North Carolina Department of Environmental Quality
Divison of Energy, Mineral and Land Resources
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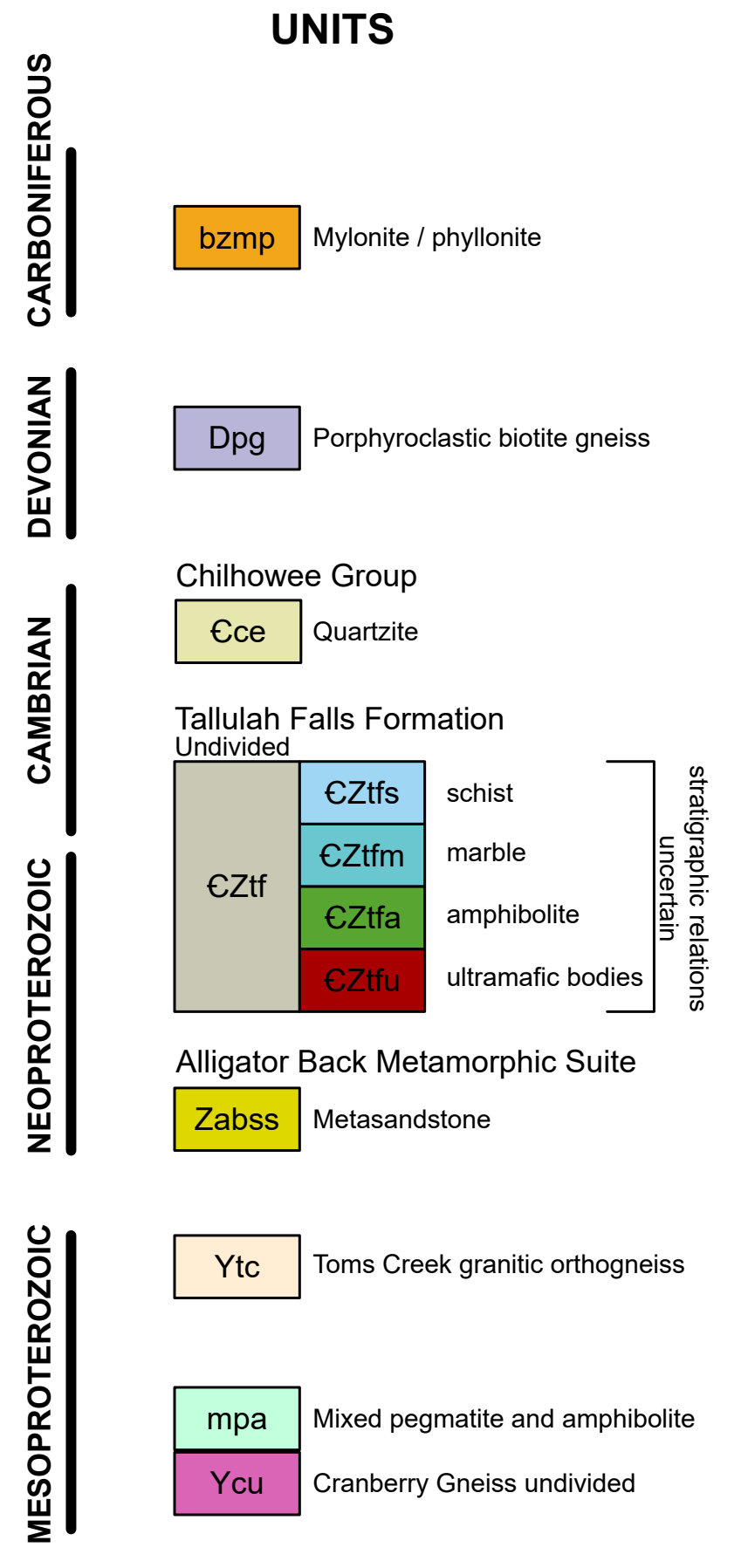
North Carolina Geological Survey
Open File Report 2020-07

Marion West 7.5-minute Quadrangle, Open File Report 2020-07

CORRELATION OF MAP UNITS



CARBONIFEROUS

bzmp Mylonite / phyllonite

DEVONIAN

Dpg Porphyroclastic biotite gneiss

CAMBRIAN

Chilhowee Group

€ce Quartzite

Tallulah Falls Formation
Undivided

€Ztf

€Ztfs schist

€Ztfm marble

€Ztfa amphibolite

€Ztfu ultramafic bodies

stratigraphic relations uncertain

NEOPROTEROZOIC

Alligator Back Metamorphic Suite

Zabss Metasandstone

MESOPROTEROZOIC

Ytc Toms Creek granitic orthogneiss

mpa Mixed pegmatite and amphibolite

Ycu Cranberry Gneiss undivided

INTRODUCTION

The Marion West 7.5-minute quadrangle lies in McDowell county, western North Carolina. Within the quadrangle are the city of Marion and the smaller communities of Providence, Pleasant Gardens, and Garden Creek. Interstate 40, U.S. Routes 70 and 221, and N.C. Highways 226 and 80 are the major transportation corridors on the quadrangle. Major water features include Lake Tahoma, Catawba River, and Buck Creek. Total elevation relief is 1,924 feet with a low of 1,195 feet along the Catawba River and a high of 3,119 feet at Greenlee Mountain. A significant portion of the quadrangle is located along the Blue Ridge escarpment, the steep transition zone between the mountain and piedmont physiographic provinces.

GEOLOGIC OVERVIEW

Bedrock of the Marion West quadrangle is composed of units within five thrust sheets (from structurally highest to lowest): Fries/Spruce Pine, eastern Tugaloo, Fork Ridge, Table Rock, and Wilson Creek. The Table Rock and Wilson Creek thrust sheets comprise the Grandfather Mountain window, a tectonic window overlain by the Blue Ridge-Piedmont Megathrust that contains the upper thrust sheets exposed on the quadrangle (Fries/Spruce Pine, eastern Tugaloo, and Fork Ridge). Brief descriptions of the units within these thrust sheets are given below, beginning in the northwest corner of the map and proceeding to the southeast.

