North Carolina Department of Environmental Quality
Energy Group
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North Carolina Geological Survey
Open File Map 2016-06

CORRELATION OF MAP UNITS

PALEOZOIC

Pzmg

NEOPROTEROZOIC

Alligator Back Metamorphic Suite

Zab: Zabss, Zabs, Zaba, Zabgs — stratigraphic relations uncertain

Ashe Metamorphic Suite

Za: Zacg, Zass, Zas, Zaa, Zau — stratigraphic relations uncertain

INTRODUCTION

The Montreat 7.5-minute Quadrangle lies in central western North Carolina, northeast of the city of Asheville, and within parts of Buncombe, McDowell, and Yancey counties. The south central part of the quadrangle is occupied by the towns of Black Mountain and Montreat. Major transportation corridors include the Blue Ridge Parkway (bisects the northern half of the quadrangle) and the Norfolk-Southern Railway (southeastern section of the quadrangle). There are large tracts of undeveloped land on the quadrangle including the Asheville municipal watershed (central-west) and parts of the Pisgah National Forest that flank the Asheville watershed to the east and west. A portion of Mount Mitchell State Park is on the northeast part of the quadrangle. Total elevation relief is 4609ft with a low of 1920ft and a high of 6529ft. Major streams include the North Fork of the Swannanoa River, Mill Creek, Peach Orchard Creek, Blue Sea Creek and the headwaters of the South Toe River. The Buncombe-McDowell and McDowell-Yancey county boundaries follow the Eastern Continental Divide in the southeastern portion of the quadrangle.

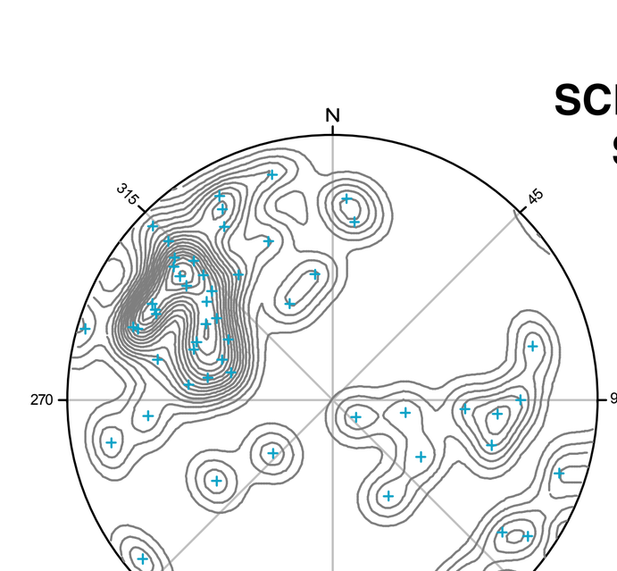
GEOLOGIC OVERVIEW

The Montreat quadrangle comprises the Neoproterozoic to early Cambrian Ashe Metamorphic Suite/Tallulah Falls Formation (AMS/TFF) and Alligator Back Metamorphic Suite (ABMS) of the Tugaloo terrane. Both units 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). Numerous pegmatites occur within the AMS and ABMS and are thought to be related to the 361-392 Ma pegmatites within the Spruce Pine Plutonic Suite (Mapes, 2002). No formal stratigraphic units are recognized in the AMS and ABMS, but zones of dominant lithologies are shown on the map.

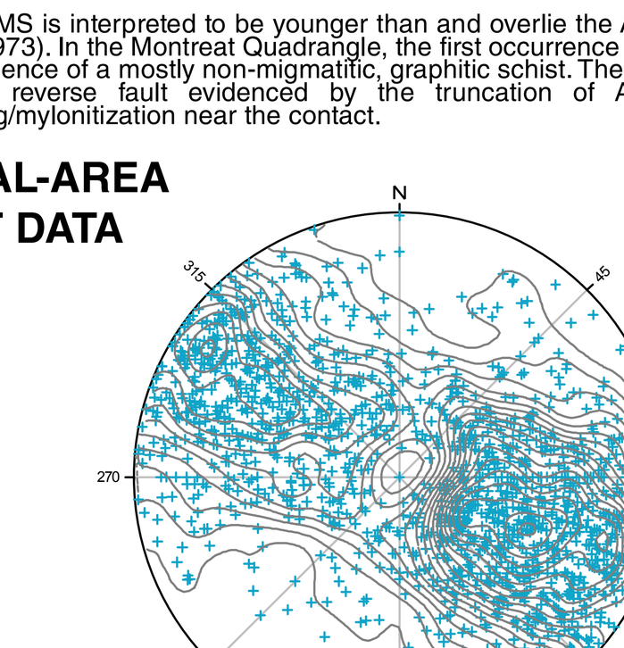
Rocks of the AMS have been metamorphosed to sillimanite- and kyanite-grade conditions as opposed to rocks of the ABMS that have been metamorphosed to kyanite-grade conditions. The kyanite-sillimanite isograd generally trends NE-SW across the center of the map area. Both the AMS and ABMS have been complexly folded. The ABMS and southeastern portions of the AMS are non-migmatitic. Migmatization increases markedly to the NW in the AMS. In the central and northwest portions of the quadrangle most foliations strike NE/SW, and are steeply dipping either to the NW or SE from folding. Timing of metamorphism is constrained by unmetamorphosed trondhjemite dikes dated at 420-405 Ma (Miller et al., 2000; Mapes, 2002) that outcrop to the east of the quadrangle. In the SE section of the Montreat quadrangle, the AMS and ABMS are strongly sheared to mylonitic with mainly SE-dipping foliation and exhibit a greenschist facies overprint associated with reactivation of the Brevard fault zone, a regionally extensive NE/SW trending Alleghanian ductile fault zone that is exposed less than 1 km SE of the quadrangle (Hatcher and others, 2007).

