Pamphlet to accompany:

NCGS Open File Report 2025-04

Compiled bedrock geologic map of the Henderson and western portion of the Roanoke Rapids 30' x 60' quadrangles, North Carolina (version 10/29/2025)

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Reference:

Blake, D.E., Stoddard, E.F., Bradley, P.J., and Pelt, K.E. 2025, Compiled bedrock geologic map of the Henderson and western portion of the Roanoke Rapids 30' x 60' quadrangles, North Carolina: North Carolina Geological Survey, Open-file Report 2025-04, scale 1:100,000, in color, with accompanying pamphlet.

BACKGROUND

This compiled geologic map, partially supported by the U.S. Geological Survey (USGS), National Cooperative Geologic Mapping Program under STATEMAP marks year-4 of a multi-year project to compile the entire bedrock portion of the Henderson 30' x 60' Quadrangle (Henderson 100K sheet) and the western 4–1:24K quadrangles of the Roanoke Rapids 30'x 60' Quadrangle (Roanoke Rapids 100K sheet) in support of the USGS US Geoframework Initiative (USGI) vision for a nation-wide, seamless geologic map.

The goal of this compilation effort was to produce a new 1:100,000-scale digital geologic map of the study area using the USGS Geologic Mapping Schema (GeMS). When available, geologic data at scales more detailed the 1:100,000-scale were used (i.e. 1:24,000-scale data). FY20 and FY21 phases of the compilation effort, in the eastern portions of the map area, compiled data from detailed geologic mapping at the 1:24,000-scale. The FY22 phase of the compilation effort, in the western portions of the map area, compiled legacy data at scales ranging from 125K- to 24K-scales. From July 2022 to June 2023, NCGS staff conducted targeted foot and vehicle traverses to validate contacts from the legacy sources and to collect new field data. Close attention was paid to rectifying edge-match issues between legacy data and recent 24K-scale mapping to allow accurate transitions of map units from areas with detailed data to areas of legacy data collected at smaller scales (e.g. 48K). More detailed and closer spaced traverses targeted areas of structural or stratigraphic complexity. Less detailed and wider spaced traverses were used in areas of less complex structure or rock types (e.g. areas underlain by homogenous plutons received less attention). LiDAR data displayed as hillshade was used to help identify lineaments and possible faults and dikes that may be groundwater sources or preferred pathways for groundwater contaminants.

FY23 compilation efforts combined the separate GeMS database deliverables into one database with edge-matched units and unified unit descriptions. One of the goals of this compilation effort was to create seamless map units in GIS between adjacent 30’ x 60’ maps and between North Carolina and Virginia. To that end, North Carolina utilized the line work of the South Boston 30’ x 60’ map that straddles the NC-VA state line (Horton et al., 2022a and 2022b). When mapping was compatible and utilized the best available data, the vertices of the ContactsAndFaults line were snapped to the end points in the South Boston 30’ x 60’ map. In several locations, more detailed data in the Henderson 30’ x 60’ map was incompatible with the presented contacts in the South Boston 30’ x 60’ map. Additional compilation work in the southern portion of the South Boston 30’ x 60’ map is needed to create seamless transition from the South Boston to the Henderson 30’ x 60’ geologic maps.

PAST WORKERS

Specific geologic map data sources are listed in the DataSources table in the geodatabase. Individual open-file reports and Blake et al. (2012) include additional geologic map references and local to regional geologic and tectonic overviews. Major data sources across the Henderson and western portion of the Roanoke Rapids 30’ x 60’ geologic map are provided on the map layout (see the Index to Workers, Plate 1). Individual descriptions of map units (DMUs) correspond with data provided in the individual open file reports and are presented below to generally correspond with the youngest down to oldest and west-to-east spatial display of the correlation of map units (Plate 2).

GEOLOGIC SETTING

The compiled bedrock geologic map for the Henderson and western portion of the Roanoke Rapids 30’ x 60’ quadrangles depicts the metamorphosed igneous and sedimentary lithodemic and lithostratigraphic, and plutonic lithologic units across nine third-order lithotectonic elements (see the Index to Terranes on Plate 1). Located in the transition between the central and eastern Piedmont provinces, these elements are, from west to east, the Carolina terrane, Deep River Triassic basin, easternmost Carolina terrane, Falls Lake terrane, Crabtree terrane, Raleigh terrane, Warren terrane, Spring Hope terrane, and Roanoke Rapids terrane.

Ductile right-slip strands of the Eastern Piedmont fault system separate greenschist-facies suprastructural terranes (Neoproterozoic to Cambrian Carolina, easternmost Carolina, Spring Hope, and Roanoke Rapids) from amphibolite-facies infrastructural terranes (Neoproterozoic to Devonian Falls Lake, Crabtree, Raleigh, and Warren). These structures are, from west to east, the Falls Lake-Nutbush Creek, Neuse River, Lake Gordon, Macon, and Hollister mylonite/fault zones. Numerous syn-kinematic to post-kinematic, Mississippian to Pennsylvanian-Permian granitoid plutons intrude both the fault strands and terranes. Brittle-ductile normal fault strands associated with the Deep River Triassic basin that overprint individual terranes, fault strands, and plutons are, from west to east, the Fishing Creek, Jonesboro, and Upper Barton Creek faults. Jurassic diabase intrudes pre-existing units.

The variation in low-grade to high-grade metamorphic units across the geologic map represents the accumulation of volcanic, volcaniclastic sedimentary, and associated plutonic protoliths formed in peri-cratonic magmatic arc-basin complexes. These rocks have peri-Laurentian- and/or peri-Gondwanan-realm affinities. West of the Lake Gordon mylonite zone the Carolina, easternmost Carolina, Falls Lake, Crabtree, and Raleigh terranes appear to be fault blocks associated with Carolinia, a peri-Gondwanan island-arc domain. East of the Lake Gordon mylonite zone, the Warren terrane records potential links to either peri-Laurentian and/or peri-Gondwanan island-arc domains. The Spring Hope and Roanoke Rapids terranes are elements in a peri-Gondwanan island-arc domain, but it is unclear whether they are related to Carolinia. The overprinting metamorphic mineral assemblages, fabric elements, and structures appear to mark a progressive sequence of: (1) transpressional buildup of an Alleghanian orogeny collision zone between peri-Laurentian and peri-Gondwanan domains during late Paleozoic Pangean continental amalgamation, and (2) the transtensional to extensional collapse of the collision zone during late Permian to Late Triassic and Jurassic rifting and breakup of Pangea.

Coastal Plain sediments only overlay older crystalline units in the very northeastern portion of the Roanoke Rapids quadrangle surrounding Littleton, North Carolina. Older alluvium deposits are present along major drainages in addition to modern floodplain deposits. Coastal Plain and surficial sediments are not displayed on the geologic map.

ACKNOWLEDGEMENTS

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DESCRIPTION OF MAP UNITS

Note for dikes and veins in map area

Many dikes and veins are unlabeled or are too small to be easily found on this 100K-scale map in PDF or paper format. Specific dikes and veins can be searched in the MapUnitLines FeatureClass in the GeMS database. For site specific investigations, the GeMS database should be used in conjunction with the best available scale source map.

LATEST PERMIAN TO EARLY CENOZOIC ROCKS

FAULT ROCKS

CzMzsc **Silicified cataclasite (Cenozoic-Mesozoic)**—Silicified and highly fractured zones containing mm- to cm-scale silicified angular clasts. Extensional veins of rhombohedral quartz prisms and epidote common. Silicified and epidotized clasts of metamorphosed diorite, tonalite, or granodiorite may be locally preserved. In some areas, silicification and epidotization are so extensive that protolith relations are obscured. Brittle deformation is interpreted to be Mesozoic or Cenozoic in age, but it may also include Paleozoic effects.

CzMzcf **Cataclastic fault zone (Cenozoic-Mesozoic)**—Silicified and highly fractured zone containing mm- to cm-scale silicified angular clasts. Extensional veins of rhombohedral quartz prisms and local epidote common. Silicified and epidotized clasts of granitic gneiss locally preserved. Considered to be Mesozoic or Cenozoic in age.

CzMzqv **Vein quartz and quartz breccia (Cenozoic-Mesozoic)**—White to light gray, coarse-crystalline, highly fractured and cataclastic vein quartz. Typically associated with shear zones. Locally contains sericite and/or chlorite phyllonite clasts. Down-dip slickenline lineation common on fracture surfaces. Locally includes subhedral quartz crystals as vein infilling in the Oxford 7.5-minute quadrangle. May be equivalent to CzMzsc.

INTRUSIVE ROCKS (UNMETAMORPHOSED)

Jd **Diabase (Jurassic)**—Steeply dipping to vertical dikes of dark green-black or gray to bluish-black or black, melanocratic, slightly to severely weathered, fine- to medium-crystalline diabase that may be olivine, magnetite, and ilmenite bearing. Weathers to tan-gray, spheroidally rounded, dense boulders and cobbles or punky cobbles and pebbles that can be traced along strike when outcrop is absent. Locally porphyritic with phenocrysts of plagioclase. Also occurs as shallow-dipping sills in the Northwest Durham, Northeast Durham, Stem, Wilton, and Creedmoor 7.5-minute quadrangles. In the Stem 7.5-minute quadrangle, plagioclase and augite phyric diabase locally becomes gabbroic, especially where large sills intrude Late Triassic sedimentary rocks. Diabase commonly forms massive stream outcrops and waterfalls in sill outcrops above the sedimentary rocks and along dikes that inject the crystalline rocks. Includes Jurassic diabase from reconnaissance and geophysical data as depicted in Gottfried et al. (1991).

Jd2 **Two-pyroxene diabase (Jurassic)**—Steeply dipping to vertical, gray to bluish-black, medium-crystalline and typically plagioclase phyric, olivine-free augite + pigeonite diabase. Commonly contains quartz and/or alkali feldspar granophyre. Contains magnetite.

Jp **Rhyolite porphyry (Jurassic)**—Dark gray to black, strongly porphyritic aphanitic rocks containing phenocrysts of K-feldspar (sanidine-anorthoclase) and quartz, and locally microphenocrysts of Fe-Ti oxide minerals, ferropigeonite, and amphibole. Commonly with ovoid, locally aligned amygdules of calcite, silica, or a green swelling clay mineral. Occurs in steeply dipping, NNW-trending dikes that correlate with linear magnetic anomaly highs. Weathers spheroidally. Refer to GeMS database for location.

Jfp(?) **Felsic porphyry (Jurassic)**—Olive drab porphyritic aphanitic rock with a very fine-crystalline (almost glassy) groundmass and phenocrysts of quartz having beta morphology, and plagioclase, with or without alkali feldspar. May belong to an unmapped dike. Observed at a single location northwest of Ingleside, North Carolina. Refer to GeMS database for location.

MzPzlp **Lamprophyre dike (Early Mesozoic(?)-Late Paleozoic)**—Fine- to medium-crystalline, pandiomorphic lamprophyre with generally idiomorphic phenocrysts up to

1.5 mm of red-brown kaersutitic(?) hornblende + red-brown biotite + pale pink to beige augite. Hornblende is the most abundant Fe/Mg mineral, then biotite, and clinopyroxene. Hornblende occurs in a slender prismatic habit and is randomly oriented. Biotite plates have inclusions of hornblende. The groundmass consists of extensively sericitized K-feldspar and saussuritized plagioclase, with K-feldspar about twice as abundant as plagioclase. The rock contains sparse amygdules of epidote or clinozoisite up to 1 cm in diameter. Up to 5% of the rock contains opaque minerals, including pyrite. The rock is unmetamorphosed but shows significant late-magmatic and/or hydrothermal alteration. Secondary minerals include calcite. Classified as a vogesite. Refer to GeMS database for location.

TRIASSIC SEDIMENTARY ROCKS OF THE NEWARK SUPERGROUP

DEEP RIVER BASIN

DURHAM SUB-BASIN

OTHER UNITS OF THE DURHAM SUB-BASIN

Trccw **Conglomerate of the Chatham Group - western border (Triassic)**—Reddish-brown to dark brown, matrix- to clast-supported, pebble to cobble conglomerate; clasts are subrounded to rounded consisting of primarily of quartz and foliated and unfoliated felsic volcanic rocks. Matrix consists of coarse to very coarse sand.

Trcbr **Sandstone and mudstone breccia (Triassic)**—Mottled red, yellow-brown, and light gray breccia and foliated breccia derived from Triassic sedimentary rocks. Hematite coatings on subparallel slip surfaces in mudstone and siltstone impart a foliated appearance. Breccia consists primarily of angular sandstone clasts in a muddy matrix.

Trsb **Silicified breccia (Triassic)**—Light gray to white, silicified rock that has been multiply brecciated and annealed. Contains angular clasts of probable pre-Triassic rock along the Jonesboro fault.

Trbz **Contact metamorphosed sedimentary rock (Triassic)**—This rock is present at or near the contact with a diabase sill (laccolith). Lithologically equivalent to surrounding Triassic sedimentary rock map unit except the contact metamorphosed variety due to Jurassic magmatism is medium to dark gray to dark maroon probably from dark red-black hematitic cement. Sedimentary textures and mineralogy are generally preserved. Secondary sericite is present in the matrix of some contact metamorphosed sandstone.

LITHOFACIES ASSOCIATION III

Trcs **Interbedded sandstone and pebbly sandstone of the Chatham Group (Triassic)**—reddish-brown to dark brown, irregularly bedded to massive, poorly to moderately sorted, medium- to coarse-grained, muddy lithic arkose, 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-m thick, with good lateral continuity. Unit grades eastward into Trcs/c.

Trcs/c **Sandstone with interbedded conglomerate (Triassic)**—reddish-brown to dark brown, irregularly bedded, poorly sorted, coarse-grained to pebbly, muddy lithic sandstone with interbedded pebble to cobble conglomerate. Muscovite is rare to absent in the matrix. Well-defined conglomerate beds distinguish this unit from conglomerate basal lag gravel 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 scoured into the underlying sandstone beds. Unit grades eastward into Trcc.

Trcc **Conglomerate (Triassic)**—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.

LITHOFACIES ASSOCIATION II

Trcc/s **Conglomerate, sandstone, and mudstone of the Chatham Group Lithofacies Association III (Triassic)**—Red-brown, clast- to matrix-supported, poorly sorted, gravel conglomerate, conglomeratic muddy sandstone, muddy sandstone, and subordinate mudstone.

Trcs/si2 **Sandstone with interbedded siltstone (Triassic)**—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 lag gravels consist of clasts of quartz, bluish-gray quartz crystal tuff, and mudstone rip-ups. These rocks are assigned to the Lithofacies Association II of Hoffman and Gallagher (1989) and Clark et al. (2001).

Trcc/ms **Conglomerate and muddy sandstone of the Chatham Group Lithofacies Association II (Triassic)**—Red-brown, clast-supported, cobble and boulder conglomerate with subordinate sandy, gravelly conglomerate and muddy sandstone. Predominant lithic clasts are subangular to subrounded granitic and felsic intrusive rocks. Matrix contains both mud and sand components.

Trcfa/si **Feldspathic arenite and siltstone undivided (Triassic)**—Interlayered whitish-yellow and pink-brown, fine- to coarse-grained feldspathic arenite and red-brown, fine-grained, thinly bedded siltstone. Both lithologies can contain interbeds of pebbly feldspathic arenite and polymictic conglomerate.

Trcfa **Feldspathic arenite (Triassic)**—Whitish-yellow and pink-brown, fine- to coarse-grained feldspathic arenite. Individual pink K-feldspar clasts common in feldspathic arenite along with subrounded to rounded blue-gray quartz pebbles and grains. Typically displays white clay and/or silica cement. Locally contains cross-beds and horizons of polymictic conglomerate that include epidosite, greenstone, and metagranitoid clasts up to 15 cm in diameter.

Trcsi **Siltstone and minor pebbly sandstone (Triassic)**—Red-brown, fine-grained, thinly bedded siltstone that locally contains interbeds of pebbly sandstone. Pebbles range from granitoid to milky quartz clasts. Commonly overlain by diabase sills that locally produce a deep maroon-brown coloration, and well-indurated outcrops may indicate baking due to contact metamorphism.

LITHOFACIES ASSOCIATION I

Trcs/si1 **Sandstone with interbedded siltstone of the Chatham Group Lithofacies Association I (Triassic)**—Grayish-pink, pinkish-gray, and light-gray, fine- to coarse-grained, micaceous, slightly clayey, moderately poor to moderately well-sorted, subangular to subrounded arkose and lithic arkose; dark red to reddish-brown, very silty, micaceous, moderately well-sorted, fine-grained sandstone; and dark red to reddish-brown, massive, and thickly laminated, bioturbated, micaceous to very micaceous siltstone and mudstone. Muscovite flakes up to 3 mm in diameter are common especially in the siltstone. Fine-grained flakes of biotite in the arkose and lithic arkose are a distinctive accessory. Randomly oriented and vertical, cylindrical structures, often filled with pale green, fine-grained, quartz sandstone, are interpreted to be burrows. Bedding, when observed, is parallel to slightly wavy, occurring as thick laminations to thin bedding (0.5 cm to 5 cm). These rocks are assigned to Lithofacies Association I of Hoffman and Gallagher (1989), Watson (1998), and Clark et al. (2001).

PERMIAN TO MISSISSIPPIAN INTRUSIVE ROCKS

PM(?)rcg **Ruin Creek gneiss (Permian-Mississippian)**—Variably tan-orange to gray-orange, fine- to medium-crystalline, well-foliated and lineated, K-feldspar porphyroclastic granitic gneiss. White mica + chlorite and recrystallized K-feldspar + quartz + plagioclase define the shear foliation and mineral stretching lineation.

PM(?)fgf **Foliated felsic gneiss (Permian-Mississippian)**—Dark to light pink-red-orange, leucocratic (CI less than 2), fine- to coarse-crystalline felsic protomylonitic, mylonitic, and ultramylonitic granitic gneiss. Variably foliated and lineated and locally containing relict red-orange K-feldspar porphyroclasts and pegmatitic K-feldspar and quartz layers and boudins. Forms resistant lakeside outcrops and fields of cobbles and boulders that are highly fractured. Outcrops are reminiscent of the Ruin Creek Gneiss (PM(?)rcg) or Falls Leucogneiss (Zflg) between the cities of Henderson and Raleigh.

PMpg **Pegmatitic granite (Permian-Mississippian)**—Gray-white to pink-white, very coarsely crystalline, microcline + plagioclase + quartz + muscovite, and biotite pegmatitic granite. Some outcrops exhibit a graphic texture.

WILTON PLUTON

PPwg **Granite of the Wilton pluton (Pennsylvanian)**—Grayish-orange to pinkish-orange, leucocratic (CI less than 15), medium- to coarse-crystalline, weakly foliated or lineated to nonfoliated, biotite granite (Robitaille, 2004). Locally molybdenite bearing.

CEDAR CREEK PLUTON

PPccg **Granite of the Cedar Creek pluton (Pennsylvanian)**—Pink-white, medium- to coarse-crystalline, unfoliated to moderately foliated and lineated biotite granite with local pegmatite granite.

ROLESVILLE BATHOLITH

PPbg **Biotite granite (Permian-Pennsylvanian)**—Pink-white, medium- to coarse-crystalline, unfoliated to weakly foliated biotite granite and local pegmatite granite.

PPrgfm **Foliated to mylonitic granite and granitoid orthogneiss (Permian-Pennsylvanian)**—Pink or salmon and white, leucocratic (CI less than 5 – 15), medium- to coarse-crystalline, commonly porphyritic or porphyroclastic biotite granite, biotite leucogranite, and biotite granitoid orthogneiss. Strongly foliated, protomylonitic, or mylonitic in most exposures. Mantled K-feldspar porphyroclasts with local dynamically recrystallized tails indicate a dextral shear sense. Pegmatite granite and aplite dikes and sills are common and may be deformed. Includes some minor undeformed granite. Also includes minor biotite schlieren and biotite and biotite-hornblende gneiss enclaves. Crops out in the northwestern Vicksboro 7.5-minute quadrangle, and along its western edge. Equivalent to Pg1 of the Middleburg 7.5-minute quadrangle and PPrgm and PPrgf of the Henderson 7.5-minute quadrangle. Lies between the Nutbush Creek fault zone and Lake Gordon mylonite zone. Equivalent to granite units Pg1 on the geologic map of the Middleburg 7.5-minute quadrangle (Stoddard et al., 2016).

PPrgv **Averette granitoid (Pennsylvanian)**—massive, coarse-crystalline biotite +/- muscovite granitoid, having abundant subhedral orange K-feldspar megacrysts to 1 cm in length. Locally foliated near western margin of the Rolesville batholith (Speer, 1994).

PPrdg **Diorite-gabbro of the Rolesville batholith (Permian-Pennsylvanian)**—Medium-crystalline biotite granodiorite, hornblende-biotite diorite, quartz diorite, and biotite-hornblende gabbronorite, apparently unmetamorphosed and surrounded by PPrgd.