FRIES/SPRUCE PINE THRUST SHEET

The Fries/Spruce Pine thrust sheet is part of the western Tugaloo terrane. This thrust sheet contains Neoproterozoic metasedimentary and mafic rocks of the Ashe and Alligator Back Metamorphic Suites. These rocks are thick sequences of complexly deformed and metamorphosed clastic sediments deposited in marine rift basins. Interspersed with these sediments are lesser amounts of mafic volcanic rocks and ultramafic rocks thought to have originated as oceanic crust at a spreading center (Misra and Conte, 1991; Raymond and Abbott, 1997). These metasedimentary lithologies were complexly deformed and metamorphosed to amphibolite facies conditions during Taconic orogenesis. Rocks of the Spruce Pine thrust sheet are structurally above the Fork Ridge thrust sheet. Field data from the Marion West quadrangle indicate that this contact is overturned toward the northwest in this area.

FORK RIDGE THRUST SHEET

On the Marion West quadrangle the Fork Ridge thrust sheet is comprised of the Cranberry granitic gneiss and, tentatively, the porphyroclastic biotite gneiss unit. Extensive mylonitization obscures contact relationships but the porphyroclastic biotite gneiss unit is interpreted to intrude the Ashe Metamorphic Suite on the adjoining Old Fort quadrangle and, possibly, Mesoproterozoic basement gneisses on the Marion West quadrangle. A preliminary age date of 360 Ma for the porphyroclastic biotite gneiss (R. McAleer, March 2020, personal communication) is intriguing as Paleozoic intrusions into the Mesoproterozoic basement have not previously been reported for this area.

The Cranberry gneiss undivided unit on the Marion West quadrangle is primarily a granitic orthogneiss with lesser amounts of biotite granitic gneiss and amphibolite. It is exposed NW of the Linville Falls fault and is interpreted to be Mesoproterozoic in age (Bryant and Reed, 1970). Lesser amounts of chlorite and muscovite within the unit differentiate it from the Toms Creek granitic orthogneiss on the quadrangle. The Fork Ridge thrust sheet and the underlying Grandfather Mountain Window are separated by the Linville Falls fault, an Alleghanian greenschist-facies ductile thrust fault (Van Camp and Fullagar, 1982).

GRANDFATHER MOUNTAIN WINDOW

The Grandfather Mountain Window is cored by Mesoproterozoic basement gneisses. These gneisses are overlain by the Table Rock thrust sheet. The Grandfather Mountain Window is framed by the Linville Falls fault.

TABLEROCK THRUST SHEET

Cambrian-aged quartzites of the Chilhowee Group represent a rift-to-drift transition during the opening of the Iapetus Ocean basin (Hatcher and others, 2007). On the Marion West quadrangle the quartzite occurs as several small mylonitic slices along the Linville Falls fault and one large body in contact with the Toms Creek granitic orthogneiss along the Tablerock thrust fault (Bryant and Reed, 1970; Conley and Drummond, 1981).

WILSON CREEK BASEMENT THRUST SHEET

This is an informally named thrust sheet that constitutes the lowest structural area on the quadrangle. The Toms Creek granitic gneiss unit is of unknown age and is informally named after an undeformed core of granitic orthogneiss in the Johnson Paving Co. Inc. quarry along Toms Creek. Most of the unit is strongly mylonitic, only recognizable by pink potassium-feldspar layers and plentiful chlorite and muscovite. The Toms Creek gneiss is a subunit within the Mesoproterozoic Wilson Creek gneiss mapped by Bryant and Reed (1970).

BREVARD ZONE

The Linville Falls fault framing the Grandfather Mountain Window is cut by the Brevard Zone, a prominent NE-SW-striking feature. The Brevard Zone is a linear fault zone that extends from Alabama to Virginia. It has a complex history of multiple reactivations with the earliest movement during the Neoacadian orogeny. This first movement was ductile and high-temperature with an oblique to strike-slip motion. During the Alleghanian orogeny, the Brevard fault reactivated with ductile strike-slip motion reaching greenschist-facies conditions, and later, experienced brittle dip-slip motion (Hatcher and others, 2007). On the Marion West quadrangle the mylonite/phyllonite unit of the Brevard Zone is comprised of rocks that have been extremely mylonitized. The mylonitization makes protolith recognition very difficult and the mylonite/phyllonite zone likely contains panels of both Toms Creek gneiss and Tallulah Falls metasediments.

EASTERN TUGALOO TERRANE

Lying southeast of the Brevard Zone, the Tallulah Falls Formation consists of metasedimentary and meta-igneous rocks interpreted to have been deposited in a distal marine basin outboard of the Laurentian rifted margin (Hatcher and others, 2007). TFF rocks on the quadrangle have been metamorphosed to upper amphibolite facies and are migmatitic.

Mylonitic and non-mylonitic foliations within the quadrangle dominantly strike NE-SW and dip moderately to the SE. The prominent fracture set strikes NW-SE and is steeply dipping. A minor fracture set strikes NE-SW and is moderately to steeply dipping.

DESCRIPTION OF MAP UNITS[1]

bzmp

Mylonite/phyllonite — Intensely deformed rocks with unknown protoliths. Tan to light-gray to dark-gray to light-olive-gray, to greenish-gray; fine- to coarse-grained; lepidoblastic to porphyroblastic; strongly foliated; mylonitic, locally ultramylonitic, locally brecciated; consists of sericite, quartz, feldspar, biotite, chlorite, and accessory graphite, garnet, sulfides, magnetite, and opaque minerals. Lenticular muscovite-aggregate porphyroblasts flattened in the mylonitic foliation planes impart a distinctive "fish scale" or "button" appearance to phyllonites. Locally interlayered with porphyroclastic biotite gneiss, granitic orthogneiss, and felsic gneiss.

