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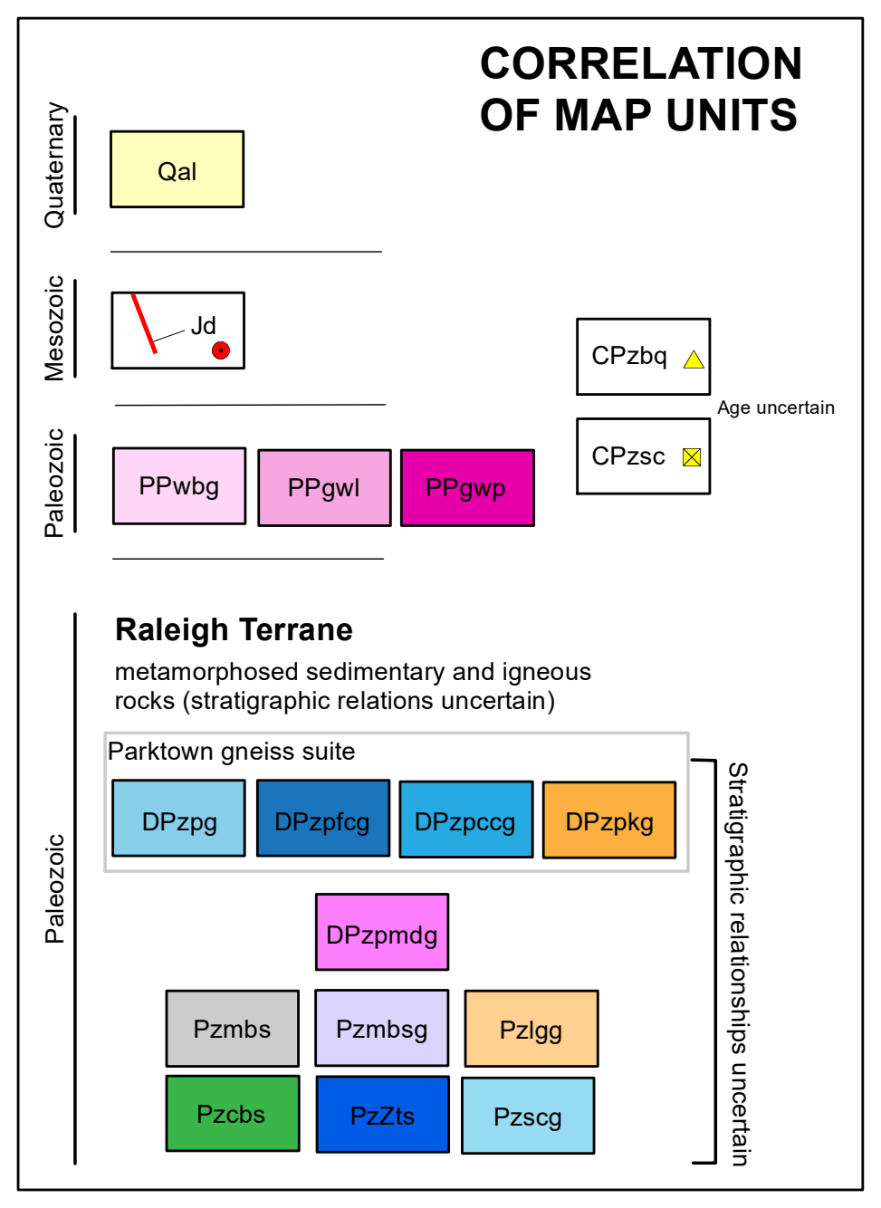
## CORRELATION OF MAP UNITS



INTRODUCTION

The Warrenton 1:24,000 Quadrangle lies in the northeastern North Carolina Piedmont entirely within rural Warren County. It is located 75 km northeast of Raleigh in the Henderson 1:100,000 sheet. The towns of Norlina and Warrenton, the county seat, are the largest urban areas. Fishing Creek is the largest stream in the southern portion of the quadrangle. Its drainage basin includes Possumquarter, Horse, Phoebus, Matthews, Rocky, and Owens Creeks, and the upper reaches of Reedy Creek. All are generally west- to east-flowing tributaries to the Tar River. In the northern portion of the quadrangle, Hawtree, Sawmill, Malones, and Terrapin Creeks as well as Cabin Branch flow generally northward from Warren Plains, Norlina, and Ridgeway towards the Roanoke River and Lake Gaston. Natural exposures of crystalline rocks occur along these drainages, their numerous small unnamed tributaries, and small roadcuts leading into incised drainages. The topographically highest areas along drainage divides constitute broad, generally flat plains underlain by unconsolidated Cenozoic sedimentary deposits and Pennsylvanian-Permian Wise granite pavement outcrops from the unincorporated communities of Snow Hill and Warren Plains just northwest of Warrenton to Norlina, Ridgeway, Wise, and Oine. Elevations range from approximately 450 feet above sea level in areas adjacent to the intersection of U.S. 158 and Warren Plains Road to less than 250 feet along Possumquarter, Hawtree, and Sawmill Creeks at the southeastern and northeastern corners of the quadrangle as well as Cabin Branch, Terrapin, and Malones Creeks along the northern boundary of the quadrangle. U.S. Highway 401 and Business U.S. Highway 158 meet in downtown Warrenton. U.S. 401 and U.S. 158 continue northwest from Warrenton to Norlina where they intersect U.S. 1 on its way south to Henderson and north to South Hill, Virginia. U.S. 158 continues east through Littleton to Roanoke Rapids. U.S. 401 continues southwest from Warrenton to Louisburg, the Franklin County seat, while NC 58 starts in Warrenton and extends southeast to Nashville, the Nash County seat. Northeast-southwest-oriented I-85 passes through Oine just northwest of Norlina.