The ABMS is interpreted to be younger than and overlie the AMS (Conley, 1985; Rankin et al., 1973). In the Montreat Quadrangle, the first occurrence of the ABMS is indicated by the presence of a mostly non-migmatitic, graphitic schist. The contact is interpreted as an oblique reverse fault evidenced by the truncation of AMS units and increased shearing/mylonitization near the contact.

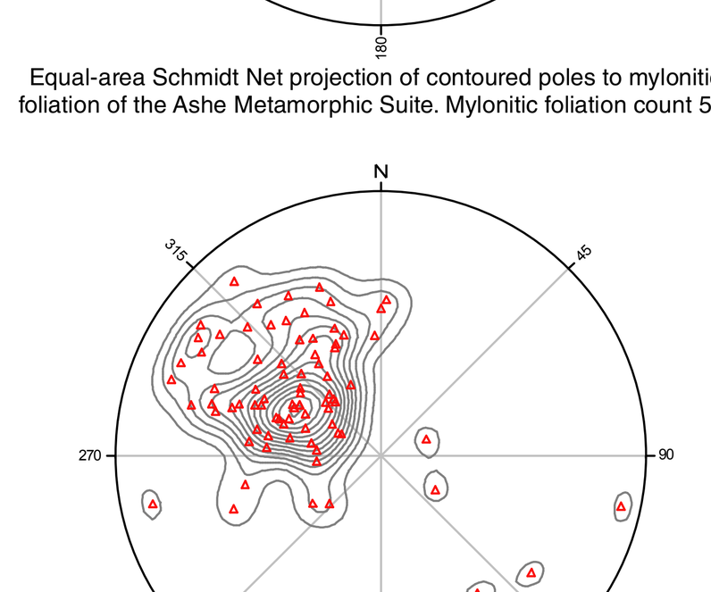
SCHMIDT EQUAL-AREA STEREONET DATA



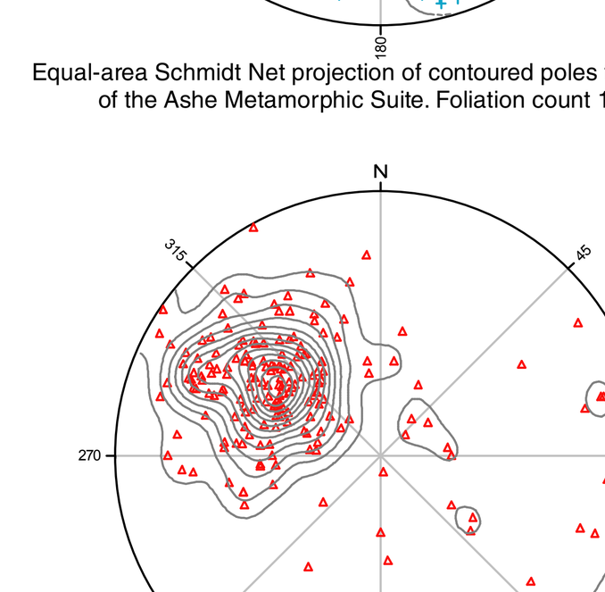
Equal-area Schmidt Net projection of contoured poles to mylonitic foliation of the Ashe Metamorphic Suite. Mylonitic foliation count 54.



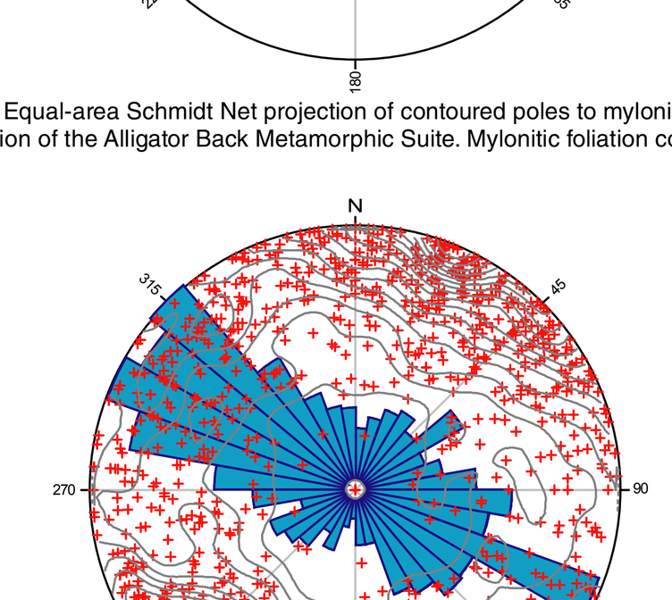
Equal-area Schmidt Net projection of contoured poles to foliation of the Ashe Metamorphic Suite. Foliation count 1691.



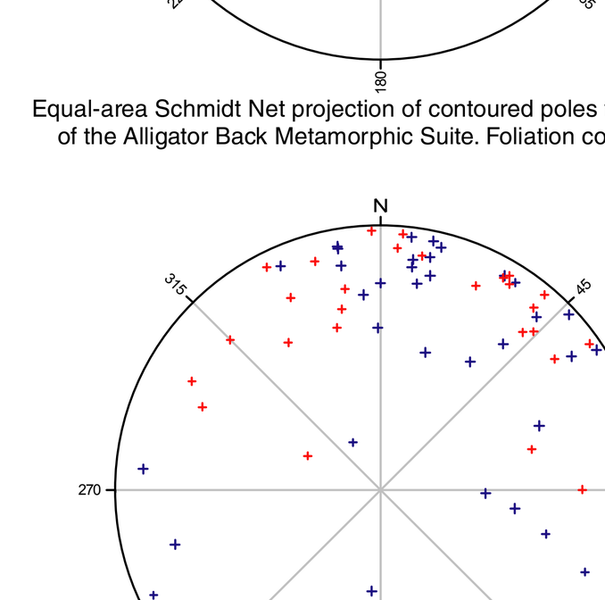
Equal-area Schmidt Net projection of contoured poles to mylonitic foliation of the Alligator Back Metamorphic Suite. Mylonitic foliation count 81.



