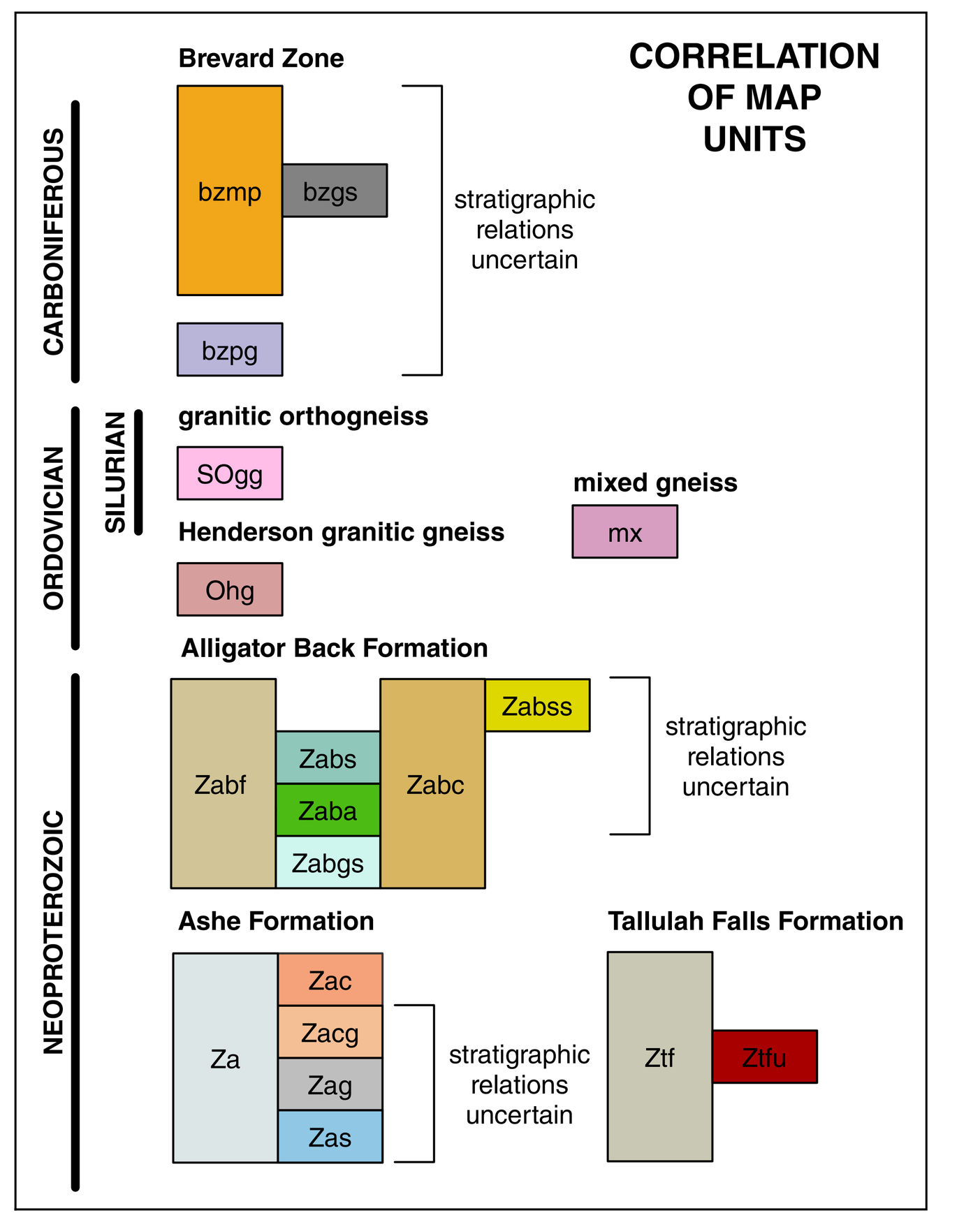
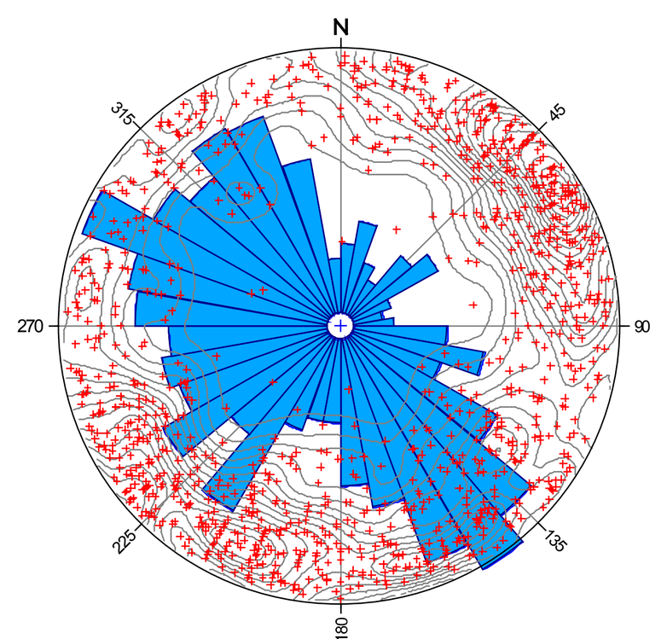
North Carolina Department of Environment and Natural Resources
Divsion of Energy, Mineral, and Land Resources
Tracy E. Davis, Division Director
Dr. Kenneth B. Taylor, State Geologist

