Chapter 6

Petrography

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A petrographic analysis was conducted as part of the effort to determine how, and to what degree, pottery may have been moving into the Sandhills from surrounding regions. The sample included 70 ceramic sherds and 53 clay test tiles representing eight drainages in the Sandhills, Coastal Plain, and Piedmont (Table B.7).

The objective of the petrographic study was to establish a baseline of information about the petrological variability observed in pottery and clays from the Sandhills and surrounding regions. This was accomplished by characterizing the minerals, rock fragments, and other components identified in standard size petrographic thin sections (Figure 6.1; Appendix D). In addition, the petrographic characteristics of the sherds and clays were used to identify possible source locations for the pottery samples.

This chapter describes the results of the petrographic study and compares them with those from a previous study of Fort Bragg pottery conducted by Herbert et al. (2002). Appendix D contains a full description of the methodology and point count data for the pottery samples.

Petrographic Criteria for Characterizing Pottery and Clays

Archaeologists often use terms that are misconstrued by geologists, and vice versa. The following discussion of nomenclature and terminology is offered to circumvent this dilemma.

In this study, the materials composing the prehistoric pottery and ceramic test tiles are separated into two types, *plastic* and *aplastic*, based upon certain material properties. *Paste* refers to the entire ceramic matrix including plastic and aplastic components.

Plastic components are predominately clay minerals and generally comprise most of the sherd or test tile matrix. During firing, clay minerals respond to changes in temperature and react to produce an amorphous glass or a partially amorphous intermediate-reaction product. This vitrification process destroys or dramatically changes the optical characteristics of the materials, preventing identification of the original clay minerals. In addition, the grain size of clay is generally less than 0.01 mm and therefore below the optical resolution of the BH-2 microscope (Rice 1987:38, Figure 2.2).

Nonclay minerals and rock fragments are referred to as *aplastic* components and can be identified through petrographic analysis. Aplastic materials greater than 0.1 mm in diameter were evaluated for crystal shape (angular, subangular, subrounded, or rounded), color (clear, translucent, or colored), pleochroism (change of color upon rotation of the stage in plane-polarized light), and presence of alteration minerals (secondary minerals resulting from alteration

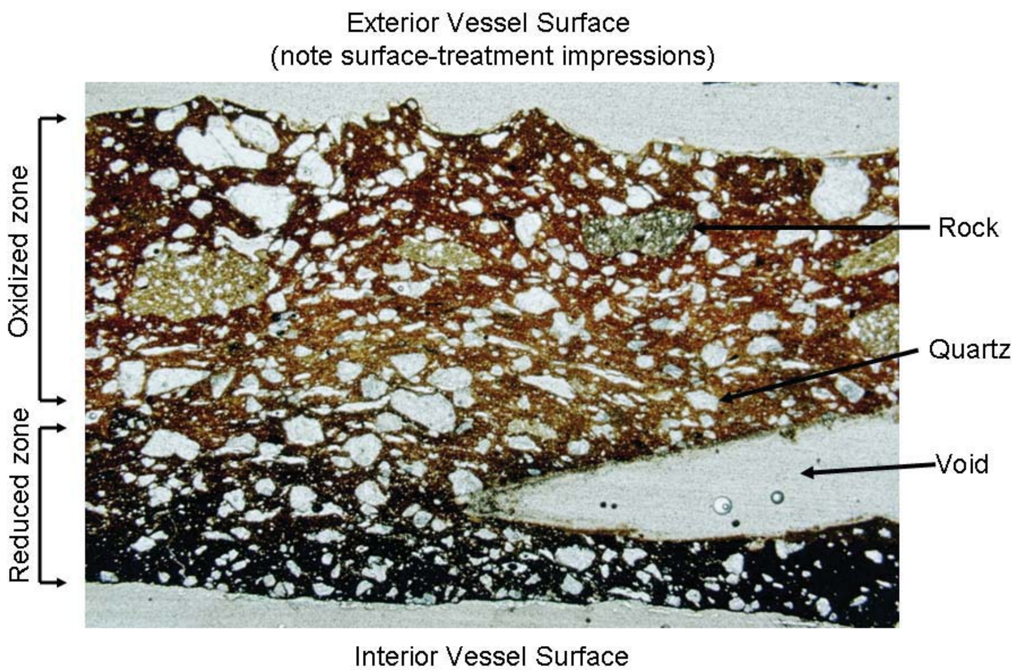

Figure 6.1. Ceramic petrographic thin section illustrating the orientation of the cross section and some common attributes analyzed in this study.

of original minerals). Opaque minerals, which appear black under plane-polarized light, were also evaluated.

Temper is generally defined by archaeologists as aplastic material added to clay to enhance the workability or firing characteristics of the paste (Rice 1987:74). It is often difficult to ascertain whether specific aplastic components of pottery have been deliberately added to enhance the workability of the paste or are present simply as naturally occurring constituents of the clay (Rice 1987; Stoltman 1989). In this study, aplastic materials with grain sizes smaller than 0.1 mm are considered to be naturally occurring components of the paste material. Aplastic materials with grain sizes greater than 0.1 mm are classified as tempering materials, although one of the goals of this study is to determine whether naturally occurring, coarse aplastic materials can be distinguished from deliberately added components.

Aplastic Component Categories

Aplastic materials were divided into three categories: mineral grains or fragments, rock fragments, and other constituents. *Mineral grains* include

- quartz,
- mica (muscovite or biotite),
- feldspar (plagioclase or K-feldspar),
- mafic minerals (pyroxene or amphibole),
- opaque minerals (generally hematite or magnetite based upon color, optical relief, and grain shape), and
- other minerals (including epidote or clinozoisite, tourmaline, and zircon).

Quartz minerals were distinguished using criteria such as monocrystalline versus polycrystalline texture, grain size, and degree of angularity and rounding. Mica was identified as either muscovite or biotite based upon mineral color and pleochroism, Michel-Levy interference colors, and extinction angle. However, the firing process often changes the color characteristics of the micas, generating a small degree of uncertainty in the identification.

Feldspar minerals were typically identified based upon the presence or absence of diagnostic twinning. A mineral exhibiting no twinning was described as feldspar. Plagioclase was identified by characteristic albite polysynthetic twinning, while lack of albite twinning or presence of "tartan plaid" intersection twinning identified K-feldspar (also termed potassium feldspar or alkali feldspar). Plagioclase and K-feldspar can also sometimes be distinguished based on alteration minerals. Because plagioclase and K-feldspar have slight chemical differences, they alter according to different chemical reactions and produce different alteration assemblages. Sericite (or "white mica") and argillite (a clay mineral) are common alteration minerals for both plagioclase and K-feldspar, but saussurite (or epidote) is only formed through the alteration of Ca-plagioclase.

Mafic minerals are generally colored in plane-polarized light and have characteristic cleavage, interference colors, and extinction angles. Pyroxene and amphibole represent two groups of mafic minerals with slight variations in chemistry and mineral properties. As with the feldspar minerals, characteristic mineral properties help discriminate one mafic group from the other. In addition, the presence of other minerals within the paste can also be used to constrain the identity of mafic minerals. For example, pyroxene would be commonly associated with plagioclase feldspar but not quartz, while amphibole would be associated with quartz, biotite or muscovite mica, and plagioclase feldspar.

Other minerals include those that have high hardness, density, or chemical resistivity to weathering. Minerals such as tourmaline are often associated with specific rock types (e.g., high-alumina granites) and might have specific applicability as "mineral tracers" in some sedimentary depositional environments.

The *rock fragment* category includes igneous, sedimentary, and metamorphic types. Rock fragments in the majority of samples include

- diabase igneous rock fragments,
- quartz + feldspar igneous rock fragments occurring with or without mafic and/or opaque minerals,
- polygranular igneous or metamorphic quartz rock fragments (sometimes with fluid inclusions and rutile needles), and
- sedimentary or metasedimentary rock fragments.

Other constituents include

- grog (with or without aplastic mineral grains),
- argillaceous clay fragments (argillaceous clay clots or hematite-stained clots), and
- charcoal or petrified wood fragments.

Grog and argillaceous clay fragments (ACF) share many morphological and optical characteristics, so distinguishing between them can be very difficult. Grog refers to fired pottery fragments deliberately added to the clay in order to enhance workability or thermal shock resistance during firing (Whitbread 1986). ACF are naturally occurring inclusions of air-dried clay (Cuomo di Caprio and Vaughan 1993); Whitbread (1986) refers to these inclusions as "argillaceous pellets." In this study, ACF are separated into two types: argillaceous clay clots and hematite-stained clay clots. Argillaceous clay clots appear as angular to subrounded fragments that are nearly indistinguishable from the surrounding paste (Figure 6.2). Indeed, these clay clots completely blend into the paste under cross-polarized light and are thus virtually impossible to detect through point counting. Nevertheless, slightly different abundances of clay minerals or aplastic mineral crystals in the argillaceous clay clots and paste produce subtle yet distinctive optical differences. In contrast, hematite-stained clay clots are iron rich and stand out as brick red or dark red ovals or lozenges with few mineral inclusions.

Firing Conditions

Firing conditions (temperature and atmosphere) can sometimes be interpreted from the color of the sherd (Rice 1987; Rye 1981; Velde and Druc 2000). Light color (e.g., light red, pink, pale rose, light tan, light greenish tan) may indicate low carbon content, high firing temperature, or oxidizing conditions, while a dark color (e.g., black, black-gray, dark gray) may indicate high carbon content, low firing temperature, and reduced (i.e., low oxygen) firing conditions. The presence of both oxidation and reduction may be recorded on a single vessel as "fire clouding" (a phenomenon caused by variations in temperature and oxidization resulting from uneven fuel and ventilation) or as differences in core and surface color in sherd cross sections. Munsell colors for sherd cores and test tile surfaces were recorded for the hand samples (see Appendixes A and B) and are noted in the petrographic analysis of thin sections.

The ceramic samples display oxidation features on the inner and outer surfaces. These features extend into the sherd for several millimeters. In some sherds there is a darker core between these oxidized zones indicating that either organics were originally present and oxidized only near the surfaces or the pot was fired in a reduced-oxygen environment and then cooled quickly. Observations and measurements of the size of the oxidized zones and the degree of oxidation to reduction were noted.

Other Observations

It was also noted that some sherds show secondary alteration in fractures and along broken edges. This mineralization is apparent as a localized color change and may have resulted from usage or burial and interaction with groundwater.

The percentage of void spaces is sometimes used as a basis for characterizing pottery types (Whitbread 1987), but it was not used in the classification of samples for this study. Nevertheless, void spaces were evaluated during point counting to assess the loss of organic inclusions (through firing or dissolution) or mineral and rock fragments (due to plucking during thin-section preparation and finishing).

Results: Ceramic Samples

The 70 pottery samples can be separated into three distinct petrographic groups based on characteristic aplastic inclusions (Table 6.1). Group I samples are characterized by the presence of diabase (pyroxene + plagioclase) rock fragments. Group II samples contain quartz + feldspar

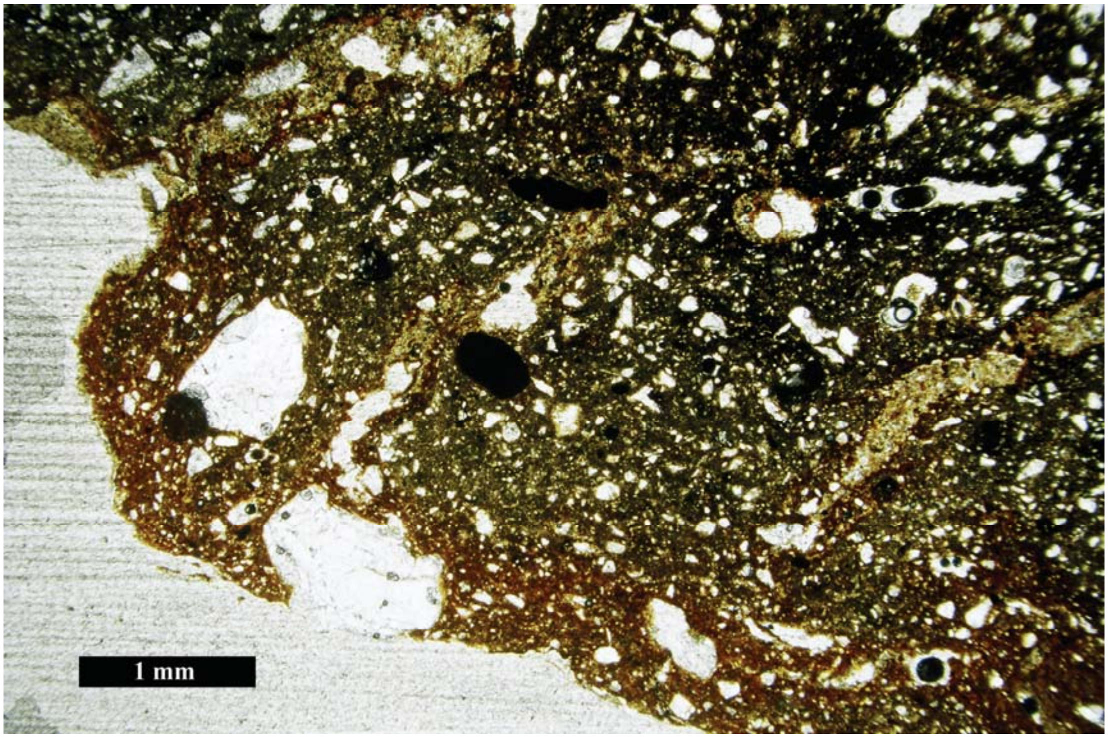

Figure 6.2. ACF in pottery sample JMH068 (plane-polarized light). Argillaceous clay clots (center, top left, and bottom right of center) are yellow brown, worm-like in appearance, and contain quartz and feldspar inclusions. Hematite-stained clay clots (center and top right of center) are reddish black and lack visible mineral inclusions. Aplastic components are mainly medium- to fine-grained quartz, feldspar, and biotite. Paste is dark golden tan to brown and is nearly isotropic in optical behavior. Note that there are aplastic components within the paste that are probably quartz and feldspar minerals.

rock fragments, quartz mineral fragments, and mafic mineral fragments. Group III samples are rich in muscovite mica, quartz mineral fragments, and quartz rock fragments and generally lack mafic minerals such as pyroxene or amphibole. Groups II and III contain samples exhibiting considerable petrographic variability, but the samples within these groups share enough general similarities that it was decided to divide the groups into subgroups rather than create additional distinct groups.

The general characteristics of the groups, subgroups, and samples are summarized below. More detailed descriptive information and point count data for the 70 sherds are included in Appendix D.

Group I

Group I contains four Middle Woodland Yadkin series sherds from the Lower Little, Haw, and Yadkin drainages (Table 6.2). These sherds are dominated by coarse to very coarse (0.5–2.0 mm) pyroxene + plagioclase diabase rock fragments (Figure 6.3). The associated mineral suite is composed mainly of pyroxene and plagioclase mineral fragments which are probably derived from the breakdown of the diabase. The pyroxene is probably a clinopyroxene (augite). The plagioclase is Ca-rich (probably labradorite).

Table 6.1. Characteristic Aplastic Inclusions in Petrographic Groups.

	Petrographic Groups				
		Group II		Group III	
Inclusions	Group I	A	B	A	B
Mineral Grains					
Pyroxene	x				
Feldspar (plagioclase or potassium)	x	x	x		
Amphibole		x	x		
Biotite		x	x		
Muscovite		x	x	x	x
Quartz (monocrystalline)		x	x	x	x
Opaque (hematite or magnetite)		x	x	x	x
Rock Fragments					
Diabase (pyroxene- and/or plagioclase-rich)	x				
Quartz + feldspar + mafic minerals		x			
Quartz + feldspar		x	x		
Quartz (polygranular) fragments		x	x	x	x
Other					
Grog				x	x
ACF - Hematite-stained clay clots				x	x
ACF - Argillaceous clay clots				x	

Group I sherds have a consistent black to black-gray color that may be a result of reduced firing. Alternatively, the dark color may be what happens when Ca-Mg-Fe-rich diabase is fired under oxidizing conditions.

Diabase fragments in sample JMH006 comprise almost 30% of the paste and range from medium to very coarse in size, allowing them to be observed in thin section without magnification. The nearly pristine condition of these fragments suggests a source close to a diabase exposure. The original vessel may have been constructed from a residual saprolite material that did not require the addition of temper.

In addition to diabase fragments, samples JMH031, JMH046, and JMH047 also have a small amount of monocrystalline quartz mineral fragments and polygranular quartz rock fragments (Figure 6.4). The presence of these different types of quartz fragments may reflect a mixing of sedimentary materials during fluvial transportation, a suggestion reinforced by the observation that the diabase fragments in JMH046 and JMH047 show signs of alteration. The polygranular quartz rock fragments in JMH031 are different in texture, appearance, and shape than the ones found in JMH046 and JMH047.