Metasedimentary Rocks

€ce

Chilhowee Group
Quartzite — White, fine- to medium-grained; thin- to thick-bedded; consists of about >85% quartz, 10% muscovite-sericite, 1-3% plagioclase, and traces of apatite, zircon, epidote group minerals, and titanite.

€Ztf

Tallulah Falls Formation (TFF)
Undivided — Heterogeneous unit consisting of biotite gneiss interlayered with lesser amounts of metagraywacke, schistose metagraywacke, mica schist, metasandstone, amphibolite, felsic gneiss, and altered ultramafic bodies. Biotite gneiss is typically gray to grayish-black; medium- to coarse-grained; well foliated; compositionally layered; locally protomylonitic; inequigranular; locally porphyroblastic to lepidoblastic; migmatitic; consists of plagioclase, quartz, biotite, potassium feldspar, muscovite, garnet, epidote group minerals, chlorite, and opaque minerals. Commonly interlayered with other TFF lithologies.

Metagraywacke — Medium-light-gray to medium-dark-gray; medium- to coarse-grained; foliated (ranges from massive to gneissic); equigranular to inequigranular; granoblastic to lepidoblastic; migmatitic; consists of quartz, plagioclase, biotite, muscovite, potassium feldspar, and minor garnet, opaque minerals, epidote, and apatite; thickness of layering ranges from decimeters to meters. Interlayered at all scales with other TFF lithologies.

€Ztfs

Garnet-Mica schist — Very light-gray to greenish-gray to medium-gray; fine- to coarse-grained; strongly foliated; inequigranular; lepidoblastic to porphyroblastic; locally migmatitic; consists of approximately 50% muscovite, 35% quartz, 5% biotite, 5% garnet, 2% plagioclase feldspar, and trace opaque minerals; interlayered with other TFF lithologies.

€Ztfm

Marble — Medium to dark gray; fine- to medium-grained; non- to weakly foliated; equigranular, granoblastic; consists of approximately 70% calcite and/or dolomite, 13% plagioclase, 12% quartz, 4% potassium feldspar and 1% muscovite.

€Ztfs

Amphibolite — Amphibolite is typically mottled white to dark-green to black; fine- to coarse-grained; foliated; equigranular to nematoblastic; consists of hornblende, plagioclase, biotite, epidote group minerals, quartz, and minor garnet, chlorite, pyroxene, titanite, and opaque minerals. Commonly interlayered with other TFF lithologies.

€Ztfu

Ultramafic bodies — Dark-green to silvery-grayish-green; fine- to medium-grained; non-foliated to strongly foliated; equigranular; granoblastic to nematoblastic to lepidoblastic; consists of tremolite/actinolite, relict pyroxene, hornblende, chlorite, talc, serpentine, relict olivine, opaque minerals, plagioclase feldspar, magnetite, spinel, and other accessory minerals. Compositions of altered ultramafic bodies are variable and mineralogical variations could not be mapped at a 1:24,000 scale.

Zabss

Alligator Back Metamorphic Suite
Metasandstone — Interlayered metamorphosed sandstones with compositions including arkosic arenite, biotite-bearing metawacke, and quartzite. Tan to medium-gray to light-green; fine- to medium-grained; foliated to locally mylonitic; equigranular to inequigranular; consists of quartz, feldspar, muscovite, biotite, and minor accessory minerals; notably contains little schist, amphibolite, or garnet.

Meta-igneous Rocks

Dpg

Porphyroclastic biotite gneiss — Heterogeneous mix of porphyroclastic and porphyroblastic, mylonitic biotite gneiss, quartzo-feldspathic gneiss, granitic orthogneiss, felsic gneiss, phyllonite, mylonite, and amphibolite, with minor biotite metawacke and metasandstone. Biotite gneiss is typically light-gray to grayish-black; well foliated; locally protomylonitic to ultramylonitic; medium- to coarse-grained; inequigranular; 2-10 mm sized porphyroblasts and/or porphyroclasts; lepidoblastic; consists of quartz, plagioclase, biotite, potassium feldspar, muscovite, minor epidote, garnet, and titanite. Radiometric age date of approximately 360 Ma (McAleer, personal communication, 2020).

Ytc

Toms Creek granitic orthogneiss — Semi-massive variety is coarse grained and equigranular with little chlorite and muscovite; mylonitic variety is fine- to medium-grained and equigranular with alternating pink potassium feldspar layers with silver-green chlorite-muscovite layers; both varities consist of potassium feldspar, quartz, plagioclase, muscovite, chlorite, and sericite; may contain small mafic/chloritic pods.

mpa

Pegmatite and amphibolite — Heterogeneous mix of pegmatite, amphibolite, altered ultramafic rocks, and minor amounts of biotite gneiss; Unit present along contact of Cranberry Gneiss and metasandstone.

Pegmatite — White to light gray to light pink; coarse-grained; granoblastic; consists of quartz, plagioclase, potassium feldspar, muscovite, biotite, and minor amounts of opaque minerals and garnet.

Ycu

Cranberry Gneiss undivided — Granitic orthogneiss with minor amounts of biotite gneiss; white to light pink; medium- to coarse-grained; equigranular to inequigranular; mylonitic to protomylonitic; consists of quartz, plagioclase, potassium feldspar, muscovite, biotite, and minor amounts of opaque minerals, epidote, chlorite, and garnet.