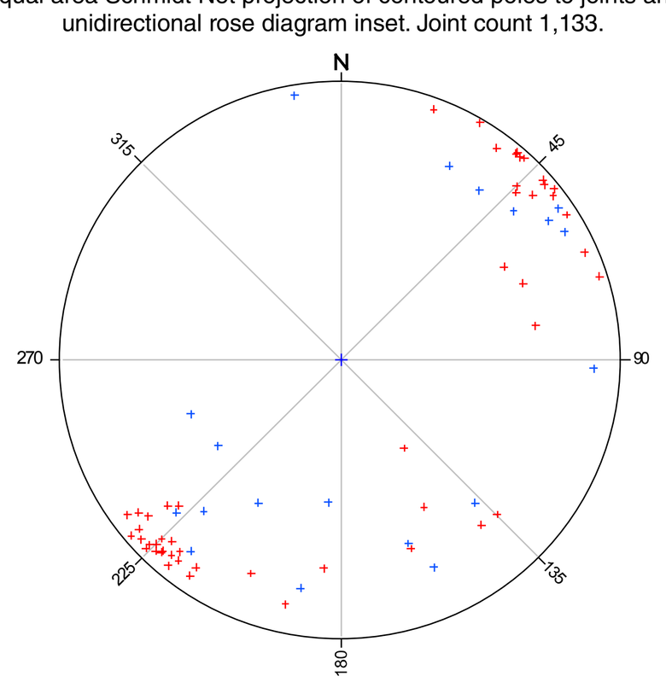
This Geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program

