DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF ENERGY, MINERAL, AND LAND RESOURCES
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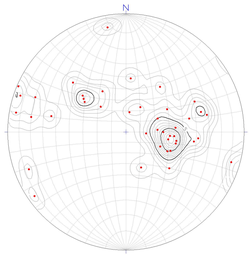
NORTH CAROLINA GEOLOGICAL SURVEY
OPEN FILE REPORT 2012-04



Equal Area Schmidt Net Projection of
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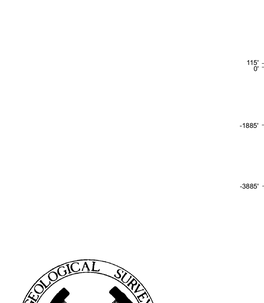
Contour Interval = 1 N = 42



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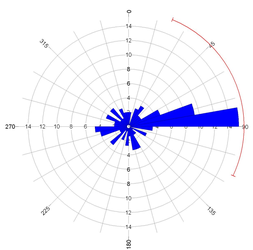
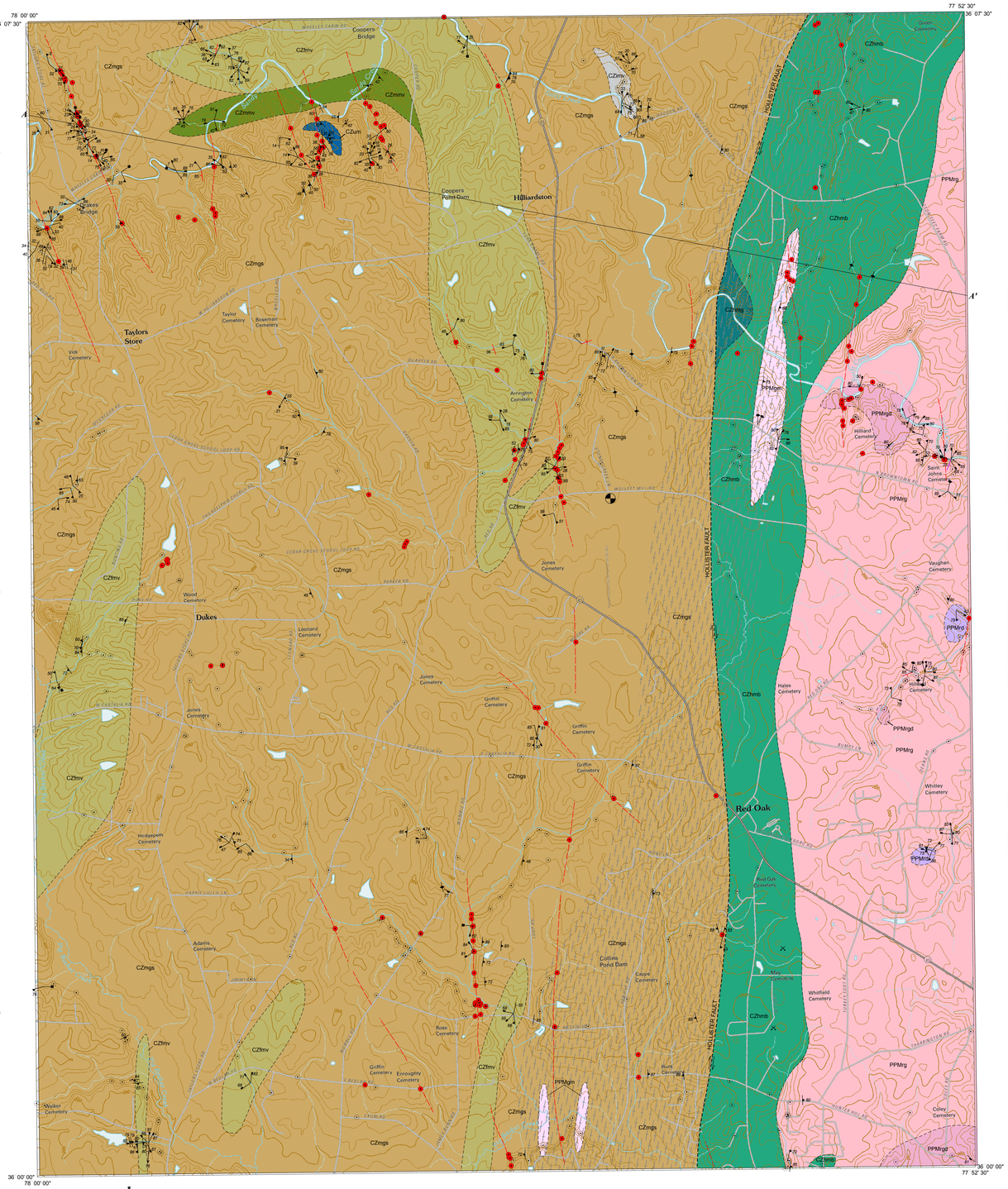
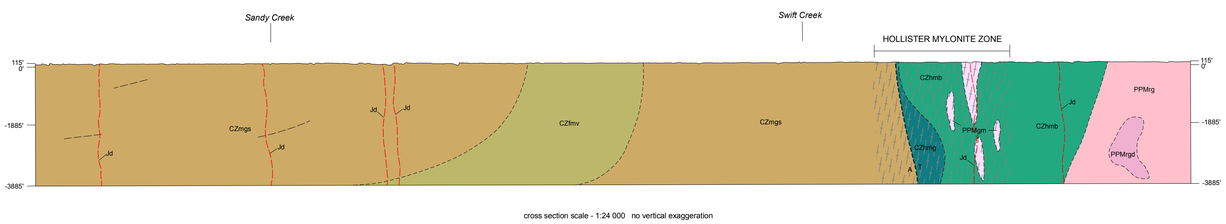