Triassic- to Jurassic-age diabase dikes have been mapped (mainly by aeromagnetic surveys) in the Piedmont of North Carolina (North Carolina Geological Survey 1985). Surface exposures of diabase can be found in the eastern Piedmont (see Chapter 2 and Figure 2.4). For comparison with the Group I sherds, diabase samples were acquired from Albemarle, where there is good outcrop exposure. The rock fragments in the Group I sherds are identical to those from

Table 6.2. Petrographic Group Assignments for Ceramic Samples.

Group: Sample ID	Site	Drainage	Region	Type
Group I:				
JMH006	31Hk123	Lower Little	Sandhills	Yadkin Fabric Impressed
JMH031	Doerschuk	Yadkin	Piedmont	Yadkin Fabric Impressed
JMH046	Haw River	Haw	Piedmont	Yadkin Plain
JMH047	Haw River	Haw	Piedmont	Yadkin eroded
Group IIA:				
JMH032	Doerschuk	Yadkin	Piedmont	Dan River Simple Stamped
JMH033	Doerschuk	Yadkin	Piedmont	Yadkin Fabric Impressed
JMH034	Doerschuk	Yadkin	Piedmont	Jenrette Plain
JMH040	Doerschuk	Yadkin	Piedmont	Yadkin Net Impressed
JMH045	Haw River	Haw	Piedmont	Yadkin Plain
JMH048	Haw River	Haw	Piedmont	Yadkin Plain
Group IIB:				
JMH014	31Mr253	Drowning Creek	Sandhills	Yadkin Fabric Impressed
JMH015	31Mr241	Drowning Creek	Sandhills	Sand-tempered Plain
JMH035	Doerschuk	Yadkin	Piedmont	New River Cord Marked
JMH036	Doerschuk	Yadkin	Piedmont	New River Net Impressed
JMH037	Doerschuk	Yadkin	Piedmont	Yadkin Check Stamped
JMH038	Doerschuk	Yadkin	Piedmont	Yadkin Cord Marked
JMH039	Doerschuk	Yadkin	Piedmont	Dan River Net Impressed
JMH041	Haw River	Haw	Piedmont	Yadkin Paddle-edge Stamped
JMH042	Haw River	Haw	Piedmont	Yadkin Cord Marked
JMH043	Haw River	Haw	Piedmont	Yadkin Plain
JMH044	Haw River	Haw	Piedmont	Cape Fear Fabric Impressed
JMH049	Haw River	Haw	Piedmont	Yadkin Plain
JMH050	Haw River	Haw	Piedmont	Yadkin eroded
JMH067	Waccamaw	Waccamaw	Coastal Plain	Cape Fear Fabric Impressed
Group IIIA:				
JMH001	31Hk868	Lower Little	Sandhills	Hanover II Fabric Impressed
JMH002	31Ht392	Lower Little	Sandhills	Hanover II Fabric Impressed
JMH003	31Ht273	Lower Little	Sandhills	Cape Fear III Fabric Impressed
JMH004	31Hk127	Lower Little	Sandhills	Hanover II Fabric Impressed
JMH005	31Hk59	Lower Little	Sandhills	Hanover I Cord Marked
JMH007	31Cd750	Lower Little	Sandhills	Hanover I Paddle-edge Stamped
JMH008	31Ht269	Lower Little	Sandhills	Mt. Pleasant Cord Marked
JMH009	31Cd486	Lower Little	Sandhills	Cape Fear Cord Marked
JMH010	31Hk715	Lower Little	Sandhills	Hanover Fabric Impressed
JMH011	31Mr241	Drowning Creek	Sandhills	Hanover I Cord Marked
JMH012	31Mr259	Drowning Creek	Sandhills	Hanover II Fabric Impressed
JMH013	31Mr241	Drowning Creek	Sandhills	Deptford Linear Check Stamped
JMH016	31Sc71	Drowning Creek	Sandhills	New River Paddle-edge Stamped
JMH019	31Mr93	Lower Little	Sandhills	Hanover II Cord Marked
JMH020	31Mr241	Drowning Creek	Sandhills	New River Cord Marked
JMH021	Breece	Cape Fear	Coastal Plain	Hanover II Paddle-edge Stamped
JMH023	Breece	Cape Fear	Coastal Plain	Hanover II Fabric Impressed

Table 6.2. Petrographic Group Assignments for Ceramic Samples (continued).

Group: Sample ID	Site	Drainage	Region	Type
JMH024	Breece	Cape Fear	Coastal Plain	Hanover II Fabric Impressed
JMH025	Breece	Cape Fear	Coastal Plain	Cape Fear Cord Marked
JMH026	Breece	Cape Fear	Coastal Plain	Hanover II Fabric Impressed
JMH027	Breece	Cape Fear	Coastal Plain	Hanover I Fabric Impressed
JMH028	Breece	Cape Fear	Coastal Plain	Hanover I Fabric Impressed
JMH029	Breece	Cape Fear	Coastal Plain	Hanover I Fabric Impressed
JMH030	Breece	Cape Fear	Coastal Plain	Hanover II Fabric Impressed
JMH053	Kolb	Pee Dee	Coastal Plain	Yadkin Cord Marked
JMH054	Kolb	Pee Dee	Coastal Plain	New River Cord Marked
JMH056	Kolb	Pee Dee	Coastal Plain	New River Fabric Impressed
JMH058	Kolb	Pee Dee	Coastal Plain	Cape Fear Fabric Impressed
JMH059	Kolb	Pee Dee	Coastal Plain	Cape Fear Fabric Impressed
JMH060	Kolb	Pee Dee	Coastal Plain	Hanover I Fabric Impressed
JMH061	Waccamaw	Waccamaw	Coastal Plain	Thoms Creek Punctate
JMH063	Waccamaw	Waccamaw	Coastal Plain	Hanover II Fabric Impressed
JMH065	Waccamaw	Waccamaw	Coastal Plain	Hanover I Fabric Impressed
Group IIIB:				
JMH017	31Mr93	Lower Little	Sandhills	New River Cord Marked
JMH018	31Sc87	Drowning Creek	Sandhills	Deptford Check Stamped
JMH022	Breece	Cape Fear	Coastal Plain	New River Fabric Impressed
JMH055	Kolb	Pee Dee	Coastal Plain	Yadkin Cord Marked
JMH057	Kolb	Pee Dee	Coastal Plain	New River Cord Marked
JMH062	Waccamaw	Waccamaw	Coastal Plain	Cape Fear Fabric Impressed
JMH064	Waccamaw	Waccamaw	Coastal Plain	Hanover II Fabric Impressed
JMH066	Waccamaw	Waccamaw	Coastal Plain	Cape Fear Fabric Impressed
JMH069	Waccamaw	Waccamaw	Coastal Plain	Cape Fear Fabric Impressed
JMH070	Waccamaw	Waccamaw	Coastal Plain	Cape Fear Fabric Impressed
Unassigned:				
JMH051	Kolb	Pee Dee	Coastal Plain	Yadkin Fabric Impressed
JMH052	Kolb	Pee Dee	Coastal Plain	Hanover Fabric Impressed
JMH068	Waccamaw	Waccamaw	Coastal Plain	Hanover eroded

Albemarle. It is thus hypothesized that the materials from which Group I samples were made came from areas of the Piedmont where diabase dikes are exposed and weathered. The Doerschuk site from which sample JMH031 was recovered is in the vicinity of the Albemarle outcrops, and the Haw River site from which samples JMH046 and JMH047 were acquired is less than 8 km away from diabase exposures in the Deep River Basin. The different appearances of the quartz rock fragments in the Doerschuk and Haw River samples are consistent with two different source locations.

Significantly, the site on Fort Bragg from which JMH006 was acquired is approximately 30 km from the nearest diabase dike, but the unaltered condition of the rock and mineral fragments in this sample suggests that they did not experience long-term chemical weathering or extensive

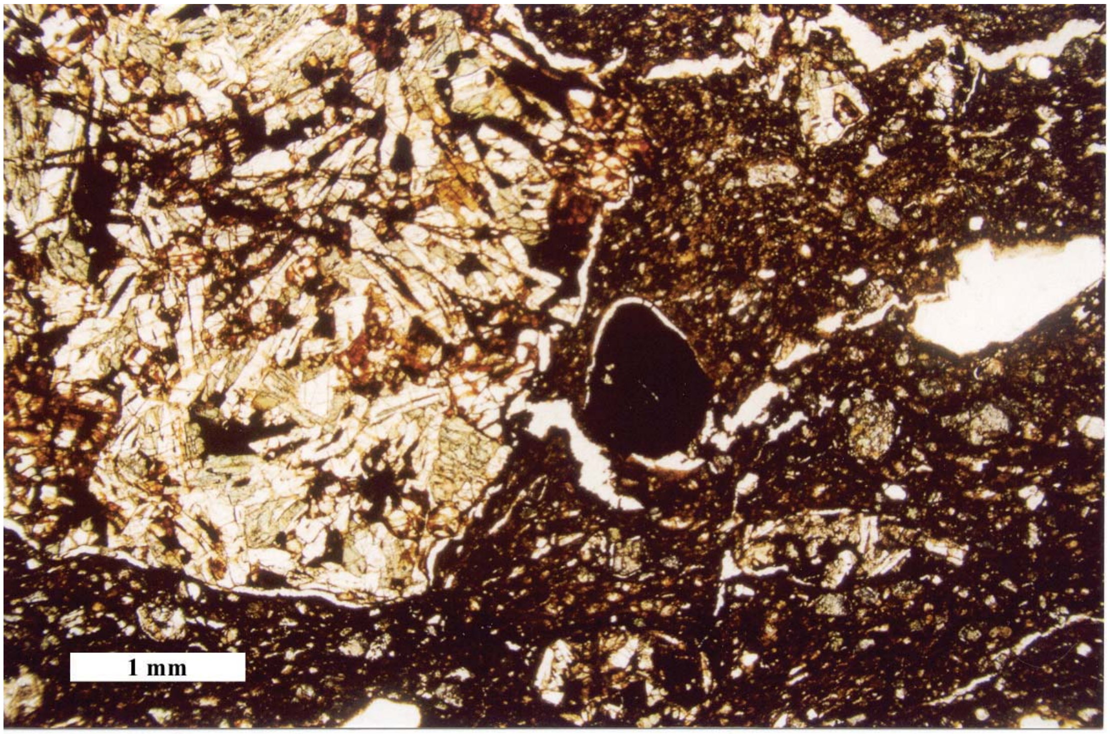

Figure 6.3. Diabase rock fragment (left) in pottery sample JMH006 (plane-polarized light). Also note the rounded grog fragment (center) with partial separation void and pyroxene and plagioclase mineral fragments.

fluvial transportation. It is therefore likely that JMH006 was manufactured some distance from the site where it was recovered.

Group II

Group II is defined by the presence of quartz + feldspar igneous rock fragments. It is divided into two subgroups based on variation in mafic mineral components (i.e., amphibole and biotite). Sherds in Group IIA contain cohesive quartz + feldspar + mafic rock fragments. Group IIB samples contain quartz + feldspar rock fragments and *individual* mafic mineral fragments, but the quartz + feldspar rock fragments do not have visible mafic components.

Group IIA. Group IIA includes six samples from the Yadkin and Haw drainages (Table 6.2). These sherds contain coarse to very coarse mineral fragments. Five of them have a consistent dark coloration, while JMH040 has a distinct black core and red outer oxidation region.

In thin section the rock fragments are of two types. One is a subangular to subrounded, polygranular quartz with sutured grain boundaries (Figure 6.5). The other rock fragment type is quartz + feldspar + mafic igneous rock (Figure 6.6).

Group IIA samples also contain coarse- to medium-grained biotite and amphibole mineral fragments that are probably derived from the quartz + feldspar + mafic rock material. Feldspar mineral fragments could also be derived from the rock fragments because both show extensive alteration to sericite and argillite (Figures 6.6–6.7).

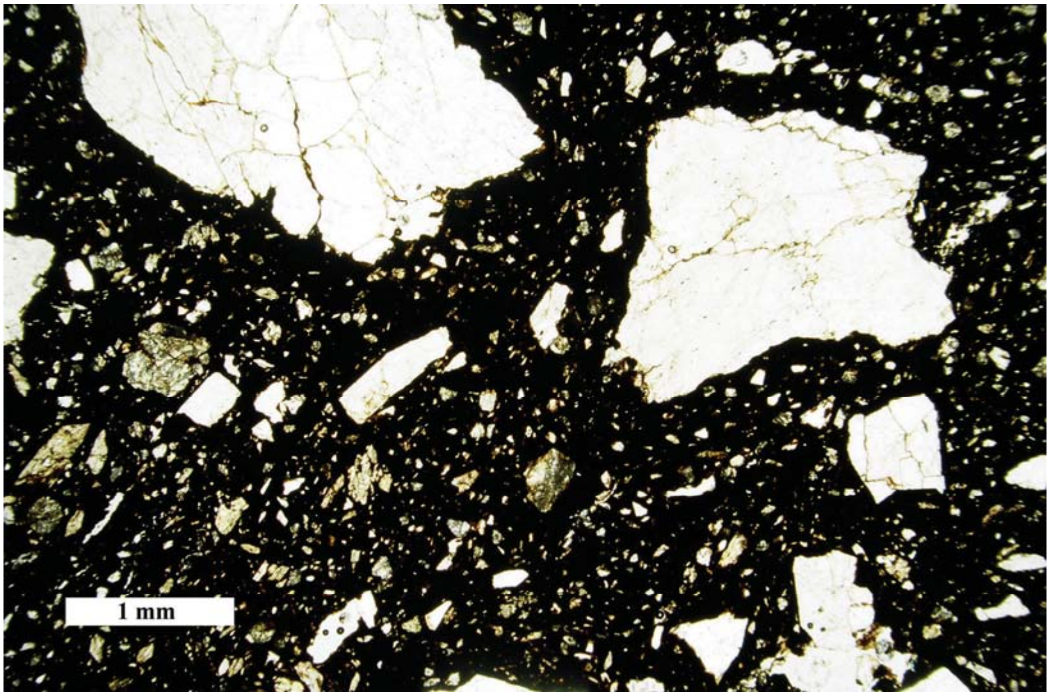

Figure 6.4. Coarse to very coarse (0.5–2.0 mm), blocky to subangular quartz mineral and rock fragments in sample JMH046 (cross-polarized light). The surrounding clay material is dominated by mafic minerals (clinopyroxene or amphibole) and also includes feldspar and quartz.

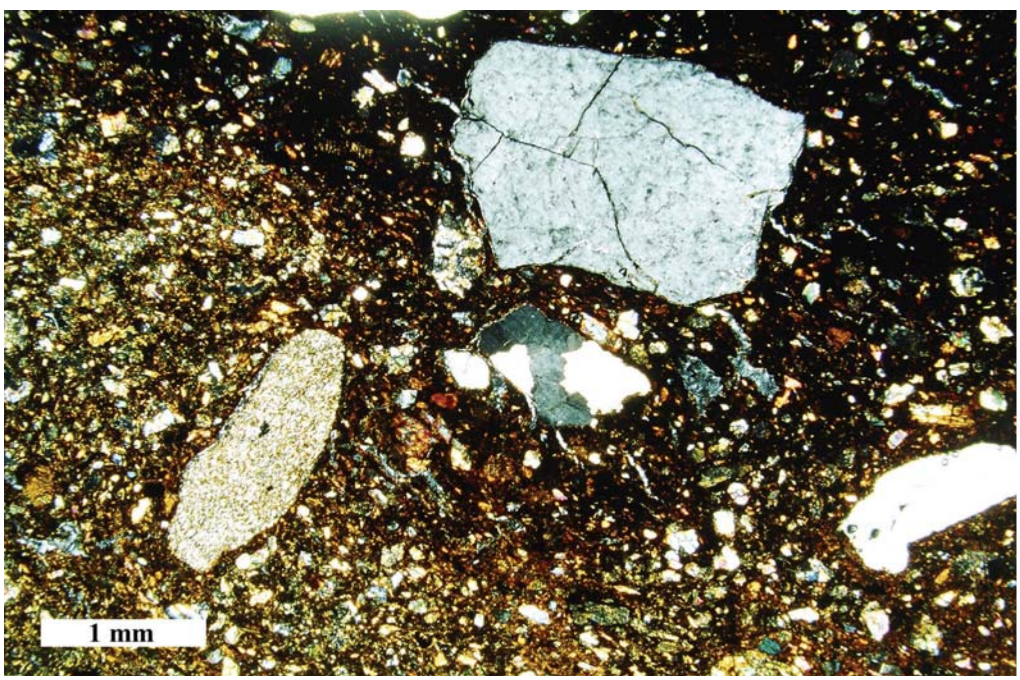

Figure 6.5. A polygranular quartz rock fragment with sutured grain boundaries (center) in sample JMH034 (cross-polarized light). Also note the very coarse, angular quartz mineral fragment (top) and the elongate, rounded sedimentary rock fragment (left of center). The paste is nearly isotropic, with fine-grained quartz, biotite, and feldspar minerals.

