North Carolina Department of Environmental Quality
Division of Energy, Mineral and Land Resources
William E. Toby Vinson, Jr., Interim Director
Kenneth B. Taylor, State Geologist

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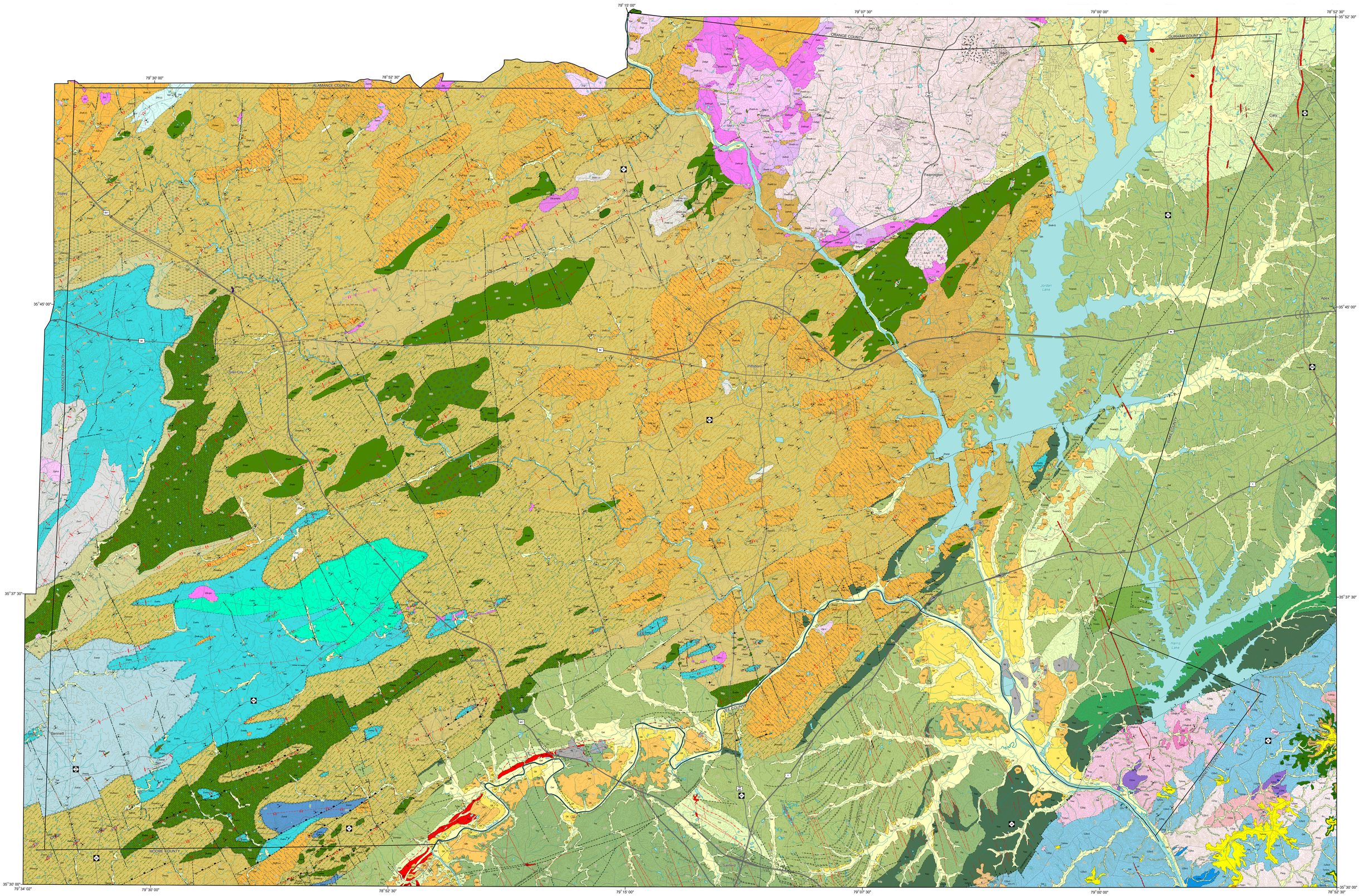
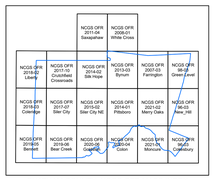
North Carolina Geological Survey
Open File Report 2022-03 (Plate 1)
Version 5/13/24

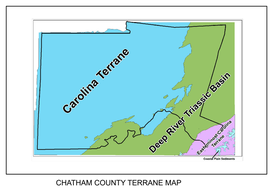


LOCATION OF CHATHAM COUNTY

CHATHAM COUNTY 1:24,000 QUADRANGLES



CHATHAM COUNTY NCGS OFR MAPS INDEX



CHATHAM COUNTY TERRANE MAP

SCALE 1:50 000
CONTOUR INTERVAL - 10 FEET

1 0.5 0 1 2 3 4 Miles
3,000 0 3,000 6,000 9,000 12,000 15,000 18,000 21,000 Feet
1 0.5 0 1 2 3 4 5 Kilometers

Lambert Conformal Conic projection
NAD 1983 State Plane North Carolina FIPS 3200 (Meters)

Geologic Map of Chatham County and Surrounding Areas, North Carolina

Compiled by Philip J. Bradley

Contributions to geologic mapping in alphabetical order by: Randy Bechtel, William B. Blocher, Philip J. Bradley, J. Robert Butler, Timothy W. Clark, Norman K. Gay, David A. Grimley, Heather D. Hanna, Michael J. Malaska, Brandon T. Peach, Aaron K. Rice, Edward F. Stoddard, and Mary E. Watson.

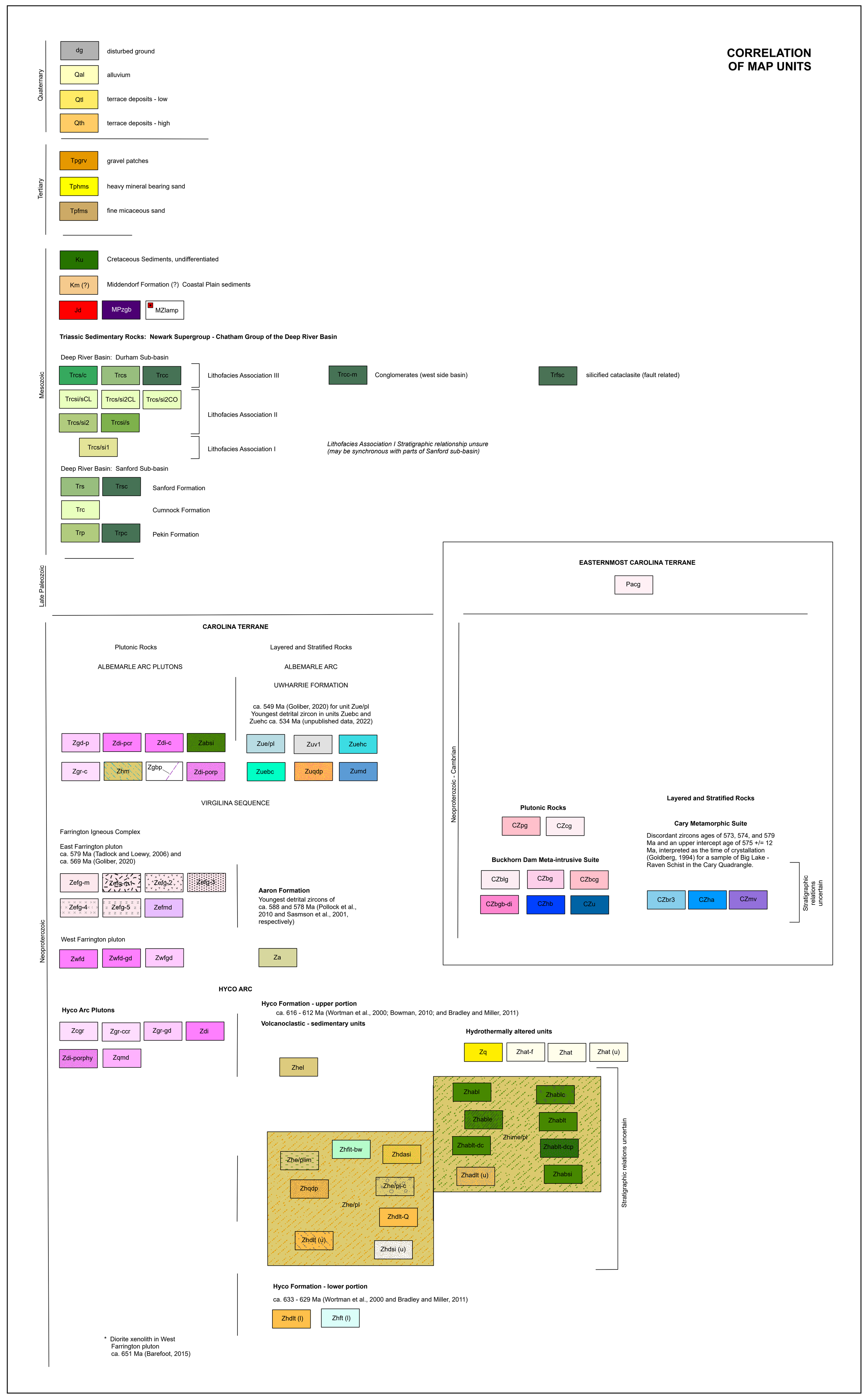
The majority of the geologic contacts south of the Cape Fear River within the Triassic basin were digitized as presented by Reinemund (1955).

Map preparation and editing by Philip J. Bradley, Michael A. Medina and Emily K. Michael
Digital representation by Michael A. Medina, Philip J. Bradley and Emily K. Michael

2022
Version 5/13/24

Edits up to 10/27/23 - Includes new scale bar, new pattern (Zhe/plim)
Edits up to 11/30/22 - Included stratigraphic and unit revisions after results of detrital zircon data.
Edits up to 5/13/24 - Created new base map, including contours, water bodies, roads and streets.

