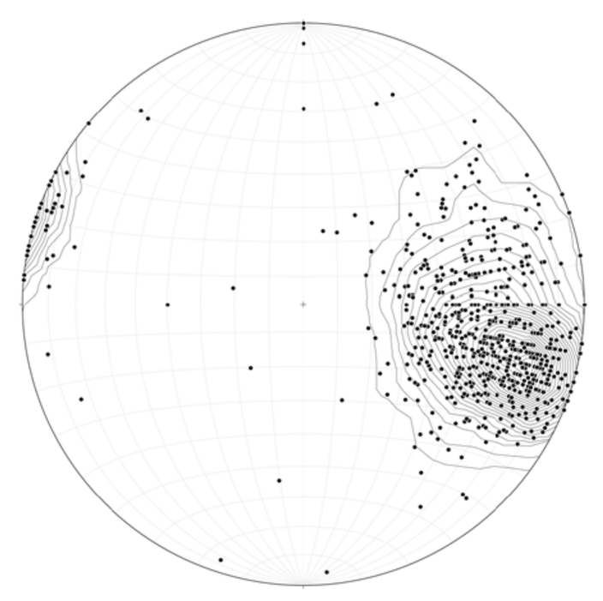
North Carolina Department of Environmental Quality
Energy Group
Jenny Kelvington, Executive Director
Kenneth B. Taylor, State Geologist

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

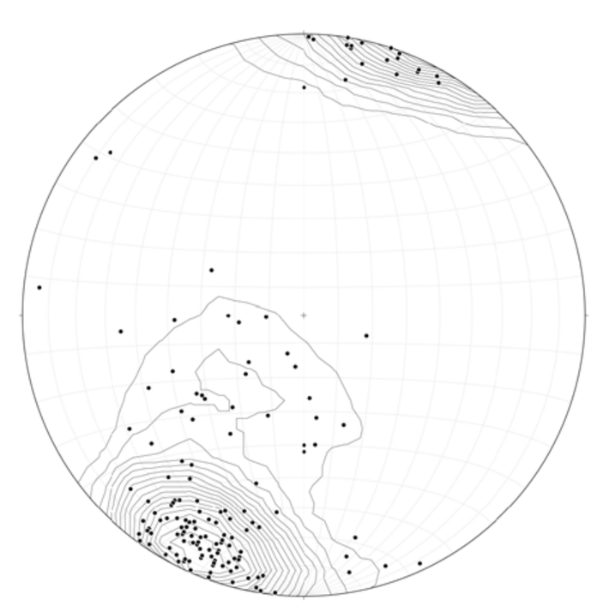
North Carolina Geological Survey
Open File Report 2016-17

Equal-Area Schmidt Net Projections and Rose Diagram

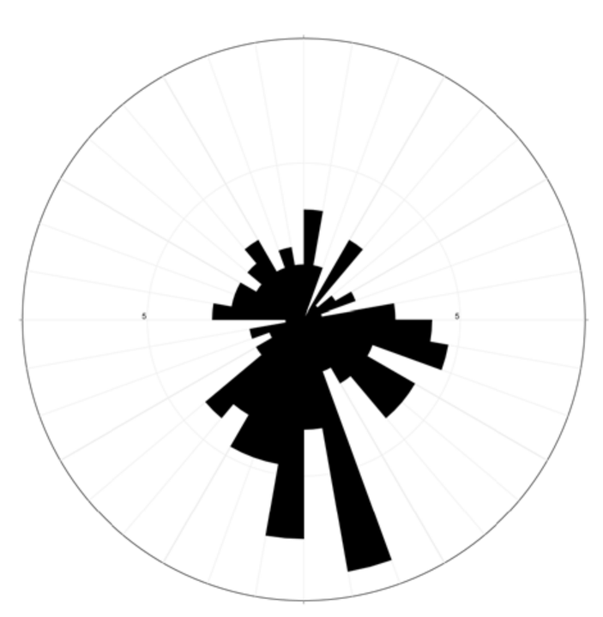
Plots and calculations created using Stereonet v. 8.6.0 based on Allmendinger et al. (2013) and Cardozo and Allmendinger (2013)



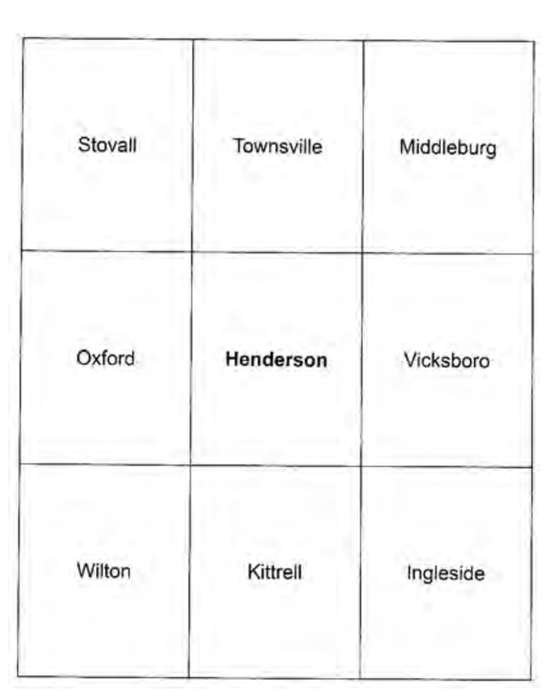
Equal-Area Schmidt Net Projection of Contoured Poles to Regional Metamorphic and Shear Foliations
Contour Interval = 2 sigma N = 731