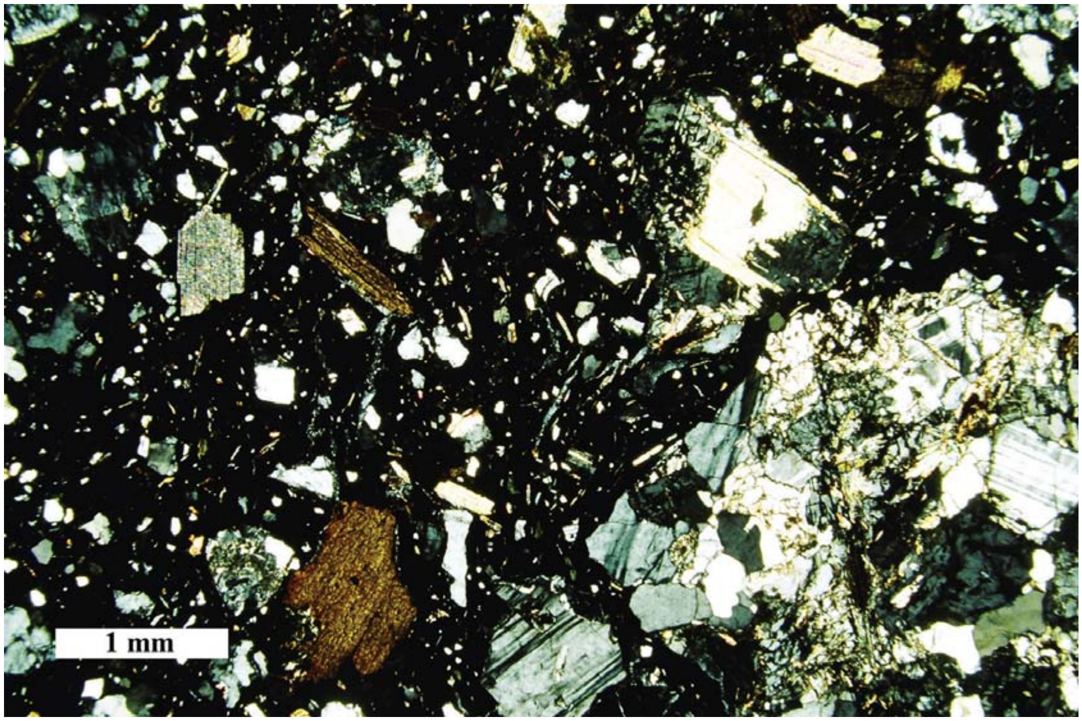

Figure 6.6. Polygranular quartz + K-feldspar (microcline) + mafic igneous rock fragments (right of center) in sample JMH033 (cross-polarized light). The feldspar displays fine-grained sericite alteration. Other aplastic inclusions include blocky, golden brown biotite crystals (left of center) and blocky microcline (twinned; bottom center).

Sample JMH034 contains what appear to be sedimentary or metasedimentary rock fragments (Figure 6.5). These fragments are subrounded to elongate (with rounded edges) and contain fine to very fine, subrounded to subangular grains of quartz and possibly feldspar. The fragments in Yadkin sample JMH034 are very similar to rock fragments from the Tillery Formation in the Piedmont. The Tillery Formation crops out along the Uwharrie River and is a thinly-laminated siltstone and claystone with horizons of metamorphic schist and phyllite. There are a number of sedimentary and metasedimentary units that could also be similar to the fragments in JMH034, however, so this is not a definitive comparison.

Finally, the four sherds from the Yadkin drainage (JMH032–JMH034, JMH040) include carbonized plant matter that appears to be wood charcoal (Figure 6.8).

Group IIB. Fourteen samples comprise Group IIB (Table 6.2). Most of the sherds are from the Doerschuk and Haw River sites. Eight are classified as Yadkin series, which by definition indicates that they are tempered with angular rock fragments.

The majority of the sherds in Group IIB are generally red-brown, and some exhibit a thin oxidation zone at the sherd edge. Four of the Group IIB sherds are very dark and resemble Group IIA sherds (JMH037–JMH038, JMH049–JMH050). Three of the samples were cut thinner than the standard 30 μm, and their color appears reddish tan to tan-yellow due to higher light transmission (JMH039, JMH041, JMH044).

The major aplastic components in Group IIB sherds are quartz + feldspar rock fragments (without mafic mineral components); polygranular quartz rock fragments; and mica, amphibole,

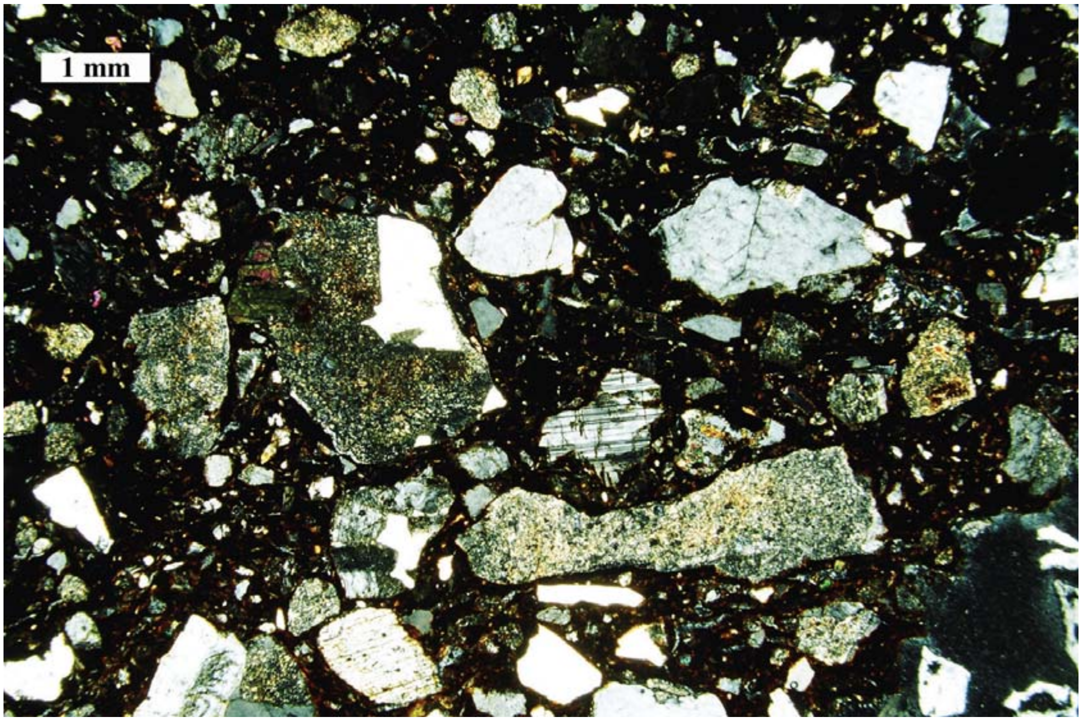

Figure 6.7. Highly-altered quartz + feldspar rock fragments (left of center) and feldspar mineral fragments (bottom center) in sample JMH048 (cross-polarized light). The feldspar in the rock and mineral fragments displays fine-grained sericite alteration. Also note the unaltered blocky plagioclase fragment (polysynthetic twinning; center).

and opaque mineral fragments. The percentage of rock and mineral fragments varies from about 15 to 30% of the paste material. Samples exhibit a range of muscovite and biotite mica content from none visible to 16%, with most samples falling in the 1–3% range.

The feldspar in the quartz + feldspar rock fragments is usually K-feldspar (microcline), but some specimens have both K-feldspar and plagioclase. The feldspar is often heavily altered, indicated by the presence of sericite, argillite, or epidote alteration minerals. In addition, many of the feldspar fragments show graphic texture. This texture occurs when granitic magma bodies cool slowly and quartz exsolves, forming tiny blebs. The presence of graphic texture and abundance of K-feldspar suggests that the rock fragments are derived from an intermediate to felsic plutonic source.

Although the quartz + feldspar rock fragments lack mafic mineral components, the presence of individual mafic mineral grains in the paste and the alteration of the feldspars suggest that the raw materials used for Group IIB and Group IIA sherds may be related. Such a scenario might result if distinct levels of the weathering profile (i.e., soil and saprolite) of an intermediate-igneous source rock (quartz + feldspar + mafic) were differentially exposed, eroded, and transported to produce clay source areas with slightly different characteristics.

Samples JMH039, JMH043, and JMH067 do not contain quartz + feldspar rock fragments but are nevertheless assigned to Group IIB based on the presence of mafic mineral fragments.

Re-examination of thin sections from the Herbert et al. (2002) prior study of pottery from Fort Bragg sites confirmed that the three Yadkin Net Impressed samples in that study (Samples 13, 16, and 17) would be included in Group IIB.

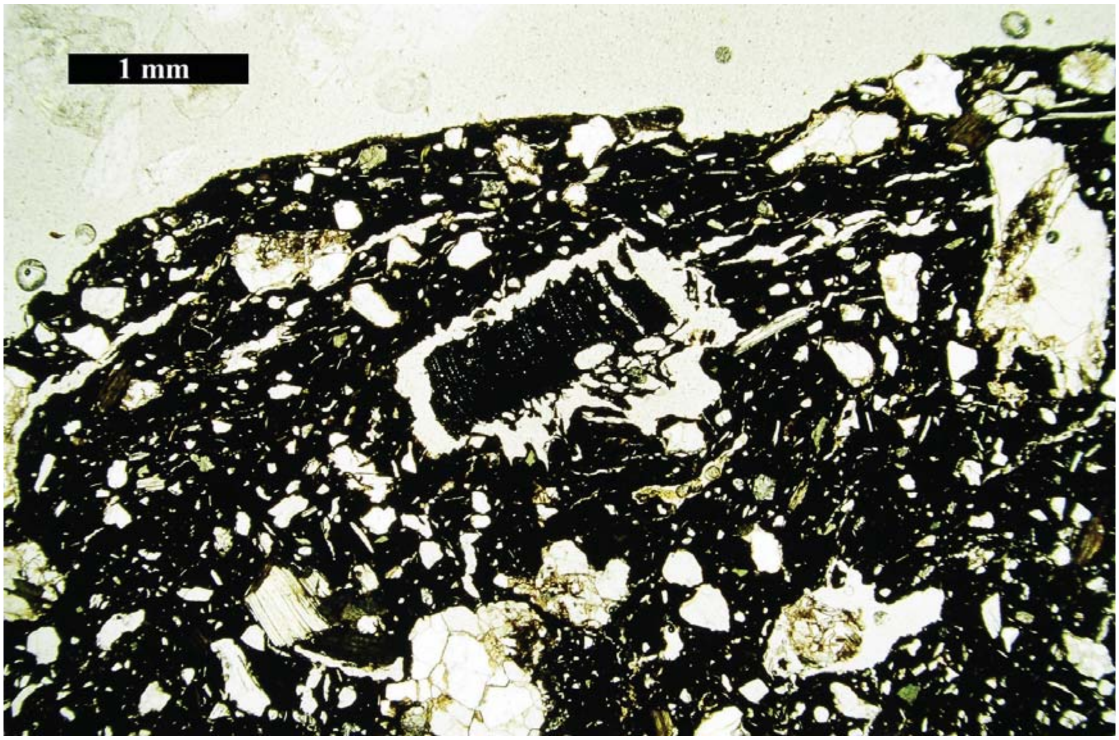

Figure 6.8. Carbonized plant fragment with separation void (center) in sample JMH034 (plane-polarized light).

Group III

The majority of Sandhills and Coastal Plain samples are assigned to Group III (Table 6.2). Sherds in this group are generally red-brown, although a few samples with sections cut thinner than 30 µm are light reddish brown to reddish brown. All of the Group III samples contain polygranular quartz rock fragments and/or a mineral association of monocrystalline quartz minerals and muscovite mica laths. The polygranular quartz rock fragments are probably derived from metamorphic rock.

Muscovite is generally found in two size distributions. In the medium- to coarse-grained size, its abundance ranges from 2–3%. In the very fine- to fine-grained size, its abundance reaches about 10%. In samples that do not have any of the medium- to coarse-grained laths (e.g., JMH007), muscovite is found in the very fine- to fine-grained fractions at an abundance of approximately 2–3%.

All mica in the very fine fraction was classified as muscovite, but effects related to firing and iron staining made it nearly impossible to obtain enough optical information to definitely state that there was no biotite. Medium- to coarse-grained biotite is present in a few samples, and it is highly possible that some of the very fine-grained mica identified as muscovite may be biotite.

Many of the Group-III specimens contain tourmaline, zircon, and/or rutile. These minerals are considered to be diagnostic constituents of soils derived from Coastal Plain sediments (Windom et al. 1971). Seven sherds in Group III also have possible sedimentary or metasedimentary rock fragments (JMH024–JMH025, JMH027, JMH029–JMH030, JMH058, and JMH064; Figure 6.9).

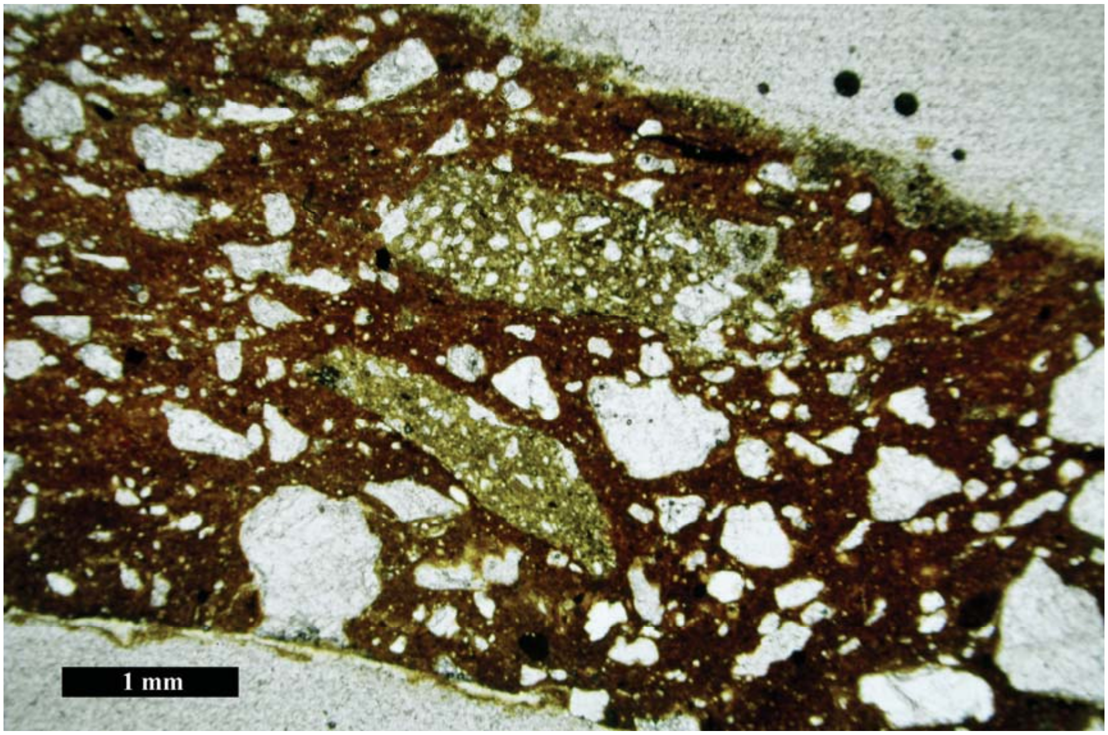

Figure 6.9. Sedimentary or metasedimentary rock fragments (center; note the finer-grained mineral inclusions) in sample JMH058 (plane-polarized light). The other aplastic fragments include coarse quartz rock fragments and medium- and fine-grained quartz and feldspar minerals.

Group III is further subdivided into two subgroups based upon the presence of argillaceous clay clots. Thirty-three samples with argillaceous clay clots make up Group IIIA, and 10 samples lacking such clots are classified as Group IIIB (Table 6.2).

Under plane-polarized light, the argillaceous clay clots appear as angular, subangular, and subrounded fragments ranging from a light yellowish-green tan to a more yellow brown with a little rust red color (Figure 6.2). They contain medium- and coarse-grained quartz, blocky feldspar, and variable amounts of mica laths embedded in a very fine-grained mass of clay, quartz, and mica. Under cross-polarized light, the interference color is dominated by quartz and feldspar inclusions (first-order gray Michel-Levy).