GEOLOGIC FRAMEWORK

Pre-Mesozoic crystalline rocks of the Warrenton Quadrangle lie within the composite Pennsylvanian-Permian Rolesville-Wise plutons or are lithodemes within the eastern Raleigh terrane. Unmetamorphosed biotite ± muscovite granite of the Wise pluton underlies most of western and northeastern portions of the quadrangle. Metamorphic rocks of the eastern Raleigh terrane are outcrop- to map-scale xenoliths throughout the Wise pluton. There is also a large swath of country rock in the southeastern portion of the quadrangle that extends into the Afton, Inez, and Macon Quadrangles to the south and east. The eastern Raleigh terrane rocks are interpreted to have regionally metamorphosed plutonic-volcanic or sedimentary protoliths based upon mineralogical and textural relationships and U/Pb zircon geochronology. The xenolithic metamorphic rocks achieved the biotite-garnet zone during upper greenschist to amphibolite facies metamorphism. While sillimanite is reported in schist from the Middleburg Quadrangle to the west of the Wise pluton, hand sample petrography did not identify this index mineral in the western Warrenton Quadrangle. However, thin section petrography is still pending due to the CoVid-19 pandemic. Isolated country rock sillimanite-bearing assemblages formed during localized middle to upper amphibolite facies metamorphism occur in the southeast portion of the quadrangle. Some exposures also record a greenschist facies, chlorite zone retrograde overprint of prograde biotite-rich assemblages.

Some outcrops are well foliated, but display only localized evidence of dynamic recrystallization, especially xenoliths within the western Wise biotite granite. They may have experienced some degree of contact metamorphic recrystallization due to granite plutonism. Other outcrops are moderately to highly transposed crystal-plastic phyllonitic or protomylonitic to mylonitic S and localized L-S tectonites, especially in the southeastern portion of the quadrangle. This tectonothermal overprint is primarily the result of late Paleozoic Alleghanian orogenesis developed during dextral transpressional evolution of the Eastern Piedmont fault system (EPFS; Hatcher et al., 1977; Farrar, 1985a, 1985b; Russell et al., 1985; Stoddard et al., 1991; Sacks, 1999; Hatcher, 2010; Blake et al., 2012). Upper greenschist to upper amphibolite facies metamorphic rocks record two deformation events. Northwest- or southeast-plunging tight to isoclinal F1 folds and S1 axial surface gneissosity or schistosity overprint mesoscale transposed compositional layers, S0. It is not yet clear if this foliation is a result of a prior mid-to-late Paleozoic regional metamorphic and deformation event or a regional dextral phyllonitic or dextral mylonitic overprint associated with the Alleghanian orogeny. A mineral stretching lineation is commonly oriented subparallel to the F1 fold hinges in high-strained tectonites in the southeastern portion of the quadrangle. The S0 and S1 regional foliation is refolded by generally north-northeast to south-southwest plunging, upright to east-vergent tight to open, and locally chevron style F2 folds. Some bull quartz veins and localized cataclasite reflect a brittle structure overprint that may be late Paleozoic to early Mesozoic, or possibly Cenozoic in age. Jurassic diabase dikes are unmetamorphosed and generally strike north-northwest across the Warrenton Quadrangle. Stream drainages contain variable amounts of Quaternary alluvium.

In several paleogeographic and lithotectonic reconstructions of the southern Appalachian orogen and the eastern Piedmont physiographic province, the Raleigh terrane is grouped with the 633-528 Ma Carolinia domain (Stoddard et al., 1991; Hibbard et al., 2002, 2006; Blake et al., 2012). Carolinia is one of several exotic second order lithotectonic domains that are part of the first-order peri-Gondwanan realm and circum-Atlantic island-arc systems amalgamated to eastern Laurentia during mid-Paleozoic arc-continent collision. Carolinia was dissected into third-order terranes by the EPFS during Laurentian-Gondwanan continent-continent collision in the late Paleozoic era (Hatcher et al., 1977; Bobyarchick, 1981). The terranes differ in their proportions of magmatic and volcanogenic sedimentary rocks, environments of formation, major and trace element, isotopic and zircon U-Pb geochemical signatures, and crustal levels of tectonothermal overprinting. Both the EPFS and the terranes are now exposed on the flanks and across the hinge of the Wake-Warren antiform, a regional-scale foliation arch in the eastern Piedmont. Carolinia suprastructural terranes remained at upper-crustal levels during Alleghanian orogenesis and record greenschist facies metamorphism on the flanks of the antiform. Infrastructural terranes, including the Raleigh terrane, are also exposed on the flanks and in the hinge zone of the Wake-Warren antiform. They reached mid-crustal levels and were subjected to the upper greenschist to upper amphibolite facies metamorphism. In contrast, Farrar (1985a, 1985b), Farrar and Owens (2001), and Hatcher (2010) interpreted the Raleigh terrane to be related to the Mesoproterozoic Goochland domain in the Virginia Piedmont. There, Owens et al. (2010) obtained 1.1 Ga and 385 Ma U-Pb magmatic zircon ages on the State Farm and Maidens Gneisses, respectively. The Goochland domain is interpreted to have a Laurentian rather than peri-Gondwanan affinity.

Recently, however, the link between the eastern Raleigh terrane east of the Lake Gordon shear zone and Carolinia has come under question based upon new mapping and zircon U-Pb analyses. Peach et al. (2017), Peach (2018), Finnerty et al., (2019), Finnerty (2020), Nolan et al. (2020), and Nolan (2020) report new LA-ICP-MS U-Pb magmatic and detrital zircon ages for upper greenschist to amphibolite facies schist and gneiss from the eastern Raleigh terrane in the Afton, Inez, Littleton, Macon, Middleburg, Vicksboro, and Warrenton Quadrangles. The informal Soul City gneiss from the eastern Middleburg Quadrangle yielded 60 zircon grains that contained a multi-modal and detrital age distribution. Prominent age modes in this distribution are ca. 1969, 1533, 1200, and 1015 Ma. The maximum depositional age for this sample of Soul City gneiss is interpreted to be early Paleozoic (Peach, 2018). A ca. 336 Ma zircon age is interpreted to be related to late Paleozoic granitic micro-diking during Alleghanian orogeny plutonism (Peach et al., 2017; Peach, 2018). A sample collected in hornblende biotite gneiss in the eastern Vicksboro Quadrangle yielded 64 zircon grains that contained a multi-modal and detrital age distribution. Prominent age modes in this distribution are ca. 2058, 1762, 1461, 1178, 500, and 360 Ma. The maximum depositional age for this sample of hornblende biotite gneiss is interpreted to be early Paleozoic (Nolan, 2020).