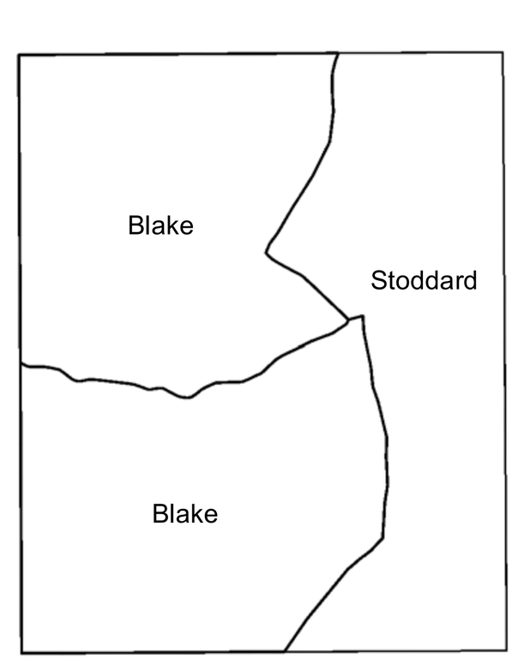
Equal-Area Schmidt Net Projection of Contoured Mineral Stretching Lineations
Contour Interval = 2 sigma N = 163



Unidirectional Rose Diagram of Joints N = 171
Outer Circle = 9%
Mean vector = 171 degrees