Unassigned

Three samples are not assigned to any of the petrographic groups described above (Table 6.2). Samples JMH051, JMH052 and JMH068 appear to have experienced partial vitrification during firing. These sherds have textures of melted rock glass, and their optical characteristics are nearly isotropic. Sample JMH051 is dominated by paste with only a few medium- to coarse-grained aplastic mineral fragments. Sample JMH052 contains quartz grains and a couple of grog fragments with fine-grained mineral inclusions. Samples JMH051 and JMH052 are too vitrified to allow point counting but probably contain quartz and clay minerals, suggesting they may be similar to Group III samples. Sample JMH068 has a very ‘swirly’ appearance, probably reflecting poorly mixed paste, and vitrification appears to have been in the clay-mineral-rich portions of the sherd.

Results: Clay Samples

The 53 clay test tiles examined in this study represent 42 untempered clay samples and 11 tempered samples. The mineralogical characteristics of the untempered samples are discussed here, and the tempered samples are treated in a subsequent section.

The following descriptions summarize the general aplastic characteristics of the clay samples by drainage and attempt to classify them according to the scheme developed for the pottery samples. In most cases it is not possible to assign clay samples to a specific petrographic subgroup as was done for the prehistoric ceramics, but most samples can be assigned to a general group (i.e., II or III). The results reveal that general regional distinctions can be seen based on differences in proportion and type of natural rock and mineral constituents.

Sandhills Samples

Twelve clay samples from the Sandhills were submitted for petrographic analysis. Seven can be tentatively assigned to Group III, one is tentatively assigned to Group IIB, and the other four could not be attributed to a defined petrographic group (Table 6.3).

Lower Little River Samples. Eleven clay test tiles representing the Lower Little drainage were fashioned into thin sections for petrographic analysis. The thin section for sample FBR002, however, exhibited so much void space that it was excluded from the study. The other ten samples exhibit considerable variability, but many can be loosely grouped into sets.

Samples FBR003–FBR005 and FBR010 were collected within 6 km of each other and are petrographically similar. Samples FBR004, FBR005, and FBR010 represent the Cretaceous-age Cape Fear Formation. Sample FBR010 is dominated by quartz mineral and quartz rock fragments (Figure 6.10). It contains very little mica and more aplastic mineral fragments than clay minerals. Sample FBR004 resembles FBR010 but has larger aplastic fragments and plagioclase feldspar. Interestingly, sample FBR005 was collected from the same location as FBR010 but appears more similar to FBR004. It contains quartz and feldspar minerals and quartz rock fragments with no visible mica (Figure 6.11). In many ways FBR005 is similar to Waccamaw sample FBR067.2 (discussed below), which has 10% sand temper added (Figure 6.12). Sample FBR003 is from a Cretaceous-age Middendorf Formation deposit and contains angular to subangular quartz mineral fragments but no quartz rock fragments. These four samples are tentatively assigned to Group III.

Samples FBR007–FBR009 form a second set of petrographically similar samples that can also tentatively be classified as Group III. Samples FBR008 and FBR009 are derived from Middendorf Formation deposits on the slopes of a broad upland terrace. Sample FBR009 is dominated by quartz and mica (mostly muscovite) mineral fragments and contains a very coarse quartz + feldspar rock fragment (Figure 6.13; cf. quartz-dominated Sample FBR010 in Figure 6.10). Sample FBR008 resembles FBR009 but includes more coarse rock fragments. Both samples fired to a brownish green color. Sample FBR007 is an alluvial sample that was collected almost 12 km from sample FBR008, but its alluvial sediments are likely derived from the same upland terrace. It also resembles sample FBR009 but contains more mica and fired to a reddish brown color.

The test tiles for Sandhills samples FBR059 and FBR067 were fired at 950°C. These two samples appear to be partially vitrified, which posed problems for analysis and precluded them

Table 6.3. Selected Petrographic Characteristics of Clay Samples.[a]

Region/Drainage: Sample ID	Mineral Grains: Mafic[b]	Feldspar[c]	Mica[d]	Quartz	Opaque	Rock Fragments: Quartz	Quartz + Feldspar	Feldspar	Sedimentary	Other: Argillaceous Clay Clots	Hematite-stained Clay Clots	Tentative Group Assignment
Sandhills/Lower Little:												
FBR003	-	-	-	x	-	-	-	-	-	-	-	III
FBR004	-	x (Pl)	-	xx	-	x	-	-	-	-	-	III
FBR005	-	x	-	x	-	x	-	-	-	-	-	III
FBR007	-	-	xx (Ms)	xx	-	-	x	-	-	-	-	III
FBR008	-	-	xx (Ms)	xx	-	-	x	-	-	-	-	III
FBR009	-	-	xx (Ms)	xx	-	-	x	-	-	-	-	III
FBR010	-	-	tr	xx	-	x	-	-	-	-	-	III
FBR017	-	x	-	xx	x	x	-	-	-	x	x	IIB
FBR059	-	-	-	xx	-	x	-	-	-	-	-	-
FBR067	-	x	-	x	-	-	-	-	-	-	-	-
Sandhills/Drowning Creek:												
FBR006	-	-	-	x	-	-	-	-	-	-	x	-
Coastal Plain/Cape Fear:												
FBR011	tr (Am)	x (Kfs)	x (Ms, Bt)	x	x	x	x	-	-	-	x	III
FBR012	-	x	x (Bt)	x	-	x	-	-	-	-	-	III
FBR013	-	x (Kfs)	-	xx	x	x	x	-	-	-	x	III
FBR014	-	-	x (Bt)	x	-	-	-	-	-	-	x	III
FBR016	-	x	x (Bt)	x	-	x	-	-	-	-	xx	III
Coastal Plain/Pee Dee:												
FBR019	-	-	xx (Ms)	xx	-	-	-	-	-	-	-	III
FBR020	-	-	xx (Ms)	xx	-	-	-	-	-	-	-	III
FBR021	-	-	xx (Ms)	xx	-	-	-	-	-	-	-	III
FBR023	-	-	xx (Ms)	xx	-	-	x	-	-	-	x	III
FBR027	-	-	xx (Ms)	x	-	-	-	-	-	-	x	III
Coastal Plain/Waccamaw:												
FBR081	-	x	-	xx	-	-	-	-	-	-	-	III
FBR082	-	x	-	xx	-	-	-	-	-	-	x	III
FBR083	x	x	-	xx	-	-	-	-	-	-	-	III
FBR084	-	x	-	xx	-	-	-	-	-	-	x	III
FBR085	-	x	-	xx	-	-	-	-	-	-	x	III

Table 6.3. Selected Petrographic Characteristics of Clay Samples (continued).[a]

Region/Drainage:	Mineral Grains					Rock Fragments				Other		Tentative Group Assignment
Sample ID	Mafic[b]	Feldspar[c]	Mica[d]	Quartz	Opaque	Quartz	Quartz + Feldspar	Feldspar	Sedimentary	Argillaceous Clay Clots	Hematite-stained Clay Clots	
Piedmont/Haw:												
FBR029	-	-	-		-	x	x	-	x (sandstone)	-	x	II
FBR030	-	-	-		-	x	-	-	x (sandstone)	-	-	II
FBR035	-	-	-		-	x	x	-	-	-	-	II
FBR040	-	-	-		-	x	x	-	-	-	-	II
FBR041	-	x (Pl)	-	xx	x	x	x	-	x (siltstone or sandstone)	x	-	II
Piedmont/Yadkin:												
FBR048	x	x	x	x	x	x	x	-	-	-	x	IIB
FBR049	xx	xx	-	xx	xx	x	x	x	-	-	xx	IIB
FBR051	-	-	x (Bt)	x	x	x	x	-	-	-	-	IIB
FBR054	-	x	-	x	-	x	-	-	-	-	x	III
FBR055	-	x	-	x	-	x	x	-	-	-	x	III
Piedmont/Deep:												
FBR058	x (Am)	-	-	x	-	-	x	-	-	-	x	IIB
FBR071	-	-	-	xx	-	-	-	-	-	-	x	IIB
FBR074	-	-	-	xx	-	-	x	-	x (sandstone)	-	x	IIB
FBR077	-	-	-	xx	-	-	-	-	x	-	x	IIB
FBR080	-	-	x	x	-	x	x	-	-	-	-	IIB

[a] Key: xx, abundant; x, present; tr, trace.
[b] Key: Am, amphibole.
[c] Key: Kfs, K-feldspar; Pl, plagioclase.
[d] Key: Bt, biotite; Ms, muscovite.

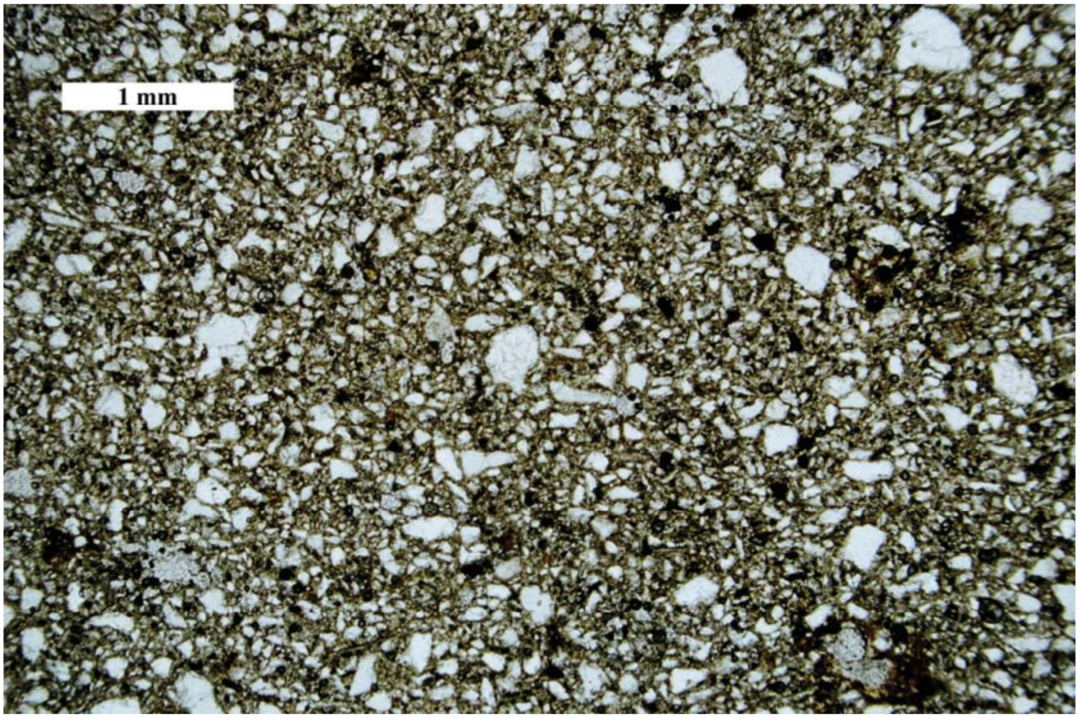

Figure 6.10. Clay sample FBR010 dominated by very fine- and fine-grained, subrounded and subangular quartz (plane-polarized light).

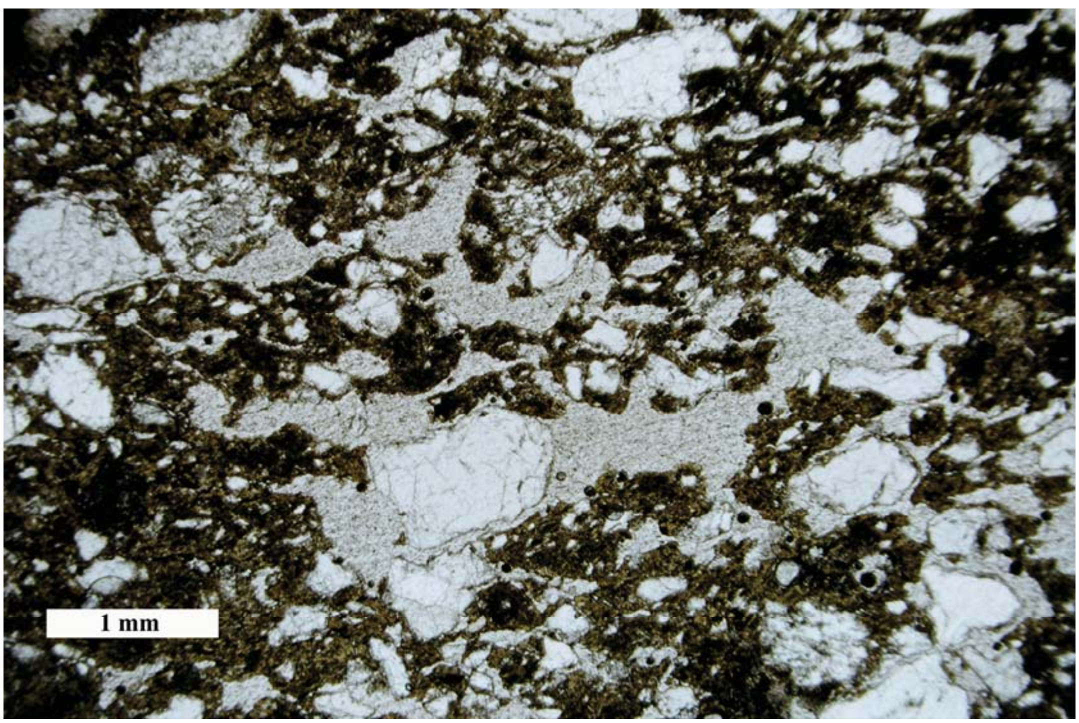

Figure 6.11. Clay sample FBR005 with coarse-grained quartz and feldspar mineral fragments and quartz rock fragments (plane-polarized light). This sample contains many voids and appears to have experienced some melting in the clay-rich portions.

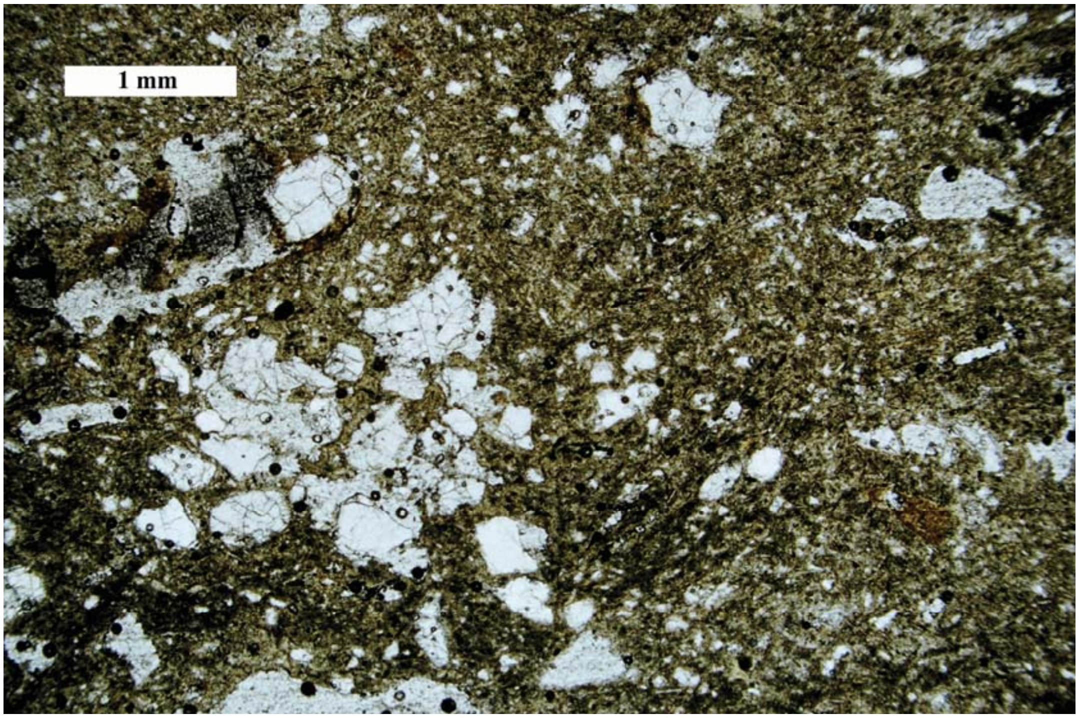

Figure 6.12. Clay sample FBR067 tempered with 10% quartz sand (test tile FBR067.2; plane-polarized light). The added sand temper makes this test tile difficult to distinguish from the untempered test tile for sample FBR005 (Figure 6.11).

from being assigned to a petrographic group. Nevertheless, they form a third set of petrographically similar samples. Sample FBR059 is dominated by quartz mineral and quartz rock fragments (Figure 6.14). Sample FBR067 is dominated by clay and contains quartz and feldspar mineral fragments (Figure 6.15).

