proportions downstream to its mouth near Cherry Point (Figure 2-21B). Chert increases at 61 to 63 km from the Fall Zone, although much less than quartzite. Similar to the Cape Fear drainage, the overall diversity of assemblages increases downstream from 61 km.

In distal quads (>20 km) from trunk stream, Figure 2-20B shows that the diversity of raw material is higher at a shorter distance from the Fall Zone. Percentages of quartz and metavolcanics remain high, but quartzite is proportionally more prominent at a shorter distance. This may have some connection with distance upstream from the confluence of the trunk stream with primary auxiliary drainage rather than distance from the Fall Zone. This may relate to task groups use of auxiliary drainage for activities associated with hunting or other resource acquisition behavior (Binford, 1980).

Roanoke River Basin

Table 2-1C shows data compiled for the Roanoke River Basin. All eight quadrangles occur proximal (< 20 km) to the trunk stream (Roanoke River). The Thelma and Roanoke Rapids quadrangles occur within the Fall Zone about 16 and 5 km, respectively, west of its eastern edge. The results posted in Table 2-1C and Figure 2-22 suggest a dominance of quartz along the drainage with near equal proportions of quartz and metavolcanics west of the eastern edge of the Fall Zone (Figure 2-23). Quartzite increases at 45 km from the Fall Zone, remains nearly equal in occurrence with quartz to 78 km, and then, proportionally, greatly surpasses quartz and metavolcanics in a downstream direction. Quartz dominates at 84 km from the Fall Zone.

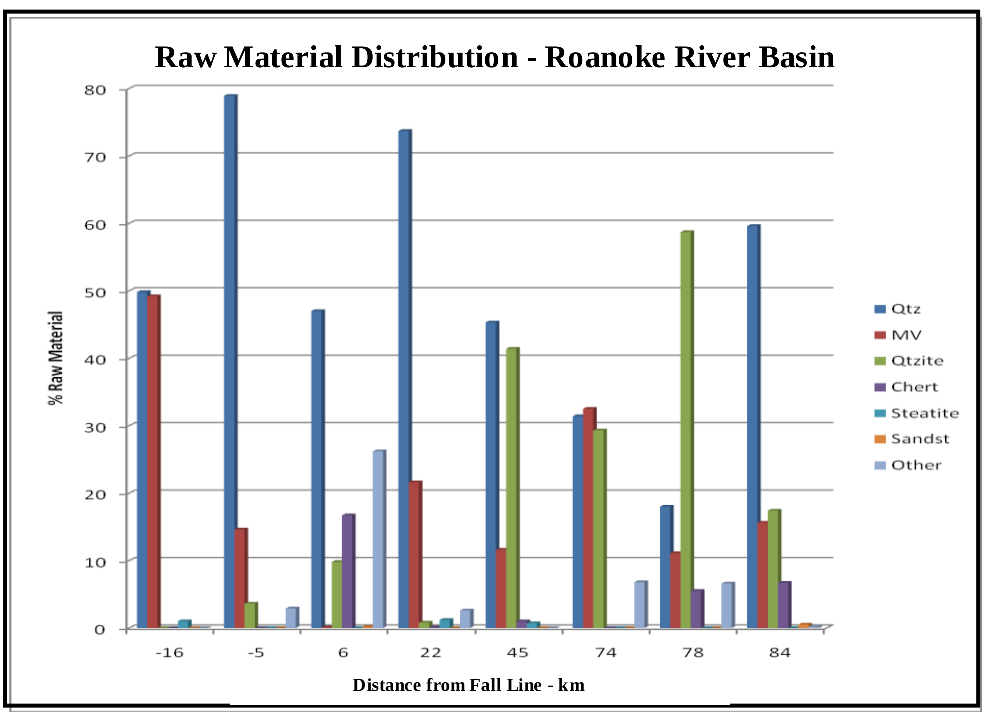


Figure 2-22. Distribution of raw materials within 20 km of trunk stream, Roanoke River Basin.