Unidirectional Rose Diagram of Joints
N = 150
Outer Circle = 15%
Mean direction = 69





cross section scale - 1:24 000 no vertical exaggeration

INTRODUCTION

The Red Oak 7.5-minute quadrangle lies in the easternmost North Carolina Piedmont, a few miles northwest of the City of Rocky Mount and entirely within Nash County. NC Highway 43 runs northwest from Rocky Mount to the Town of Red Oak in the southeastern part of the quadrangle, then continues northward through the quadrangle. Interstate 95, running north-south, lies a few miles east of the Red Oak Quadrangle, and US Highway 64 runs east-west about a mile to the south. In addition to the town of Red Oak, the map area includes three named unincorporated crossroads communities: Dukes, Hilliardston, and Taylors Store. The northern half of the quadrangle is deeply incised by Swift Creek (also called Sandy Creek to the west), which drains eastward into the Tar River east of Rocky Mount. Pig Basket Creek drains to the south in the southern part of the quadrangle. Much of the drainage divide between Swift Creek and Pig Basket Creek is a broad, flat area largely underlain by Coastal Plain sediments. Exposures of crystalline rocks occur almost exclusively along creeks, with good outcrops along Swift/Sandy Creek and its tributaries. Total relief in the quadrangle is just under 200 feet, the highest elevation being 306 feet above sea level near the western edge of the quadrangle between Taylors Store and Dukes, and the lowest about 115 feet above sea level where Swift Creek leaves the eastern edge.

PREVIOUS WORK

Previous geologic investigations pertinent to the Red Oak 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 Castalia Quadrangle, just west of Red Oak, and mapping by Gay (2004) includes the Nashville Quadrangle to the south. The Spring Hope Quadrangle, immediately southwest, has been the subject of mapping by Stetler (1997) and Clark and others (2004; see also Carpenter and others, 1995). Farther north, other published maps in the region include those of Sacks and others (2011) and Stoddard and others (2011). Additional mapping by Sacks (1999 and unpublished manuscript map), in a study of the Hollister fault zone, constitutes portions of the geologic map. Mapping by Kite (1982) included part of the Red Oak Quadrangle.

Other research pertinent to the geology of the Red Oak 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). Moncla (1990) studied the Rocky Mount pluton, including exposures in the Red Oak Quadrangle. Weems and others (2009) produced a map of the surficial geology of the Roanoke Rapids 1:100,000 sheet, including the Red Oak Quadrangle. They show two map units of the Atlantic Coastal Plain in the Red Oak Quadrangle: the Moore House member(?) of the Yorktown Formation in patches at high elevations in the extreme western part of the quadrangle, and the Chowan River Formation covering large portions of the eastern two-thirds of the quadrangle. They also show the Thornburg fault, a high-angle fault with east side down, trending north-northwest across the northwestern portion of the quadrangle, and constituting a scarp that separates two terraces of the Coastal Plain.

