North Carolina Department of Environmental Quality
Energy Group
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North Carolina Geological Survey
Open File Report 2016-12
(revised 12/19/2017)

CORRELATION OF MAP UNITS

Quaternary
- Qal

Tertiary
- Tug

Mesozoic
- Jd
- qv
- ccl

Paleozoic

Northwest Gupton Pluton
- PPrwg
- PPqd

Raleigh Terrane
metamorphosed sedimentary and igneous rocks (stratigraphic relations uncertain)
- PzYmbs
- PzZigg
- PzZbg

Macon Fault Zone

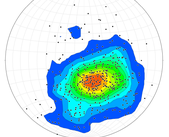
Spring Hope Terrane
metamorphosed volcaniclastic sedimentary and pyroclastic rocks (stratigraphic relations uncertain); radiometric ages on dacite range from ca. 525 to 628 Ma (Goldberg, 1994; Horton and Stern, 1994; Coler and Samson, 2000; Stoddard and Miller, 2011)
- CZmps
- CZm
- CZmv
- CZmmv
- CZmgs

Neoproterozoic - Cambrian

Equal Area Schmidt Net Projections and Rose Diagram

Plots and calculations created using Stereonet v. 8.6.0 based on Allmendinger et al. (2013) and Cardozo and Allmendinger (2013)

Equal Area Schmidt Net Projection of Contoured Poles to Schistosity and Shear Foliation within Domain II (Raleigh Terrane)
Contour Interval = 2 sigma N = 450



Equal Area Schmidt Net Projection of Contoured Mineral Lineations, Pencil Lineations and Lineations within Domain III (Raleigh Terrane)
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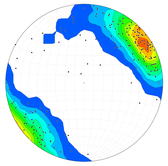

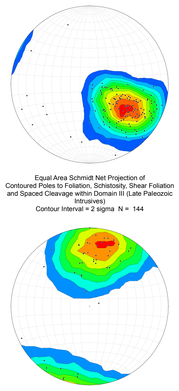

Equal Area Schmidt Net Projection of Contoured Poles to Foliation, Schistosity, Shear Foliation and Spaced Cleavage within Domain III (Late Paleozoic Intrusives)
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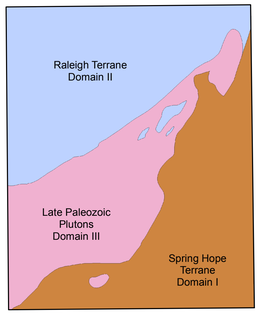

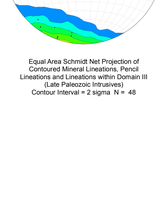

Equal Area Schmidt Net Projection of Contoured Mineral Lineations, Pencil Lineations and Lineations within Domain III (Late Paleozoic Intrusives)
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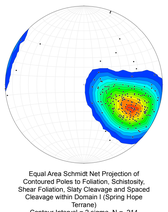

Equal Area Schmidt Net Projection of Contoured Poles to Foliation, Schistosity, Shear Foliation, Shear Foliation, Shear Cleavage and Spaced Cleavage within Domain I (Spring Hope Terrane)
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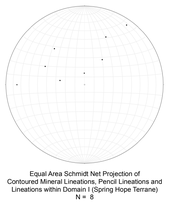
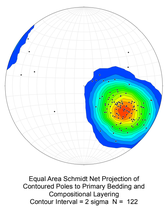
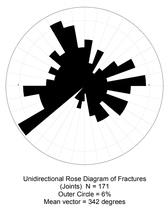


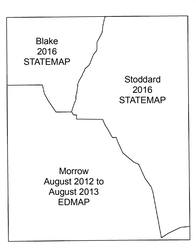
Equal Area Schmidt Net Projection of Contoured Mineral Lineations, Pencil Lineations and Lineations within Domain I (Spring Hope Terrane)
N = 8



Equal Area Schmidt Net Projection of Contoured Poles to Primary Bedding and Compositional Layering
Contour Interval = 2 sigma N = 122



Unidirectional Rose Diagram of Fractures (Joints) N = 171
Outer Circle = 6%
Mean vector = 342 degrees



