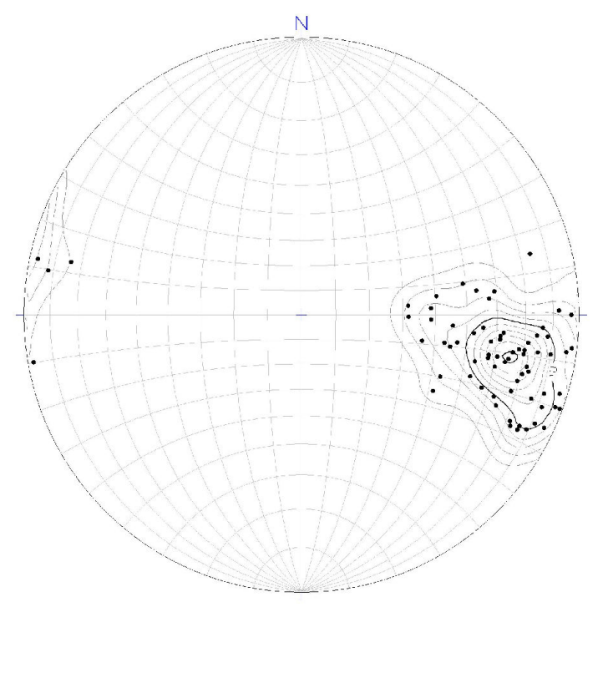
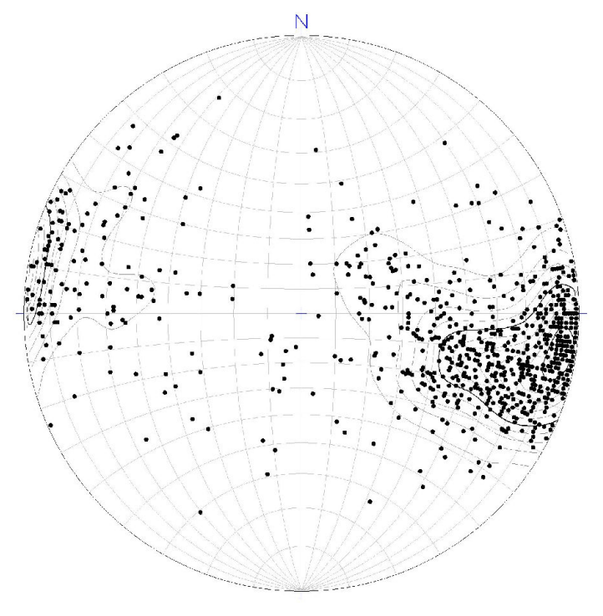
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF LAND RESOURCES
JAMES D. SIMONS, DIRECTOR AND STATE GEOLOGIST

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program

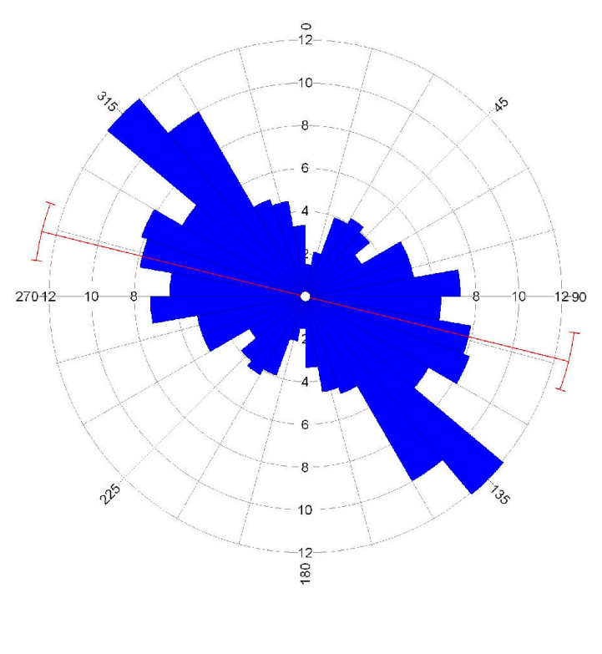
NORTH CAROLINA GEOLOGICAL SURVEY
OPEN FILE REPORT 2011-02