PPrgd **Granitoid facies d (Pennsylvanian)**—Pink or salmon and white, leucocratic (CI = 5 – 12), fine- to coarse-crystalline, but primarily medium-crystalline equigranular to moderately porphyritic (very rarely megacrystic), rarely foliated, biotite +/- muscovite monzogranite. Commonly has an almost idiomorphic texture with well-formed K-feldspar + plagioclase crystals. Contains common biotite schlieren and local biotite crystal clots. Pegmatite granite dikes and pods are extremely common; locally, isolated megacrysts of K-feldspar 1-4 cm in length also occur. Unit also contains relatively common xenoliths of Raleigh terrane country rocks, especially in the Ingleside and Louisburg 7.5-minute quadrangles. Less commonly contains autoliths of fine-crystalline granodiorite or tonalite and may display igneous layering between biotite-rich and biotite-poor phases. Weathered surfaces are commonly nubbly, friable, and/or cavernous. Rolesville main phase of Speer (1994).

PPrgj **Granitoid facies j (Permian-Pennsylvanian)**—Heterogeneous granitoid unit consisting of streaky, gneissic, or layered biotite granitoid and biotite granitoid gneiss. Includes granite, leucogranite, and granodiorite and their gneissic counterparts. Generally medium crystalline but ranges from fine to coarse. Locally, K-feldspar megacrysts range up to 3 cm in length. Locally, unit exhibits strong compositional layering. Elsewhere vague phase layering, boudinage of darker phases, biotite schlieren, or xenoliths of biotite gneiss. Additionally, granite may exhibit K-feldspar or biotite alignment foliation. Planar fabric elements may be contorted and possibly transposed. Pegmatite and aplite granite dikes are abundant and locally deformed. Consistently associated with granitoid of the main Rolesville phase PPrgd in the Henderson 7.5-minute quadrangle.

PPrgk **Granitoid facies k (Permian-Pennsylvanian)**—White, pink, orange or buff, leucocratic (CI = 2 – 8), medium-crystalline, generally equigranular biotite +/- muscovite leucogranite and granite, locally with garnet phenocrysts. Locally associated with and contains xenoliths of gneiss and schist. Commonly crosscut by pegmatite granite dikes locally having smoky quartz. Intrudes and contains autoliths of fine-to medium-crystalline biotite granite PPrgi.

PPg **Unnamed granite (Permian-Pennsylvanian)**—White, pink, orange or buff, leucocratic (CI = 8 – 15), medium-crystalline, equigranular to weakly porphyritic biotite ± muscovite granite. Includes fine- to medium-crystalline, non-porphyritic, locally foliated white mica ± garnet ± biotite leucogranite (CI less than 5), and rare granodiorite (CI = 15 – 20). Pegmatite granite dikes common. In the Hollister 7.5-minute quadrangle, unit is a medium gray medium-crystalline biotite and muscovite-biotite granite.

PPdg **Diorite-gabbro (Permian-Pennsylvanian)**—Dark gray, mesocratic (CI = 40 – 60), medium- to coarse-crystalline hornblende diorite and gabbro and their weakly metamorphosed equivalents. Uralitized augite is common. Also contains magnetite and typically titanite.

PPrgl **Granitoid facies l (Permian-Pennsylvanian)**—Leucocratic (CI = 15 – 20), medium-crystalline (typically 3 - 5 mm), hypidiomorphic granular to weakly porphyritic biotite granodiorite. Contains titanite + apatite + opaque minerals. Occurs in three small, mapped pods.

PPrgi **Granitoid facies i (Permian-Pennsylvanian)**—White, light gray, or tan, leucocratic (CI = 5 – 12), fine- to medium-crystalline, equigranular to weakly porphyritic biotite +/- muscovite granite, locally with pink K-feldspar. Locally contains K-feldspar phenocrysts up to 8 mm in length but does not contain schlieren or xenoliths and contains fewer pegmatite granite dikes than most other granitoid phases.

PPrgg **Granitoid facies g (Permian-Pennsylvanian)**—Fine- to medium-crystalline, leucocratic (CI = 8 – 14) white to pale gray biotite monzogranite to granodiorite. Locally carries a weak biotite foliation. Rare xenomorphic to subidiomorphic garnet phenocrysts are less than 1 mm in diameter. Crosscut by thin pegmatite granite dikes having beige to white-colored K-feldspar. Displays gray to white weathering surfaces but is distinctively more resistant to weathering when compared to the other granitoid phases.

PPge **Leucogranite (Permian-Pennsylvanian)**—Fine- to medium-crystalline, non-porphyritic, locally foliated muscovite +/- biotite +/- garnet leucogranite and granite. (CI = 4 – 10). Occurs profusely along the northwestern margin of the Gupton and Northwest Gupton plutons, the eastern margin of the main Rolesville batholith in the northwestern Gold Sand and Bunn East 7.5-minute quadrangles, and sporadically elsewhere, notably near and within pluton reentrants, intermingled with sillimanite-muscovite schist northwest of the crossroads of Moulton, and in the zone of mixed rocks separating the larger plutons. Locally contains pegmatite granite dikes in many localities, and quartz-muscovite greisen in the Bunn East 7.5-minute quadrangle. Includes unnamed bodies (PPge) in the Warren and Spring Hope terranes.

PPrge **Granitoid facies e (Permian-Pennsylvanian)**—Leucocratic (CI = 4 – 10), fine- to medium-crystalline, non-porphyritic, locally foliated muscovite +/- biotite +/- garnet leucogranite and granite. Occurs profusely along the northwestern margins of the Gupton and Northwest Gupton plutons, and the eastern margin of the main Rolesville batholith in the northwestern Gold Sand and Bunn East 7.5-minute quadrangles. Occurs sporadically elsewhere, notably near and within pluton reentrants, intermingled with sillimanite-muscovite schist northwest of the crossroad at Moulton, and in the zone of mixed rocks separating the main Rolesville plutons. Locally contains pegmatite granite dikes in many localities, and quartz-muscovite greisen in the Bunn East 7.5-minute quadrangle. Includes unnamed bodies (PPge).

PPrgh **Granitoid facies h (Permian-Pennsylvanian)**—White to tan, leucocratic (CI = 8 – 18), fine- to medium-crystalline, equigranular to weakly K-feldspar porphyritic, biotite +/- muscovite syenogranite to monzogranite. Locally carries a weak foliation of robust biotite flakes. Occurs locally as unmapped pods (autoliths?) with PPrgd. Locally, dikes of PPrgd cut rocks similar to PPrgh, PPrgg, and PPrgi.

ROLESVILLE BATHOLITH OR BUGGS ISLAND PLUTON (?)

PPfg **Foliated granitic rocks (Permian-Pennsylvanian)**—Leucocratic to mesocratic, medium- to coarse-crystalline, locally megacrystic, porphyroclastic, strongly foliated tan-gray to blue-gray, biotite + white mica granite and white mica ± biotite ± garnet leucogranite. Commonly protomylonitic to mylonitic and ultramylonitic and porphyroclastic. Includes mylonitized pegmatitic to coarsely crystalline, porphyroclastic white mica ± biotite + quartz + feldspar metagranitoid sills that produce a migmatitic appearance. Also includes granitoid orthogneiss and numerous enclaves of biotite + hornblende gneiss, notably at the Greystone Quarry northeast of Henderson. Lies at least partly within and along the western boundary of the Lake Gordon mylonite zone. Equivalent to granite units Pg2 and Pg3 on the geologic map of the Middleburg 7.5-minute quadrangle (Stoddard et al., 2016).

WISE PLUTON

PPwgp **Wise pegmatitic granite (Permian-Pennsylvanian)**—Pegmatitic quartz + white mica granite exposed in an abandoned quarry.

PPwlg **Wise leucogranite (Permian-Pennsylvanian)**—Hololeucocratic and aplitic leucogranite facies within biotite granite of the Wise pluton.

PPwbg **Wise biotite granite (Permian-Pennsylvanian)**—Tan to pink-white to pink-gray, hololeucocratic (CI = 5 – 10), holocrystalline, phaneritic fine- to medium-crystalline, xenomorphic equigranular biotite granite. Primary mineral assemblage includes Na-plagioclase + microcline + quartz + biotite, and locally minor muscovite + garnet. In a few outcrops, muscovite can increase in abundance to be nearly equal to the biotite content. Some outcrops of porphyritic biotite granite contain K-feldspar phenocrysts up to 1 cm in length. Transitions from biotite granite to graphic granite and pegmatitic granite can occur. Locally contains subidiomorphic to xenomorphic garnet phenocrysts ranging from 0.5-1 mm in diameter. Mostly undeformed, although locally a very weak biotite foliation may be preserved. Hololeucocratic (CI less than 5) pegmatitic microcline + quartz + Na-plagioclase + muscovite granite pods and dikes crosscut biotite granite in many exposures. Small xenoliths and larger domains of upper greenschist to amphibolite facies gneiss and schist are included throughout the biotite granite. Many have a common 160-180°, 90° gneissosity or schistosity that is similar in orientation to surrounding wall rock foliation that may indicate they are stoped country rock blocks. Biotite granite forms large to small flat pavements, flat to rounded hillside ledges, boulder fields of large blocks on ridge tops and in valleys, cascades and waterfalls in streams, and float litter on hillsides and in streams. Numerous crosscutting tension fractures, some infilled with quartz, occur throughout the biotite granite.

BUNN PLUTON

PPrgn **Bunn granitoid (Permian-Pennsylvanian)**—Massive, medium- to coarse-crystalline biotite + muscovite granitoid, identical to the Rolesville main phase (PPrgd) except containing accessory monazite. Zoned pegmatite granite dikes that have smoky quartz are relatively common (Speer, 1994).

NORTHWEST GUPTON PLUTON

PPnwqd **NW Gupton quartz diorite (Permian-Pennsylvanian)**—Green-gray and dark gray-white spotted, mesocratic (CI = 55 – 60), medium-crystalline quartz diorite and tonalite. Composed of hornblende + plagioclase + quartz +/- biotite. Quartz diorite is locally porphyritic. Plagioclase and hornblende phenocrysts are prismatic and tabular, respectively, and 2–5 mm in length. Texturally, these rocks range from undeformed to mylonitic quartz diorite. Locally, deformed and metamorphosed portions are amphibolitic. Quartz diorite occurs as small pods within PPnwg that are locally crosscut by K-feldspar megacrystic granite dikes.

PPnwg **NW Gupton granite (Permian-Pennsylvanian)**—White-gray, leucocratic (CI = 5 – 10), medium- to very coarse-crystalline granite, mostly in the Inez 7.5-minute quadrangle. Primary mineral assemblage includes K-feldspar + quartz + plagioclase ± white mica. Locally this rock contains biotite and red garnet phenocrysts 1-3 mm in diameter. Locally contains abundant enclaves of gneiss and schist, as well as numerous dikes and pods of pegmatite granite and aplite. Pegmatite granite is white gray to pinkish gray, leucocratic (CI = 10 – 20), coarse-crystalline granite comprised of coarse to pegmatitic orthoclase, coarse crystalline quartz and Na-plagioclase, medium to coarse white mica ± biotite. Accessory minerals include titanite + zircon + apatite. Orthoclase and white mica porphyroclasts are commonly 1-5 cm in diameter. Aplitic zones are white-gray, leucocratic (CI = 5), finely crystalline granite. Aplite commonly occurs in larger outcrops of leucogranite and pegmatitic granite. This unit is locally inferred by the presence of large white mica flakes in the soil profile. A portion of the contact of this unit is defined by a 3-5 m-wide zone of silicified cataclasite that defines the contact with the Warren terrane to the northwest along Wolfpit Branch. In Franklin County, granitic rocks are locally porphyritic and/or strongly deformed.

PPnwge **NW Gupton granitoid facies e (Permian-Pennsylvanian)**—Leucocratic (CI = 4 – 10), fine- to medium-crystalline, non-porphyritic, locally foliated muscovite +/- biotite +/- garnet leucogranite and granite. Occurs profusely along the northwestern margin of the Gupton and Northwest Gupton plutons, the eastern margin of the main Rolesville batholith in the northwestern Gold Sand and Bunn East 7.5-minute quadrangles, and sporadically elsewhere, notably near and within pluton reentrants, intermingled with sillimanite-muscovite schist northwest of the crossroads of Moulton, and in the zone of mixed rocks separating the larger plutons. Locally contains pegmatite granite dikes in many localities, and quartz-muscovite greisen in the Bunn East 7.5-minute quadrangle. Includes unnamed bodies (PPge) in the Warren and Spring Hope terranes.

PPnwgf **NW Gupton high-strain zone (Permian-Pennsylvanian)**—Continuous zone of weakly to strongly foliated protomylonitic to mylonitic granite strikes northeast and extends from the southwest corner of the Inez 7.5-minute quadrangle to the northeast of Fishing Creek. Stretched quartz ribbons define a mineral rodding lineation between the white mica and biotite foliation. Several smaller cm- to m-wide zones of high-strain leucogranite also trend northeast-southwest and are consistent with other locally developed tectonic fabric elements. Chlorite films along fracture surfaces, silica and epidote replacement of pre-existing minerals, and discrete zones of silicified cataclasite indicate a localized brittle overprint.

GUPTON PLUTON

PPgge **Gupton granitoid facies e (Permian-Pennsylvanian)**—Leucocratic (CI = 4 – 10), fine- to medium-crystalline, non-porphyritic, locally foliated muscovite +/- biotite +/- garnet leucogranite and granite. Occurs profusely along the northwestern margin of the Gupton and Northwest Gupton plutons, the eastern margin of the main Rolesville batholith in the northwestern Gold Sand and Bunn East 7.5-minute quadrangles, and sporadically elsewhere, notably near and within pluton reentrants, intermingled with sillimanite-muscovite schist northwest of the crossroads of Moulton, and in the zone of mixed rocks separating the larger plutons. Locally contains pegmatite granite dikes in many localities, and quartz-muscovite greisen in the Bunn East 7.5-minute quadrangle. Includes unnamed bodies (PPge) in the Warren and Spring Hope terranes.

PPggc **Granitoid facies c (Permian-Pennsylvanian)**—White to buff, leucocratic (CI = 10 – 15), fine- to medium-crystalline, equigranular, unfoliated biotite granite. Constitutes the main body (southeastern portion) of the Gupton pluton.

CASTALIA PLUTON

PPcga **Granitoid facies a (Permian-Pennsylvanian)**—White or pink and white, leucocratic (CI around 10), medium- to coarse-crystalline, moderately K-feldspar porphyritic, unfoliated biotite granite and monzogranite. Buff weathering is common in granite outcrops. Constitutes the main body of the Castalia pluton.

PPcgb **Granitoid facies b (Permian-Pennsylvanian)**—White, gray and pale pink, leucocratic (CI = 5 – 10), medium- to coarse-crystalline, equigranular, unfoliated biotite +/- garnet +/- muscovite granite and leucogranite. Locally contains magnetite. Occurs along the margins of the Castalia pluton.

PPcgd **Granite to granodiorite (Permian-Pennsylvanian)**—White, leucocratic (CI = 12 – 18), fine- to coarse-crystalline, equigranular, locally foliated biotite granite and granodiorite.

PANACEA SPRINGS PLUTON

PPpc **Panacea Springs granite (Permian-Pennsylvanian)**—Medium-gray, leucocratic, coarse-crystalline, porphyritic, foliated biotite granite composed of plagioclase + microcline + quartz + biotite + opaque minerals, and minor white mica. Locally contains K-feldspar megacrysts as long as 3 cm. Locally mylonitic along eastern margin (Sacks, 1996). Sampled in the Littleton 7.5-minute quadrangle and analyzed by Vynhal and McSween (1990) as their "deformed Butterwood Creek" granite. Mylonitic sample of PPpc was analyzed by Boltin (1985) and plots as a monzogranite (sample HRB40).

PPpm **Panacea Springs monzogranite to quartz monzonite (Permian-Pennsylvanian)**—Medium-gray, megacrystic, weakly foliated biotite +/- hornblende monzogranite to quartz monzonite composed of K-feldspar megacrysts in a matrix of coarse-crystalline plagioclase + microcline + quartz + biotite + opaque minerals + white mica. K-feldspar megacrysts range up to 5 cm in length. A chemical analysis (Grundy, 1983, sample 27-1) yielded CIPW norms that plot in the quartz monzonite field.

OTHER PLUTONIC ROCKS

PPmm **Medoc Mountain granite (Permian-Pennsylvanian)**—Tan to pink-white to pink-gray, leucocratic (CI = 5 – 7), phaneritic medium-crystalline, xenomorphic equigranular biotite granite. Pavement outcrops are common east of Little Fishing Creek in Medoc Mountain State Park and east of Medoc Mountain Road where the Moss-Richardson molybdenite deposit was located (Carpenter, 1976). Only disturbed earth mounds now reflect this mine activity. Elongate and tabular stock that crosscuts the Hollister fault zone shear foliation in protomylonitic to mylonitic diorite gneiss of the Roanoke Rapids terrane. Numerous boulder fields and crosscutting tension fractures of bull quartz are located within the granite. Only locally is silicified granite(?) mylonitized and cataclastically fractured. However, some zones are several m in length and width and are always associated with the bull quartz tension fractures. Local epidote blebbing and variably developed "pinking" overprinting both K-feldspar and plagioclase by hydrothermal fluids are commonly encountered. Reminiscent of hydrothermal "pinking" events that affect other late Paleozoic and Alleghanian orogeny mylonite zones and Permian-Pennsylvanian granite plutons (Bartholemew et al., 2009; Dennis, 2010).

PPlm **Lawrenceville granite (Permian-Pennsylvanian)**—Medium gray, K-feldspar megacrystic, weakly foliated biotite quartz monzonite to monzogranite composed of microcline megacrysts as long as 5 cm (Sacks, 1996) in a matrix of coarse-crystalline plagioclase, microcline, quartz, biotite, opaque minerals, and minor white mica. A chemical analysis (Grundy, 1983; sample 84-1) yielded CIPW norms falling in the fields of quartz monzonite to monzogranite.

PPe **Enterprise granite (Permian-Pennsylvanian)**—Light- to medium gray, leucocratic (CI = 10 – 15), porphyritic to K-feldspar megacrystic biotite granitoid. Typically, gneissic and mylonitic. Salmon, pink, or beige K-feldspar porphyroclasts 0.5-

2.0 cm in length lie in a quartzofeldspathic matrix consisting of alternately biotite-rich and biotite-poor 1 to 3 mm-thick layers.

PPa **Airlie granite (Permian-Pennsylvanian)**—Light gray or beige, fine- to medium-crystalline, dominantly equigranular biotite, muscovite, muscovite-biotite, and muscovite-biotite-garnet monzogranite and leucomonzogranite. Generally massive, but locally weakly to moderately foliated. Mylonitic along western margin of the pluton (Sacks, 1999). Crosscuts and locally contains enclaves of megacrystic Butterwood Creek granite. Whole-rock chemical analyses show weakly to strongly peraluminous composition for Airlie granite samples. Samples collected from the abandoned Alston Quarry are leucogranitoid rocks. Garnet phenocrysts from these rocks are spessartine-almandine solutions (average mole % is 46.9 almandine, 48.3 spessartine, 2.7 pyrope, 2.1 grossular). White mica (muscovite?) inferred to be magmatic is phengitic, containing 4.5 - 5.5 weight % FeO; 0.47-0.71 weight % TiO_2, and 0.76-1.46 weight % MgO). Mineral analyses are unpublished but fall in the range described by Miller and Stoddard (1981) and Miller et al. (1981). According to Boltin (1985; Table 7), plagioclase from biotite monzogranite (HRB 95) is oligoclase An21-25, while plagioclase from leucomonzogranite (HRB 2) is albite to oligoclase (An9-14).

PPb **Butterwood Creek granite (Permian-Pennsylvanian)**—Medium gray to tan, K-feldspar megacrystic biotite +/- hornblende monzogranite or quartz monzonite with accessory titanite. Generally massive, locally with a weak magmatic alignment of K-feldspar megacrysts. Plagioclase analyzed by Boltin (1985; Table 7, HRB 74) yielded an andesine range (An31-38). At its western and northwestern margin, where it is intruded by the Airlie granite within the Hollister fault zone, the Butterwood Creek granite carries a strong high-strain fabric. There, K-feldspar megacrysts are strongly aligned, quartz ribbons are developed, and the composite S-C mylonitic foliation is defined by aligned feldspars, biotite and quartz ribbons and C’ shear bands that offset the main foliation in a dextral shear sense (Sacks, 1999). Sampled studied from the Aurelian Springs 7.5-minute quadrangle by Vynhal and McSween (1990) as their “undeformed Butterwood Creek granite.” A single whole-rock chemical analysis of Butterwood Creek granite yielded CIPW norms plotting in the quartz monzonite field. Grundy (1983) analyzed samples of Butterwood Creek granitoids from the Thelma 7.5-minute quadrangle.