Equal-area Schmidt Net projection of contoured poles to foliation of the Alligator Back Metamorphic Suite. Foliation count 186.



Equal-area Schmidt Net projection of contoured poles to joints and unidirectional rose diagram inset. Joint count 1402.



Equal-area Schmidt Net projection of fold hinges in blue and mineral lineations in red. Fold hinge count 55. Mineral lineation count 41.

DESCRIPTION OF MAP UNITS

Pzmg **Migmatite** — White to very-light-gray; non-foliated to weakly foliated; medium- to coarse-grained; equigranular; granoblastic; occurs commonly as thin layers and lenses (thickness of layering ranges from centimeters to meters) within other rock types and mappable bodies; locally gradational with pegmatite; consists of plagioclase feldspar, quartz, potassium feldspar, muscovite, sericite, biotite, minor opaques, and trace amounts of zircon. Migmatite (neosome) was most likely derived from local melting during regional high-grade metamorphism.

Alligator Back Metamorphic Suite

Zab **Undivided** — Heterogeneous unit consisting of interlayered layers and lenses of laterally and vertically grading sedimentary and mafic volcanic rocks metamorphosed to kyanite grade. Rock types include metagraywacke, metawacke, metasandstone, schistose metagraywacke, and schist with minor amounts of metasiltstone, quartzite, and calc-silicate. Thickness of layering ranges from centimeters to meters.

Metagraywacke — medium-light-gray to medium-dark-gray; fine- to medium-grained; foliated; granoblastic; consists of quartz, plagioclase feldspar, biotite > muscovite, with minor amounts of garnet, potassium feldspar, chlorite, titanite, epidote group minerals, tourmaline, rare staurolite, other accessory minerals, and trace amounts of zircon and apatite.

Metawacke — light-tan to light-gray; fine- to medium-grained; foliated to mylonitic; granoblastic to lepidoblastic; consists of quartz, plagioclase feldspar, muscovite > biotite, sericite, chlorite with minor amounts of garnet, potassium feldspar, titanite, apatite, and other accessory minerals; locally has millimeter scale "pin-striped" fabric.

Schistose Metagraywacke — medium-gray to dark-gray; fine- to medium-grained; well foliated to mylonitic; equigranular to inequigranular; granoblastic to lepidoblastic to porphyroblastic; locally migmatitic; consists of quartz, plagioclase feldspar, 40-60% muscovite and/or biotite with minor amounts of garnet, kyanite, and accessory minerals.

Zabss **Metasandstone** — Tan to light-gray to medium-gray to light-green; fine- to medium-grained; foliated to locally mylonitic; equigranular to inequigranular; consists of quartz, feldspar, muscovite, locally biotite, and accessory minerals; interlayered with lesser amounts of quartzite, metasiltstone, metagraywacke, metawacke, and schistose metagraywacke; locally has a thin "pin-striped" tectonic fabric.

Zabs **Schist** — Garnet-mica schist, muscovite schist, muscovite-biotite schist; very light-gray to greenish-gray to medium-gray; medium- to coarse-grained; well foliated and locally mylonitic; inequigranular; lepidoblastic; consists of muscovite, biotite, garnet, quartz, plagioclase feldspar, potassium feldspar, and minor accessory minerals; locally contains chlorite, chloritoid, staurolite, tourmaline, kyanite, graphite, and trace zircon. Interlayered with lesser amounts of schistose metagraywacke, metasandstone, and phyllonite.

Zaba **Amphibolite** — Dark-green to black; fine- to medium-grained; foliated to mylonitic; equigranular; granoblastic to nematoblastic; locally porphyroblastic; consists of hornblende, plagioclase feldspar, actinolite, chlorite, epidote group minerals with trace amounts of quartz, garnet, titanite, magnetite, and other opaque minerals.

Zabgs **Graphitic schist** — Dark-gray to greenish-gray to medium-gray; fine- to medium-grained; well foliated to mylonitic; equigranular to inequigranular; lepidoblastic to porphyroblastic; locally with kyanite porphyroblasts; consists of muscovite, biotite, garnet, sericite, quartz, graphite, feldspar, chlorite, staurolite, pyrite, and accessory minerals; interlayered with lesser amounts of metasandstone, metawacke, metasiltstone, schistose metagraywacke, schist, and phyllite.

Ashe Metamorphic Suite

Za **Undivided** — Heterogeneous unit consisting of interlayered layers and lenses of laterally and vertically grading sedimentary and mafic volcanic rocks metamorphosed to kyanite and sillimanite grade. Rock types include metagraywacke schist, schistose metagraywacke, conglomeratic metagraywacke, metaconglomerate, metasandstone, amphibolite, and minor calc-silicate. Thickness of layering ranges from centimeters to meters.

Metagraywacke — medium-light-gray to medium-dark-gray; medium- to coarse-grained; weakly foliated to foliated; equigranular to inequigranular; granoblastic to lepidoblastic; locally migmatitic; consists of quartz, plagioclase feldspar, biotite, muscovite, garnet, epidote, staurolite, chlorite, opaques with trace potassium feldspar and zircon; thickness of layering ranges from decimeters to meters; interlayered with other Za lithologies.

Schistose Metagraywacke — medium-gray to dark-gray; fine- to medium-grained; well foliated; equigranular to inequigranular; granoblastic to lepidoblastic to porphyroblastic; locally migmatitic; consists of quartz, plagioclase feldspar, muscovite, biotite, garnet, minor sillimanite or kyanite, and accessory minerals; interlayered with other Za lithologies.

Calc-silicate — light-gray; medium- to coarse-grained; weakly foliated; consists of quartz, feldspar, epidote group minerals, garnet, biotite, pyroxene, and trace chlorite.