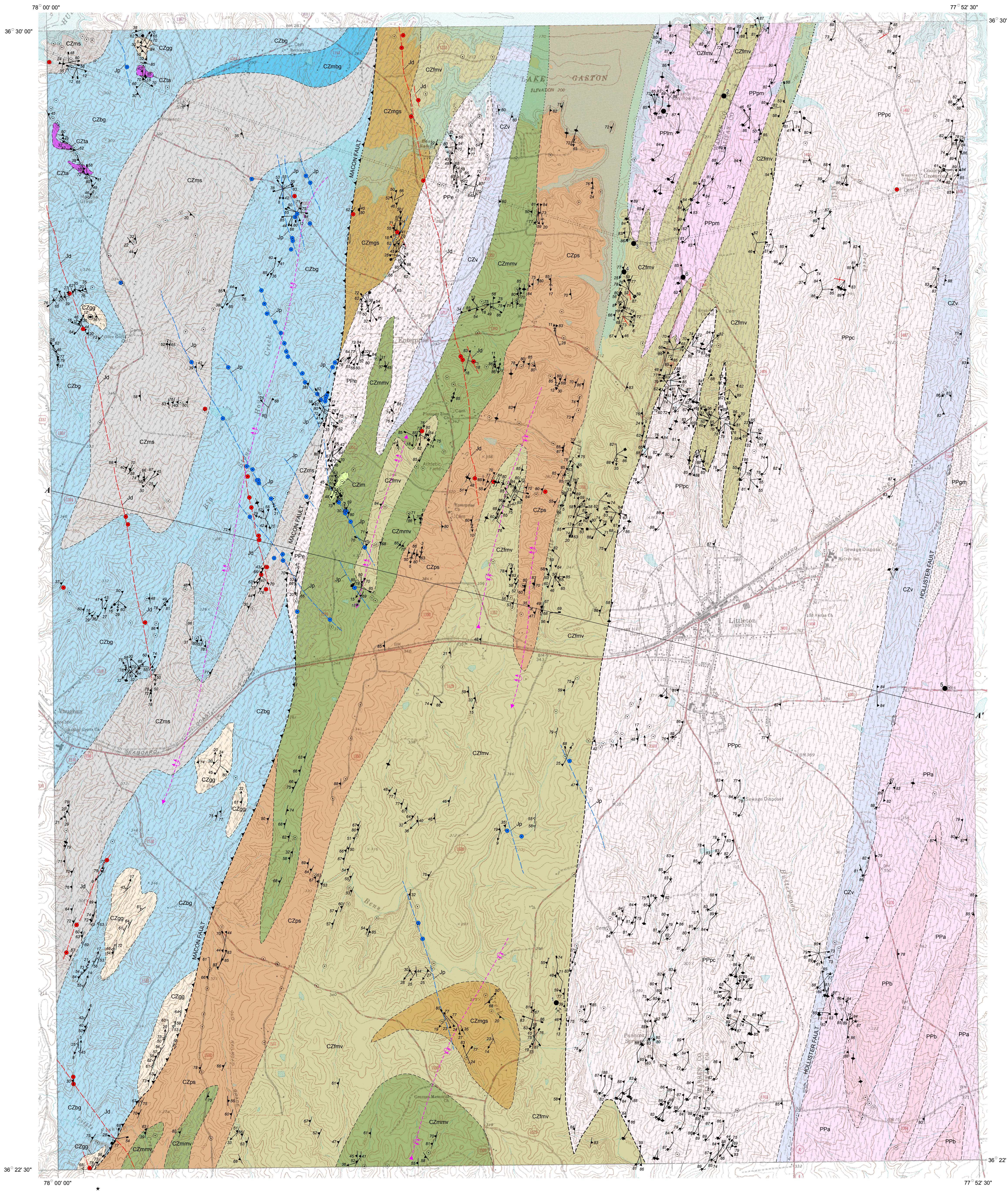
Equal Area Schmidt Net Projection of Poles to Primary Layering.
Contour Interval = 2 N = 72

