DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF ENERGY, MINERAL, AND LAND RESOURCES
KENNETH B. TAYLOR, STATE GEOLOGIST

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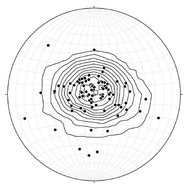
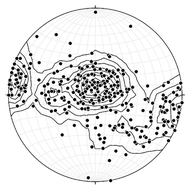
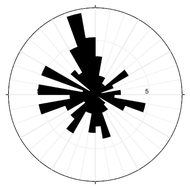
NORTH CAROLINA GEOLOGICAL SURVEY
OPEN FILE REPORT 2013-04



Equal Area Schmidt Net Projection of Contoured Poles to Primary Bedding and Compositional Layering
Contour Interval = 2 sigma N = 92

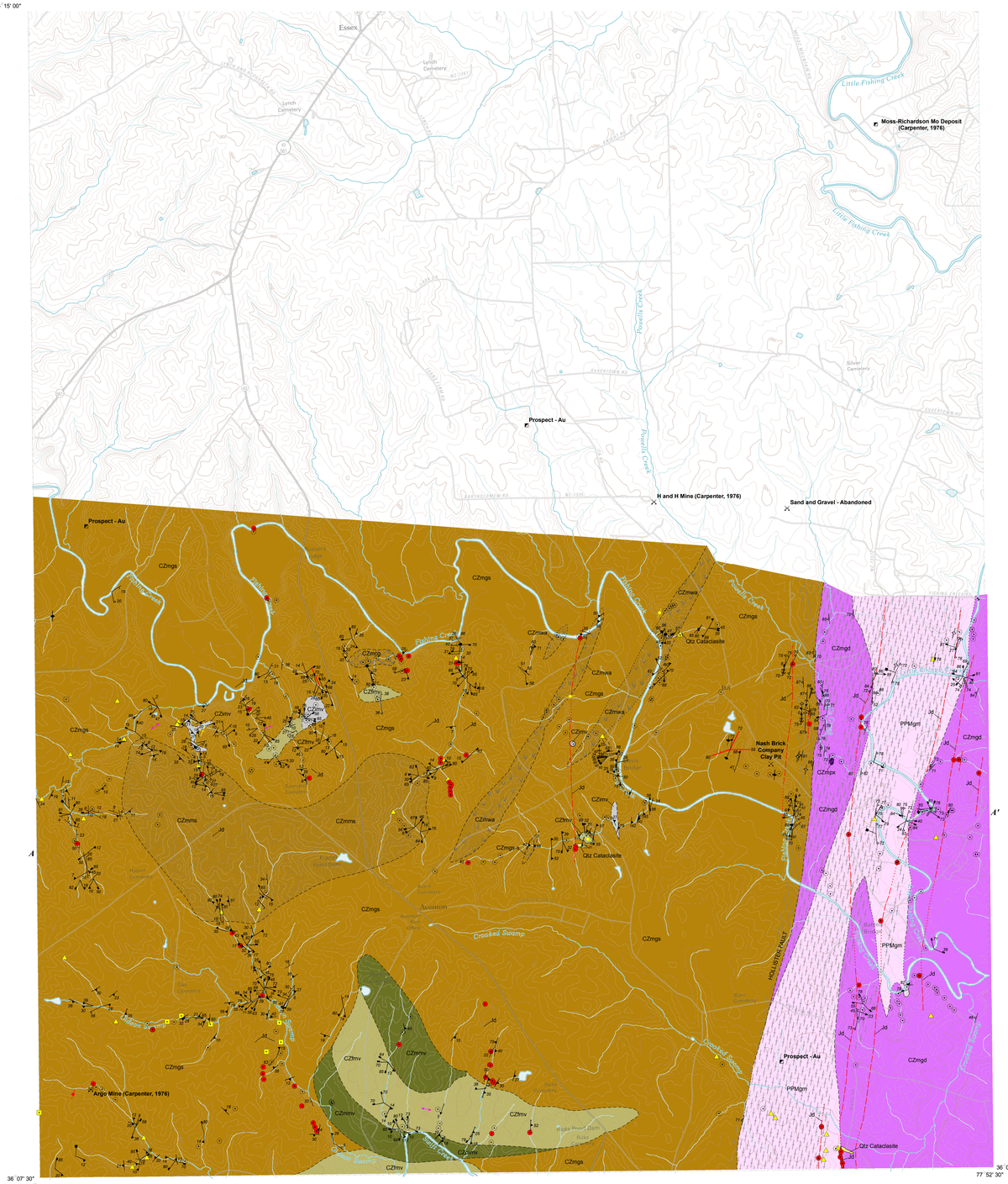


Equal Area Schmidt Net Projection of Contoured Poles to Foliation, Schistosity, Cleavage, Phyllitic Cleavage, Spaced Cleavage, and Shear Foliation