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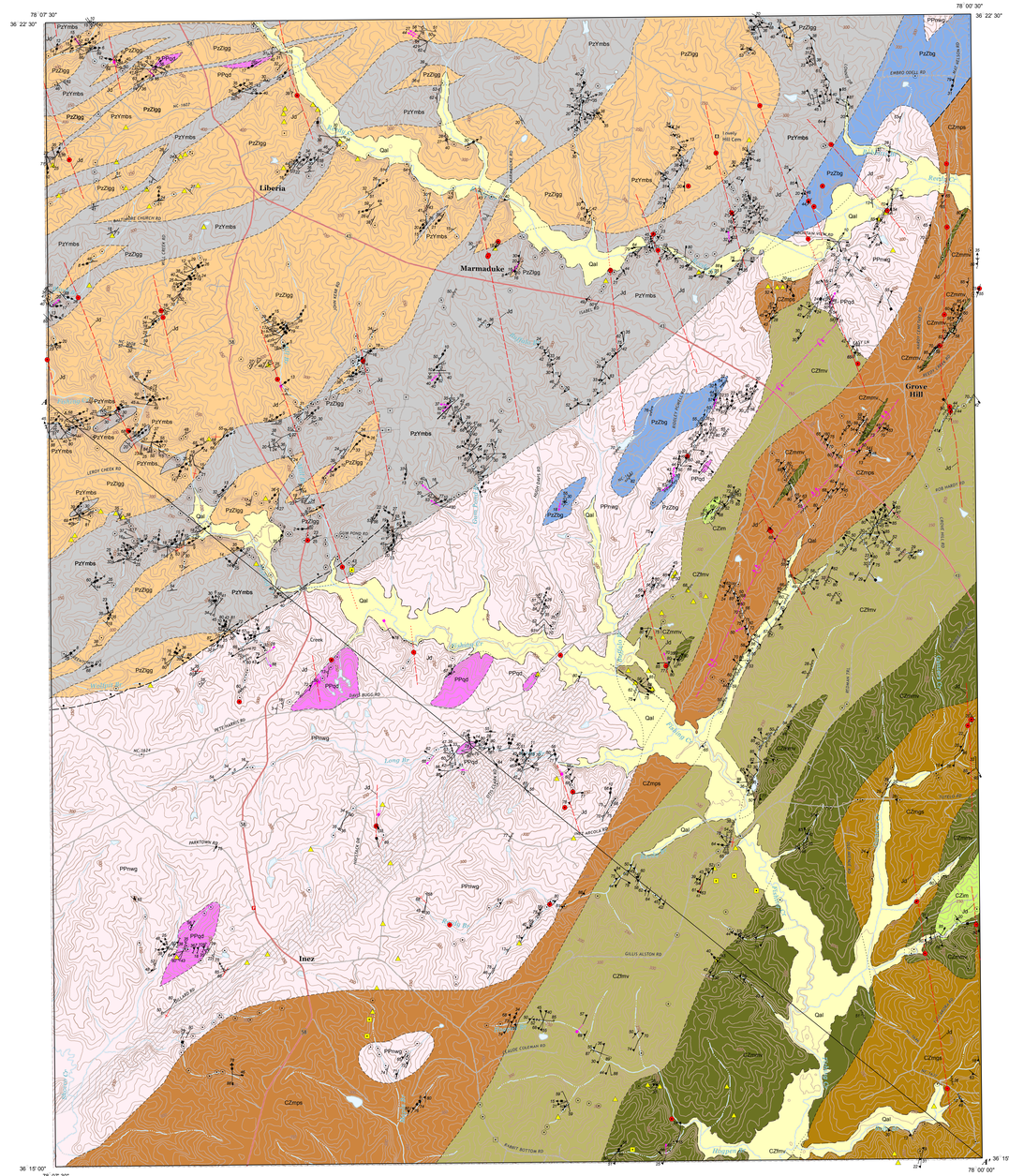


Topographic base produced by the United States Geological Survey
Altered by the North Carolina Geological Survey for use with this map.
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and 1,000-meter grid: Universal Transverse Mercator, Zone 17S
10,000-foot ticks: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

Imagery.....NAIP, May 2012
Roads.....©2006-2012 TomTom
Hshes.....GNIS, 2012
Hydrography.....National Hydrography Dataset, 2012
Contours.....National Elevation Dataset, 2008
Boundaries.....Census, ITMC, IBC, USGS, 1972 - 2012

Bounds of GeoPDF based on 7.5-minute grid projection in UTM 17S, North American Datum of 1983 (NAD83). Geologic polygons tied to 7.5-minute grid projection in State Plane coordinates for edge-matching with legacy GIS data, as such some overlap and underlap of map unit polygons occur around edge of map.