Zacg **Conglomeratic metagraywacke** — Medium-light-gray to medium-dark-gray; coarse-grained (mainly granule size, but locally pebble size clasts); non-foliated to foliated; inequigranular; granoblastic; consists of quartz, plagioclase feldspar, biotite, muscovite, potassium feldspar, and trace opaque minerals; thickness of layering ranges from meters to tens of meters; granule and pebble composition is dominantly quartz with lesser amounts of feldspar; interlayered with metaconglomerate, metasandstone, metagraywacke and lesser amounts of other Za lithologies.

Metaconglomerate — medium-light-gray to medium-dark-gray; coarse-grained (mainly pebble size, but with some granule size clasts); non-foliated to foliated; locally contains deformed quartz clasts up to 7.5 cm in length; inequigranular; granoblastic; consists of quartz, plagioclase feldspar, potassium feldspar, biotite, muscovite, chlorite, minor titanite, apatite, epidote group minerals with trace opaque minerals and zircon; thickness of layering ranges from meters to tens of meters; pebble and granule composition is dominantly quartz with lesser amounts of feldspar; clasts contain inclusions of quartz, muscovite, biotite, and plagioclase feldspar; interlayered with other Za lithologies.

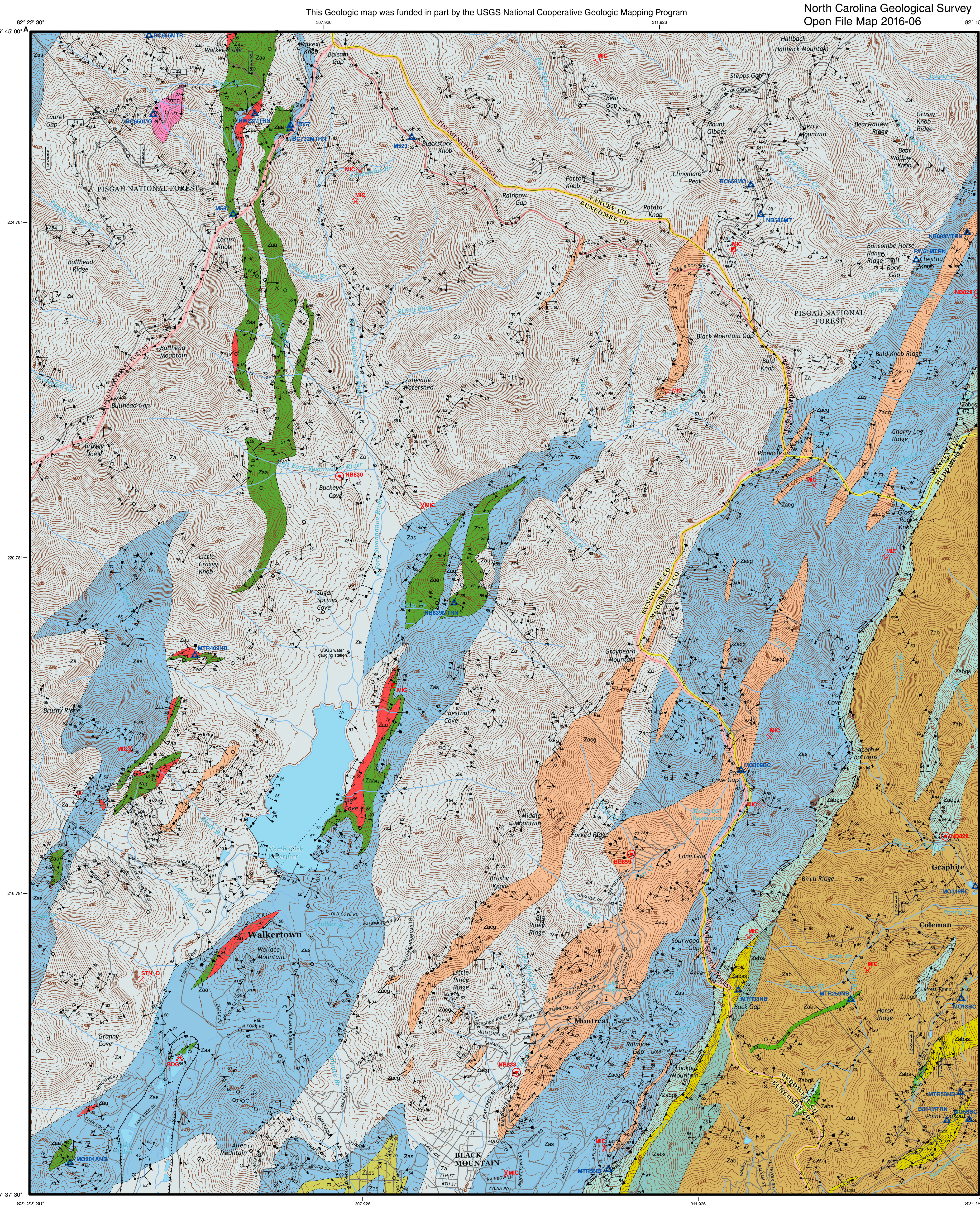
Zass **Metasandstone** — tan to medium-light-gray to gray; fine- to coarse-grained; weakly foliated to mylonitic; equigranular; locally migmatitic; consists of quartz, feldspar, muscovite, biotite, minor opaques, and trace zircon and other accessory minerals; interlayered with other Za lithologies.

Zas **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 muscovite, sericite, quartz, biotite, garnet, plagioclase feldspar, sillimanite or kyanite, chlorite, and trace opaques; interlayered with other Za lithologies.

Zaa **Amphibolite** — Where mappable it occurs as a metamorphic alteration of an ultramafic or mafic rock. Dark-green to black; fine- to coarse-grained; weakly to strongly foliated; equigranular; granoblastic to nematoblastic; consists of hornblende, plagioclase feldspar, epidote group minerals, quartz, garnet, chlorite, relict pyroxene, titanite, magnetite, and opaques. Locally contains small bodies of altered ultramafic rocks not mapped at this scale. Can occur as a very minor rock type throughout the other map units, where it may represent a metamorphosed volcanic rock.