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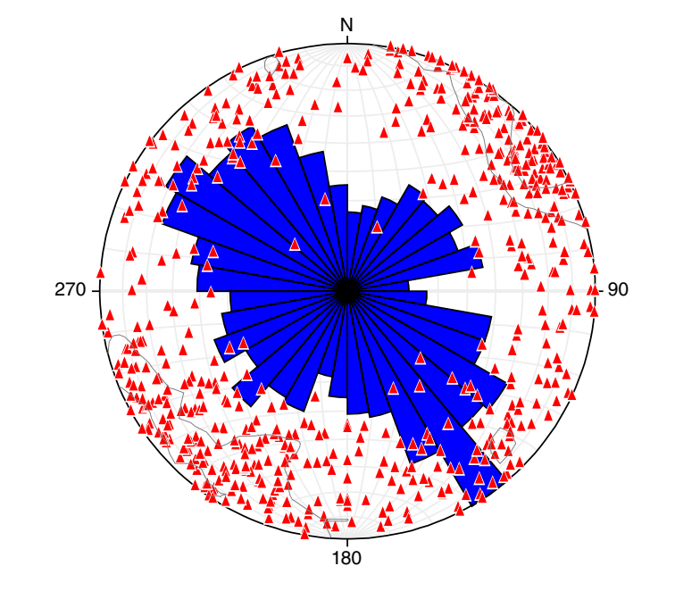
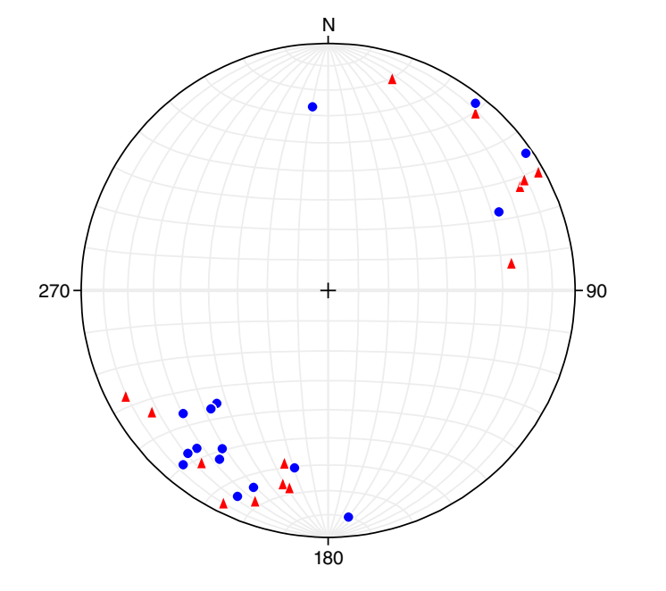
[1] Mineral abundances are listed in decreasing order of abundance based upon visual estimates of hand samples and thin-sections.

SCHMIDT EQUAL AREA STEREONET DATA

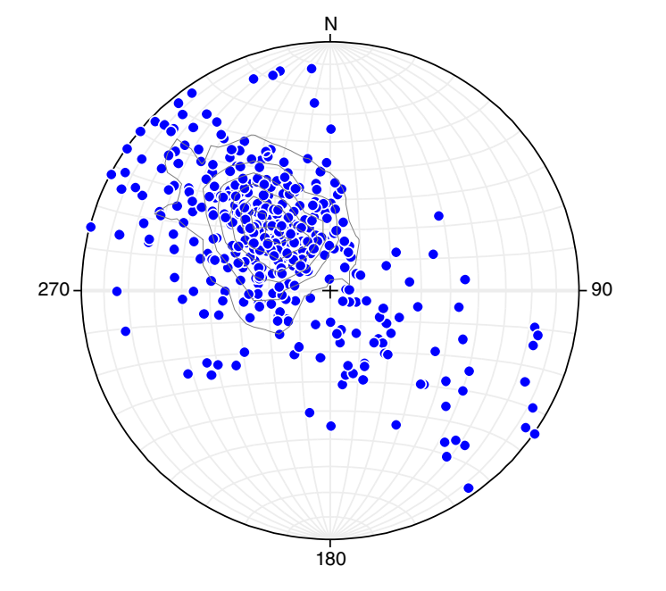
Stereonets created using Stereonet 10 (Allmendinger, et al., 2012; Cardozo and Allmendinger, 2013.)



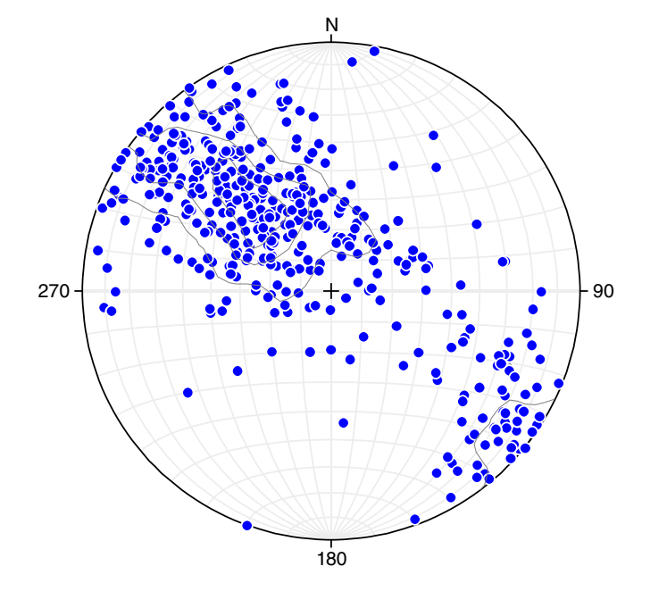
Contoured poles to joints and unidirectional rose diagram inset. Joint count 595.



Bearing and plunge of fold hinges in blue and mineral lineations in red. Fold hinge count 16. Mineral lineation count 14.



Contoured poles to foliation. Foliation count 406.



Contoured poles to mylonitic foliation. Mylonitic foliation count 349.