PPgm **Granitoid rocks and metamorphosed and foliated granitoid rocks (Permian-Pennsylvanian)**—Light tan, gray-white to orange, or pinkish-white, leucocratic (CI less than 20), phaneritic medium- to coarse-crystalline, hypidiomorphic to xenomorphic granular granite, granodiorite, or quartz diorite. Commonly foliated (S>L) and locally lineated (L>S) to produce protomylonitic to mylonitic granitoid gneiss containing relict K-feldspar porphyroclasts, quartz ribbons, and a biotite mineral aggregate lineation. Individual samples may contain porphyroclastic magnetite crystals up to 3 mm in length. Locally, felsic minerals are altered to a dark gray color. Forms elongate, tabular bodies within and adjacent to the Hollister fault zone. Granitoids appear to be intrusive into the rocks of the Halifax County complex within the Roanoke Rapids terrane. May be related to granitoid rocks of the Rocky Mount pluton (Spruill et al., 1987; Moncla, 1990; Stoddard et al., 2012) or to other granitoid rocks mapped by Sacks (1999).

PPfgm **Mylonitic granitoid rocks (Permian-Pennsylvanian)**—High-strain equivalent of PPgm in the Hollister fault zone.

ROCKY MOUNT PLUTON

PPMrg **Granite and leucogranite (Permian-Pennsylvanian-Mississippian)**—Medium- to coarse-crystalline equigranular to weakly porphyritic pale pink to salmon, or light gray biotite granite. Massive and unfoliated to moderately foliated. Biotite weathers to vermiculite. Also fine to medium-crystalline light gray to tan equigranular biotite +/- muscovite +/- garnet leucogranite. Unit commonly includes small tabular to patchy white pegmatite granite bodies.

PPMrgd **Granodiorite (Permian-Pennsylvanian-Mississippian)**—Black and white, medium- to coarse-crystalline, typically porphyritic, unfoliated to moderately foliated biotite +/- hornblende granodiorite to tonalite.

PPMrd **Diorite, quartz diorite, and tonalite (Permian-Pennsylvanian-Mississippian)**—Fine- to medium-crystalline, equigranular amphibole +/- biotite diorite, quartz diorite, and tonalite. Correlates, in part, with "hornblende-biotite tonalite of uncertain relations" of Moncla (1990).

COUNTRY LINE CREEK COMPLEX IN THE HYCO SHEAR ZONE

MZclg **Unseparated biotite granite orthogneiss (Mississippian-Neoproterozoic)**—Medium gray, weakly to strongly foliated, mainly medium-crystalline biotite gneiss. Commonly weathers to a buff color.

MZclm **Neoproterozoic mafic gneiss and amphibolite interlayered with Mississippian pegmatite granite and orthogneiss (Mississippian-Neoproterozoic)**—Greenschist to amphibolite facies mafic gneiss with interlayered granitoids and pegmatite granite. Subordinate biotite gneiss and minor metamorphosed pyroxenite, semi-pelitic schist, and felsic schist (Shell, 1996). Mafic gneiss ranges from amphibolite to biotite -amphibole gneiss. Commonly, layered on a cm to m scale, although in some places they are massive, with a medium- to coarse-crystalline, gabbro-like texture. Mafic gneiss is extensively interlayered with pegmatite granite, locally envelope brownish-gray, fine-crystalline metamorphosed granitoids, and crosscut by pegmatite granite. North of the Yanceyville orthogneiss in the Yanceyville and Leasburg 7.5-minute quadrangles, the complex is characterized by a very regularly layered, cm-scale, fine- to medium-crystalline gray biotite + blackish green amphibole gneiss with interlayered granitic orthogneiss (Shell, 1996). Locally, over the span of a few m, the regularly layered gneiss grades into migmatite (sensu lato) with a network of foliated coarse granitoid containing m-scale pods of amphibolite with layering and foliation oblique to that in the granitoid. Biotite gneiss is a minor component of the Country Line complex. Typically, it is a fine- to medium-crystalline and equigranular, gray quartz + feldspar + biotite + garnet gneiss. Generally, forms massive and homogeneous lens-shaped bodies too small to be resolved at 1:24,000. A U-Pb analysis of zircon from a layered mafic gneiss sub-unit in the South Boston 30' x 60' geologic map area yielded a discordant upper intercept age of 613.9 +/-9.3 Ma that is interpreted to reflect a protolith age for the mafic gneiss. Zircon and sphene from the same sample yielded a concordant age of ca. 323 Ma (Wortman et al., 1998). Concordantly interlayered pegmatite granite increases in volume towards the Mississippian Yanceyville orthogneiss, suggesting that the concordant pegmatite granite also has a Mississippian age. The unit is a mixture of Neoproterozoic and Mississippian rocks.

CAROLINA TERRANE

ALBEMARLE ARC

ALBEMARLE ARC PLUTONS

CZagb **Goshen gabbro (Cambrian-Neoproterozoic)**—Mesocratic to melanocratic, medium- to coarse-crystalline hornblende diorite to gabbro. Plagioclase is variably saussuritized in diorite causing a greenish color. Local talc-like fracture coatings present in the gabbro. Likely metamorphosed. Glover and Sinha (1973) interpreted body as a post-metamorphic pluton. Has textural similarities with the Stony Mountain gabbro of the Albemarle arc (DeDecker et al., 2013).

CZarp **Roxboro Pluton (Cambrian-Neoproterozoic)**—Pinkish, leucocratic (CI<10), medium- to coarse-crystalline, unfoliated to locally very weakly foliated, hypidiomorphic granular, metamorphosed granite. Mafic minerals are most commonly chlorite topotaxially intergrown with biotite and/or actinolite topotaxially intergrown with hornblende. Pluton map pattern truncates Aaron Formation units and Hyco Formation volcanic rocks. Wortman et al. (2000) reported a TIMS U-Pb zircon age of 546.5+3.0/-2.4 Ma for the Roxboro pluton.

UWHARRIE FORMATION

Zafp **Felsic porphyry (Neoproterozoic)**—Light-gray to white, massive rhyolite with euhedral to subhedral phenocrysts largely of sodic plagioclase but commonly also quartz. Massive to schistose with metamorphic sericite + chlorite + biotite + epidote. Described as a felsite porphyry by Hadley (1974). QAP analysis from Hadley (1973) plots samples above the rhyolite field likely indicating metamorphic alteration.

VIRGILINA SEQUENCE

Zpyba **Porphyritic meta-andesite (Neoproterozoic)**—Fine-crystalline dikes with 2-6 mm plagioclase phenocrysts, commonly saussuritized by epidote in a dark green groundmass of quartz + chlorite + epidote + hornblende. Chlorite also topotaxially replaces hornblende. Occur as thin, less than 10 m-wide dikes. Refer to GeMS database for location.

VIRGILINA SEQUENCE PLUTON

Zgrm **Metagranite (Neoproterozoic)**—Gray to medium pink or pink-orange, medium- to coarse-crystalline, metamorphosed biotite granite and quartz monzonite. Contains accessory hornblende. Mainly equigranular but locally porphyritic. Pink K-feldspar phenocrysts are distinctive. Rose quartz common. Generally, unfoliated except for a locally developed spaced cleavage with sericite films in the vicinity of the Fishing Creek fault zone.

AARON FORMATION

Samson et al. (2001) reported a youngest (SHRIMP-II) detrital zircon 238U/206Pb date of ca. 578 Ma collected from the southern portion of the South Boston 100K. Pollock et al. (2010) reported a youngest LA-ICP-MS U-Pb zircon age of 588 +- 11 Ma for the unit in the Chapel Hill 100K.

*NOTE: Preliminary LA-ICP-MS U-Pb zircon analyses in 2024 from a meta-sandstone on the eastern limb of the Virgilina synclinorium within the Aaron Formation indicates all Maximum Depositional Ages (MDA) are between ca. 540 Ma and ca. 545 Ma (T. LaMaskin, personal communication, 2025). As such the Aaron Formation stratigraphic placement is in question.

Za **Aaron Formation (Neoproterozoic)**—Light-gray, blocky to thin-bedded, slaty to phyllitic, metamorphosed mudstone, siltstone, sandstone and conglomerate. Mudstone and siltstone are the dominant rock types. Distinctive, light-gray to white, fine- to medium-crystalline quartz sandstone with local occurrence of conglomerate identical to Zac unit. Lesser amounts metamorphosed felsic to mafic volcanic rocks interlayered in the unit.

Zac **Metaconglomerate and metasandstone of the Aaron Formation (Neoproterozoic)**—Metamorphosed clast-supported conglomerate, and conglomerate having phyllitic matrix; interbedded with slate or phyllite and metamorphosed pebbly to granular quartz sandstone. The metamorphosed clast-supported conglomerate is poorly sorted and predominantly consists of white subrounded quartz pebbles and smaller light and dark pebbles of volcaniclastic rock in pale green sandy to phyllitic matrix.

Zap **Phyllitic metasiltstone of the Aaron Formation (Neoproterozoic)**—Light-brownish-gray to medium-gray to very-light-gray, fine-crystalline phyllite. Composed mainly of quartz + sericitic white mica, and commonly plagioclase. Chlorite is a common accessory mineral. Locally contains minor greenstone and metamorphosed interlayers of phyllitic sandstone, phyllitic felsic tuff, and chloritic tuff. Local occurrence of quartz sandstone identical in appearance to sandstone in Za and Zac units.

Zap-hs **High-strain zone of phyllitic metasiltstone of the Aaron Formation (Neoproterozoic)**—High-strain zone of phyllonite in the metamorphosed phyllitic siltstone of the Aaron Formation.

Zav **Virgilina member of the Aaron Formation (Neoproterozoic)**—Mainly metamorphosed felsic to mafic volcaniclastic rocks with local andesitic to greenstone basaltic lava. Volcaniclastic rocks include tuffaceous, non-tuffaceous, and phyllitic siltstone to conglomerate and local fine-crystalline felsic tuff. Local occurrence of quartz sandstone identical in appearance to sandstone in Za and Zac units.

HYCO ARC

HYCO FORMATION - UPPER PORTION

HYDROTHERMALLY ALTERED UNITS

Zq **Quartz bodies (Neoproterozoic)**—White, beige, red, and tan, sugary to porcelaneous, very fine- to medium-crystalline, massive quartz rock to quartzite-like rock. Outcrops are usually massive. Quartzite-like rock is occasionally mixed with sericite and/or pyrophyllite. Addition of sericite and/or pyrophyllite gives the otherwise massive quartzite-like rock a foliation. Pyrite forms cubic crystals and empty cubic molds of crystals that are up to 12 mm cube faces. Boulders up to several m in diameter and outcrops of white-colored massive quartz are common.

Zhat **Altered tuffs of the lower portion of the Hyco Formation (Neoproterozoic)**—Very light gray to light greenish gray (whitish in areas) with red and yellow mottling. Alteration consists of silicified, sericitized and pyrophyllitized rock. Sericite phyllite, pods of pyrophyllite, and quartz + pyrophyllite rock all with less than 1 mm- to 2 mm-diameter weathered sulfides are common. Fine-crystalline chloritoid porphyroblasts less than 1 mm in diameter occur in some pyrophyllite bearing rocks. Relict lithic clasts and kaolinitized feldspar crystal shards are visible in some exposures. Relict structures are obliterated in heavily altered rocks. Boulders up to several m in diameter and outcrops of massive milky quartz and quartz + sericite rock are common.

Zhat/vcs **Altered tuffs and volcaniclastic sedimentary rocks (Neoproterozoic)**—Mixed unit of altered volcaniclastic rocks and volcaniclastic sedimentary rocks. Metamorphic recrystallization consists of silicified, sericitized and pyrophyllitized rock. Chloritoid locally present. Volcaniclastic sedimentary rocks include conglomeratic siltstone to conglomerate that may be variably metamorphosed. Includes area of quartz-sericite-paragonite rock (Zvqs of Schmidt et al., 2006). Metamorphosed andesitic to basaltic lavas, and massive quartz locally present.

Zhhar **Hydrothermally altered rocks (Neoproterozoic)**—Mixed unit of hydrothermally altered rocks consisting of dense siliceous cryptocrystalline rock; quartz-pyrophyllite rocks +/- kaolinite + andalusite + chloritoid + sericite + paragonite + iron oxides; quartz-sericite rocks +/- paragonite + K-feldspar + iron oxides; and quartz-chloritoid-chlorite rocks +/- sericite + hematite. Described in detail by Hughes (1987) and Schmidt et al. (2006).

Zhdlt-a **Altered dacitic lavas and tuffs (Neoproterozoic)**—Tan to buff to white, locally red-brown to yellow, leucocratic (CI less than 5), altered and metamorphosed dacitic lavas and tuffs. Intense hydrothermal alteration and elemental leaching. Produced domains of sericite-quartz phyllite, sericite-quartz rock, quartz-pyrophyllite (± andalusite?) rock, and massive pyrophyllite having radiating crystal habit, especially on the top and north and south flanks of Bowlings Mountain (Tallyho) where pyrophyllite was mined. Punky rocks having hematite and limonite coatings and stains, and limonite replacement of sulfide minerals, likely pyrite, are also common. Relict lithic clasts and kaolinized feldspar crystal shards are visible in some exposures distal to Bowlings Mountain. All relict structures are obliterated in highly altered rocks, especially in domains where primarily fine-crystalline drusy to sugary quartz + more minor feldspar and white mica form due to intense silicification. Some silicified domains are mixed with sericite-rich phyllite, giving local outcrops a highly foliated structure (Zhfdlt-a). Unit equivalent to unit h in McConnell and Glover (1982).

Zhfdlt-a **Foliated altered dacitic lavas and tuffs (Neoproterozoic)**—Foliated equivalent of Zhdlt-a in local zones of partitioned strain.

VOLCANICLASTIC–SEDIMENTARY UNITS

Zhe/p **Mixed epiclastic-pyroclastic rocks (Neoproterozoic)**—Grayish-green to greenish-gray, metamorphosed tuffaceous sandstone, conglomeratic sandstone, and siltstone, and minor phyllite. Siltstone typically is weakly phyllitic. Contains lesser amounts of fine- to coarse, metamorphosed tuff and lapilli tuff. Tuffs are differentiated from other volcaniclastic rocks by the presence of zones of cryptocrystalline texture that exhibit conchoidal-like fractures in between foliation domains. Minor metamorphosed andesitic to basaltic lavas and tuffs present. Silicified and/or sericitized altered rock similar to the Zhat unit are locally present. Unit is interpreted to grade into the Zhe/pl unit. Contact with Zhe/pl designated at first occurrence of metamorphosed dacitic lavas.

Zhe/pl **Mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas (Neoproterozoic)**—Grayish-green to greenish-gray, locally with distinctive reddish-gray or maroon to lavender coloration. Contains metamorphosed conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Weakly metamorphosed lithologies are locally bedded and tuffaceous with a cryptocrystalline-like groundmass. Siltstone is locally phyllitic. Locally contains interbedded metamorphosed dacitic lavas identical to Zhdlt unit. Contains lesser amounts of metamorphosed fine- to coarse tuff and lapilli tuff with a cryptocrystalline-like relict groundmass.

Minor metamorphosed andesitic to basaltic lavas and tuffs present. Silicified and/or sericitized altered rock similar to Zhat unit are locally present. Metamorphosed conglomerate and conglomeratic sandstone typically contain subrounded to angular clasts of dacite in a clastic matrix. Zhe/pl distinguished from Zhe/p by presence of metamorphosed dacite and is interpreted to represent a facies change to an area more proximal to the active volcanic centers compared to Zhe/p. Cloud et al. (1976) fossil locality from unit in Durham County.

Zhfe/p **Foliated mixed volcanogenic sedimentary and pyroclastic rocks (Neoproterozoic)**—Grayish-green to greenish-gray, highly foliated and metamorphosed siltstone/mudstone, sandstone, and tuffaceous sandstone. Contains lesser amounts of metamorphosed fine- to coarse ash tuff and lapilli crystal lithic tuff. Metamorphosed siltstone is medium to thickly laminated (3mm-7mm) and alternates in color between greenish and greenish gray. Locally contains domains of massive magnetite rock and thinly laminated, layered magnetite-enriched metamorphosed siltstone. Metamorphosed sandstone is generally massive, with subangular to subrounded, moderately to well sorted quartz grains and lithic fragments. Metamorphosed tuffaceous sandstone is typically massive with moderately to poorly sorted, angular to subangular grains of plagioclase and quartz crystals. Metamorphosed pyroclastic tuff is generally massive and contains relict xenomorphic to subidiomorphic plagioclase and quartz phenocrysts in a relict fine, recrystallized ash groundmass. Minor metamorphosed basaltic to andesitic lavas/shallow intrusions occur locally in the southern portion of the mapped unit. The western and middle portion of the mapped unit is predominantly metasedimentary rocks. Metavolcanic rocks occur in the eastern portion of the unit in contact with metaplutonic rocks. Rocks are comparable to the Ze/p unit in the Rougemont 7.5-minute quadrangle (Bradley et al., 2011).

Zhmst **Matrix supported tuffs (Neoproterozoic)**—Green-gray to green, weakly foliated to well-foliated and metamorphosed, matrix-supported, polymictic lapilli tuffs and tuff breccias. Angular to sub-rounded, lithic fragments range from less than 1 mm up to 0.5 m in diameter. Protolith interpreted as a resedimented syn-eruptive volcaniclastic deposit in which texturally unmodified volcaniclastic debris and entrained, texturally more mature accidental clasts were incorporated into a rapidly resedimented package of sediment. Interpreted to be emplaced via submarine mass flows, subaerial landslides, and/or lahars.

FELSIC TO INTERMEDIATE VOLCANIC UNITS

Zhc **Felsic crystal metatuff (Neoproterozoic)**—Light gray to yellowish gray, fine- to medium-crystalline, weakly to moderately foliated and metamorphosed felsic crystal tuff. Matrix of very fine-crystalline quartz + feldspar + sericitic white mica contains quartz + plagioclase phenocrysts 2-5 mm in length. Weathers grayish orange to moderate brown. Contains minor intercalated beds of fissile to massive, metamorphosed fine-crystalline felsic tuff and volcanic sandstone. Occurs at several stratigraphic horizons.

Zhf **Fissile felsic metatuff (Neoproterozoic)**—Very light gray to white to yellowish gray, metamorphosed fine-crystalline fissile to phyllitic tuff. Composed of fine-crystalline feldspar + quartz + minor sericitic white mica. Common accessory minerals include biotite + magnetite as tiny octahedra + secondary epidote + chlorite. Laminated to thick bedded. Locally has flattened lithic clasts and sparse phenocrysts of quartz or plagioclase. Contains minor interlayers of metamorphosed crystal tuff, feldspathic sandstone, feldspar porphyry, quartz dacite porphyry, mafic tuff, and amygdaloidal basalt. Occurs at different stratigraphic levels. Same unit as pCh of Kreisa (1980), Zfm of Peper et al. (1996), and Zf of Peper and Wygant (1997) and Burton (1995). Lens south of Buffalo granite in south-central Virginia was mapped as “Goshen schist” by Laney (1917)

Zhq **Quartz metaporphyry (Neoproterozoic)**—Light-gray to white, medium-crystalline, massive to weakly foliated and metamorphosed, partly schistose and fissile, muscovite-quartz-feldspar porphyry containing relict subidiomorphic phenocrysts of gray quartz 4 mm in diameter. A small pod of hypabyssal rock 3 km south of Finchley, in the southeastern part of Clarksville North 7.5-minute quadrangle, south-central Virgina, has apophyses, dikes, and sills extending into metamorphosed bedded lithic-crystal tuff. Larger lenses south of Buffalo granite are extrusive rock. Lenses 2.3 km southeast of Buffalo Junction, Virginia, and along U.S. Highway 15 are light-gray to white, medium-crystalline, metamorphosed massive to weakly layered, partly schistose and fissile, quartz-feldspar muscovite porphyry containing rounded relict subidiomorphic phenocrysts of qray quartz 4 mm across. A lens 1 km southwest of Soudan, Virginia, is light-gray, metamorphosed medium-bedded quartz porphyry interleaved with pebbly felsic tuff and thin-bedded felsic crystal tuff. Same as unit Zqm of Peper et al. (1996) and Zq of Peper and Wygant (1997).