Contour Interval = 2 sigma N = 336

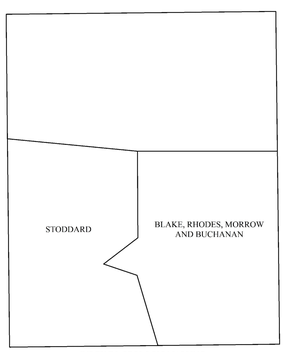


Unidirectional Rose Diagram of Fractures (Joints) N = 171
Outer Circle = 8%
Mean vector = 297 degrees

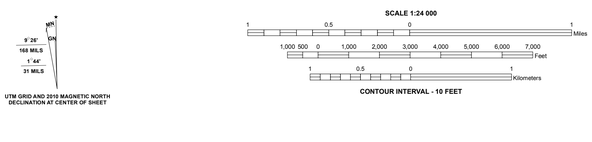
MAJOR GEOLOGIC FEATURES



Geology mapped between September 2012 and May 2013.
Field assistance provided by Barry Lumpkin and Eddie Hull.



INDEX TO GEOLOGIC MAPPING



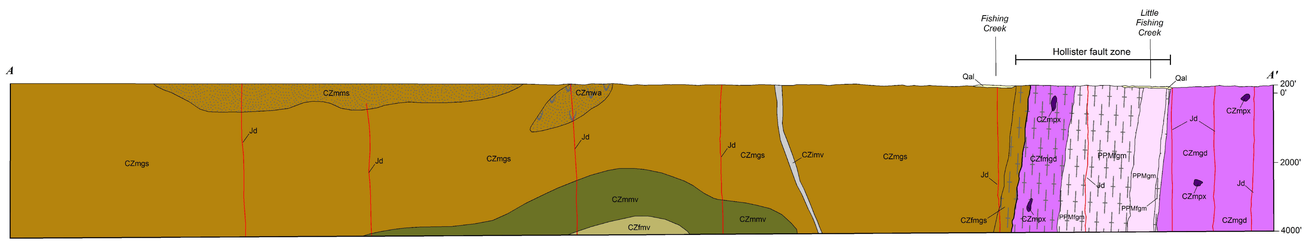
UTM GRID AND 2010 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

1 0.5 0 1 Miles
1,000 500 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet
1 0.5 0 1 Kilometers