CORRELATION OF MAP UNITS



EXPLANATION OF MAP SYMBOLS

CONTACTS, FAULTS AND OTHER FEATURES

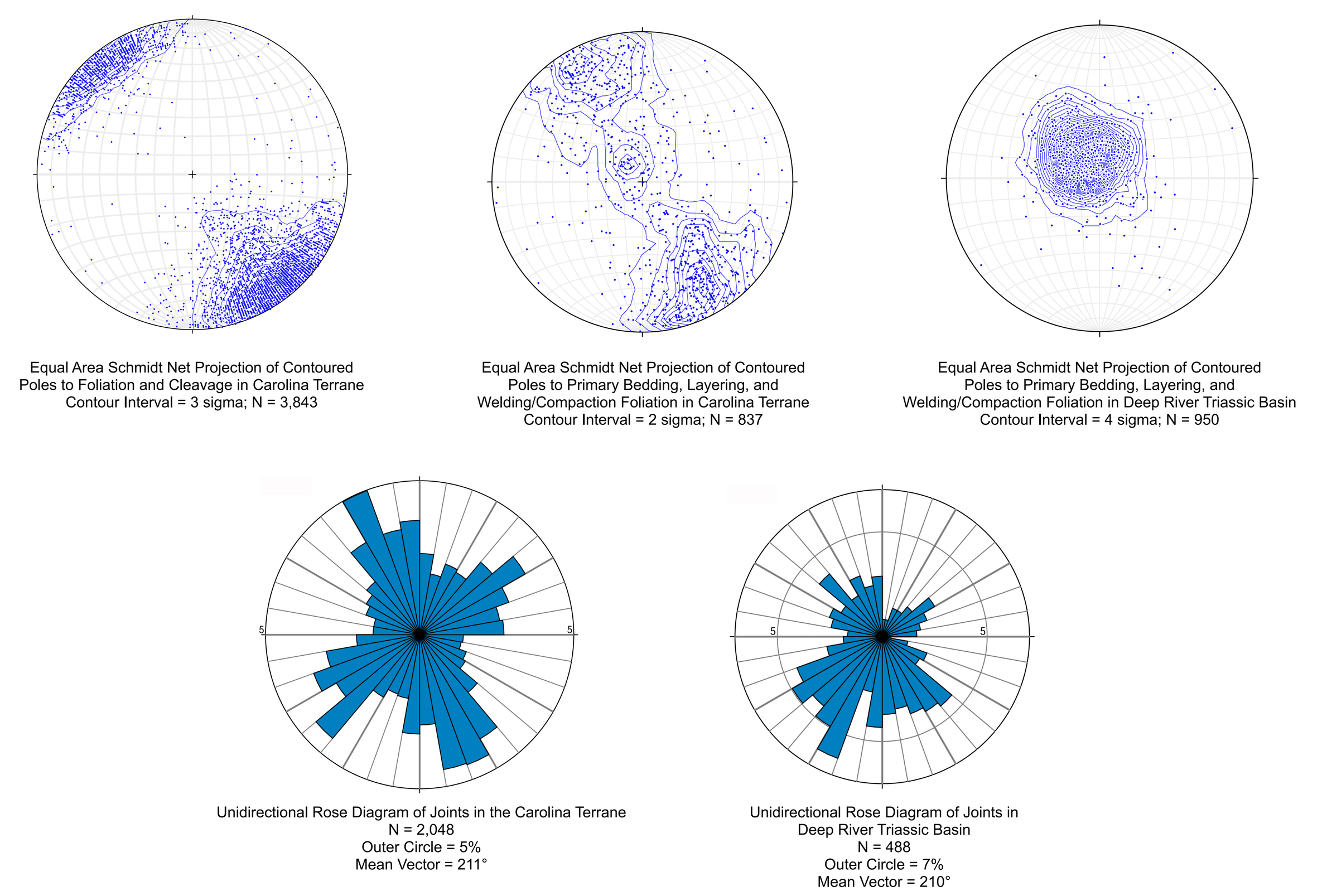
- location known
- inferred contact, dotted where concealed, ? where questionable
- inferred gradational contact, dotted where concealed
- unconformity - inferred
- fault - location known
- inferred fault, dotted where concealed, ? where questionable
- normal fault, dotted where concealed
- fault-high angle reverse - inferred, dotted where concealed ? where questionable
- conglomerate beds within Pekin and Sanford Formations, (Reinemund, 1955)
- diabase dike - inferred, dotted where concealed
- inferred diabase intruded along fault, dotted where concealed
- inferred Zgbp dike
- lineament - lidar inferred
- anticline - inferred, dotted where concealed, ? where existence questionable
- syncline - inferred, dotted where concealed, ? where existence questionable
- overturned anticline - inferred, dotted where concealed, ? where existence questionable
- overturned syncline - inferred, dotted where concealed, ? where existence questionable
- coal bed inferred, dotted where concealed (Reinemund, 1955)
- surficial geologic units contact

PLANAR FEATURES, QUARRIES AND OTHER FEATURES

- 41 strike and dip of bedding
- 26 strike and dip of Triassic bedding (Reinemund)
- strike of vertical bedding
- 85 strike and dip of cleavage
- 82 strike and dip of welding/compaction foliation
- 73 strike and dip of foliation
- strike of vertical foliation
- AU Gold prospect
- CLY Clay pit - abandoned
- CLY_BK Clay pit (brick clay) - active; Clay pit (brick clay) - abandoned
- COA Coal pit; Coal mine - abandoned; Coal mine - abandoned shaft
- CU Copper prospect; Copper mine - abandoned; Copper mine - abandoned shaft
- FE Iron prospect; Iron mine - abandoned; Iron prospect - abandoned shaft
- PPY Pyrophyllite prospect; Pyrophyllite mine - active; Pyrophyllite mine - abandoned
- SDG Sand and gravel pit - active; Sand and gravel pit - abandoned
- STN_C Crushed stone quarry - active; Crushed stone quarry - abandoned
- STN_F Flagstone quarry - abandoned
- UNK Prospect pit - commodity unknown

Equal Area Schmidt Net Projections and Rose Diagram

Plots and calculations created using Stereonet v. 10.2.0 based on Allmendinger et al. (2013) and Cardozo and Allmendinger (2013)



Equal Area Schmidt Net Projection of Contoured Poles to Foliation and Cleavage in Carolina Terrane Contour Interval = 3 sigma; N = 3,843

Equal Area Schmidt Net Projection of Contoured Poles to Primary Bedding, Layering, and Welding/Compaction Foliation in Carolina Terrane Contour Interval = 2 sigma; N = 837

Equal Area Schmidt Net Projection of Contoured Poles to Primary Bedding, Layering, and Welding/Compaction Foliation in Deep River Triassic Basin Contour Interval = 4 sigma; N = 950

Unidirectional Rose Diagram of Joints in the Carolina Terrane N = 2,048 Outer Circle = 5% Mean Vector = 211°

Unidirectional Rose Diagram of Joints in Deep River Triassic Basin N = 488 Outer Circle = 7% Mean Vector = 210°

INTRODUCTION

Chatham County and surrounding areas are underlain by four major geologic elements (Plate 1, inset A). They are, from west to east: the Carolina terrane, Deep River Triassic basin and the easternmost Carolina terrane. Coastal Plain sediments overlay units within the Deep River Triassic basin and the easternmost Carolina terrane. Older alluvium deposits are present along major drainages in addition to modern floodplain deposits.

Carolina Terrane

The Carolina terrane is composed of Neoproterozoic to Cambrian metamorphosed volcanic, volcano-sedimentary, sedimentary and intrusive rocks (Hibbard et al., 2002; and Hibbard et al., 2006). The Carolina terrane is separated into three lithotectonic units: 1) the Hyco arc, 2) the Aaron Formation of the redefined Virgilina sequence (Hibbard et al., 2013) and 3) the Albemarle arc (Hibbard et al., 2013). In Chatham County, there is evidence for all three lithotectonic units with rocks belonging to the Hyco Arc and Aaron Formation in most abundance.

In Chatham County and adjacent areas, the Hyco Arc consists of the Hyco Formation which include ca. 633 to 612 Ma (Wortman et al., 2000; Bowman, 2010; Bradley and Miller, 2011) metamorphosed layered volcaniclastic rocks and plutonic rocks. Available age dates (Wortman et al., 2000; Bradley and Miller, 2011) indicate the Hyco Formation may tentatively be divided into lower (ca. 630 Ma) and upper (ca. 615 Ma) portions with an apparent intervening hiatus of magmatism. In northeastern Chatham County, Hyco Formation units are intruded by the East Farrington pluton and associated West Farrington pluton. Two age dates are available for the East Farrington Pluton: a recent date of 569.0 ± 1.1 Ma from Goliber (2020) and a previous date of ca. 579 Ma of Tadlock and Loewy (2006). The Aaron Formation consists of metamorphosed layered volcaniclastic rocks with youngest detrital zircons of ca. 588 and 578 Ma (Pollock et al., 2010 and Samson et al., 2001, respectively). Hibbard et al. (2013) interprets an at least 24 million year unconformity between the Aaron and underlying Hyco Formation.

Rocks interpreted to be part of the Albemarle arc in Chatham County include volcaniclastic units in the western portion of the County and intrusive rock types that cut Hyco and/or Aaron Formation units. A sample from the map scale unit Zue/pl yielded an U-Pb zircon age of ca. 549 Ma (Goliber, 2020). Two samples were collected for detrital zircon analysis in units Zuehc and Zuebc. The youngest detrital zircons from both units were ca. 534 and 535 Ma, respectively.

Easternmost Carolina Terrane

The southeastern corner of the map area is underlain by metamorphosed crystalline rocks of the Cary sequence (Parker, 1979; Farrar, 1985). The Cary sequence is interpreted to be part of the Carolina terrane but separated from the rest of the terrane by the Triassic basin (Hibbard et al., 2002). For this map, related rocks are identified as being part of the Easternmost Carolina terrane. One of the main rock units is the Big Lake-Raven Rock schist. In the Cary Quadrangle, a sample from the unit yielded discordant 207Pb/206Pb zircons ages of 573, 574, and 579 Ma and an upper intercept age of 575 ± 12 Ma, interpreted as the time of crystallization (Goldberg, 1994). This is a similar age to the Aaron Formation.