SCALE 1:24 000

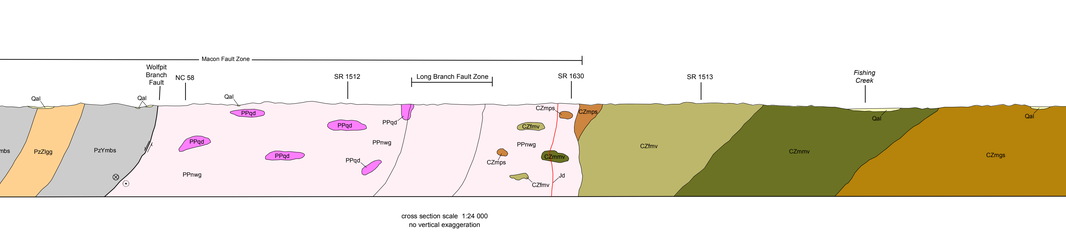
CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

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 0.6.11

INEZ, NC
2013

ROAD CLASSIFICATION

Expressway — Local Connector
Secondary Hwy — Local Road
Ramp — 4WD
Interstate Route — US Route — State Route



cross section scale 1:24 000
no vertical exaggeration

GEOLOGIC MAP OF THE INEZ 1:24,000 QUADRANGLE, WARREN COUNTY, NORTH CAROLINA

By Robert H. Morrow IV, Edward F. Stoddard and David E.Blake

Geology mapped under STATEMAP - January 2016 to May 2016.
Geology mapped under EDMAP – August 2012 to August 2013

Digital representation by Michael A. Medina and Philip J. Bradley

2016
(Revised 12/19/2017)

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program under STATEMAP (Award - 2015, G15AC00237) and the Educational Mapping Program (EDMAP) award number G12AC20314, awarded to Dr. David E. Blake for Robby H. Morrow..

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INTRODUCTION

The Inez 7.5-minute quadrangle lies in the northeastern Piedmont of North Carolina within southern Warren County. The rural communities of Liberia, Marmaduke, Grove Hill and Inez lie within the quadrangle. Two state highways cut across the quadrangle: NC 58 runs north to south from Warrenton through Inez, continuing south to Centerville, and NC 43 runs west to east from Warrenton to Arcola. The rural community of Inez in the southwestern portion of the quadrangle has a fire station and several small churches. Inez is the site of a large lumber mill and several small cattle farms. Fishing Creek, the largest tributary to the Tar River, drains from northwest to southeast across the quadrangle. Tributaries to Fishing Creek include Gunters Creek, Bobs Branch, Buffalo Branch, Gum Pond Branch, Hogpen Branch, Long Branch, Mill Branch, Reedy Branch and Wolfpit Branch. In the northern part of the quadrangle, NC Highway 43 constitutes a drainage divide. The portion of the quadrangle northeast of the highway is drained by Reedy Creek andits tributary Bobbitts Branch. Total relief in the quadrangle is about 210 feet, with a topographic high of about 380 feet along NC 58 in the southern portion of the quadrangle, while the low point is just less than 170 feet above sea level along the confluence of Bob's Branch and Fishing Creek.

GEOLOGIC FRAMEWORK

The geology of the quadrangle is characterized by three distinct groups of rocks. These rocks include Neoproterozoic to Cambrian metamorphic rocks of the Raleigh terrane and the Macon fault zone found in the northwestern portion of the field area. Neoproterozoic to Cambrian metamorphic rocks of the Spring Hope terrane underlie the southeastern sections of the field area. Locally, Pennsylvanian age granitic rocks of the Northwest Gupton pluton separate these two terranes.

One major late Paleozoic fault crosses the Inez Quadrangle. The Macon fault, which separates the Raleigh and Spring Hope terranes and locally deforms the Northwest Gupton pluton, trends east- northeast across the quadrangle. Rocks within the Macon fault zone are predominantly gneiss and schist of middle-upper-amphibolite facies. They may be mylonitic equivalents of Raleigh terrane, Spring Hope terrane, or Pennsylvanian-Permian plutonic rocks. Raleigh terrane lithologies are mapped within and west of the Macon fault zone in surrounding quadrangles, and include biotite granitoid gneiss, hornblende-biotite gneiss, sillimanite-biotite schist, biotite schist, amphibolite, and granitic plutonic rocks (Farrar, 1985a; Sacks, 1996, 1999; Sacks and others, 2011; Stoddard and others 2009, 2011; Stoddard, 2010; Blake and others, 2012). Rocks of the Raleigh terrane are interpreted to represent the infrastructure of the Peri-Gondwanan Neoproterozoic island-arc system known as the Carolinia superterrane (Hibbard and others, 2002).

The Spring Hope terrane is exposed east of the Macon fault zone. It consists predominantly of metavolcanic and metasedimentary rocks metamorphosed to greenschist facies, and locally to middle-amphibolite facies near the Macon fault zone. Locally these rocks are metamorphosed to albite-epidote hornfels facies when in contact with or included within Pennsylvanian age plutons. Protoliths of these rocks include mafic and felsic volcanic rocks, as well as volcanogenic sedimentary rocks (Bollin and Stoddard, 1987; Stoddard and others 2009, 2011; Sacks and others, 2011; Stoddard, 2012). These rocks have been suggested to be a supratructural component of Carolinia (Hibbard and others, 2002). No fossils have been identified in the Spring Hope terrane, but radiometric ages on dacite range from 525 to 628 Ma (Goldberg, 1994; Horton and Stern, 1994; Coler and Samson, 2000; Stoddard and Miller, 2011).