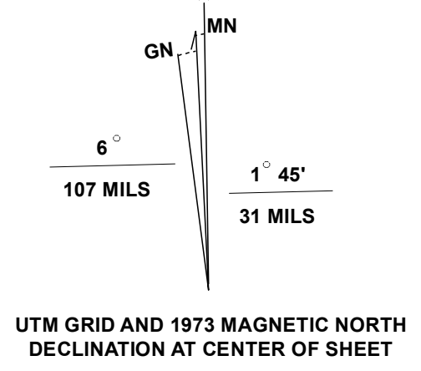


Equal Area Schmidt Net Projection of
Contoured Poles to Foliation and Mylonitic Foliation
Contour Interval = 2 N = 1213

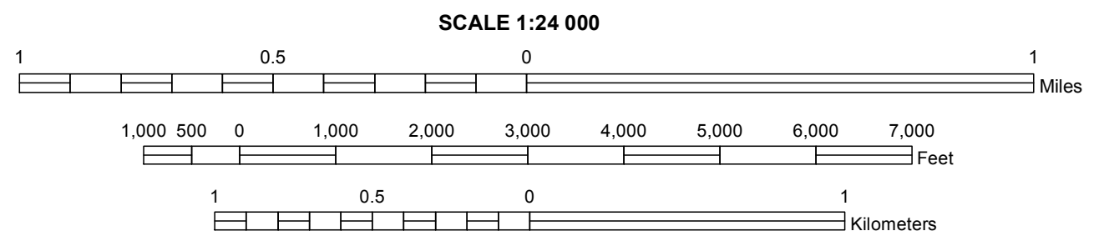


Unidirectional Rose Diagram of Joints N = 331
Outer Circle = 12%
Mean direction = 284