North Carolina Geological Survey
Open File Map 2014-03

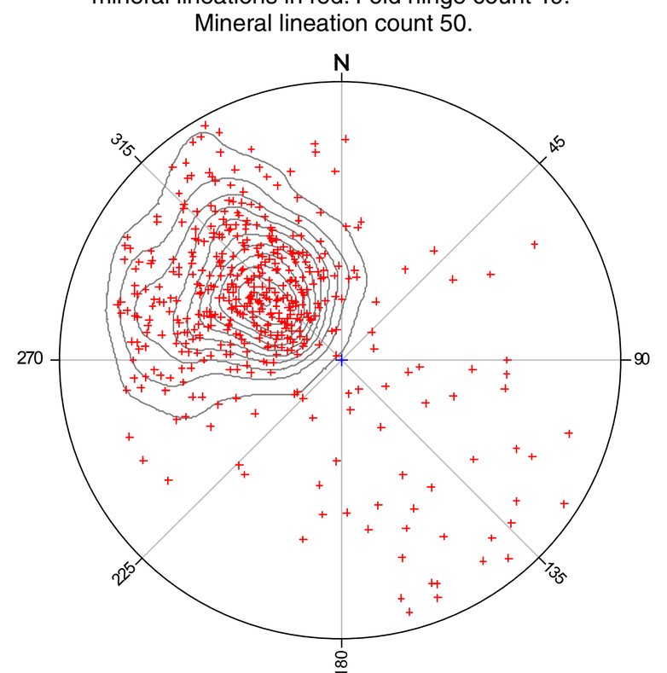




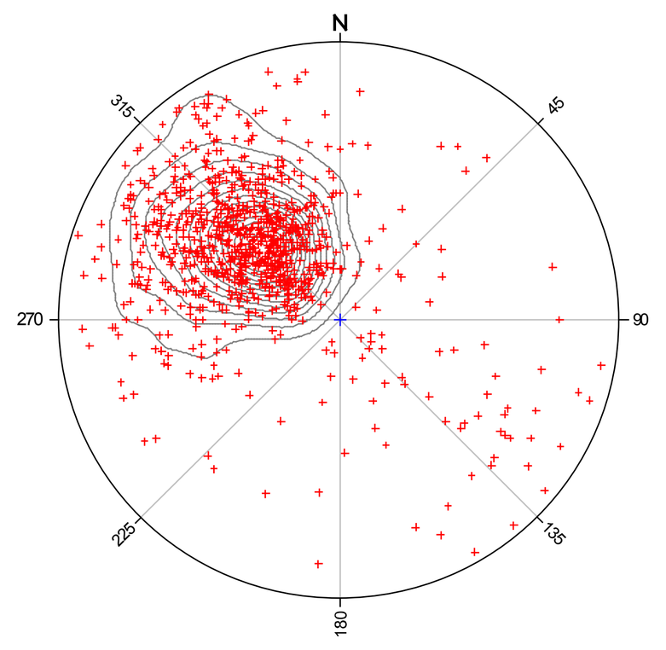
Equal area Schmidt Net projection of contoured poles to joints and unidirectional rose diagram inset. Joint count 1,133.



Equal area Schmidt Net projection of fold hinges in blue and mineral lineations in red. Fold hinge count 19. Mineral lineation count 50.



Equal area Schmidt Net projection of contoured poles to foliation. Foliation count 459.



Equal area Schmidt Net projection of contoured poles to mylonitic foliation. Mylonitic foliation count 947.

DESCRIPTION OF MAP UNITS

Brevard Mylonite Zone

Mylonite/phyllonite (bzmp) — 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; 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 mylonitic phyllite, metasandstone, metasiltstone, quartzite, meta-arkose, metagraywacke, muscovite schist, schistose metagraywacke, porphyroblastic biotite gneiss and felsic gneiss.

Graphitic metasiltstone and phyllite (bzgs) — Medium-gray to dark-gray; fine-grained; inequigranular; lepidoblastic; well foliated; mylonitic; consists of quartz, graphite, sericite, biotite, and opaques. Interlayered with phyllite, mylonite, and metasandstone. Thickness of layering ranges from centimeters to meters. Locally with "fishscale" or "button" appearance (see bzmp).

Porphyroblastic gneiss (bzpg) — Heterogeneous mix of porphyroclastic and porphyroblastic mylonitic biotite gneiss, quartzo-feldspathic gneiss, phyllonite, metagraywacke, metasandstone, mica schist, granitic orthogneiss, and amphibolite. Parent unit unknown. Biotite gneiss is typically light-gray to grayish-black; well foliated; locally protomylonitic; medium- to coarse-grained; inequigranular; porphyroblastic to porphyroclastic to lepidoblastic; locally migmatitic; consists of 30 to 40% quartz, 30 to 40% plagioclase, 5 to 20% biotite, 3 to10% muscovite, 3 to 5% potassium feldspar, 0 to 2% epidote and accessory pyrite and/or pyrrhotite occur locally. Interlayered amphibolite characterized by dark-colored, fine-grained matrix with feldspar porphyroblasts, and magnetite sericite chlorite schist.

Intrusive Rocks

Mixed Gneiss (mx) — Heterogeneous unit consisting of Henderson augen gneiss (Ohg), granitic gneiss (SOgg), quartzo-feldspathic gneiss, mylonite, and biotite paragneiss of unknown affinity; typically mylonitic or protomylonitic, locally migmatitic. Biotite gneiss is dark-gray to grayish-black; fine- to coarse-grained; well foliated; protomylonitic to mylonitic; inequigranular; porphyroclastic and locally porphyroblastic; consists of quartz, plagioclase, biotite, potassium feldspar, muscovite, and epidote.

Granitic gneiss (SOgg) — White to medium-gray to light-gray; medium- to coarse-grained; equigranular; granoblastic; mylonitic to protomylonitic; consists of quartz, plagioclase, potassium feldspar, muscovite, biotite, and minor amounts of opaques, epidote, chlorite, and garnet. Differs from Henderson Gneiss in general lack of augen, increased muscovite content, and more felsic composition. Correlative with the 438 Ma intrusives into the Henderson Gneiss of Lemmon (1973). Includes local bodies of metagraywacke not mappable at this scale.