Sample FBR017 was collected from a Middendorf Formation deposit in the eastern Sandhills, but it is more similar to Haw River sample FBR041 (discussed below) than to other Sandhills samples. Compared to sample FBR041, however, FBR017 has a greater proportion of quartz, feldspar, and opaque mineral fragments and dark red hematite-stained clay clots (Figure 6.16; cf. Figure 6.17). In addition, FBR017 contains some clasts that may be quartz-rich argillaceous clay clots or possibly sedimentary rock fragments. This petrography places FBR017 in Group IIB.

Drowning Creek. The single sample from the Drowning Creek drainage is dominated by very fine, vitrified clay minerals. Sample FBR006 has only a few hematite-stained clay clots and quartz mineral fragments (Figure 6.18). It is similar to Lower Little River sample FBR067 and can be grouped with samples FBR067 and FBR059. It cannot be assigned to a defined petrographic group.

Coastal Plain Samples

All fifteen clay samples from the Coastal Plain can be tentatively assigned to Group III (Table 6.3). Nevertheless, differences exist both between and within drainages.

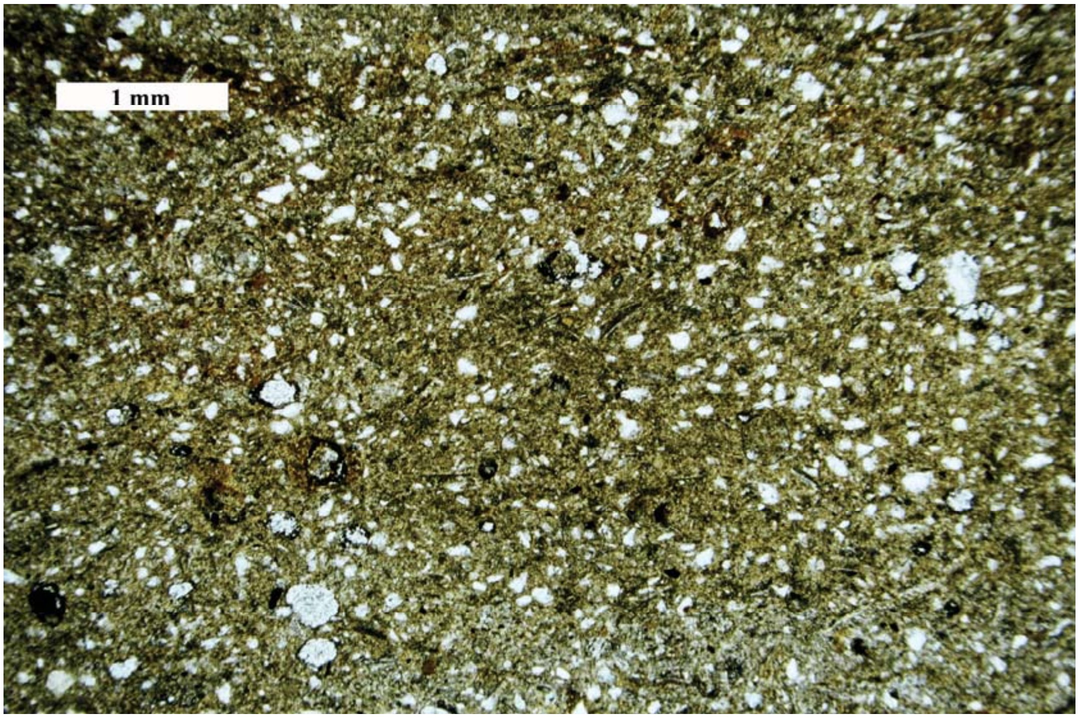

Figure 6.13. Clay sample FBR009 with very fine- and fine-grained quartz and muscovite (plane-polarized light).

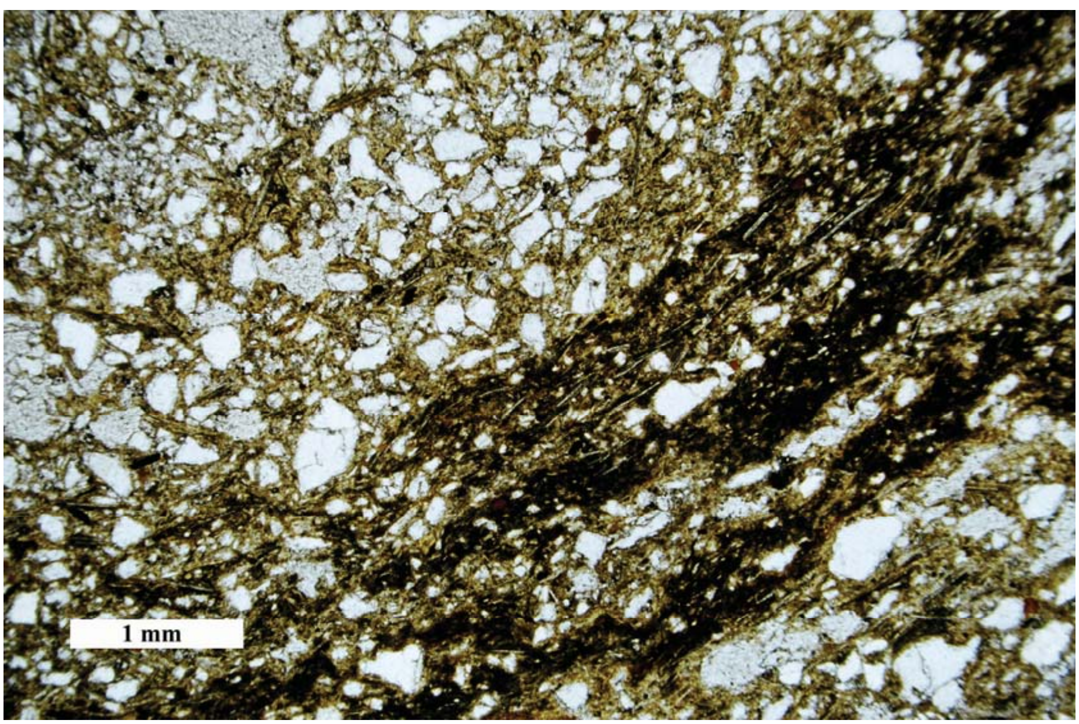

Figure 6.14. Clay sample FBR059 with fine- to coarse-grained, angular to subangular quartz mineral and rock fragments (plane-polarized light). The darker stripes are vitrified clay.

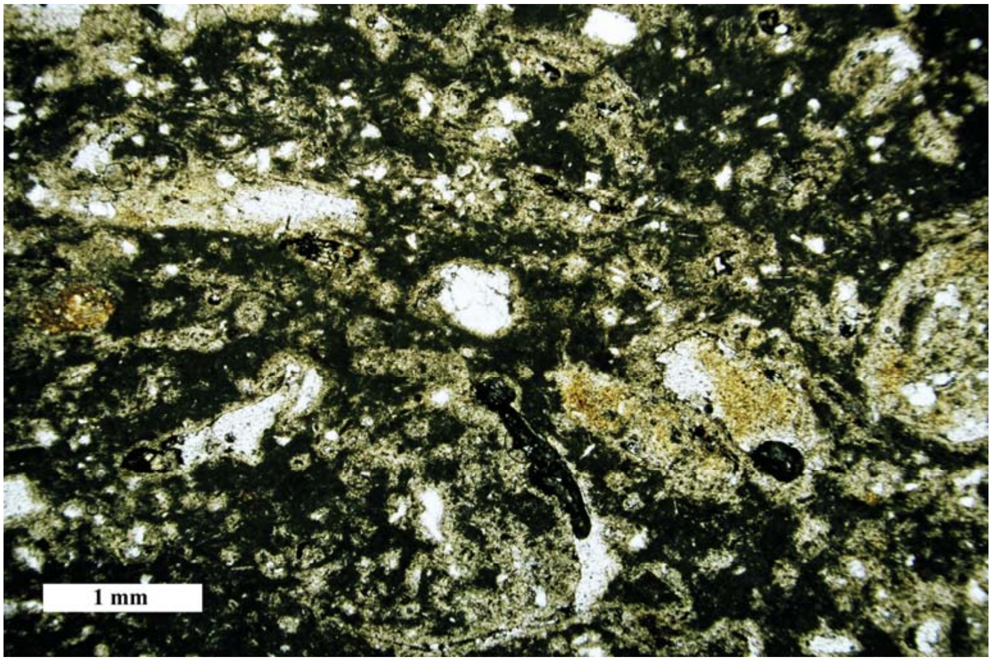

Figure 6.15. Clay sample FBR067 with fine- and medium-grained, blocky to subrounded quartz and feldspar mineral fragments (plane-polarized light). Note partially vitrified (isotropic) paste due to high firing temperature.

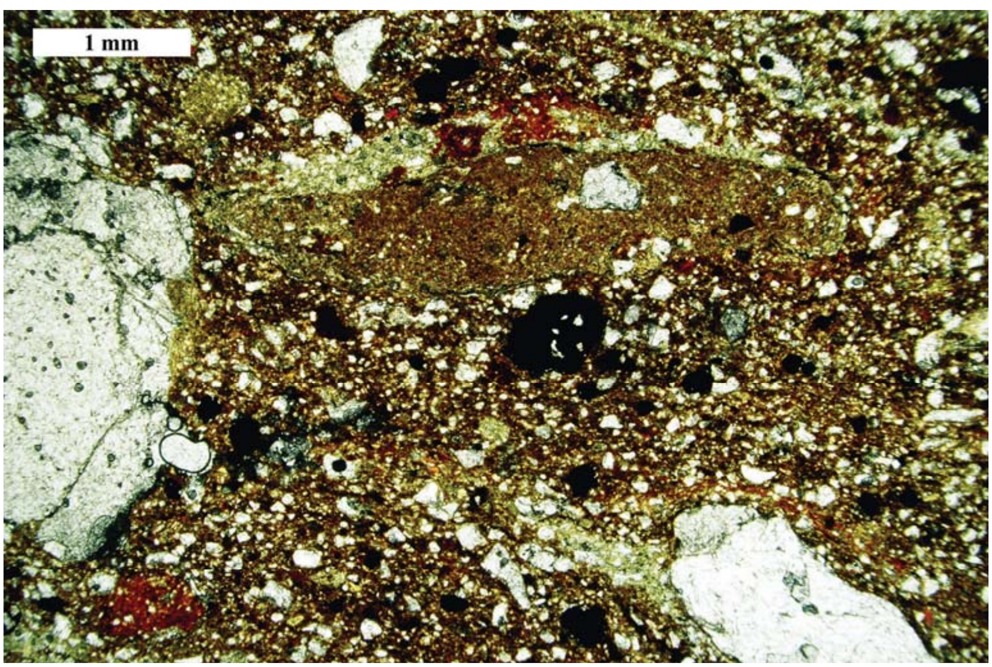

Figure 6.16. Clay sample FBR017 with fine- and medium-grained, subangular and angular quartz (left), feldspar, and opaque mineral fragments; quartz rock fragments (lower right); and dark red hematite-stained clay clots with quartz mineral inclusions (center; plane-polarized light). There are also some quartz mineral-rich argillaceous clay clots (center above large hematite-stained clay clot).

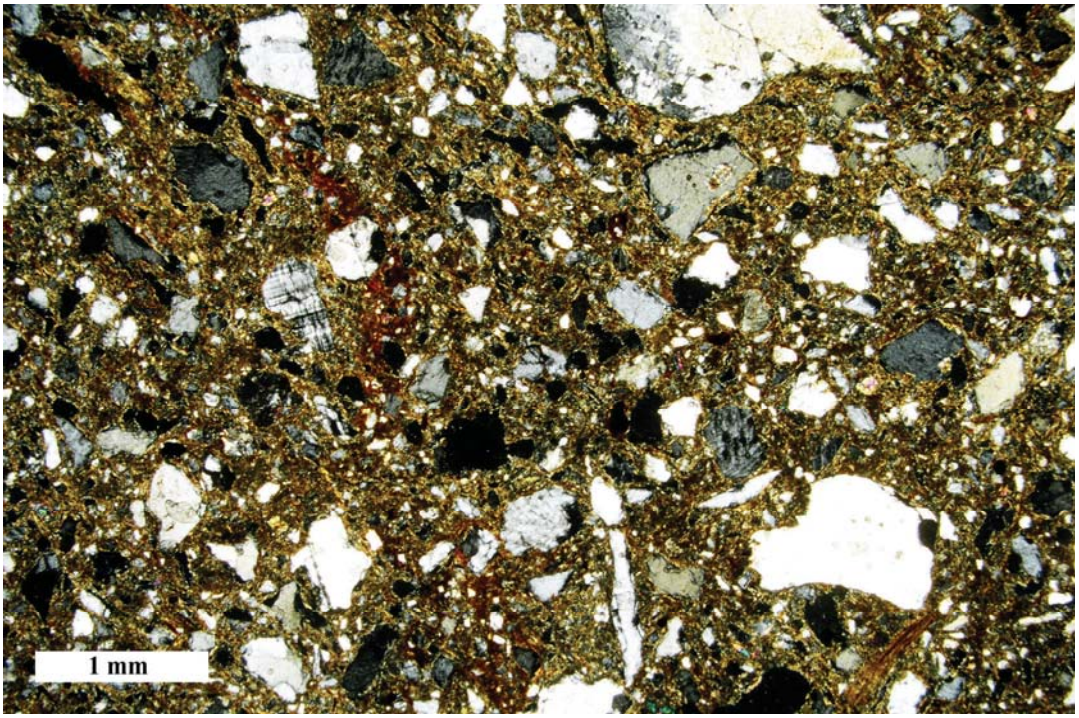

Figure 6.17. Clay sample FBR041 with fine to very coarse fragments of quartz, plagioclase, opaque minerals, an unknown high relief mineral (not very abundant), and sedimentary rock (plane-polarized light). There are also a few reddish brown argillaceous clay clots.

Cape Fear River. The five clay samples from the Cape Fear drainage exhibit variability that may be in part related to their locations within the sedimentary system. These samples represent a quartz-dominated system but vary with respect to particle size, which is a function of sorting.

Sample FBR011 is a stream bank sample with polygranular quartz and quartz + feldspar rock fragments and quartz, K-feldspar (microcline), muscovite, and biotite mineral fragments (Figure 6.19). The mica fragments occur in proportions greater than 1%. Subangular to blocky opaque minerals (approximately 1%) and one fragment of amphibole are also present. Sample FBR011 also contains small (0.2 mm in diameter), rounded, dark red hematite-stained clay clots and black opaque minerals.

Samples FBR012–FBR013 are floodplain samples. FBR012 is characterized by quartz, feldspar, and biotite minerals and quartz rock fragments. The aplastic components, however, are subordinate to the amount of clay. Sample FBR013 has abundant quartz, undifferentiated feldspar, and microcline mineral fragments and polygranular quartz and quartz + feldspar rock fragments. A few opaque minerals and red hematite-stained clay clots were observed.

Sample FBR014 is another stream bank sample with very fine-grained quartz, biotite, and a few visible hematite-stained clay clots. Sample FBR016 is from a tributary streambed and appears to be a cross between FBR014 and FBR012, but it also contains a lot of red hematite-stained clay clots.

Pee Dee River. All five Pee Dee samples include extremely fine- to very fine-grained aplastic material consisting mostly of quartz and muscovite mica. Sample FBR023 also has a few red hematite-stained clay clots and a quartz + feldspar rock fragment, while sample FBR027

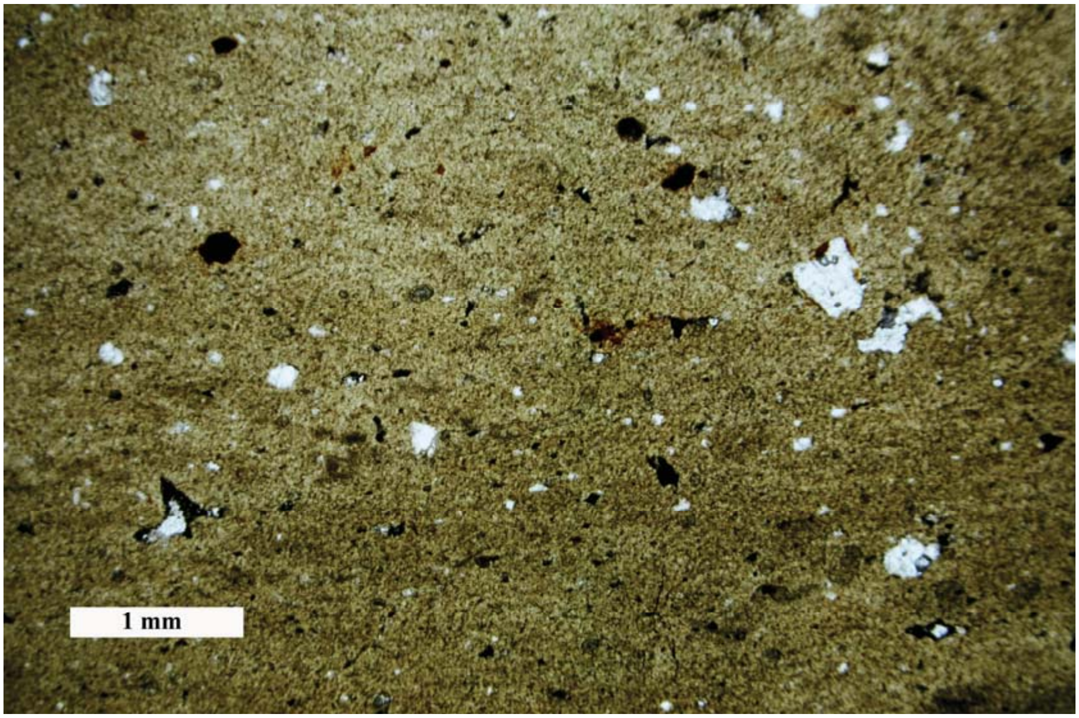

Figure 6.18. Clay sample FBR006 with very fine-grained clay, dark red-black hematite-stained clay clots, and fine- to medium-grained quartz mineral fragments (plane-polarized light).