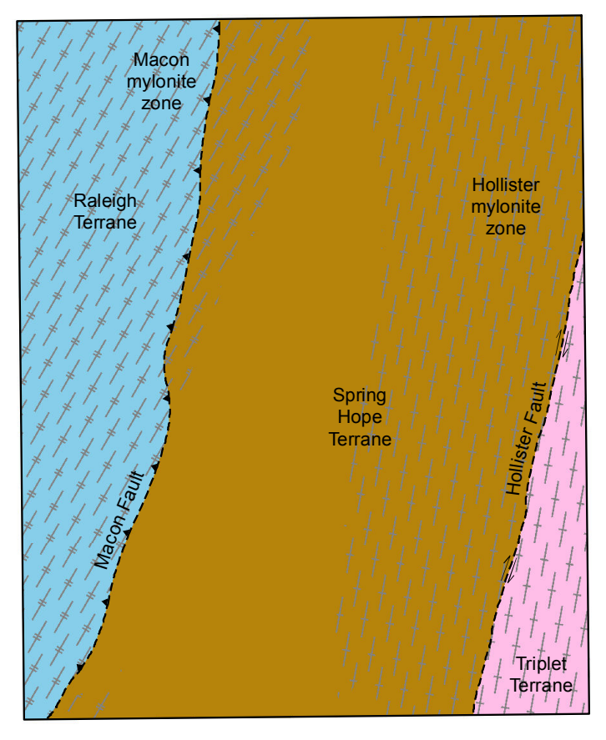


UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

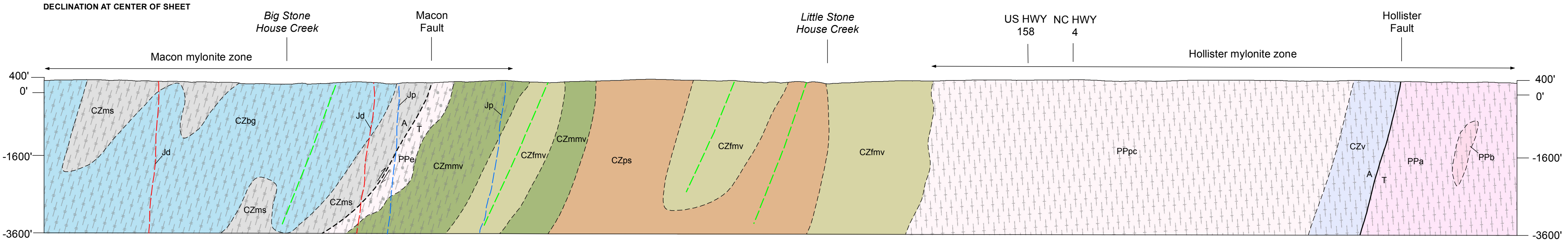


CONTOUR INTERVAL 10 FEET

MAP LOCATION



MAJOR GEOLOGIC FEATURES



cross section scale: 1:24 000 elevation in feet no vertical exaggeration

WHOLE ROCK CHEMISTRY OF SELECTED SAMPLES

					OXIDES IN WEIGHT PERCENT												TRACE ELEMENTS IN PPM					
sample	geochem ID	rock type	map unit	source	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Rb	Sr	Y	Zr	Nb	Ba
LIT-R	1	leucogneiss	CZfmv	S	76.30	0.24	12.70	3.35	0.21	0.05	1.11	4.50	2.47	0.03	nd	100.96	122	87	84	373	24	nd
35-1	2	leucogneiss	CZfmv	G	71.75	0.33	15.95	1.96	0.01	0.45	0.03	0.68	8.83	nd	1.42	101.41	209	61	45	312	nd	1301
39-6	3	leucogneiss	CZfmv	G	72.67	0.29	14.74	1.79	0.02	0.46	0.44	2.54	7.35	nd	0.43	100.73	165	65	27	290	nd	1292
80-1	4	leucogneiss	CZfmv	G	73.74	0.27	16.29	0.91	0.04	0.46	0.67	1.39	7.03	nd	1.16	101.96	252	144	42	263	nd	920
73-1	5	granitoid	Ppa	G	67.57	0.25	16.40	1.83	0.05	0.45	1.07	3.18	5.61	nd	1.12	97.53	282	154	13	156	nd	562
27-1	6	granitoid	PPpm	G	64.08	0.67	15.92	3.81	0.06	0.73	2.15	3.57	5.61	nd	0.73	97.33	163	454	24	243	nd	1336
84-1	7	granitoid	PPlm	G	64.10	0.71	15.00	3.86	0.09	0.69	2.28	3.42	4.95	nd	0.71	95.81	189	442	25	293	nd	1135

Analysis of LIT-R by X-ray fluorescence spectrometry; North Carolina State University; Others by XRF at East Carolina University, except MgO and Na_2O by Atomic Absorption spectrophotometry at University of North Carolina, Chapel Hill
Total Fe as Fe_2O_3; nd=not determined
L.O.I. = percent weight loss on ignition
source: G= Grundy (1983); S= Stoddard and others (1987)

BEDROCK GEOLOGIC MAP OF THE LITTLETON 7.5-MINUTE QUADRANGLE, WARREN AND HALIFAX COUNTIES, NORTH CAROLINA

By Edward F. Stoddard, Paul E. Sacks, Timothy W. Clark and Randy Bechtel

Digital representation by Michael A. Medina, Heather D. Hanna and Philip J. Bradley

2011

INTRODUCTION

The Littleton 7.5-minute quadrangle lies in the northeastern Piedmont, partly along the south shore of Lake Gaston and within 1.5 miles of the Virginia state line. The Warren-Halifax County line runs nearly north-south through the quadrangle, except for a jog around the western edge of the town of Littleton, which itself lies entirely in Halifax County. The majority of the quadrangle lies within Warren County to the west of the town. US Highway 158 runs approximately west to east across the quadrangle, following the southern drainage divide of the Roanoke River basin. NC Highway 4, which runs south to Rocky Mount, has its northern termination at US 158 in Littleton. NC Highway 903 enters the quadrangle from the east edge, coinciding with US 158; at Littleton, NC 903 turns north, exiting the northern edge of the quadrangle before crossing Lake Gaston at Eaton's Ferry Bridge and terminating at the Virginia state line. The old Seaboard Coast Line Raleigh and Gaston railway spur ran parallel to US 158 across the quadrangle, but it is now defunct and the tracks have been removed. Aside from the town of Littleton, the Warren County portion of the quadrangle contains the unincorporated communities of Enterprise, Epworth, and part of Vaughan, while the unincorporated community of Cooleys Crossroads lies in Halifax County. Panacea Springs, a former resort hotel featuring mineral waters, is located in the upper reaches of Bens Creek in the southeastern part of the quadrangle. It thrived during the latter part of the 19th century, and up until about 1920.

