

## Chapter 2

# Geology

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Samples for this study were drawn from the Carolina Coastal Plain and the North Carolina Piedmont (Figure 2.1). The general geological, pedological, and hydrological characteristics of these two physiographic provinces are therefore relevant to our results and interpretations.

### **The Carolina Coastal Plain**

The Carolina Coastal Plain is a region of broad, relatively flat terraces of primarily unconsolidated sediments and carbonate rocks (Figure 2.2). These materials, ranging in age from Cretaceous to Quaternary, were deposited in shallow seas by rivers draining the Blue Ridge and Piedmont provinces (Rogers 1999).

Accumulation of sediments over 100 million years has gradually expanded the Coastal Plain seaward. During the same period, continuous uplifting of the interior has given the region a wedge-like cross section, with the thickest and youngest deposits occurring along the coast and the thinnest and oldest deposits exposed in the upper Coastal Plain. Cretaceous, Tertiary, and Quaternary deposits form roughly parallel belts that follow the southwest to northeast trend of the coastline, and elevation gradually increases from the coast to the Piedmont.

In the southwestern Coastal Plain of North Carolina, the Cape Fear Arch disrupts this general pattern. The axis of this active structural upwarp runs northwest to southeast and extends from offshore into the Appalachian Mountains (Rogers 2006; Siple 1999 [1957]). At least 250 million years of uplift along the arch has preserved the relict dunes of the North Carolina Sandhills and exposed Cretaceous strata that are buried elsewhere in the Coastal Plain.

### *Geologic Formations*

Upper Cretaceous deltaic and marine deposits are divided into four stratigraphic units (Figure 2.3): the Cape Fear Formation, the Middendorf Formation, the Black Creek Group, and the Peedee Formation (North Carolina Geological Survey 1985; Sohl and Owens 1991).<sup>1</sup> The lowermost unit, the Cape Fear Formation, consists of interbedded clays and sands exposed along deeply entrenched rivers such as the Cape Fear and Lower Little (Sohl and Owens 1991). The overlying Middendorf Formation includes fluvial-deltaic sands and clays commonly exposed on valley slopes and uplands in the Sandhills. Above the Middendorf Formation, the Black Creek Group encompasses the Tar Heel, Bladen, and Donoho Creek Formations and is generally characterized by carbonaceous clays and micaceous and fossiliferous sands. The uppermost Cretaceous unit, the Peedee Formation, comprises massive sands, clays, and limestones.

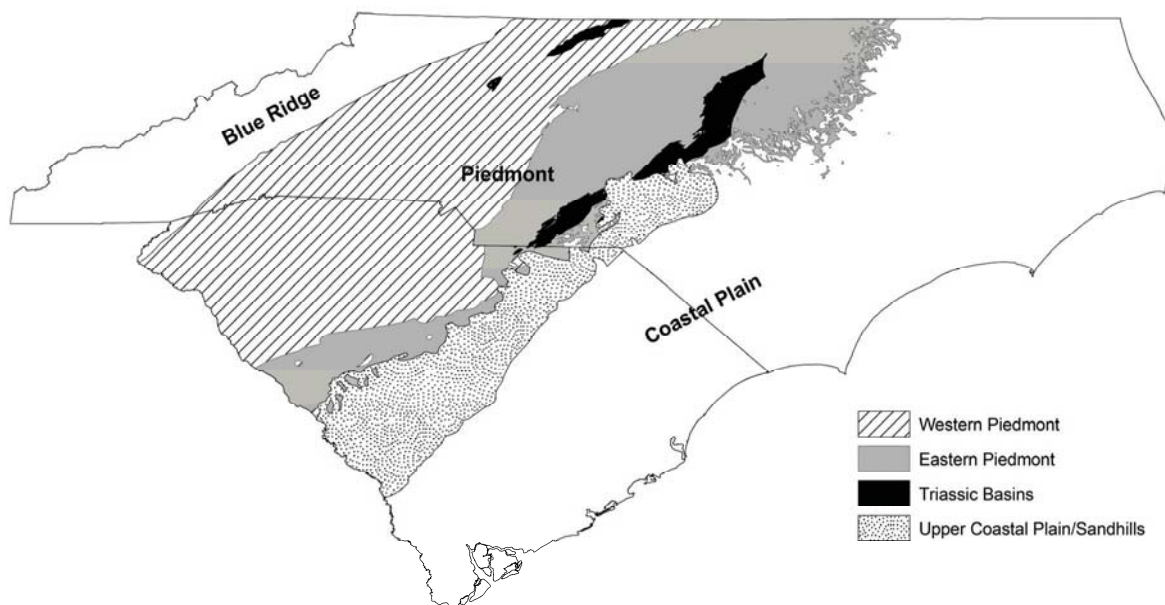


Figure 2.1. Major physiographic regions of the Carolinas (North Carolina Geological Survey 1998a; South Carolina Geological Survey 2005).

Tertiary sand and limestone deposits are located north and south of the study area. Quaternary deposits are largely undifferentiated and consist of marine and fluvial sands, clays, and gravels (North Carolina Geological Survey 1985).