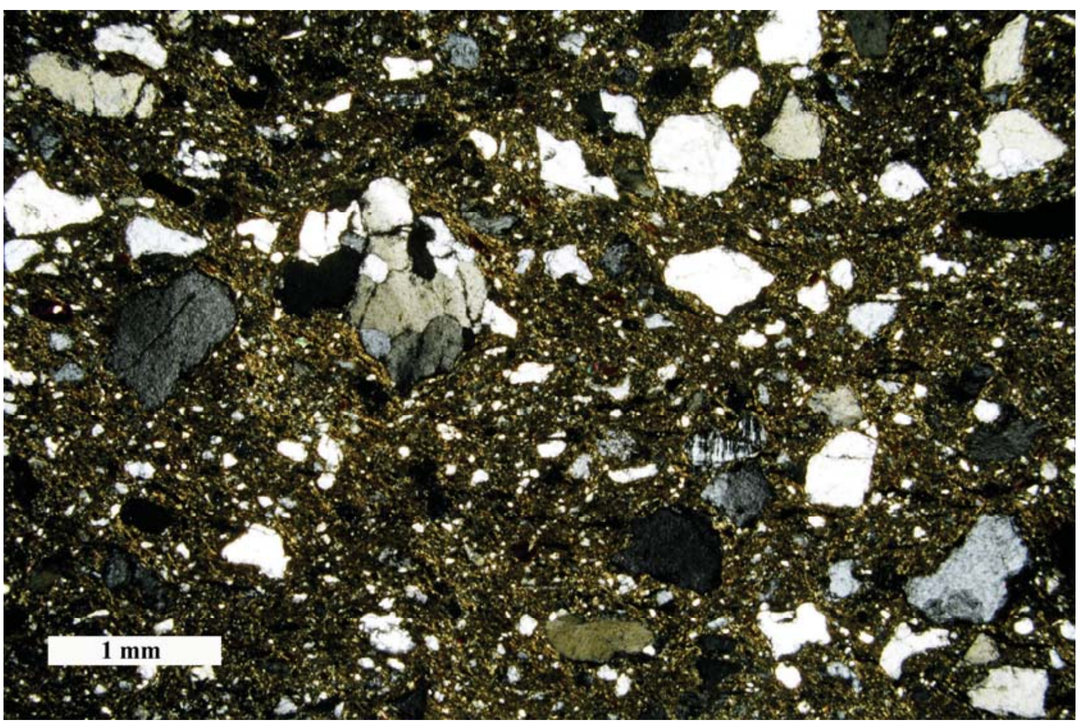

Figure 6.19. Quartz rock fragments (center) and K-feldspar (microcline) in clay sample FBR011 (cross-polarized light).

contains numerous red hematite-stained clay clots and only a few visible quartz mineral fragments (0.1 mm grain size; Figure 6.20).

Waccamaw River. All five Waccamaw clay samples are dominated by quartz minerals (i.e., sample FBR081; Figure 6.21). A few subrounded feldspar mineral fragments were observed with the quartz mineral fragments or, in the case of FBR083, with a single mafic mineral fragment. Samples FBR082, FBR084, and FBR085 also contain red hematite-stained clay clots.

Piedmont Samples

Thirteen of the 15 Piedmont samples can be tentatively assigned to Group II (Table 6.3). Two samples from the Yadkin drainage are classified as Group III.

Haw River. The five clay samples collected in the Haw drainage contain quartz rock fragments and, with the exception of FBR030, quartz + feldspar rock fragments (Figure 6.17). They consequently fall into Group II but exhibit enough variation that they can be categorized into two classes. One class includes three samples characterized by sedimentary rock fragments (FBR029, FBR030, and FBR041), while the other includes two samples lacking sedimentary rock fragments (FBR035 and FBR040).

Yadkin River. The five clay samples collected in the Yadkin drainage are quite variable. Samples FBR048, FBR049, and FBR051 are characterized by quartz rock and quartz + feldspar rock fragments and are thus classified as Group IIB (Figure 6.22). However, these three clay samples have proportionally less quartz + feldspar rock fragments than the majority of Group II pottery samples.

Yadkin samples FBR054 and FBR055 generally lack quartz + feldspar rock fragments, although a few were observed in FBR055 (Figure 6.23). These two samples are clay dominated with fine- and medium-grained quartz and feldspar mineral fragments, quartz rock, and some rounded red hematite-stained clay clots. FBR054 and FBR055 are tentatively classified as Group III. They were collected several kilometers downstream of the Group IIB samples, however, so it is possible that their quartz and feldspar mineral grains are derived from the same quartz + feldspar rock that occurs as fragments in FBR048, FBR049, and FBR051.

Deep River. All five Deep River clay samples can be assigned to Group IIB. Samples FBR058 and FBR080 were collected from the bank of the Deep River at the Carbonton hydroelectric dam. Both are clay rich and contain quartz mineral fragments. Sample FBR058 also contains amphibole and quartz + feldspar rock fragments (Figure 6.24), while sample FBR080 contains quartz rock fragments, a quartz + feldspar rock fragment, and some mica (Figure 6.25). The petrographic variability between these two samples that were collected within only a few meters of each other supports the decision to lump generally similar samples (i.e., Group IIA and IIB samples) rather than split them into distinct groups.

Samples FRB071, FBR074, and FBR077 were collected in upland settings downstream from FBR058 and FBR080. These samples contain abundant very fine quartz minerals and some red hematite-stained clay clots in varying amounts (Sample FBR071; Figure 6.26). FBR074 also contains quartz + feldspar rock fragments and quartz sandstone fragments (Figure 6.27). FBR077 has a few rounded, coarse- to very coarse-grained sedimentary or metasedimentary rock fragments, but they differ from the quartz sandstone found in FBR074.

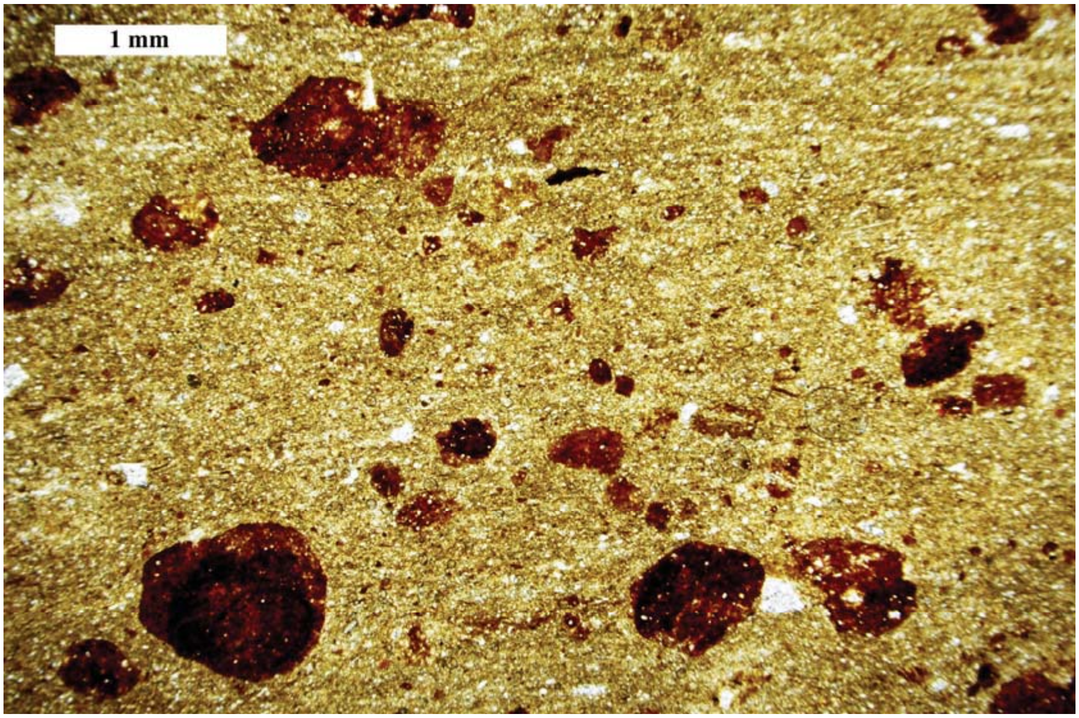

Figure 6.20. Red hematite-stained clay clots in clay sample FBR027 (plane-polarized light).

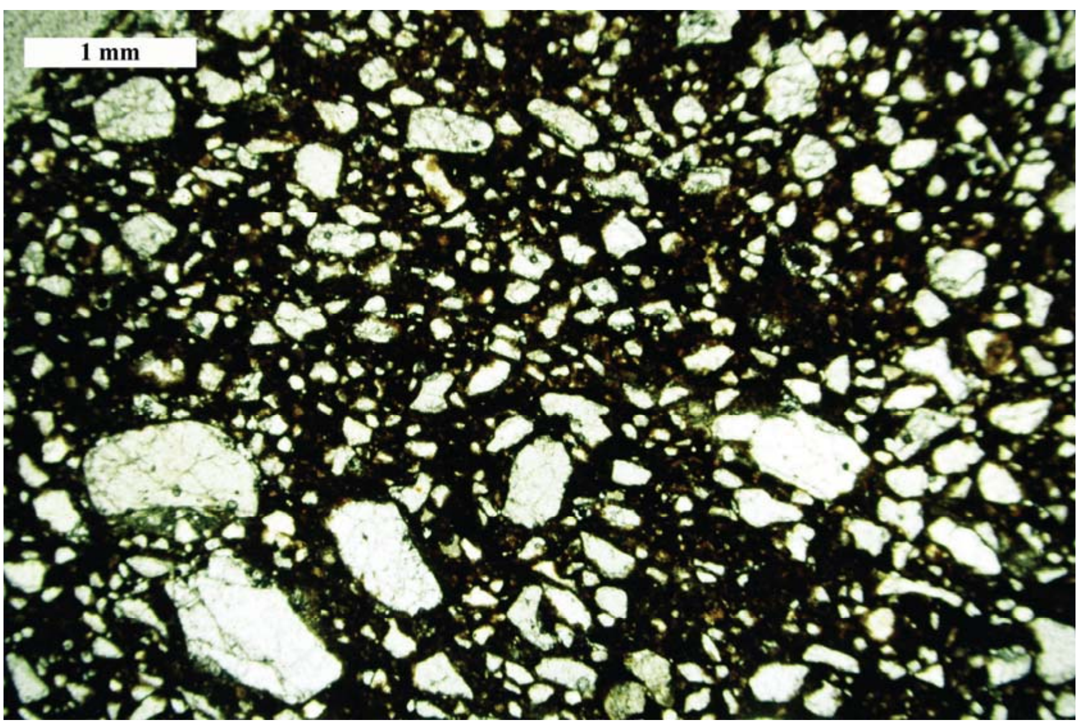

Figure 6.21. Clay sample FBR081 with subrounded to subangular quartz mineral fragments (plane-polarized light).

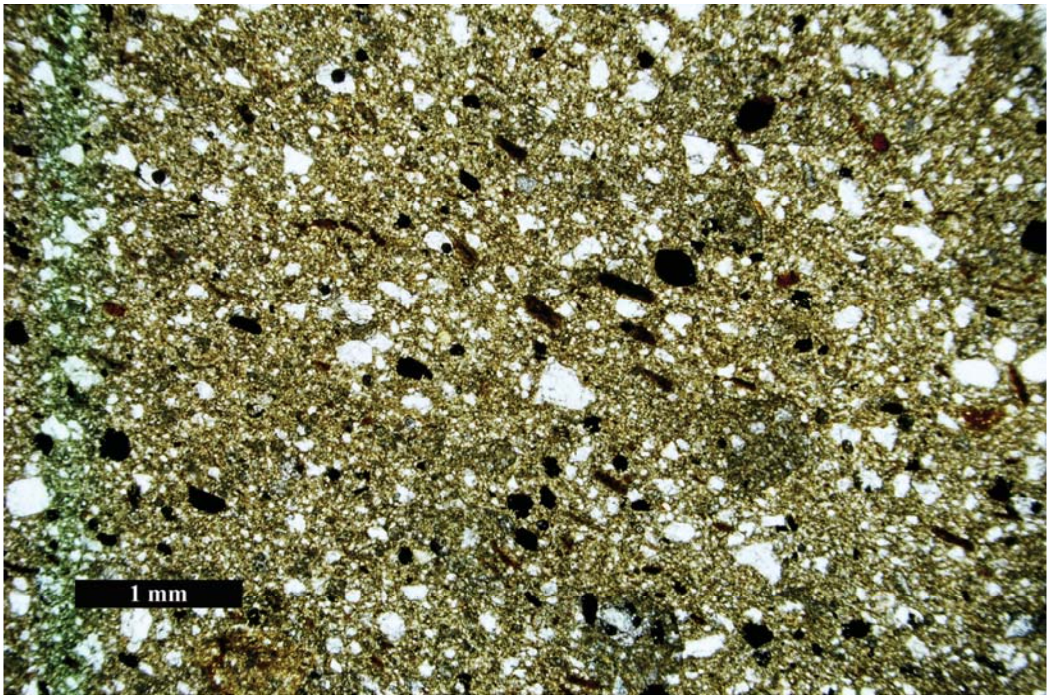

Figure 6.22. Clay sample FBR049 with subangular quartz and opaque mineral fragments and abundant fine- and medium-sized, subrounded and elliptical red hematite-stained clay clots (plane-polarized light).

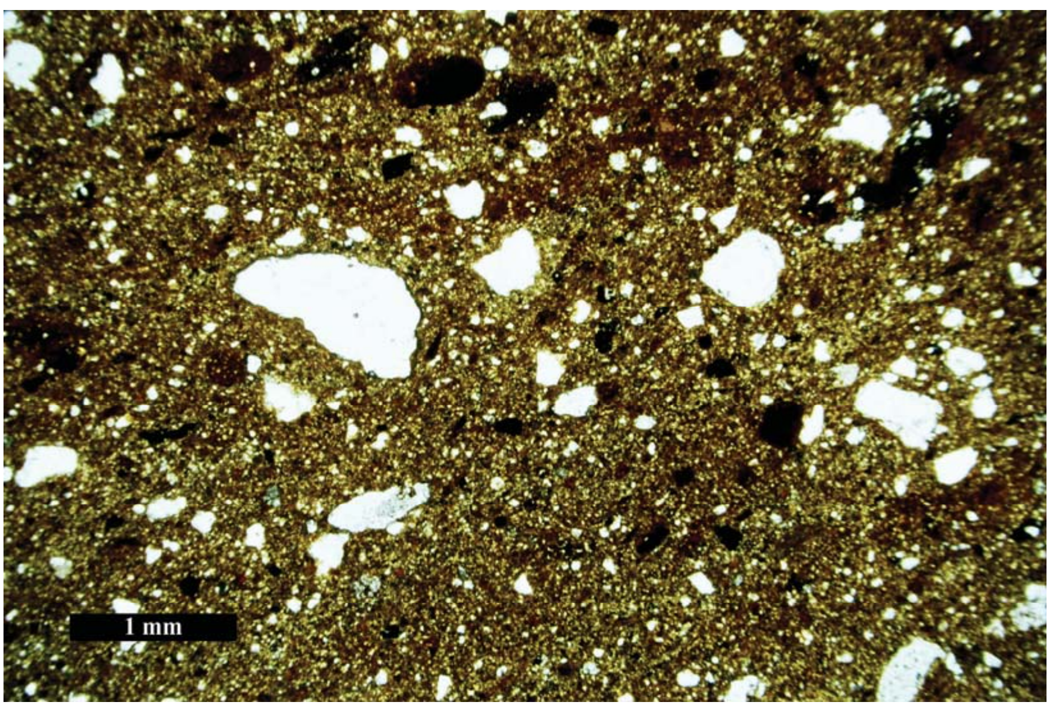

Figure 6.23. Clay sample FBR055 with fine- and medium-grained quartz and feldspar mineral fragments, quartz + feldspar rock fragments, and rounded red hematite-stained clay clots (plane-polarized light).