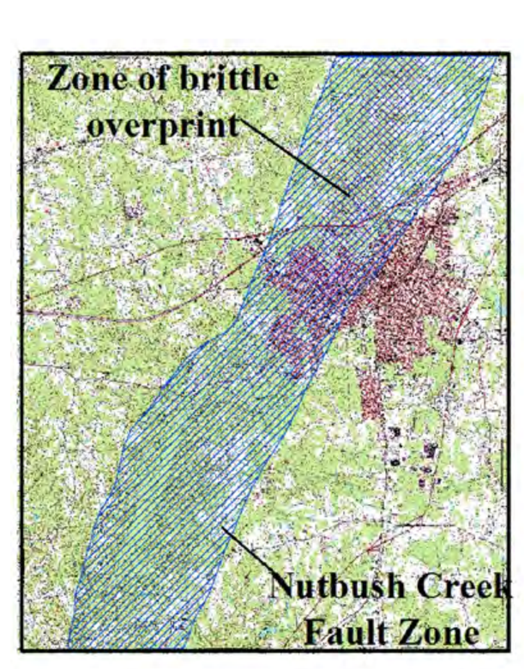


ADJOINING 7.5' QUADRANGLES



GEOLOGIST INDEX

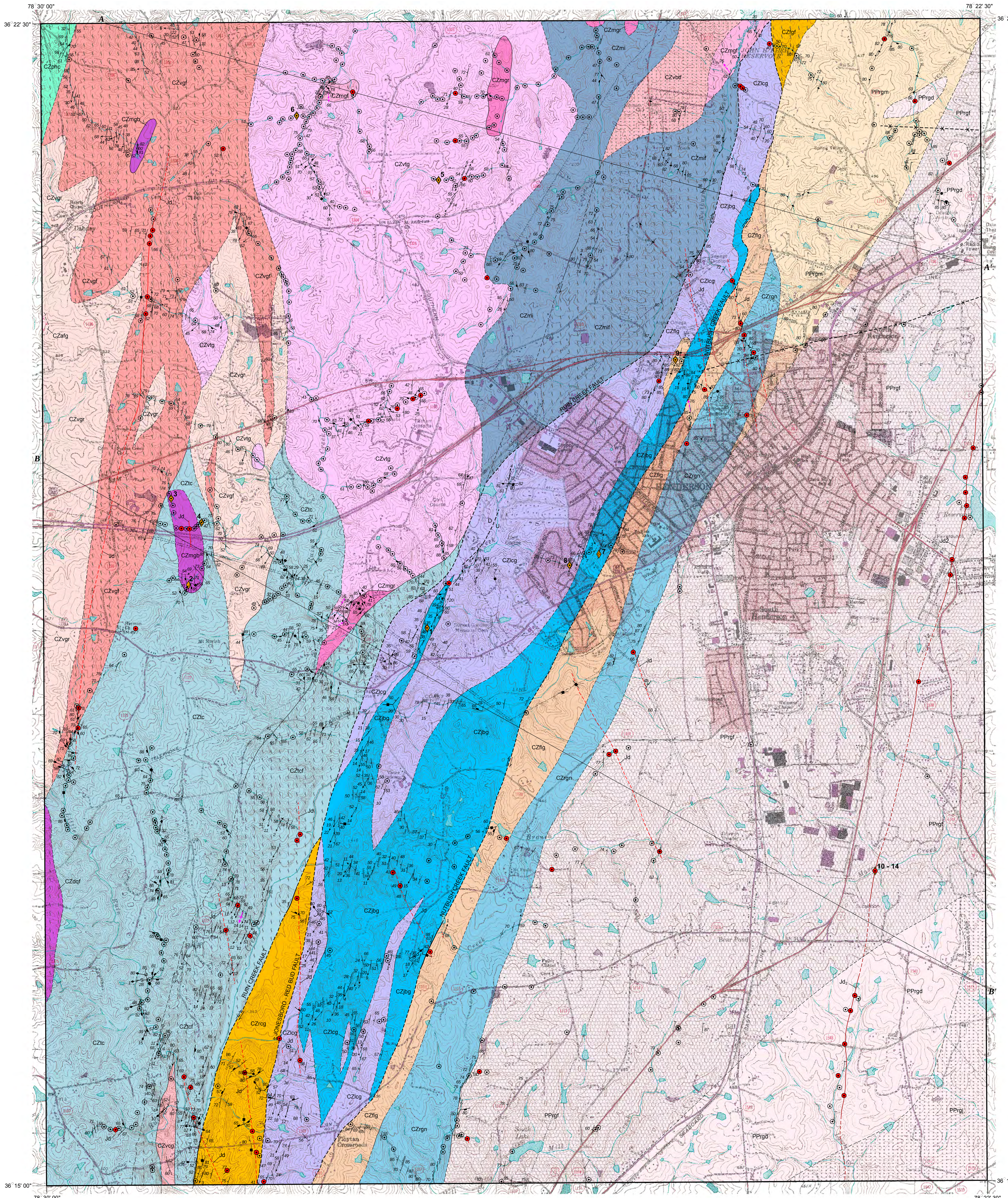
Southwest portion mapped by Blake, February-September 2001; northwest and eastern portions mapped by Blake and Stoddard, January-October 2004.



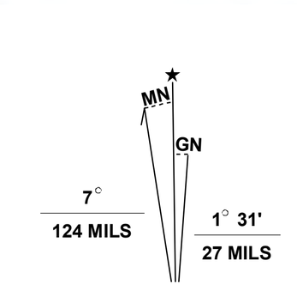
MAP SHOWING LOCATION OF NUTBUSH CREEK FAULT ZONE WITH ZONE OF BRITTLE OVERPRINT

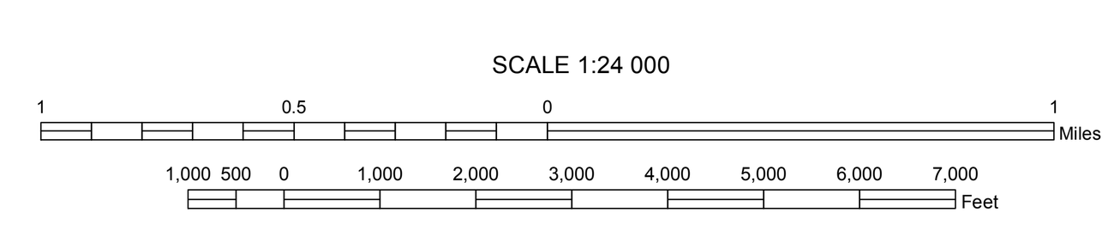
Disclaimer:
This map is preliminary and has been reviewed for conformity with the North Carolina Geological Survey editorial standards or with the North American Stratigraphic Code. Further revisions or corrections to this map may occur.

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award numbers 00HQAG0148 and 03HQAG0170.