In the eastern Afton Quadrangle, two samples of the informal Parktown fine-crystalline gneiss yielded 35 and 55 grains that both contained unimodal age distributions interpreted to be magmatic in origin. The weighted mean ages of these samples are 410.5 ± 3.7 Ma and 403 ± 2.1 Ma, corresponding with the Early Devonian period (Peach et al., 2017; Peach, 2018; Nolan et al., 2020; Nolan, 2020). In the southern Macon Quadrangle, a sample of the informal Possumquarter gneiss yielded 32 grains that contained a unimodal age distribution interpreted to be magmatic in origin. The weighted mean age of this sample is 403.2 ± 3.2 Ma, also corresponding with the Early Devonian period (Finnerty et al., 2019; Finnerty, 2020). A sample of the Liberia gneiss from the Inez Quadrangle yielded two different types of zircon grains based upon cathodoluminescence analysis. Cathodoluminescent-bright (CL-light) zircon yielded a multi-modal age distribution of ca. 2108–415 Ma that includes prominent age modes of ca. 680, ca. 585, and ca. 450 Ma. Cathodoluminescent-dark (CL-dark) zircon that have Th/U < 0.1 yielded a unimodal age distribution of ca. 331±12 Ma (Finnerty et al., 2019; Finnerty, 2020). The Liberia gneiss is interpreted to have formed in the middle Paleozoic era and metamorphosed in the middle to late Paleozoic era.

A sample from the western Littleton Quadrangle, originally called the Littleton schist but now correlated with the Mill Branch schist, yielded 48 grains that contain a multi-modal and detrital age distribution. Prominent age modes in this distribution are ca. 1570, 973, 577, and 418 Ma. The maximum depositional age for this sample of schist is interpreted to be early to middle Paleozoic (Peach et al., 2017; Peach, 2018). A sample of garnet biotite schist from the southeast Warrenton Quadrangle yielded 72 grains that contain a multi-modal and detrital distribution. Prominent age modes in this distribution are ca. 2031, 1484, 1191, 924, and 484 Ma. The maximum depositional age for this sample of garnet biotite schist is interpreted to be middle Paleozoic based upon the mean ages of the youngest cluster of grains (Finnerty et al, 2019; Finnerty, 2020). Three samples of Mill Branch schist from the Macon and Inez Quadrangles yielded 51, 55, and 41 grains containing multi-modal and detrital distributions. Prominent age modes of these distributions are ca. 1899, 1420, 963, 586, and 410 Ma. The maximum depositional ages are interpreted to be middle Paleozoic based upon the mean ages of the youngest cluster of grains (Finnerty, 2020; Nolan, 2020). The restriction of detrital zircon ages to 2.0–1.0 Ga and a Cambrian depositional age of the Soul City gneiss and hornblende biotite gneiss in the Vicksboro Quadrangle suggest a difference in provenance as compared to other eastern Raleigh terrane schist samples to the east. Portions of the eastern Piedmont mapped as a single Carolinia-related Raleigh terrane may in fact represent different structural blocks that have distinct Laurentian versus Gondwanan domain affinities (Blake et al.,2012; Peach et al., 2017; Peach, 2018).

PREVIOUS GEOLOGIC MAPPING

Prior geologic investigations pertinent to the Warrenton Quadrangle include several regional and reconnaissance studies. Parker (1968) defined the structural framework of the North Carolina Eastern Piedmont. A multi-county map by McDaniel (1980) includes Warren County at the 1:100,000 scale. Farrar (1985a, 1985b) mapped the entire eastern Piedmont of North Carolina, defined map units, and proposed a regional stratigraphic and tectonic model. The 1:24,000-scale maps surrounding the Warrenton Quadrangle include a four-quadrangle area by Stoddard and others (2009) in the Gold Sand and Centerville Quadrangles to the south of the Warrenton Quadrangle in the eastern Raleigh terrane. Peach (2018) and Nolan (2020) have mapped the eastern and western Afton Quadrangle, respectively, in the eastern Raleigh terrane and Rolesville-Wise batholith directly south of the Warrenton Quadrangle. The Inez, Macon, Hollister, and Littleton Quadrangles (Boltin, 1985; Sacks et al., 2011; Stoddard et al., 2011; Morrow, 2015; Morrow et al., 2016; Rice and Blake, 2017; Finnerty, 2020) lie to the east of the Warrenton and also include exposures of the eastern Raleigh terrane. Mapping by Horton et al., (1993) and Sacks (1996a, 1996b, 1996c) include lithologies of the eastern Raleigh terrane to the north and northeast of the Warrenton Quadrangle in the South Boston 1:100,000 sheet and the Bracey, South Hill SE, and Gasburg 1:24,000 Quadrangles. Stoddard et al. (2016) mapped the western Raleigh terrane between the Nutbush Creek-Lake Gordon shear zones in the Middleburg Quadrangle just to the west of the Warrenton Quadrangle. Stoddard et al., (2018) also mapped the eastern Raleigh terrane and Rolesville batholith in the northeastern Vicksboro Quadrangle just to the southwest of the Warrenton Quadrangle.

DESCRIPTION OF MAP UNITS

The pre-Mesozoic crystalline rocks of the Warrenton 1:24,000 Quadrangle are primarily early Paleozoic to Devonian metamorphic units within the eastern Raleigh terrane, Pennsylvanian-Permian granite of the composite Rolesville-Wise plutons and Jurassic diabase. Local outcrops of highly silicified or silicified-epidotized cataclasite rock have unclear protolith affinities and ages. Some localities preserve relict plutonic and possibly sedimentary textures that when combined with bulk mineral assemblages and geochronological relationships provide criteria for potential protolith identification. The classification of igneous rocks uses the nomenclature of the International Union of Geological Sciences (IUGS) subcommission on the systematics of igneous rocks after Le Maitre (2002). A preliminary lithodemic designation for eastern Raleigh terrane metamorphic rocks follows Articles 31-42 of the North American Stratigraphic Code. All the Cenozoic-aged geologic materials identified on the map have a detrital origin involving mud- to gravel-sized clasts and occur as part of Tertiary upland sediment deposits or Quaternary stream and floodplain deposits.