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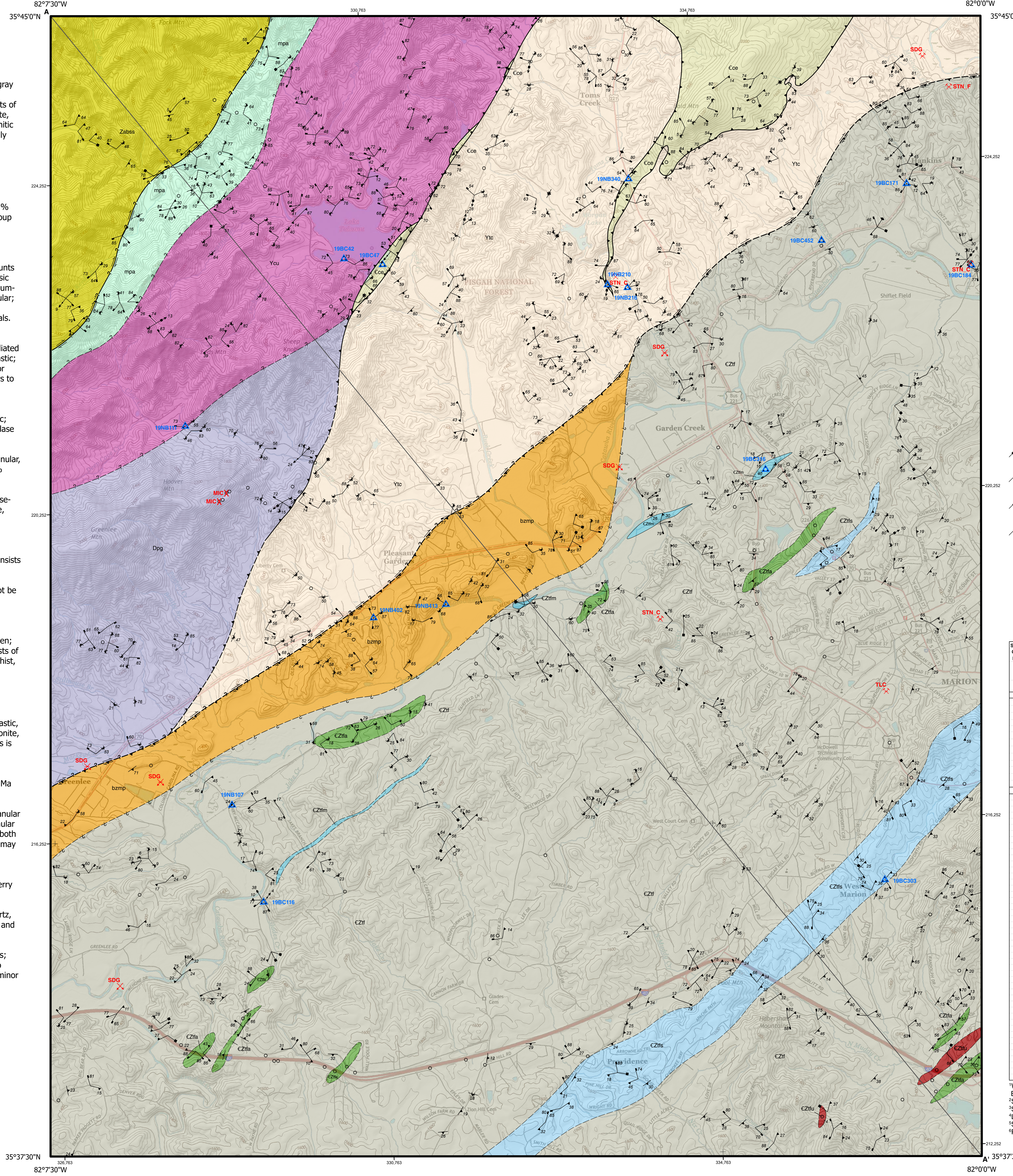


EXPLANATION OF MAP SYMBOLS

CONTACTS

Zone of Confidence: 300m

Contact—Identity and existence certain, location accurate

Contact—Identity and existence certain, location approximate

Contact—Identity and existence questionable, location approximate

Thrust fault (1st option)/Strike-slip fault, right-lateral offset—Identity and existence certain, location approximate. Saw teeth on upper (tectonically higher plate). Arrows show relative motion

Strike-slip fault, right-lateral offset--Identity questionable, existence certain, and location accurate. Arrows show relative motion

Thrust fault (1st option)—Identity and existence certain, location accurate. Saw teeth on upper (tectonically higher plate).

PLANAR FEATURES

(For multiple observations at one locality, symbols are joined at the "tail" ends of the strike lines)

64 Inclined metamorphic or tectonic foliation—Showing strike and dip

80 78 Inclined metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike and dip

Vertical metamorphic or tectonic foliation—Showing strike

Vertical metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike

Vertical mylonitic foliation—Showing strike

79 Inclined mylonitic foliation—Showing strike and dip

38 Inclined generic foliation (origin not specified)—Showing strike and dip

71 Small, minor inclined joint—Showing strike and dip

86 66 Small, minor inclined joint, for multiple observations at one locality—Showing strike and dip

Small, minor vertical or near-vertical joint, for multiple observations at one locality—Showing strike

Small minor vertical or near-vertical joint—Showing strike

23 46 Inclined mylonitic foliation, for multiple observations at one locality—Showing strike and dip

Vertical mylonitic foliation, for multiple observations at one locality—Showing strike

LINEAR FEATURES

6 Inclined aligned-mineral lineation—Showing bearing and plunge

18 Inclined slickenline, groove, or striation on fault surface—Showing bearing and plunge

56 Inclined fold hinge of generic (type or orientation unspecified) small, minor fold—Showing bearing and plunge

12 Inclined generic (origin or type not known or not specified) lineation or linear structure—Showing bearing and plunge

OTHER FEATURES

○ Float station

NB206 Thin section and whole rock analysis sample location

X Prospect (pit or small open cut)

Abandoned sand, gravel, clay, or placer pit

Abandoned open pit, quarry, or glory hole

NATURAL RESOURCES

MIC - Mica **SDG** - Sand and gravel **STN_C** - Crushed stone **STN_F** - Flagstone **TLC** - Talc