Zhl **Coarse-crystalline felsic metatuff (Neoproterozoic)**—Heterogeneous unit composed chiefly (about 50%) of metamorphosed very coarse- to coarse-crystalline felsic volcaniclastic crystal and crystal-lithic tuff, but with appreciable metamorphosed fine-crystalline felsic tuff (~25%), and less extrusive and hypabyssal rhyodacite (~l5%). Metamorphosed mafic extrusive rock, dikes, and volcaniclastic rocks are less abundant (~10%), but mafic clasts are present in most exposures of felsic volcaniclastic rock. Metamorphosed crystal-lithic tuff is very coarse crystalline. It contains subangular to rounded clasts of metamorphosed fine-crystalline felsite porphyry, crystal-lithic tuff, fine-crystalline quartz (metachert?), rhyodacite, and mafic mudstone. Broken, subhedral to rounded crystals of quartz and plagioclase are common. Metamorphosed mudstone interbeds have angular to subrounded basalt blocks 1 m in diameter. Intercalated metamorphosed fine-crystalline and schistose quartz dacite and quartz dacite porphyry weather yellow-tan to deep red and reddish orange. These intercalated rocks contain quartz + plagioclase, and a few percent sericite + quartz (gray subidiomorphic and porphyroclastic crystals defining relict phenocrysts with tails about 4-mm long + tiny magnetite octahedral 1-2 mm in diameter. Maximum clast size in outcrop decreases generally northeastward along the strike of the unit from boulder- to cobble-sized clasts south of the latitude of Finchley to pebble-sized clasts north of the latitude of Finchley. Mafic metatuff, that typically compose ~10% of exposures southwest of Finchley, Virgina, decrease in abundance in the unit to compose less than 3% of exposures northeast of Finchley. Eruptive sequences, 100-150-m thick, of metamorphosed rhyodacite flows overlain by metamorphosed coarse-crystalline crystal-lithic tuff grade upward into airfall tuff. Relations are visible in Kerr Reservoir shore exposures in Longwood Park on Grassy Creek, Virginia. Aggregate thickness of metamorphosed rhyodacite flows as much as 120 m in cliffs along Kerr Reservoir southeast of Clarksville. Metamorphosed mafic flows, dikes, and tuffs are most abundant in unit south and east of Spewmarrow Creek where they make up 25% of the exposures. Includes unit Zft of Peper et al. (1996) and Zl of Peper and Wygant (1997)

Zhdlt (u) **Dacitic lavas and tuffs (Neoproterozoic)**—Dark gray to gray-black, leucocratic (CI less than 5), siliceous, metamorphosed microcrystalline lava and porphyritic lava containing white plagioclase + gray quartz phenocrysts up to 4 mm in diameter. Weathers to a tan-white color. Locally interlayered with dark gray to black, metamorphosed non-welded lithic lapilli tuff. Clast types include gray-black microcrystalline lava and plagioclase porphyritic lava. Weathers to a tan-white color. Distinction between lavas and massive tuffs is difficult to discern at the mesoscale in many locations. Aggregates of white mica + quartz + plagioclase highlight steeply east-dipping foliation and steeply dip-parallel mineral stretching lineation domains inferred to be highly fractured and/or phyllonitic high-strain zones (CZfdlt). Protoliths to the metamorphosed lavas are interpreted to be extrusive or hypabyssal intrusions associated with dacite domes. Metamorphosed tuff interlayers are either pyroclastic dacitic ash flow or air fall deposits generated during dome eruption.

Zhfdlt (u) **Foliated dacitic lavas and tuffs (Neoproterozoic)**—Foliated equivalent of Zhdlt unit in local zones of partitioned strain.

Zhdsi (u) **Dacitic shallow intrusive of the upper portion of the Hyco Formation (Neoproterozoic)**—Gray-green, light green to green, greenish-gray to light gray, metamorphosed dacite and plagioclase porphyritic dacite with a granular-textured groundmass to micro-granodiorite. A fine phaneritic texture visible with 7x hand lens. Locally, fine- to medium-crystalline 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 metamorphosed fine-crystalline tuffs. Metamorphic rock from Rougemont quarry includes greenish-gray to light gray, aphanitic to weakly plagioclase porphyritic dacite to micro-granodiorite. Relict plagioclase phenocrysts are saussuritized in a matrix of recrystallized feldspar + quartz with dark-colored clots (less than 1 mm to 4 mm) interpreted at the macroscale to be chlorite(?) masses and/or relict enclaves of dark gray metamorphosed dacite. Contains lesser amounts of dark gray, metamorphosed aphanitic dacite interpreted as shallowly emplaced intrusion probably co-magmatic with Zhdlt (u) unit. Silicification, sulfide mineralization, and aggregates of white mica + quartz highlight steeply dipping foliation and steeply plunging mineral stretching lineation domains inferred to be highly fractured and/or phyllonitic and protomylonitic high-strain zones (Zhfdsi).

Zhfdsi **Foliated dacitic shallow intrusions (Neoproterozoic)**—Inferred highly fractured and/or phyllonitic and protomylonitic high-strain zones of the Zhdsi unit.

Zfcd **Fragmental/clastic dacite (Neoproterozoic)**—Dark gray-green to black-green, melanocratic (CI greater than 65), fine- to medium-crystalline, metamorphosed dacite of uncertain origin. Forms two prominent enclaves exposed as resistant, creekside, and hillside exposures in metamorphosed diorite. Contains subangular to subrounded, variably mm- to cm-sized fragments or clasts of felsic metaplutonic and mafic to intermediate metavolcanic and metaplutonic protoliths. Protoliths to metavolcanic rocks are interpreted to be possibly volcanic vent, lahar, or epiclastic/volcaniclastic derived.

Zpmd **Porphyritic metadacite (Neoproterozoic)**—White to tan aphanitic to porphyritic metamorphosed dacite. Outcrops as variably fractured boulders on hillsides and hilltops across two distinctive, resistant topographic highs in the northwestern corner of the Oxford 7.5-minute quadrangle. Relict gray quartz phenocrysts up to 7-9 mm in diameter are set in a fine-crystalline felsic matrix. Locally, near the very top of the topographic highs, this unit contains enclaves of Zhdlt (u).

INTERMEDIATE TO MAFIC VOLCANIC UNITS

Zhable **Andesitic to basaltic lavas with interlayered epiclastic rocks (Neoproterozoic)**—Light green, gray-green, gray, and dark gray, metamorphosed, unfoliated typically, 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. 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 (Neoproterozoic)**—Green, gray-green, gray, dark gray and black, unfoliated typically, 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 at some outcrops. Locally interlayered with metasedimentary rocks identical to the Zhe/pl and Zhe/p unit.

Zhadlt **Andesitic to dacitic lavas and tuffs (Neoproterozoic)**—Distinctive black to dark gray, metamorphosed porphyritic lava with plagioclase phenocrysts up to 4 mm in length, and flow-banded lava with local amygdules. Lavas interlayer with gray to black, metamorphosed welded and non-welded, coarse tuff, lapilli tuff, and tuff breccias.

Zhg **Greenstone (Neoproterozoic)**—Dark green, fine-crystalline, massive to weakly foliated, locally amygdaloidal, albite + epidote + chlorite greenstone (metabasalt), and dark-green, well-foliated albite-epidote-chlorite phyllite interpreted as metamorphosed basaltic tuff within the Hyco Fm. Same as unit Zm of Burton (1993, 1995).

Zhpm **Fine-crystalline porphyritic metabasalt (Neoproterozoic)**—Dark gray, very fine-crystalline, massive, metamorphosed porphyritic basalt containing abundant concentrically zoned phenocrysts of calcic plagioclase. Crystals have epidote-sericite altered cores that are 4 mm across in a fine-crystalline, altered chlorite + epidote + sericite matrix. Hypabyssal intrusive rock forms apophyses into metamorphosed felsic tuff. Mapped as unit Zpm in the Clarksville South 7.5-minute quadrangle (Peper et al., 1996)

HYCO ARC PLUTONS

Zdito **Metadiorite-metatonalite (Neoproterozoic)**—Dark gray to green-black, mesocratic to melanocratic (CI = 50 – 65), phaneritic, metamorphosed diorite, quartz diorite, and hornblende-biotite tonalite. Outcrops as medium to large boulder fields on hillsides and farm fields, but also in creek bottoms. Minor to accessory amounts of quartz are present in the metamorphosed diorite, while in the metamorphosed tonalite, quartz is typically gray and ranges up to 4 mm in length. Accessory magnetite associated with chloritized hornblende is common, and accessory K-feldspar is locally present. Epidote group minerals commonly replace plagioclase and impart a pale green color to hand samples. Chlorite topotaxially replaces hornblende. Rare relict clinopyroxene occurs within hornblende. Generally, unfoliated to weakly foliated. However, well developed foliation defined by chlorite are common in localized shear zones and contacts with other rock units. Typically, plutonic rocks include enclaves of grayish-green to green-black metamorphosed andesite and basalt (Zab). Outcrop-scale crosscutting relations indicate felsic lithodemes Zbgp, Zvgr, and Zgrm are younger than the metamorphosed diorite and tonalite.

Ztrg **Trondhjemite and granodiorite (Neoproterozoic)**—Light pink-tan to tan-gray-white, leucocratic (CI less than 5), fine- to medium-crystalline metamorphosed trondhjemite and granodiorite containing conspicuous white plagioclase + blue-gray quartz, and locally K-feldspar in a phaneritic, hypidiomorphic granular texture. May occur as domains of small chips and cobbles in a soil having an orange-brown coloration, especially along the crystalline-sedimentary rock contact between the Carolina terrane and the Deep River Triassic basin. Some chips carry white mica while others are highly epidotized and in part silicified suggesting a local ductile-brittle deformation overprint. In other areas, forms cm-scale dikes that crosscut coarser-crystalline metamorphosed tonalite and granodiorite.

Zbgp **Coarse-crystalline biotite metagranite porphyry (Neoproterozoic)**—Tan to brown mesocratic to leucocratic, medium- to coarse-crystalline metamorphosed biotite granite porphyry. Bluish to gray quartz phenocrysts ranging from 1-3 mm in size are set in a matrix of plagioclase and pink K-feldspar. Biotite forms small mafic clots.

Zgd **Metagranodiorite (Neoproterozoic)**—Grayish-white, coarse-crystalline, unfoliated and locally fractured, leucocratic (CI less than 15), metamorphosed blue-gray quartz biotite+/- hornblende(?) granodiorite.

Zgms **Granodiorite tonalite of the Stem and Moriah plutons (Neoproterozoic)**—Light tan-gray white, bluish-gray white, or pinkish-white, leucocratic (CI = 5 – 15), phaneritic medium- to coarse-crystalline, metamorphosed hypidiomorphic to xenomorphic granular granodiorite and tonalite. This unit combines the previously mapped Zstg unit in the Stem (Blake et al., 2009) and eastern Lake Michie 7.5-minute quadrangles and Moriah pluton of McConnell (1974) in the western portion of the Lake Michie 7.5-minute quadrangle. Major minerals include plagioclase + K-feldspar + quartz with lesser amounts of biotite and hornblende. Plagioclase is highly sericitized, especially in An-richer phenocryst cores. K-feldspar typically displays granophyric texture at the microscale. If present, biotite is commonly topotaxially recrystallized to chlorite while hornblende may be topotaxially recrystallized to chlorite, epidote, and actinolite-opaque mineral. Metamorphosed trondhjemite and monzonite pods may represent dikes or differentiated portions of the pluton. Western facies surrounding Lake Michie locally becomes granitic. Outcrops locally contain enclaves of metamorphosed microdiorite of the Zdim and Zdib units. Locally, mm- to cm-scale, metamorphosed granite dikes crosscut granodiorite. Wortman et al. (2000) reported TIMS U-Pb zircon dates of 613.4 +2.8/-2 Ma from metamorphosed granite and 613.9 +1.6/-1.5 Ma from metamorphosed diorite sampled from the Moriah pluton in the western portion of the Lake Michie 7.5-minute quadrangle.

Zfgms **High-strain zones granodiorite tonalite of the Stem and Moriah plutons (Neoproterozoic)**—High-strain equivalent of Zgms. Aggregates of white mica + quartz + plagioclase + K-feldspar highlight steeply dipping foliation and dip-parallel mineral stretching lineation domains inferred to be highly fractured and/or phyllonitic and protomylonitic high-strain zones.

Zagms **Altered granodiorite and granite of the Stem and Moriah pluton (Neoproterozoic)**—Light pinkish gray to gray, leucocratic (CI = 10 – 30), fine-to medium-phaneritic, metamorphosed equigranular to porphyritic granodiorite and granite that is highly recrystallized and hydrothermally and chemically altered. Major minerals forming a relict xenomorphic granular phaneritic texture likely include plagioclase + K-feldspar + quartz that are now combinations of fine- to medium-crystalline, foliated and non-foliated domains of white mica and recrystallized feldspar and quartz. Outcrops, and more commonly float cobbles and boulders display apparent silicification, while other samples display chemical weathering that develops predominantly clay mineralization mixed with silica. Some rocks additionally display Fe-oxide-hydroxide staining. Unit interpreted to be a hydrothermally recrystallized and altered portion of Zgms.

Zfagms **Foliated granodiorite and granite of the Moriah pluton (Neoproterozoic)**—Domains of highly foliated rocks of the Zagms unit are separated as Zfagms. Light pinkish gray to gray, leucocratic (CI = 10 – 30), fine- to medium-phaneritic, metamorphosed equigranular to porphyritic granodiorite and granite that is highly recrystallized and hydrothermally and chemically altered. Major minerals forming a relict xenomorphic granular phaneritic texture likely include plagioclase + K-feldspar + quartz that are now combinations of fine- to medium-crystalline, foliated and non-foliated domains of white mica and recrystallized feldspar and quartz. Outcrops, and more commonly float cobbles and boulders display apparent silicification, while other samples display chemical weathering that develops predominantly clay mineralization mixed with silica. Some rocks additionally display Fe-oxide-hydroxide staining. Unit interpreted to be a hydrothermally recrystallized and altered portion of Zgms.

Zbto **Hornblende-bearing biotite tonalite (Neoproterozoic)**—Intermediate light green to gray-green, to dark gray-green-black, leucocratic to mesocratic (CI = 15 – 30), medium-crystalline, metamorphosed hypidiomorphic granular biotite and hornblende tonalite and minor granodiorite. Crosscut by mm- to cm-scale metamorphosed trondhjemite, monzonite, and granodiorite dikes. Commonly forms hillside boulder outcrops and stream waterfalls, as well as massive bluff outcrops along the Tar River. Saussuritized and sericitized plagioclase and blue-gray quartz phenocrysts form leucocratic domains that contrast with mesocratic chloritized domains of hornblende + biotite. Locally, a weak "swirly" compositional layering appears in weathered outcrops that have a dark coloration. Some mm-scale black "clots" that range up to 1 cm may be relict hornblende or recrystallized greenstone clasts. Cm- to m-scale enclaves of greenstone, either very fine-crystalline metamorphosed diorite or andesite are conspicuous throughout the pluton. May be the western equivalent of the metamorphosed Gibbs Creek tonalite on the east side of the Deep River Triassic basin.

Ztg **Unfoliated biotite metatonalite and minor metagranodiorite (Neoproterozoic)**—Variably green-gray to gray-white, medium- to coarse-crystalline, metamorphosed biotite tonalite, and granodiorite. Quartz is a bluish to locally light gray, with plagioclase commonly showing saussuritization to epidote group minerals.

Zgd-gr-p **Granodiorite to granite of Piney Mountain Creek area (Neoproterozoic)**—Metamorphosed composite pluton of dominantly medium-crystalline hornblende granodiorite with lesser amounts of medium-crystalline hornblende granite. Contains typically dark green to black, less than 1 mm to 4 mm clots of actinolitic(?) amphibole and chlorite masses. Locally contains pinkish-hued feldspars.

Zgd-porph **Porphyritic granodiorite (Neoproterozoic)**—Greenish-gray with a pinkish-hue; metamorphosed hornblende-bearing, plagioclase porphyritic granodiorite. Plagioclase phenocrysts are green from saussuritization and range from 2 to 8 mm in a matrix of very fine-crystalline quartz and K-feldspar. Weathered surfaces exhibit a distinct and strongly developed porphyritic texture. Porphyritic rhyolite of the Buckwater Creek pluton of Newton (1983).

Zmdi **Microdiorite (Neoproterozoic)**—Variably light green, gray-green, and dark black-green, melanocratic to mesocratic (CI greater than 50), fine- to medium-crystalline, metamorphosed microdiorite. Crops out as enclaves in all metamorphosed plutonic units. Chlorite + epidote + albite + white mica + minor biotite form a crystalloblastic matrix that locally contains relict plagioclase phenocrysts in porphyritic diorite and porphyroblastic actinolite as a pseudomorph of hornblende and/or pyroxene. Where foliated, forms chlorite white mica phyllonite or schist. Highly fractured outcrops have triclinic fracture symmetry, forming subvertical cataclasite clasts. Some outcrops are highly silicified and epidotized.

Zdib **Diorite of the Butner pluton (Neoproterozoic)**—Greenish-gray to grayish-green to green, mesocratic to melanocratic (CI = 40 – 70), fine- to medium-phaneritic, metamorphosed diorite, microdiorite, and quartz diorite. Textures range from equigranular to porphyritic with hypidiomorphic to xenomorphic granular plagioclase + hornblende phenocrysts ranging up 1-3 mm in tabular length. Major minerals include plagioclase and hornblende. Plagioclase crystals are highly saussuritized and in lesser amounts sericitized. Some crystals display evidence of Ca-rich cores with Na-rich rims. Hornblende may be recrystallized to chlorite, epidote, and actinolite-opaque mineral. Locally contains 5-10% quartz classifying it as a quartz diorite. The western facies of the unit is typically finer crystalline, having crystal size increasing towards the east. Foliated metamorphosed dacite enclaves are common within the intrusive unit. Silicification, sulfide mineralization typically, pyrite, and aggregates of white mica and quartz highlight steeply dipping foliation and plunging mineral stretching lineation domains inferred to be highly fractured and/or phyllonitic and protomylonitic high-strain zones (Zfdib). Locally, highly leached and stained outcrops of pyrite-Fe-oxide-hydroxide mark these deformation zones. Texturally and mineralogically equivalent to Zdim.

Zfdib **Foliated diorite of the Butner pluton (Neoproterozoic)**—Unit interpreted to be the highly fractured and/or phyllonitic and protomylonitic high-strain equivalent of greenish-gray to grayish-green to green, mesocratic to melanocratic (CI = 40 – 70), phaneritic fine- to medium-crystalline, metamorphosed diorite, microdiorite, and quartz diorite. Textures range from equigranular to porphyritic with hypidiomorphic to xenomorphic granular plagioclase and hornblende phenocrysts ranging up 1-3 mm in tabular length. Major minerals include plagioclase + hornblende. Plagioclase crystals are highly saussuritized and in lesser amounts sericitized. Some crystals display evidence of Ca-rich cores with Na-rich rims. Hornblende may be recrystallized to chlorite, epidote, and actinolite-opaque mineral. Locally contains 5-10% quartz classifying it as a quartz diorite. The western facies of the unit is typically finer grained, having crystal size increasing towards the east. Foliated, metamorphosed dacite enclaves are common within the intrusive unit. Silicification, sulfide mineralization, pyrite typically, and aggregates of white mica and quartz highlight steeply dipping foliation and steeply plunging mineral stretching lineation domains. Locally, highly leached and stained outcrops of pyrite-Fe-oxide-hydroxide mark these deformation zones. Texturally and mineralogically equivalent to Zdim.

Zdim **Diorite of the Moriah pluton (Neoproterozoic)**—Greenish-gray to grayish-green to green, mesocratic to melanocratic (CI = 40 – 70), phaneritic fine- to medium-crystalline, metamorphosed diorite, microdiorite, and quartz diorite. Textures range from equigranular to slightly porphyritic with hypidiomorphic to xenomorphic granular plagioclase and hornblende phenocrysts ranging up to 1-3 mm in tabular and prismatic length, respectively. Major minerals include plagioclase + hornblende. Plagioclase crystals are highly saussuritized and in lesser amounts sericitized. Hornblende may be recrystallized to chlorite + epidote + actinolite-opaque mineral. Locally contains 5-10% quartz highlighting differentiated outcrops of metamorphosed quartz diorite. Foliated equivalent mapped as (Zfdim). Texturally and mineralogically equivalent to Zdib in Granville County portions of the Lake Michie 7.5-minute quadrangle.

Zfdim **Foliated diorite of the Moriah pluton (Neoproterozoic)**—Foliated unit of Greenish-gray to grayish-green to green, mesocratic to melanocratic (CI = 40 – 70), phaneritic fine- to medium-crystalline, metamorphosed diorite, microdiorite, and quartz diorite. Textures range from equigranular to slightly porphyritic with hypidiomorphic to xenomorphic granular plagioclase and hornblende phenocrysts ranging up to 1-3 mm in tabular and prismatic length, respectively. Major minerals include plagioclase and hornblende. Plagioclase crystals are highly saussuritized and in lesser amounts sericitized. Hornblende may be recrystallized to chlorite + epidote + actinolite-opaque mineral. Locally contains 5-10% quartz highlighting differentiated outcrops of metamorphosed quartz diorite. Texturally and mineralogically equivalent to Zdib in Granville County portions of the Lake Michie 7.5-minute quadrangle.

Zgh **Hornblende gabbro (Neoproterozoic)**—Includes large round plutons at Eastland Creek, Beaver Pond Creek, and Spewmarrow Creek, plus smaller bodies (four within foliated biotite granite) in the Boydton 7.5-minute quadrangle in south-central Virginia. Gabbro at Eastland Creek: Medium-gray to dark-gray, medium- to coarse-crystalline, metamorphosed hornblende-labradorite gabbro to local clinopyroxene-rich hornblende gabbro containing secondary epidote + sericite + chlorite. Locally crosscut by melanocratic medium--crystalline metamorphosed hornblende quartz-diorite and leucocratic hornblende quartz diorite dikes. Contains numerous greenstone inclusions. Gabbro at Beaver Pond Creek: Dark gray, very-coarse to coarse-crystalline, metamorphosed hornblende gabbro and hornblende-clinopyroxene gabbro that contains deuteric epidote + sericite + chlorite. Crosscut by dikes of medium-crystalline, metamorphosed hornblende diorite and light-gray leucocratic hornblende quartz diorite. Contains inclusions of phyllite and fissile metamorphosed felsite and quartz porphyry. Hadley (1973, 1974) described augite + minor olivine + brown hornblende replacing diopsidic pyroxene. Gabbro at Spewmarrow Creek: Dark-gray to black, medium- to coarse-crystalline, metamorphosed hornblende-clinopyroxene-calcic-plagioclase gabbro. Locally contains minor olivine + brown hornblende replacing diopsidic pyroxene. Smaller gabbro bodies in the Boydton 7.5-minute quadrangle, Virginia, 0.5 km north of Skipwith and 0.4 km north of Liberty Church, are mostly dark-gray to black, coarse- to medium--crystalline, metamorphosed clinopyroxene-hornblende-calcic-plagioclase gabbro to melanocratic hornblende quartz diorite. Igneous hornblende from the Beaver Pond Creek and Spewmarrow Creek gabbro in the Clarksville South 7.5-minute quadrangle, Virgina (Peper et al, 1996), have complex $^{40}Ar/^{39}Ar$ age spectra that show maximum ages of cooling through closure of ca. 600 Ma and ca. 586 Ma, respectively (Kunk et al., 1995).