SEDIMENTARY UNITS

Qal

**Qal – alluvium:** Tan-brown, unconsolidated, poorly sorted, angular to subrounded clay, silt, sand and gravel- to cobble-sized clasts derived from surrounding older lithodemic and plutonic units. Deposited within and along stream drainages as point bar, natural levee, and floodplain sediments.

HYDROTHERMAL AND FAULT UNITS

CPzbq △

**CPzbq – bull quartz:** White to dark gray, gravel to boulder sized clasts of milky and smoky quartz. Outcrops range in size from isolated boulder piles to larger hilltop exposures. Linear arrays of bull quartz may form regularly spaced outcrops. Occurrences of these arrays are possibly related to mineralization associated with pegmatitic granite or formed along tension gashes or brittle faults.

CPzsc ☒

**CPzsc – silicified cataclasite:** Green gray to white, fine crystalline quartz ± epidote rock. This mineral assemblage typically replaces the original protolith rock. Outcrops are generally massive and highly fractured. Local occurrences and linear arrays may be related to brittle faulting.

INTRUSIVE ROCKS

Jd ●

**Jd – diabase:** Melanocratic (CI greater than 80), dark gray to black, fine- to medium-crystalline, aphyric to phyric and dense diabase consisting primarily of plagioclase, augite, and locally olivine. May be plagioclase phyric. Weathered surfaces are generally tan gray, grayish or brownish in color and pockmarked. Crops out typically as isolated, spheroidal weathered stream and hillside cobbles, boulders, and boulder fields. Vertically to steeply dipping outcrops of diabase in streams are dikes that range up to several m in thickness. Red dashed lines link individual station locations where stream outcrops or boulders of diabase form linear arrays. Red dots indicate isolated float occurrences.

PPwbg
PPgwl
PPgwp

**PPwbg – Wise pluton biotite granite:** Hololeucocratic (CI=5-10), tan to pink white to pink gray, holocrystalline, phaneritic to fine- to medium-crystalline, xenomorphic equigranular biotite granite. The primary mineral assemblage includes Na-plagioclase, microcline, quartz, biotite, and locally minor muscovite and 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, and muscovite granite pods and dikes crosscut biotite granite in many exposures. **PPgwl** is a hololeucocratic and aplitic leucogranite domain within biotite granite. **PPgwp** is a pegmatitic quartz white mica granite exposed in an abandoned quarry. 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 orientation similar to surrounding wall rock foliation orientations 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.

METAMORPHIC ROCKS OF THE EASTERN RALEIGH TERRANE

Note: Order of listed units does not imply a stratigraphic sequence, although units that clearly preserve meta-plutonic textures and relationships are listed first.

Pzlgg

**Pzlgg – Liberia granodiorite and granodioritic gneiss:** Hololeucocratic to leucocratic (CI=5-25), light tan to gray white brown, phaneritic medium- to coarse-crystalline protomylonitic to mylonitic biotite muscovite granodiorite and locally biotite muscovite granite. The CIPW normative mineralogy (A. Rice, personal communication) of the Liberia gneiss plots on a QAP diagram as a monzogranite. Primary mineral assemblage includes relict phaneritic to crystalloblastic microcline, Na-plagioclase, quartz, muscovite, biotite, and locally garnet. May contain xenomorphic prisms or blebby epidote, allanite, monazite, and apatite crystals. Compositionally layered and ribboned quartz and porphyritic to porphyroclastic K-feldspar crystals that range from 1 cm to more than 10 cm occur within granodiorite to granodioritic gneiss protomylonite. A gradational transition into granodioritic mylonite and ultramylonite occurs in high-strain zones. Muscovite and locally abundant biotite mark the penetrative shear foliation that asymmetrically wrap winged K-feldspar porphyroclasts and consistently preserve a west-side north sense of fish flash regardless of the steep dip direction of the shear foliation. Recrystallized wings are commonly elongate in the direction of a locally penetrative mineral stretch lineation of quartz-feldspar rods and phyllosilicate aggregates. Locally, chlorite topotaxially replaces biotite. Growth of chlorite “rosettes” is interpreted to indicate a greenschist facies retrograde overprint of this unit. Locally granodioritic gneiss is interlayered with mesocratic and porphyroclastic plagioclase biotite tonalite gneiss protomylonite to mylonite. This unit appears to be correlative to the CZmxg unit of Stoddard et al. (2009) and Sacks et al. (2011). It has a complex zircon grain history, but potentially has a middle Paleozoic age.

DPzpmdg

**DPzpmdg – Possumquarter biotite meta-monzodiorite to monzodiorite gneiss:** Chiefly mesocratic (CI=25-50), brownish black to greenish black, phaneritic medium crystalline and commonly white spotted porphyritic to porphyroclastic plagioclase biotite gneiss protomylonite. The CIPW normative mineralogy (A. Rice, personal communication) of the Possumquarter gneiss plots on a QAP diagram as a monzodiorite. Mineral assemblage includes large relict phenocrystic plagioclase, biotite greater than hornblende, quartz, sphene, apatite, and opaque minerals. Large, readily identifiable K-feldspar crystals were not observed, but K-feldspar may be present in the finer crystalline, relict igneous matrix. Locally, monzodiorite contains xenomorphic and zoned epidote crystals and xenoblastic and skeletal garnet porphyroblasts up to 1 cm in diameter. An increase in the amounts of quartz, plagioclase, and biotite mark quartz diorite while hornblende and plagioclase dominate local and less common exposures of diorite. Protomylonitic and mylonitic equivalents of these rocks are commonly observed. A white mica-biotite and quartz ribbon shear foliation as well as degree of crystalloblastic matrix and plagioclase porphyroclast development mark the transition into highly deformed gneissic equivalents. Local 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 garnet porphyroblasts while plagioclase, especially in diorite, may be saussuritized and sericitized. Growth of chlorite “rosettes” is interpreted to indicate a greenschist facies retrograde overprint of this unit. Early Devonian magmatic unimodal zircon ages and relict igneous textures from the Possumquarter gneiss demonstrates that this lithodeme had a plutonic, volcanic, or proximal volcanogenic sedimentary protolith (Peach et al., 2017; Peach, 2018; Finnerty, 2020; Nolan, 2020), although surrounding rocks may have older early to middle Paleozoic ages.