North of US 158, streams draining north into Lake Gaston (formerly the Roanoke River) have incised relatively deep channels. The three most significant of these, Mill Creek and Big and Little Stone House Creeks, have NNE trends that are at least partly controlled by the structure of the bedrock geology. South of the US 158 drainage divide, Butterwood Creek, Bens Creek, and Little Fishing Creek drain southward and southeastward, eventually emptying into Fishing Creek at the Halifax-Nash County line. Total relief in the quadrangle is less than 200 feet, with a high just about 390 feet above sea level just east of the town of Littleton, while the low point is Lake Gaston at 200 feet. Despite the low relief, bedrock exposure is fairly good along creeks and the lakeshore; in addition, the granitic rocks are well exposed on ridges and slopes.

GEOLOGICAL FRAMEWORK

Three major groups of rocks underlie the quadrangle: from west to east they include late Proterozoic to Cambrian metamorphic rocks of the Raleigh terrane, similar-age metamorphic rocks of the Spring Hope terrane, and a number of late Paleozoic granitoid plutons in the eastern part of the quadrangle. Two major late Paleozoic faults also lie within the quadrangle. The Macon fault separates the Raleigh terrane from the Spring Hope terrane. The Hollister fault, which separates the Spring Hope terrane from the Triplet terrane, tracks through younger granitic rocks in the eastern part of the quadrangle. Metamorphic rocks of the Triplet terrane occur east of the Littleton Quadrangle in the Thelma Quadrangle. The Raleigh terrane consists of gneisses and schists, and is interpreted as an infrastructural component of a Neoproterozoic volcanic arc (Hibbard and others, 2002). The suprastructural Spring Hope terrane comprises metasedimentary and metavolcanic rocks. All metamorphic rocks of the quad have been subjected to mid- to upper-amphibolite facies conditions.

Lake Paleozoic granitic rocks in the quad range from medium-grained and equigranular to strongly megacrystic, and from some undeformed granites to those strongly deformed into ribbon mylonites. Nearly all of the granitic rocks are divided into five separate bodies; they are the Butterwood Creek, Airlie, Panacea Springs, Lawrenceville, and Enterprise plutons. The Butterwood Creek and Airlie plutons intrude metamorphic rocks of the Triplet terrane, while the other three intrude the Spring Hope terrane. An age of 292 +/- 31 Ma was reported by Russell and others (1985) for the Butterwood Creek pluton, but subsequent mapping, shown here, indicates that some of the samples analyzed in their study are from the Panacea Springs pluton. Nevertheless, a late Paleozoic (Alleghanian) age is likely for all five granitic plutons in the Littleton Quadrangle.

Intrusive rocks of Jurassic age cut the older rocks of the quadrangle. These are of two types: olivine diabase and rhyolite porphyry. Both types occur as NNW-trending, steeply dipping dikes; the porphyries comprise a swarm of dikes in the western half of the quadrangle. The unusual rhyolite porphyry has been dated at 196 – 200 Ma by several methods (Stoddard and others, 1986; Ganguli and others, 1995). In the eastern part of the quadrangle, several high and flat areas, underlain by sedimentary deposits of the Atlantic Coastal Plain, are not shown on the geologic map.

PREVIOUS WORK

Previous geologic investigations pertinent to the Littleton Quadrangle include several regional and reconnaissance studies. Parker (1968) defined the structural framework of the region. McDaniel (1980) mapped a multi-county region, including Warren County, at a scale of 1:100,000. Farrar (1985a, b) mapped the entire eastern Piedmont of North Carolina, defined map units for the region, and proposed a model for the tectonic evolution of the region.