Locally, the Northwest Gupton pluton separates rocks of the Macon fault zone and the Spring Hope terrane. It is oriented NE-SW across the quadrangle. Textures of the intrusive rocks range from finely crystalline and aplitic to equigranular and locally megacrystic, and from undeformed to strongly deformed. The composition of these rocks ranges from K-feldspar granite to monzogranite with smaller biotite granite pods. Smaller bodies of quartz diorite and tonalite are confined within the boundaries of these plutons. A regionally extensive shear foliation is developed within localized zones of high strain, overprinting these rocks in the same relative orientation as the Macon fault, suggesting that motion along this fault was synchronous with respect to pluton emplacement. In addition, Jurassic age diabase, olivine diabase and locally porphyritic plagioclase diabase crosscut all older crystalline rocks as subvertically to vertically dipping dikes.

PREVIOUS WORK

The southern portion of the Inez Quadrangle was mapped through partial funding by the USGS Educational Mapping Program (EDMAP) as part of a masters thesis (Morrow, 2015). Previous geologic investigations relevant to the Inez 1:24K Quadrangle include numerous regional and reconnaissance studies. Parker (1968) defined the structural framework for the region. McDaniel (1980) mapped Warren County at a scale of 1:100K. Farrar (1985a,b) mapped the entire eastern Piedmont, defined map units, and proposed a regional tectonic model. Detailed 1:24K-scale mapping by Sacks (1996, 1999) has provided lithologic and structural data within the Macon fault zone along the NC-VA state line to the north in the Gasburg quadrangle. More recent detailed-scale mapping has been completed in the Gold Sand and Centerville quadrangles to the south and the Littleton and Hollister quadrangles to the northeast and east, respectively (Stoddard and others, 2009; 2011; Sacks and others, 2011).

DESCRIPTION OF MAP UNITS

Modified rock unit descriptions of Morrow (2015) and Sacks and others (2011) were used. Igneous rock descriptions for this publication use the classification scheme of Le Maitre (2002). Schmidt equal-area stereonet analysis was completed on planar and linear fabric elements using R.W. Allmendinger's plotting program Stereonet version 8.8.5 (Allmendinger and others, 2013 and Cardozo and Allmendinger, 2013). Contouring on stereogram plots is used to assess data density distribution using the Kamb method (Kamb, 1959).

DESCRIPTIONS OF MAP UNITS

SEDIMENTARY UNITS

Qal – Quaternary alluvium: Tan-brown, unconsolidated, poorly sorted, angular to subrounded clay, silt, sand and gravel- to cobble sized clasts. Clasts derived from surrounding older metamorphic and plutonic units. Deposited in stream drainages and floodplains.

Tug – Tertiary upland gravels: Tan-brown to orange-brown, poorly sorted, unconsolidated subrounded to rounded gravels- to cobble sized clasts. Clasts derived from surrounding older metamorphic and plutonic units. Gravels were deposited on highlands prior to downcutting by stream drainages. Occurrence is generally restricted to above 300' elevation.

HYDROTHERMAL UNITS

qv - Vein Quartz: white- dark gray, gravel to boulder sized clasts of milky and smoky quartz. Outcrops range in size from isolated boulder piles to entire hilltops. Linear ridges of quartz are identified using regularly spaced outcrops. Occurrence of such ridges is possibly related to mineralization along tension gashes and faults. An east-west trending example is present in the northeast portion of map – northeast of HWY 43. Yellow triangle symbols indicate isolated outcrops or float occurrences.

ccl - Silicified Cataclasite: Green-gray to white, finely crystalline quartz + plagioclase + epidote + chlorite rock. Locally, this mineral assemblage completely replaces the host rock. Outcrops are generally massive and highly fractured. Its occurrence is suggested to be related to brittle faulting. One major brittle fault segment is inferred to trend east-west along Wolfpit branch. Yellow square symbols indicate isolated outcrops or float occurrences.

INTRUSIVE UNITS

Jd – diabase: Fine to medium-grained, dark gray to black, equigranular to locally plagioclase porphyritic diabase, typically olivine-bearing. Commonly weathers to tan-gray, spheroidal boulders and cobbles. Occurs in vertical to steeply dipping dikes. The traces of the larger dikes correlate with and may be partly inferred on the basis of linear magnetic highs. In the Inez quad, nearly all diabase dikes trend NW to NNW. Red dots indicate isolated outcrops or float occurrences.