Zdp **Metadiorite porphyry (Neoproterozoic)**—Dark gray to black, mesocratic to melanocratic (CI = 40–60), metamorphosed porphyritic diorite. Contains plagioclase + hornblende + minor biotite + opaque minerals. Plagioclase phenocrysts reaching 1 cm in length are contained in an aphanitic matrix and have undergone extensive saussurite and sericite reaction replacement commonly showing the phenocrysts core more extensively replaced than the rims, suggesting normal zoning. Locally, contains phenocrysts of K-feldspar. Unit intrudes into surrounding units.

HYCO FORMATION - LOWER PORTION

FELSIC TO INTERMEDIATE VOLCANIC UNITS

Zhft (l) **Felsic tuffs (Neoproterozoic)**—Grayish-green to greenish-gray and silvery-gray, massive to foliated and metamorphosed volcaniclastic pyroclastic rocks consisting of fine- to coarse-crystalline tuffs, lapilli tuffs, and minor welded tuffs. Pyroclastic tuffs are differentiated from other volcaniclastic rocks by zones of cryptocrystalline texture that exhibit conchoidal-like fractures that lie in between foliation domains. Layering ranges from massive to thinly bedded. Contains lesser amounts of metamorphosed volcaniclastic sedimentary rocks including volcanic sandstone, and lithic wacke with minor siltstone and phyllite.

Zhdlt (l) **Dacitic lavas and tuffs of the lower portion of the Hyco Formation (Neoproterozoic)**—Distinctive gray to dark gray, siliceous, metamorphosed cryptocrystalline dacite, porphyritic dacite with plagioclase phenocrysts, and flow-banded dacite. Metamorphosed welded and non-welded tuffs associated with lavas include greenish-gray to grayish-green, fine tuff, coarse plagioclase crystal tuff, lithic lapilli tuff, and tuff breccia. Dacite is interpreted to have been coherent pyroclastic extrusive rocks or hypabyssal intrusions associated with dome formation. Protoliths to metamorphic tuff are interpreted to be episodic pyroclastic flow deposits, air fall tuffs, or reworked tuffs generated during formation of dacite domes. Wortman et al. (2000) report a TIMS U-Pb zircon age of 632.9 +2.6/-1.9 Ma from a sample within this unit in the Chapel Hill 7.5-minute quadrangle in Orange County.

Zhdsi (l) **Dacitic shallow intrusive of the lower portion of the Hyco Formation (Neoproterozoic)**—Gray-green, light green to green, metamorphosed plagioclase porphyritic dacite that has a granular-textured groundmass. Grades into micro-granodiorite having a phaneritic texture visible with a 7x hand lens. Contains lesser amounts of fine- to medium-crystalline granodiorite. Plagioclase phenocrysts range typically from 1 mm to 4 mm in length. Black-colored amphibole, when visible, forms phenocrysts less than 1 mm to 1 mm in prism length and as intergrowths with plagioclase. Amphibole intergrowths distinguish this rock from fine-crystalline tuff. Enclaves of dark gray, plagioclase porphyritic dacite are common and locally produce a pseudo-clastic appearance in outcrop. Bradley and Miller (2011) reported a Ca-TIMS U-Pb zircon age of 628.5 ±1 Ma for a metamorphosed dacite from this unit in southern Orange County.

CAROLINA TERRANE ROCKS EAST OF THE FISHING CREEK FAULT ZONE

VIRGILINA SEQUENCE PLUTONS

VEINS AND DIKES ASSOCIATED WITH THE VANCE COUNTY PLUTON

Many dikes and veins are unlabeled or are too small to be easily found on this 100K-scale map in PDF or paper format. Specific dikes and veins can be searched in the MapUnitLines FeatureClass in the GeMS database. For site specific investigations, the GeMS database should be used in conjunction with the best available scale source map.

PzZap **Aplite (Paleozoic-Neoproterozoic)**—Very fine-crystalline light gray to dark-greenish or brownish-gray aplite dikes. From Parker (1963) unit ap.

PzZph **Phyllite zones (Paleozoic-Neoproterozoic)**—Sericite-chlorite phyllites zones.

PzZqft **Quartz veins (quartz-specularite-tourmaline) (Paleozoic-Neoproterozoic)**—Quartz veins with the mineralogy quartz + specularite + tourmaline. From Parker (1963).

PzZqt **Quartz veins (quartz-tourmaline) (Paleozoic-Neoproterozoic)**—Quartz veins associated with the mineralogy quartz + tourmaline. From Parker (1963).

PzZqw **Quartz veins (quartz-huebnerite) (Paleozoic-Neoproterozoic)**—Quartz veins associated with the mineralogy quartz + huebnerite. From Parker (1963). Designated as Mqw in the USGS SIM 3483 map and pamphlet for the South Boston 30' x 60' sheet (Horton et al., 2022).

PzZqz **Quartz veins (barren) (Paleozoic-Neoproterozoic)**—Barren quartz veins. From Parker (1963).

PzZsi **Siliceous belts (Paleozoic-Neoproterozoic)**—Siliceous belts of probably silicified breccia zones and inclusions. From Parker (1963).

MzZtrt **Hypersthene tonalite (Mesozoic-Neoproterozoic)**—coarse-crystalline, dark-colored dikes of hypersthene tonalite. Interpreted to be Triassic in aged. From Parker (1963).

PLUTONIC ROCKS ASSOCIATED WITH THE VANCE COUNTY PLUTON

Zvh **Metamorphosed hornblende granodiorite to quartz diorite to quartz monzonite (Neoproterozoic)**—Light-gray to brown weathering, coarse- to very coarse-crystalline, locally pegmatitic, equigranular to subporphyritic metamorphosed granitoids. Contains hornblende (5–10 percent) + biotite (3–7 percent) in clots and patches 6 mm to 1 cm in length. Also contains gray quartz crystals 4–6 mm in length. Relict concentric zoning is visible in altered calcic plagioclase (albite + epidote + sericite). Outcrops have a spotted appearance due to patchy clusters of mafic minerals as well as small, rounded inclusions of fine-crystalline, biotite-rich quartz diorite (1 cm to as much as 1 m in length). Mica-rich palimpsests of phyllite, folded inclusions of felsite and greenstone, and pods (autoliths?) of hornblende diorite are common. Described as albite granodiorite by Parker (1963), who reported as much as 20 percent K-feldspar in matrix. Also corresponds to metamorphosed hornblende granodiorite to quartz monzonite (CZhm) of Peper et al. (1996) and tonalite (CZvt) of Blake et al. (2010).

Zvbht **Biotite metatonalite and metagranodiorite of the intermediate Vance County pluton (Neoproterozoic)**—Dark to intermediate gray-blue, mesocratic (CI greater than 25 – 50), coarse-crystalline metamorphosed tonalite and minor granodiorite. Commonly forms medium- to coarse-crystalline boulder outcrops. Granular saprolite and saprock exposures display a dark salt-and-pepper appearance. Biotite phenocrysts +/- mm-scale prismatic hornblende join rounded to tabular, saussuritized and sericitized pale green plagioclase and gray to distinctly cobalt blue quartz phenocrysts that give fresh outcrops a blue-green tint. Locally contains foliated and unfoliated enclaves of fine-crystalline chlorite phyllite, and metamorphosed gabbro and diorite. Crosscut by mm- to m-scale, metamorphosed monzonite, granodiorite, and trondhjemite dikes.

Zvtg **Metatonalite and metagranodiorite (Neoproterozoic)**—Gray to tan colored on weathered outcrops, and white to pinkish white on fresh exposures of metamorphosed tonalite and granodiorite. Commonly forms medium- to coarse-crystalline boulder outcrops. Granular saprolite and saprock exposures display a salt-and-pepper appearance. Biotite plates ± mm-scale prismatic hornblende are generally conspicuous, as are rounded to tabular, saussuritized and sericitized pale green plagioclase and gray to distinctly cobalt blue quartz phenocrysts. Includes elongate to rounded enclaves of fine-crystalline, metamorphosed gabbro, diorite, and basalt. Locally crosscut by fine-crystalline metamorphosed granite or trondhjemite dikes. In the Henderson 7.5-minute quadrangle, concentrations of biotite, gray-colored white mica, and polycrystalline quartz and feldspar domains define mm- to cm-scale, high-strain zones that crosscut relict phaneritic texture. Felsic rods combine with mica aggregate films to define a mineral stretching lineation in all high-strain varieties.

Zvcg **Granitoid of the Vance County pluton (?) (Neoproterozoic)**—Gray-white to green-white, mesocratic (CI less than 40), coarse-crystalline, unfoliated to foliated, metamorphosed biotite hornblende granodiorite containing conspicuous relict blue quartz phenocrysts.

Zvgr **Felsic meta-intrusive suite (Neoproterozoic)**—Metamorphosed equivalents of leucogranite, quartz monzonite, trondhjemite and granodiorite. Generally leucocratic ranging from pale pink to light tan and light gray and medium to very fine crystalline. Sericite partly replaces perthitic microcline, and sericite and epidote group minerals partly replace sodic plagioclase. Biotite ranges from less than 10% to accessory amounts. Accessory magnetite is locally present. Generally, unfoliated but there are localized foliated zones that contain sericite + quartz phyllonite. Includes enclaves of gray-green to green-black metamorphosed andesite and basalt (Zab). Unit was mapped primarily on the presence of float cobbles and quartz-rich residuum where outcrops are rare.

Zvgf **Foliated equivalent of felsic meta-intrusive suite (Neoproterozoic)**—Strain-partitioned protomylonitic to ultramylonitic gneissic, and locally phyllonitic equivalents of Zvgr. Includes pale green to light gray sericite + quartz +/- chlorite phyllonite. Composite S-C fabric, and spaced cleavage common. Thin mm- to cm-scale gneissic layering defined by polycrystalline aggregates of feldspar + quartz and white mica +/- biotite. Felsic rods combine with mica aggregate films to define a mineral stretching lineation. Includes enclaves of greenstone consisting of gray-green to green-black metamorphosed andesite and basalt (Zab).

TABBS CREEK META-INTRUSIVE SUITE

Ztc **Tabbs Creek meta-intrusive suite (Neoproterozoic)**—Variably green-gray to gray-white, fine-to medium-crystalline, variably fractured greenstone and metamorphosed gabbro, diorite, tonalite, trondhjemite, granodiorite, and locally granite. Biotite concentrations vary and produce outcrops that range from leucocratic to mesocratic. Biotite in particular, and hand samples in general, are commonly chloritized and display fine-scale dynamic recrystallization, which can mask relict phaneritic textures, especially in easternmost exposures adjacent to the Nutbush Creek fault zone. Plagioclase commonly displays saussurite and sericite replacement, and large quartz phenocrysts are generally lacking. More mafic varieties are crosscut by fine-to coarse-crystalline, metamorphosed biotite hornblende quartz diorite to granodiorite, and locally metamorphosed trondhjemite to granite. Greenstone, and metamorphosed gabbro and diorite form enclaves within more felsic rocks or contain variably oriented dikes of more felsic rocks.

Ztcf **Foliated Tabbs Creek meta-intrusive suite (Neoproterozoic)**—Moderately to strongly foliated varieties of Tabbs Creek meta-igneous suite (Ztc) where mapped separately.

Zgdf **Foliated Tabbs Creek metagranodiorite (Neoproterozoic)**—Gray-green, leucocratic (CI less than 15) fine- to coarse-crystalline, well-foliated and lineated, metamorphosed granodiorite. Chlorite + white mica define a variably developed protomylonitic to mylonitic foliation and mineral stretching lineation. In the Wilton 7.5-minute quadrangle, relict bluish gray quartz + feldspar define a porphyroclastic microstructure. Also includes light green to dark green, fine- to medium-crystalline, massive, chlorite-epidote-rich greenstone, and locally, green, fine-crystalline, well-foliated and lineated, chlorite phyllonite in the Wilton 7.5-minute quadrangle south of the Tar River.

GIBBS CREEK PLUTON

Zgc **Gibbs Creek pluton (Neoproterozoic)**—Light green to gray-green, leucocratic (CI less than 20), fine- to medium-crystalline, metamorphosed biotite +/- hornblende granodiorite. In Wilton 7.5-minute quadrangle, metamorphosed granodiorite develops porphyritic facies and equigranular facies. Chlorite and white mica indicate a metamorphic overprint of igneous biotite, hornblende, and feldspar. Numerous mm- to cm-scale, relict feldspar phenocrysts indicate a porphyritic texture in western portions of the pluton, and locally throughout the pluton. Eastern portions of the pluton have a relict equigranular phaneritic texture. Multiple cm- to m-scale enclaves of foliated, fine-crystalline amphibolite to epidosite, and foliated and metamorphosed biotite-chlorite granitoid are conspicuous throughout the pluton, especially in its central portion. Four pods of meta-ultramafic rocks also form enclaves. In Grissom 7.5-minute quadrangle, granodiorite locally contains planar zones of dark green to gray-green, fine-crystalline, well-foliated and lineated chlorite phyllonite.

Zgcf **Foliated Gibbs Creek pluton (Neoproterozoic)**—Foliated and locally lineated equivalent of the Zgc metagranodiorite. Chlorite and white mica define a metamorphic replacement of biotite + hornblende + feldspar, and are well developed in phyllonitic to mylonitic fracture and shear foliation zones. Less foliated rocks develop a sheen due to an oriented, fine-crystalline white mica overprint of feldspar. Locally, mm- to cm-scale relict feldspar phenocrysts define a porphyroclastic microstructure. Locally zones of silica + epidote that form silicified ridges overprint the foliated rocks, especially in its western portions.

MISCELLANEOUS YOUNGER PLUTONIC ROCKS

Zmgr **Metagranite/metagranodiorite/metatrondhjemite (Neoproterozoic)**—Light gray, pink or tan colored, fine-crystalline and metamorphosed granitic, granodioritic and/or trondhjemitic dikes in contact with metamorphosed tonalite and granodiorite of the Vance County pluton. In the Townsville 7.5-minute quadrangle, dikes also crosscut and contain xenoliths of the Vance County pluton. Leucocratic (CI less than 5) typically with minor to accessory biotite plates and a relict phaneritic to crystalloblastic texture/microstructure. Pink-green varieties dominate the outcrop population in the Townsville 7.5-minute quadrangle. Magnetite is also locally present in the Townsville 7.5-minute quadrangle. Outcrops may be highly fractured, forming resistant hillside cobble and boulder fields.

Zpyg **Porphyritic metagranite (Neoproterozoic)**—Pink K-feldspar (2-8mm) and gray quartz phenocrysts in a relict medium-crystalline gray and white groundmass. Occur as dikes crosscutting metamorphosed gabbro and diorite (Zgbdi) in the Oxford 7.5-minute quadrangle.

Zafg **Alkali feldspar granite (Neoproterozoic)**—Pinkish to orange, medium- to coarse-crystalline alkali feldspar metagranite. Quartz phenocrysts, 1-2 mm in size, appear bluish in hand sample and pinkish-orange K-feldspar phenocrysts, 1-2mm in size, occur in a groundmass of nearly all K-feldspar with minor quartz. Rock unit occurs as small undeformed but metamorphosed intrusive bodies.

Ztjf **Metatrondhjemite (Neoproterozoic)**—White to pale gray, fine-crystalline, foliated epidote + sericite + quartz + plagioclase rock. Differentiated felsic and sericite laminae characterize locally developed mylonitic varieties. Accessory pale green epidote and up to 5% pyrite are distinctive.

Zvfp **Felsic porphyry (Neoproterozoic)**—Buff to whitish-tan, leucocratic (CI less than 1), porphyritic to aphanitic metamorphosed dacite to rhyolite(?) with less than 5-10 mm quartz and feldspar phenocrysts.

Zmgb **Metagabbro (Neoproterozoic)**—Dark gray-green to green-black, melanocratic, and fine- to medium-crystalline metamorphosed gabbro with localized coarse-crystalline varieties. Commonly displays a relict gabbroic texture with chlorite and hornblende neocrystallization, and locally magnetite replacing pyroxene as uralite. Saussuritization of plagioclase is common. Generally, unfoliated and variably fractured. May display a "boxwork" fracture-fill of quartz and epidote. Commonly occurs as lobate bodies injected by younger metagranitoid dikes. High-strain varieties recrystallized to chlorite + white mica + plagioclase phyllonite and mylonite.

Zmg **Metagabbro (Neoproterozoic)**—Dark to medium green, melanocratic, medium-to fine-crystalline, locally plagioclase porphyritic metagabbro dike. Commonly, chlorite + white mica mark fracture and shear foliations. Forms a dike crosscutting the Gibbs Creek pluton (Zgc) and meta-ultramafic rocks in the Wilton7.5-minute quadrangle.

Zgb **Metagabbro (Neoproterozoic)**—Black to gray-black, melanocratic, fine-to medium-crystalline metagabbro. Relict pyroxene + metamorphic hornblende common. Magnetite is present in sufficient amounts to make the rock distinctly magnetic. Sheared varieties along the contact with the Fishing Creek fault zone include mylonite and blastomylonite with pinked plagioclase porphyroclasts. Chlorite + plagioclase phyllonite typically with composite S-C fabric.

Zdi **Metadiorite (Neoproterozoic)**—Intermediate dark gray and green-black-white, mesocratic (CI less than or equal to 50), medium- to coarse-crystalline, hypidiomorphic granular metamorphosed diorite. Crosscut by mm- to cm-scale metamorphosed trondhjemite, monzonite, and granodiorite dikes. Commonly form hillside boulder outcrops and stream waterfalls, as well as massive bluff outcrops along the Tar River. Saussuritized and sericitized plagioclase and chloritized hornblende are common, and minor amounts of quartz may be present, locally producing metamorphosed quartz diorite. Porphyritic varieties with hornblende phenocrysts occur in some coarser facies. Other localities richer in plagioclase have a 'spotted' appearance. Cm- to m-scale enclaves of greenstone, either very fine-crystalline metamorphosed diorite or andesite are conspicuous. May be the southwest equivalent of metamorphosed diorite and quartz diorite in the Oxford 7.5-minute quadrangle.

Zdq **Quartz metadiorite (Neoproterozoic)**—Light gray, white and black, mesocratic, fine-to medium-crystalline, metamorphosed hornblende + biotite + quartz diorite, subordinate metamorphosed granite with minor metamorphosed granodiorite. Plagioclase partially replaced by sericite + epidote group minerals. Chlorite topotaxially replaces biotite and hornblende. Quartz comprises 5-25% of the rock, locally as light, blue-gray phenocrysts. Generally non-foliated but localized weakly foliated varieties occur in the Wilton 7.5-minute quadrangle. Outcrops in the Oxford 7.5-minute quadrangle include enclaves and dikes of gray-green to green-black metamorphosed andesite and basalt (Zab).

Zdqf **Foliated quartz metadiorite (Neoproterozoic)**—Biotite, commonly topotaxially replaced by chlorite, defines foliation surfaces along with sericite and flattened quartz and feldspar phenocrysts. S-C composite fabric common as well as localized very fine-crystalline siliceous mylonite. Includes zones of chlorite + sericite + quartz phyllonite. Occurs on the west and east sides of the Fishing Creek fault zone.

Zgbdi **Hornblende metagabbro-metadiorite (Neoproterozoic)**—Dark gray to green-black, fine- to coarse-crystalline, metamorphosed hornblende gabbro with subordinate metamorphosed hornblende diorite. Includes minor fine-crystalline metamorphosed trondhjemite dikes. Accessory pyrite locally present. Minor to accessory amounts of quartz present in the metamorphosed diorite. Accessory magnetite associated with chloritized hornblende is common, and secondary pinked feldspar is locally present. Sericite and epidote group minerals commonly replace plagioclase (albite to andesine). Poikilitic hornblende phenocrysts with plagioclase inclusions locally present in coarser varieties. Where epidote group minerals replace plagioclase, they impart a pale green color to the hand sample. Relict clinopyroxene (augite?) is rarely present within hornblende. Generally, unfoliated to weakly foliated. However, well-developed chlorite phyllonitic foliation is common in localized shear zones and along the contacts with other rock units. Cm- to m-scale gray-green to green-black enclaves of greenstone, representing either very fine-crystalline metamorphosed andesite or basalt (Zab) are conspicuous.