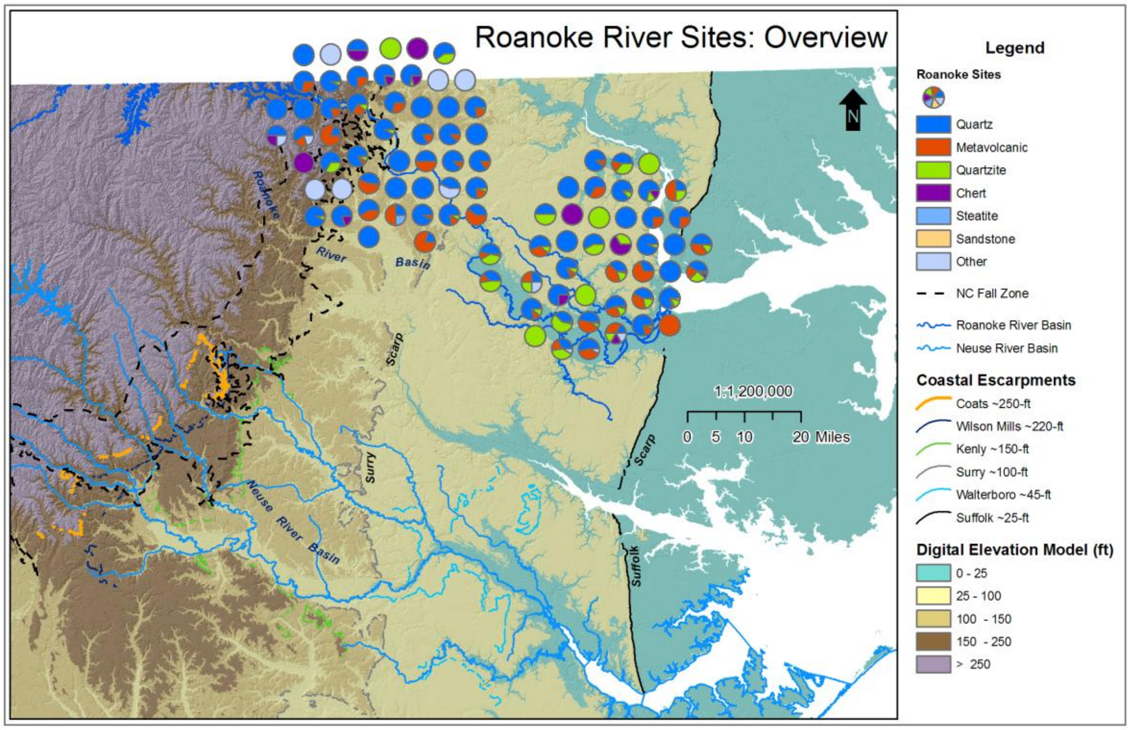


Figure 2-23. Diagrammatic view of Roanoke River Basin archaeological site locations. NOTE: Point locations for sites are exaggerated in size to show the relative percentages of material type (see legend), and are not to scale, nor in their proper spatial location.

PATTERNS IN THE LITHIC LANDSCAPE SUGGESTED BY LITHIC RAW MATERIAL ASSEMBLAGES

Our evaluation of the spatial distribution of lithic raw material assemblages in the context of the geologic and geomorphic setting reveals two preliminary but specific patterns in the nature of the lithic landscape of the NC Coastal Plain. First, potential source areas exist within upland settings of the Coastal Plain. This outcome is documented in the case study presented below. Routine detailed geologic mapping by the NCGS identifies outcrops and includes descriptions of the composition and grain size of near surface sediment and formations. In particular, detailed mapping in the Raleigh 100K sheet, identified easily accessible, surficial gravel patches within upland settings. The second pattern is related to changes in the range of variation in raw material assemblages as a function of distance from the Fall Zone. These patterns are discussed below.