PPrwg – Northwest Gupton Granite: Mainly mylonitic to locally undeformed. Leucocratic (CI=5-10) white-gray, medium- to very coarse crystalline granite. The primary mineral assemblage includes K-feldspar + quartz + plagioclase ± white mica. Locally this rock contains biotite and red garnet 1-3 mm in size. Locally contains abundant enclaves of gneiss and schist, as well as numerous dikes and pods of pegmatite and aplite. Pegmatite is leucocratic (CI= 10-20) white-gray to pinkish gray, coarse crystalline granite comprised of coarse to pegmatitic orthoclase, coarse crystalline quartz and Na-plagioclase, medium-coarse white mica ± biotite. Accessory minerals include sphene + zircon + apatite. Orthoclase and white mica porphyroclasts are commonly 1-5 cm in diameter. Aplitic zones are leucocratic (CI=5) white-gray, finely crystalline granite. Aplite is commonly exposed within larger outcrops of leucogranite and pegmatitic granite. This unit is locally inferred by the presence of large white mica flakes in the soil profile. This unit locally carries evidence of ductile and brittle deformation. A continuous zone of weakly to strongly foliated protomylonitic to mylonitic granite strikes northeast and extends from the southwest corner of the quadrangle to the northeast of Fishing Creek. Here, stretched ribbons of quartz define a mineral rodding lineation and lie between a white mica and biotite foliation. Several smaller centimeter to meter wide zones of ductily deformed leucogranite also trend northeast-southwest and are consistent with other locally developed tectonic fabric. Chlorite films along fracture surfaces, silica and epidote replacement and discrete zones of silicified cataclasite suggest a localized brittle overprint. 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 Raleigh terrane along Wolfpit Branch.

PPqd – Northwest Gupton quartz diorite: Mesocratic (CI 55-60), green-gray and dark gray-white spotted, medium crystalline quartz diorite-tonalite. Composed of hornblende + plagioclase + quartz ± biotite. Quartz diorite is locally porphyritic. Plagioclase and hornblende phenocrysts are prismatic and tabular, respectively, and are 2-5 mm in length. Texturally, these rocks range from undeformed to mylonitic. Locally, deformed and metamorphosed portions are amphibolite. Quartz diorite occurs as small pods confined within PPrwg. The pods are locally crosscut by megacrystic K-feldspar granite dikes.

METAMORPHIC ROCKS OF THE SPRING HOPE TERRANE

Note: order of listed units does not imply stratigraphic sequence

CZm – intermediate-mafic metaplutonic rocks: Dark green to greenish-black, medium- to coarse-grained weakly foliated to massive metagabbro or metadiorite consisting of amphibole and plagioclase, with or without clinopyroxene, with local quartz and epidote; and tan to brownish medium-grained weakly to non-foliated metadiorite containing plagioclase, biotite, quartz, and local epidote or clinozoisite. Displays probable relict plutonic texture.

CZmmv – mafic metavolcanic rocks: Green to dark green, fine to medium grained, weakly to moderately foliated amphibolite, amphibole gneiss, greenstone, phyllite, and quartz-epidote rock containing various mixtures of hornblende, plagioclase, epidote/clinozoisite, quartz, chlorite, and opaque minerals. In the neighboring Hollister quad, includes metabasalt having obvious relict primary igneous textures including plagioclase phenocrysts and randomly oriented groundmass laths, as well as amygdules filled with calcite, epidote-clinozoisite, or quartz (Bollin and Stoddard, 1987). Bollin and Stoddard (1987) also describes a hyaloclastite breccia. Chemical analyses of metabasalt and amphibolite suggest either ocean-floor or volcanic-arc affinities (Bollin, 1985) while the metabasalts are interpreted to be low-K abyssal tholeiites that underwent spilitization and low-grade metamorphism (Bollin, 1985).

CZmv – felsic metavolcanic rocks: Light grayish-tan, fine-grained, layered felsic gneiss composed primarily of plagioclase, quartz, and microcline, with minor or accessory biotite, garnet, amphibole, epidote, white mica and opaque minerals. Typically contains significant magnetite. Relict phenocrysts of sodic plagioclase and/or quartz are locally present. Rock is distinctively hornfelsic in contact aureoles and where occurring as enclaves within 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 pseudomorphous after mafic phenocrysts or possibly amygdules. Interpreted to be pyroclastic or lava in origin. Includes Bens Creek leucogneiss of Farrar (1985a,b) and quartzite of McDaniel (1980); also believed to be correlative with "dacitic bluestone" mapped to the southwest (Stoddard, 1993; Stoddard and others, 2009). Major-element chemical data indicate that the rock has a rhyodacitic protolith. The unit includes dacitic to rhyolitic rocks based on analyzed samples from elsewhere (Stoddard, 1993; Stoddard and others, 2011).