Zgbdif **Foliated equivalent of hornblende metagabbro-metadiorite (Neoproterozoic)**—Chlorite defines foliation surfaces along with flattened and aligned hornblende and plagioclase phenocrysts. Includes zones of chlorite + plagioclase phyllonite.

MISCELLANEOUS OLDER PLUTONIC AND VOLCANIC ROCKS

Zct **Carolina terrane metagranitoid (Neoproterozoic)**—Orange-tan to pinkish-tan, leucocratic (CI generally less than 5), fine- to medium-crystalline, highly fractured, metamorphosed biotite-bearing trondjhemite to granodiorite. Locally, biotite can increase in abundance and or be topotaxially replaced by chlorite. Gray to bluish gray quartz phenocrysts are conspicuous and unit is locally porphyritic. Zones of silicification and pyritization are present.

Zmi **Mixed suite of meta-igneous rocks (Neoproterozoic)**—Variably colored and fine- to medium-crystalline, metamorphosed mafic, intermediate, or felsic plutonic rocks. Metamorphosed basalt and chlorite phyllite are associated with dark green-black, fine- to medium-crystalline, metamorphosed gabbro crosscut by blue-gray to green-black, fine- to medium-crystalline, metamorphosed diorite. Both rock types are cut by dikes and larger bodies of leucocratic, fine- to medium-crystalline, metamorphosed trondhjemite-granite having variable K-feldspar and biotite percentage. Mafic and intermediate varieties display saussurite and sericite formation and local chloritization to phyllite.

Zmif **Foliated mixed suite of meta-igneous rocks (Neoproterozoic)**—Variably green colored, fine- to medium-crystalline, phyllonite, protomylonite, and mylonite formed from metamorphosed felsic, intermediate, and mafic plutonic rocks of the mixed meta-intrusive suite within the Nutbush Creek fault zone. Chlorite and white mica films define a phyllonitic to fine-spaced gneissic foliation and aggregate mineral stretching lineation. Degree of dynamic recrystallization varies, with polycrystalline quartz + feldspar + phyllosilicates displaying a gradational range from relict igneous to porphyroclastic S-C foliation, shear bands, and mineral stretching lineation as composite fabric elements.

Zab **Meta-andesite and metabasalt (Neoproterozoic)**—Dark gray-green to black-green, melanocratic, fine-crystalline +/- quartz + chlorite + epidote + hornblende + plagioclase rocks. Chlorite replaces hornblende and epidote group minerals replace plagioclase. Accessory magnetite + quartz are common. Generally, unfoliated. Foliated varieties defined by aligned chlorite + hornblende. "Boxwork" fabric defined by intersecting quartz-epidote veins is distinctive. Probably represents metamorphosed hypabyssal basalt and andesite intrusive rocks, as well as very fine-crystalline equivalents of metamorphosed diorite and gabbro units. Occurs commonly as enclaves within other intrusive rock units. Equivalent in part to the metamorphosed mafic volcanic unit of Hadley (1974).

Zabf **Foliated equivalent of meta-andesite and metabasalt (Neoproterozoic)**—Chlorite defines foliation surfaces and includes localized zones of +/- sericite + chlorite phyllite.

Zan **Quartz meta-andesite and metatrondhjemite (Neoproterozoic)**—Light to medium gray to gray-green, metamorphosed fine- to very-fine crystalline, hornblende quartz andesite and diorite, trondhjemite and subordinate fine-crystalline diorite. Chlorite partially topotaxially replaces hornblende, and sericite + epidote group minerals partially replace plagioclase. Generally, non-foliated, but foliated and highly fractured near the contact with Trcc in the Deep River Triassic basin.

Zcu **Meta-ultramafic rocks undivided (Neoproterozoic)**—Dark gray to light green, fine- to coarse-crystalline, massive to foliated talc + actinolite + serpentine schist, serpentinite, and actinolite rock. May occur independently or as a lithologic assemblage within the Gibbs Creek pluton.

Zcuf **Foliated ultramafic rocks (undivided) (Neoproterozoic)**—Foliated equivalent of Zcu related to local zones of partitioned strain within the Gibbs Creek pluton.

HIGH-STRAIN ROCKS IN THE FISHING CREEK FAULT ZONE

Zfgd **Foliated biotite granodiorite (Neoproterozoic)**—Green-black to pink, mesocratic (CI = 35), medium- to coarse-crystalline, foliated and metamorphosed biotite granodiorite. Crops out as small circular to ovoid-shaped pods in the creek bottom of Coon Creek in the Oxford 7.5-minute quadrangle. Some outcrops show only a weak incipient foliation; however, along Coon Creek within the Fishing Creek fault zone, metamorphosed granodiorite becomes a protomylonite. Contains quartz + plagioclase + K-feldspar + chlorite + minor opaque mineral clots. Chlorite + white mica + flattened plagioclase crystals locally define fracture and shear foliations. Chlorite encases rotated and asymmetrical plagioclase and quartz porphyroclasts that display wings of recrystallized quartz and plagioclase in protomylonitic rock types. Schistose rocks consist of mostly chlorite and display a composite S-C fabric foliation development.

Zga **Deformed equivalent of Zgrm (Neoproterozoic)**—Pink and green to pink and gray metamorphosed granite and quartz monzonite. Sericite partially replaces K-feldspar. Sericite and epidote partially replace plagioclase. Highly fractured and brecciated varieties with iron oxide and manganese oxide fracture coatings occur along the Fishing Creek fault zone. Thin chlorite and sericite films coat fracture surfaces. Pink K-feldspar + green chlorite are distinctive in foliated varieties along with composite S -C fabric. Greenstone occurs locally as enclaves of green to green-gray, fine- to medium-crystalline, massive and typically spheroidal boulders with plagioclase + pyroxene + hornblende + epidote group minerals. Pyrite bearing typically.

Zphcs **Sericite chlorite schist and phyllonite (Neoproterozoic)**—Light gray-green, schistose rocks probably derived from sheared intermediate metamorphosed intrusive rocks. Mylonitic fabric locally developed as mm-scale differentiated micaceous and felsic laminae along with flattened and rotated polycrystalline quartz-plagioclase aggregates. S-C composite fabric common.

Zphc **Chlorite schist and phyllonite (Neoproterozoic)**—Light greenish gray to dark green, foliated and lineated schistose rocks derived primarily from sheared intermediate and mafic intrusive rocks (Zdq, Zdi, and Zgbdi). Includes chlorite sericite phyllonite and sericitic felsic mylonite. Mylonitic fabric locally developed as mm-scale differentiated micaceous and felsic laminae along with flattened and rotated polycrystalline quartz + plagioclase aggregates. Includes thin zones of metamorphosed and foliated quartz diorite (Zdq) and gabbro (Zgbdi). S-C composite fabric common, and highly fractured and brecciated varieties occur near the Fishing Creek fault zone. Iron oxide and manganese oxide commonly coats fractured and foliated surfaces, especially in the Henderson 7.5-minute quadrangle. Porphyroclasts of flattened and rotated polycrystalline aggregates of plagioclase + quartz are common. Quartz + feldspar + chlorite + white mica contribute to a mineral aggregate slickenline lineation.

Zphs **Sericite quartz schist and phyllonite (Neoproterozoic)**—Light gray schistose rocks probably derived from sheared felsic intrusive rocks and possibly felsic pyroclastic rocks. In the Oxford 7.5-minute quadrangle, mylonitic fabric locally developed as mm-scale differentiated micaceous and felsic laminae along with flattened and rotated polycrystalline quartz + plagioclase aggregates. S-C composite fabric elements are common. In the Wilton 7.5-minute quadrangle, unit includes highly fractured quartzose rock and minor amounts of felsic metamorphosed intrusive rocks.

HIGH-STRAIN ROCKS IN THE NUTBUSH CREEK FAULT ZONE

Zvbm **Chlorite biotite phyllonite and mylonite (Neoproterozoic)**—Light greenish-gray to dark green, foliated and lineated phyllitic rocks derived primarily from recrystallized biotite metatonalite of the intermediate Vance County pluton.

Includes chlorite and sericite protomylonite through ultramylonite and phyllonite that form distinctive relict igneous and high-strain compositional layers. Iron oxide and manganese oxide commonly coat fractured and foliated surfaces. Flattened and rotated polycrystalline aggregates of plagioclase + quartz common as porphyroclastic minerals that form composite S-C and C' foliations. Quartz + feldspar + chlorite + white mica contribute to mineral aggregate, mineral stretching, and slickenline lineations.

Zmgf **Foliated biotite metagranitoid (Neoproterozoic)**—Light gray, pink-green, or tan-gray, generally leucocratic (CI less than 10), fine- to medium-crystalline metagranitoid rock having a foliation that is defined by aligned biotite plates. Quartz-feldspar crystalloblastic matrix displays distinct shape foliation that is oriented parallel to the biotite plates. Locally contains magnetite. Depending upon the white mica content, commonly displays a crystalloblastic protomylonitic to ultramylonitic or phyllonitic microstructure. Crosscut by biotite-poor and biotite-free metamorphosed granitoid dikes. Forms a foliated enclave in an unfoliated portion of the metamorphosed tonalite in the Vance County pluton. Outcrops may be highly fractured, forming resistant hillside and lakeside outcrops and cobble and boulder fields.

Zvbhtf **Foliated to mylonitic metamorphosed biotite tonalite and granodiorite of the intermediate Vance County pluton (Neoproterozoic)**—Dark to intermediate gray-blue, mesocratic (CI = 25 – 50), medium- to coarse-crystalline metamorphosed tonalite and minor granodiorite. Locally crosscut by mm- to m-scale metamorphosed monzonite, granodiorite, and trondhjemite dikes. Located within the Nutbush Creek fault zone in the Henderson 7.5-minute quadrangle, this unit is the strongly deformed equivalent of Zvbt from the Townsville 7.5-minute quadrangle.

Zvbhtsc **Silicified cataclasite in Zvbht (Neoproterozoic)**—Silicified and highly fractured zone overprinting the metamorphosed biotite tonalite and granodiorite of the intermediate Vance County pluton (CZvbt).

EASTERNMOST CAROLINA TERRANE

BEAVERDAM META-INTRUSIVE SUITE

Zbdi **Beaverdam metadiorite (Neoproterozoic)**—Grayish-white to greenish-white, mesocratic (CI less than 40), coarse-crystalline, unfoliated to well-foliated metamorphosed biotite hornblende granodiorite to diorite.

Zqdi **Beaverdam blue quartz metadiorite (Neoproterozoic)**—Buff to green and white, mesocratic (CI less than 40), coarse-crystalline, metamorphosed and unfoliated biotite + hornblende granodiorite to diorite, containing conspicuous phenocrysts of blue quartz.

Zbdgp **Beaverdam metadiorite, metagabbro, and metapyroxenite (Neoproterozoic)**—Mixed assemblage of metamorphosed biotite and hornblende-biotite diorite, hornblende gabbro, and pyroxenite.

Zbgb **Beaverdam metagabbro and metapyroxenite (Neoproterozoic)**—Black and white to greenish black, melanocratic to hypermelanocratic (CI greater than 40), fine- to medium-crystalline, unfoliated to well-foliated metamorphosed gabbro to pyroxenite.

Zpx **Beaverdam metapyroxenite (Neoproterozoic)**—Greenish-black, hypermelanocratic (CI greater than 90), medium- to coarse-crystalline, massive, metamorphosed pyroxenite with minor amounts of talc, magnetite, and chlorite.

UMSTEAD META-INTRUSIVE SUITE

Zrcg **Reedy Creek metagranodiorite (Neoproterozoic)**—Light tan-gray-white, bluish gray-white, or pinkish-white, leucocratic (CI less than 10), medium -crystalline, and locally porphyritic metamorphosed granodiorite. Contains typically, 2-4 mm blue quartz phenocrysts. Boulder fields and massive outcrops are xenomorphic to subidiomorphic metagranodiorite or foliated and lineated, protomylonitic to mylonitic granodioritic orthogneiss. Aggregates of white mica + quartz + plagioclase + orthoclase highlight a mineral stretching lineation. Locally contains subidiomorphic biotite plates and isolated clots of epidote + biotite and is white mica-rich in gneissic layers. Contains enclaves of Sycamore Lake greenstone and microdiorite and is crosscut by fine-crystalline aplite dikes.

FALLS LAKE TERRANE

Zfs **Falls Lake schist (Neoproterozoic)**—Variably gray colored, mesocratic, fine- to coarse-crystalline biotite + white mica + oligoclase + quartz schist. Locally displays gneissic layering. Commonly contains xenoblastic to subidioblastic porphyroblasts of garnet + staurolite + kyanite, and/or chlorite. Encloses pods of metagabbro, amphibolite, and undivided meta-ultramafic rocks. Five zircon fractions of a dominant zircon grain population in a sample from the Bayleaf 7.5-minute quadrangle yielded TIMS $^{207}Pb/^{206}Pb$ ages ranging from 1117 to 1359 Ma, but plot near a lower discordia intercept of 590 Ma (Goldberg, 1994). Preliminary unpublished NCGS geochronologic data from LA-ICP-MS U-Pb zircon analyses also in the Bayleaf 7.5-minute quadrangle bore a multi-modal population of grains dominated by ca. 626 to ca. 608 Ma Maximum Depositional Ages. Based upon the detrital zircon age distributions and relict clastic textures, protoliths for the schist are interpreted to be Neoproterozoic (Ediacaran Period) sedimentary rocks.

Zfkq **Kyanite quartzite (Neoproterozoic)**—Silver-white, fine- to medium-crystalline, foliated, white mica + kyanite + opaque mineral quartzite.

Zfqz **Quartzite (Neoproterozoic)**—White, granular, and well-foliated quartzite.

Zfu **Meta-ultramafic rocks (undivided) (Neoproterozoic)**—Variably metamorphosed ultramafic rocks including metapyroxenite, actinolite-chlorite schist, and talc schist.

Zfus **Serpentinite (Neoproterozoic)**—Pale greenish-gray, fine-crystalline, and massive to moderately foliated serpentinite. Contains fibrous tremolite + clots of magnetite + minor amounts of talc. Associated with dark green, unfoliated, chlorite-actinolite rock.

Zfua **Actinolite rock and actinolite-chlorite schist (Neoproterozoic)**—Dark green, schistose to almost massive, splintery rock composed of actinolite + varied amounts of chlorite. Minor amounts of talc + magnetite octahedra are common.

Zfut **Talc schist (Neoproterozoic)**—White to gray, medium-crystalline, porphyroblastic talc-tremolite schist, talc-chlorite schist, and soapstone. Rhombohedral cavities suggest former carbonate mineral (ankerite or magnesite?).

Zfa **Amphibolite (Neoproterozoic)**—Dark gray to black, fine- to coarse-crystalline, well-foliated amphibolite dikes generally parallel to foliation within wall rock.

Zfhg **Hornblende gneiss (Neoproterozoic)**—Dark gray to black, fine- to medium-crystalline, poorly to moderately foliated hornblende-plagioclase gneiss and amphibolite. May contain biotite or epidote. Where biotite content is high, may be somewhat schistose.

Zfmg **Metagabbro (Neoproterozoic)**—Light green to blue-green, fine- to medium-crystalline, massive, metamorphosed gabbro containing relict plagioclase and hornblende, and metamorphic actinolite + epidote + opaque minerals.

Zfgn **Felsic gneiss (Neoproterozoic)**—Constitutes minor blocks and pods within Falls Lake schist. Dominantly fine-crystalline quartz + plagioclase +/- microcline with minor white mica +/- biotite +/- garnet gneiss. Micas display a weak foliation within the quartz + feldspar matrix, which commonly preserves a recrystallized triple-junction texture. These pods may represent original layers, dikes, or enclaves.

CRABTREE TERRANE

Zmca **Middle Creek amphibolite (Neoproterozoic)**—Dark grayish-black to dark green, fine- to medium-crystalline, foliated and lineated, layered, epidote-bearing hornblende gneiss to amphibolite. Locally contains opaque mineral-rich metapyroxenite. A sample of amphibolite from the Wilton 7.5-minute quadrangle yielded an LA-ICP-MS U-Pb zircon magmatic age of ca. 562 Ma (Fishel et al., 2024). Informal lithodemic name adopted from Robitaille (2004).

Zmcg **Middle Creek gneiss (Neoproterozoic)**—Gray colored, mesocratic (CI less than 30), fine- to coarse-crystalline, locally schistose and lineated, biotite quartz dioritic to granodioritic gneiss and fine- to medium-crystalline amphibolitic gneiss. Interlayered with pink-gray to orange-tan, leucocratic (CI less than 10), fine- to medium-crystalline, locally lineated, white mica biotite granitoid gneiss. Informal lithodemic name adopted from Robitaille (2004).

Zjbg **Joes Branch gneiss (Neoproterozoic)**—Bluish-gray to tannish gray, mesocratic (CI less than 35), fine- to medium-crystalline, well foliated and locally compositionally layered or schistose, biotite dioritic to granodioritic gneiss.

Locally contains green-black, fine- to medium-crystalline crystalloblastic amphibolite and mm-scale layered amphibolitic gneiss. Alignment of hornblende defines a subhorizontal mineral stretching lineation. Informal lithodemic name adopted from Blake and Stoddard (2004).

Zlcg **Little Creek gneiss (Neoproterozoic)**—Pink-gray to orange-tan, leucocratic (CI less than 10), fine- to medium-crystalline, well foliated to lineated, white mica ± biotite granitic gneiss. Locally is magnetite-bearing. Informal lithodemic name adopted from Blake and Stoddard (2004).

Zbgn **Biotite layered gneiss (Neoproterozoic)**—White, gray, and black, compositionally layered and well-foliated biotite-quartz-plagioclase gneiss

Zcmgs **Mixed gneiss and schist (Neoproterozoic)**—Complex assemblage of highly intercalated gneissic and schistose rocks. Includes felsic gneiss, compositionally layered gneiss, quartz-ribbon gneiss, amphibolite, hornblende gneiss, hornblendite, layered biotite gneiss, muscovite schist, muscovite + garnet gneiss, biotite + muscovite + garnet schist, talc schist, and quartzite.

Zcwq **White mica-rich and quartz-rich schist (Neoproterozoic)**—Gold-gray to silver-gray, very fine- to fine-crystalline, moderately well-foliated quartz-biotite and/or chlorite-white mica schist containing sparse to abundant garnet porphyroblasts interlayered with silver-white, fine- to medium-crystalline, moderately foliated white mica + plagioclase + quartz schist.

Zum **Meta-ultramafic rocks (Neoproterozoic)**—Dark green to black, fine- to coarse-crystalline, massive to foliated talc + chlorite + actinolite schist and actinolite rock, locally with octahedral magnetite crystals.

RALEIGH TERRANE

PzZmbs **Muscovite-biotite schist (Paleozoic-Neoproterozoic)**—Medium-crystalline muscovite-biotite schist, locally with chlorite or sillimanite and commonly felsic. Occurs as float and sparse saprolitic exposures representing enclaves within younger granitoid rocks.

PzZahg **Amphibolite and hornblende gneiss (Paleozoic-Neoproterozoic)**—Blue-green-white to gray-green, mesocratic (CI = 50), medium-crystalline, foliated and lineated gneissic rock having compositional layers of darker amphibolite and lighter felsic hornblende gneiss. Occurs as isolated outcrops within younger granitoid rocks. Interpreted to be enclaves.

PzZgg **Gneissic biotite granitoid (Paleozoic-Neoproterozoic)**—Foliated biotite granitoid and granitoid orthogneiss interlayered with Raleigh gneiss. Two samples of gneiss from the Wake Forest 7.5-minute quadrangle returned LA-ICP-MS U-Pb zircon ages of ca. 568 Ma and ca. 294 Ma Fishel et al. (2024).

Zflg **Falls leucogneiss (Neoproterozoic)**—Pink-gray to orange-tan, leucocratic (CI less than 5), medium-crystalline, weakly to moderately foliated and strongly lineated, magnetite biotite granitic gneiss. Ca-TIMS U-Pb analyses of the leucogneiss yielded a discordant upper intercept age of 550.8 +/- 4.9 Ma (Caslin, 2001). Caslin et al. (2001) reported three fractions of small, clear, equant grains produced a discordant upper intercept age of ca. 543 Ma. Five fractions of highly metamict, brown zircon grains bore a discordant upper intercept age of ca. 545 Ma and interpreted this magmatic age as crystallization of plutonic protolith. Informal lithodemic name adopted from Farrar (1985a, 1985b).