Case Study – Upland Lithic Sources

Detailed geologic mapping, (1:24,000 scale on 7.5 minute quadrangles), by NCGS has identified upland gravel deposits in the Stancils Chapel, Lucama, Kenly West, and Kenly East quadrangles. In this area, bedrock is close to the ground surface (<10 ft). These gravels typically have a sandy matrix, and are exposed at the ground surface primarily in areas where the irregular bedrock surface forms topographic highs, allowing these basal Coastal Plain gravels to outcrop. These sandy gravels occur in outcrops as surficial, patchily-distributed, map units on upland terraces (Figures 2-24 and 2-25). NCGS drill holes in this area commonly encounter basal gravel at the contact between Coastal Plain sediments and the underlying weathered crystalline bedrock, which may indicate that these gravels are widespread at this contact. The gravel deposits are likely Late Pliocene (~ 1.8 - 2.5 Ma: nonconformant with revisions in Gibbard et al. (2010)) in age and may have originated as basal lags associated with an unconformity or a transgressive ravinement surface. Bedrock here is dominated by metamorphosed volcanic rocks (Clark et al. 2004). In some areas of Stancils Chapel quadrangle, pebbles and cobbles of quartz lack a sandy matrix in this zone above weathered bedrock. At some localities, gravel facies may be as thick as 1 m (3.3 ft). The gravel patches at the landscape surface are interpreted as erosional remnants of formerly thicker and more areally extensive units.

Most of the surficial gravel patches occur in agricultural fields, where recent plowing to depths of 0.45 m (1.5 ft) exposes them. Gravel clasts are commonly broadly distributed in a sandy matrix, and are rounded to subrounded in shape, indicating high-energy conditions. Many fields are completely littered with gravel (Figure 2-25). NCGS mapped these gravels by walking the open fields and visually determining the gravels' composition and the areal extent of outcrops. The relative density of the gravel patches was estimated using qualitative terms such as low, medium, and high density. Overall, most of the gravel patches were deemed relatively dense. Outcrops have extents that range in size from 0.24 to 5.15 acres. Eighty percent of the mapped gravel patches are less than five acres in size. The mean extent is 1.69 acres, with a standard deviation of 1.23 acres. A few patches are larger, with extents that cover broad, flat interfluve regions.

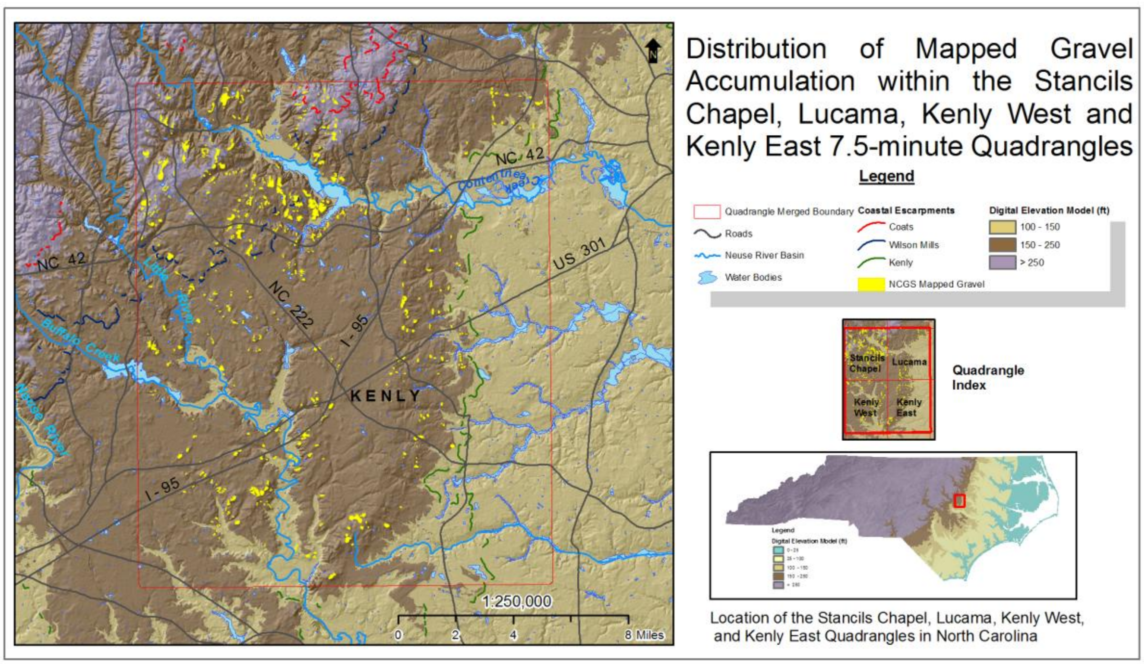


Figure 2-24. Map of gravel patches on selected 7.5 Minute Quadrangles.