Deep River Triassic Basin

Portions of the eastern and south-central areas of the map area are underlain by Triassic-aged sedimentary rocks of the Deep River Mesozoic basin. The basin is separated into three sub-basins (Durham, Sanford and Wadesboro). The Colon cross structure (Campbell and Kimball, 1923 and Reinemund, 1955), located within Chatham and Lee counties, is a constriction zone in the basin characterized by crystalline rocks overprinted by complex brittle faulting. The Colon cross-structure marks the transition between the Durham and Sanford sub-basins.

Sanford and Durham Sub-basins Stratigraphy

The Merry Oaks and Moncure quadrangles are situated in the transition between the Sanford and Durham sub-basins. In the Sanford sub-basin, a three-layer stratigraphy has been identified and formalized from oldest to youngest as the Pekin, Cumnock and Sanford Formations (Campbell and Kimball, 1923 and Reinemund, 1955). In the Durham sub-basin, this three-layer system is not recognized. Previous mapping by North Carolina Geological Survey staff separated the Durham sub-basin into lithofacies associations using the nomenclature of Smoot et al. (1988). Hoffman and Gallaghar (1989) began using the lithofacies association nomenclature and it was subsequently adopted for all mapping in the Durham sub-basin. The formation mapping of Reinemund (1955) in the Sanford sub-basin and the lithofacies association mapping in the Durham sub-basin are incompatible (Clark et al., 2001). These two methods of mapping meet in the Moncure and Merry Oaks Quadrangles. The detailed investigation of the contrasting mapping methods and establishment of a unified stratigraphic nomenclature for the Sanford and Durham sub-basins is out of the scope of this mapping project. As such, the map units from the adjacent Cokesbury Quadrangle (Butler et al., 2016) were extended into Moncure to mark the change of unit nomenclature from the Sanford sub-basin to the Durham sub-basin. Additional work is needed to establish a new stratigraphic nomenclature for the entire Deep River basin.

Post Triassic Rock Units

Dikes of Jurassic aged diabase intrude the Triassic sediments and crystalline rocks of the map area. Coastal Plain sediments are present in the southern portion of the map area. Quaternary aged alluvium is present in most modern river valleys, with at least two levels of fluvial terraces along the major drainages. These terraces, where preserved, likely mark the location and elevation of ancestral river systems, prior to incision to the modern floodplain levels.

Folds in the Carolina Terrane

The Hyco Arc and Aaron Formation lithologies were folded and subjected to low grade metamorphism during the ca. 578 to 554 Ma (Pollock, 2007; Pollock et al., 2010) Virgilina deformation (Glover and Sinha, 1973; Harris and Glover, 1985; Harris and Glover, 1988; and Hibbard and Samson, 1995). In the map area, original layering of Hyco and Aaron Formation lithologies are observed ranging from shallowly to steeply dipping and are interpreted to be a result of open to tight folds that are locally overturned.

Rocks in the map area were also subjected to the ca. 450 MA Cherokee deformation and low grade metamorphism (Hibbard et al., 2010 and 2012). Outcrop evidence of Cherokee deformation in the map area is scarce. Evidence is best exposed in area pyrophyllite mines where outcrop scale folds deform an earlier foliation. This folding is associated with local deformation along several identified high angle reverse faults in the map area (e.g. Glendon Fault).

Faults

Several terrane internal ductile faults have been recognized in Chatham and adjacent Moore County within the Carolina terrane. The best known is the Glendon fault and has long been recognized by past workers (e.g. Stuckey, 1928 and Conley, 1962). The Glendon fault is a high angle reverse fault that is a locus of pyrophyllite alteration for a distance of over 30 km (18 miles) in northeast Moore County and into southern Chatham County. The Glendon fault is interpreted to be parallel to the axial surfaces of regional-scale overturned folds and disrupts an anticline near its crest (Green et al., 1982 and Klein, 1985). In general, the Glendon fault is a zone of intense deformation ranging from 10 to 50 meters wide with abundant small-scale folds, fractures and deformed and undeformed quartz veins indicating a complicated movement history (Klein, 1985). Quartz veins may be folded and high strain foliations present within the fault zone overprint and/or transpose primary bedding and regional foliation. Main movement on the Glendon fault is speculated to be related to the Cherokee deformation.

Several other high angle reverse faults with varying degrees of hydrothermal alteration were identified during mapping. Metamorphic foliation data indicates that the dip of the foliation progressively becomes more shallow to the southeast approaching the high angle faults. In the immediate area of the faults, sericite (± pyrophyllite) phyllites and schistose phyllites with composite-like fabrics are common. It is interpreted that the older foliation has been transposed to a younger phyllonitic foliation within the fault zones.

Abundant evidence of brittle faulting at the outcrop-scale, map-scale and large-scale lineaments (as interpreted from hillshade LiDAR data) are present in the map area. The brittle faulting and lineaments are interpreted to be associated with Mesozoic extension. Major named brittle normal faults include: the Jonesboro Fault, Bonsal-Morrisville Fault, Deep River Fault, Gulf Fault and Indian Creek Fault. The map area includes the Colon cross-structure that marks the transition between the Durham and Sanford sub-basins. Numerous map-scale relay-ramps are present in this area. A fault bounded block within the Carolina terrane along the Deep River (in the northwest corner of the Moncure Quadrangle and southwest corner of the Merry Oaks Quadrangle) has been identified with rotated metamorphic foliations up to 70 degrees clockwise. This rotation is speculated to be related to rotation of a breeched relay ramp.

Past Workers

County wide reconnaissance-scale mapping and compilation work by Wilson and Carpenter (1975, updated 1981) was some of the first work in the area. Several masters theses, PhD dissertations, independent research by academics, research by the NCGS and USGS staff and independent geologists have been carried out in the map area and include: Abdelzahir, 1978; Allen and Wilson, 1968; Babiker, 1978; Bain and Harvey, 1977; Bain and Brown (1980); Berry, 1943; Black, 1977; Clark, 1998; Eligman, 1987; Green et al., 1982; Green, 1977; Hauck, 1977; Heckert et al., 2012; Hicks, 1982; Hughes, 1987; Moore, 1980; Nixon, 1954; Parker, 1979; Powers, 1985 and 1993; Ragland and Butler, 1972; Rapprecht, 2010; Reinemund, 1955; Schmidt et al., 2006; Stirewalt et al., 1981; Tingle, 1982; Wagener, 1964 and 1965; and Wilkinson, 1978.

This map is a compilation of modified and edited data from previously published or manuscript 1:24,000-scale mapping of the following quadrangles: Green Level (Watson, 1998), New Hill (Clark et al., 2004), Farrington (Bradley et al., 2007), White Cross (Bradley and Stoddard, 2008), Bynum (Bradley et al., 2013b), Silk Hope (Hanna and Bradley, 2014), Pittsboro (Bradley et al., 2014), Siler City NE (Hanna et al., 2015), Cokesbury (Butler et al., 2016), Siler City (Bradley et al., 2017a), Crutchfield Crossroads (Bradley et al., 2017b), Liberty (Bradley et al., 2018a), Coleridge (Bradley et al., 2018b), Bennett (Bradley et al., 2019a), Bear Creek (Bradley et al., 2019b), Goldston (Rice et al., 2020), Colon (Bradley et al., 2020), Moncure (Bradley et al., 2021a) and Merry Oaks (Bradley et al., 2021b). A preliminary review of the regional lithologies is summarized in Bradley (2013a) and later refined in the 2022 Carolina Geological Society guidebook (in progress).

Reinemund (1955), is an important work, that has laid the foundation for the geology with in the Triassic basin. For this mapping effort, Reinemund's maps were georeferenced to a digital elevation model from Hillshade LiDAR. Geologic contacts within the Triassic basin were digitized and modified, if needed. Most of the geology south of the Cape Fear and Deep rivers within the Triassic basin was digitized as presented by Reinemund.

Mineral Resources

The map area has many historic, abandoned, active and potential mineral resources including: coal deposits; natural gas potential; historic iron, copper and gold mines/prospects; pyrophyllite deposits; crushed stone; and a long history of clay product mining. The location of individual mineral resources is provided on the map. Refer to the individual 1:24K quadrangles for brief details about the mineral resources present in each quadrangle and specific references.

Description of Map Units

All pre-Mesozoic rocks in the map area have been metamorphosed to at least the chlorite zone of the greenschist metamorphic facies. Many of the rocks display a weak or strong metamorphic foliation. Although subjected to metamorphism, the rocks retain relict igneous, pyroclastic, and sedimentary textures and structures that allow for the identification of protolith rocks. As such, the prefix "meta" is not included in the nomenclature of the pre-Mesozoic rocks described in the map area. Dikes of Jurassic-aged diabase intrude the crystalline rocks and Triassic sediments of the map area. Triassic-aged sediments and Jurassic diabase dikes are not metamorphosed. Quaternary aged alluvium is present in most major drainages.

Map units of metavolcanic and metavolcaniclastic rocks include various lithologies that when grouped together are interpreted to indicate general environments of deposition. The dacitic lavas and tuffs unit is interpreted to represent dacitic domes and proximal pyroclastics. The andesitic to basaltic lavas (with tuffs or conglomerates) units are interpreted to represent eruption of intermediate to mafic lava flows and associated pyroclastic and/or epiclastic deposits. The epiclastic/pyroclastic units are interpreted to represent deposition from the erosion of dormant and active volcanic highlands. Some of the metavolcaniclastic units within the map area display lithologic relationships similar to dated units present in northern Orange and Durham Counties. Due to these similarities, the metavolcanic and metavolcaniclastic units have been tentatively separated into upper and lower portions of the Hyco Formation; geochronologic data in the map area is needed to confirm this interpretation. A review of the regional lithologies is summarized in Bradley (2013a).

Unit descriptions and stratigraphic correlations were maintained from adjacent mapping in Orange County (Bradley et al., 2016). The nomenclature of the International Union of Geological Sciences subcommission on igneous and volcanic rocks (IUGS) after Le Maitre (2002) is used in classification and naming of the units. The classification and naming of the rocks is based on relict igneous textures, modal mineral assemblages, or normalized mineral assemblages when whole-rock geochemical data is available. Pyroclastic rock terminology follows that of Fisher and Schminke (1984).