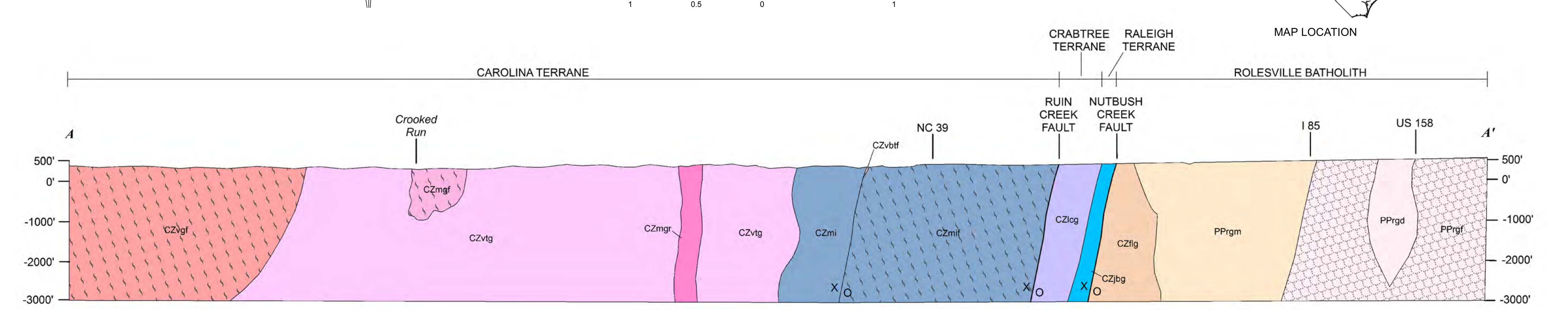


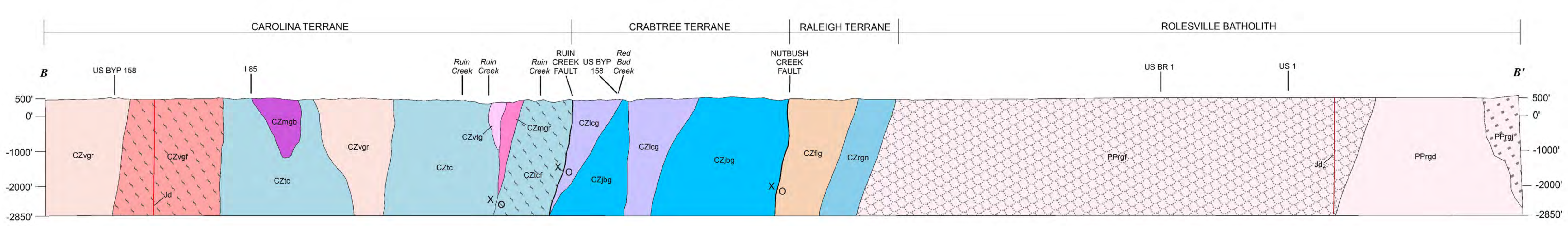
Base topographic map is digital raster graphic image of the Henderson 7.5-minute USGS quadrangle (1970, revised 1982).





MAP LOCATION





WHOLE ROCK CHEMISTRY OF SELECTED SAMPLES

OXIDES IN WEIGHT PERCENT

map no.	sample	rock type	map unit	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	Cr2O3	L.O.I.	Total
1	HN04-4956	biotite gneiss	CZjbg	62.72	0.93	15.61	6.22	0.13	1.79	4.77	4.35	1.50	0.25	<0.01	1.00	99.27
2	HN04-5024	metagabbro	CZmgb	46.93	1.40	16.07	11.72	0.18	7.18	10.07	2.58	0.52	0.16	0.02	2.00	98.83
3	HN04-5110	metagabbro	CZmgb	48.70	1.73	16.35	10.12	0.17	5.63	9.29	3.26	1.01	0.28	0.02	1.55	98.11
4	HN04-5129	greenstone	CZtc	49.10	1.74	16.60	10.05	0.17	5.26	9.01	3.59	1.11	0.28	0.01	1.25	98.17
5	HN04-5266	metatonalite	CZvtg	67.25	0.40	16.57	2.96	0.05	1.09	3.58	4.80	1.85	0.12	<0.01	0.95	99.62
6	HN04-5420	metatonalite	CZvtg	67.42	0.40	16.08	2.95	0.05	0.98	3.08	4.43	2.63	0.12	<0.01	0.95	99.09
7	HN04-5448	biotite gneiss	CZjbg	63.27	0.94	16.01	5.53	0.12	1.69	4.15	4.59	1.87	0.25	<0.01	0.85	99.27
8	HN04-5451	felsic gneiss	CZlcg	72.90	0.34	14.62	2.28	0.03	0.67	1.90	4.34	2.18	0.07	<0.01	0.50	99.83
9	HE-119	felsic gneiss	CZflg	78.60	0.10	11.50	1.03	0.01	0.12	0.24	4.02	3.96	<0.01	<0.01	0.35	99.93
9	DUP-HE-119	felsic gneiss	CZflg	78.70	0.10	11.50	1.05	0.01	0.12	0.23	4.03	3.96	<0.01	<0.01	0.40	100.10
10	HD-1	diabase 2	Jd2	50.50	0.71	15.20	10.80	0.17	6.90	11.20	1.93	0.28	0.08	0.04	0.80	98.61
11	HD-2	diabase 2	Jd2	50.90	0.66	15.40	11.00	0.18	7.38	10.80	1.99	0.37	0.07	0.05	0.50	99.30
12	HD-3B	diabase 2	Jd2	51.00	0.95	16.50	12.00	0.18	5.22	10.60	2.40	0.54	0.11	0.03	0.60	100.13
13	HD-4	diabase 2	Jd2	50.50	0.85	17.80	10.80	0.16	4.34	10.80	2.50	0.61	0.11	0.03	0.80	99.30
14	HD-5	diabase 2	Jd2	51.90	0.79	16.50	11.20	0.17	5.18	10.40	2.54	0.63	0.13	0.04	0.70	100.18