DPzpg
DPzpfcg
DPzpccg
DPzpkg

**DPzpg –Parktown gneiss suite:** Compositionally diverse and strongly layered lithodemic suite of intermediate and quartzofeldspathic gneiss. The CIPW normative mineralogy (A. Rice, personal communication) of a Parktown gneiss sample plots on a QAP diagram as a dacite/granodiorite. Mineralogy includes biotite, hornblende, plagioclase, quartz, K-feldspar, and local clinopyroxene, magnetite, epidote, garnet, and chlorite. Originally mapped as a single lithodeme in the eastern Afton and southeastern Warrenton Quadrangles (Blake et al., 2018; Peach, 2018). In the western Afton (Nolan, 2020) and western Warrenton Quadrangles, the Parktown gneiss is a suite that contains three mineralogically and texturally distinct lithodemes. They include mesocratic (CI=35-65) black green to black blue to blue gray Parktown fine-crystalline gneiss (**DPzpfcg**) and Parktown coarse-crystalline gneiss (**DPzpccg**), and hololeucocratic to leucocratic (CI=5-35) medium gray to gray white to tan white, fine- to medium-crystalline Parktown porphyroclastic K-feldspar ± biotite gneiss (**DPzpkg**). Saprolite cutbanks and hard rock pavements, blocky knickpoints, waterfalls, and cascades are common. Lithodemes vary in thickness of gneissic compositional layers from a few cm to 10s of cm. All display crystalloblastic recrystallization textures. Isolated or trains of plagioclase or K-feldspar porphyroclasts and leucosome stringers of feldspar and quartz contribute to the gneissosity and are commonly ptygmatically folded, especially in the eastern portion of the Parktown suite. Fine-crystalline gneiss has whitish tan to light gray to dark gray, fine-to medium-crystalline, and mm-to-cm-scale quartzofeldspathic layers that alternate with minor 0.5 to 2 mm thick hornblende-bearing biotite layers. Lithodeme has non-mappable interlayers of fine lepidoblastic biotite quartz schist, and quartz-plagioclase gneiss that may be metamorphosed trondhjemite. Pink, orange, or white K-feldspar porphyroclasts that range between 5 and 25 mm in diameter distinguish porphyroclastic K-feldspar gneiss. When it is the dominant lithology, it only contains interlayers of fine-crystalline gneiss. Primarily preserves a regional metamorphic foliation of biotite and hornblende. Local protomylonitic to ultramylonitic gneiss preserves penetrative dynamic recrystallization and kinematic indicators, especially in eastern outcrops of the suite adjacent to the Mill Branch schist. A sequence of outcrops may preserve any combination of the three lithodemes because of their complex interlayering and F1 tight to isoclinal folding. Fine-crystalline chlorite may topotaxially replace fine- to medium-crystalline biotite in the foliation plane in all three lithodemes and vermiculite replaces biotite in weathered exposures. Epidote is a common secondary metamorphic mineral that replaces fine- to medium-crystalline plagioclase during saussuritization. These relationships are interpreted to indicate a greenschist facies retrograde overprint. Numerous layers appear to preserve relict igneous mineral assemblages and features, but some interlayers may be metasedimentary due to complex interlayering. The lithodemes are part of the eastern Raleigh terrane in the southeastern Warrenton Quadrangle and common as country rock xenoliths in the Wise granite. Early Devonian magmatic unimodal zircon ages from the Parktown gneiss demonstrates that at least some deformed layers had plutonic, volcanic, or proximal volcanogenic sedimentary protoliths (Peach et al., 2017; Peach, 2018; Finnerty, 2020; Nolan, 2020), although surrounding rocks may have older early to middle Paleozoic ages.

Pzmbs

**Pzmbs – Mill Branch schist:** Leucocratic silver green gray to reddish green gray to gray and orange brown, 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 porphyroblasts are 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. Growth of chlorite “rosettes” is 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, as well as biotite and garnet. Hydrothermal metasomatism and breakdown of relict feldspars may be a factor in the muscovite as well as schist development. Protoliths for the schist appear to be early to middle Paleozoic sedimentary rocks based upon its multi-modal and detrital zircon age distribution.

Pzgmbs

**Pzgmbs – garnet-rich muscovite biotite schist:** Mesocratic silver brown to black brown, fine-to-medium-crystalline tourmaline-bearing garnet white mica biotite schist. The abundance of plagioclase, biotite, garnet, and tourmaline prisms mark this unit. Plagioclase commonly occurs as large relict igneous phenocrysts 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 yields 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. They are generally up to 5 mm in diameter and distinctly purple red. Microscopically, their 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 and zircon are common accessory minerals. Chlorite may impart a pale green coloration to some samples. It topotaxially replaces biotite and joins white mica in the shear foliation. Locally it may partially surround some xenoblastic garnet. Growth of chlorite “rosettes” is interpreted to be a greenschist facies retrograde overprint of this unit. 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.