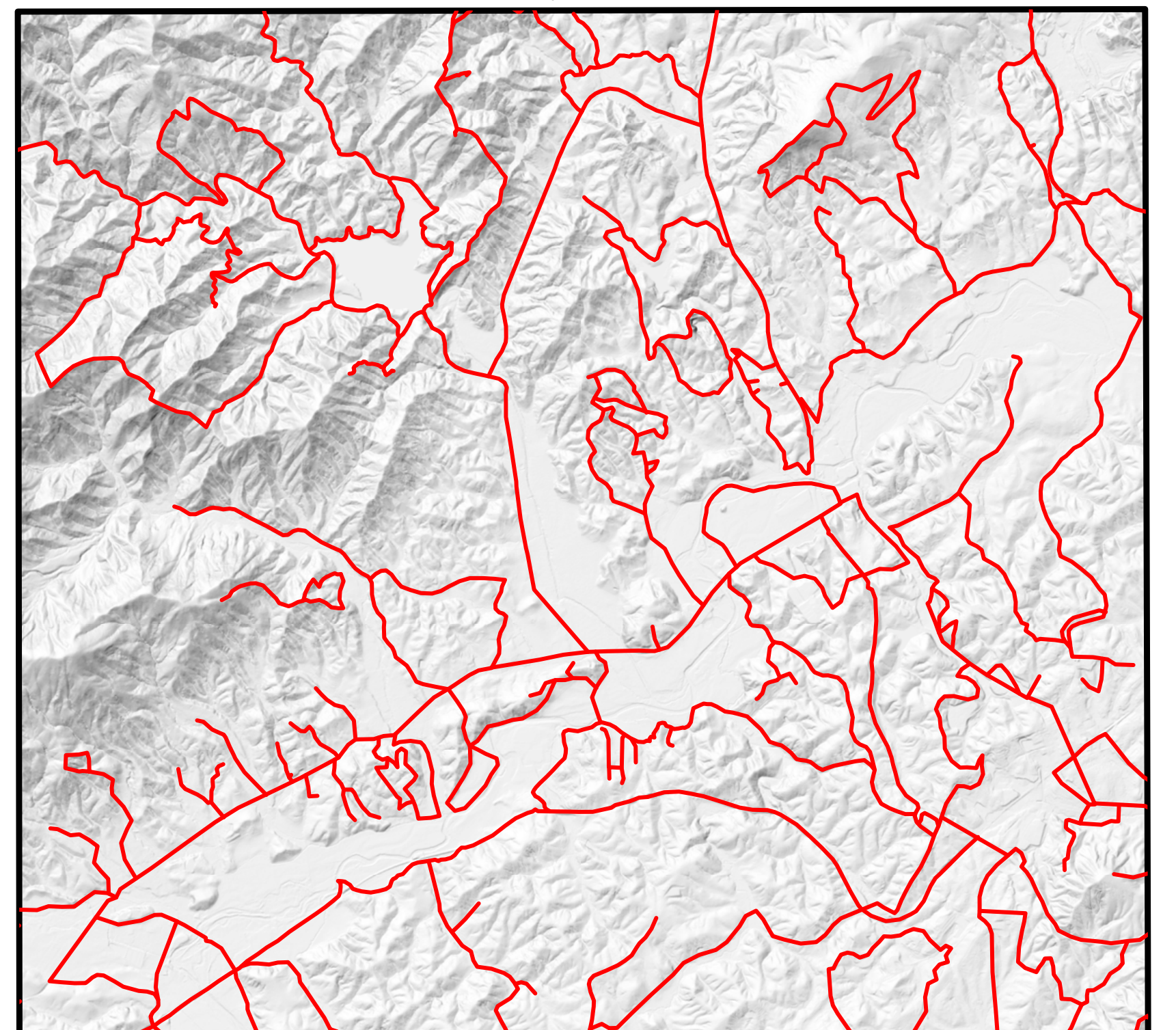
WHOLE ROCK ICP ANALYSIS[1] OF SELECTED SAMPLES