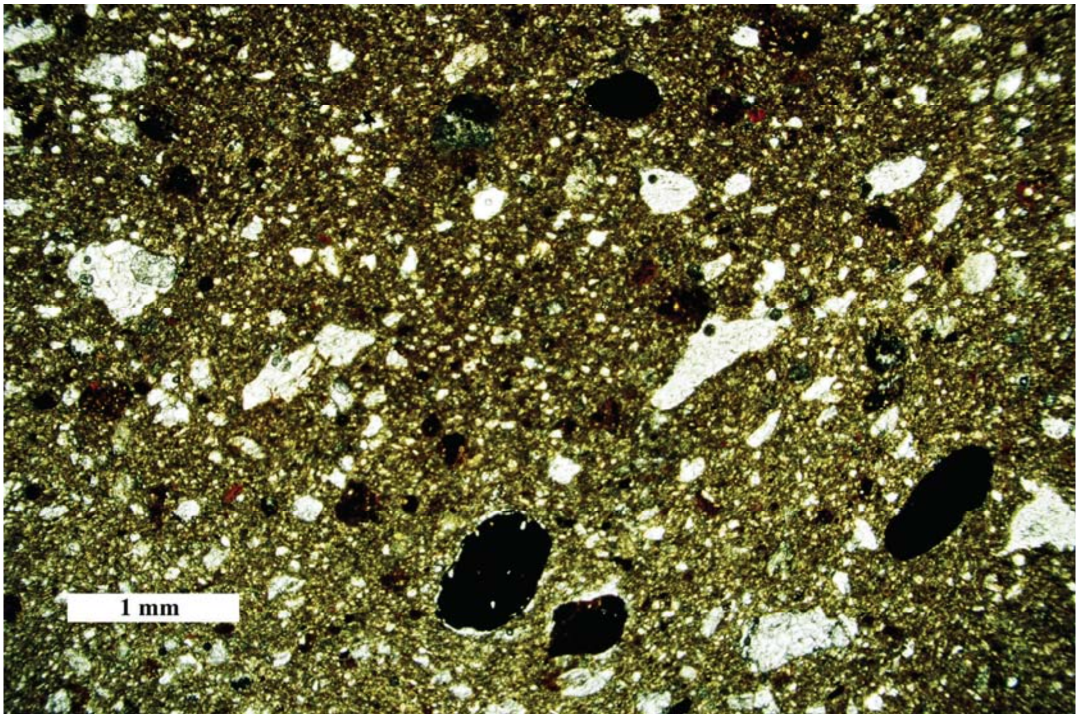

Figure 6.24. Clay sample FBR058 with fine- to medium-grained quartz mineral fragments and some rounded red hematite-stained clay clots (plane-polarized light).

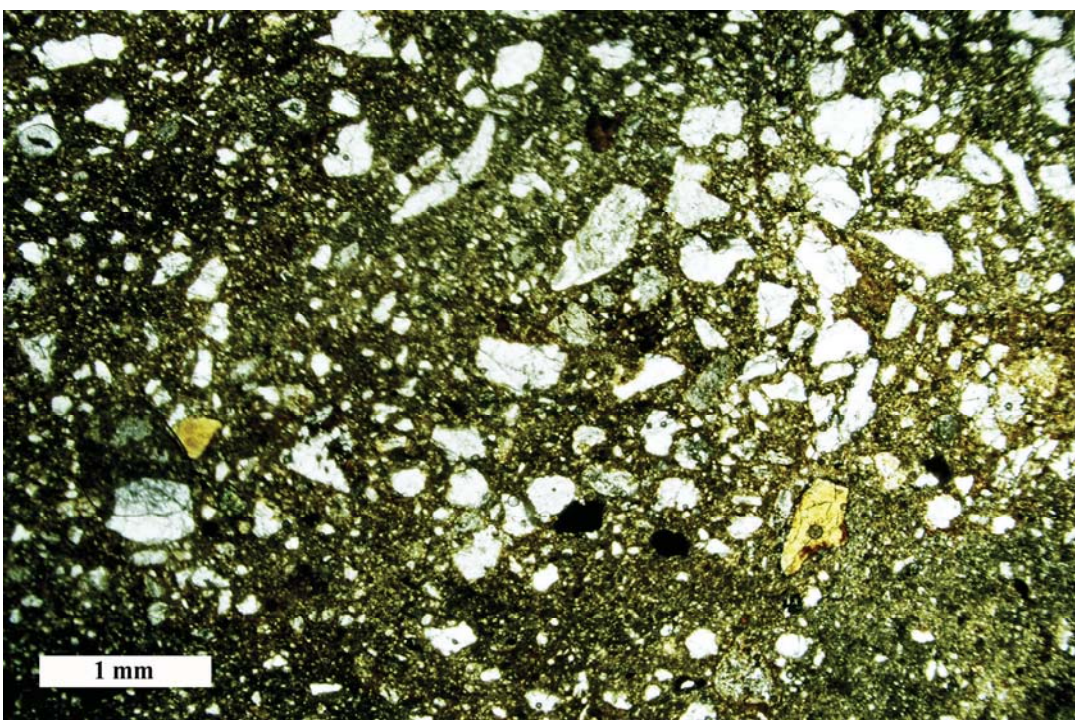

Figure 6.25. Clay sample FBR080 with subrounded quartz rock fragments and quartz mineral fragments (plane-polarized light).

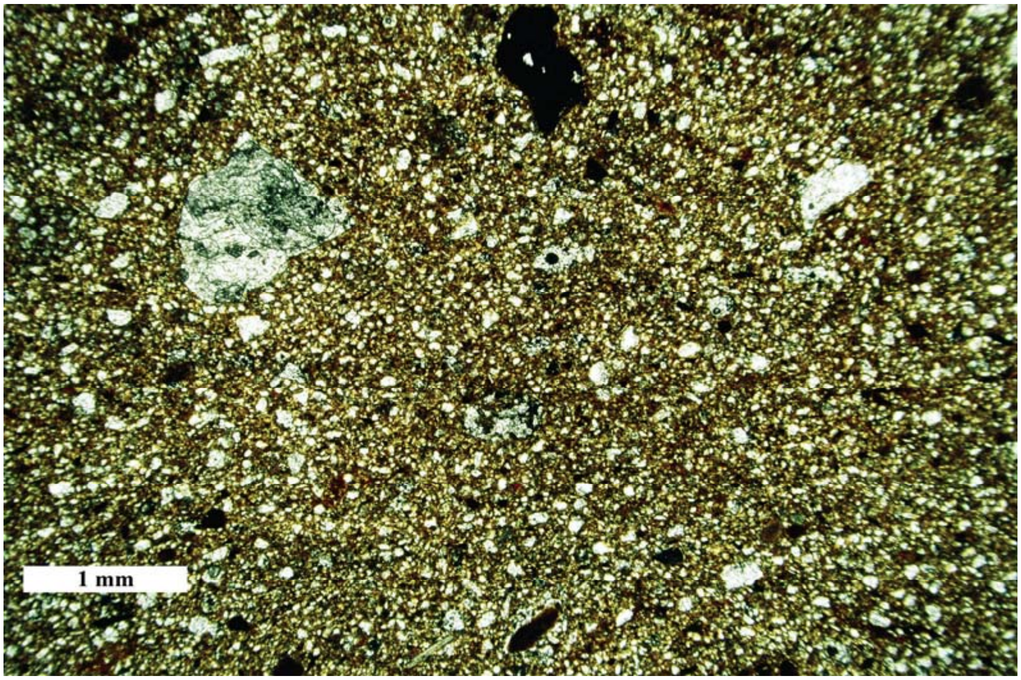

Figure 6.26. Clay sample FBR071 with abundant very fine-grained quartz minerals, red hematite-stained clay clots, and a few coarser-grained quartz mineral fragments (left of center; plane-polarized light).

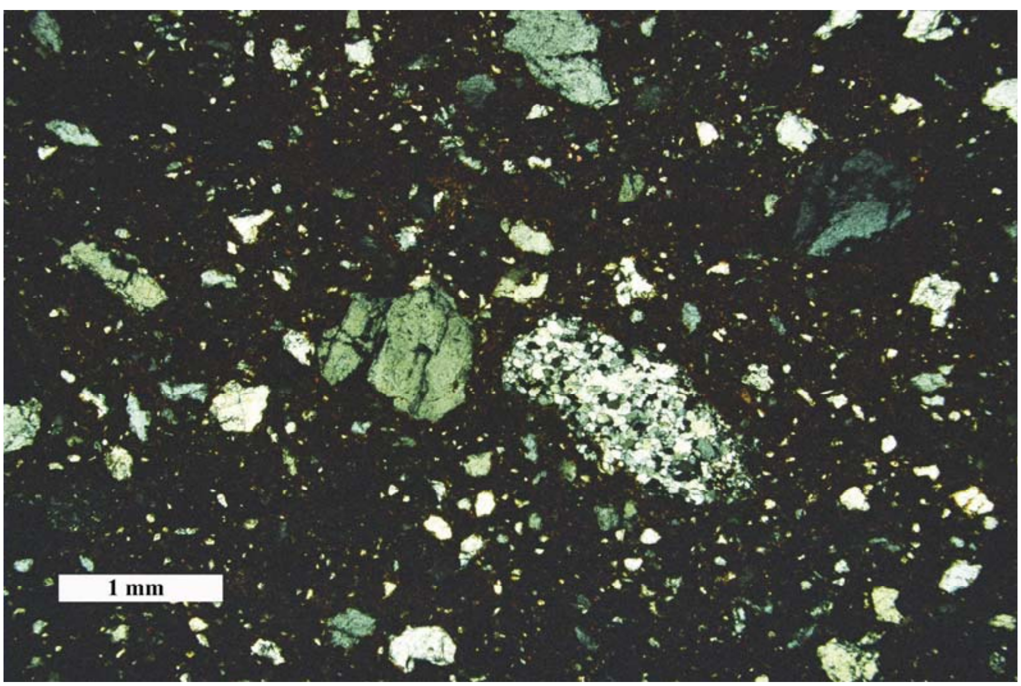

Figure 6.27. Clay sample FBR074 with coarse, polygranular metasedimentary rock fragments (center), quartz + feldspar rock fragments, and quartz mineral fragments (cross-polarized light). The dark matrix suggests reducing conditions.

Discussion

The petrographic observations demonstrate that some regional clay types can be distinguished on the basis of naturally occurring aplastic components of the matrix. This is especially true where those components include materials other than quartz rock or mineral fragments. For example, the relatively homogeneous, very fine-grained aplastic composition of the Pee Dee samples makes them quite distinct from samples representing other drainages.

It is also true, however, that certain characteristics of the samples seem to transcend regional boundaries, as revealed by similarities between samples from different regions. For example, Lower Little River sample FBR017 and Haw River sample FBR041 both have aplastic material including quartz, plagioclase, and opaque mineral fragments; polygranular quartz, quartz + feldspar, and sedimentary or metasedimentary rock fragments; and red hematite-stained clay clots (cf. Figures 6.16 and 6.17). They are difficult to tell apart petrographically and, if represented in ceramic sherds, would be grouped together based on the presence of similar aplastic components. Likewise, Yadkin samples FBR054 and FBR055 have aplastic compositions comparable to that of Deep River sample FBR058 (cf. Figures 6.23 and 6.24).

The Question of Added Temper

Distinguishing between naturally occurring aplastic particles and material purposefully added to clay to alter its character has long challenged archaeological ceramicists. In order to improve our ability to distinguish between natural rock or mineral inclusions and materials added as temper, 11 tempered test tiles were examined and compared with prehistoric pottery samples (Table 6.4).

This comparison was complicated by the fact that the test tiles and sherds were fired under different conditions. The tiles were uniformly oxidized by electric kiln firing, while many of the prehistoric ceramic sherds were fired in a reduced atmosphere. Consequently, the sherds have black or darkened matrices that make identification of diagnostic inclusions difficult and direct comparisons with clay tiles challenging. Nevertheless, some similarities between clay and pottery samples were recognizable and may provide clues as to whether pottery inclusions are natural or added.

Grog versus ACF

Some of the test tiles revealed optically distinct macroscopic textural and compositional features that were classified as ACF. The observation that these fragments occur naturally in the clay tiles indicates that it is necessary to attempt to evaluate how to separate them from grog, as these two types of inclusions share many morphological and optical traits that make them difficult to distinguish. For example, Pee Dee clay sample FBR027 includes brick red hematite-stained clay clots that look similar to grog particles (Figure 6.20). In addition to these red clay clots, argillaceous clay clots were also observed in some of the samples. In such cases, differences in texture and microstructure between argillaceous clay clots and the surrounding clay matrix can be very subtle or indistinguishable. Thin skins of hematite-rich precipitate (or possibly oxidized surfaces) sometimes form on the outside of these fragments, affecting hydration and resulting in incomplete mixing of argillaceous clay clots with the clay matrix. Roundness, internal particle orientation, and presence or absence of shrink rims can be used to

Table 6.4. Tempered Test Tiles Analyzed.

Sample ID	Drainage	Temper (Weight %)
FBR040.4	Haw	10% weathered granitic rock (FBR088)
FBR040.5	Haw	10% weathered granitic rock (FBR089)
FBR040.6	Haw	10% weathered metavolcanic rock (FBR090)
FBR040.7	Haw	10% fresh diabase (FBR091)
FBR040.8	Haw	10% Deep River quartz (FBR086)
FBR049.5	Yadkin	10% fresh diabase (FBR091)
FBR023.3	Pee Dee	10% local grog[a]
FBR023.4	Pee Dee	10% nonlocal grog[b]
FBR011.2	Cape Fear	10% nonlocal grog[b]
FBR011.3	Cape Fear	10% local grog[a]
FBR012.2	Cape Fear	10% nonlocal grog[b]

[a] Local grog was made by crushing fired test tiles fashioned from the sample clay.

[b] Nonlocal grog was made by crushing unprovenienced sherds.

distinguish argillaceous clay clots from grog, but these characteristics are not always consistently associated with one or the other (Cuomo di Caprio and Vaughan 1993).

The ability to distinguish between purposefully added grog and natural inclusions has important implications for identification and classification of prehistoric ceramics. It is especially important given that grog-tempered pottery is a key artifact type used to identify the Middle Woodland Hanover phase in the Sandhills and Coastal Plain.

While this problem deserves much more attention, this study was primarily concerned with identifying the characteristics of inclusions that would allow sherds to be linked with clay source areas. Accordingly, the problem of identifying grog is discussed briefly in the context of test tiles made from two Coastal Plain clays to which grog was added.

To determine what grog might look like in Pee Dee clay, grog-tempered test tiles made from sample FBR023 were examined. Local grog (i.e., crushed, fired test tile made from the same clay) in test tile FBR023.3 is distinguishable by slight color and texture differences, internal particle orientation different from the matrix, particle angularity, and presence of shrink rim (Figure 6.28).

A similar test was made using a Cape Fear clay sample tempered with local grog (FBR011.3). This test tile was nearly indistinguishable from untempered samples. However, when the same clay was tempered with nonlocal grog (FBR011.2), the added component was easily recognized due to the compositional differences and a pronounced color contrast between the grog and clay matrix (Figure 6.29).