Pzgscg

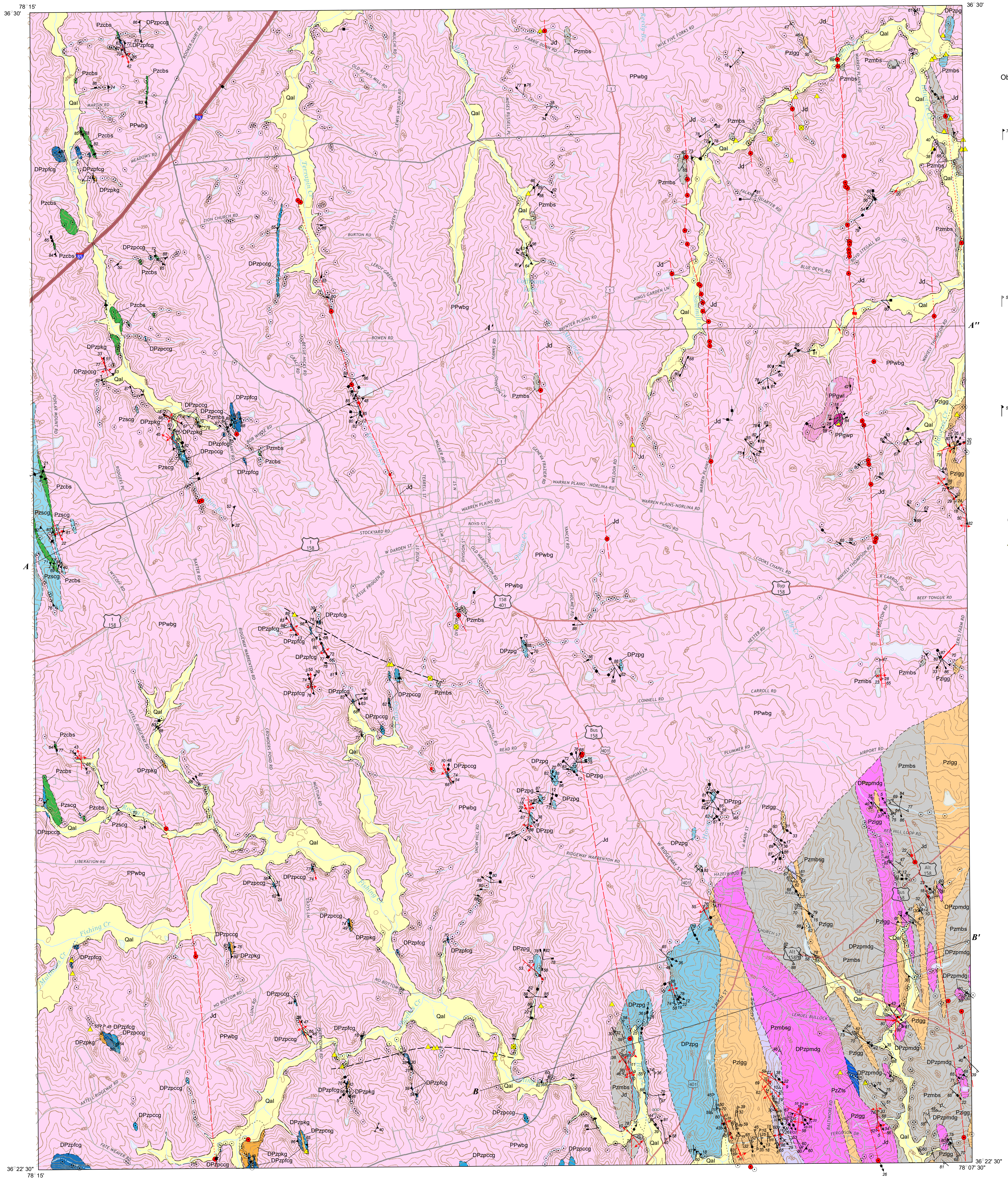
**Pzscg – Soul City gneiss:** Mesocratic to locally melanocratic black gray to blue gray, fine-crystalline biotite hornblende gneiss. May contain clinopyroxene and/or epidote in its metamorphic mineral assemblage. Biotite and hornblende define a regional foliation associated with mm- to cm-scale and relatively equigranular 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 Quadrangle. Local cm-scale compositional layers may be tight to isoclinally F1 folded and then openly F2 refolded. Some discrete granitic gneiss dikes may crosscut the gneiss or be isoclinally folded. Lithodeme may be interlayered with mesocratic medium- to coarse-crystalline biotite hornblende gneiss. These layers contain spotted hornblende and/or plagioclase porphyroclasts and 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 Quadrangles. The protolith for this gneiss appears to be an early Paleozoic sedimentary rock based upon its multi-modal and detrital zircon age distribution.

Pzcbs

**Pzcbs – Cabin Branch schist:** Locally leucocratic 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, and 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 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 Wise biotite granite and may correlate with white mica schist (CZwms) in the Middleburg Quadrangle to the west (Stoddard et al., 2016). Locally in contact with the Soul City gneiss in the western Warrenton Quadrangle and may have a similar sedimentary protolith history.

PzZts

**PzZts – actinolite-bearing talc schist:** White to tannish white float cobbles and massive to foliated chips of very fine-crystalline talc schist and soapstone are exposed between Possumquarter Creek and Baltimore Road on the southeastern side of Warrenton. Pale green to white, thin actinolite porphyroblasts are primarily visible microscopically as small elongate prisms. The porphyroblasts are randomly distributed in the fine talc matrix. The talc schist is similar to other bodies mapped within the Littleton Quadrangle (Stoddard et al., 2011). There talc schist occurs within biotite gneiss. Contact relationships with adjacent rock types were not readily observed here, and the schist lies along the contact between Possumquarter gneiss and Mill Branch schist described above.

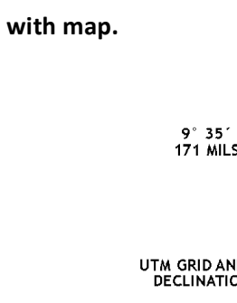


Produced by the United States Geological Survey.
Altered by the North Carolina Geological Survey for use with map.
Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 17S
10 000-foot ticks: North Carolina Coordinate System of 1983

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery....NAIP, June 2014
Roads.... U.S. Census Bureau, 2015 - 2016
Names....GNIS, 2016
Hydrography....National Hydrography Dataset, 2014
Contours....National Elevation Dataset, 2008
Boundaries....Multiple sources; see metadata file 1972 - 2016

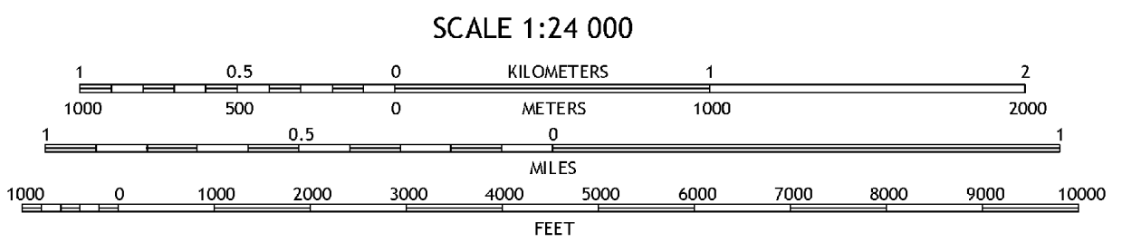
Wetlands....FWS National Wetlands Inventory 1977 - 2014



UTM GRID AND 2016 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

| U.S. National Grid |
|---|
| 100,000-m Square ID |
| QA |
| Grid Zone Designation |
| 17S |