### *Soils and Clays*

Upland soils derived from Coastal Plain sediments are generally quartz-rich with sandy surface textures. Diagnostic heavy minerals include zircon, tourmaline, rutile, staurolite, sillimanite, and kyanite (Windom et al. 1971). Soil composition within floodplains is influenced by the nature of fluvial deposits: rivers originating in the Coastal Plain are associated with quartz-rich soils, while rivers originating in the Piedmont give rise to soils of mixed mineralogies derived from Piedmont and Coastal Plain sediments (Buol 2003; Neiheisel and Weaver 1967; Windom et al. 1971).

Sedentary clays are rare in the Coastal Plain and particularly unusual in the Sandhills. They are most likely to be found on the upper terraces of major rivers where stable conditions have persisted long enough to allow the formation of argillic horizons (Buol 2003). Such settings generally exhibit extreme textural variation over relatively small distances, however, making it difficult to locate sedentary clay pockets.

Most sedimentary clays belong to the smectite group, although kaolinite and illite are common in some Cretaceous deposits (Heron 1960; Reves 1956; Sohl and Owens 1991). Consequently, alluvial clays deposited by rivers originating in the Coastal Plain are generally smectite-rich (Neiheisel and Weaver 1967; Steponaitis et al. 1996; Windom et al. 1971). In contrast, clays deposited by Piedmont-draining rivers typically contain a mixture of Coastal Plain-derived smectite and Piedmont-derived kaolinite (Neiheisel and Weaver 1967; Windom et al. 1971).

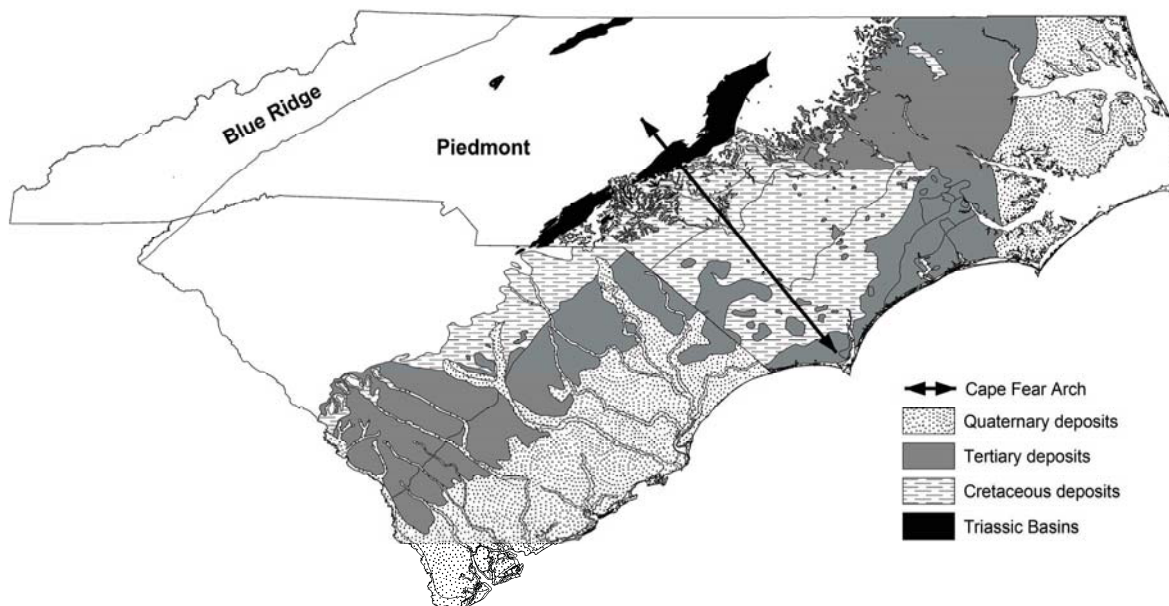


Figure 2.2. Geologic features of the Carolina Coastal Plain (North Carolina Geological Survey 1998a; South Carolina Geological Survey 2005). The arrow representing the axis of the Cape Fear Arch approximates the location of maximum uplift.

### The North Carolina Piedmont

The North Carolina Piedmont is a region of gently rolling hills and low ridges underlain by Proterozoic and Paleozoic metamorphic and intrusive igneous rocks. For present purposes, it can be divided into eastern and western halves (Figure 2.1). The eastern Piedmont consists primarily of low-grade metavolcanic and metasedimentary rocks of the Carolina Slate Belt (Figure 2.4). The western Piedmont is dominated by higher-grade gneisses, schists, and amphibolites. All Piedmont samples included in this study come from the eastern Piedmont.

#### *The Carolina Slate Belt*

The metamorphic rocks of the Carolina Slate Belt commonly contain chlorite, epidote, and other greenschist-facies minerals. Volcaniclastic parent rocks were primarily Late Proterozoic quartz- and plagioclase-rich dacites (Rogers 2006), although approximately 150 metagabbro and metabasalt dikes are apparently derived from Early Phanerozoic mafic intrusions.