SURFICIAL DEPOSITS

dg - Disturbed ground: Consists of fill in highway embankments, railway embankments, and mine spoil piles, as well as areas of removed earth in mined-out-areas (former coal mines)

Qal - Alluvium: Unconsolidated poorly sorted and stratified deposits of angular to subrounded clay, silt, sand and gravel- to boulder-sized clasts, in stream drainages. May include point bars, terraces and natural levees along larger stream floodplains. Structural measurements depicted on the map within Qal represent outcrops of crystalline rock inliers surrounded by alluvium.

Qtl - Quaternary low terrace deposits: Silt loam to clay loam to sand, with some gravelly zones near unit base; yellowish brown to brown; in some areas, difficult to differentiate from high levels of modern floodplain; ranges from 2 feet to several feet thick or more; some areas are strath terraces with thin terrace deposits over red, clayey residuum developed into Triassic bedrock. [this unit is similar in concept to Qg2 of Reinemund (1955)]

Qth - Quaternary high terrace deposits: Silt loam to sandy loam to gravelly loamy sand (up to 40 % gravel); yellowish brown to reddish brown; gravel consists primarily of white, rounded to subrounded quartz pebbles, with rare cobbles; the fluvial depositional sequence generally fines upwards, with gravelly zones typically revealed along eroding slopes; total thickness of map unit is typically 2 to 10 feet; may consist of a lag deposit in strath terraces over a red, silty clay to clay residuum developed into fine-grained Triassic bedrock. Mapped areas may include multiple, undifferentiated high terrace levels. Contains E and Bt horizons of an Ultisol soil profile, with significant alteration extending several feet into the unit. May exhibit crude stratification or cross bedding at depth. [this unit is similar in concept to Qg3 of Reinemund (1955)]

Atlantic Coastal Plain

Tpgrv – Gravel Patches: Gravel layers as much as 3 m thick with rounded clasts of vein quartz and quartzite as much as 30 cm in diameter, typically overlain by 2 to 3 meters of dark red clayey sand and gravelly sand. Gravel layers are best developed within 5 km of the Cape Fear River; in general, the gravel layers decrease in thickness and size of clasts away from the river and probably grade laterally into finer-grained sediments of the Coastal Plain. The gravels are tentatively correlated with the Citronelle gravels that locally occur in the upper Coastal Plain, landward from the Orangeburg scarp. The gravels are mainly unconformable above deep saprolite derived from granite and felsic metavolcanic rocks, but in the southeastern part of the quadrangle were deposited (unconformably?) upon the Middendorf Formation.

Tphms – Heavy Mineral Bearing Sand: Silty and clayey; reddish brown, tan, and gray; fine- to very- coarse grained; poor to moderately poor sorting; subangular to rounded quartz sand. Contains rare heavy minerals (dominantly a suite with staurolite, dravite and rutile); rare mica; rare rose quartz quartz. Massively bedded, rarely laminated. Near surface mottling usually obscures sedimentary structures. Basal contact is erosional. Unit is of probable Pliocene age.

Tpfms – Fine micaceous Sand: Clay, and clayey silt; yellowish, orangish and reddish; unit is composed of two discrete lithofacies - the lower facies is characterized by medium to very coarse grained laminated quartz sand with internally graded laminae; moderately to poorly sorted; contains minor amounts of well-rounded and typically size-sorted (0.5-2cm) quartz pebbles, in thin beds and scattered within this lower section. Mica and whitish weathered feldspar are common constituents. Gradational contact with Upper portion, consisting of a very fine grained to medium-grained quartz sand with minor amounts of silt and clay; trace to about 10% mica; well to very well sorted; trace of very fine grained, rounded to well-rounded heavy minerals (dominantly dravite and rutile); massive to well-laminated; minor flaser bedding, with local well-developed wavy, lenticular and flaser bedding ; trace of bioturbation. Thickness ranges up to about 40-feet. The unit rests unconformably upon Ku.

Ku – Cretaceous Sediments, Undifferentiated: Unconsolidated to semi-consolidated, dark red to orange and yellowish-white sand and arkosic sand, locally with lenses of gravel. Plinthite and cross-bedding are present in some outcrops. The base of the unit is an unconformity. The upper part of the unit is weathered and reworked to loose, light gray to light brown sand and pebbly sand, as much as one meter thick, that may be washed downslope into stream valleys. This unit possibly includes strata of different ages, but it is poorly exposed and drill data are needed to define it adequately. This unit is tentatively assigned to the Cretaceous, but may include Coastal Plain sediments of Tertiary age.

Km(?) - Middendorf Formation: Unconsolidated white sand with brown silt and clay. Locally quartz gravel to small cobbles present. Identified as Tertiary-aged high level surficial deposits by Reinemund (1955) and identified as the Middendorf Formation on the Geologic Map of North Carolina (NCGS, 1985).

INTRUSIVE ROCKS (Unmetamorphosed)

Jd - Diabase: Black to greenish-black, fine- to medium-grained, dense, consists primarily of plagioclase, augite and may contain olivine. Locally has gabbroic texture. Occurs as dikes up to 100 ft wide. Diabase typically occurs as spheriodally weathered boulders with a grayish-brown weathering rind.

MPzgb - Gabbro: Melanocratic (CI greater than 50), fine-grained gabbro. Distinctive brown weathering. Occurs as a small map scale body and dike in the Crutchfield Crossroads Quadrangle that is closely associated with a diabase dike. In the Siler City Quadrangle occurs as isolated boulders along the trend of a diabase dike. Appears unmetamorphosed.

MZlamp - Lamprophyre (?): Gray to pinkish gray, fine- to medium-grained, exceptionally dense, with alkali-feldspar, plagioclase and amphibole. The groundmass consists of alkali feldspar and plagioclase, with alkali feldspar more abundant than plagioclase. Plagioclase crystals (greater than 1 cm) also occur are subhedral and commonly zoned. Locally, amphibole occurs in elongate slender prismatic habit (1-4 mm) and is randomly oriented. Sparse amygdules of quartz(?) up to 5 mm present locally. The rock is unmetamorphosed but may have magmatic and/or hydrothermal alteration. Occurs as dikes that are coincident with diabase. Outcrop and boulders are typically spheriodally weathered with reddish-brown weathering rind. Red square station locations mark outcrops or boulders.

TRIASSIC SEDIMENTS OF THE DEEP RIVER BASIN - CHATHAM GROUP

DURHAM SUB-BASIN

Trcs/si1 - Sandstone with interbedded siltstone of the Chatham Group Lithofacies Association I: Pinkish-gray, light-gray, and light-tan; fine- to coarse-grained, micaeous, slightly clayey, moderately poor to moderately well sorted, subangular to subrounded arkose and lithic arkose; maroon, very silty, micaeous, moderately well sorted, fine-grained sandstone; and maroon, massive, and thickly laminated, bioturbated, micaeous to very micaeous, siltstone and mudstone. Muscovite flakes up to 3 mm diameter are common especially in the siltstone. Fine-grained flakes of biotite in the arkose and lithic arkose is a distinctive accessory. Randomly oriented and vertical, cylindrical structures often filled with pale-green, fine-grained, quartz sandstone are interpreted as burrows. Bedding, when observed, is parallel to slightly wavy, occurring as thick laminations to thinly bedded (0.5 cm to 5 cm). These rocks are assigned to the Lithofacies Association I of Hoffman and Gallagher, 1989 and Watson, 1998. The clastic rocks of Lithofacies Association I are interpreted to have been deposited in a braided stream fluvial system.

Trcs/si2 - Sandstone with interbedded siltstone of the Chatham Group Lithofacies Association II: Cyclical depositional sequences of whitish-yellow to grayish-pink to pale red, coarse- to very coarse-grained, trough cross-bedded lithic arkose that fines upward through yellow to reddish-brown, medium- to fine-grained sandstone, to reddish-brown, burrowed and rooted siltstone. Bioturbation is usually surrounded by greenish-blue to gray reduction halos. Coarse-grained portions contain abundant muscovite, and basal gravel lags consist of clasts of quartz, bluish-gray quartz crystal tuff, and mudstone rip-ups.

Trcs/si2CL - Sandstone with interbedded siltstone of the Chatham Group Lithofacies Association II with chert and limestone: Arkosic sandstone, sandstone and siltstone of Lithofacies II with local occurrence of chert and less common limey sediments and nodular and thin limestones. Unit contacts are based on Bain and Harvey (1977) and Wheeler and Textoris (1978).

Trcs/si2CO - Sandstone with interbedded siltstone of the Chatham Group Lithofacies Association II with coal: Arkosic sandstone, sandstone and siltstone of Lithofacies II with local occurrence of thin coal and shale layers. Unit contacts are based on Bain and Harvey (1977) figure 24 and Bain and Brown (1980) figure 4.

Trcsi/s - Siltstone with interbedded sandstone of the Chatham Group Lithofacies Association II: Reddish-brown, extensively bioturbated, muscovite-bearing, siltstone interbedded with tan to brown, fine- to medium-grained, muscovite-bearing, arkosic sandstone, usually less than one meter thick. Siltstones can contain abundant, bedded, calcareous concretions (interpreted as caliche) and iron nodules. Bioturbation is usually surrounded by greenish-blue to gray reduction halos.

Trcsi/sCL - Siltstone with interbedded sandstone of the Chatham Group Lithofacies Association II with chert and limestone: Mainly siltstone of Lithofacies II with local occurrence of chert and less common limey sediments and nodular and thin limestones. Unit contacts are based on Bain and Harvey (1977) and Wheeler and Textoris (1978).

Trcs - Interbedded sandstone and pebbly sandstone of the Chatham Group Lithofacies Association III: Reddish-brown to dark brown, irregularly bedded to massive, poorly to moderately sorted, medium- to coarse-grained, muddy lithic arkoses, with occasional, matrix-supported granules and pebbles or as 1-5 cm thick basal layers. Muscovite is common to absent. Occasional bioturbation is usually surrounded by greenish-blue to gray reduction halos. Beds are tabular, 1-3 meters thick, with good lateral continuity. Unit grades eastward into Trcs/c.