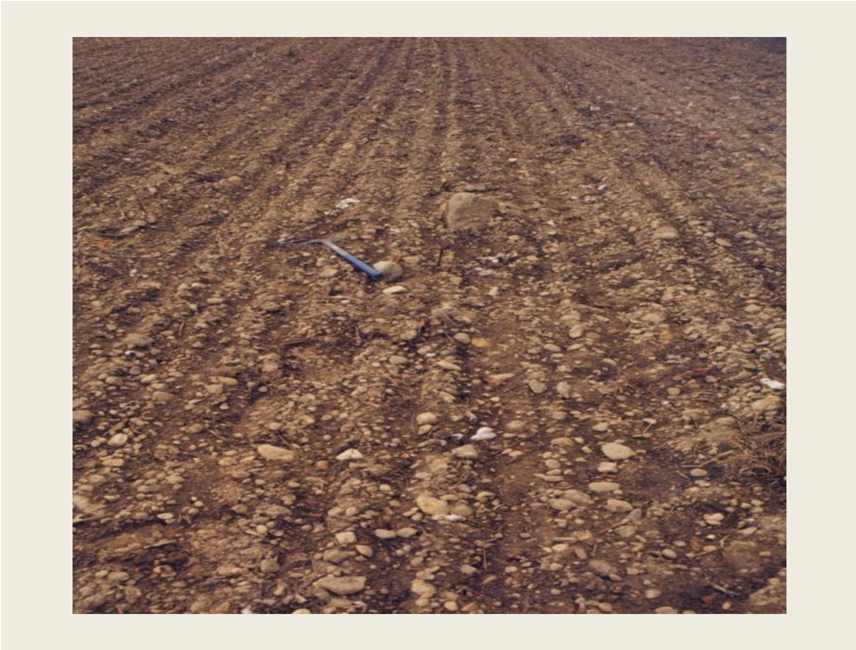


Figure 2-25. Example of a high-density gravel patch in a recently tilled field. The pick in this image is ~ 2.5-feet in length.

Figure 2-26 shows compositional variation in gravel lag units mapped by NCGS, compared to raw material assemblages documented at archaeological sites by the OSA in the Stancils Chapel quadrangle. Gravel lags are shown in orange. Archaeological sites are shown as bars denoting the percentages of raw material types. The circles represent the composition of the NCGS mapped gravels. The lag gravels are dominated by relatively high percentages of quartz and metavolcanic clasts. Lithic raw material assemblages at archaeological sites proximal to these surficial gravel lags show similar high frequencies of occurrence for quartz and metavolcanics. The apparent correlation between composition of the local sedimentary gravels (gravel lag map unit), and lithic assemblages at nearby sites, strongly suggests that the gravels lags functioned as local sources for lithic raw material.

Proximality Trends in Lithic Raw Materials – Fall Zone and Surry Scarp Relationships

In the three drainage basins, the diversity of lithic raw material assemblages changes as a function of distance from the Fall Zone. Changes range from a dominance of quartz and metavolcanics in the upper reaches of the study area (west of Surry Scarp) to a more varied mix of materials in the lower reaches (east of Surry Scarp). In particular, the use of quartzite and chert increases as a function of distance from the Fall Zone in all three river basins. The major changes in diversity occur in the middle portions of the Cape Fear and Neuse drainages in the vicinity of the Surry Scarp (see Figure 2-4). In the Roanoke Basin, the change in diversity occurs a shorter distance from the Fall Zone, but also close to the Surry Scarp. Our results strongly suggest that the area of the Surry Scarp serves as a boundary between the lithic resources used in the middle to upper Coastal Plain and those used in the lower Coastal Plain (terminology after Daniels et al. 1984). These patterns are not coincidences, but may be directly related to actual differences in the geologic and geomorphic framework, the lithic landscape, and an associated human response to the changes in lithic resource availability, above and below the Surry Scarp.