The North Carolina portion of the Slate Belt comprises two rock suites. The Virgilina synclinorium extends from Durham into Virginia, and the Uwharrie or Albemarle suite encompasses the Uwharrie Mountains of the Albemarle-Asheboro region. The Virgilina sequence is older than the Uwharrie suite and experienced local deformation around 600 million years ago (Butler and Secor 1991; Rogers 2006). Taconic regional metamorphism of the entire belt occurred sometime after 500 million years ago when the terrane moved away from the western margin of South America and collided with eastern North America (Rogers 2006). Undeformed granitic intrusions dating to approximately 300 million years ago constrain the

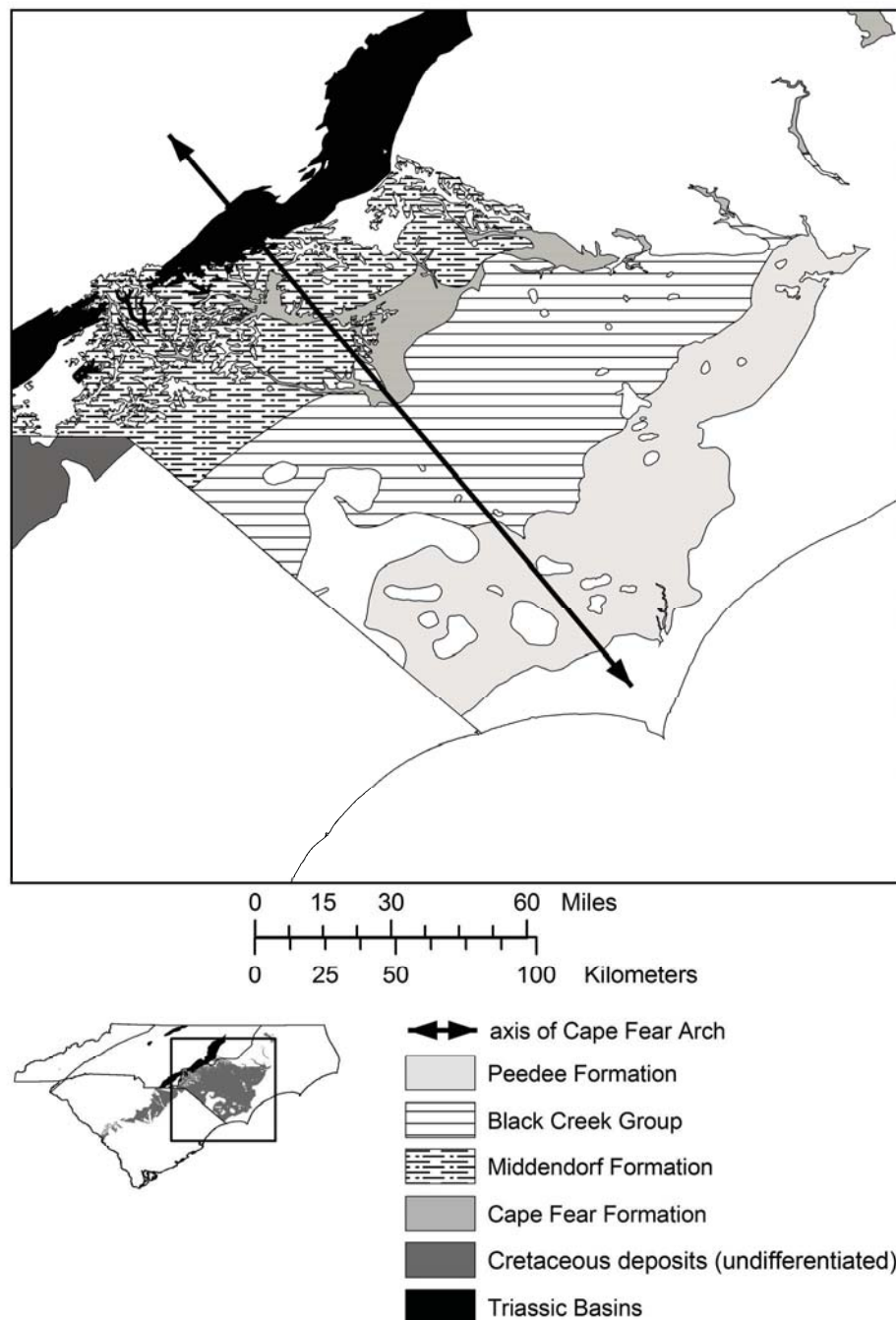


Figure 2.3. Cretaceous deposits of the North Carolina Coastal Plain (North Carolina Geological Survey 1998a; South Carolina Geological Survey 2005).

timing of the regional metamorphism, and potassium-argon dates suggest it occurred around 480–450 million years ago (Butler 1991).

Piedmont soils derived from Carolina Slate Belt rocks are generally quartz-, feldspar-, and mica-rich clays and loams (Buol 2003), although sandy soils can be found in some upland areas. Diagnostic heavy minerals include amphiboles (especially hornblende), epidote, and pyroxenes (Neiheisel and Weaver 1967; Windom et al. 1971).