Boltin (1985) mapped the Hollister Quadrangle immediately to the south of the Littleton Quadrangle. The Hollister Quadrangle was updated with new data concurrently with the Littleton Quadrangle (Sacks and others, 2011). Sacks (1996a, b, c, d) mapped a strip of four 7.5-minute quadrangles along the Virginia-North Carolina border. One of these, the Gasburg Quadrangle (Sacks, 1996c), lies immediately to the north of the Littleton Quadrangle. Additional mapping by Sacks (1999 and unpublished manuscript map), in a study of the Hollister fault zone, constitutes the eastern portion of the geologic map and served as the impetus for this study.

Other research pertinent to the geology of the Littleton Quadrangle includes two studies involving mapping and chemical analyses of some of the granitic rocks of the area (Koehler, 1982; Grundy, 1983), investigations of Mesozoic dikes (Delorey, 1983; Stoddard and others, 1986; Stoddard, 1992), and metamorphic studies (Boltin and Stoddard, 1987; Stoddard, 1999). Two published field trip guides include stops within the quadrangle (Stoddard and others, 1987; Sacks and others, 1999).

DESCRIPTION OF MAP UNITS

INTRUSIVE ROCKS

Jp – rhyolite porphyry: Dark gray to black, strongly porphyritic dike rocks containing phenocrysts of alkali feldspar (sanidine-anorthoclase) and quartz, and locally microphenocrysts of Fe-Ti oxide minerals, ferropigeonite, and amphibole. Commonly with ovoid, locally aligned amygdules of calcite, silica, or a green swelling clay mineral. Occurs in steeply dipping, NNW-trending dikes that correlate with linear magnetic highs. Weathers spheroidally. Described more fully elsewhere (Delorey, 1983; Stoddard and others, 1986; Stoddard, 1992). Blue dots indicate outcrops or float occurrences.

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 Littleton quad, nearly all diabase dikes trend NW to NNW. Red dots indicate outcrops or float occurrences.

PPpc, PPpm – Panacea Springs granite: Medium-gray, megacrystic, weakly foliated biotite +/- hornblende monzogranite to quartz monzonite (PPpm) composed of megacrysts of microcline in a matrix of coarse-grained plagioclase, microcline, quartz, biotite, opaque minerals, and minor white mica; microcline megacrysts are as long as 5 cm. A chemical analysis (Grundy, 1983, sample 27-1) yields norms falling in the quartz monzonite field. See Table. Medium-gray, coarse-grained, porphyritic, foliated biotite monzogranite to quartz monzonite (PPpc), composed of plagioclase, microcline, quartz, biotite, opaque minerals, and minor white mica; locally contains microcline phenocrysts as long as 3 cm. Locally mylonitic along eastern margin (Sacks, 1996c). Apparently sampled in the Littleton quad and analyzed by Vynhal and McSween (1990) as their "deformed Butterwood Creek" granite.

PPlm – Lawrenceville granite: Medium-gray, megacrystic, weakly foliated biotite quartz monzonite to monzogranite (PPlm) composed of megacrysts of microcline in a matrix of coarse-grained plagioclase, microcline, quartz, biotite, opaque minerals, and minor white mica; microcline megacrysts are as long as 5 cm (Sacks, 1996c). A chemical analysis (Grundy, 1983, sample 84-1) yields norms falling in the quartz monzonite to monzogranite range. See Table.

Ppa – Airlie granite: Light gray or beige, fine- to medium-grained, dominantly equigranular muscovite, muscovite-biotite, and muscovite-biotite-garnet monzogranite and leucogranite. Generally massive, but locally weakly to moderately foliated. Mylonitic along western margin (Sacks, 1999). Cuts and locally contains enclaves of megacrystic Butterwood Creek granite. A chemical analysis (Grundy, 1983, sample 73-1) yields norms falling in the monzogranite field. See Table.