GEOLOGICAL FRAMEWORK

Low-grade metamorphic rocks of the Spring Hope terrane underlie the western two-thirds of the Red Oak Quadrangle. Most of these rocks are metasedimentary in nature, dominantly metasiltstone and metagraywacke. Metavolcanic rocks are also present, and in one location there are metamorphosed ultramafic rocks. No fossils have been found in the Spring Hope terrane, but radiometric ages on metavolcanic rocks range from 525 to 628 Ma (Goldberg, 1994; Horton and Stern, 1994; Coler and Samson, 2000; Stoddard and Miller, 2011). The Hollister fault zone separates the Spring Hope terrane from the Roanoke Rapids terrane to the east. In the Red Oak Quadrangle, the Roanoke Rapids terrane consists of metabasalt, amphibolite and metagabbro belonging to the Halifax County mafic-ultramafic complex (Kite, 1982; Kite and Stoddard, 1984). Metamorphosed granitoid intrusive rocks from elsewhere in the Roanoke Rapids terrane have been dated from 607 to 672 Ma (Horton and Stern, 1994; Coler and Samson, 2000). The Spring Hope and Roanoke Rapids terranes are inferred to represent elements of one or more Neoproterozoic volcanic arcs (Hibbard and others, 2002). The late Paleozoic Rocky Mount granitoid pluton underlies the eastern edge of the quadrangle. It has been dated at ca. 345 Ma (Moncla, 1990). Numerous dikes of Jurassic olivine diabase have intruded the older crystalline rocks; the dikes strike dominantly northwest or north.

Metamorphic rocks of the quadrangle have been subjected to greenschist facies conditions, with sparse evidence of hornfels conditions near the western margin of the Rocky Mount pluton. Metamorphic rocks retain sedimentary bedding or primary volcanic layering in many exposures, while in others a metamorphic foliation is present. In the western part of the quadrangle, where bedding is best preserved, it is variable but tends to strike northwest and dip gently southwest. In the central part of the quadrangle, both bedding and foliation are steeper and their strikes change closer to north-south. These observations are generally consistent with the mapping of Farrar (1985a), who shows the axial trace of the upright, south-plunging Spring Hope synform (his F3) just west of the Red Oak Quadrangle. In Farrar's map, the eastern limb of the synform merges with and is cut off by the Hollister fault zone. Farrar (1985a) also shows an older (his F2) generation of regional-scale folds that are refolded by the Spring Hope synform.

Sedimentary deposits of the Atlantic Coastal Plain are widespread, covering most of the higher flat areas in the quadrangle. Although they are not shown on the map, most of the coastal plain deposits encountered in this mapping consist of unconsolidated sands and gravels. They typically lie at elevations higher than 180 feet above sea level. Rounded quartz cobbles are common, as are local concentrations of heavy minerals. In a number of spots, indurated sandstone is present, commonly with rusty iron-oxide cement. In one location northeast of Red Oak near the eastern edge of the quadrangle, at an elevation of about 165 feet, the nonconformable contact of sandstone with underlying granite is exposed, and is indicated on the map.

DESCRIPTION OF MAP UNITS

INTRUSIVE ROCKS

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. Red dots indicate isolated outcrops or float occurrences.