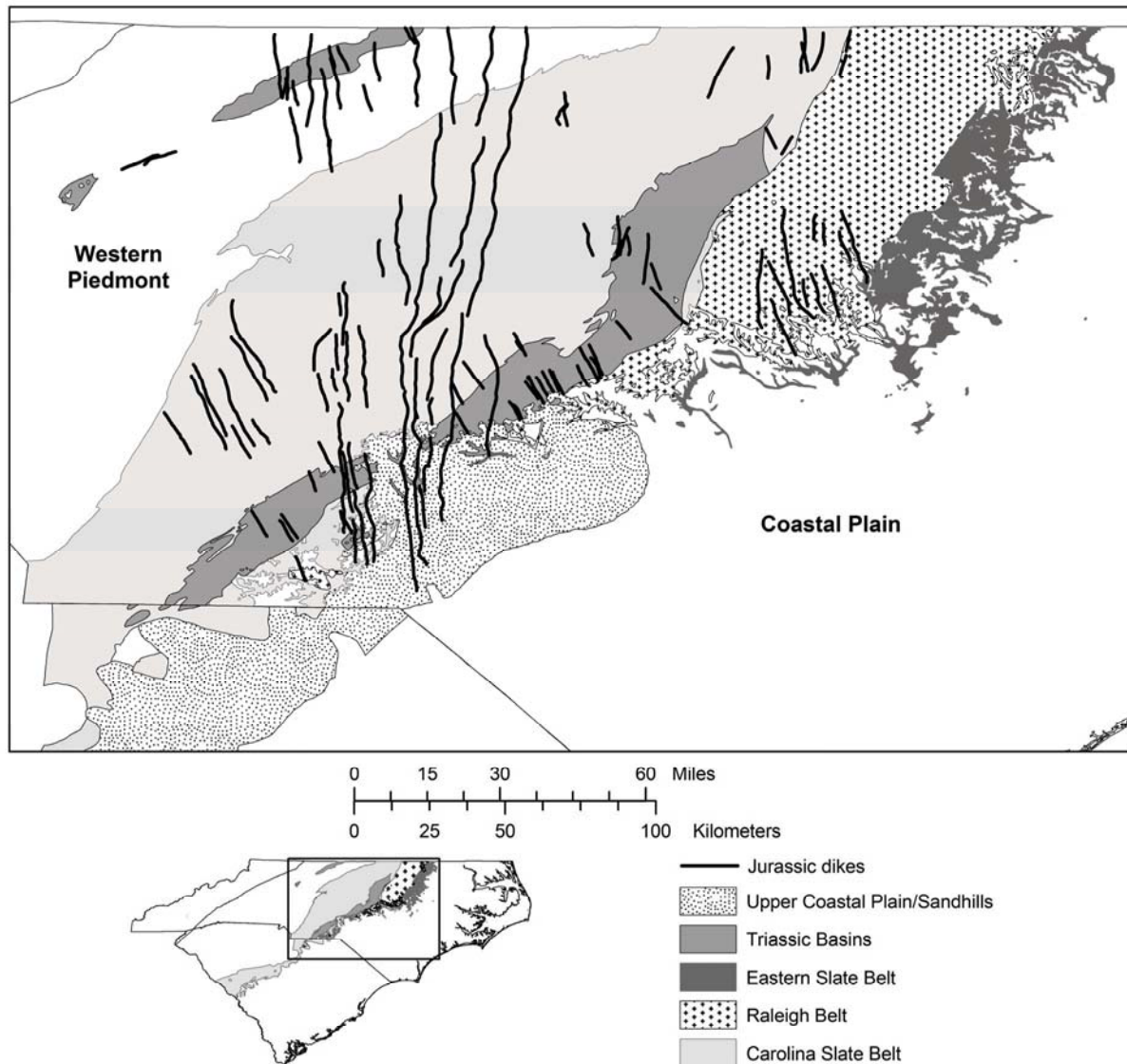


Figure 2.4. Geologic features of the eastern Piedmont (North Carolina Geological Survey 1998a, 1998b; South Carolina Geological Survey 2005).

Feldspars weather into kaolin group minerals, which are consequently the dominant clay minerals in the Carolina Slate Belt. Illite, chlorite, vermiculite, and hydroxy-interlayered vermiculite are also locally present, but smectite is generally absent except in the vicinity of metagabbro intrusions in the Albemarle-Asheboro region (Buol 2003; Neiheisel and Weaver 1967; Olive et al. 1989; Steponaitis et al. 1996; Windom et al. 1971).

#### *The Deep River Triassic Basin*

East of the Slate Belt, the Deep River Triassic basin contains sedimentary rocks. The basin extends approximately 240 km in length and is bounded by the Sandhills to the southeast and by

amphibolite-facies gneisses and schists of the Raleigh Belt to the northeast. It is believed to have formed during rifting accompanying the breakup of Pangea and the opening of the Atlantic Ocean approximately 200–190 million years ago (Olsen et al. 1991; Rogers 2006).

The general stratigraphic sequence within the Deep River basin reveals fluvial, lacustrine, and deltaic deposits. It includes four units: (1) a basal conglomerate overlain by sandstones and mudstones, (2) clay shale and mudstone, (3) cross-bedded sandstones and massive mudstone, and (4) poorly sorted conglomerate and sandstone (Olsen et al. 1991:148). Soils derived from these deposits are generally loams and sandy loams.

Deep River basin clays are typically a mixture of smectite and kaolinite and provide the basis for North Carolina's brick industry (Feiss et al. 1991). It is unclear whether the smectite component is an in situ weathering product or has a sedimentary origin (Buol 2003). Regardless, clays in the Deep River basin are more similar to upper Coastal Plain clays than they are to clays found in the Carolina Slate Belt (Olive et al. 1989).