Trcs/c - Sandstone with interbedded conglomerate of the Chatham Group Lithofacies Association III: Reddish-brown to dark brown, irregularly bedded, poorly sorted, coarse-grained to pebbly, muddy lithic sandstones with interbedded pebble to cobble conglomerate. Muscovite is rare to absent in the matrix. Well-defined conglomerate beds distinguish this unit from conglomerate basal lags of Trcs. An arbitrary cut-off of less than 50 percent conglomerate distinguishes this unit from the Trcc conglomerate facies. Conglomerate beds are channel-shaped and scour into the underlying sandstone beds. Unit grades eastward into Trcc.

Trcc - Conglomerate of the Chatham Group: Reddish-brown to dark brown, irregularly bedded, poorly sorted, cobble to boulder conglomerate. Muscovite is rare to absent in the very coarse-grained to gravelly matrix. An arbitrary cut-off of greater than 50 percent conglomerate distinguishes this unit from the Trcs/c facies. Clasts are chiefly miscellaneous felsic and intermediate metavolcanic rocks, quartz, epidote, bluish- gray quartz crystal tuff, muscovite schist, and rare meta-granitic material. Maximum clast diameters are in excess of 2 m locally.

Trcc-m - Conglomerate of the Chatham Group in the Merry Oaks Quadrangle: Reddish-brown to dark brown, irregularly bedded, poorly sorted, cobble to boulder conglomerate. Clasts are chiefly miscellaneous felsic and intermediate metavolcanic rocks and quartz. Typically present adjacent to border faults.

Trfsc - Silicified cataclasite (fault related): Tan, tan-brown and white, silicified cataclasite, commonly stained with hematite or limonite and/or displaying hematite-filled fractures. Other fractures are in filled with idiomorphic quartz crystals or massive milky quartz. Angular clasts of Triassic sedimentary units and the highly silicified and relict foliated crystalline rocks are common along the Jonesboro normal fault.

SANFORD SUB-BASIN

Trs - Sanford Formation: Mainly red to brown, locally purple, coarse-grained, arkosic sandstones and conglomerates. Subordinate amounts of claystone, siltstone and fine-grained sandstone (Reinemund, 1955).

Trsc - Conglomerate of the Sanford Formation: Mainly conglomerates with fragments of metamorphic rock and quartz embedded in and interbedded with red mudstone, siltstone and sandstone (Reinemund, 1955). Equivalent to Trcc of Lithofacies Association III in the Cokesbury Quadrangle.

Trc - Cumnock Formation: Gray and black claystone, shale and siltstone. Gray sandstone. Contains beds of coal and carbonaceous (organic-rich) shale (Reinemund, 1955). Includes coal horizons.

Trp - Pekin Formation: Gray, Brown to maroon, white mica bearing, interbedded mudstones, siltstones and arkosic sandstones. Outcrops and boulders of float identified as part of Pekin Formation are strongly indurated compared to conglomerates identified as part of Chatham Group. Identified as the Pekin Formation by Reinemund (1955).

Trpc - Conglomerate of the Pekin Formation: Reddish-brown to dark brown to purplish-red, irregularly bedded, poorly sorted, cobble to boulder conglomerate. Clasts are chiefly miscellaneous felsic and intermediate metavolcanic rocks and quartz. Typically present adjacent to border faults. Outcrops and boulders of float identified as part of Pekin Formation are strongly indurated compared to conglomerates identified as part of Chatham Group. Identified as the Pekin Formation-basal conglomerate by Reinemund (1955).

CAROLINA TERRANE

ALBEMARLE ARC PLUTONS

Zgd-p - Granodiorite of the Parks Crossroads pluton: Leucocratic (CI=5) , fine- to medium-grained, equigranular metamorphosed, granodiorite. Mineral assemblage includes quartz, plagioclase, and green hornblende +/- chlorite, +/- epidote. Likely correlative to the Parks Crossroads pluton of Tingle (1982).

Zdi-pcr - Diorite of the Providence Church Road area: Mesocratic (CI~50), greenish-gray to grayish-green, fine- to medium-grained, metamorphosed, hypidiomorphic granular diorite. Major minerals include plagioclase and amphibole. Plagioclase crystals are typically sericitized and saussuritized. Amphiboles are typically altered to chlorite and actinolite masses. Gabbro intermingled locally.

Zdi-c - Diorite of the Colon Quadrangle: Mesocratic (CI~50), greenish-gray to grayish-green, fine- to medium-grained, metamorphosed, hypidiomorphic granular diorite. Major minerals include plagioclase and amphibole. Plagioclase crystals are typically sericitized and saussuritized. Amphiboles are typically altered to chlorite and actinolite masses. Includes microdiorite textured rock. Locally, amphiboles are acicular up to 1 cm long. Located in the Colon Quadrangle.

Zabsi - Andesitic to basaltic shallow intrusive: Grayish-green to light green, ranges from aphanitic to plagioclase porphyritic and locally amphibole/pyroxene porphyritic, metamorphosed, andesite to basalt. May exhibit a granular-textured groundmass with microdioritic to microgabbroic texture (visible with 7x hand lens). Dark green to black colored amphibole/pyroxene phenocrysts, when present, occurs as masses (up to 4 mm). Interpreted to intrude Hyco and Aaron Formations. May be an apophysis of the Zdi unit in map area. Occurs as spheroid-shaped boulders and massive outcrop in map area.

Zgr-c - Granite of the Colon Quadrangle: Leucocratic, locally pale pink; medium- to coarse-grained, equigranular metamorphosed granite and granodiorite; locally contains epidote and/or chlorite clots possibly pseudomorphic after hornblende. Located in the Colon Quadrangle.

Zhm - Hunter Mountain dike: Distinctive, mesocratic, greenish-gray, plagioclase porphyritic (with plagioclase phenocrysts up to 1 cm long) granodiorite to diorite. Matrix is fine-grained consisting of interlocking plagioclase and amphibole (possibly pyroxene) crystals up to 1 mm. Correlated with the Hunter Mountain dike complex of Hauck (1977).

Zgbp - Gabbro to gabbro porphyry dike: Gabbro to gabbro porphyry dike: Dark green to black, melanocratic, metamorphosed, medium-grained gabbro to fine-grained, plagioclase porhyritic gabbro porphyry. Present as a dike.

Zdi-porp - Diorite porphry of the Goldston Quadrangle: Mesocratic to melanocratic (CI~50-60), greenish-gray to grayish-green, fine- to medium-grained groundmass with euhedral to subhedral phenocrysts (2-12 mm) of white to pale yellow plagioclase. Major minerals include plagioclase and amphibole. Plagioclase crystals are typically sericitized and saussuritized. Amphiboles are present as small clusters and are typically altered to chlorite and actinolite masses. The unit occurs as large boulders and/or outcrop that is nonfoliated and locally it includes aphanitic to porphyritic andesite to basalt. Appears to cut the Aaron Formation. Present in the Goldston Quadrangle.

UWHARRIE FORMATION

Zue/pl - Uwharrie Formation mixed epiclastics, pyroclastics and lavas of the Devils Tramping Ground area: Grayish-green to greenish-gray, metamorphosed tuffaceous sandstones, conglomeratic sandstones, siltstones and minor phyllite. The siltstones typically are weakly phyllitic. Contains lesser amounts of fine- to coarse tuff, welded tuff and dacitic lavas. Fiamme-like shaped clasts are common in the conglomerates, sandstones and tuffs. Quartz and feldspar crystal fragments are common in the sedimentary components, tuffs and lavas. Silicified and/or sericitized altered rock and quartz with adularia are locally present. The unit yielded an U-Pb zircon age of 548.7 ± 1.1 Ma (Goliber, 2020). The unit is interpreted to be in gradational contact with unit Zuehc. Contact with unit Zuehc designated at first occurrence of sandstones with angular clasts or primary volcanic rocks.

Zuv1 - Uwharrie Formation volcanics: Mixed felsic to mafic epiclastic-pyroclastic rocks with interlayered felsic to mafic lavas: Grayish-green to green; metamorphosed: non-tuffaceous to tuffaceous conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Pyroclastic rocks are grayish-green to greenish-gray and silvery-gray; massive to foliated fine- to coarse tuffs. Tuffs are differentiated from other volcaniclastic rocks by the presence of zones of cryptocrystalline texture that exhibit conchoidal-like fractures in between foliation domains. Gray to greenish-gray, siliceous, cryptocrystalline dacite and porphyritic dacite with plagioclase phenocrysts. Gray-green, gray, to green; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; metamorphosed: andesitic to basaltic lavas and shallow intrusions. Diorite locally intrudes.

Zuqdp - Quartz dacite porphyry: Porphyritic with aphanitic groundmass and sub- to euhedral phenocrysts (2-6 mm) of white to salmon plagioclase and gray to dark gray (beta-) quartz; phenocrysts typically constitute 20 to 25% of the rock. May locally have fine-grained intrusive texture. Interpreted as either lava flows or shallow intrusives possibly associated with domes. Similar looking to quartz dacite porphyry unit within the Bynum Quadrangle (Bradley et al., 2013b)

Zumd - Uwharrie Formation mudstones: Distinctive thinly bedded to very thinly bedded siltstones and mudstones.

Zuehc - Epiclastic rocks of the Harpers Crossroads area: Metasedimentary package that ranges from fine-grained siltstones to coarse-grained sandstones, pebbly sandstones and conglomerates. The sandstones, pebbly sandstones and conglomerates commonly contain rounded to subangular clasts of quartz ranging from sand- to gravel-sized. In the sandstones, feldspar is the most prominent mineral grain; quartz varies from sparse to abundant in hand sample. Lithic clasts are typically prominent and range from sand- to gravel-size. A sample from the unit was collected adjacent to the Siler City Airport for detrital zircon analysis (NCGS sample COL-3055). The four youngest detrital zircons are: ca. 534, 538, 538 and 538 Ma. Previously mapped as part of the Aaron Formation on open file maps of western Chatham County.