CONTOUR INTERVAL - 10 FEET

MAP LOCATION



cross section scale - 1:24 000
no vertical exaggeration

INTRODUCTION

The Essex 7.5-minute Quadrangle lies in the easternmost North Carolina Piedmont. The southern portion of the quadrangle, as herein defined, is partially bounded on the north by Fishing Creek, the Nash County – Halifax County line. The unincorporated communities of Aventon (Nash County) and Ita (Halifax County) are located in the area. In the northwestern part of the area, north-flowing creeks drain into White Oak Swamp or empty directly into Fishing Creek. Gideon Swamp drains much of the southwestern part, and is itself a tributary of Swift Creek, which lies to the south in the northern Red Oak quadrangle. Little Fishing Creek, a major tributary, flows south to join Fishing Creek near the southeastern corner of the quadrangle. Powells Creek is a south-flowing tributary of Little Fishing Creek, and Crooked Swamp flows generally eastward to join Fishing Creek near the eastern edge of the quadrangle. Exposures of crystalline rocks occur almost exclusively along these creeks, while the higher areas constitute broad generally flat surfaces that appear to be underlain by unconsolidated young sedimentary deposits. The elevations in the map area range from about 315 feet above sea level along Harrison Road (SR 1401) at the western edge of the quadrangle, to less than 110 feet along Fishing Creek at the eastern edge of the quadrangle.

PREVIOUS WORK

Previous geologic investigations pertinent to the Essex Quadrangle include several regional and reconnaissance studies. Parker (1968) defined the structural framework of the region. Wilson and Spence (1979) produced a reconnaissance map of Nash County. Farrar (1985a, b) mapped the entire eastern Piedmont of North Carolina, defined map units for the region, and proposed a stratigraphy and a tectonic model. A map of a four-quadrangle area by Stoddard and others (2009) includes the Centerville Quadrangle, just west of Essex. The Hollister Quadrangle (Sacks and others, 2011) lies to the northeast of Essex. Additional mapping by Sacks (1999 and unpublished manuscript map), in a study of the Hollister fault zone, includes part of the southeastern Essex Quadrangle. Mapping and related research by Kite (1982) included part of the eastern Essex Quadrangle. Other research relating to the geology of the Essex Quadrangle includes geophysical studies of the Hollister fault zone by Fletcher (1992) and by Lawrence (1999), a study of the sub-Coastal Plain basement (Lawrence and Hoffman, 1993), and a study of quartz-rich rocks in the area, interpreted as quartz arenites by Stanley (1978).

DESCRIPTION OF MAP UNITS

The pre-Mesozoic crystalline rocks of the southern Essex 1:24K Quadrangle lie within both the Spring Hope and Roanoke Rapids terranes. The terrane-bounding late Paleozoic Hollister fault (Farrar, 1985b; Sacks, 1999) runs north to south through the eastern part of the area. These rocks were metamorphosed to the chlorite zone of the greenschist facies during Neoproterozoic and Paleozoic tectonothermal activity. Only Jurassic diabase dikes are not regionally metamorphosed. Contact metamorphic effects occur locally where diabase intrudes metasedimentary rocks. While subjected to this low-grade regional metamorphism and locally displaying fracture, foliation, and lineation, most prominently within and near the Hollister fault zone, most crystalline rocks preserve relict plutonic, volcanic, or volcanogenic sedimentary textures, which when combined with bulk rock compositions, allow for protolith identification. Therefore, the prefix "meta" is not included in the nomenclature of the pre-Mesozoic rocks described in the quadrangle. In some exposures, especially within the Hollister fault zone, highly partitioned strain produces either variably fractured, phyllonitic, or proto-mylonitic and mylonitic rocks of meta-igneous and metasedimentary origin. Local outcrops of highly silicified or silicified-epidotized cataclasite rock have unclear protolith affinity. The classification and naming of metaigneous rocks in the southern Essex 1:24K Quadrangle uses the nomenclature of the International Union of Geological Sciences (IUGS) subcommission on the systematics of igneous rocks after Le Maitre (2002). Relict igneous textures, modal mineral assemblages, or normalized mineral assemblages when whole-rock geochemical data are available, provide the basis for naming metaigneous units. Past regionally related maps and lithologic descriptions of McDaniel (1980), Kite (1982), Kite and Stoddard (1984), Farrar (1985a, b), and Stoddard and others (2009, 2012) assisted in the development of these descriptions.