Henderson Gneiss (Ohg) — Medium-gray to medium-bluish-gray to mottled black and white; inequigranular; medium- to coarse-grained matrix with distinctive megacrysts (augen) of microcline variable in size and abundance; typically protomylonitic to mylonitic and granoblastic to lepidoblastic; massive to well foliated. Protolith is dominantly biotite granite that ranges to tonalite; consists of potassium feldspar, plagioclase, quartz, biotite, muscovite and sericite, epidote group minerals, opaques and trace amounts of titanite, zircon and apatite; locally pegmatitic and migmatitic. Locally microcline augen exceed 3 cm in length. The augen structures are produced by a high temperature protomylonitic overprint. Radiometric age date of approximately 447 Ma (Moecher et al., 2011).

Alligator Back Metamorphic Suite

Coarse-grained (Zabc) — Heterogeneous unit consisting primarily of interlayered medium- to coarse-grained metagraywacke, metasandstone, and schistose metagraywacke; foliated to mylonitic. Metagraywacke is medium-light-gray to medium-dark-gray; foliated; granoblastic; consists of quartz, plagioclase, biotite, muscovite, with minor amounts of garnet, potassium feldspar, and other accessory minerals. Metasandstone is tan to medium-light-gray to gray; foliated; granoblastic; consists of quartz, potassium feldspar, plagioclase, with minor amounts of muscovite, biotite and other accessory minerals. Schistose metagraywacke is medium-gray to dark-gray; well foliated; granoblastic to lepidoblastic; consists of quartz, plagioclase, muscovite, biotite, garnet, and minor accessory minerals. Primary rock types are interlayered with lesser amounts of meta-arkose, phyllite, phyllonite, and amphibolite.

Fine-grained (Zabf) — Heterogeneous unit consisting primarily of interlayered phyllite and metasiltstone. Phyllite is light-gray to medium-gray to grayish- green; fine-grained; well foliated to mylonitic; lepidoblastic; consists of sericite, quartz, chlorite, graphite, and accessory minerals. Metasiltstone is medium-gray to olive-gray to brown-black; fine- to medium-grained; well foliated to mylonitic; granoblastic to lepidoblastic; consists of quartz, feldspar, biotite, muscovite, garnet, chlorite, and accessory minerals. Primary rock types are interlayered with lesser amounts of phyllonite, mylonite, metagraywacke, metasandstone, meta-arkose, schistose metagraywacke, schist, and greenstone (metabasalt).

Alligator Back schist (Zabs) — Garnet-mica-schist, muscovite schist, muscovite-biotite schist, locally graphitic. Very light-gray to greenish-gray to medium-gray; medium- to coarse-grained; well foliated; locally mylonitic; inequigranular; lepidoblastic to porphyroblastic; Interlayered with lesser amounts of schistose metagraywacke, metasandstone, and phyllonite. Includes rare occurrences of garnet-tourmaline schist consisting of 45 to 50% muscovite, 30 to 45% nematoblastic, prismatic black tourmaline, 5 to 7% quartz, 3 to 5% garnet, 1 to 2% opaque minerals including magnetite. Tourmaline schists are typically associated with tourmaline quartz veins that contain massive and prismatic tourmaline, up to 25mm in length.

Metasandstone (Zabss) — Tan to light-gray to medium-gray to light-green, fine- to medium-grained, equigranular to inequigranular, foliated to locally mylonitic; consists of quartz, feldspar, muscovite, and accessory minerals; interlayered with lesser amounts of meta-arkose, metasiltstone, phyllonite, metagraywacke, and schistose metagraywacke; locally has a thin “pin-striped” fabric.

Amphibolite (Zaba) — Dark-green to black; fine- to medium-grained; equigranular; granoblastic to nematoblastic; foliated to mylonitic; consists of hornblende, actinolite, plagioclase, chlorite, epidote group minerals, with trace amounts of garnet, titanite, magnetite and other opaque minerals. Interlayered with phyllonite and meta-arkose.

Alligator Back graphitic schist and metasandstone (Zabgs) — Graphitic schist is 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 sericite, quartz, graphite, feldspar, chlorite, kyanite, pyrite, and accessory minerals. Interlayered with lesser amounts of metasandstone, metasiltstone, schistose metagraywacke, schist, and phyllite.