Zuebc - Epiclastic rocks of the Bear Creek area: Grayish-green to green, locally with distinctive reddish-gray or maroon to lavender coloration, siltstones, sandstones, conglomerates, and conglomeratic siltstone (greywacke). Siltstones are locally phyllitic. Siltstones typically display bedding ranging from mm-scale up to 10 cm, bedding layers traceable for several feet locally, may exhibit soft sediment deformation. Locally tuffaceous with a relict vitric texture. Locally contain interbedded intermediate to mafic volcanic lavas. Conglomerates and conglomeratic sandstones typically contain rounded to angular clasts. Deposition interpreted as distal from volcanic center. A sample from the unit was collected approximately 0.5 miles southwest of the Bear Creek intersection on a creek adjacent to HWY 902 on the property of Chatham Central High School for detrital zircon analysis (NCGS sample BK-626). The three youngest detrital zircons are: ca. 535, 535 and 536 Ma. Previously Zhesc on Bradley et al. (2019b).

VIRGILINA SEQUENCE PLUTONS

Farrington Igneous Complex

The Farrington igneous complex consists of several map scale plutons that are grouped into the East and West Farrington plutons. The East Farrington pluton is composed dominantly of granite to granodiorite with several map scale facies with distinct mineral and textural characteristics. U-Pb zircon geochronologic data for the East Farrington pluton include, a ca. 578.7 ± 5.5 Ma date from Tadlock and Loewy (2006) and a 569.0 ± 1.1 Ma date from Goliber (2020).

The West Farrington pluton is a gradationally zoned composite pluton (Ragland and Butler, 1972) that is characterized by diorite in the northern portions of the map, diorite to granodiorite along its southwestern margins, and leucogranodiorite in the central portions of the pluton. The intrusive relationships between the different phases of the East and West Farrington pluton are not well understood. Based on intrusive relationships observed in outcrop, boulders, and map patterns, it is interpreted that the Zwfd and Zwfd-gd are locally cut by Zwgd. Zefmd locally cuts West Farrington related units and Zefg-m cuts Zefmd.

East Farrington pluton

Zefg-m - East Farrington pluton main facies: Unfoliated, orange pink to pinkish-gray to gray, medium- to coarse-grained, equigranular to slightly porphyritic, amphibole (va. hornblende?) granite. Amphibole content varies from approximately 5 to 10% by volume and occurs locally as dark green, elongate crystals up to 1.5 cm long and amorphous intergrowths with feldspar and quartz up to 0.5 cm diameter. Dark gray xenoliths/enclaves up to 8 cm in diameter are common. Grain size becomes finer and xenoliths/enclaves larger near the pluton edge. Cavities, less than 1mm in diameter, with euhedral terminating crystals are common in some specimens. Weakly foliated outcrops are present along Pokeberry Creek and several other locations. In thin section the main facies can be separated into two groups: 1) rocks with a porphyritic texture with orthoclase and plagioclase phenocrysts in a groundmass of intergrown orthoclase, plagioclase and quartz with a granophyric texture (micrographic texture) and 2) porphyritic and equigranular rocks consisting of orthoclase, plagioclase and quartz without a granophyric texture in matrix. The two varieties appear to be intermingled throughout the study area.

Zefg-m1 - East Farrington pluton main facies variety 1: Identical to main facies but with dark green, chlorite masses up to 4 mm diameter. In thin section, the chlorite masses are intergrowths of chlorite and dark green, fibrous amphibole.

Zefg-2 - East Farrington pluton porphyritic granite: Gray, fine-grained groundmass with pink- and white-colored phenocrysts (1 mm to 4 mm) of orthoclase and plagioclase, granite. Anhedral to acicular-shaped, dark green, amphiboles (less than 1mm to 4 mm long) present in groundmass of quartz and orthoclase and as intergrowths with orthoclase and plagioclase phenocrysts. Present as several map scale bodies and as outcrop scale enclaves surrounded by East Farrington pluton main facies rock.

Zefg-3 - East Farrington pluton fine-grained granite: Orange pink, fine-grained granite. Similar texture and mineralogy to East Farrington pluton main facies but with an overall fine-grained texture. White feldspar phenocrysts compose less than 5% of rock.

Zefg-4 - East Farrington pluton gray granitoid: Unfoliated to foliated, light gray to light greenish-gray, medium-grained granite to granodiorite. White-colored feldspar content is greater than pink feldspars. Foliated specimens have visible white mica growth and less pink feldspars than unfoliated specimens. Foliated rock is present along portions of Pokeberry Creek, Pritchards Mill Creek and Cumbo Branch.

Zefg-5 - East Farrington pluton satellite granite: Unfoliated, orange pink to pinkish-gray to gray, fine- to medium-grained, equigranular, amphibole (va. hornblende?) granite. Similar to East Farrington pluton main facies but overall finer-grained.

Zefmd - East Farrington monzodiorite porphyry: Leucocratic to mesocratic, light gray to dark grayish-green where fresh, olive drab weathering, plagioclase-phyric monzodiorite and diorite. Fine- to medium-grained groundmass, with phenocrysts to 8 mm. Quartz phenocrysts very rare. Commonly has a cloudy, splotchy, or mottled appearance. Locally contains salmon-colored feldspar phenocrysts and/or orange ovoids interpreted as cavity filling or weathered phenocrysts. May have a thin light beige outer weathering rind. Weathered surface may be pitted. Locally sulfide-bearing, saussuritized, or streaked with tiny epidote veins. Fine-grained near margins.

West Farrington pluton

Zwfd - West Farrington pluton diorite: Mesocratic, unfoliated, medium- to coarse-grained, with dark green amphibole (actinolite after hornblende) diorite. Locally with chlorite/biotite; dominantly equigranular but locally weakly plagioclase porphyritic; includes quartz diorite, granodiorite, quartz monzodiorite, and tonalite; commonly contains ovoid enclaves of green to black microdiorite to 0.5 m; grades to local patches of more mafic diorite and gabbro; fine dense to slabby hornfelsed country rocks occur locally as enclaves and near contacts; locally strongly saussuritized and pale greenish; white weathering with plagioclase occurring in positive relief giving a bumpy texture.

Zwfd-gd - West Farrington pluton diorite to granodiorite: Mesocratic to leucocratic, unfoliated, medium- to coarse-grained with dark green amphibole and/or biotite diorite. Quartz content varies locally causing field identification to vary from diorite, quartz diorite, and leucogranodiorite (looks tonalitic locally). Locally with pinkish feldspars. Generally identical to Zwfd but with more intermingled granodiorite with abundant visible quartz.

Zwfgd - West Farrington pluton leucogranodiorite: Leucocratic to mesocratic, unfoliated, medium- to coarse-grained, biotite-bearing with dark green amphiboles leucogranodiorite. Quartz content varies locally causing field identification to vary from quartz diorite, leucogranodiorite, to tonalite. Locally with pink feldspars. Granophyric texture occurs locally in map area south of Collins Mountain.

VIRGILINA SEQUENCE

AARON FORMATION

Za - Aaron Formation: Metasedimentary package that ranges from fine-grained siltstones to coarse-grained sandstones, pebbly sandstones and conglomerates. Pebbly sandstone and conglomerates are distinctive and commonly contain rounded to subrounded clasts of quartz ranging from sand- to gravel-size. Lithic clasts are typically prominent and range from sand- to gravel-size. Harris (1984), performed a detailed sedimentary study of the Aaron Formation to the immediate west of the map area. Detrital zircon analysis from a sample from unit Zuehc, led to an extensive re-evaluation of the extent of the Aaron Formation in Chatham County. The Aaron Formation is interpreted to be present adjacent to and folded with Hyco Formation units. Similar looking conglomerates are present in unit Zuehc. Units within the study area of Harris (1984) need to be re-evaluated to differentiate Aaron Formation lithologies from similar looking lithologies that yield Uwharrie Formation related detrital zircons.

HYCO ARC PLUTONS

Zcgr - Granite of the Chatham pluton: Leucocratic, light brownish to beige or creamy, and locally pale pink or green; medium- to coarse-grained, equigranular metamorphosed leucocratic granodiorite and granite; locally weakly porphyritic with beta-quartz forms; grades to quartz porphyry in zones of cleavage development; quartz may be bluish; locally reddish weathering; locally contains epidote and/or chlorite clots possibly pseudomorphic after a hornblende; feldspar and quartz grains resist weathering and produce a bumpy surface; plagioclase and quartz phenocrysts sit in a granophyric matrix of alkali feldspar and quartz. Correlative to the Chatham granite of Hauck (1977). May be genetically related to Zhqdp unit.

Zgr- ccr -Granite of the Crutchfield Crossroads Quadrangle: Leucocratic, medium- grained, equigranular metamorphosed, granite or tonalite.

Zgr-gd - Granite to granodiorite: Leucocratic, fine- to medium- grained, equigranular metamorphosed, granite to granodiorite.

Zdi - Diorite: Mesocratic (CI~50), greenish-gray to grayish-green, fine- to medium-grained, metamorphosed, hypidiomorphic granular diorite. Major minerals include plagioclase and amphibole. Plagioclase crystals are typically sericitized and saussuritized. Amphiboles are typically altered to chlorite and actinolite masses. May be gabbroic locally.

Zdi-porphy - Diorite porphyry of the Silk Hope Quadrangle: Mesocratic to almost melanocratic, greenish-gray to gray diorite porphyry with fine- to medium-grained groundmass and euhedral phenocrysts (up to 18 mm) of light gray to white plagioclase. Plagioclase crystals can be saussuritized. Unit locally includes mesocratic, equigranular, plagioclase+amphibole, fine- to medium-grained intrusive diorite to monzodiorite.

Zqmd - Quartz monzodiorite: Composite pluton of mesocratic, coarse- to medium-grained, equigranular, quartz monzodiorite, diorite and granodiorite. Major minerals include plagioclase and amphiboles with lesser amounts of quartz. Amphiboles appear altered to chlorite and actinolite masses. Feldspars have a light pinkish-hue locally. Includes a distinctive plagioclase porphyritic granodiorite to diorite on South Fork Cane Creek. Unit identified as the Lindley Farms Quartz Monzonite by Schmidt et al. (2006). Schmidt et al. (2006) whole rock and modal analyses were replotted on IUGS ternary diagrams and plot in the quartz monzodiorite field.