### *Mafic Dikes*

Two swarms of Early Jurassic igneous dikes cut across the eastern Piedmont. An older swarm of olivine- and quartz-normative-diorite intrusions trends northwest, while a slightly younger swarm of quartz-normative-diorite dikes strikes approximately north-south (Beutel et al. 2005). The northwest-striking dikes tend to be shorter, narrower, and more closely spaced than the north-trending dikes (Ragland 1991:173). Both swarms formed sometime between 199 and 197 million years ago (Beutel et al. 2005).

In some cases, samples from the two swarms can be distinguished based on normative mineralogy. It may also be possible to discriminate between northwest-striking dikes from the Carolina Slate Belt and those from the Deep River basin based on Rb/Sr ratios, which decrease from west to east (Ragland 1991:177).

## **River Basins and Drainages**

The samples collected for this study represent eight drainages in three river basins: the Haw, Deep, Lower Little, and Cape Fear drainages of the Cape Fear River basin; the Yadkin and Pee Dee drainages of the Yadkin-Pee Dee River basin; and the Drowning Creek and Waccamaw drainages of the Lumber River basin (Figure 2.5).

### *The Cape Fear River Basin*

The Cape Fear River basin incorporates the Haw, Deep, Lower Little, and Cape Fear drainages (Figure 2.6). The Haw and Deep Rivers originate in the western Piedmont and cut through the Carolina Slate Belt and Deep River Triassic basin before merging to form the Cape Fear River. Approximately 6 km above the confluence of the Haw and Deep Rivers, the B. Everett Jordan dam floods approximately 5,641 ha of the Deep River Triassic basin, including the location of the Haw River site (31Ch29) from which pottery samples were drawn for this study (see Chapter 3).

The Cape Fear River passes through the Raleigh Belt and a small segment of the metamorphic Eastern Slate Belt before draining the North Carolina Coastal Plain. It is fed by the Lower Little River, which originates in the Sandhills and drains most of Fort Bragg.