SAMPLE[2]	19NB413	19NB402	19NB340	19NB210	19BC47a	19BC303	19BC316	19BC452	19BC171	19NB107	19BC116	19BC184	19BC42	19NB111	19NB216a
COORDINATES[3]	219,012N, 331,604E	218,873N, 330,719E	224,112N, 333,985E	222,836N, 333,691E	202,313N, 320,190E	215,498N, 336,833E	220,531N, 335,540E	223,291N, 336,308E	223,950N, 337,363E	216,654N, 328,929E	215,461N, 329,276E	222,934N, 338,118E	223,250N, 330,496E	221,276N, 328,504E	222,792N, 333,931E
ROCK TYPE[4]	mylonite	mylonite	meta-arenite	meta-arenite	meta-arenite	garnet - mica schist	siliceous marble	biotite granitic gneiss	biotite granitic gneiss	biotite gneiss	biotite gneiss	quartz monzonite	granitoid	ultramafic	granitic orthogneiss
MAP UNIT	bzmp	bzmp	Cce	Cce	Cce	Ztfs	Ztfm	Ztf	Ztf	Ztf	Ztf	Ztf	Ycu	Ycu	Ytc
MAJOR OXIDES IN PERCENT															
SiO_2	65.88	61.52	88.88	84.99	87.59	56.06	32.33	66.46	69.08	59.09	64.4	72.64	56.32	46.5	76.49
Al_2O_3	15.06	17.85	4.9	7.49	5.63	20.7	10.26	15.41	13.95	18.38	15.7	13.92	18.23	14.9	12.68
Fe_2O_3	7.23	8.15	2.22	2.06	1.72	11.56	3.71	4.82	5.36	7.38	6.28	1.41	7.46	16.22	1.37
MgO	1.89	1.96	0.19	0.33	0.19	2.08	1.17	1.6	1.51	2.26	2	0.07	2.41	5.17	0.18
CaO	1.56	1.05	0.02	0.03	0.01	0.53	27.15	1.88	1.98	1.71	2.38	1.12	3.86	7.63	0.32
Na_2O	2.78	2.09	0.04	0.04	0.05	0.79	1.6	2.4	2.62	2.79	3.35	4.91	4.85	3.3	3.92
K_2O	1.92	2.84	2.65	2.83	2.9	4.48	2.23	2.31	2.11	4.79	3.46	4.75	3.16	0.99	4.47
TiO_2	1.24	0.98	0.45	0.76	0.33	1.36	0.38	0.76	0.74	0.78	0.71	0.07	0.93	3.87	0.08
P_2O_5	0.15	0.12	0.01	0.02	0.03	0.11	0.17	0.21	0.18	0.21	0.19	0.02	0.42	0.38	0.02
MnO	0.13	0.13	0.01	0.01	<0.01	0.1	0.05	0.03	0.15	0.08	0.11	0.02	0.09	0.21	0.08
Cr_2O_3	0.008	0.01	0.003	0.002	<0.002	0.014	0.004	0.003	0.007	0.009	0.006	<0.002	0.004	0.008	<0.002
LOI[5]	1.9	3.1	0.5	1.2	1.5	1.7	20.5	3.9	2.1	2.2	1.2	0.7	1.9	0.5	0.3
SUM[6]	99.81	99.83	99.95	99.87	99.96	99.81	99.6	99.86	99.86	99.79	99.82	99.77	99.79	99.74	99.95
ELEMENTS IN PPM[7]															
Ba	549	520	396	452	399	2563	390	509	660	1237	681	1263	1252	264	330
Ni	34	42	<20	<20	<20	33	<20	22	23	29	27	<20	<20	36	<20
Sc	14	17	3	4	3	24	9	8	14	16	12	<1	11	25	4
Be	5	1	<1	1	<1	3	<1	<1	<1	4	4	<1	3	<1	<1
Co	18.2	23.6	3.2	3.4	2.1	20.2	8	11	11.3	13.6	13.9	0.9	15.6	45.3	1.2
Cs	3.1	2.3	0.2	0.6	0.3	2.1	1.9	1.6	1.2	3.9	3.2	0.8	0.7	0.2	0.3
Ga	18.2	22.6	5.3	9.9	6.5	27.6	14.2	18.3	15.1	28.1	22.8	24.7	18.5	19.7	13.7
Hf	11.2	8.6	6.7	15.6	5.1	6.9	4	9.4	6.3	6.5	5.4	6.1	8.5	4.6	3.1
Nb	17.4	17.1	6.7	11.5	5.6	26.7	8.2	16.7	12.1	21.1	20.2	16.2	10.2	18.6	12.5
Rb	80.6	113.3	45.5	64	51.1	127.2	80.6	95.3	81.6	139.4	133.4	200.5	93.1	17.5	101
Sn	2	3	<1	1	<1	4	1	5	1	4	4	1	<1	2	<1
Sr	254.1	205.1	35.3	20.7	30.9	107.4	2507.6	201	202.9	301	282.9	164.8	516.9	467.9	104.7
Ta	1.2	1.1	0.4	0.7	0.4	1.7	0.5	1.1	0.7	1.5	1.3	0.8	0.5	1	0.4
Th	10.4	13.6	6.1	12.4	4.5	15.1	6.9	6.4	9.7	16.2	13.5	43.7	1.9	1.7	10.5
U	2.1	2.6	1	1.9	1.6	3	3.5	1.1	1.1	4.8	3.4	12.6	0.8	0.4	5.2
V	110	90	19	39	23	151	34	77	79	82	74	9	91	228	<8
W	1.5	1.4	0.6	1.6	0.9	1.4	0.9	0.8	<0.5	2.8	4.6	<0.5	<0.5	<0.5	1.3
Zr	425.2	313.4	257.3	614.6	180.1	248	155.7	362.1	243.1	242.2	187	138.4	357.4	172.9	69.9
Y	40.5	30	8.4	35.9	8.6	50.2	30.9	14.2	52.9	53.3	45	10.4	20.2	29.1	39.3
La	39.6	25.9	13.7	53.9	14.4	74.3	50	19.5	70	81.4	65.8	315.8	42.2	19.9	14.5
Ce	78.4	44.4	26.9	81.2	25.4	154.1	99.8	27.8	37.2	165.3	129.1	524.9	82.9	43.6	31
Pr	10.24	6.92	3.42	14.37	3	17.57	11.72	3.97	14.24	18.8	15.33	52.03	9.66	5.9	3.63
Nd	37.7	25.9	14.3	55.8	12.3	67.2	45.5	14.1	55.2	70.9	58.3	171.8	40.8	27.2	14.1
Sm	8.15	5.2	2.71	10.71	2.56	12.37	8.49	3.27	10.8	13.32	11.08	17.11	7.1	6.16	4.45
Eu	1.66	0.98	0.42	2.39	0.52	2.22	1.4	1.08	2.21	2.13	1.8	3.34	2.25	1.97	0.3
Gd	7.35	4.28	2.07	8.5	1.88	11.16	7.38	3.16	10.53	11.84	9.72	6.82	5.91	6.45	5.13
Tb	1.2	0.7	0.27	1.22	0.26	1.67	1.05	0.5	1.54	1.74	1.48	0.5	0.75	0.96	0.96
Dy	7.23	4.83	1.61	6.94	1.74	9.82	6.06	2.9	9.76	10.31	8.57	1.62	3.77	5.79	6.29
Ho	1.59	1.15	0.29	1.38	0.31	1.94	1.15	0.53	2.07	1.96	1.66	0.16	0.75	1.15	1.31
Er	4.73	3.93	0.82	3.92	1.06	5.51	3.2	1.46	6.51	5.63	4.74	0.27	2.01	3.11	3.88
Tm	0.69	0.6	0.12	0.57	0.14	0.77	0.4	0.19	0.96	0.78	0.64	0.06	0.27	0.42	0.59
Yb	4.35	4.06	0.92	3.89	1.11	4.89	2.55	1.26	6.74	4.98	4.02	0.52	1.82	2.7	4
Lu	0.69	0.62	0.14	0.53	0.18	0.72	0.38	0.19	1.02	0.77	0.63	0.07	0.27	0.42	0.58
Mo	0.3	0.3	3.4	0.2	1.3	1.1	0.9	0.5	0.4	0.6	1.3	1.4	0.3	1.7	1.3
Cu	28.7	10.1	6.7	3.6	2.8	26.3	13.2	21.2	8.8	21.7	32.9	13.9	24	16.9	2.9
Pb	3.2	3.2	1.5	1.5	2.1	2.9	8.2	8.5	5.2	2	8.1	254.6	4.1	1.6	3.8
Zn	92	113	5	3	2	64	56	104	60	121	130	44	81	68	6
Ni	29.9	42.8	6.2	2.8	3.6	35.1	12.6	19.5	24.6	29.7	26.9	2.7	7.4	19.5	2.3
As	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	1.3	<0.5	<0.5	<0.5
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1
Sb	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
Bi	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5.9	<0.1	<0.1	<0.1
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	<0.1	<0.1	<0.1
Au	0.7	0.6	<0.5	<0.5	<0.5	1.1	0.9	0.6	<0.5	<0.5	<0.5	0.8	<0.5	<0.5	<0.5
Hg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tl	<0.1	<0.1	<0.1	<0.1	<0.1	0.4	0.5	0.5	0.4	0.7	0.8	0.2	0.4	<0.1	<0.1
Se	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5