Zau **Altered Ultramafics** — 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, pyroxene, hornblende, chlorite, talc, serpentine, relict olivine, opaques, plagioclase feldspar, magnetite, and other accessory minerals. These mineralogical variations could not be mapped at a 1:24,000 scale. Amphibolite within and adjacent to this unit occurs as a metamorphic alteration of the ultramafic or mafic rock. Thickness of amphibolitic alteration is variable. Contains inclusions of other variations of altered mafic and ultramafic rock.

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



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:State Plane North Carolina FIPS 3200 (Meters)
4,000-meter ticksState Plane North Carolina FIPS 3200 (Meters)

Roads...©2006-2012 TomTom
Roads within US Forest Service Lands............FSTopo Data with limited Forest Service updates, 2013
Names...GNIS, 2013
Hydrography....................National Hydrography Dataset, 2012
Contours...........................National Elevation Dataset, 2008
Boundaries...................Census, IBWC, IBC, USGS, 1972 - 2012

MN GN
6° 35´ 117 MILS
0° 46´ 14 MILS
UTM GRID AND 2013 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

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

SCALE 1:24 000
KILOMETERS 1 0.5 0 1 2
METERS 1000 500 0 1000 2000
MILES 1 0.5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

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 0.6.11

NORTH CAROLINA

QUADRANGLE LOCATION

Barnardsville	Mount Mitchell	Celo
Craggy Pinnacle	Montreat	Old Fort
Oteen	Black Mountain	Moffitt Hill

ADJOINING 7.5' QUADRANGLES

ROAD CLASSIFICATION

Expressway — Local Connector
Secondary Hwy — Local Road
Ramp — 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.

MONTREAT, NC
2013

EXPLANATION OF MAP SYMBOLS

CONTACTS

Contact—Identity and existence certain, location inferred

Contact—Identity and existence certain, location concealed

Thrust fault—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate. Arrows indicate relative motion.

PLANAR FEATURES

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

- Inclined metamorphic or tectonic foliation—Showing strike and dip
- 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
- Inclined mylonitic foliation—Showing strike and dip
- Inclined mylonitic foliation, for multiple observations at one locality—Showing strike and dip
- Inclined bedding, for multiple observations at one locality—Showing strike and dip
- Small, minor inclined joint—Showing strike and dip
- 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
- Inclined cleavage, for multiple observations at one locality—Showing strike and dip

LINEAR FEATURES

- Inclined crenulation lineation—Showing bearing and plunge
- Inclined aligned-mineral lineation—Showing bearing and plunge
- Inclined slickenline, groove, or striation on fault surface—Showing bearing and plunge
- Inclined fold hinge of generic (type or orientation unspecified) small, minor fold—Showing bearing and plunge