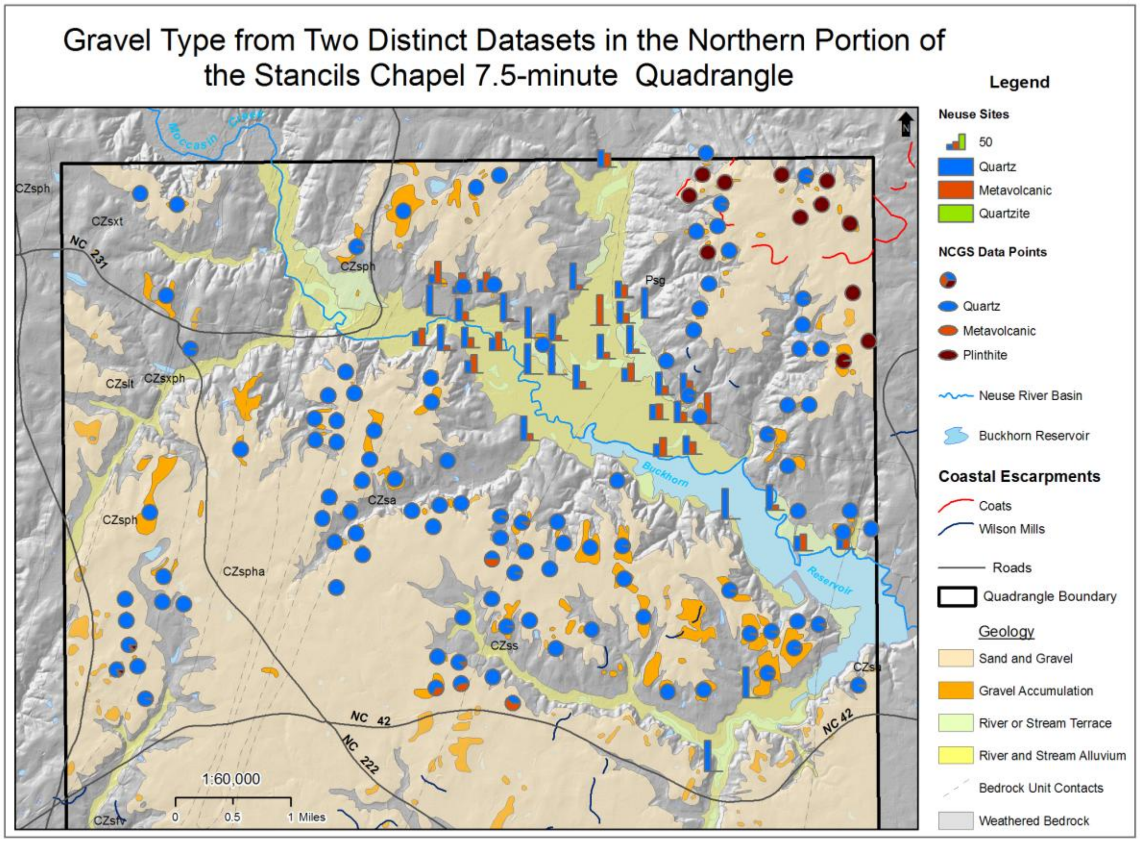


Figure 2-26. Distribution of gravel locations on the Stancils Chapel 7.5-minute USGS quadrangle. Bar graph locations refer to archaeological sites and are predominantly quartz and metavolcanic rock fragments. Circle data points are from the NCGS and show a predominance of quartz gravel.

The area in the vicinity of the Surry Scarp may have served as a secondary aggregation zone for prehistoric populations moving through the Coastal Plain, particularly during the Archaic. Similar to the Fall Zone further to the west, the Surry Scarp may have functioned as an ecotone for mobile groups in transit between the upper and lower Coastal Plain. The wide variation of resources associated with these areas could have supported population aggregates and facilitated temporary base camps and other short-term occupations. This inference merits further work as a part of long-term goals established for this project.