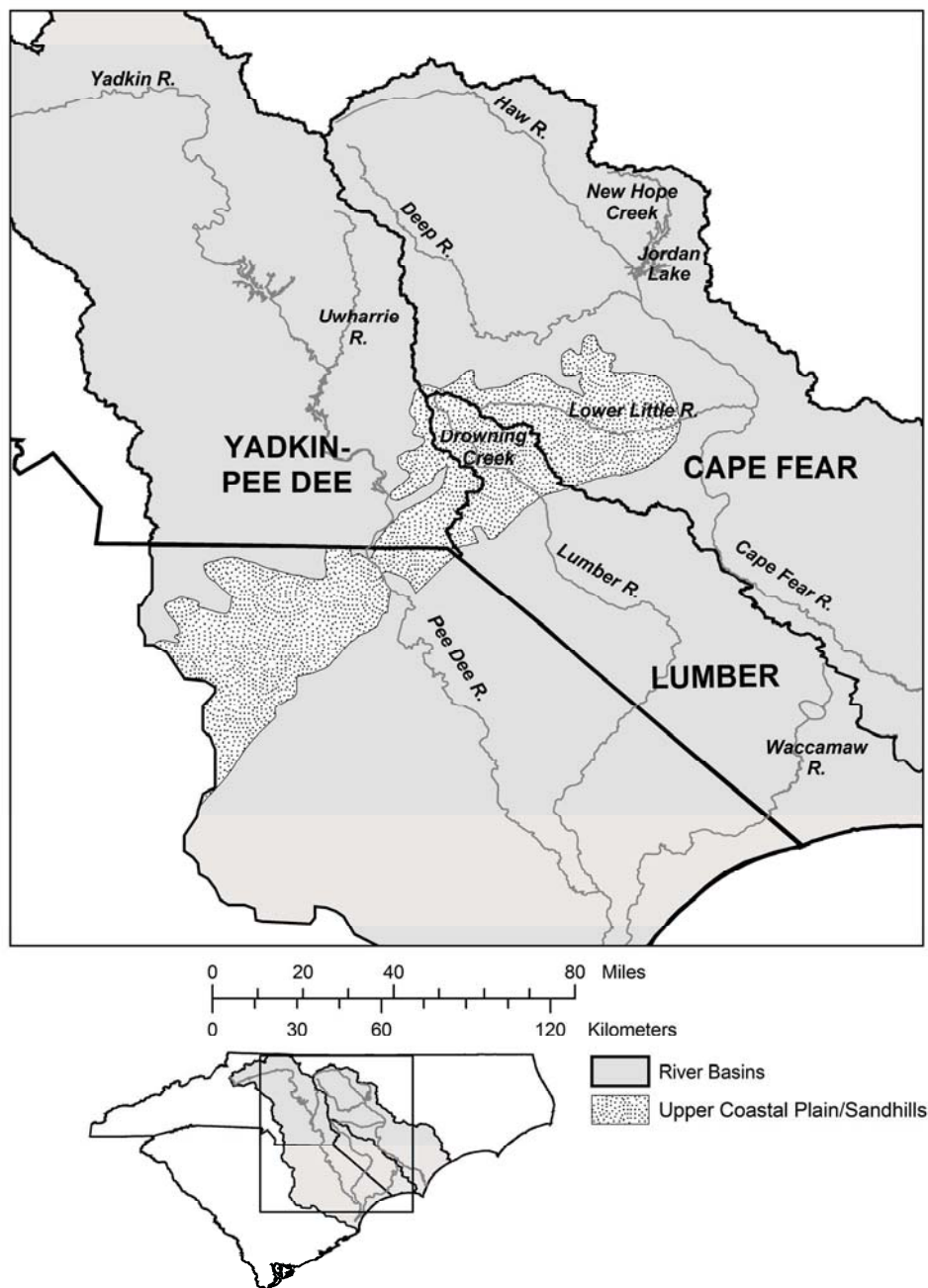


Figure 2.5. Rivers and river basins mentioned in the text (United States Department of Agriculture 1998; United States Geological Survey 2002).

### *The Yadkin-Pee Dee River Basin*

The Yadkin-Pee Dee River basin includes the Yadkin, Uwharrie, and Pee Dee Rivers (Figure 2.7). The headwaters of the Yadkin lie in the eastern Blue Ridge province, but the bulk of the river's length spans the western Piedmont. The Yadkin cuts through the Uwharrie suite, where it

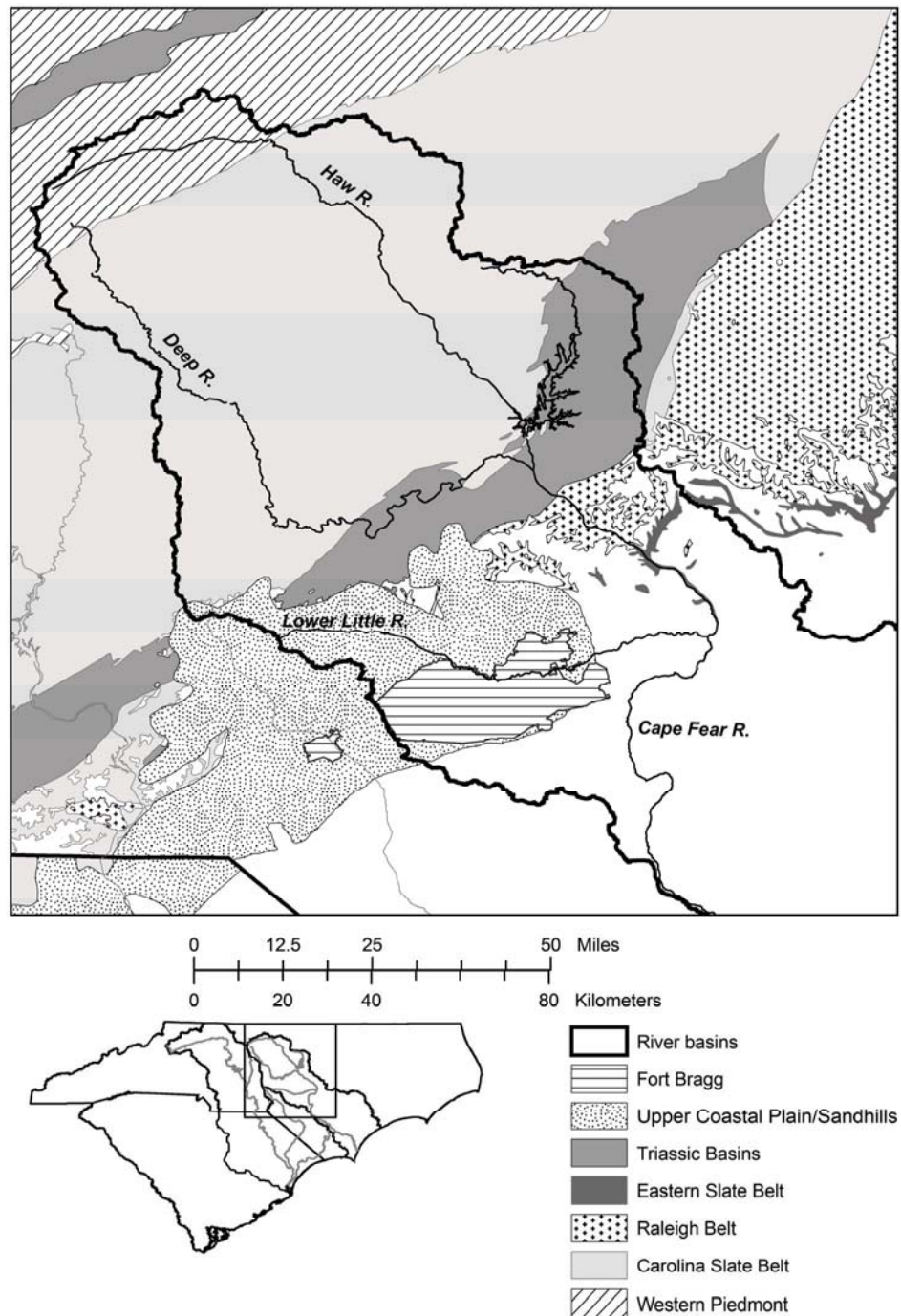


Figure 2.6. The Cape Fear River basin (North Carolina Geological Survey 1998a; South Carolina Geological Survey 2005; United States Department of Agriculture 1998; United States Geological Survey 2002).

ultimately merges with the Uwharrie River to become the Pee Dee. The Pee Dee River then traverses the Deep River Triassic basin and more of the Carolina Slate Belt before entering the Coastal Plain of South Carolina.