Mineral and Rock Fragments

In many of the samples observed in this study, it is also possible to recognize subtle differences between mineral and rock fragments added as temper and those occurring naturally

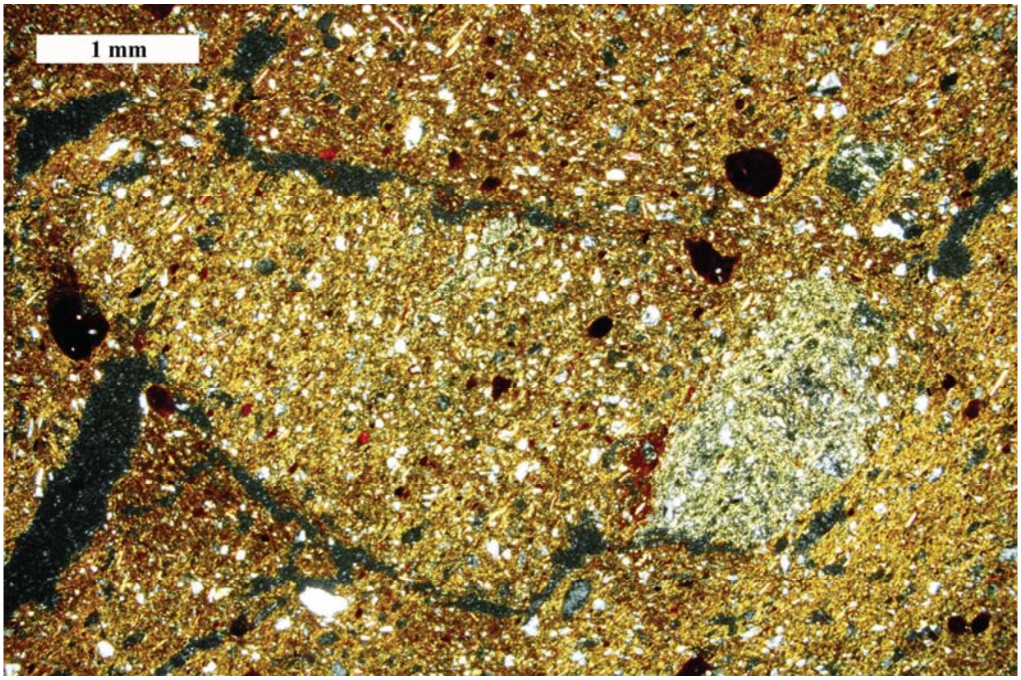

Figure 6.28. Clay sample FBR023 tempered with local grog (test tile FBR023.3; plane-polarized light). The coarse grog particle (center) has a slightly different color, texture, and orientation of inclusions than the surrounding matrix. Also note the particle's angularity and shrink rim.

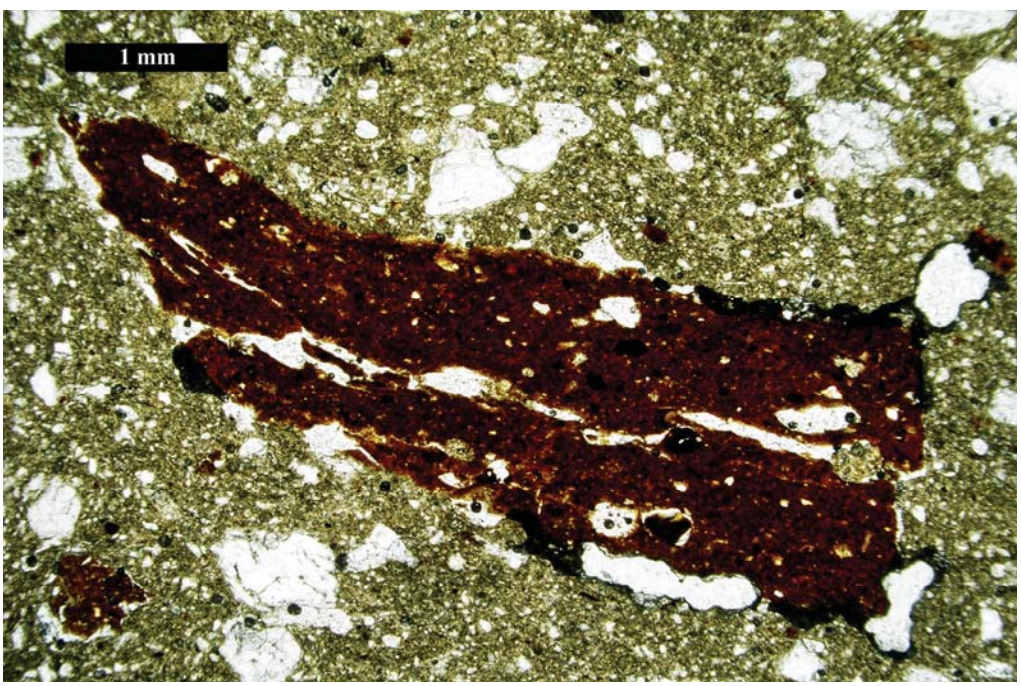

Figure 6.29. Clay sample FBR011 tempered with nonlocal grog (test tile FBR011.2; plane-polarized light). Note the distinct color and textural differences between the added grog fragment and the surrounding clay body.

in the clay. Often, the initial clue is the large size and angularity of rock fragments. Large (> 2 mm), angular rock fragments are unusual natural inclusions in raw clay samples dug for the purpose of making pottery. However, the distinction between temper and natural inclusions must be made on a case-by-case basis.

It is especially difficult to separate natural fragments from added rock and mineral fragments when they are of the same type. For example, quartz-rich Haw River clay sample FBR040 tempered with crushed quartz (test tile FBR040.8) was nearly impossible to distinguish from the untempered sample unless very large (4–7 mm) quartz temper fragments were in the field of view (Figure 6.30; Table 6.4).

On the other hand, a distinctive added temper is often identifiable. If rock fragments in a sample include characteristic minerals (e.g., amphibole, mica, or tourmaline) while the finer-grained aplastic material is found to be devoid of these materials, deliberate addition of the rock fragments would be implied. Crushed igneous and metavolcanic rock tempers were clearly distinguishable in test tiles FBR040.4, FBR040.5, FBR040.6, and FBR040.7 (Figure 6.31; Table 6.4). Nevertheless, it can still be difficult (if not impossible) to identify temper in clays exhibiting a lot of natural variation.

Quartz. In some test tiles, quartz temper was identifiable. The quartz used as temper was monocrystalline vein quartz, while the quartz fragments occurring naturally in most clays are polycrystalline. These differences are obvious in the flat sections of the thin-section pucks examined at 10× magnification.

Differences in particle size or angularity may also help distinguish quartz temper from natural inclusions. The quartz used to temper test tiles was crushed and added without winnowing or sorting. The resulting temper included every particle size from powder to pebble, was notably angular, and commonly included thin flakes and splinters (shapes not likely in the naturally occurring sample).

In theory, then, pottery tempered with quartz prepared by crushing should be distinguishable from pottery with naturally occurring quartz (grit) by the presence of flakes in the prepared-temper samples. In practice, flakes are difficult to capture in thin section, as the sample sections are very thin and the chances of sectioning a flake in a manner that reveals a characteristic profile is low. This factor increases the importance of properly defining the range of sizes and shapes that distinguish natural and artificial tempering. Had the test tiles been point-counted to produce quantitative data, they likely would have exhibited a bimodal distribution with the naturally occurring material (0.5–1.5 mm) comprising one mode and the added granule- and pebble-sized particles (> 2.0 mm) comprising another, with few particles in intermediate sizes.

Diabase. In an effort to determine whether the diabase fragments observed in the four Group I pottery samples are natural inclusions or purposefully added temper, two test tiles tempered with crushed diabase rock were examined. One test tile was made from a Haw River clay sample (FBR040.7; Figure 6.32), while the other was made from a Yadkin sample (FBR049.5).

Test tile FBR040.7 appears similar to Group I pottery sample JMH031 from the Doerschuk site, except that the test tile includes fewer and more rounded quartz mineral fragments. JMH031 includes approximately 20% diabase rock fragments in a paste composed of clay minerals and greater than 30% medium to very coarse, subangular to angular, quartz mineral fragments. These characteristics suggest the addition of diabase material to a coarse quartz-rich paste material. Alternatively, the sherd could represent a clay source derived from two different parent materials concentrated in one area, but this is an unlikely scenario.

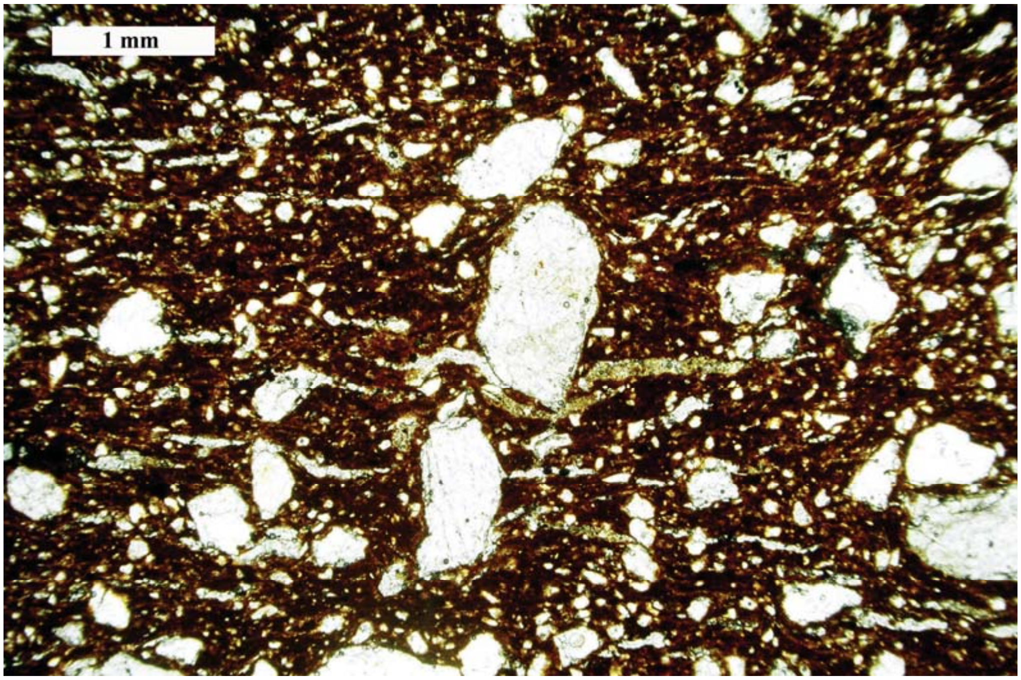

Figure 6.30. Clay sample FBR040 tempered with crushed quartz fragments (test tile FBR040.8; plane-polarized light). In this view, added quartz temper is indistinguishable from natural inclusions.

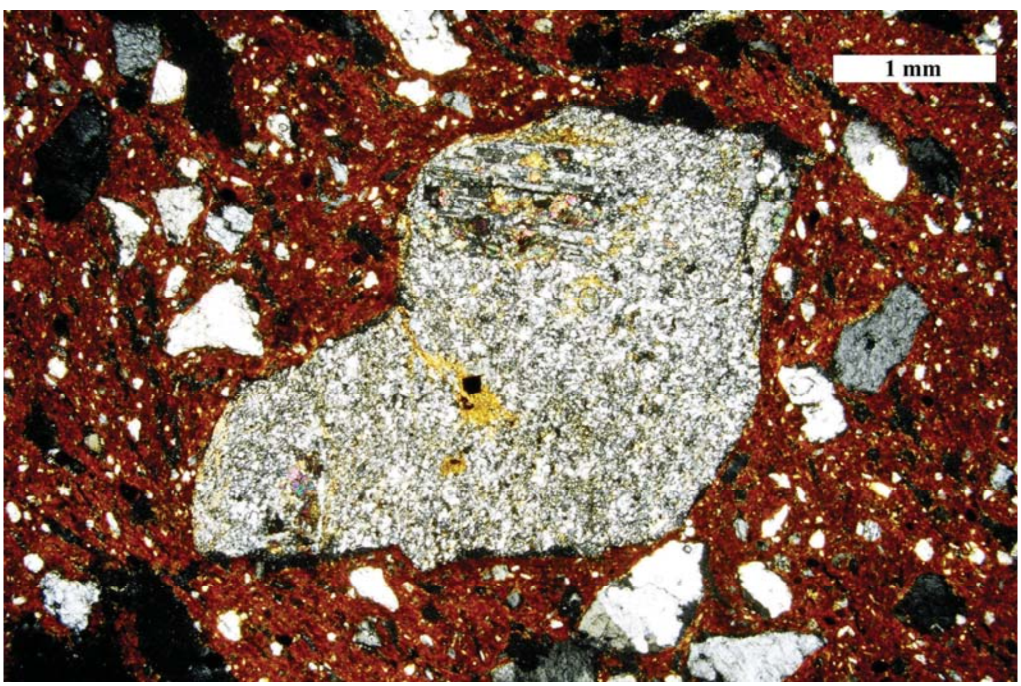

Figure 6.31. Clay sample FBR040 tempered with metavolcanic rock fragments (test tile FBR040.6; cross-polarized light). Note the coarse metavolcanic rock fragment (center) with plagioclase phenocrysts in a fine crystalline groundmass of quartz and muscovite mica. This rock fragment has experienced sericite alteration.

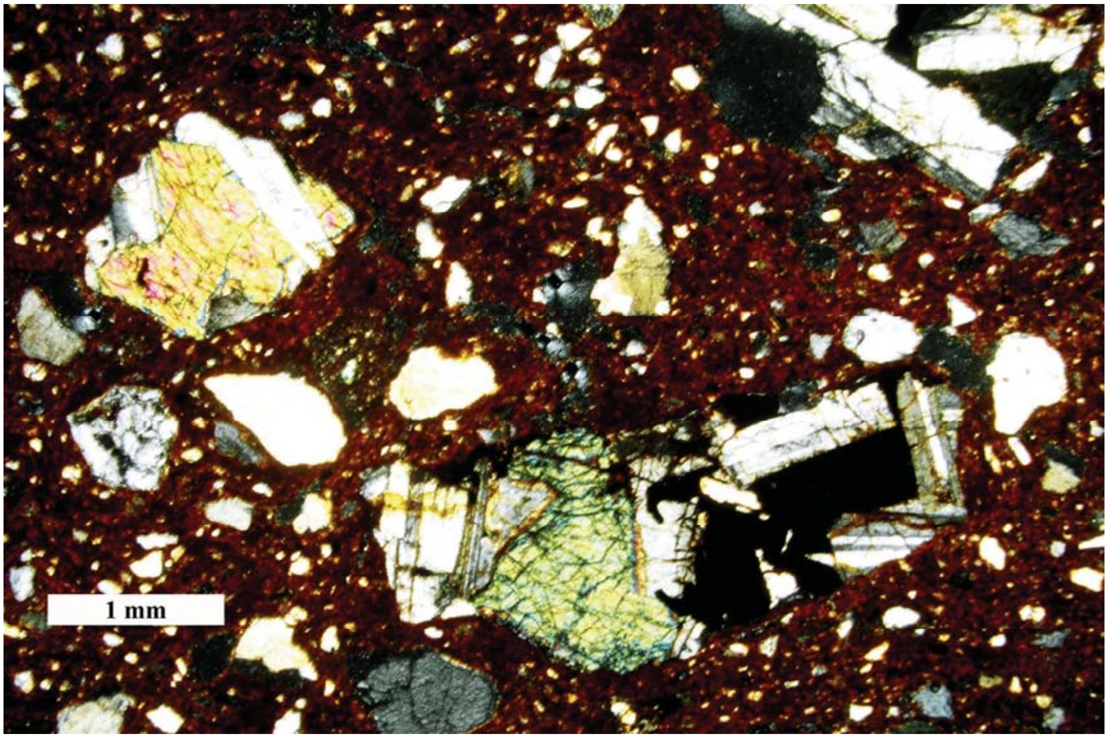

Figure 6.32. Clay sample FBR040 tempered with unweathered diabase rock fragments (test tile FBR040.7; cross-polarized light). Note the coarse plagioclase-pyroxene rock fragment (bottom center) and quartz mineral and rock fragments (gray or clear subangular and subrounded grains).

Group I pottery sample JMH046 from the Haw River site contrasts with JMH031. Sample JMH046 is composed of coarse to very coarse, blocky to angular quartz mineral and rock fragments in a paste dominated by mafic minerals (Figure 6.4). Because it is not likely that mafic material and quartz would be found in the same location, it is likely that the quartz was added as temper. Crushed quartz temper in test tile FBR040.8 made from Haw River clay approximates the type and angularity of the larger quartz fragments found in JMH046, but the test tile does not adequately represent the mafic paste composition of the sherd. None of the clay test tiles examined for this study have a mafic paste like that of sherd JMH046.

Group I sherd JMH047 is similar in some ways to JMH046, but the largest aplastic inclusions include not only quartz but also amphibole (or clinopyroxene) and heavily altered plagioclase rock fragments. The paste also contains fragments of amphibole (or clinopyroxene) and feldspar but not quartz, suggesting the quartz fragments have been intentionally added.

Finally, neither of the two test tiles tempered with crushed diabase replicates the distribution of aplastic material found in sherd JMH006. Diabase fragments in sample JMH006 comprise almost 30% of the paste and are nearly pristine, suggesting the vessel was constructed from a residual saprolitic clay that was not intentionally tempered.

Conclusions

In summary, three distinct petrographic groups are represented in the ceramic sample and appear to reflect regional differences in resources. Groups I and II generally consist of sherds from the Piedmont, while Group III consists of sherds from the Coastal Plain and Sandhills. Similar patterning in the clay data suggests that the majority of sherds were probably constructed with resources from the same general region in which they were found.