PzZrgn **Raleigh gneiss (Paleozoic-Neoproterozoic)**—Mixed unit of mainly fine- to coarse-crystalline, well foliated, compositionally layered, and locally lineated biotite granitoid gneiss, and lesser amounts of biotite + hornblende gneiss, metagabbro, amphibolite, and biotite schist. Some mafic PzZrgn rocks locally contain relict clinopyroxene or metamorphic garnet porphyroblasts, and locally display hornfelsic texture adjacent to the Rolesville batholith. Also includes leucogranitic gneiss containing garnet crystals and local magnetite. Gneiss is crosscut by dikes of pink to gray granitic pegmatite granite and white to gray graphic granite. Also occurs as xenoliths within rocks of the Rolesville granitic batholith. Three amphibolite samples in the Raleigh gneiss from the Raleigh East and Raleigh West 7.5-minute quadrangles in the Raleigh 30' x 60' sheet yielded LA-ICP-MS U-Pb zircon ages of ca. 580 Ma, ca. 561 ma, and ca. 555 Ma, interpreted to be magmatic crystallization ages (Fishel et al., 2024). A felsic gneiss sample from the Raleigh East 7.5-minute quadrangle bore an LA-ICP-MS U-Pb zircon age of ca. 294 Ma, interpreted to be a magmatic crystallization age (Fishel et al., 2024). Informal lithodemic name adopted from Farrar (1985a, 1985b).

CZrl **Leucocratic gneiss (Cambrian-Neoproterozoic)**—Very light gray, fine-crystalline, leucocratic epidote + plagioclase + quartz felsic gneiss, locally containing darker, hornblende-bearing gneiss interlayers.

CZrhg **Hornblende gneiss (Cambrian-Neoproterozoic)**—Dark gray to black, fine- to medium-crystalline, poorly to moderately foliated hornblende-plagioclase gneiss and amphibolite. May contain biotite or epidote. Where biotite content is high, hornblende gneiss may be somewhat schistose.

CZru **Meta-ultramafic rocks (Cambrian-Neoproterozoic)**—Dark green to black, fine- to coarse-crystalline massive to foliated talc + chlorite + actinolite schist and actinolite rock, locally with octahedral magnetite crystals.

WARREN TERRANE

INTRUSIVE ROCKS (METAMORPHOSED)

Pzgg1 **Granitoid gneiss (Paleozoic)**—Medium to dark gray, fine- to medium-crystalline, moderately to well foliated biotite-quartz-plagioclase ± K-feldspar gneiss and schist. Locally carries garnet, epidote, or sulfide minerals. Varies from unlayered biotite granitoid gneiss to variably layered biotite gneiss to schistose biotite gneiss and rarely biotite schist. Layers are typically discontinuous. Locally protomylonitic, mylonitic, or ultramylonitic. Locally crosscut by dikes and/or sills of pegmatite granite and/or leucogranite. Also, xenoliths occur within granite bodies. Equivalent to ZPfg on the geologic map of the Middleburg 7.5-minute quadrangle (Stoddard et al., 2016).

Pzlgg **Liberia monzogranite gneiss (Paleozoic)**—Light tan-brown to white gray, leucocratic (CI = 10 – 20), medium- to coarse-crystalline, protomylonitic to mylonitic quartz + K-feldspar + biotite + white mica gneiss and locally granite. Commonly transitions to quartz + K-feldspar + plagioclase + biotite granodioritic gneiss. Locally contains garnet (1-5 mm), allanite, epidote, and opaque minerals, and biotite topotaxially replaced by chlorite. Gneissic layering of biotite, K-feldspar (1-7 cm), and quartz (1-5 cm) ribbons. Mantled K-feldspar porphyroclasts exhibit asymmetric tails of quartz +/- K-feldspar and plagioclase +/- white mica that indicate tops-to-the-northeast sense of shear. Recrystallized tails are commonly elongated in the direction of a locally penetrative mineral stretching lineation of quartz-feldspar rods and phyllosilicate aggregates. Contains enclaves of biotite-rich granitic and granodiorite gneiss. Informal lithodemic name adopted from Morrow (2015).

Pzgg2 **Granitic gneiss (Paleozoic)**—Light tan, light gray, and light brown, fine- to medium-crystalline felsic gneiss and foliated metamorphosed granitoid, consisting of quartz, sodic plagioclase, microcline, white mica, and local biotite. May display a retrograde metamorphic overprint including chlorite and sericite after biotite and feldspar.

PARKTOWN GNEISS SUITE UNITS

DPzpkg **Parktown porphyroclastic gneiss (Devonian-Paleozoic)**—Light tan to light brown to orangish-brown, fine- to coarse-crystalline, weakly to strongly foliated and locally protomylonitic, leucocratic, biotite granodioritic gneiss. Pink, orange, and white K-feldspar porphyroclasts are inferred to be relict porphyritic phenocrysts rather than dynamically recrystallized mylonitic megacrysts. Local interlayers are fine- to medium-crystalline, thin-compositionally layered, mesocratic, black and white biotite felsic gneiss. Vermiculite replacing biotite is common in most exposures. Large gneiss knickpoints, waterfalls, and stream cutbanks are the most common types of outcrops. Informal lithodemic name adopted from Nolan (2020).

DPzpccg **Parktown coarse-crystalline gneiss (Devonian-Paleozoic)**—Black and white, mesocratic, fine- to coarse-crystalline, thin- to thick-compositionally layered, mesocratic, hornblende + biotite + quartz dioritic gneiss having local interlayers of light tan to light brown to orangish brown, leucocratic, fine- to coarse-crystalline, weakly to strongly foliated and locally protomylonitic biotite granitic gneiss having pink, orange, and white K-feldspar porphyroclasts, and fine to medium crystalline, thin-compositionally layered, mesocratic, black and white biotite felsic gneiss. This lithodeme of the Parktown gneiss suite is interpreted to be a metamorphosed dacite based on geochemical analysis (Fishel et al., 2024; Fishel, 2026). Vermiculite replacing biotite is common in most exposures. Large, blocky and small, saprolitic stream cutbanks are the most common outcrops of the quartz dioritic orthogneiss. Informal lithodemic name adopted from Nolan (2020).

DPzpfcg **Parktown fine-crystalline gneiss (Devonian-Paleozoic)**—Black and white, mesocratic, fine- to medium-crystalline, thinly compositionally layered, biotite felsic gneiss that has a variable abundance of biotite. Vermiculite replacing biotite is common in most exposures. Locally interlayered with fine-crystalline biotite quartz schist having strongly developed crenulation cleavage. Small saprolitic stream cutbanks are the most common outcrops of the biotite felsic gneiss. Informal lithodemic name adopted from Nolan (2020).

DPzpg **Parktown gneiss (Devonian-Paleozoic)**—Dark grayish-green to greenish-black, predominantly mesocratic (CI = 35 – 60), fine- to medium-crystalline hornblende and biotite hornblende gneiss composed of plagioclase + hornblende, and local biotite + quartz + clinopyroxene + magnetite, and/or epidote interlayered with medium-gray to greenish-gray, leucocratic (CI = 5 – 30), very fine- to fine-crystalline biotite gneiss and grayish-tan, muscovite-biotite gneiss composed of plagioclase + quartz + biotite + white mica + locally garnet. Also contains interlayers of biotite schist composed of quartz + plagioclase + biotite and white mica +/- hornblende. Locally displays compositional layering and well-developed gneissosity. LA-ICP-MS U-Pb zircon analyses of two Parktown gneiss samples yielded ca. 450-350 Ma ages with ca. 410 and 412 modes, produced only three Precambrian zircon grains at ca. 1915, 614, and 593 Ma., and interpreted Maximum Depositional Ages (MDAs) of 406 ± 3 Ma and 407 ± 3 Ma (Peach, 2017, 2018; Nolan 2020; LaMaskin et al., 2021). Informal lithodemic name adopted from Peach (2018).

DPzpgu **Parktown gneiss undifferentiated (Devonian-Paleozoic)**—Medium to dark gray, fine- to medium-crystalline, moderately to well foliated biotite-quartz-plagioclase+/-alkali feldspar gneiss and schist. Varies from non-banded biotite granitoid gneiss to variably banded biotite gneiss to schistose gneiss and biotite schist. Rarely includes zones of hornblende-biotite schist, hornblende gneiss, or felsic gneiss with or without biotite and/or muscovite. Locally carries garnet + epidote, or sulfide minerals. Contains felsic layers with abundant feldspar augen or fine-crystalline, poorly foliated, weakly layered quartz-biotite gneiss with fewer augen. Locally associated with dikes and/or sills of pegmatite granite and/or leucogranite. Gneiss xenoliths also occur within granitoid bodies. Informal lithodemic name adopted from Peach (2018).

LITHODEMIC UNITS

Pzscg **Soul City gneiss (Paleozoic)**— Black-gray to blue-gray, mesocratic to locally melanocratic, fine-crystalline biotite hornblende gneiss. May contain clinopyroxene and/or epidote in its metamorphic mineral assemblage. Biotite and hornblende define a regional foliation associated with mm- to cm-scale and relatively equigranular and crystalloblastic plagioclase and quartz compositional layers. Variations in percentage of dark to light minerals highlight the compositional layers whose boundaries may locally be gradational. Local crystal-size variations in part due to an L-S mylonitic overprint, especially adjacent to the Lake Gordon shear zone on its east side in the eastern Middleburg 7.5-minute quadrangle. Local cm-scale compositional layers may be tightly to isoclinally F_1 folded, and then openly F_2 refolded. Some discrete granitic gneiss dikes crosscut the gneiss or are isoclinally folded. Fine-crystalline biotite hornblende gneiss may be interlayered with mesocratic medium- to coarse-crystalline biotite hornblende gneiss. These coarser layers contain spotted hornblende and/or plagioclase porphyroclasts that resemble a relict phaneritic texture reminiscent of quartz diorite to tonalitic orthogneiss in the Parktown coarse crystalline gneiss (DPzpccg). A greater percentage of hornblende to biotite and a finer crystalloblastic matrix distinguishes Soul City gneiss from biotite-rich Parktown fine-crystalline gneiss (DPzpfcg). Occurs along the western portion of the Wise granite as country rock xenoliths and a larger stoped block along the boundary between the Middleburg and Warrenton 7.5-minute quadrangles. The protolith for this gneiss appears to be an early Paleozoic sedimentary rock based upon its multi-modal and detrital zircon age distribution. LA-ICP-MS U-Pb zircon analyses of two gneiss samples are dominated by ca. 2.0-1.0 Ma ages with ca. 1200 Ma and ca. 490 Ma age modes, and Maximum Depositional Ages (MDAs) ca. 500 and ca. 502 Ma (Peach et al., 2017; Peach, 2018; Nolan, 2020; LaMaskin et al., 2021). Informal lithodemic name adopted from Peach (2018) based upon the mapping of Stoddard et al. (2016).

Pzwms **White mica schist (Paleozoic)**—Gray to gray-tan, medium-fine- to medium-crystalline, strongly foliated and lineated white mica + sillimanite + garnet schist; green-gray, medium crystalline, strongly foliated and lineated, white mica + chlorite +/- sillimanite +/- garnet schist; white mica + biotite schist; and very rare crenulated white mica + kyanite + corundum schist. Sillimanite is commonly overgrown by white mica, which helps to define the schistosity. Contact with Pzgg1 is often transitional. Flattened and rotated quartz and feldspar commonly occur as porphyroclastic aggregates forming composite S-C shear surfaces along with C' shear bands defined by white mica. Intruded typically by pegmatitic to coarsely crystalline, porphyroclastic white mica +/- biotite + quartz + feldspar gneissic metagranitoid sills that produce a migmatitic aspect in outcrop. Locally includes small bodies of leucogranite.

Pzcbs **Cabin Branch schist (Paleozoic)**—Locally gray-white to more commonly mesocratic silver-black to speckled silver to gray-green, medium- to coarse-crystalline biotite and biotite white mica schist. Mineral assemblage includes biotite + white mica + plagioclase + abundant quartz + locally garnet. Outcrops are commonly medium-crystalline schist that may develop a weak compositional layering between coarser biotite-rich schistosity and finer quartz-richer and plagioclase-poorer gneissosity. Leucocratic schist contains white mica but no biotite. Gray-green schist contains chlorite that topotaxially replaces biotite and is interpreted to be a greenschist-facies retrograde overprint. Small stringers, dikelets, and larger cm-scale felsic compositional layers appear to be deformed and metamorphosed trondhjemite or granodiorite. Some schist contains abundant 1-3 mm xenoblastic to subidioblastic violet-purple garnet porphyroblasts in a lepidoblastic biotite matrix. Speckled shiny color in some schist outcrops due to coarse white mica porphyroblasts that are reminiscent of the Mill Branch schist. Common as small xenoliths in the western portion of the Wise biotite granite in the Warrenton 7.5-minute quadrangle (Blake et al., 2020) and may correlate with white mica schist (CZwms) in the Middleburg 7.5-minute quadrangle (Stoddard et al., 2016). Locally in contact with the Soul City gneiss in the western Warrenton 7.5-minute quadrangle and may have a similar sedimentary protolith history. Informal lithodemic name adopted from Blake et al. (2020).

DPzpqbg **Possumquarter biotite gneiss (Devonian-Paleozoic)**—Chiefly brownish black to greenish black, medium-crystalline and commonly white spotted, relict clastic to porphyroclastic plagioclase + biotite gneiss protomylonite. Mineral assemblage includes large relict plagioclase, biotite greater than hornblende + quartz + sphene + apatite + opaque minerals. Large K-feldspar crystals were not observed, but K-feldspar may be present in the finer crystalline matrix. Locally, biotite gneiss contains xenomorphic and zoned epidote crystals and xenoblastic and skeletal garnet porphyroblasts up to 1 cm in diameter. Increased quartz, plagioclase, and biotite content versus hornblende and plagioclase define a coarse compositional layering. Protomylonitic and mylonitic equivalents are commonly observed. A white mica-biotite versus quartz ribbon shear foliation as well as degree of crystalloblastic matrix and plagioclase relict clast to porphyroclast development mark the transition into highly deformed gneissic equivalents. Locally, winged plagioclase porphyroclasts and asymmetric shear foliation indicate west-side north displacements regardless of the steep dip direction of the shear foliation. Chlorite topotaxially replaces biotite or infills fractures separating skeletal xenoblastic garnet porphyroblasts while plagioclase may be saussuritized and sericitized. Chlorite "rosettes" are interpreted to indicate a greenschist-facies retrograde overprint. A CIPW normative mineralogy (A. Rice, personal communication) of the Possumquarter biotite gneiss plots in the field of monzodiorite. An LA-ICP-MS U-Pb zircon analysis of a gneiss sample from the Macon 7.5-minute quadrangle yielded ca. 482-388 Ma ages with a ca. 405 mode and a Maximum Depositional Age (MDA) ca. 405 Ma. Zircon ages and relict textures are interpreted to indicate that this lithodeme had a plutonic, volcanic, or proximal volcanogenic sedimentary protolith. Variable REE chemistry suggests a metasedimentary origin for the lithodeme (Finnerty, 2020; Finnerty, 2021; LaMaskin et al.,

2021) similar to other Early Devonian units in the Warren terrane. Informal lithodemic name adopted from Finnerty (2020) and Blake et al. (2020).

DPzmbsg **Garnet-rich muscovite biotite schist (Devonian-Paleozoic)**—Silver-brown to black-brown, mesocratic, fine- to-medium-crystalline tourmaline-bearing garnet white mica biotite schist. Abundance of plagioclase, biotite, garnet, and tourmaline prisms mark this unit. Plagioclase commonly occurs as large relict igneous clasts now porphyroclasts similar to those in the Possumquarter gneiss. Foxy red-brown biotite and white mica form a shear foliation that wraps the porphyroclasts and typically yielded a west-side north sense of displacement where observed. Small segments and larger ribbons of polygonized quartz also contribute to the shear foliation. Biotite and white mica wrap abundant rounded to elongate xenoblastic to subidioblastic garnet porphyroblasts generally up to 5 mm in diameter and distinctly purple red. Microscopically, garnet cores are imbedded with fine sieve inclusions, some of which are oriented parallel to the external foliation. Tourmaline prisms are trigonal and black at the mesoscale and are zoned at the microscale. Some prisms have inclusion trails oriented at a high angle to the external shear foliation, and locally biotite and tourmaline are included in plagioclase. Apatite + zircon are common accessory minerals. Chlorite may impart a pale green coloration to some samples and topotaxially replaces biotite and joins white mica in the shear foliation. Locally, chlorite may partially surround some xenoblastic garnet porphyroblasts. Chlorite “rosettes” are interpreted to be a greenschist-facies retrograde overprint. An LA-ICP-MS U-Pb zircon analysis of a schist sample from the Warrenton 7.5-minute quadrangle yielded age modes ca. 1476 Ma, ca. 1190 Ma, and ca. 485 Ma, and Maximum Depositional ages ca. 485 or possibly 414 Ma (Finnerty et al., 2021; LaMaskin et al., 2021). The protolith for this schist appears to be an early to middle Paleozoic sedimentary rock based upon its multi-modal and detrital zircon age distribution.

Pzsms **Sillimanite-muscovite schist (Paleozoic)**—Bluish-green to gray to golden or white, fine- to coarse-crystalline, moderately to well-foliated muscovite +/- biotite schist. Locally, the schist may be strongly and chaotically crenulated. May display rusty or maroon weathering. Locally carries sillimanite + kyanite + garnet + pyrite and/or very rare staurolite. Includes quartz-muscovite schist and maroon-weathering, poorly foliated muscovite schist as well as local kyanite-quartz rock or sillimanite-quartz rock. Commonly associated with pegmatite granite and/or leucogranite.

DPzmbs **Mill Branch schist (Devonian-Paleozoic)**—Silver green-gray to reddish green-gray to gray and orange-brown, leucocratic, fine- to medium-crystalline and crystalloblastic quartz white mica schist. White mica, likely muscovite, in any given sample may be large and randomly ordered, form rosettes of plates between clusters of other minerals, or form random plates and rosettes between shear foliation domains in phyllonite. Fish flash typically indicates west-side north displacement in a steeply dipping foliation. Quartz ribbons, local foxy red biotite plates, elongate crystals and aggregates of opaque minerals, and very minor epidote contribute to the shear foliation in phyllonite. Domains of quartz-rich versus white mica-rich mineralization appear to be a relict compositional layering, although it is not clear if they are preserved sedimentary clasts or sheared layering. In some white mica-rich domains, sillimanite prisms up to several cm long as well as fibrolitic sillimanite reside in the white mica matrix. In some samples, optically continuous, but disaggregated prisms of sillimanite appear to be crosscut and replaced by white mica. Small prismatic chloritoid porphyroblasts were identified in one sample. Garnet is locally developed as small xenoblastic and sometimes sieved porphyroblasts. They may also be xenoblastic skeletal or fractured crystals that appear as large individual porphyroblasts at the mesoscale. Chlorite replaces garnet along these fractures. Chlorite plates also topotaxially replace biotite and are aggregates in the shear foliation. Chlorite "rosettes" are interpreted to be a greenschist-facies retrograde overprint of this unit. The schist commonly weathers to a rusty red color due to Fe-oxide or Fe-hydroxide minerals and may be a consequence of the breakdown of abundant chlorite, biotite, and garnet. Metasomatism and breakdown of relict feldspars may be a factor in the muscovite as well as schist development. LA-ICP-MS U-Pb zircon analyses of schist samples from the Macon and Inez 7.5-minute quadrangles yielded age modes ca. 1150 Ma and ca. 1050-1020 Ma and are dominated by ca. 590-515 Ma and ca. 430-410 ages. Maximum Depositional Ages for the Mill Branch schist range from 409 Ma to 407 Ma. Protoliths for the schist appear to be Early Devonian sedimentary rocks based upon the multi-modal and detrital zircon age distributions. Informal lithodemic name adopted from Peach (2018).

DPzhbs **Hubquarter Creek schist (Devonian-Paleozoic)**—Silvery bluish-gray to greenish-gray, fine- to-medium-crystalline schist containing white mica + quartz +/- plagioclase, sillimanite, and opaque minerals. Sillimanite has either fibrolitic or prismatic habits. Commonly displays phyllonitic fabric with fish flash that typically indicates tops-to-the-northeast. Locally contains tourmaline. This unit appears to be correlative to the Macon Formation of Farrar (1985a, 1985b). An LA-ICP-MS U-Pb zircon analysis of a schist sample from the Littleton 7.5-minute quadrangle yielded a range of ages from 1800 Ma to 410 Ma and age modes ca. 1026 Ma, 588 ma, and 429 Ma. The schist is interpreted to have a Maximum Depositional Age of ca. 409 Ma in the Early Devonian Period (Peach et al., 2017; Peach, 2018; LaMaskin et al., 2021). Informal lithodemic name adopted from Finnerty (2020).

Pzmxg **Mixed gneiss (Paleozoic)**—Mixed unit consisting of tannish pink to gray, leucocratic, fine- to medium-crystalline, well foliated, fissile plagioclase + K-feldspar + quartz + muscovite + biotite orthogneiss with local K-feldspar augen, and dark greenish gray to black, fine- to medium-crystalline, poorly to moderately foliated amphibolite with local chlorite + actinolite. May also contain biotite gneiss or biotite-muscovite schist. Commonly occurs with granite, foliated granite, or leucogranite in the Inez 7.5-minute quadrangle.

Pzbbg **Big Branch biotite gneiss (Paleozoic)**—Predominantly interlayered medium-gray to greenish-gray, fine- to medium-crystalline biotite gneiss and grayish-tan muscovite-biotite gneiss composed of plagioclase + quartz + biotite + white mica, and local garnet. Interlayered with dark grayish-green to greenish-black, medium-crystalline hornblende and hornblende-biotite gneiss composed of plagioclase and hornblende, and local biotite + quartz + clinopyroxene + magnetite, and/or epidote. Also contains minor interlayers of muscovite schist. Informal lithodemic name adopted from Finnerty (2020) and Rice (2021).