CZmgs – metagraywacke and metasiltstone: Light greenish to medium-brown or gray, fine- to medium-grained metagraywacke; fine, typically phyllitic, slaty or fissile metasiltstone. Consists of quartz, plagioclase, white mica, biotite, epidote and opaque minerals. Locally displays relict clastic texture and sedimentary bedding or laminae, commonly with a tectonic cleavage at an angle. May weather into thin slabs. Includes minor metavolcanic rocks including felsic varieties with possible phenocrysts of plagioclase and quartz, and chlorite-actinolite phyllite likely derived from a mafic protolith.

CZmps – Maple Branch schist: Gray-silvery gray, medium to coarse-crystalline white mica schist. This unit also contains conspicuous, subidiobastic porphyroblasts of garnet and staurolite that are 1-5 mm in diameter and length, respectively. The schistosity is flattened around the garnet and staurolite porphyroblasts. These rocks may be quartz-rich or quartz-poor and locally contain biotite. When in contact with the northwestern arm of the Gupton pluton, these rocks are metamorphosed to albite-epidote hornfels zone. Loose grains of andalusite have been reported from this unit in the southern Inez quadrangle (Stoddard and others, 1987). This unit may be the higher grade metamorphic equivalent of CZmgs.

METAMORPHIC ROCKS OF THE RALEIGH TERRANE

Note: order of listed units does not imply stratigraphic sequence

PzZigg – Liberia granite and granitic gneiss: Leucocratic (CI=15), light tannish gray-brown, medium-coarsely crystalline protomylonitic-ultramylonitic quartz + K-feldspar + white mica granite. Locally contains garnet and/or tourmaline. Commonly, porphyritic K-feldspar granite transitions into predominantly mylonitic to ultramylonitic porphyroclastic K-feldspar and plagioclase granitic gneiss within the Macon fault zone. Quartz and K-feldspar augen are compositionally layered in a white mica ± biotite mylonitic shear foliation and are 1-5 mm and 1-10 mm in diameter, respectively. Feldspar augen exhibit asymmetric tails comprised of quartz ± feldspar ± white mica that suggest tops to the northeast dextral shear sense. These rocks commonly develop a white mica aggregate and quartz rodding lineation that also indicates dextral shear sense. This unit is correlative to the CZmxg unit of Stoddard et al. (2009) and Sacks et al. (2011).

PzZbg – biotite gneiss: Predominantly interlayered leucocratic (CI 5-30) medium-gray to greenish-gray, fine to medium-grained biotite gneiss and grayish-tan muscovite-biotite gneiss composed of plagioclase, quartz, biotite, white mica, and local garnet. Interlayered with mesocratic (CI 35-60), dark grayish-green to greenish-black, medium-grained amphibole and amphibole-biotite gneiss composed of plagioclase and amphibole, and local biotite, quartz, clinopyroxene, magnetite and/or epidote. Also contains minor interlayers of muscovite schist. Locally displays compositional layering and a well-developed gneissosity.

PzYmbs – Mill Branch schist: Leucocratic (CI= 20-30), tan-orange brown, fine-medium crystalline white mica schist to chlorite-white mica phyllonitic schist. The primary mineral assemblage includes white mica, quartz, K-feldspar ± biotite and chlorite. Local Fe/Mn oxide staining may give this unit a red- orange appearance. Large white mica 'fish' porphyroblasts consistently show tops to the northwest and tops to the northeast suggesting dextral-normal shear sense. Individual white mica grains form a mineral aggregate lineation within the Macon fault zone. Stretched quartz and K-feldspar aggregates lie between white mica foliation and create a mineral rodding lineation. This unit is correlative to the CZms unit of Stoddard et al. (2009). Because of the Mesoproterozoic detrital zircon dates obtained from the Soul City amphibolitic gneiss (Peach et al., 2017) and the unclear protolith relationships in the Mill Branch schist, it is currently inferred to range from the Mesoproterozoic to Paleozoic, hence the PzYmbs unit age notation.