INTRUSIVE ROCKS

Jd – diabase: Melanocratic (CI greater than 80), dark gray to black, fine to medium aphyric to phyric, dense diabase consisting primarily of plagioclase, augite and locally olivine. May be plagioclase phyric. Occurs as dikes and sills and is typically seen as spheroidally weathered stream and hillside boulders and cobbles. Weathered surfaces are generally tan gray, grayish or brownish in color. Occurs in vertically to steeply dipping dikes. Red dashed lines link individual station locations where stream outcrops or boulders of diabase are exposed. Traces of larger dikes correlated with and extrapolated along strike using linear aeromagnetic anomalies. Red dots indicate isolated outcrops or float occurrences.

PPMgm – granitoid rocks and metamorphosed and foliated granitoid rocks: Leucocratic (CI less than 20), light tan, gray white to orange, or pinkish-white, medium to coarse phaneritic, hypidiomorphic to xenomorphic granular granite, granodiorite, or quartz diorite. Commonly foliated (S greater than L) and locally lineated (L greater than S) to produce protomylonitic to mylonitic granitoid gneiss containing relic feldspar porphyroclasts, quartz ribbons, and biotite aggregate mineral lineation (denoted as foliated granitoid, PPMfgm, in cross section). Individual samples may contain porphyroclastic magnetite crystals up to 3 mm in length. Locally, felsic minerals are altered to a dark gray color. Forms an elongate, tabular body within and adjacent to the late Paleozoic, Alleghanian orogeny Hollister fault zone. Granitoids appear to be intrusive into the rocks of the Halifax County complex within the Roanoke Rapids terrane. They may or may not be related to granitoid rocks of the Rocky Mount pluton (Spruill and others, 1987; Moncla, 1990; Stoddard and others, 2012) or to other granitoid rocks mapped by Sacks (1999 and unpublished).

METAMORPHIC ROCKS OF THE SPRING HOPE TERRANE

Note: Order of listed units does not imply stratigraphic sequence.

CZfmv - Felsic metavolcanic rocks: Leucocratic (CI less than 5), bluish gray, tan or white weathered, siliceous, aphanitic dacite tuff or porphyritic dacite. Dacite is usually massive and ranges from fine ash to porphyritic plagioclase crystal tuff. Contains a generally massive, relict aphanitic groundmass of plagioclase, quartz, and sparser K-feldspar. Locally may be quartz porphyritic. Metamorphic overprint and strain produce a weak phyllitic cleavage in some samples. Interpreted to have a pyroclastic or shallow intrusive origin. Unit is inferred to be correlative, at least in part, with felsic metavolcanic rocks (CZfmv) of Stoddard and others (2012) in the adjoining Red Oak 1:24K Quadrangle to the south, and the Gold Sand, Centerville, Castalia, Justice, and Hollister 1:24K Quadrangles to the west and north (Stoddard and others, 2009; Sacks and others, 2011). Includes distinctive gray, bluish-gray, tan, or white weathering, thinly layered and locally strongly fissile 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 including significant magnetite. Rare relict phenocrysts of sodic plagioclase and/or quartz are locally present. Interpreted to be pyroclastic or lava in origin. Believed to be correlative with Bens Creek leucogneiss of Farrar (1985a,b), quartzite of McDaniel (1980), and "dacite bluestone" of Stoddard (1993); Stoddard and others (2009). The lithology includes dacitic to rhyolitic rocks based on analyzed samples from elsewhere (Stoddard, 1993; Stoddard and others, 2011; Sacks and others, 2011). Zircons from an exposure located in the north-central Centerville Quadrangle gave a discordant upper intercept U-Pb age of 524.9 +/- 8.6 Ma (Stoddard and Miller, 2011). This lithology is commonly associated with subordinate mafic metavolcanic rocks (CZmmv where shown on map). The CZfmv unit also includes light colored, generally fine grained and phyllitic to schistose rocks consisting of white mica, quartz, feldspar(s), chlorite, and rare biotite and epidote. Commonly contain relict phenocrysts of quartz (typically showing beta morphology) as well as sodic plagioclase, and/or white to beige and typically flaccate lapilli. Interpreted as crystals- and crystal-lithic tuff. Chemical and petrographic data from the Bunn East Quadrangle (Stoddard, 1993) indicate that at least some of these rocks are rhyodacitic in composition, and locally have relict K-feldspar phenocrysts. Zircons from felsic crystal tuff in the Bunn East Quadrangle have yielded a preliminary U-Pb upper intercept crystallization age of 590 +/- 3 Ma (Goldberg, 1994). Unit also includes tuffaceous metasedimentary rocks, as well as rare intermediate metavolcanic rocks, mineralogically similar to felsic varieties but with a higher percentage of epidote and/or biotite, taking on a darker hue or a salt-and-pepper appearance.