Pzmbg **Mylonitic biotite gneiss (Paleozoic)**—Interlayered, variably mylonitic biotite gneiss, muscovite-biotite gneiss, muscovite schist, hornblende gneiss, and felsic gneiss. Unit added to edge-match with the Gasburg 7.5-minute quadrangle.

Pzhg **Hornblende gneiss (Paleozoic)**—Dark gray to black, medium-crystalline, poorly to moderately foliated hornblende-plagioclase gneiss and amphibolite. May contain biotite or epidote. Where biotite content is high may be somewhat schistose. Occurs as xenoliths within granitoid bodies. Larger bodies are mapped as pods.

Pzts **Actinolite-bearing talc schist (Paleozoic)**—White to tannish-white float cobbles and massive to foliated chips of very fine-crystalline talc schist and soapstone in the Warrenton 7.5-minute quadrangle. Pale green to white and thin actinolite porphyroblasts are primarily visible microscopically as small elongate prisms randomly distributed in a fine-crystalline talc matrix. Talc schist lies along the contact between Possumquarter gneiss and Mill Branch schist. Contact relationships with adjacent rock types were not readily observed described above. The talc schist is similar to bodies mapped within the Littleton 7.5-minute quadrangle (Stoddard et al., 2011). There, talc schist occurs within biotite gneiss.

SPRING HOPE TERRANE

CZimv **Intermediate metavolcanic and metaplutonic rocks (Cambrian-Neoproterozoic)**—Diverse light green, greenish gray, bluish green, black-green, light gray, gray, beige or brown, mesocratic (CI = 45), fine- to medium-crystalline, metamorphosed phaneritic plagioclase + quartz, and/or hornblende-porphyritic rocks including microdiorite, andesite, quartz diorite, gabbro, diorite, granodiorite, or quartz keratophyre. Unfoliated typically and rarely well foliated and slaty or phyllitic. May be well jointed, gnarly weathered, silicified, and/or brecciated. Includes variable proportions of epidote + biotite + chlorite + sericitic white mica + plagioclase + opaque minerals + K-feldspar + titanite. Commonly, primary igneous hornblende, biotite, and plagioclase are at least partly replaced by metamorphic epidote + white mica + biotite + chlorite + opaque minerals. Pyrite cubes are locally abundant. Locally spheroidally weathered. May represent hypabyssal dikes, sills, or lava flows, at least in part, as well as epizonal plutons. Inferred to be correlative with intermediate metavolcanic rocks (CZimv) of Stoddard et al. (2012) in the Red Oak 7.5-minute quadrangle, and potentially with the rare occurrences of intermediate metavolcanic rocks (included with CZfmv) reported in the Centerville and Castalia 7.5-minute quadrangles (Stoddard et al., 2009).

CZim **Intermediate-mafic metaplutonic rocks (Cambrian-Neoproterozoic)**—Dark green to greenish-black, medium- to coarse-crystalline weakly foliated to massive, metamorphosed diorite or gabbro consisting of amphibole + plagioclase + clinopyroxene, with local quartz + epidote. Tan to brownish, medium-crystalline, weakly to non-foliated metadiorite contains plagioclase + biotite + quartz + local epidote or clinozoisite. Displays relict plutonic textures.

CZmmv **Mafic metavolcanic rocks (Cambrian-Neoproterozoic)**—Includes massive fine- to medium-crystalline epidote + chlorite + actinolite + albite greenstone; chlorite phyllite and schist; weakly to non-foliated, medium- to coarse-crystalline amphibolite consisting of hornblende + intermediate plagioclase, with or without epidote/clinozoisite, + Fe-Ti oxide minerals. Metamorphosed basalt displays relict volcanic texture and common quartz +/- epidote amygdules. In hornfels contact aureole adjacent to granite plutons, mafic metavolcanic rocks are typically fine- to medium-crystalline, dense unfoliated rocks consisting of hornblende (and/or actinolite), epidote (or clinozoisite), plagioclase, titanite, Fe-Ti oxide minerals, and locally quartz and/or chlorite. Plagioclase may be twinned or untwinned. Microscopically, both amphibole and plagioclase may be optically zoned, perhaps indicating metamorphic reactions resulting from thermal metamorphism following a lower temperature regional event. Locally, mafic hornfels may be strongly layered with darker amphibole and/or epidote-rich layers alternating with lighter-colored felsic layers. Exposure of unusual mafic hornfels about 1.6 km north of Centerville contains mineral assemblages that have multiple amphiboles, including cummingtonite, together with garnet + biotite + Fe-Ti oxide minerals + Ca-rich plagioclase (Stoddard et al., 1987). Mafic metavolcanic rocks also occur as enclaves along the contact between the Castalia and Gupton plutons in the Justice 7.5-minute quadrangle.

CZfmv **Felsic metavolcanic rocks (Cambrian-Neoproterozoic)**—Includes distinctive bluish, gray, or white weathering, thinly layered and locally strongly fissile fine-crystalline rocks consisting predominantly of very strongly recrystallized mosaic matrix of very fine quartz + sodic plagioclase +/- microcline. Relict plagioclase phenocrysts and rare quartz phenocrysts are present. Biotite and white mica may be present but are sparse. Layering is locally defined by biotite aggregates. Rock is distinctively hornfelsic near granite plutons. Common metamorphic minerals especially in hornfels zone include Ca-amphibole, Mn-Fe garnet, and magnetite. These minerals may occur in clusters, suggesting they are pseudomorphs after mafic phenocrysts or possibly amygdules. Major element geochemical data from the Bunn East

7.5-minute quadrangle (Stoddard, 1993) indicate that the rocks are dacitic and interpreted have felsic pyroclastic flows or lava protoliths. Occurs in abundance as wall rock enclaves along the contact between the Castalia and Gupton plutons in the Justice 7.5-minute quadrangle. Also includes light-colored, generally fine-crystalline and phyllitic to schistose rocks consisting of white mica + quartz + plagioclase + K-feldspar + chlorite + rare biotite + epidote. Commonly contain relict phenocrysts of quartz, typically showing beta morphology, sodic plagioclase, and/or white to beige and typically flattened lithic lapilli clasts. Interpreted as quartz and plagioclase crystal- and quartz and plagioclase crystal-lithic dacitic tuff. Geochemical and petrographic data from the Bunn East 7.5-minute quadrangle (Stoddard, 1993) indicate that at least some of these rocks are rhyodacitic in composition and locally have relict K-feldspar phenocrysts. Goldberg (1994) obtained TIMS $^{207}Pb/^{206}Pb$ upper intercept crystallization ages of ca. 590 and ca. 589 Ma from two discordant zircon fractions from metamorphosed dacitic crystal tuff in the Bunn East 7.5-minute quadrangle. Horton and Stern (1994) obtained a TIMS $^{207}Pb/^{206}Pb$ zircon age of ca. 544 for a metamorphosed dacitic tuff. A metamorphosed crystal-lithic dacite tuff ("Bluestone") in CZfmv yielded discordant Ca-TIMS U/Pb zircon age and an upper intercept of 524.9 ± 8.6 Ma in the Centerville 7.5-minute quadrangle. Also includes rare intermediate metavolcanic rocks that are mineralogically similar to felsic metavolcanic rocks but have a higher percentage of epidote and/or biotite, taking on a darker hue or salt-and-pepper appearance.

CZv **Metavolcanic rocks undivided (Cambrian-Neoproterozoic)**—Mixed fine- to medium-crystalline metavolcanic rocks of felsic, mafic, or intermediate composition, interlayered together with metamorphosed volcaniclastic sedimentary rocks. Includes phyllite, schist, gneiss, greenstone, amphibolite, and metagraywacke/lithic wacke.

Zmms **Metamorphosed mudstone and siltstone (Neoproterozoic)**—Subunit of Zmgs in which fine-grained metasedimentary rocks dominate.

CZspe **Muscovite phyllite and tuff (Cambrian-Neoproterozoic)**—Dominantly white mica phyllite or fine schist, locally displaying penetrative crenulation cleavage. Locally contains flattened and disk-shaped relict quartz phenocrysts 2-5 mm in diameter. Locally includes quartz-epidote rock, metamorphosed siltstone, mudstone, graywacke, or impure quartzite. Also includes metamorphosed medium- to coarse-crystalline, laminated epiclastic rocks or lithic-crystal dacitic tuff containing local flattened pumice lapilli and/or quartz crystals. Interpreted to have mixed dacitic pyroclastic and volcaniclastic sedimentary protoliths.

CZmps **Maple Branch muscovite-garnet schist (Cambrian-Neoproterozoic)**—Silver to gray, white mica schist and phyllite commonly containing porphyroblasts of staurolite and garnet. Also contains quartz + chlorite + biotite + tourmaline + sodic plagioclase + opaque minerals. Well crenulated typically, with crenulation cleavage overprinting the schistosity. Unit also includes rare interlayers of fine-crystalline micaceous quartzite. One quartzite specimen contains biotite + muscovite + chloritoid + staurolite + garnet + opaque minerals. Informal lithodemic name adopted from Morrow (2015).

Zmgs **Metasedimentary rocks (Neoproterozoic)**—Predominantly metamorphosed graywacke and siltstone, and minor mudstone and conglomerate. Metagraywacke may be massive or poorly bedded. Typically shows good relict clastic texture of medium sand- to silt-sized clasts of sericitized feldspar and quartz. Metamorphic biotite + epidote are common in the matrix, as is white mica. As overall grain size decreases, white mica increases in abundance. Fine opaque mineral clasts are common. In addition to the minerals listed above, Corbitt (1987) described chlorite + garnet + allanite + zircon + tourmaline in metagraywacke from the Portis Mine cores. Thinly bedded to laminated, cyclic and graded bedding, and scour-and-fill structures have been reported by Waltman (1985) and Corbitt (1987) in the eastern Centerville 7.5-minute quadrangle, Boltin (1985) in the southwestern Hollister 7.5-minute quadrangle, and Blake et al. (2024) in the Essex 7.5-minute quadrangle. Where stratigraphic facing direction could be inferred, beds appear to be upright in every case. Greenish tan, beige, or gray, fine-grained and fissile phyllitic siltstone, light tan to medium brown, massive and phyllitic mudstone, and local interlayers of light to dark green to medium brown or gray, fine- to medium-grained feldspathic wacke and lithic arenite. Metamorphosed siltstone and mudstone may weather slabby and have a high white mica content indicating an abundance of fine-grained clay minerals and feldspar versus quartz. Higher clay mineral + chlorite content in some outcrops may indicate a higher amount of muddy matrix and sericitized lithic clasts of plagioclase + K-feldspar relative to quartz. Abundant rounded monocrystalline and polycrystalline quartz clasts, plagioclase and microcline grains and small volcanic lithic clasts are common in conglomeratic beds. Quartzose rocks which may be fine metasandstone, or impure quartzite may be interlayered with white mica phyllite. These rocks contain biotite and/or garnet and locally may be feldspathic. Magnetite quartzite, biotite quartzite, and amphibole quartzite, and may be, at least in part, derived from altered and silicified felsic or intermediate metavolcanic rocks. Intrusive sills and dikes, now metadiorite and metabasalt, as well as minor volcanic layers occur within this map unit, but are too small to show on the map. In a study utilizing rock cores from the Portis Gold Mine, Waltman (1985) describes intrusions of quartz diorite and quartz keratophyre that are associated with mineralized quartz veins and metagraywacke. Waltman (1985) and Corbitt (1987) also describe rocks interpreted as metamorphosed intermediate and mafic volcanic rocks interlayered with metagraywacke. There are also local exposures of granular and/or sucrosic, fine- to medium-crystalline, pure quartz rocks. These have been interpreted by Stanley (1978) as metamorphosed quartz arenite resulting from residual accumulations of quartz phenocrysts weathered out of felsic volcanic rocks in pocket beach environments of the volcanic arc. However, because of a general lack of apparent primary sedimentary structures, these rocks may instead have resulted from recrystallization of zones of hydrothermal quartz alteration. Also occurs in CZmmv and PPga. Sedimentary characteristics of the unit are interpreted to indicate that these rocks may be turbidite deposits, perhaps as distal drape aprons on the flanks of local volcanic centers. Metamorphosed lithic arenite/wacke in Zmgs bears a Maximum Depositional Age of ca. 637 Ma based upon LA-ICP-MS U-Pb zircon analyses in the Essex 7.5-minute quadrangle (Blake et al., 2024). Stoddard and Miller (2011) analyzed a metamorphosed dacitic tuff in Zmgs that yielded a nearly concordant Ca-TIMS U-Pb age of ca. 628 Ma in the Centerville 7.5-minute quadrangle.

Zfmgs **Metasedimentary high-strain rocks (Neoproterozoic)**—High-strain equivalent of Zmgs.

Zmbs **Muscovite-biotite schist and semi-schist (Neoproterozoic)**—Fine-crystalline, quartzose (and possibly feldspathic?) muscovite-biotite schist, phyllite, and semi-schist or micaceous quartzite. Biotite porphyroblasts produce a salt-and-pepper appearance. Relict bedding is suggested by layers that have varying mica to quartz ratio. White mica defines the schistosity and white mica-rich layers may be crenulated. Locally contains tiny garnet porphyroblasts. Some exposures are fissile or have slabby weathering. May be the stratigraphic equivalent to portions of the Zmgs at higher metamorphic grade. Occurs in the north-central Centerville 7.5-minute quadrangle.

Zmgs-c **Metamorphosed conglomerate (Neoproterozoic)**—Subunit of Zmgs characterized by exposures of recrystallized pebbly wacke and conglomerate. Conglomerate contains clasts of mono- and polycrystalline quartz + feldspars, and likely volcanic clasts, up to one cm. Conglomerate appears to be matrix supported; mica-rich matrix contains chlorite + epidote + opaque minerals, including magnetite. LA-ICP-MS U-Pb zircon analyses (Blake et al., 2024) yielded a Maximum Depositional age of ca. 642 on a metamorphosed conglomerate from the Essex 7.5-minute quadrangle

Zmwa **Metamorphosed quartz wacke (Neoproterozoic)**—Primarily grayish green, light greenish to medium brown or gray, recrystallized fine- to medium-grained feldspathic wacke. Individual exposures are generally massive and poorly bedded. Higher clay mineral content in feldspathic wacke indicates a higher abundance of sericitized feldspar relative to quartz in arenite, which overall has a better-preserved vitreous luster of individual quartz grains. Abundant lithic clasts and rounded quartz + plagioclase + microcline grains, as well as small volcanic lithic fragments highlight its relict clastic texture. Their sedimentary characteristics suggest that these rocks may have originated as turbidite deposits, perhaps as distal drape aprons on the flanks of local volcanic centers associated with Zmgs. Unit is inferred to be map-scale horizons that are correlative with metamorphosed graywacke (Zmgs) of

Stoddard et al. (2012) in the adjoining Red Oak 7.5-minute quadrangle, as well as in the Centerville and Castalia 7.5-minute quadrangles, respectively (Stoddard et al., 2009). LA-ICP-MS U-Pb zircon analyses (Blake et al., 2024) yielded a Maximum Depositional age of ca. 642 on a metamorphosed lithic wacke from the Essex 7.5-minute quadrangle.

Zegs **Enclaves of gneiss and schist (Neoproterozoic)**—Along with metavolcanic rocks, biotite schist, muscovite schist, biotite gneiss, amphibolite, and granitic gneiss occur as enclaves (primarily xenoliths of country rocks) within granitoid plutons and as trains defining septa along the contacts between plutons including the Rolesville, Gupton, Northwest Gupton, and Castalia.

Zshum **Meta-ultramafic rocks (Neoproterozoic)**—Pale to dark green or gray, hypermelanocratic, medium-crystalline, massive to schistose rocks containing varying proportions of actinolite + talc + chlorite. Locally, sparse rhombohedral cavities suggest the former presence of magnesite.

ROANOKE RAPIDS TERRANE

HALIFAX COUNTY COMPLEX

Zhmb **Metabasalt (Neoproterozoic)**—Dark green to black, melanocratic, fine-crystalline rocks consisting of hornblende and/or actinolite + plagioclase + epidote/clinozoisite + titanite + opaque minerals, and locally quartz and/or sulfide minerals. Most retain relict igneous textures, with plagioclase phenocrysts and/or random orientation of plagioclase laths. Others are massive to foliated amphibolite, some strongly deformed. Includes metabasalt, basaltic amphibolite, and amphibolite of Kite and Stoddard (1984). Chemical analyses show metamorphosed basaltic rocks of the Halifax County complex are low-K tholeiite similar to ocean-floor and volcanic-arc basalts (Kite, 1982; Kite and Stoddard, 1984). One basaltic amphibolite from the Red Oak 7.5-minute quadrangle (LKRO-157) was among the samples analyzed by Kite (1982). This unit includes isolated occurrences of metamorphosed gabbro, diorite, and quartz diorite, and correlates well with the "mafic igneous complex of the Roanoke Rapids terrane" mapped in the Nashville 7.5-minute quadrangle (Gay, 2004).

Zfhmb **Deformed metabasalt (Neoproterozoic)**—Deformed metabasalt and amphibolite of the Halifax County complex within the Hollister fault zone.

Zhmg **Metagabbro (Neoproterozoic)**—Dark green to black, melanocratic, typically coarse-crystalline, metamorphosed and unfoliated rocks consisting of blocky hornblende and/or prismatic actinolite + plagioclase + epidote/clinozoisite, + opaque minerals. Hornblende is uralitic and probably formed as pseudomorphs after primary clinopyroxene. Rock may contain a relict interlocking igneous texture. Also includes less common metamorphosed diorite and quartz diorite. These metaplutonic lithologies also occur sporadically as unmapped bodies within the metamorphosed basalt unit.

Zhmgd **Metagabbro/metadiorite and metabasalt/microdiorite (Neoproterozoic)**—Black to dark green to light greenish gray, mesocratic to melanocratic (CI = 40 – 80), medium-crystalline gabbro and diorite. Unfoliated outcrops contain plagioclase + hornblende + epidote or clinozoisite + opaque minerals, and locally quartz and sulfide minerals. Preserves a relict phaneritic texture between blocky plagioclase + tabular hornblende. Uralite in irregular xenomorphic hornblende or actinolite are interpreted to indicate that these crystals may be pseudomorphs after magmatic clinopyroxene in gabbro. Other relict phaneritic samples display interlocking, xenomorphic to hypidiomorphic granular plagioclase + hornblende that are interpreted to be magmatic diorite. Fine-crystalline equivalents are interpreted to be metamorphosed basalt, in some cases now amphibolite, and metamorphosed microdiorite that preserve a relict aphanitic to fine phaneritic igneous texture. Scattered outcrops of metamorphosed quartz diorite, hornblende tonalite, trondhjemite, and locally granodiorite are intimately associated with the metamorphosed gabbro and diorite and are interpreted to be more quartz-rich and differentiated magmatic rocks of the Halifax County complex. Where overprinted by the Hollister fault zone, steeply dipping chlorite-rich phyllonite, mylonite, and gabbro/diorite gneiss protomylonite are produced from the original igneous protoliths. Unit is inferred to be correlative with mafic to intermediate rocks of the Halifax County complex of Kite (1982) and Kite and Stoddard (1984), as well as metamorphosed gabbro (CZhmg) and metabasalt (CZhmb) of the Halifax County complex mapped by Stoddard et al. (2012) in the Red Oak 7.5-minute quadrangle just to the south of the Essex 7.5-minute quadrangle.

Zfhmgd **Deformed metagabbro/metadiorite and metabasalt/microdiorite (Neoproterozoic)**—Deformed and metamorphosed gabbro and diorite and basalt and microdiorite of the Halifax County complex. Where overprinted by the Hollister fault zone, steeply dipping chlorite-rich phyllonite, mylonite, and gabbro/diorite gneiss protomylonite are produced from the original igneous protoliths.

Zhmpx **Metapyroxenite cumulate (Neoproterozoic)**—Pale to dark green, melanocratic (CI greater than 80), medium-crystalline and massive metamorphosed pyroxenite. Blocky actinolite porphyroblasts up to 7 mm in length display uralite, interpreted to be a pseudomorph of original magmatic cumulate pyroxene crystals that have been replaced by mats of actinolite prisms during metamorphic recrystallization. Pale green clinozoisite is interstitial to actinolite and may reflect the reaction replacement of intercumulate plagioclase in the original igneous ultramafic protolith. Forms an undeformed pod or phacoid of ultramafic rock and gabbro/diorite surrounded by deformed and foliated gabbro and diorite of the Halifax County complex within the Hollister fault zone along Powells Creek due west of its confluence with Little Fishing Creek. Another pod is located in the small stream just east and north of Little Fishing Creek and County Road 1338, respectively, in the Ringwood 7.5-minute quadrangle to the east of the Essex 7.5-minute quadrangle. Unit is inferred to be correlative with metamorphosed ultramafic rocks of the Halifax County complex of Kite (1982) and Kite and Stoddard (1984).

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