TRACE ELEMENTS IN PPM (AU IN PPB)

map no.	sample	Ag	As	Au*	B	Ba	Be	Bi	Cd	Ce	Co	Cs	Cu	Dy	Er	Eu	Ga	Gd	Ge	Hf	Hg
1	HN04-4956	0.03	<0.01	1		378.4				51.5	10.4	2.2	34	6.67	3.97	1.88	17	7.53		7	
2	HN04-5024	0.03	1.9	1		70.1				15.9	43.1	0.5	94	3.79	2.3	1.11	17	3.79		3	
3	HN04-5110	0.04	1.6	<1		162.9				41	35.4	0.8	75	4.99	2.9	1.7	19	5.76		4	
4	HN04-5129	0.04	0.1	<1		190.2				49.8	34.5	0.6	77	5.72	3.36	1.89	20	6.52		4	
5	HN04-5266	<0.01	0.1	<1		333.9				38.7	6	1.2	12	2.02	1.07	0.83	18	2.74		4	
6	HN04-5420	<0.01	0.3	<1		436.4				35.9	5.3	1.2	14	1.61	0.89	0.78	18	2.24		4	
7	HN04-5448	0.05	0.5	>1		520.4				51.7	9.3	2	40	6.17	3.78	1.9	17	7.04		8	
8	HN04-5451	0.03	<0.1	<1		505.8				18.3	2.9	0.7	5	1.49	1.32	0.35	14	1.05		4	
9	HE-119	<1	<1	<1	<10		0.2	0.15	0.04	80.4	<0.5	0.9	<5	10.9	6.42	0.71	17	8.98	0.1	7	<0.01
9	DUP-HE-119	<1	<1	<1	<10		0.2	0.15	0.04	78.2	<0.5	0.8	<5	10.1	6.18	0.72	17	8.8	0.1	7	<0.01
10	HD-1																				
11	HD-2																				
12	HD-3B																				
13	HD-4																				
14	HD-5																				

map no.	sample	Ho	In	La	Lu	Mo	Nb	Nd	Ni	Pb	Pr	Rb	Sm	Sn	Sr	Ta	Tb	Th	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
1	HN04-4956	1.35		23.6	0.55	<2	6	30.4	6		7.04	27.1	7.3	2	428.4	<0.5	1.18	2.4	<0.5	0.56	0.74	110	<1	36.3	3.7	55	265
2	HN04-5024	0.8		6.8	0.31	4	4	11.4	125		2.36	10.8	2.9	1	333.2	<0.5	0.59	1.2	<0.5	0.3	0.33	248	<1	20.2	2	62	94
3	HN04-5110	0.99		16.7	0.42	<2	8	24	62		5.81	20.5	5.2	2	431.6	0.6	0.9	1.5	<0.5	0.44	0.41	236	<1	27.7	2.8	77	163
4	HN04-5129	1.15		19.4	0.49	<2	10	29.6	54		7.07	22.7	6.2	2	435.1	0.7	0.99	1.3	<0.5	0.5	0.39	247	<1	31.7	3.2	87	154
5	HN04-5266	0.37		21.2	0.16	<2	5	16.5	8		4.41	44	3.2	1	470.8	<0.5	0.38	7.2	<0.5	0.16	1.09	46	<1	11	1	41	139
6	HN04-5420	0.33		21.5	0.17	<2	4	14.3	6		4.06	58.9	2.4	<1	386.6	<0.5	0.31	9.7	<0.5	0.14	1.53	44	<1	9	1	32	129
7	HN04-5448	1.27		24.5	0.53	<2	7	30.4	6		6.93	43.9	6.8	2	347.2	<0.5	1.06	5.8	<0.5	0.54	1.42	90	2	35.9	3.7	70	306
8	HN04-5451	0.36		5	0.26	<2	4	5.3	<5		1.39	46	1.2	<1	207.3	<0.5	0.2	8.2	<0.5	0.21	1.79	35	2	10.8	1.6	36	118
9	HE-119	2.2	0.04	35.1	0.93	4	11	40.7	<5	1.2	10.3	92.5	8.9	3		0.7	1.62	8.8	<0.5	0.95		5	<1	54.8	6.3		167
9	DUP-HE-119	2.21	0.04	34.7	0.88	4	10	40.2	<5	1.1	10.3	88.9	9.3	3		0.5	1.61	8.2	<0.5	0.9		<5	<1	54.1	6.3		174
10	HD-1											10			147												47
11	HD-2											16			160												46
12	HD-3B											19			183												59
13	HD-4											20			195												58
14	HD-5											22			219												67

Geochemical analyses by SGS Minerals (Toronto, Canada) using method codes XRF76Z, IMS95A, and FAI303, and individual element method code ICMS12B for Ta.
Total Fe as Fe2O3
L.O.I. = percent weight loss on ignition
Blank data cell indicates sample not analyzed for paramater
* Au in ppb

Bedrock Geologic Map of the Henderson 7.5-minute Quadrangle, Vance County, North Carolina

By
David E. Blake and Edward F. Stoddard

Digital representation by Michael A. Medina

2016

Intrusive Rocks

Jurassic

Jd - Diabase: Steeply dipping to vertical dikes of gray to bluish-black, fine- to medium-grained diabase, locally porphyritic with phenocrysts of plagioclase. Most common variety is olivine bearing. Solid lines where observed, and dashed where inferred from correlation and aeromagnetic data. Isolated diabase stations indicated by a red circle.