CZimv - Intermediate metavolcanic and metaplutonic rocks: Diverse mesocratic (CI=45) light green, greenish gray, bluish green, black green, light gray, gray, beige or brown fine to medium phaneritic to plagioclase, quartz, and/or hornblende-porphyritic rocks including microdiorite, meta-andesite, meta-quartz diorite, diorite, granodiorite or quartz keratophyre. Typically unfoliated, but may be well jointed, gnarly weathered, silicified and/or brecciated. Includes variable proportions of epidote, biotite, chlorite, sericitic white mica, plagioclase, opaque oxides, K-feldspar, and titanite. Primary igneous hornblende, biotite and plagioclase are typically at least partly replaced by the metamorphic minerals epidote, white mica, biotite, chlorite and opaque oxides. Pyritic cubes are locally abundant. Locally spheroidally weathered; rarely well foliated and slaty or phyllitic. May represent dikes, sills, or lava flows, at least in part, as well as plutons. Unit is inferred to be correlative with intermediate metavolcanic rocks (CZimv) of Stoddard and others (2012) in the adjoining Red Oak 1:24K Quadrangle to the south, and potentially with the rare occurrences of intermediate metavolcanic rocks (included with CZfmv) reported to the west and southwest in the Centerville and Castalia 1:24K Quadrangles (Stoddard and others, 2009).

CZmmv - Mafic metavolcanic rocks: Green, dark green, or black, fine to medium grained, massive and non-foliated or weakly to moderately foliated amphibolite, greenstone, phyllite, and quartz-epidote rock containing various mixtures of hornblende, plagioclase, epidote/clinozoisite, quartz, chlorite, and opaque minerals. Locally includes metabasalt having relict plagioclase phenocrysts and rare metagabbro. Chemical analyses of mafic metavolcanic rocks of the Spring Hope terrane in the Hollister Quadrangle (Sacks and others, 2011) are low-K tholeiites inferred to have ocean-floor or volcanic arc affinities (Boltin, 1985; Boltin and Stoddard, 1987).

CZmwa – Metamorphosed quartz wacke and arenite: Primarily grayish green, light greenish to medium brown or gray, fine- to medium-grained feldspathic wacke and quartz arenite. 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 fragments and rounded quartz, plagioclase, and K-feldspar grains, as well as small volcanic lithic fragments highlight a relict clastic texture in the wacke. 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 CZmgs. Unit is inferred to be map-scale horizons that are correlative with metagraywacke (CZmgs) of Stoddard and others (2012) in the adjoining Red Oak 1:24K Quadrangle to the south, as well as to the west and southwest in the Centerville and Castalia 1:24K Quadrangles, respectively (Stoddard and others, 2009).