A Baseline Model Regarding the Lithic Landscape of the NC Coastal Plain

The results of this study suggest that surficially exposed gravel lag deposits associated with unconformities or transgressive surfaces likely served as reliable, primary sources of quartz and metavolcanic raw materials for prehistoric populations. This is at least the case for upland interfluves proximal to the Fall Zone. Knowledge of the locations of these types of sources could eliminate or greatly reduce the element of chance with respect to lithic procurement. Such knowledge facilitates conscious decisions regarding group movements and schedules made in light of known commodities. The results of this study suggest that lithic resources within the

Coastal Plain are not confined merely to rivers and streams. Rather, sources for lithic materials are potentially variable and widely distributed across the landscape, including patches of outcrops with concentrations of gravel-sized clasts in upland areas. From a geologic perspective, the Coastal Plain is thus far more complex and diverse than previously thought, in terms of raw material availability. With this realization comes the understanding that the complexity and relative high diversity of the lithic landscape invokes equally complex and diverse responses from human populations in the area. Given this understanding, future studies related to lithic raw material procurement and use within the Coastal Plain should be guided by some basic models adapted to hunter-gatherer subsistence and settlement patterns.

A GENERAL MODEL OF RAW MATERIAL PROCUREMENT FOR THE COASTAL PLAIN

A general model of prehistoric lithic raw material procurement for the Coastal Plain of NC should be strongly rooted in various assumptions and principles associated with human ecology (e.g., Jochim 1976; Butzer 1982). We suggest that the basic assumptions underlying a general model follow those proposed by Jochim (1976) for hunter-gatherer subsistence and settlement. While these ideas have a wide use within anthropological studies, they are rarely directly applied to lithic procurement studies in NC, particularly in the Coastal Plain. First, we assume that lithic raw material procurement is patterned behavior. We also assume that regularities exist in these behavioral patterns which serve to solve or address problems or issues related to individual and group survival. These regularities are expressed in terms of adaptive relationships between a given human group and their resources (Jochim 1976:8-9). Relationships are expressed in decisions which become instituted as economic strategies (patterned group behavior). These assumptions, at the very basic level, are deemed equally applicable to highly mobile hunter-gatherers (Archaic groups) and more sedentary, more constricted (Woodland) groups within the Coastal Plain of NC.

Adapted from Jochim (1976:10), the general assumptions are:

1	Lithic raw material procurement and use within the Coastal Plain are the results of conscious choices.
2	These choices are mostly deliberative rather than solely opportunistic.
3	Deliberation is rational, based on preferences for raw materials.
4	The probabilities of the outcomes of choices are sometimes uncertain and must be estimated based on knowledge of resource location and the basic lithic landscape.
5	Choices seek to satisfy predetermined levels of need in terms of tool forms and functions.
6	Choices will allow mixed strategy solutions to satisfy raw material needs.
7	Desire to achieve specific goals underlies most decisions regarding lithic raw material acquisition.

The underlying principles, adapted from Jochim (1976), include: 1) problems requiring solutions or choices related to lithic raw material acquisition are conveniently formulated as systems; and 2) problems are best approached in the context of human ecology and human responses to the existing lithic landscape (see Jochim 1976:10). As stated, the context is rooted in the human response to the lithic landscape of the Coastal Plain. The basic issues or problems related to lithic procurement (adapted from Jochim (1976:11) are: which lithic resources should be collected and used, in what quantity, from which sites, and by which members of a particular group. Utilizing Jochim, these are combined into a set of problem areas that include lithic resource use scheduling, site placement to facilitate procurement, and demographic arrangement (1976:11). Each problem, as it relates to lithic procurement in the Coastal Plain, is considered as a subsystem within the overall economic and subsistence framework of a particular group. Again, these issues cannot be addressed in terms of lithic procurement without a relatively good geologically-based understanding of the lithic landscape, and the logistics of identifying and utilizing the patchy distribution of the resources within the Coastal Plain.