Ashe Metamorphic Suite

Undivided (Za) — 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 schist, schistose metagraywacke, metagraywacke, conglomeratic metagraywacke, metaconglomerate, metasandstone, amphibolite, and minor calc-silicate. Thickness of layering ranges from centimeters to meters. Where possible Za was mapped and subdivided based on dominant rock type into four lithologic map units:

Metaconglomerate (Zac) — Medium-light-gray to medium-dark-gray; non-foliated to weakly foliated; coarse-grained (most commonly pebble size, but with some granule size feldspar and quartz clasts. Locally contains deformed quartz pebbles up to 7.5 cm in length); inequigranular; granoblastic; consists of quartz, plagioclase, biotite, muscovite, potassium feldspar, and trace opaque minerals; thickness of layering ranges from meters to tens of meters; pebble and granule composition is dominantly quartz with lesser amounts of feldspar; interlayered with other Za lithologies.

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

Garnet-Mica Schist (Zas) — Very light-gray to greenish-gray to medium-gray; strongly foliated; coarse-grained; equigranular to inequigranular; lepidoblastic to porphyroblastic; locally migmatitic; consists of muscovite, sericite, quartz, biotite, garnet, plagioclase, sillimanite or kyanite, chlorite, and trace opaques; interlayered with other Za lithologies.

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

Tallulah Falls Formation

Undivided (Ztf) — Heterogeneous sequence of metamorphosed sedimentary and volcanic rocks that include bodies of plutonic rocks not mappable at this scale. On the Black Mountain quadrangle, rock types within the Tallulah Falls Formation are interlayered at all scales and are mylonitic. This unit consists of interlayered porphyroclastic and porphyroblastic biotite gneiss, mylonite; metagraywacke, and lesser amounts of muscovite schist, garnet-mica schist, metasiltstone, schistose metagraywacke, metasandstone, meta-arkose, amphibolite, biotite granitic orthogneiss, and small bodies of altered mafic/ultramafic rock that were mapped separately (Ztfu).

Altered Ultramafic and Mafic Rocks (Ztfu) — Altered ultramafic rocks (metaperidotite) are dark-green to silvery-grayish-green; weakly foliated to foliated; fine- to medium-grained; equigranular; granoblastic to lepidoblastic; consists of 0 to 97% hornblende, 55 to 65% chlorite, 0 to 30% magnetite and other opaques, 7-10% enstatite, 3 to 5% talc, and trace carbonate. Altered mafic rocks (metagabbro) are dark green to green-black, weakly foliated to strongly foliated, very-fine to medium-grained, equigranular to mylonitic; consist of 10 to 65% chlorite, 0 to 45% amphibole, 3 to 25% plagioclase, 2 to 25% epidote, 0 to 5% quartz, 0 to 5% magnetite; and 0 to 3% augite.