Jd_2 – Two-pyroxene diabase: olivine-free diabase having augite and low-calcium pigeonitic pyroxene, commonly with quartz-alkali feldspar granophyre. Typically strongly plagioclase porphyritic. Solid lines where observed, and dashed where inferred from correlation and aeromagnetic data. Isolated diabase stations indicated by a red circle.

Pennsylvanian - Permian

PPrgd – Granitoid facies d: Fine to coarse-grained, but primarily medium-grained equigranular to moderately porphyritic (very rarely megacrystic), rarely foliated, pink or salmon and white biotite +/- muscovite monzogranite. Commonly has an almost idiomorphic fabric with well-formed alkali feldspar and plagioclase grains. CI = 5 - 12. Contains common biotite schlieren and local biotite crystal clots. Pegmatite dikes and pods are extremely common; locally, isolated xenocrysts of alkali feldspar 1 - 4 cm in length also occur. Unit also contains relatively common xenoliths of Raleigh terrane country rocks, especially in Ingleside and Louisburg quadrangles. Less commonly contains autoliths of fine granodiorite or tonalite and may display igneous layering between biotite-rich and biotite-poor phases. Weathered surfaces are commonly nubbly, friable and/or cavernous. Rolesville main phase of Speer (1994).

PPrgf – Foliated granite of the Rolesville batholith: Gray-white to pink-white, medium-grained, locally weakly porphyritic, moderate- to well-foliated, leucocratic (CI less than 15) biotite granite and pink-white, medium- to -coarse-grained, unfoliated to weakly foliated granite, leucogranite, and granitic to leucogranitic gneiss. Locally pegmatitic. Leucocratic varieties locally contain muscovite or garnet.

PPrgm – Mylonitic granite of the Rolesville batholith: fine, medium, or coarse-grained, locally porphyritic, white to pink biotite granite and muscovite-biotite leucogranite showing variably developed mylonitic fabric. Commonly gneissic and/or intruded by pegmatite dikes. Winged K-feldspar porphyroclasts and asymmetric folds show evidence of dextral shear. Subhorizontal lineation is common.

PPrgj – Granitoid facies j of the Rolesville batholith: Heterogeneous granitoid unit consisting of streaky, gneissic, or layered biotite granitoid and biotite granitoid gneiss. Includes granite, leucogranite, and granodiorite and their gneissic counterparts. Generally medium grained but ranges from fine to coarse. Locally has alkali feldspar xenocrysts up to 3 cm. Locally exhibits strong compositional banding, elsewhere vague phase layering, boudinage of darker phases, biotite schlieren, or xenoliths of biotite gneiss. Additionally may contain feldspar or biotite foliation. Planar fabric elements may be contorted and possibly transposed. Pegmatite and aplite dikes are abundant and locally deformed.

Metamorphic Rocks

Late Proterozoic – Cambrian

Carolina terrane

CZmgr – Metagranite/metatrondhjemite: Light gray, pink or tan colored, fine-grained granitic and/or trondhjemitic suite of dikes or enclaves in contact with metatonalite and metagranodiorite of the Vance County pluton. Generally displays a leucocratic (CI less than 5) color index with minor to accessory biotite plates and a relict phaneritic to crystalloblastic texture/microstructure. Outcrops may be highly fractured, forming resistant hillside cobble and boulder fields.

CZafg - alkali feldspar granite: Pinkish to orange medium to coarse grained alkali feldspar granite. Quartz phenocrysts 1-2 mm in size, appear bluish in hand sample, and pinkish orange potassium feldspar phenocrysts, 1-2mm in size occur in a groundmass of nearly all potassium feldspar with minor quartzs. Present in the adjacent Oxford Quadrangle.

CZphc – Chlorite phyllonite and mylonite: Light greenish-gray to dark green, foliated and lineated phyllitic rocks derived primarily from recrystallized felsic, intermediate, and mafic intrusive rocks. Includes chlorite and sericite phyllonite and mylonite that form in distinctive relict compositional layers. Iron and manganese oxide commonly coats fractured and foliated surfaces. Flattened and rotated polycrystalline aggregates of plagioclase and quartz common as porphyroclastic minerals. Quartz, feldspar, chlorite, and white mica contribute to a slickenline lineation.

CZvcg – Granitoid of the Vance County pluton (?): Gray-white to green-white, coarse-grained, unfoliated to foliated, mesocratic (CI less than 40) biotite hornblende metagranodiorite containing conspicuous relict blue quartz phenocrysts.

CZvgf – Foliated felsic tonalite/trondhjemite, granodiorite, and granite of the Vance County pluton: Strain partitioned protomylonitic to ultramylonitic gneiss, and locally phyllonitic equivalents of CZvgr. Thin mm- to cm-scale gneissic layering defined by polycrystalline aggregates of feldspar and quartz and fine- to medium-grained domains of white mica and locally biotite. Felsic shape rods combine with mica aggregate films to define a mineral stretch lineation in all high strain varieties.