Zone of brittle overprint from the Long Branch Fault Zone

REFERENCES

Allmendinger, R. W., Cardozo, N. C., and Fisher, D., 2012, Structural Geology Algorithms: Vectors and Tensors: Cambridge, England, Cambridge University Press, 289 pp.
Blake, D.E., E.F. Stoddard, P.J. Bradley, and T.W. Clark, 2012, Neoproterozoic to Mesozoic petrologic and ductile-brittle structural relationships along the Alleghanian Nutbush Creek fault zone and Deep River Triassic basin in North Carolina: Field Guide for the Geological Society of America Annual Meeting, p. 219-261.
Bollin, W.R. 1985, Geology of the Hollister 7 1/2-minute quadrangle, Warren and Halifax counties, North Carolina: Metamorphic transition in the Eastern slate belt: [M.S. thesis], North Carolina State University, Raleigh, North Carolina, 87 p.
Boltin, W. R., and E. F. Stoddard, 1987, Transition from Eastern Slate belt to Raleigh belt in the Hollister area, eastern North Carolina Piedmont: Southeastern Geology, v. 27, p. 185-205.
Cardozo, N., and Allmendinger, R. W., 2013, Spherical projections with OSXStereonet: Computers and Geosciences, v. 51, no. 0, p. 193 - 205, doi: 10.1016 j.cageo.2012.07.021.
Coler, D., and Samson, S., 2000, Characterization of the Spring Hope and Roanoke Rapids terranes, southern Appalachians: A U–Pb geochronolgic and Nd isotopic study: Geological Society of America Abstracts with Programs, v. 32, p. A-11-12.
Farrar, S.S., 1985a, Stratigraphy of the northeastern North Carolina Piedmont: Southeastern Geology, v. 25, p. 159-183.
Farrar, S.S., 1985b, Tectonic evolution of the easternmost Piedmont, North Carolina: Geological Society of America Bulletin, v. 96, p. 362-380.
Goldberg, S. A., 1994, U-Pb geochronology of volcanogenic terranes of the eastern North Carolina Piedmont: Preliminary results, in Stoddard, E. F., and D. E. Blake (eds.), Geology and Field Trip Guide, Western Flank of the Raleigh Metamorphic Belt, North Carolina: Carolina Geological Society Guidebook, p. 13-17.
Hibbard, J. P., E. F. Stoddard, D. T. Secor, and A. J. Dennis, 2002, The Carolina Zone: Overview of Neoproterozoic to Early Paleozoic peri-Gondwanan terranes along the eastern flank of the southern Appalachians: Earth Science Reviews, v. 57, p. 299-339.
Horton, J. W., Jr., and T. E. Stern, 1994, Tectonic significance of preliminary uranium-lead ages from the eastern Piedmont of North Carolina: Geological Society of America Abstracts with Programs, v. 26, p. 21.
Kamb, W.B., 1959, Ice petrofabric observations from Blue Glacier, Washington in relation to theory and experiment: Journal of Geophysics Research., v. 64, p. 1891–1909.
Le Maitre, R.W., ed., 2002, Igneous Rocks: A Classification and Glossary of Terms: Recommendations of the International Union of Geological Sciences (IUGS) Subcommission on the Systematics of Igneous Rocks: Cambridge, Cambridge University Press, 252p.
McDaniel, R. D., 1980, Geologic map of Region K: North Carolina Department of Natural Resources and Community Development, Geological Survey Section, Open File Map NCGS 80-2 [scale 1:100,000].
Morrow, R.H, 2015, The Macon fault zone: a folded dextral shear strand of the Eastern Piedmont Fault System in North Carolina, [M.S. thesis], University of North Carolina Wilmington, Wilmington, North Carolina, 117 p.
Parker, J. M., III, 1968, Structure of easternmost North Carolina Piedmont: Southeastern Geology, v. 9, p. 117-131.
Peach, B.T., Blake, D.E., and LaMaskin, T.A., 2017, Zircon geochronology of the Raleigh terrane in the North Carolina eastern Piedmont: Geological Society of America Abstracts with Programs, v. 49, doi: 10.1130/abs/2017SE-289947.
Sacks, P.E., 1996, Geologic map of the Gasburg 7.5-minute quadrangle, Brunswick County, Virginia, and Warren, Northampton, and Halifax Counties, North Carolina: U.S. Geological Survey, Miscellaneous Field Studies Map MF-2287, scale 1:24,000.
Sacks, P.E., 1999, Geologic overview of the eastern Appalachian Piedmont along Lake Gaston, North Carolina and Virginia, in Sacks, P. E. (ed.), Geology of the Fall Zone region along the North Carolina-Virginia state line: Carolina Geological Society Field Trip Guidebook, p. 1-15.
Sacks, P. E., W. R. Boltin, and E. F. Stoddard, 2011, Bedrock geologic map of the Hollister 7.5-minute quadrangle, Warren and Halifax Counties, North Carolina, North Carolina: North Carolina Geological Survey Open-file Report 2011-03, scale 1:24,000, in color.
Stoddard, E. F., 1993, Eastern Slate belt volcanic facies, Bunn - Spring Hope area, NC: Geological Society of America Abstracts with Programs, v. 25, p. 72.
Stoddard, E.F., 2010, Bedrock geologic map of the Ingleside 7.5-minute quadrangle, Franklin and Vance Counties, North Carolina: North Carolina Geological Survey Open-file Report 2010-05, scale 1:24,000, in color.
Stoddard, E.F., 2012, Rocks, structures and geologic relationships of the Spring Hope terrane, northeastern North Carolina Piedmont: Geological Society of America Abstracts with Programs, v. 44, No. 7, p. 484.
Stoddard, E.F., S.S. Farrar, J.R. Huntsman, J.W. Horton, Jr., and W.R. Boltin, 1987, Metamorphism and tectonic framework of the northeastern North Carolina Piedmont: in Whitecar, G.R. (ed.), Geological Excursions in Virginia and North Carolina: Geological Society of America, Southeastern Section Field Trip Guidebook. p. 43-86.
Stoddard, E.F., S. Fuemmeler, R. Bechtel, T. W. Clark, and D. P. Sprinkle II, 2009, Preliminary bedrock geologic map of the Gold Sand, Centerville, Castalia, and Justice 7.5-minute quadrangles, Franklin, Nash, Warren and Halifax Counties, North Carolina: North Carolina Geological Survey Open-file Report 2009-03, scale 1:24,000, in color.
Stoddard, E. F., and Miller, B. V., 2011, The Spring Hope terrane: Lithostratigraphy and new age constraints: Geological Society of America Abstracts with Programs, v. 43, No. 2, p. 31.
Stoddard, E. F., Sacks, P. E., Clark, T. W., and Bechtel, R., 2011, Bedrock geologic map of the Littleton 7.5-minute quadrangle, Warren and Halifax Counties, North Carolina: North Carolina Geological Survey Open-file Report 2011-02, scale 1:24,000, in color.