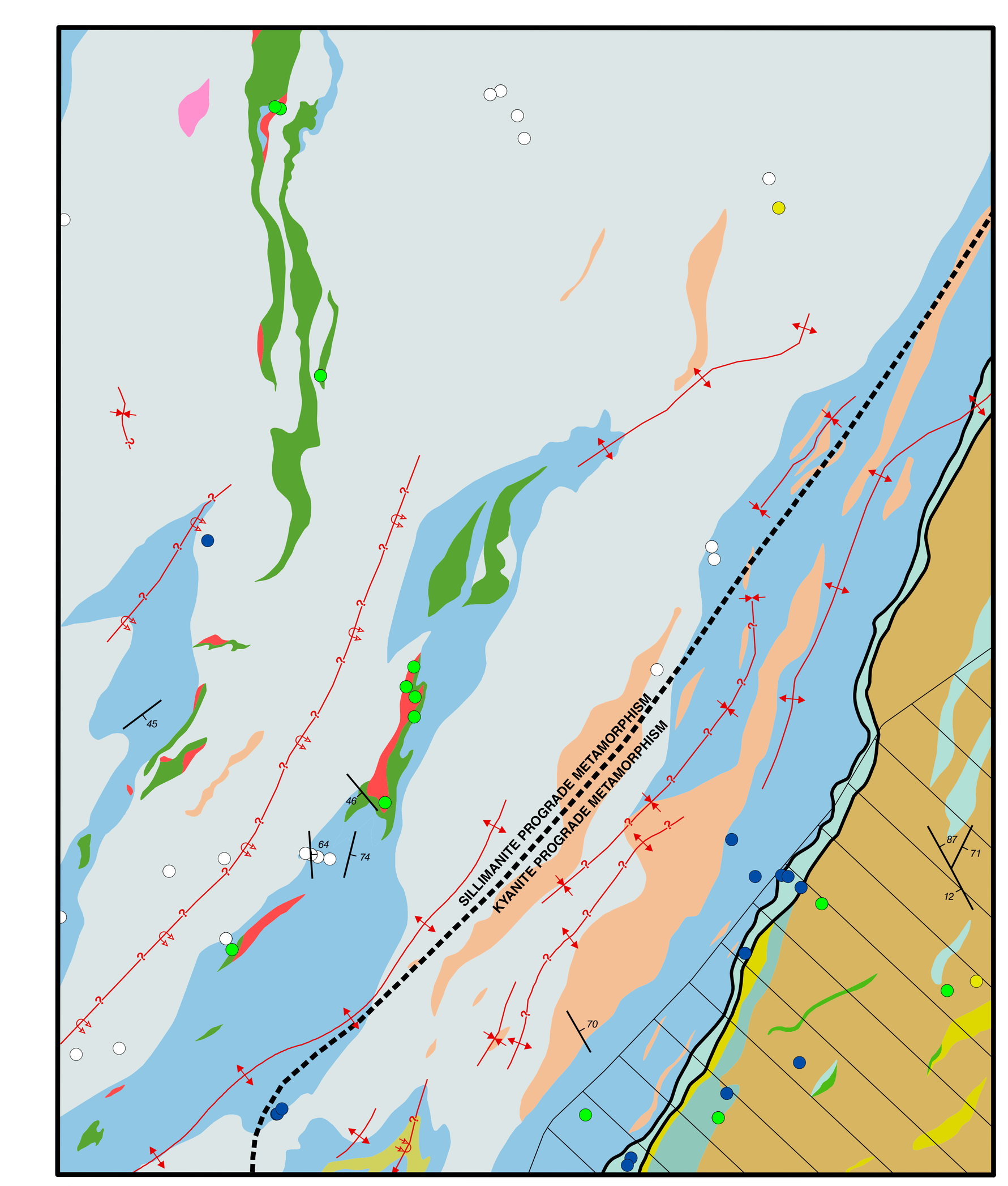
OTHER FEATURES

- Float station
- NB206 Thin section and whole rock analysis sample location
- NB392 Heavy mineral
- Prospect (pit or small open cut)
- Sand, gravel, clay, or placer pit
- Abandoned sand, gravel, clay, or placer pit
- Open pit, quarry, or glory hole
- Abandoned open pit, quarry, or glory hole
- Inclined mine shaft
- Area of abandoned sand and gravel pits

NATURAL RESOURCES

SDG - Sand and gravel MIC - Mica
STN_C - Stone, Crushed/Broken

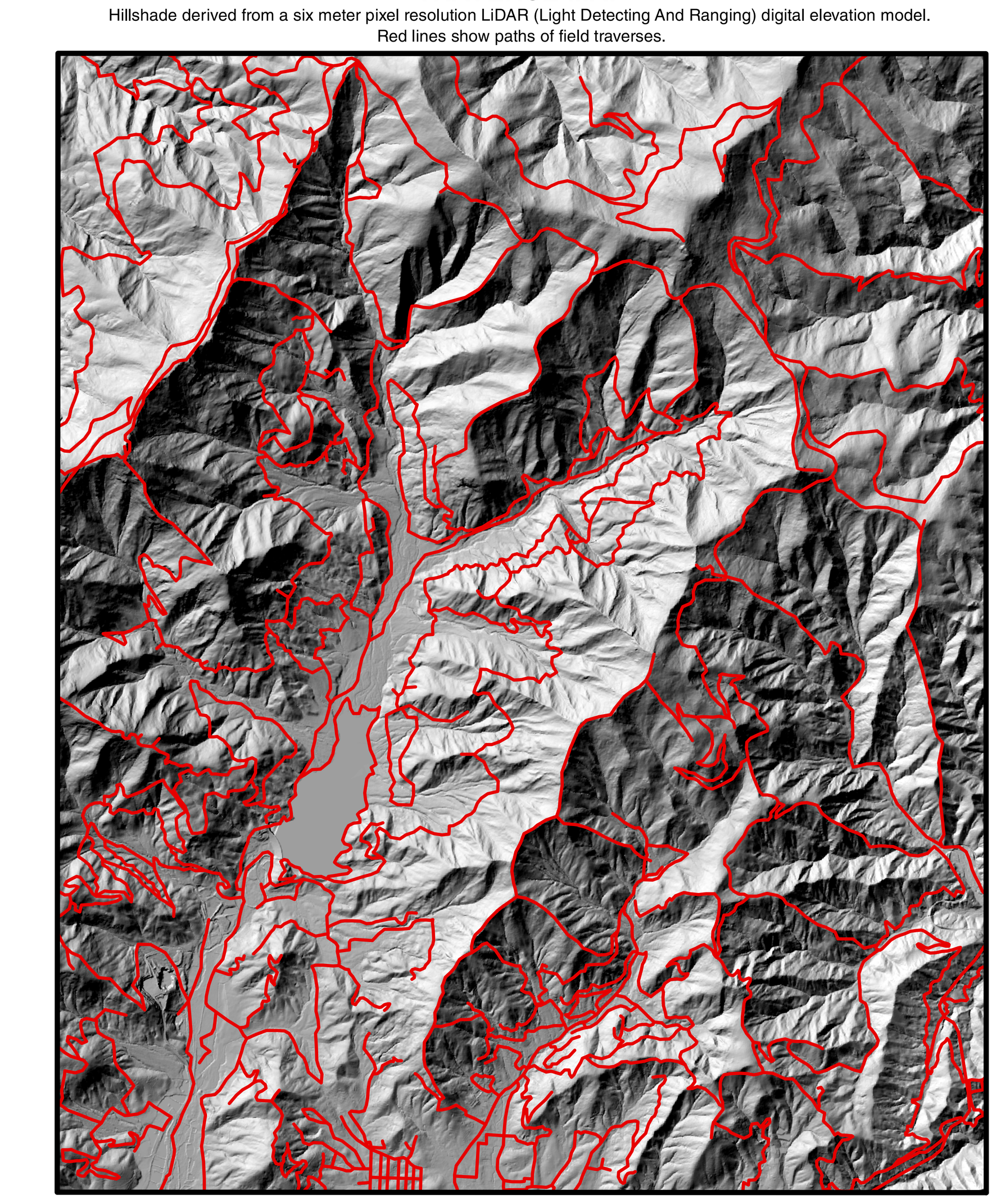
METAMORPHIC AND TECTONIC CONDITIONS



- Location where sillimanite was observed
- Location where kyanite was observed
- Location where chlorite was observed
- Location where staurolite was observed
- Area of chlorite retrograde metamorphism
- Major map-scale fault
- Small, minor inclined fault—Showing strike and dip
- Antiform—Identity or existence questionable, location accurate
- Antiform—Identity and existence certain, location accurate. Arrow shows plunge direction of fold
- Overturned antiform—Identity and existence certian, location approximate. Arrows show dip direction of limbs and plunge direction of fold
- Synform—Identity or existence questionable, location accurate
- Synform—Identity and existence certain, location accurate. Arrow shows plunge direction of fold
- Overturned synform—Identity and existence certian, location approximate. Arrows show dip direction of limbs and plunge direction of fold

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.