CZvgr – Tonalite/trondhjemite, granodiorite, and granite of the Vance County pluton: White or tan colored, medium- to coarse-grained felsic and more minor intermediate metagranitoid. Generally leucocratic (CI less than 5) due to minor or accessory amounts of biotite, more common gray white mica, and relict phenocrysts of quartz and plagioclase. Displays a distinctive granular saprock to saprolite weathering profile of the feldspar and quartz in less strained varieties. Concentrations of gray-colored white mica and polycrystalline quartz and feldspar domains define mm- to cm-scale, high strain zones that crosscut relict phaneritic texture. Felsic shape rods combine with mica aggregate films to define a mineral stretch lineation in all high strain varieties.

CZvtg – Tonalite and granodiorite of the Vance County pluton: Gray to tan colored on weathered outcrops, and white to pinkish-white on fresh exposures. Commonly, medium- to coarse-grained and granular saprolite and saprock exposures display a salt-and-pepper appearance. Phenocrysts of biotite plates ± mm-scale prismatic hornblende are generally conspicuous, as are rounded to tabular, saussaritized and sericitized pale green plagioclase and gray to distinctly cobalt blue quartz phenocrysts. Includes elongate to rounded enclaves of fine-grained metagabbro and metabasalt. Locally crosscut by fine-grained metagranite or metatrondhjemite dikes. Concentrations of biotite, gray-colored white mica, and polycrystalline quartz and feldspar domains define mm- to cm-scale, high strain zones that crosscut relict phaneritic texture. Felsic shape rods combine with mica aggregate films to define a mineral stretch lineation in all high strain varieties.

CZvbtf - Foliated to mylonitic metamorphosed biotite tonalite and granodiorite of the intermediate Vance County pluton: Dark to intermediate gray-blue, mesocratic (CI = 25-50), and medium- to coarse-grained metatonalite and minor metagranodiorite. Locally cut by mm- to meter-scale felsic metamonzonite, metagranodiorite, and metatrondhjemite dikes. Located within the Nutbush Creek fault zone in the Henderson Quadrangle, this unit is the strongly deformed equivalent of CZvbt from the Townsville Quadrangle to the north.

CZdqf - foliated meta-quartz diorite: Biotite, commonly replaced by chlorite, defines foliation surfaces along with sericite and flattened quartz and feldspar phenocrysts; S-C composite fabric common, as well as localized very fine-grained siliceous mylonite. Includes zones of +/- chlorite, sericite, quartz phyllite and phyllonite. Present in the adjacent Oxford Quadrangle.

CZtcf – Foliated Tabbs Creek meta-intrusive suite: Variably green colored, fine- to medium-grained phyllonite, protomylonite, and mylonite formed from felsic, intermediate, and mafic metaigneous rocks of the Tabbs Creek suite. Chlorite and white mica films define a phyllitic to fine spaced gneissic foliation and aggregate mineral stretch lineation. Degree of dynamic recrystallization varies, with polycrystalline quartz and feldspar displaying a gradational range from relict igneous to porphyroclastic S-C composite fabric.

CZtc – Tabbs Creek meta-intrusive suite: Variably green-gray to gray-white colored, fine- to medium-grained, biotite metatonalite-metatrondhjemite, metagranodiorite, and locally metagranite. Biotite concentrations vary and produce outcops that range in color index from leucocratic to mesocratic. Biotite in particular, and hand samples in general, are commonly chloritized and display fine-scale dynamic recrystallization, which can mask the relict phaneritic texture, especially in easternmost exposures adjacent to the Nutbush Creek fault zone. Plagioclase commonly displays saussaurite and sericite alteration, and large quartz phenocyrts are generally lacking. Greenstone and metagabbro locally occur as enclaves, and minor fine-grained leucocratic dikes crosscut more medium-grained metagranitoid.

CZmgb– Metagabbro: Dark gray-green to green-black, melanocratic, and fine- to medium-grained, with localized coarse-grained varieties. Commonly displays a relict gabbroic texture with chlorite/hornblende and local magnetite replacing pyroxene as uralite. Saussuritization of plagioclase is common. Generally unfoliated, and variably fractured. May display a "boxwork" fracture-fill of quartz and epidote. Commonly occur as lobate bodies injected by younger metagranitoid dikes. High strain varieties recrystallize to chlorite, white mica, and plagioclase phyllonite and mylonite.

CZmgf – Foliated biotite metagranitoid: Gray colored, fine- to medium-grained, and generally leucocratic (CI less than 10) color index that is defined by aligned biotite plates. Quartz-feldspar cystalloblastic matrix displays distinct shape foliation that is oriented parallel to the biotite plates. Crosscut by biotite-poor and biotite-free metagranitoid dikes. Forms a foliated enclave in an unfoliated portion of the metatonalite of the Vance County pluton.