SCALE 1:24 000



CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the
National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.19

QUADRANGLE LOCATION

| 1 | 2 | 3 |
|---|---|---|
| 4 |  | 5 |
| 6 | 7 | 8 |

ADJOINING QUADRANGLES

1 John H Kerr Dam
2 Bracey
3 South Hill SE
4 Middleburg
5 Macon
6 Vicksboro
7 Afton
8 Inez

ROAD CLASSIFICATION

| Expressway | Local Connector |
|---|---|
| Secondary Hwy | Local Road |
| Ramp | 4WD |
| Interstate Route | US Route |

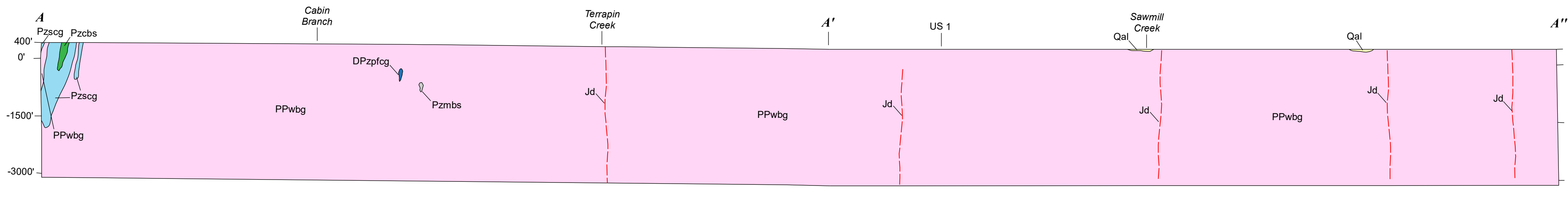
State Route

WARRENTON, NC
2016

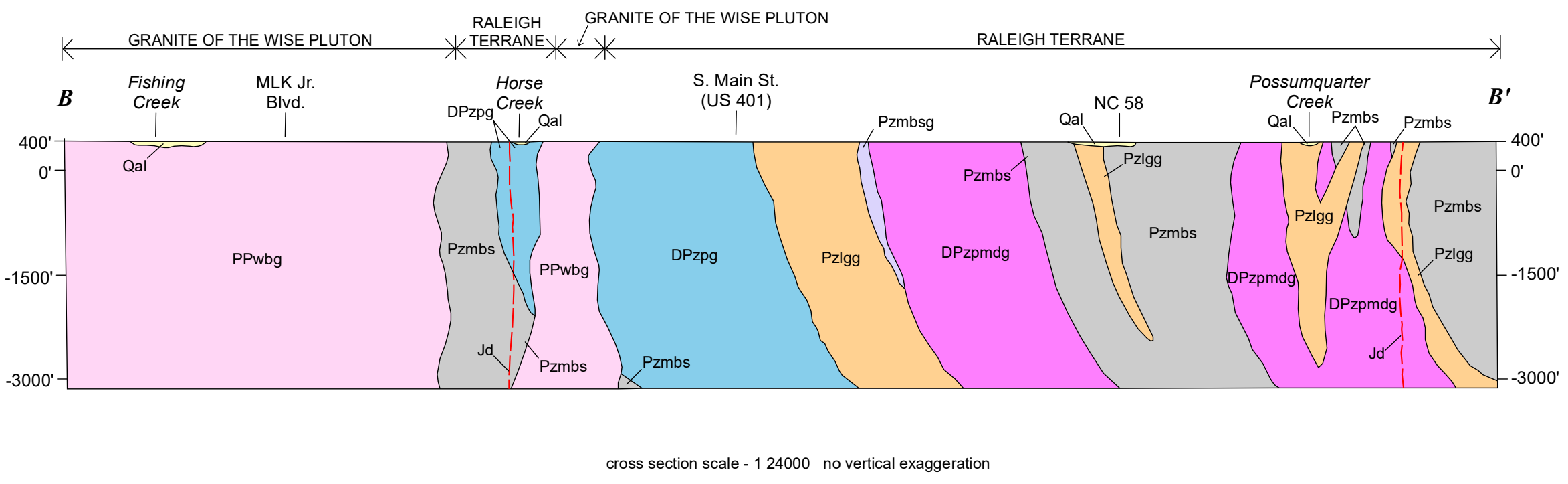
Base map is from USGS 2016 GeoPDF of the Warrenton 7.5-minute quadrangle. Air photo, map collar and select features removed. Bounds of GeoPDF based on 7.5-minute grid projection in UTM 17S; North American Datum of 1983 (NAD83).

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

**Acknowledgements:** Aaron Rice, Brandon Peach, Phil Bradley, Skip Stoddard, and Mark Carter provided field assistance, field review, and technical support for this StateMap project.



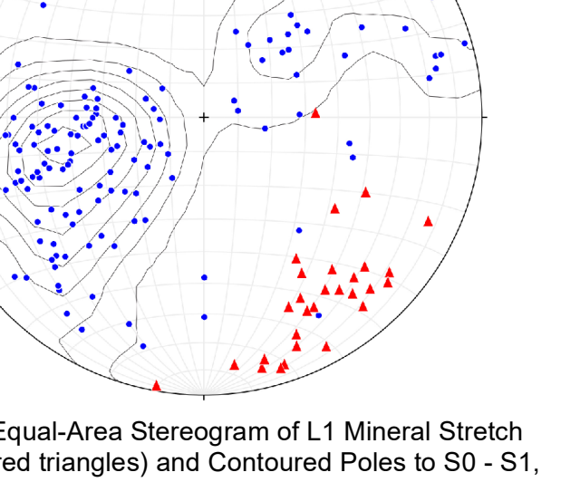
cross section scale - 1 24000 no vertical exaggeration