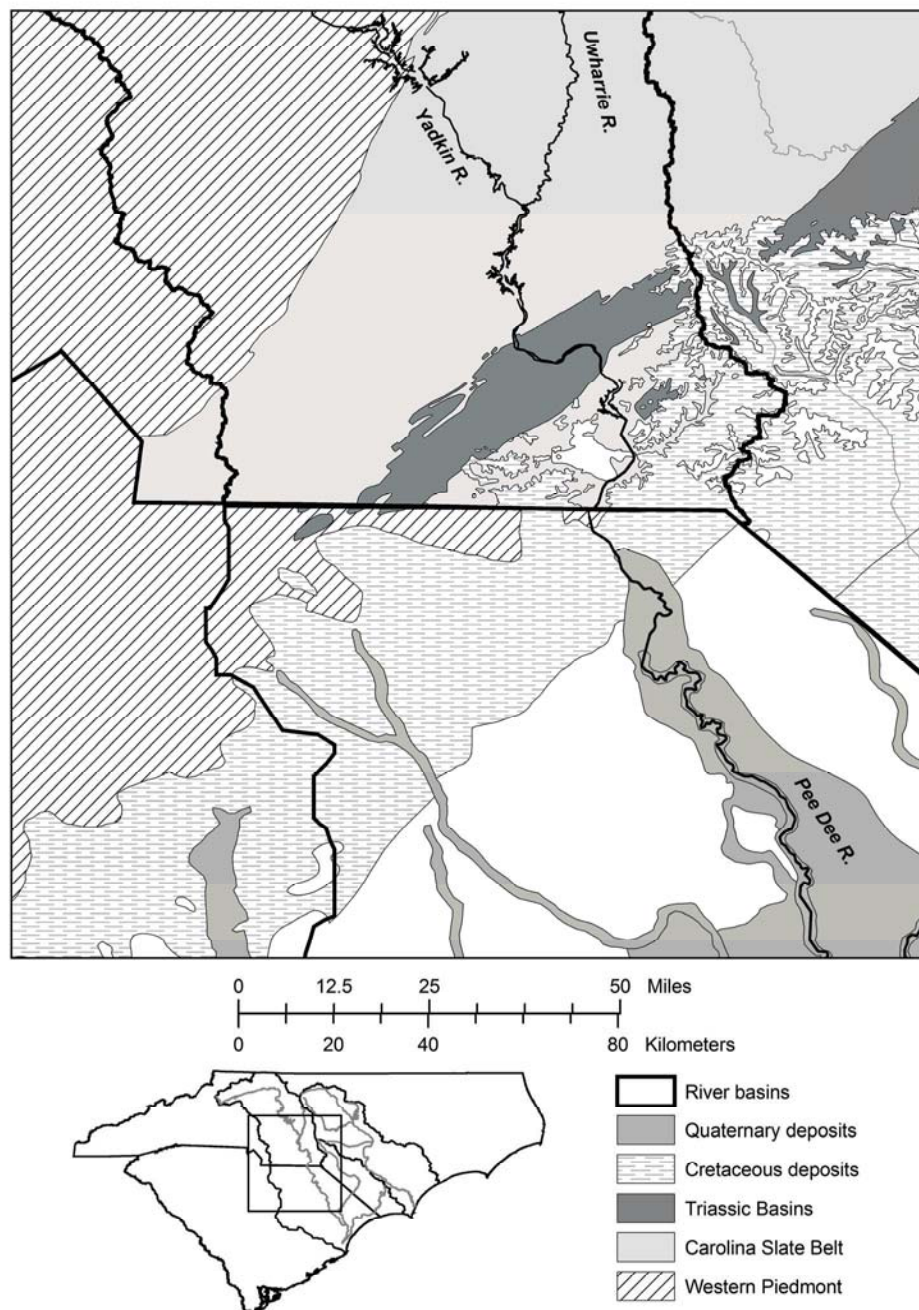


Figure 2.7. The Yadkin-Pee Dee River basin (North Carolina Geological Survey 1998a; South Carolina Geological Survey 2005; United States Department of Agriculture 1998; United States Geological Survey 2002).

### *The Lumber River Basin*

The Lumber River basin is situated entirely within the Coastal Plain (Figure 2.8). Samples representing this basin were collected from the vicinity of Drowning Creek in the Sandhills and along swampy tributaries of the Waccamaw River in North Carolina's lower Coastal Plain.