[1] Whole Rock Inductively Coupled Plasma - Atomic Emission/Mass Spectrometer analysis conducted by Bureau Veritas, 9050 Shaughnessy St, Vancouver, BC Canada V6P 6E5.
[2] Sample numbers correspond to thin section and whole rock sample localities shown on geologic map
[3] State Plane Coordinate System
[4] LOI = loss on ignition in percent
[5] SUM = Sum total in percent
[6] PPM = parts per million. Ni analyzed by Bureau Veritas LF200 and AQ200 procedures.

TRAVERSE MAP

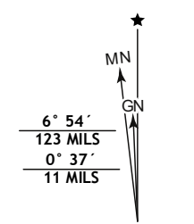
Hillshade derived from a six meter pixel resolution LiDAR (Light Detecting And Ranging) digital elevation model.
Red lines show paths of field traverses.



Topographic base produced by the United States Geological Survey.
Altered by the North Carolina Geological Survey for use with this map.
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
Projection: State Plane North Carolina FIPS 3200 (Meters)
4,000-meter ticks: State Plane North Carolina FIPS 3200 (Meters)

Imagery....NAIP, June 2014
Roads.... U.S. Census Bureau, 2015 - 2016
Roads within US Forest Service Lands....FSTopo Data with limited Forest Service updates, 2012 - 2016
Names....GNIS, 2016
Hydrography....National Hydrography Dataset, 2014
Contours....National Elevation Dataset, 2008
Boundaries....Multiple sources; see metadata file 1972 - 2016

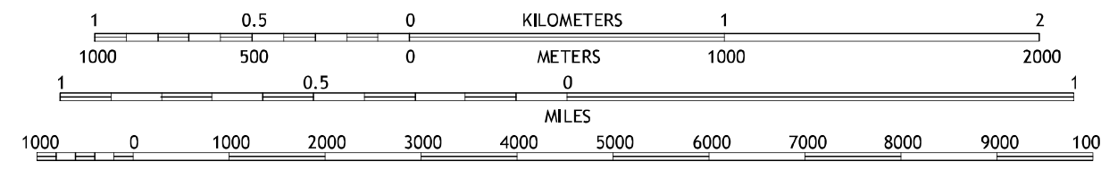
Wetlands....FWS National Wetlands Inventory 1977 - 2014



UTM GRID AND 2016 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
LV MV
Grid Zone Designation
17S

SCALE 1:24 000



CONTOUR INTERVAL 40 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the
National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.19

QUADRANGLE LOCATION

1 Celo
2 Little Switzerland
3 Ashford
4 Old Fort
5 Marion East
6 Moffitt Hill
7 Sugar Hill
8 Glenwood

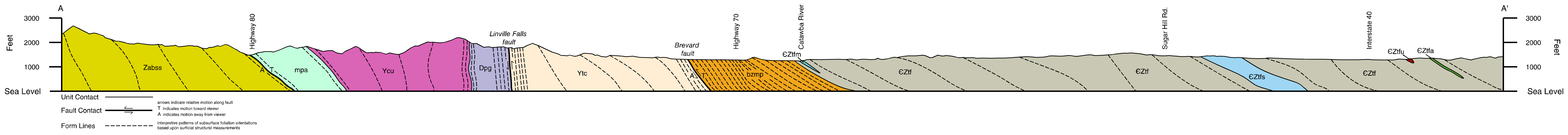
ADJOINING QUADRANGLES

ROAD CLASSIFICATION

Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route
FS Primary Route
FS Passenger Route
FS High Clearance Route

Check with local Forest Service unit
for current travel conditions and restrictions.

MARION WEST, NC
2016



NORTH CAROLINA
Department of Environmental Quality

GEOLOGICAL SURVEY
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Bedrock Geologic Map of the Marion West 7.5-minute Quadrangle, McDowell County, North Carolina

By
Bart L. Cattanach, G. Nicholas Bozdog, and Sierra J. Isard

Geology mapped from July 2019 to June 2020.
Map preparation, digital cartography and editing by G. Nicholas Bozdog, Bart L. Cattanach, and Sierra J. Isard
2020

This is an Open-File Map. It has been reviewed internally for conformity with North Carolina Geological Survey mapping standards and with the North American Stratigraphic Code. Further revisions or corrections to this Open File map may occur. Some station data omitted from map to improve readability. Please contact the North Carolina Geological Survey for complete observation and thin-section data.