CZmgs – Metamorphosed siltstone, mudstone, and interlayered feldspathic wacke and arenite: Mostly greenish tan, beige, or gray, fine grained and phyllitic, fissile siltstone, light tan to medium brown, massive and phyllitic mudstone, and local interlayers of light greenish to medium brown or gray, fine- to medium –grained feldspathic wacke and quartz arenite. Locally occurs as schist (CZmgs-s). Contains a matrix of fine-grained quartz, plagioclase, white mica, and locally sparse biotite and opaque minerals. May locally preserve a relict clastic texture and sedimentary bedding. Unit is commonly tuffaceous and includes unmapped interlayers of felsic volcanic rocks. Siltstone and mudstone eposures may weather slabby and have a high clay mineral content indicating the relative abundance of feldspar versus quartz. Cyclic bedding and graded bedding are preserved locally, although individual exposures of feldspathic wacke and quartz arenite are more 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 fragments and rounded quartz, plagioclase, and K-feldspar grains, as well as small volcanic lithic fragments highlight a relict clastic texture in the wacke. 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. Along the eastern contact of the unit, high strain associated with the late Paleozoic Alleghanian orogeny Hollister fault zone results in a subvertically dipping phyllonitic schistosity in outcrop (denoted as foliated siltstone and mudstone, CZfmgs, in cross section). There are also rare exposures of granular and/or sucrosic, fine to medium-grained pure quartz rocks. These have been interpreted by Stanley (1978) as metamorphosed quartz arenites 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. Zircons from an unmapped felsic crystal tuff layer within metasedimentary rocks in the southeastern Centerville Quadrangle gave a nearly concordant U-Pb age of 628 +/- 1.7 Ma (Stoddard and Miller, 2011). Unit is inferred to be correlative with metasiltsone, metagraywacke, and metamudstone (CZmgs) of Stoddard and others (2012) in the adjoining Red Oak 1:24K Quadrangle to the south, as well as to the west and southwest in the Centerville and Castalia 1:24K Quadrangles, respectively (Stoddard and others, 2009).

CZmms – Metamorphosed mudstone and siltstone: Subunit of CZmgs dominated by fine-grained sedimentary rocks.

CZmcg – Metamorphosed conglomerate: Subunit of CZmgs characterized by exposures of 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 and opaque oxides, including magnetite.

METAMORPHIC ROCKS OF THE ROANOKE RAPIDS TERRANE

Note: Order listed does not imply stratigraphic sequence.

HALIFAX COUNTY COMPLEX

CZmgd – Metamorphosed gabbro/diorite and basalt/microdiorite: Melanocratic to mesocratic (CI=40-80), black to dark green to light greenish gray, medium-grained gabbro and diorite. Unfoliated outcrops contain plagioclase and hornblende, epidote or clinozoisite, opaque oxide minerals, and locally quartz and sulfide minerals. Preserves a relict phaneritic texture between blocky plagioclase and tabular hornblende. Presence of uralite within irregular xenomorphic hornblende or actinolite suggests that these crystals may be pseudomorphs after magmatic clinopyroxene in gabbro. Other relict phaneritic samples display interlocking, xenomorphic to hypidiomorphic granular plagioclase and hornblende. These rocks are interpreted to be magmatic diorite. Fine-grained equivalents are interpreted to be basalt, in some cases now amphibolite, and microdiorite that preserve either an aphanitic to fine phaneritic igneous texture. Scattered outcrops of quartz diorite, hornblende tonalite, trondhjemite, and locally granodiorite are intimately associated with the gabbro/diorite and are interpreted to be more quartz-rich and differentiated magmatic rocks of the Halifax County complex. Where overprinted by the late Paleozoic Alleghanian orogeny Hollister fault zone, steeply dipping chlorite-rich phyllonite, mylonite, and gabbro/diorite gneiss protomylonite are produced from the original igneous protoliths (denoted as foliated gabbro/diorite, CZfmgd, in cross section). 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 metagabbro (CZhmg) and metabasalt (CZhmb) of the Halifax County complex mapped by Stoddard and others (2012) in the adjacent Red Oak 1:24K Quadrangle just to the south.