CZmif – Foliated mixed suite of meta-intrusives: Variably green colored, fine- to medium-grained phyllonite, protomylonite, and mylonite formed from felsic, intermediate, and mafic metaigneous rocks of the mixed meta-intrusive suite within the Nutbush Creek fault zone. Chlorite and white mica films define a phyllitic to fine spaced gneissic foliation and aggregate mineral stretch lineation. Degree of dynamic recrystallization varies, with polycrystalline quartz, feldspar, and phyllosilicates displaying a gradational range from relict igneous to porphyroclastic S-C foliation, shear bands, and mineral stretch lineation as composite fabric elements.

CZmi – Mixed suite of meta-intrusives: Variably colored and grained sized exposures depending upon the presence of mafic, intermediate, or felsic metaplutonic rocks. Generally dark green-black, fine- to medium-grained metagabbro is cut by blue-gray to green-black, fine- to medium-grained metadiorite. Both rock types are cut by dikes and larger bodies of fine- to medium-grained leucocratic metatrondhjemite/metagranite having variable biotite content. Mafic and intermediate varieties display saussurite and sericite formation, and local chloritization.

Crabtree terrane

CZrcg – Ruin Creek gneiss: Variably tan-orange to gray-orange fine to medium-grained, well foliated and lineated porphyroclastic K-feldspar granitic gneiss. White mica and recrystallized K-feldspar define the shear foliation and stretch lineation.

CZfgf – Foliated felsic gneiss: Dark to light pink-red-orange, fine- to coarse-grained leucocratic (CI less than 2) felsic mylonitic to ultamylonitic gneiss. Variably foliated and lineated, and locally contains relict red-orange K-feldspar porphyroclasts and pegmatitic K-feldspar and quartz boudins. Outcrops are reminiscent of the Ruin Creek gneiss and Falls leucogneiss.

CZlcg – Little Creek Gneiss: Pink-gray to orange-tan, fine- to medium-grained, well foliated to lineated, leucocratic (CI less than 10) white mica ± biotite granitic gneiss. Locally is magnetite-bearing.

CZjbg – Joes Branch Gneiss: Bluish-gray to tannish gray, fine- to medium-grained, well foliated and locally compositionally layered or schistose, mesocratic (CI less than 35) biotite dioritic to granodioritic gneiss. Locally contains green-black, fine- to medium-grained crystalloblastic amphibolite and mm-scale layered amphibolitic gneiss. Alignment of hornblende defines a subhorizontal stretch lineation.

Raleigh terrane

CZflg –Falls leucogneiss: Pinkish-gray to orange-tan, fine to medium-grained, weakly to moderately foliated, strongly lineated, leucocratic (CI less than 5) biotite-magnetite granitic gneiss. Discordant U-Pb upper intercept age of 550.8 +/- 4.9 Ma (Caslin, 2001) interpreted as dating crystallization of plutonic protolith.

CZrgn –Raleigh Gneiss: Mixed units of mainly fine- to coarse-grained, well foliated and compositionally layered, locally lineated mesocratic to leucocratic biotite gneiss and more minor biotite schist and white mica schist.

References

Allmendinger, R. W., Cardozo, N. C., and Fisher, D., 2013, Structural Geology Algorithms: Vectors and Tensors: Cambridge, England, Cambridge University Press, 289 pp.

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.

Speer, J.A., 1994, Nature of the Rolesville Batholith, North Carolina, *in* Stoddard, E.F. and Blake, D.E., eds., Geology and Field Trip Guide, Western Flank of the Raleigh Metamorphic Belt, North Carolina, Carolina Geological Society Guidebook for 1994 Annual Meeting, p. 57-62.

EXPLANATION OF MAP SYMBOLS

CONTACTS, FAULTS, AND OTHER FEATURES

location known
diabase location known
inferred
diabase inferred
concealed
diabase concealed
cross section

Faults- Solid where location known, dashed where inferred, dotted where concealed.
Dashed X lines - zones of late brittle fracture and/or faulting; characterized by vuggy quartz and local brecciation.
In cross sections, for ductile strike-slip faults, X indicates movement away from the observer, O indicates movement towards the observer.
For normal brittle faults, D indicates downthrown side, U indicates upthrown side.

63 strike and dip of inclined regional foliation
strike of vertical regional foliation
65 strike and dip of inclined regional shear foliation
strike of vertical regional shear foliation
80 strike and dip of biotite foliation in granitoid
strike of vertical biotite foliation in granitoid
52 strike and dip of inclined joint and/or fracture surface
strike of vertical joint and/or fracture surface
46 strike and dip of compositional layering
strike of vertical compositional layering
68 strike and dip of inclined foliation in enclave
85 strike and dip of quartz vein
38 strike and dip of slickenside surface
strike of vertical slickenside surface
15 bearing and plunge of mineral stretch lineation
30 bearing and plunge of slickenline
75 bearing and plunge of minor fold hinge
62 bearing and plunge of F3 fold hinge

diabase station location
observation station location
9 geochemical sample location