The distribution of lithic raw materials, although patchy in terms of exposure over time within the Coastal Plain, should be considered fixed in terms of physical location. The most productive decisions related to lithic procurement in this setting would likely employ mixed strategies. As such, the acquisition of raw materials could be approached in three ways: 1) as an activity embedded either in other activities or during transit between activities or settlement locations (Binford 1980); 2) as a separate task not related to other activities or group movement (Gould 1980); or 3) in a less structured manner that involves periodic, fortuitous encounters associated with activities unrelated to the first two approaches.

The results of this study suggest that the lithic landscape of the NC Coastal Plain is partitioned into two sections in terms of prehistoric lithic resource availability and use: an inner region that includes the middle to upper Coastal Plain (see Figure 2-2), and the lower Coastal Plain. These are separated by the Surry Scarp. The area between the Fall Zone and the Surry Scarp is dominated by the use of quartz and metavolcanics. A more highly diverse assemblage of raw materials is used further east within the lower Coastal Plain. Analysis suggests that in the area between the Surry Scarp and the Fall Zone, quartz and metavolcanics are reliable, readily accessible primary resources, and were used as a matter of deliberate selection rather than expedience or on an *ad hoc* basis. This is facilitated by the presence of readily available quartz and metavolcanic cobbles within gravel lag deposits on uplands and in river-borne cobble sources. These deposits were likely utilized as part of either scheduled or embedded visits by groups within the vicinity. In this upper portion of the Coastal Plain, quartz is likely the primary commodity if compared to metavolcanics. The bulk of metavolcanic materials may originate primarily to the west of the Fall Zone in the Carolina Slate Belt (Daniel 1994; Steponaitis et al. 2006), but certainly supplementary deposits occur in the area between the Fall Zone and the Surry Scarp.

East of the Surry Scarp, extensive thick surficial gravel deposits are not likely common, and may not be a component of the lithic landscape. Local outcrops of gravel lags associated with unconformities and other erosion surfaces, however, may be exposed in cliffs along major streams. These could also form predictable resources that could be utilized. The absence of either type of stable source site, (upland gravel lag or cliff with outcrop of gravel) necessitates a more variable assemblage of raw materials acquired from river-borne cobble sources of inferred, less reliable predictability.

CONCLUSIONS AND FUTURE WORK

Key to developing a baseline conceptual model is recognition of general patterns in the geomorphology of the landscape and its underlying geology, and the distribution of accessible lithic raw materials available for utilization as sources of stone for the production of tools. From a geologic perspective, to define lithic landscapes it is useful to start with geomorphic subdivision of the landscape. This includes defining river basin and watershed boundaries, mapping regional scarps and terraces, and surely separating the incised valley systems from the upland terraces. The Surry and Suffolk Scarps are natural prominent boundaries, as are the incised valley systems associated with these ancient shorelines. The incised valleys and upland terraces have inherently different stratigraphic and facies signatures, and hence potentially different lithic raw materials. Geologic maps that show subcrops and surficial units help us to predict the location of unconformities and facies associated with lithic raw materials. But detailed maps of shallow and surficial deposits are needed to delineate unique formations, and the nature of their lithology and composition. As the example presented above suggests, documentation of geologic localities that potentially produce gravel-sized clasts, and the mineralogic composition of those clasts is most useful in defining the lithic landscape.

The results of our study are general in scope, but provide preliminary insights into the nature of the lithic landscape of the NC Coastal Plain and possible patterns of prehistoric raw material use. Foremost, our results suggest that the Coastal Plain should no longer be considered a “lithic poor” region. Rather, it is a region potentially characterized by patchily distributed, but reliable, lithic resources that from a geologic perspective, may be predictable in occurrence. This patchy, but reliable characterization suggests radically different states of existence than previously thought for prehistoric lithic resource procurement. This implies alternative ways of organizing human behavior in response to the availability of resources across the landscape.