PPb – Butterwood Creek granite: Medium gray to tan, megacrystic biotite +/- hornblende monzogranite or quartz monzonite with accessory titanite. Generally massive, locally with a weak magmatic alignment of K-feldspar megacrysts. At its western and northwestern margin, where it is intruded by granite of the Airlie pluton within the Hollister fault zone, the Butterwood Creek granite carries a strong deformational fabric. There, megacrysts are strongly aligned, quartz ribbons are developed, and the foliation is composite with both a mylonitic foliation defined by aligned feldspars, biotite and quartz ribbons, and shearbands that offset the main foliation in a dextral sense (Sacks, 1999). Sampled and analyzed from the Aurelian Springs quad by Vynhal and McSween (1990) as their "undeformed Butterwood Creek granite."

Ppe – Enterprise granite: Light- to medium-gray, porphyritic to megacrystic biotite granitoid. Typically gneissic and mylonitic. Salmon, pink, or beige K-feldspar porphyroclasts 0.5-2.0 cm in length in a quartzofeldspathic matrix consisting of alternately biotite-rich and biotite-poor 1 to 3-mm thick layers. CI=10-15.

PPgm – mylonitic granite: Medium-gray, medium- to fine-grained biotite and muscovite-biotite granite in the Hollister fault zone; locally contains feldspar porphyroclasts as long as 1-2 cm; variably mylonitic or gneissic; commonly lineated (Sacks, 1996d).

METAMORPHIC ROCKS OF THE SPRING HOPE TERRANE

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

Czim – intermediate-mafic metaplutonic rocks: Dark green to greenish-black, medium- to coarse-grained weakly foliated to massive metagabbro or metadiorite consisting of amphibole, plagioclase, and 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.

CZfmv – felsic metavolcanic rocks: Light grayish-tan, bluish, or gray, thinly layered and locally strongly fissile fine-grained leucogneiss consisting predominantly of a very strongly recrystallized mosaic matrix of very fine quartz + sodic plagioclase +/- microcline. Sparse relict phenocrysts of plagioclase and rare quartz are present. Biotite and white mica may be present but are sparse; mm-scale layering is locally defined by biotite and/or magnetite. 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 (Stoddard and others, 1987, Table 1, specimen LIT-R) from a small abandoned quarry in the southern Littleton Quadrangle indicate that the rock has a dacitic protolith. Analyses from Grundy (1983) of samples north of the town of Littleton (35-1, 39-6, and 80-1) are rhyolitic in composition. See Table.

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

CZps – muscovite-garnet schist: Silver to gray white mica schist and phyllite commonly containing porphyroblasts of staurolite and garnet. May also contain quartz, chlorite, biotite, tourmaline, sodic plagioclase, and opaque minerals. Rock is typically well crenulated, with crenulation cleavage overprinting the schistosity. Unit also includes rare interlayers of fine-grained micaceous quartzite; one quartzite specimen contains biotite, muscovite, chloritoid, staurolite, garnet and opaque minerals.

CZv – metavolcanic rocks undivided: Mixed fine- to medium-grained metavolcanic rocks of felsic, mafic, or intermediate composition, together with volcaniclastic metasedimentary rocks. Includes phyllite, schist, gneiss, greenstone, amphibolite and metagraywacke.

Zone of high strain overprint of Hollister fault zone

METAMORPHIC ROCKS OF THE RALEIGH TERRANE

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

CZms – muscovite schist: silvery gray to greenish-gray, medium- to coarse-grained schist containing white mica, quartz, and commonly sillimanite and sodic plagioclase; may also contain chloritoid, tourmaline, garnet, or rarely biotite. Sillimanite may be fibrous or prismatic. Commonly displays mylonitic fabric and a button schist appearance and commonly shows retrograde metamorphic effects, with white mica, chlorite and chloritoid replacing earlier minerals. Typically interlayered with quartzofeldspathic gneiss. Includes rare soapstone and talc schist. Likely equivalent to Macon formation of Farrar (1985a,b).

CZbg – biotite gneiss: Predominantly interlayered 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 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.