Igneous rocks of the Rocky Mount pluton

The Rocky Mount pluton is a large composite intrusive body located in the easternmost Piedmont of North Carolina. Although mostly covered by sediments of the Atlantic Coastal Plain as shown on the state geological map (North Carolina Geological Survey, 1985), geophysical evidence indicates that the Rocky Mount pluton is of batholithic proportions (Lawrence and others, 1987; Spruill and others, 1987). In the Red Oak Quadrangle, good exposures exist along many of the drainages near the eastern edge of the map, and especially along the easternmost stretch of Swift Creek. Rocks of the pluton range from leucogranite to diorite in the quadrangle, but are dominantly biotite granite and granodiorite. Farrar (1980) investigated the extent and petrography of the Rocky Mount pluton, including detailed examination of a 420-foot drill core located at its inferred center. Spruill and others (1987) and Moncla (1990) also studied the pluton, and describe various aspects of its petrography, petrology, geochemistry, geophysics. Moncla (1990) also divides the Rocky Mount pluton into two intrusions, earlier "gray granitoids" and younger "white granites." He presents data on two specimens from the Red Oak Quadrangle, including a chemical analysis of a "hornblende-biotite tonalite of uncertain relations" from Flat Rock Branch near the east edge of quadrangle (his sample 52, location c3). Moncla sampled extensively two quarries located in the Rocky Mount Quadrangle southeast of Red Oak; a newer quarry in the Drake Quadrangle, located about 1.5 miles east of the Red Oak Quadrangle, was not developed at the time of Moncla's study. In his study, Moncla (1990) also determined a Mississippian age of 345+/- 2 Ma, based on a nine-point whole-rock Rb-Sr isochron. Field evidence argues for a somewhat younger age, because in the Red Oak Quadrangle, the granitic rocks appear to be unmetamorphosed, and most exposures visited do not present obvious evidence of penetrative deformation. On the other hand, sparse occurrences of deformed granitoid rocks exist within the Hollister fault zone just west of the pluton's edge. Whether they may have originated as part of the Rocky Mount pluton is not clear.

PPMrg - Granite and leucogranite: Medium to coarse-grained equigranular to weakly porphyritic pale pink to salmon, or light gray biotite granite. Massive and unfoliated to moderately foliated. Biotite weathers to vermiculite. Also fine to medium-grained light gray to tan equigranular biotite +/- muscovite +/- garnet leucogranite. Commonly includes small tabular to patchy white pegmatite bodies.

PPMrgd - Granodiorite: Medium to coarse-grained, typically porphyritic, unfoliated to moderately foliated black and white biotite +/- hornblende granodiorite to tonalite.

PPMrd - Diorite, quartz diorite and tonalite: Fine to medium-grained equigranular amphibole +/- biotite diorite, quartz diorite and tonalite. Correlates, in part, with "hornblende-biotite tonalite of uncertain relations" of Moncla (1990).

PPMgm - Deformed granitoid and/or metagranitoid rocks: Strongly foliated to mylonitic granite, leucogranite, granodiorite and granitoid gneiss. Locally with quartz ribbons and feldspar porphyroclasts. Also rare ultramylonite, breccia or microbreccia. Isolated occurrences within Hollister fault zone Age is conjectural.

METAMORPHIC ROCKS OF THE SPRING HOPE TERRANE

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

CZfmv - Felsic metavolcanic rocks: 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 contains 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 "dacitic biuestone" of Stoddard (1993; Stoddard and others, 2009). The unit includes dacitic to rhyolitic rocks based on analyzed samples from elsewhere (Stoddard, 1993; Stoddard and others, 2011; Sacks and others, 2011). Zircons from a sample of this lithology 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).
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 flattened lapilli. Interpreted as crystal- and crystal-lithic tuff. Chemical and petrographic data from the Bunn East Quadrangle (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 to felsic metavolcanic and metaplutonic rocks: Gray to brown quartz-porphyritic meta-andesite and light-gray to beige, fine-grained and massive meta-quartz diorite or quartz keratophyre. Unfoliated; generally well-jointed and gnarly weathering, silicified and/or brecciated.

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).

Czum - Meta-ultramafic rocks: Pale to dark green or gray, medium-grained, massive to schistose rocks containing varying proportions of actinolite, talc, and chlorite. Locally, sparse rhombohedral cavities suggest the former presence of magnesite.