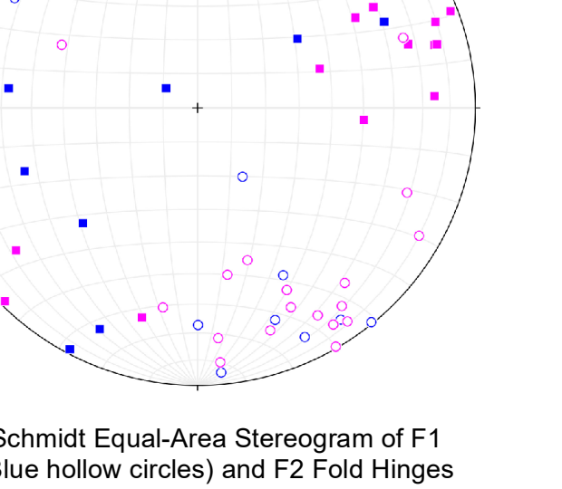
cross section scale - 1 24000 no vertical exaggeration

### Schmidt Equal-Area Stereograms and Rose Diagram

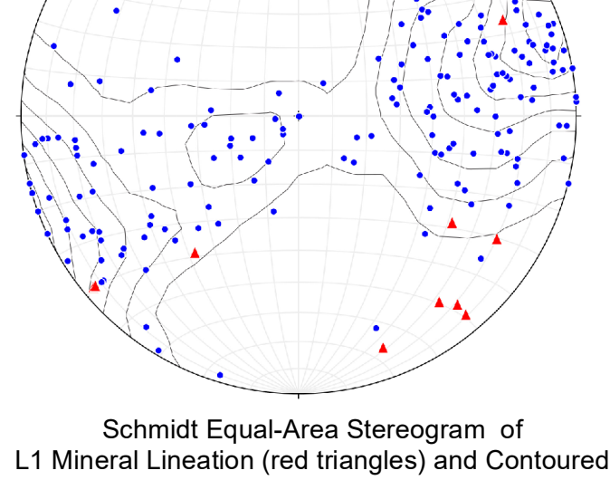
Plots and calculations created using Stereonet v.10.2.0 based on Allmendinger et al. (2013) and Cardozo and Allmendinger (2013)



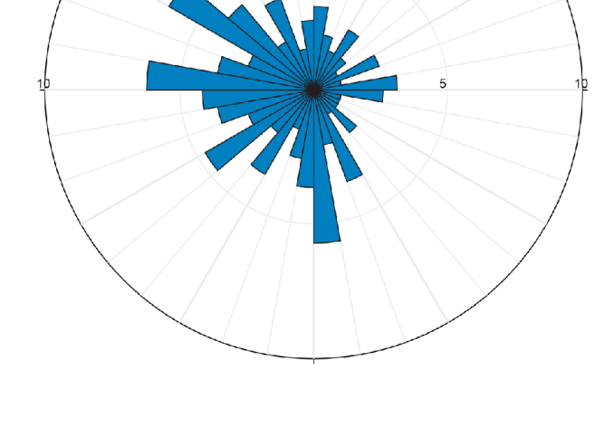
Schmidt Equal-Area Stereogram of L1 Mineral Stretch Lineation (red triangles) and Contoured Poles to S0 - S1, Shear Foliation, Gneissic Layering and Schistosity (blue circles) in eastern Raleigh terrane lithodemes, southeastern Warrenton Quadrangle.
Foliation n = 171; Mineral Lineation n = 34
Kamb Contour Interval = 2 sigma;
Significance Level = 3; Counting Net = 5% of net area



Schmidt Equal-Area Stereogram of F1 (Blue hollow circles) and F2 Fold Hinges (Magenta hollow cirlces) and Poles to F1 (Blue squares) and F2 (magenta squares) axial surfaces in eastern Raleigh terrane lithodemes, southeastern Warrenton Quadrangle.
F1 Fold hinges n = 12; F1 Axial surfaces n = 12
F2 Fold hinges n= 29; F2 Axial surfaces n=29



Schmidt Equal-Area Stereogram of L1 Mineral Lineation (red triangles) and Contoured Poles to S0 -S1: Gneissic Layering, Schistosity, and Minor Shear Foliation (blue circles) of Pendants in the Wise pluton.
Contour Interval = 2 sigma
Significance Level = 3 sigma;
Counting area = 4.39% of net area
Foliation n = 196; Mineral Lineation n = 20



Unidirectional Rose Diagram of Fracture and Joints Sets
n = 193
Outer Circle = 10%

## EXPLANATION OF MAP SYMBOLS

### CONTACTS

- contact
- concealed
- A A′ cross section
- diabase
- diabase concealed
- brittle fault

### STRUCTURAL SYMBOLS

Observation sites are centered on the strike bar or are at the intersection point of multiple symbols.
Planar feature symbols may be comined with linear features.

58 strike and dip of foliation
70 86 strike and dip of foliation (multiple observations at one location)
strike of vertical foliation (multiple observations at one location)
65 strike and dip of crenulation cleavage
25 strike and dip of spaced cleavage (multiple observations at one location)
49 strike and dip of shear foliation
strike of vertical shear foliation
53 61 strike and dip of shear foliation (multiple observations at one location)
strike of vertical shear foliation (multiple observations at one location)
46 strike and dip of gneissic layering
strike of vertical gneissic layering
53 61 strike and dip of gneissic layering (multiple observations at one location)
20 strike and dip of diabase dike trend
strike of vertical diabase dike trend

88 strike and dip of fracture or joint set
strike of vertical fracture or joint set
65 86 strike and dip of fracture or joint set (multiple observations at one location)
strike of vertical fracture or joint set (multiple observations at one location)
62 strike and dip of compositional layering
strike and dip of schistosity
strike of vertical schistosity
53 61 strike and dip of schistosity (multiple observations at one location)
78 strike and dip of fault plane
55 strike and dip of axial surface of fold
strike of vertical axial surface of fold
38 strike and dip of slickenside surface
26 bearing and plunge of mineral lineation
33 bearing and plunge of slickenline lineation
12 bearing and plunge of crenulation lineation
23 bearing and plunge of fold hinge

abandoned quarry

⊙ observation station location
● diabase station location
△ bull quartz vein station location
☒ quartz cataclasite station location

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# Bedrock Geologic Map of the Warrenton 7.5-Minute Quadrangle, Warren County, North Carolina

By David E. Blake, Aaron K. Rice, Patrick C. Finnerty, and Jack T. Nolan

*Geology mapped under STATEMAP between January and May, 2017, 2018, 2019, and January to April 2020.*

*Digital representation by Philip J. Bradley, Aaron K. Rice and Michael A. Medina*

2020

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