HYCO FORMATION

Hyco Formation-upper portion

Hydrothermally altered units

Zq - Quartz body: White, beige, red, and tan; sugary to porcelaneous; very fine- to medium-grained massive quartz rock to quartzite-like rock. Outcrops are usually massive. May contain vugs with crystal shaped terminations. Map areas contain boulders (up to several feet in diameter) and/or outcrops of white colored massive quartz.

Zhat-f - Altered tuffs within the Farrington Pluton: Very light-gray, light-greenish-gray to white, mottled red and yellow, hydrothermally altered rock interpreted to be silicified and/or sericitized tuffs. Unit occurs as map scale xenoliths within the East Farrington pluton.

Zhat - Altered tuffs: Very light gray to light greenish gray (whitish in areas) with red and yellow mottling, altered volcaniclastic rocks. Alteration consists of silicified, sericitized and pyrophyllitized rock. Sericite phyllite, pods of pyrophyllite, and quartz + phyrophyllite rock all with less than 1 mm to 2 mm diameter weathered sulfides are common. Relict lithic clasts and kaolinitized feldspar crystal shards are visible in some exposures. Relict structures are obliterated in heavily altered rocks. Map area contains boulders (up to several feet in diameter) and outcrop of massive milky quartz and quartz + sericite rock. Chloritoid and staurolite present locally.

Zhat (u) - Altered tuffs (upper portion of Hyco Formation): Very light gray to light greenish gray (whitish in areas) with red and yellow mottling, altered volcaniclastic rocks. Alteration consists of silicified, sericitized and pyrophyllitized rock. Sericite phyllite, pods of pyrophyllite, and quartz + phyrophyllite rock all with less than 1 mm to 2 mm diameter weathered sulfides are common. Relict lithic clasts and kaolinitized feldspar crystal shards are visible in some exposures. Relict structures are obliterated in heavily altered rocks. Map area contains boulders (up to several feet in diameter) and outcrop of massive milky quartz and quartz + sericite rock.

Volcanoclastic-sedimentary units

Zhel - Epiclastic rocks and lavas: Conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Siltstones and mudstones typically display bedding ranging from mm-scale up to 10 cm, bedding layers traceable for several feet locally, may exhibit soft sediment deformation. Locally tuffaceous with a relict vitric texture. Locally contain interbedded dacitic to basaltic lavas. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of dacite in a clastic matrix. Deposition interpreted as distal from volcanic center, in deep water(?), and via turbidite flows.

Zhe/pl - Mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas: Mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas: Grayish-green to greenish-gray, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Lithologies are locally bedded; locally tuffaceous with a cryptocrystalline-like groundmass. Siltstones are locally phyllitic. Locally contain interbedded dacitic lavas identical to Zhdlt unit (not present in quadrangle). Contains lesser amounts of fine- to coarse tuff and lapilli tuff with a cryptocrystalline-like groundmass. Pyroclastics, lavas, and epiclastics are mainly felsic in composition. Minor andesitic to basaltic lavas and tuffs present. Silicified and/or sericitized altered rock are locally present. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of dacite in a clastic matrix. Portions of the Zhe/pl unit are interpreted to have been deposited proximal to active volcanic centers represented by the Zhdlt unit but are also interpreted to record the erosion of proximal volcanic centers after cessation of active volcanism.

Zhe/pl-c - Conglomerate dominated mixed epiclastic-pyroclastic rocks: Grayish-green to greenish-gray, metamorphosed, conglomerate and conglomeratic sandstone. Contains abundant subangular to angular clasts of dacite in a strongly tuffaceous (with a cryptocrystalline-like groundmass) clastic matrix. Interpreted as a resedimented hyaloclastite body likely sourced from a nearby dacite dome.

Felsic to intermediate volcanic units

Zhdlt (u) - Dacitic lavas and tuffs of the upper portion of the Hyco Formation: Greenish-gray to dark gray, siliceous, aphanitic dacite, porphyritic dacite with plagioclase phenocrysts, and flow banded dacite. Dacite with hyaloclastic textures are common. Welded and non-welded tuffs associated with the lavas include: greenish-gray to grayish-green, fine tuff, coarse plagioclase crystal tuff and lapilli tuff. Locally, interlayers of immature conglomerate and conglomeratic sandstone with abundant dacite clasts are present. The dacites are interpreted to have been coherent extrusives or very shallow intrusions associated with dome formation. The tuffs are interpreted as episodic pyroclastic flow deposits, air fall tuffs or reworked tuffs generated during formation of dacite domes. The unit occurs as map scale pods surrounded by clastic rocks of Zhe/pl unit. Wortman et al. (2000) reports an age of 615.7+3.7/-1.9 Ma U-Pb zircon date for a dacitic tuff from the unit in the Rougemont quadrangle.

Zhdlt-Q - Quartz dacite lavas and tuffs: Interlayered light-gray to white, unfoliated quartz and hornblende porphyritic dacite and foliated quartz crystal tuff. Quartz phenocrysts are distinctive with di-pyramidal form ranging from 1 mm up to 4 mm diameter. Hornblende phenocrysts are brown with a vitreous luster and are present up to 4 mm diameter. In hand sample, the groundmass is light-gray to white on weathered and fresh surfaces. Unfoliated varieties are interpreted to be lava or shallow intrusive bodies; foliated varieties are interpreted to be tuff. Quartz dacite porphyry unit of Eligman (1987).

Zhqdp - Quartz dacite porphyry: Micro-granitic to Porphyritic with aphanitic groundmass and sub- to euhedral phenocrysts (2-6 mm) of white to salmon plagioclase and gray to dark gray (beta-) quartz; phenocrysts typically constitute 20 to 25% of the rock. May locally have fine-grained intrusive texture. Interpreted as either lava flows or shallow intrusives possibly associated with domes. Present as boulders in the northeast of the Siler City NE Quadrangle and within the Bynum Quadrangle.

Zhdsi (u) - Dacitic shallow intrusive of the upper portion of the Hyco Formation: Gray-green, light green to green, greenish-gray to light gray; dacite, plagioclase porphyritic dacite with a granular-textured groundmass to micro-granodiorite (intrusive texture visible with 7x hand lens). Locally fine- to medium grained granodiorite present. Plagioclase phenocrysts, when present, range from less than 1 mm to 4 mm. Black colored amphibole, when visible, occurs as phenocrysts (less than 1 mm to 1 mm) and as intergrowths with plagioclase. Amphibole intergrowths distinguish rock from fine-grained tuffs. Interpreted as shallowly emplaced dacite probably co-magmatic with Zdlt (u) unit.

Zhdasi - Dacitic to andesitic shallow intrusive: Gray to greenish-gray; dacite to andesite. Aphanitic groundmass with plagioclase and acicular amphibole phenocrysts. Weak relict cryptocrystalline texture present (less than dacites). Aphanitic dacite to andesite clasts present locally likely indicating hyaloclastic texture.

Intermediate to mafic volcanoclastic-sedimentary units

Zhime/pl - Mixed intermediate to mafic epiclastic-pyroclastic rocks with interlayered intermediate to mafic lavas: Grayish-green to green, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Lithologies are locally bedded; locally tuffaceous with a cryptocrystalline-like groundmass. Siltstones are locally phyllitic. Locally contain interbedded intermediate to mafic lavas identical to Zhablt, Zhabl, and Zhablc units. Contains lesser amounts of fine- to coarse tuff and lapilli tuff with a cryptocrystalline-like groundmass. Pyroclastics, lavas, and epiclastics are mainly intermediate to mafic in composition. Minor dacitic lavas and tuffs present. Silicified and/or sericitized altered rock similar to Zhat unit are locally present. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of andesite and basalt in a clastic matrix. Generally interpreted to have been deposited proximal to active intermediate to mafic composition volcanic centers and/or record the erosion of proximal intermediate to mafic composition volcanic centers after cessation of active volcanism. May be related to Green et al. (1982) unit C - Intermediate to Mafic Volcanics and Graywacke.

Zhe/plim - Mixed epiclastic-pyroclastic rocks with interlayered intermediate to basaltic lavas: Grayish-green to greenish-gray, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone, mudstone, and felsic fine- to coarse tuff and lapilli tuff. Siltstones are locally phyllitic. Locally contain interbedded andesitic to basaltic lavas identical to Zhabl unit. Silicified and/or sericitized altered rock are locally present. Interpreted to be in gradational contact with unit Zhe/pl and identified by increase in intermediate to mafic lavas and decrease and/or absence of dacites.

Zhfit-bw - Felsic to intermediate tuffs of the Big Woods area: Heterogenous unit of felsic to intermediate composition tuffs and with lesser interlayers of andesitic to basaltic lavas and epiclastic rocks. Abundant dacitic lavas and tuffs, identical to Zdlt unit lithologies, are interlayered within unit.

Intermediate to mafic volcanic units

Zhabl - Andesitic to basaltic lavas: Green, gray-green, gray, dark gray and black; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Conglomeratic rocks consisting of angular clasts of andesite and/or basalt occur locally and are interpreted as resedimented hyaloclastite.

Zhablc - Andesitic to basaltic lavas and conglomerate: Green, gray-green, gray, dark gray and black; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Interlayers of conglomeratic rocks consisting of angular clasts of andesite and/or basalt are common and are interpreted as resedimented hyaloclastite. Locally interlayered with pyroclastic rocks and meta-sediments identical to the Zhime/pl units.

Zhable - Andesitic to basaltic lavas with interlayered epiclastic rocks: Light green, gray-green, gray, and dark gray; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; metamorphosed: andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Contains lesser amounts of grayish-green, light green, and light gray to white; metamorphosed conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone.

Zhablt - Andesitic to basaltic lavas and tuffs: Green, gray-green, gray, dark gray and black; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture similar to a lithic tuff on some outcrops. Locally interlayered with pyroclastic rocks and meta-sediments identical to the Zhe/pl and Zhime/pl units.

Zhadlt (u) - Andesitic to dacitic lavas and tuffs of the upper portion of the Hyco Formation: Black to dark gray, gray-green to green; aphanitic andesite to dacite and porphyritic andesite to dacite with plagioclase phenocrysts. Hyaloclastic textures are common. Interlayed with the lavas are gray to black; welded and non-welded; coarse tuff, lapilli tuff, and tuff breccia. Rocks interpreted as andesites have distinct interior weathering rind of light brown to gray and fresh surfaces exhibit non-vitric like textures in contrast to dacites.