STREAM SEDIMENT HEAVY MINERAL ANALYSIS

Stream sediment heavy mineral analysis was conducted from March 2016 through May 2016 to aid geologic mapping, better define conditions of metamorphism, and inventory minerals of potential economic significance. Procedure: In the field, approximately 13.6 kg of stream sediment material is panned to approximately 300 g of heavy mineral concentrate at each sample locality. In the laboratory, concentrate is washed and passed through heavy liquid separation using tetrabromoethane, and scanned with short- and long-wave ultraviolet illumination using an Ultra-violet Products Inc. Model UVGL-48 Mineralight Lamp. Magnetite is removed with a hand magnet. A sample split is grain mounted on a standard 27x46 mm glass slide and approximately 200 grains are identified and counted with the aid of a petrographic microscope and 1.67 index of refraction oil. Results of stream sediment heavy mineral analysis are tabulated below.

Mineral abbreviations used in table: Mg-magnetite; Cor-corundum; Ms-muscovite; Gt-garnet; Zr-zircon; Bt-biotite; Rt-rutile; Czo- clinozoisite; Sil – sillimanite; Hbl-hornblende; Ttn-titanite; Tur-tourmaline; Ilm-ilmenite and other black opaque minerals; Hem-hematite and other red opaque minerals; Lx-leucoxene; Ud-unidentified.

SAMPLE[1]	COORDINATES (State Plane, NAD 83 m)	MAP UNITS DRAINED[2]	% TOTAL HM IN SAMPLE[3]	PERCENT HEAVY MINERALS IN SAMPLE[4]																	
				Mg	Cor	Ms	Gt	Zr	Bt	Rt	Czo	St	Sil	Hbl	Ky	Ttn	Tur	Ilm	Hem	Lx	Ud
NB 828	217,103N; 315,013E	Zabgs, Zab	0.52	13.43	-	0.43	-	-	-	-	2.16	0.87	-	-	-	0.87	1.73	8.66	51.51	19.48	0.87
NB 829	223,556N; 315,619E	Zas, Za, Zacg	1.52	0.08	-	-	87.93	-	-	-	-	1.50	3.50	-	-	-	-	2.00	5.00	-	-
NB 830	221,634N; 307,936E	Za, Zaa	2.45	0.10	-	-	65.93	-	0.50	0.50	-	1.50	-	14.98	11.99	-	-	2.00	2.00	0.50	-
NB 833	214,457N; 309,805E	Zacg, Za, Zas	0.38	1.58	1.48	-	56.10	0.98	0.49	-	5.91	-	-	1.48	-	-	0.98	6.89	21.65	1.97	0.49
BC 859	217,010N; 311,262E	Zacg, Za, Zas	1.07	0.52	-	-	81.84	-	-	-	2.94	1.47	1.47	0.98	0.49	-	0.00	1.47	8.33	0.00	0.49

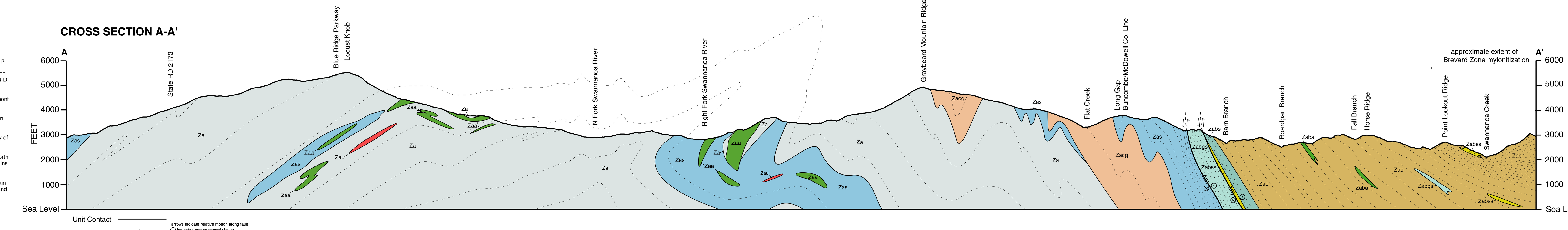
[1]Sample numbers correspond to stream sediment heavy mineral sample localities shown on geologic map
[2]Up to three most dominant map units contributing to the drainage basin, listed in decending order of map area
[3]Percentage of heavy minerals in 13.6 kg stream sediment sample
[4]Point count percentages of heavy minerals from processed samples