CZmpx – Metamorphosed pyroxenite cumulate: Melanocratic (CI greater than 80), pale to dark green, medium grained, massive pyroxenite. Blocky actinolite porphyroblasts up to 7 mm in diameter are uralitic, suggesting 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 the actinolite and may reflect the reaction replacement of intercumulate plagioclase in the original igneous ultramafic rock. Forms an undeformed pod or phacoid of ultramafic rock and gabbro/diorite surrounded by deformed and foliated gabbro/ diorite of the Halifax County complex within the late Paleozoic Alleghanian orogeny 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 south of Little Fishing Creek and County Road 1338, respectively; in the Ringwood 1:24K Quadrangle to the east of the Essex 1:24K Quadrangle. Unit is inferred to be correlative with ultramafic rocks of the Halifax County complex of Kite (1982) and Kite and Stoddard (1984).

Zone of high strain overprint of Hollister fault zone

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EXPLANATION OF MAP SYMBOLS

CONTACTS

Lithologic contacts - Distribution and concentration of structural symbols indicates degree of reliability.

- contact - location known
- contact - location inferred
- cross section line
- anticline, plunging
- syncline, plunging
- ductile fault - location inferred
- in cross section, ductile fault
- diabase dike - location inferred
- diabase dike - location concealed
- in cross section, diabase dike

LINEAR FEATURES

- 11 — bearing and plunge of crenulation lineation
- 23 — bearing and plunge of mineral lineation
- 69 — bearing and plunge of slickenline lineation
- 52 — bearing and plunge of fold hinge

PLANAR FEATURES

- 35 — strike and dip of primary layering
- 8 28 — strike and dip of primary layering (multiple observations at one location)
- 58 — strike and dip of inclined regional phyllitic cleavage/weak schistosity
- 74 41 — strike and dip of inclined regional phyllitic cleavage/weak schistosity (multiple observations at one location)
- — strike of vertical regional phyllitic cleavage/weak schistosity
- — strike of vertical regional phyllitic cleavage/weak schistosity (multiple observations at one location)
- 67 — strike and dip of inclined undifferentiated shear strain foliation
- 71 45 — strike and dip of inclined undifferentiated shear strain foliation (multiple observations at one location)
- — strike of vertical undifferentiated shear strain foliation
- — strike of vertical undifferentiated shear strain foliation (multiple observations at one location)
- 45 — strike and dip of overprinting cleavage
- 85 63 — strike and dip of overprinting cleavage (multiple observations at one location)
- 70 — strike and dip of crenulation cleavage
- 27 56 — strike and dip of spaced cleavage (multiple observations at one location)
- 68 — strike and dip of inclined joint/fracture surface
- 40 79 — strike and dip of inclined joint/fracture surface (multiple observations at one location
- — strike of vertical joint surface
- — strike of vertical joint surface (multiple observations at one location)
- 74 — strike and dip of inclined slickenline surface
- — strike of quartz vein, dip unknown
- — strike of vertical quartz vein
- — strike of vertical diabase dike
- 21 — strike and dip of axial surface of mesoscale fold
- 70 — strike and dip of inclined mesoscale fault

OTHER FEATURES

- clay pit
- clay pit - abandoned
- mine or prospect
- station location
- diabase station location
- Tertiary upland sediment location
- area of abundant quartz cataclasite
- sucrosic and friable quartz
- cataclasite
- location of bull quartz debris and/or veins

Base map is from USGS 2010 GeoPDF of the Essex 7.5-minute quadrangle.
Aerial 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).

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Scan with smartphone for link to GeoPDF of map. Third party App required.

BEDROCK GEOLOGIC MAP OF THE SOUTHERN PORTION OF THE ESSEX 7.5-MINUTE QUADRANGLE, HALIFAX, NASH AND WARREN COUNTIES, NORTH CAROLINA

By David E. Blake, Edward F. Stoddard, Daniel L. Rhodes, Robert H. Morrow and Sean D. Buchanan

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