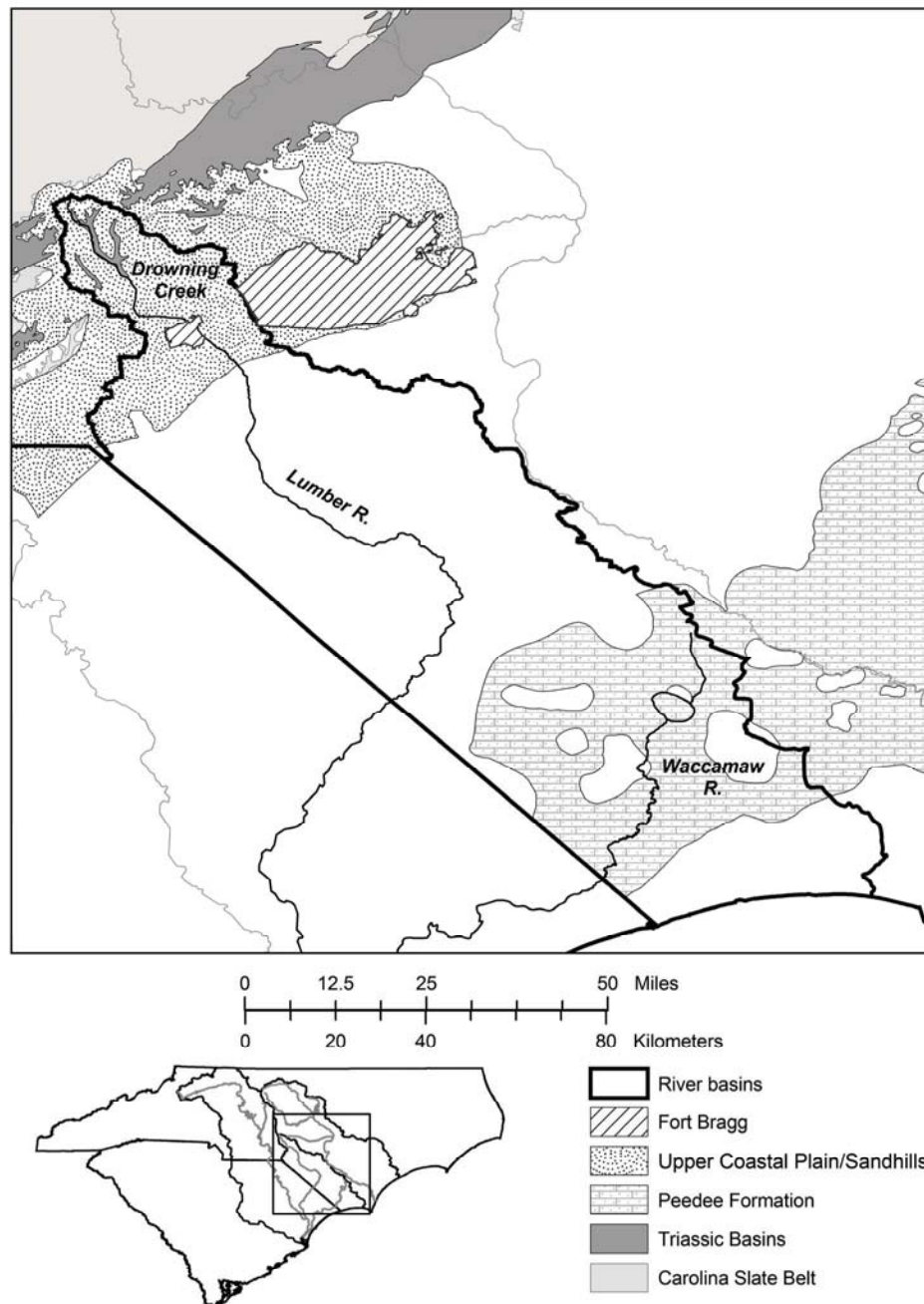


Figure 2.8. The Lumber River basin (North Carolina Geological Survey 1998a; South Carolina Geological Survey 2005; United States Department of Agriculture 1998; United States Geological Survey 2002).

Drowning Creek originates in the Sandhills and represents the headwaters of the Lumber River. It passes through part of the Deep River Triassic basin and drains Camp Mackall, an outpost approximately 65 km west of the main Fort Bragg installation. South of Camp Mackall, Drowning Creek becomes the Lumber River, which meanders into South Carolina and ultimately feeds into the Pee Dee River.

The Waccamaw River and the majority of its tributaries originate in the sands, clays, and limestone of the Peedee Formation. In North Carolina, the Waccamaw River is surrounded by swamps and marshes. It flows approximately parallel to the coast and into South Carolina, where it also joins the Pee Dee River.

### Conclusion

Geological distinctions between the Coastal Plain and Piedmont suggest that pottery made from resources obtained in these two physiographic provinces should exhibit different geochemical and mineralogical characteristics. Because the eight river drainages from which samples for this study were drawn pass through different geologic formations within the Coastal Plain and Piedmont, it is possible that precise geochemical and mineralogical analyses could allow us to further discriminate specific resource areas within these broad provinces.

### Notes

*Acknowledgments.* I thank John Rogers, Michael Smith, and Edward Stoddard for reviewing drafts of this chapter and sharing their expertise on the geology of the Carolinas.

<sup>1</sup>Recent research suggests that the name “Middendorf” has been applied to a variety of units with similar lithologies but different stratigraphic positions and ages (Prowell et al. 2003). Prowell et al. (2003) therefore recommend that the name Middendorf be restricted to strata from the type section locality in Chesterfield County, South Carolina and that its application to other units be reconsidered. In this study, however, we utilize the description and stratigraphic position of the “Middendorf Formation” as provided by the work of the North Carolina Geological Survey (1985) and Sohl and Owens (1991).