A “lithic poor” region implies a landscape nearly devoid of suitable resources. The resources are hidden or nearly absent, not readily apparent, or are obscured and inaccessible due to sediment or water cover. Lithic resource procurement in this type of landscape is a function of chance or luck, and not easily incorporated into viable settlement and subsistence strategies. Ethnographic analogs (e.g., Gould 1980) suggest that too much is at stake in terms of group well-being and survival to leave the acquisition of major resources to chance alone. Human groups require some level of confidence that certain resources will be available at given times and places. As a result, it is of great benefit for us to move beyond the assumption that materials for tool production on the Coastal Plain were collected only on an expedient basis from cobble deposits within rivers and streams. Certainly, a level of expedient resource acquisition played a part in any given system; however, such behavior served the function its name implies and did not constitute the primary mode of raw material collection over time. Clearly a different basic pattern to lithic raw material acquisition and use exists for the NC Coastal Plain. As an example, upland source areas include remnants of formerly more extensive basal lag deposits. These were likely used by prehistoric populations for raw materials on a regular basis.

This preliminary study suggests that a regional geomorphic feature, the Surry Scarp, served as a boundary for changes in raw material assemblage. Additional study, however, is needed to determine the reasons for and significance of this observation relative to human settlement and subsistence behavior over time, and the natural environment. Information on specific assemblages of artifact types as well as compositional variations in raw material sources is necessary to determine how specific materials were utilized. Also, the difficult issue of the chronological context of the data needs to be addressed, to allow testing of proposed models of human behavior and inferred changes and/or similarities across cultural periods. Lithic raw material acquisition and use studies should be incorporated into basic hunter-gatherer subsistence and settlement models (e.g., Jochim 1976).

Clearly a comprehensive understanding of the nature of the lithic landscape of the Coastal Plain is essential to fully understand prehistoric raw material acquisition and utilization patterns for this area. Previously, the geology of this region was ignored as a key component of archaeological settlement and subsistence studies. This approach is counter-productive and methodologically backward. Currently, as funding permits, NCGS geologists are actively mapping the Coastal Plain in detail using advanced techniques in remote imaging, GIS technology, and subsurface analysis. As new map units are defined, the vast complexity of the Coastal Plain region emerges. This study suggests that a comprehensive understanding of the geomorphology and framework geology of the Coastal Plain is necessary to define the natural landscape and a context for lithic acquisition studies. To promote this understanding, new research should be collaborative between professional archaeologists and geologists.

Our long-term goal is to integrate data sets collected by NC-OSA archaeologists and NCGS geologists to define features that compartmentalize the lithic landscape and apply this knowledge to interpreting prehistoric lithic raw material procurement and use. An example of a future analysis will be a comparison of the range of variation of raw materials within documented sources for local raw materials, with the range of materials from surrounding sites. The focus of this work should be to gain understanding of site distribution/function within the Fall Zone, the area of the Surry Scarp, and the lower Coastal Plain as they may relate to the nature and use of the lithic landscape for raw material procurement. This approach will allow comparative studies of the three areas (Fall Zone, Surry Scarp, and Lower Coastal Plain) and tests of models related to subsistence, settlement, and raw material acquisition.

In future studies, we recommend evaluation of archaeological site locations and their associated artifacts in the context of: 1) river basin, 2) landscape position, 3) surficial geologic unit, 4) subcrop geologic units, 5) clast composition of local sources, and 6) artifact assemblage composition. This will require collaboration between archaeologists and geologists, and intensive field investigations by both fields to characterize the geologic source areas and lithic landscapes.

More specifically, raw material assemblages should be recorded for all sites located as a part of compliance-oriented (CRM) projects. In terms of data analysis, we recommend that weights for individual artifacts be recorded as standard lab procedure. Weights of individual artifacts, in concert with counts, provide better measures in terms of raw material use (see Millis et al. 2005). Naturally-occurring cobble sources proximal to each site should be identified. These cobble sources should include not only modern stream deposits, but also gravels incorporated into facies in the rock record, and associated with unconformities and transgressive surfaces. These may be exposed in local outcrops or concentrated in soil profiles.

Finally, it should be understood that raw material acquisition and use are merely components of the greater holistic prehistoric cultural system, in the context of the framework of the natural environment. The parts cannot be separated from the whole and studied in a vacuum. Any inferred changes in raw material acquisition and use patterns should be weighed against inferred changes in the overall system, and evaluated in the context of the natural landscape.

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