WHOLE ROCK ICP ANALYSIS[1] OF SELECTED SAMPLES

SAMPLE[2]	COORDINATES (State Plane NAD 83 m)	ROCK TYPE	MAP UNIT	OXIDES IN PERCENT											ELEMENTS IN PPM[3]											LOI[4]	SUM[5]
				SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Cu	Ba	Zn	Ni	Co	Sr	Zr	Ce	Y	Nb	Sc		
BC 650 MO	226,016N; 305,856E	blastomylonite	Pzmg	71.28	14.56	3.19	1.54	3.42	3.37	1.27	0.66	0.03	0.01	<0.002	2.1	378	64	<20	9.1	463	70.6	6.4	1	3.7	2	0.5	99.91
MO 18 BC	215,158N; 315,141E	muscovite-staurolite-garnet schist	Zab	50.75	23.87	11.29	2.52	0.25	1.04	4.00	1.07	0.16	0.15	0.012	24	578	173	23	<20	116	255	125	51	19	22	4.7	99.95
MO 56 BC	213,708N; 314,920E	metasiltstone	Zab	65.89	15.48	5.87	1.96	1.00	2.32	3.90	0.87	0.26	0.05	0.005	20	929	96	28	<20	190	465	75	24	15	9	2.2	99.98
MO 319 BC	216,487N; 315,351E	metabasalt	Zab	46.00	13.63	17.25	7.77	10.25	1.87	0.27	1.01	0.05	0.26	0.024	141	15	133	83	53	57	34	<30	30	<5	58	1.4	99.82
MTR 53 NB	214,042N; 315,091E	metagraywacke	Zab	73.54	11.60	4.51	1.51	1.89	3.61	1.10	0.82	0.20	0.08	0.004	9	263	77	<20	<20	149	496	69	27	14	9	1.0	100.00
B 814MTRN	213,714N; 315,187E	garnet-muscovite-biotite schist	Zab	72.97	12.4	4.07	1.28	0.74	3.9	2.18	0.8	0.22	0.04	0.004	5.2	642	54	<20	6.4	158	534	96.7	33.2	14	7	1.2	99.86
MTR 38 NB	215,349N; 312,488E	metawacke	Zabss	86.40	6.83	1.88	0.40	0.19	0.26	1.61	0.49	0.03	0.02	<0.002	20	495	73	<20	<20	33	264	<30	20	9	3	1.8	100.02
MTR 259 NB	215,192N; 313,821E	porphyritic metabasalt	Zaba	48.99	13.11	16.65	6.72	10.41	1.36	0.29	1.03	0.06	0.22	0.017	93	25	117	72	48	68	39	<30	31	<5	54	0.9	99.84
MTR 5 NB	213,261N; 310,869E	quartz-plagioclase-muscovite schist	Zabgs	64.47	17.86	4.66	1.31	1.16	2.51	2.28	0.82	0.28	0.16	0.006	53	459	69	<20	<20	123	562	152	43	21	14	4.3	99.99
RW 51 MTRN	223,979N; 314,894E	muscovite metasandstone	Za	86.72	5.49	3.76	0.24	<0.01	0.05	1.69	0.47	0.04	0.01	<0.002	11	253	7	<20	1.6	16.9	306	20	5	8	4	1.4	99.96
BC 658 MO	224,940N; 312,952E	biotite-muscovite-garnet-sericite schist	Za	54.47	21.71	9.95	2.82	1.29	1.61	3.36	1.03	0.21	0.16	0.012	11.4	662	110	<20	15	136	250	152.8	66.2	21.9	23	3.1	99.82
BC 655 MTR	226,960N; 305,838E	metagabbro	Za	50.42	23.84	6.23	2.73	9.67	4.42	0.29	1.46	<0.01	0.06	0.002	20.5	40	24	<20	15	964	21.3	7.8	14.2	1.9	17	0.7	99.81
NB 586 MT	224,584N; 313,059E	staurolite-biotite-chlorite-garnet-muscovite schist	Za	47.89	25.74	11.24	3.26	1.45	1.55	3.98	1.17	0.22	0.15	0.013	38	727	42	40	25	145	282	178.2	64.7	21.9	23	3	99.77
M523	225,639N; 308,931E	metagrawacke	Za	50.33	21.97	11.37	3.48	3.76	3.86	2.31	1.17	0.28	0.15	0.012	9	937	102	49	37	347	258	183	87	22	28	0.7	99.65
NB 603 MTRN	224,284N; 315,512E	metaconglomerate	Zacg	85.41	6.64	2.14	0.48	1.26	1.22	1.51	0.33	0.34	0.04	<0.002	2.3	511	25	<20	3.4	125	223	24.1	23.9	6.2	3	0.5	99.95
MO 309 BC	217,966N; 312,604E	metaconglomerate	Zacg	84.61	6.77	2.84	0.77	1.08	1.70	1.07	0.45	0.01	0.04	0.002	7	239	32	<20	<20	103	274	64	14	9	4	0.6	100.01
MO 204A NB	213,551N; 304,451E	metagabbro	Zaa	46.84	14.63	13.83	7.85	11.07	2.61	0.16	1.50	0.06	0.22	0.026	12	39	101	55	46	185	96	<30	31	<5	47	1.0	99.84
NB 639 MTRN	220,075N; 309,252E	metagabbro	Zaa	49.15	13.23	15.16	5.56	8.77	3.72	0.21	2.97	0.36	0.24	0.004	7.5	219	37	<20	40	162	230	26.6	54.9	6.9	45	0.3	99.74
M587	224,797N; 306,772E	amphibolite	Zaa	45.81	16.85	11.66	9.16	10.23	1.97	0.37	1.13	0.11	0.21	0.036	5	44	134	170	58	179	78	5	41	5	53	1.9	99.53
M557	225,834N; 307489E	altered ultramafic	Zaa	49.6	6.58	11.27	22.64	7.06	0.3	0.09	0.43	0.05	0.14	0.322	124	13	73	976	105	11	24	5	7	5	16	1	99.66
MTR 409 NB	219,551N; 306,140E	meta-peridotite	Zau	41.25	6.78	12.43	30.17	3.22	0.04	0.02	0.37	<0.01	0.18	0.372	41	10	71	1540	116	31	24	<30	6	<5	16	4.4	99.52
RW 23 MTRN	225,995N; 307,051E	altered ultramafic	Zau	47.36	10.69	13	19	6.56	0.89	0.14	0.75	0.06	0.19	0.229	77.6	23	2	467	75	5.6	48.8	6.1	14.8	1.5	25	0.7	99.63
BC 732 MTRN	225,789N; 307,480E	altered ultramafic	Zau	45.96	12.45	11.39	19.8	7.16	0.67	0.1	0.92	0.07	0.19	0.211	3.8	5	2	745	85	19.2	63.8	8.3	17.5	1.3	29	0.6	99.62

[1]Whole Rock Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP) 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]PPM = parts per million
[4]LOI = loss on ignition in percent
[5]SUM = Sum total in percent

CROSS SECTION A-A'



Unit Contact
Fault Contact — arrows indicate relative motion along fault; indicates motion toward viewer; indicates motion away from viewer
Form Lines — interpretive patterns of subsurface foliation orientations based upon surficial structural measurements

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Bedrock Geologic Map of the Montreat 7.5-minute Quadrangle, Buncombe, McDowell, and Yancey Counties, North Carolina

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

Geology mapped from August 2014 to May 2016.
Map preparation, digital cartography and editing by G. Nicholas Bozdog, Bart L. Cattanach, and Sierra J. Isard
2016

This map supersedes NCGS OFR 2015-03. 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.