EXPLANATION OF MAP SYMBOLS

CONTACTS

- Location known contact
- Inferred contact
- Concealed contact
- Quaternary alluvium contact
- ductile normal fault - inferred (dashed where concealed) bar and ball on downthrown side
- in cross section, ductile normal fault letters showing relative direction ⊙ towards observer, X away from observer
- Inferred ductile fault; dotted where concealed
- A — A' Cross section line
- Inferred diabase dike; dotted where concealed
- Interpreted fold hinge of overturned anticline
- Interpreted fold hinge of overturned syncline

STRUCTURAL SYMBOLS

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

- Strike and dip of compositional layering
- Strike and dip of inclined primary bedding
- Strike and dip of vertical dike
- Strike and dip of inclined primary bedding (multiple observations at one location)
- Strike and dip of vertical dike (multiple observations at one location)
- Strike and dip of inclined schistosity and foliation
- Strike and dip of inclined joint/fracture surface
- Strike and dip of inclined schistosity and foliation (multiple observations at one location)
- Strike and dip of inclined joint/fracture surface (multiple observations at one location)
- Strike of vertical foliation
- Strike of vertical joint/fracture surface
- Strike and dip of spaced and/or slaty cleavage
- Strike and dip of vertical joint/fracture surface (multiple observations at one location)
- Strike and dip of spaced and/or slaty cleavage (multiple observations at one location)
- Strike and dip of inclined quartz vein
- Strike and dip of inclined schistosity
- Strike and dip of inclined quartz vein (multiple observations at one location)
- Strike and dip of inclined undifferentiated shear strain foliation
- Strike of vertical quartz vein
- Strike of vertical undifferentiated shear strain foliation
- Strike of vertical quartz vein (multiple observations at one location)
- Strike and dip of inclined undifferentiated shear strain foliation (multiple observations at one location)
- Strike and dip of axial surface of mesoscale fold (multiple observations at one location)
- Strike of vertical undifferentiated shear strain foliation (multiple observations at one location)
- Strike of vertical axial surface of mesoscale fold
- Strike and dip of gneissic layering
- Strike and dip of slickenside surface
- Strike and dip of gneissic layering (multiple observations at one location)
- Strike and dip of inclined small-scale fault plane
- Strike and dip of inclined dike
- Observation station location
- Bearing and plunge of mineral rod or aggregate lineation on Src
- Bearing and plunge of mineral lineation
- Horizontal mineral lineation
- Bearing and plunge of pencil lineation
- Bearing and plunge of other lineation
- Bearing and plunge of crenulation lineation
- Bearing and plunge of slickenline on Sf or Ssc surface
- Bearing and plunge of mesoscale fold hinge
- Horizontal mesozoic fold hinge

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

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