CZgg – granitic gneiss: Light tan, light gray, and light brown, fine- to medium-grained quartzofeldspathic gneiss and foliated metagranitoid, consisting of quartz, sodic plagioclase, microcline, white mica, and locally biotite. May show retrograde effects including chlorite and sericite.

CZmbg – mylonitic biotite gneiss: Interlayered, variably mylonitic biotite gneiss, muscovite-biotite gneiss, muscovite schist, amphibole gneiss, and quartzofeldspathic gneiss.

CZta – talc-actinolite schist: Light grayish-green, green, or dark green, foliated to massive talc schist, soapstone, and talc-actinolite schist composed of talc, serpentine, actinolite, and chlorite, with sparse granules of black, rusty-weathering oxide minerals.

Zone of high strain overprint of Macon fault zone

ACKNOWLEDGMENTS

Mapping by Sacks was between 1990 and 1992 during his study of the Hollister mylonite zone, funded through a National Research Council - U. S. Geological Survey Postdoctoral Fellowship and a U. S. Geological Survey contract. His data were compiled and digitized by Stoddard, Phil Bradley, and Michael Medina in 2010. Mapping of the remainder of the quad by the other authors took place in 2010 and 2011. 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 Michael Medina with office work and logistics, and for the field assistance provided by Chris Bagley, Eddie Hull and Chris Ormsby. We also wish to thank the staff at Medoc Mountain State Park for their assistance and hospitality. Finally, we want to thank all the landowners who graciously allowed access to their property and for logistical assistance; in particular John L. C. Skinner, William Thomas Skinner IV, Lewis Whitt, and Ryan Newsome and the Newsome family.

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Base topographic map is a digital raster graphic image of the
Littleton 7.5-minute quadrangle (1973),
Lambert Conformal Conic projection.

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program, award number G10AC00425.
The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

Disclaimer:
This Open-File report is preliminary and has been reviewed internally for conformity with the North Carolina Geological Survey editorial standards. Further revisions or corrections to this preliminary map may occur.

CONTACTS, FOLDS AND OTHER FEATURES

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

contact - location inferred
contact - location concealed
thrust fault - location inferred sawtooth on upthrown side
strike-slip fault - location inferred in cross section: T- towards observer A - away from observer
in cross section, inferred axial trace of fold
inferred fold hinge of plunging overturned anticline, dotted where concealed
inferred fold hinge of doubly plunging overturned anticline, dotted where concealed
inferred fold hinge of plunging overturned syncline, dotted where concealed
A A' cross section line

strike and dip of inclined primary bedding (Includes banding, layering and So for Spring Hope metasedimentary rocks)
strike and dip of inclined primary bedding (multiple observations at one locality)
strike and dip of compositional layering in leucogneiss and other high grade rocks
strike and dip of compositional layering in leucogneiss and other high grade rocks (multiple observations at one locality)
strike of vertical compositional layering in leucogneiss and other high grade rocks
strike and dip of inclined regional foliation (Includes mylonitic foliation of Sacks (1996c))
strike and dip of inclined regional foliation (Includes mylonitic foliation of Sacks (1996c)) (multiple observations at one locality)
horizontal regional foliation
strike of vertical regional foliation (includes mylonitic foliation of Sacks (1996c))
strike of vertical regional foliation (includes mylonitic foliation of Sacks (1996c)) (multiple observations at one locality)

strike and dip of inclined mylonitic foliation
strike and dip of inclined mylonitic foliation (multiple observations at one locality)
strike and dip of inclined normal slip crenulation or shear band (multiple observations at one locality)
strike of vertical normal slip crenulation or shear band
strike and dip of cleavage
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
strike of vertical joint surface (multiple observations at one locality)
geochemical sample ID

strike and dip of inclined quartz vein
strike of vertical quartz vein
strike and dip of axial surface of mesoscale fold (multiple observations at one locality)
bearing and plunge of mesoscale fold hinge
bearing and plunge of lineation
bearing and plunge of mineral lineation
bearing of horizontal lineation
bearing and plunge of slickenline
bearing and plunge of crenulation lineation
bearing of horizontal crenulation lineation
abandoned quarry
observation station location

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