Zhabsi - Andesitic to basaltic shallow intrusive of the Hyco Formation: Grayish-green to light green, metamorphosed: plagioclase porphyritic andesite to basalt with a granular-textured groundmass to very fine-grained diorite and gabbro (with intrusive texture visible with 7x hand lens – microdiorite/microgabbro). Contains lesser amounts of fine- to medium grained diorite and gabbro. Plagioclase phenocrysts typically range from 1 mm to 4 mm. Dark green to black colored amphibole, when present, occurs as phenocrysts (less than 1 mm to 1 mm) and as intergrowths with plagioclase.

Zhablt-dc - Andesitic to basaltic lavas and tuffs of the Dry Creek area: Green, gray-green, gray, dark gray and black; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Locally interlayered with meta-sediments identical to the Zhel unit. Clasts of Zhablt-dcp locally occur in conglomerates of the unit adjacent to outcrop area of Zhablt-dcp. Includes rocks of the Dry Creek unit of Hauck (1977).

Zhablt-dcp - Andesite to basalt porphyry of the Dry Creek area: Distinctive, green to dark green, andesite porphyry with aphanitic groundmass and euhedral phenocrysts (up to 10 mm) of greenish-white plagioclase; phenocrysts typically constitute 20 to 50% of the rock; local alignment of plagioclase; lesser pyroxene/amphibole phenocrysts. Green to dark green basalt porphyry with abundant pyroxene (altered to amphiboles) phenocrysts with minor plagioclase phenocrysts. Andesite and basalt porphyries locally amygdaloidal (up to 2 cm), amygdules in filling include calcite, quartz, chlorite, and epidote. Same as Dry Creek Porphyry complex of Hauck (1977).

Hyco Formation-lower portion

Felsic to intermediate volcanic units

Zhft (l) - Felsic tuffs: Grayish-green to greenish-gray and silvery-gray; massive to foliated volcaniclastic pyroclastic rocks consisting of fine- to coarse tuffs, lapilli tuffs and minor welded tuffs. Tuffs are differentiated from other volcaniclastic rocks by the presence of zones of cryptocrystalline texture that exhibit conchoidal-like fractures in between foliation domains. Layering ranges from massive to thinly bedded. Contains lesser amounts of volcaniclatic sedimentary rocks consisting of volcanic sandstones, and greywackes with minor siltstones and phyllite.

Zhdlt (l) - Dacitic lavas and tuffs of the lower portion of the Hyco Formation: Distinctive gray to dark gray, siliceous, cryptocrystalline dacite, porphyritic dacite with plagioclase phenocrysts, and flow banded dacite. Welded and non-welded tuffs associated with the lavas include: greenish-gray to grayish-green, fine tuff, coarse plagioclase crystal tuff; lapilli tuff; and tuff breccia. The dacites are interpreted to have been coherent extrusives or very shallow intrusions associated with dome formation. The tuffs are interpreted as episodic pyroclastic flow deposits, air fall tuffs or reworked tuffs generated during formation of dacite domes. Wortman et al. (2000) report a 632.9 +2.6/-1.9 Ma zircon date from a sample within the unit in the Chapel Hill quadrangle directly on strike with this unit.

EASTERNMOST CAROLINA TERRANE

Late Paleozoic plutons

Pacg - Avents Creek granite: Leucocratic (CI=1-5), light gray to pinkish gray, fine to medium grained, composed chiefly of quartz, microcline perthite, and granophyres. Low color index, abundance of perthitic alkali feldspar, and plagioclase occuring almost entirely as a component of perthite is characteristic of this hypersolvus granite. Has accessory biotite, garnet, magnetite, and white mica. Generally massive outcrops, but may be locally foliated near wall-rock contacts. Forms a large pluton exposed along Avents Creek in the southeast portion of the quadrangle,and extends into the adjacent Fuquay-Varina Quadrangle to the east and northern Mamers Quadrangle to the south. The pluton age is uncertain, but it appears to be younger than metaintrusives of the Carolina terrane and may be middle to late Paleozoic(?).

Metaintrusive units

Metagranites

CZpg - Parkers Creek metagranite: Dark gray (CI=15-20), generally fine grained, foliated to massive, garnet-biotite metagranite. Characterized in hand specimen by abundant biotite and conspicuous small garnet crystals, which give it a darker appearance than other nearby granites. The main minerals are plagioclase, perthitic microcline, quartz, biotite, garnet, and epidote, with small amounts of opaque minerals, muscovite, and sphene. The pluton crops out on both sides of Parkers Creek in its middle reaches.

CZcg - Chalk Level metagranite: Leucocratic (CI=5-8), light gray to pinkish white, fine- to medium-grained biotite metagranite. Generally has a distinct foliation with biotite as the main accessory mineral. The granite forms small plutons west of Chalk Level Church on the eastern side of the Cape Fear River valley and the lower valley of Parkers Creek.

Buckhorn Dam meta-intrusive suite

CZblg - Meta-leucogranite of the Buckhorn Dam intrusive suite: Leucocratic (CI less than 5), light-colored, medium- to coarse-grained leucogranite with poorly developed foliation; composed mainly of plagioclase, quartz, and microcline, with minor amounts of chlorite, sericite, epidote, biotite, and opaque minerals.

CZbg - Meta-granitoid rocks of the Buckhorn Dam intrusive suite: Dark-colored (CI=15-30), medium- to fine-grained, metatonalite, metagranodiorite and metagranite with variably developed foliation; composed mainly of plagioclase, quartz, epidote, microcline, biotite, and opaque minerals, with minor amounts of sericite, sphene, chlorite, and garnet. The more felsic granitoid rocks are mineralogically and chemically similar to the felsic metavolcanic rocks described below, and are probably the intrusive equivalents. The unit includes a number of small granitoid bodies, probably originally dikes and plugs, intruding felsic metavolcanic rocks northeast of the main outcrops of Buckhorn Dam intrusive suite.

CZbcg - Buckhorn Creek metagranodiorite and metagranite: Mixed facies of mesocratic (CI greater than 25) dark gray to bluish gray, fine to medium grained, weakly to moderately foliated garnet-bearing biotite metagranodiorite and metagranite and leucocratic (CI less than 10) light pinkish tan to pinkish gray, fine to medium grained, weakly to moderately foliated and locally magnetite-bearing biotite metagranite. Exposed in the upper reaches of Buckhorn Creek, as well as in the Martin Marietta Aggregates Fuquay-Varina Quarry on the adjacent Fuquay-Varina quadrangle. May be northeastern equivalents of the metamorphosed granitoid rocks of the Buckhorn Dam intrusive suite (CZbl and CZbg) or the Parkers Creek metagranite (CZpg) exposed to the southeast.

CZbgb-di - Metamorphosed gabbro to diorite of the Buckhorn Dam intrusive suite: Dark green, coarse- to fine-grained, variably foliated metagabbro and metadiorite composed mainly of epidote, chlorite, hornblende (and/or actinolite), plagioclase, opaque minerals and minor quartz. The rocks appear to be gradational into granitoids of the Buckhorn Dam intrusive suite.

CZhb - Meta-hornblendite and hornblende metagabbro: Greenish-black, medium- to coarse-grained, massive rocks composed mostly of hornblende, with lesser amounts of plagioclase, epidote, biotite, quartz, and opaque minerals. The rocks occur in four isolated groups of outcrops and residual boulders, on both sides of Avents Creek north of Cokesbury. The largest body is about 250 meters across. The occurrences are interpreted to be intrusive plugs. The rocks are mineralogically similar to some rocks of the Buckhorn Dam intrusive suite but are spatially separated from the main part of the suite and may be unrelated.

CZu - Meta-ultramafic rocks: Dark green, coarse- to fine-grained, semi-schistose to massive rocks composed mainly of chlorite, actinolite, talc (?), opaque minerals, and epidote, locally with relict clinopyroxene. Rocks occur in three small areas; two small bodies occur on the western bank of the Cape Fear River and one is associated with (and probably gradational into) metagabbro just south of the Jonesboro fault near Corinth. The age is uncertain, but the rocks are possibly related to the Buckhorn Dam intrusive suite.

Metavolcanic and metasedimentary units

Cary Metamorphic suite

CZbr3 - Big Lake-Raven Rock schist 3: Light tan to orange-brown, fine- to medium-grained, white mica schist, phyllite and gneiss. Locally preserves primary volcanic texture, either fragmental or porphyritic. Inferred to have a dacitic volcanic and/or volcaniclastic protolith. Locally includes intermediate to mafic composition rocks that have been metamorphosed to mica phyllite.

CZha - Hydrothermally altered rocks and mineralized zones: Quartz granofels, epidosite, muscovite-quartz schist, biotite schist, and iron ore. The rocks contain various combinations of quartz, muscovite, epidote, garnet, biotite, iron oxides, and manganese oxides. The rocks are fine- to medium-grained, and schistose to massive. This unit includes the Buckhorn-type iron ore deposits. Interpreted from boulders at the Buckhorn iron mine, the main seams of iron ore were as much as 2 meters thick. Protoliths of the altered rocks are probably felsic metavolcanic rocks and granite. The age of alteration and mineralization is uncertain, but the rocks are regionally metamorphosed and appear to be associated with the Avents Creek granitic intrusion or one of the older granites. Hicks (1982) interpreted the Buckhorn iron deposits as syngenetic volcano-sedimentary exhalatives.

CZmv - Interlayered mafic, intermediate, and felsic metavolcanic rocks: Mainly dark green to light gray, fine-grained metavolcanic rocks with well-developed schistosity; composed mainly of quartz, feldspar, epidote, chlorite, actinolite, biotite, and muscovite.

1:24,000 scale geology mapped: 1993-1996 and 2000-2001 (Cokesbury), 1995-1997 (Green Level), 1995-1996 (New Hill), 2006-2007 (Farrington), and 2012 to 2021 (other quadrangles). Reinemund (1955) geologic mapping from 1946-1949.

This is an Open File Map . It has been reviewed internally for conformity with North Carolina Geological Survey mapping standards and with the North American Stratigraphic Code. Further revisions or corrections to this Open File map may occur.

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