CZmgs - Metasiltstone, metagraywacke, and metamudstone: Mostly fine, greenish-tan to beige or gray, locally phyllitic, slaty or fissile, generally tuffaceous metasiltstone and light greenish to medium-brown or gray, fine- to medium-grained tuffaceous metagraywacke. Consists of quartz, plagioclase, white mica, biotite, epidote and opaque minerals. Locally displays relict clastic texture and sedimentary bedding. May weather into thin slabs. Metagraywacke may be massive or poorly bedded, with sand to silt-sized grains of volcanic rock fragments, sericitized feldspar and quartz, with biotite, epidote and white mica. Metamudstone is light tan to medium-brown, massive to laminated, and locally phyllitic. As overall grain size decreases, white mica increases in abundance. Fine opaque mineral grains are common. Graded bedding, cyclic bedding, and scour-and-fill structures were observed in outcrop. Where stratigraphic facing direction could be inferred, beds appear to be upright. Characteristics suggest that these sediments may have originated, at least in part, as turbidites on the subaqueous flank of a volcanic arc.
Unit also includes layers of metavolcanic rocks, including lithic and crystal-rich varieties of felsic tuff having phenocrysts of plagioclase and quartz. 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). Lawrence and Hoffman (1993) describe rock chips from a 45-foot borehole (their NA-A-1-84) drilled within this unit, and located about 2.5 miles north-northwest of the Town of Red Oak (location indicated on the map). They describe the rock as a "somewhat sheared volcaniclastic sandstone" containing quartz ribbons ascribed to deformation related to the Hollister fault zone.
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.

METAMORPHIC ROCKS OF THE ROANOKE RAPIDS TERRANE

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

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

CZhmg - Metagabbro of the Halifax County complex: Typically coarse-grained, dark green to black, unfoliated rocks consisting of blocky hornblende and/or prismatic actinolite, plagioclase, epidote/clinozoisite, and opaque oxide minerals. Hornblende is uralitic and probably formed as pseudomorphs after primary clinopyroxene. Rock may possess a relict interlocking igneous texture. Also includes less common metadiorite and meta-quartz diorite. These plutonic lithologies also occur sporadically as unmapped bodies within the metabasalt unit.

Zone of high strain overprint of Hollister Fault Zone

ACKNOWLEDGMENTS

Mapping by Kite took place between 1980 and 1982 as part of her M.S. thesis research at North Carolina State University. Mapping by Sacks was between 1990 and 1992 during his study of the Hollister mylonite zone with the U. S. Geological Survey. The data of Kite and Sacks were compiled and digitized by Stoddard, Phil Bradley, and Mike Medina in 2010-11. We thank J. Wright Horton, Jr., and the USGS for making their mapping available for this project. We are grateful for the assistance of Phil Bradley, Heather Hanna, and Mike Medina with office work and logistics. We also wish to express our gratitude to all the landowners who graciously allowed access to their property.

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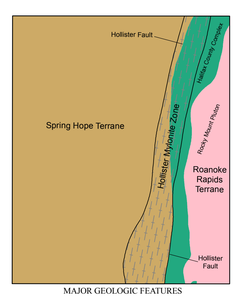

MAJOR GEOLOGIC FEATURES

CONTACTS, FOLDS AND OTHER FEATURES

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

- contact - location known
- contact - location inferred or concealed beneath coastal plain (not shown on map)
- strike-slip fault - location inferred in cross section: T towards observer, A away from observer
- diabase contact - dashed where inferred, dotted where concealed
- in cross section, primary layering form lines
- A — A' cross section line
- strike and dip of inclined primary bedding and layering
- strike and dip of inclined primary bedding and layering (multiple observations at one locality)
- strike of vertical inclined primary bedding and layering (multiple observations at one locality)
- strike and dip of inclined regional foliation
- strike and dip of inclined regional foliation (multiple observations at one locality)
- strike of vertical regional foliation
- strike of vertical regional foliation (multiple observations at one locality)
- strike and dip of cleavage (multiple observations at one locality)
- strike and dip of inclined joint surface
- strike and dip of inclined joint surface (multiple observations at one locality)
- strike of vertical joint surface (multiple observations at one locality)
- bedrock core location
- strike and dip of quartz vein
- strike of vertical quartz vein
- strike and dip of inclined pegmatite dike
- bearing and plunge of lineation
- station location
- diabase station location
- location of coastal plain/crystalline rock contact exposed
- sand and gravel pit - abandoned

Base map is from USGS 2010 GeoPDF of the Red Oak 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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Disclaimer:
This Open-File report is preliminary and has been reviewed for conformity with the North Carolina Geological Survey editorial standards or with the North American Stratigraphic Code. Further revisions or corrections to this preliminary map may occur prior to its release as a North Carolina Geological Survey map.

BEDROCK GEOLOGIC MAP OF THE RED OAK 7.5-MINUTE QUADRANGLE, NASH COUNTY, NORTH CAROLINA

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