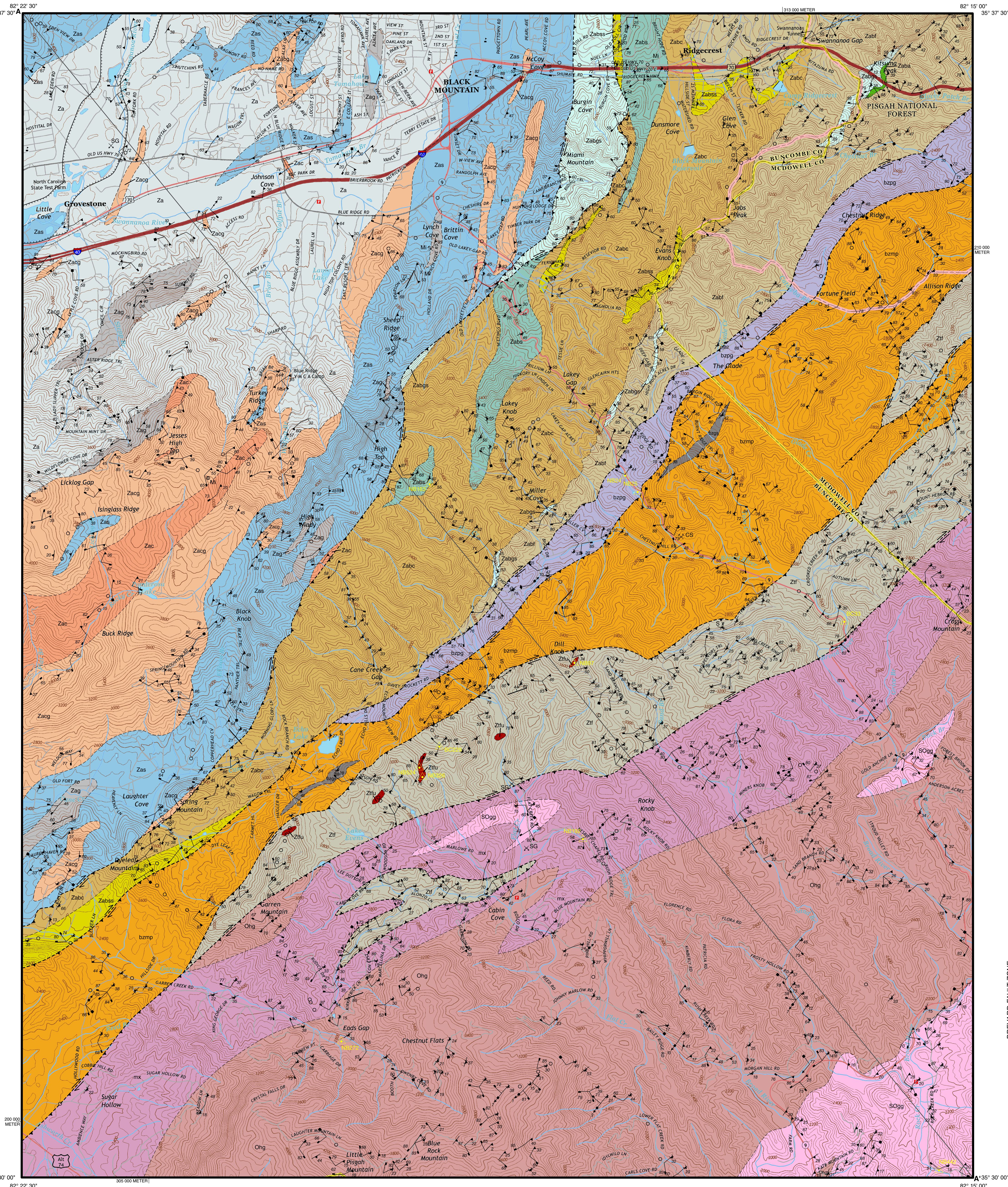
[1]Mineral percentages of rock types, where indicated, are based on thin section estimates.

References Cited

Butler, J.R., 1972, Geologic Map and Mineral Resources Summary of the Black Mountain Quadrangle, North Carolina: North Carolina Department of Natural and Economic Resources, GM 201-SE and MRS 201_SE.

Moecher, D., Hietpas, J., Samson, S., and Chakraborty, S., 2011, Insights into southern Appalachian tectonics from ages of detrital monazite and zircon in modern alluvium: Geosphere; v. 7; no. 2; p. 1-19.

Lemmon, R.E., 1973, Geology of the Bat Cave and Fruitland quadrangles and the origin of the Henderson Gneiss, western North Carolina [Ph.D. dissertation]: Chapel Hill, University of North Carolina, 193 p.



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: Universal Transverse Mercator, Zone 17S
10 000-foot ticks: North Carolina Coordinate System of 1983

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° 33´
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

Craggy Pinnacle	Montreat	Old Fort
Oteen	Black Mountain	Moffitt Hill
Fruitland	Bat Cave	Lake Lure

ADJOINING 7.5' QUADRANGLES

ROAD CLASSIFICATION

Expressway | Local Connector
Secondary Hwy | Local Road
Ramp | 4WD
Interstate Route | US Route | State Route

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

BLACK MOUNTAIN, NC
2013

EXPLANATION OF MAP SYMBOLS

CONTACTS

Contact—Identity and existence certain, location inferred

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)

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

79 Inclined mylonitic foliation—Showing strike and dip

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

Vertical or near-vertical mylonitic foliation at one locality—Showing strike

Vertical or near-vertical mylonitic foliation, for multiple observations at one locality—Showing strike

61 Inclined bedding—Showing strike and dip

56 83 Inclined bedding, for multiple observations at one locality—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—Showing strike

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

58 Small, minor inclined fault—Showing strike and dip

LINEAR FEATURES

12 Inclined crenulation lineation—Showing bearing and plunge

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

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

OTHER FEATURES

Float station

NB206 Thin section and whole rock analysis sample location

Prospect (pit or small open cut)

Sand, gravel, clay, or placer pit

Abandoned sand, gravel, clay, or placer pit

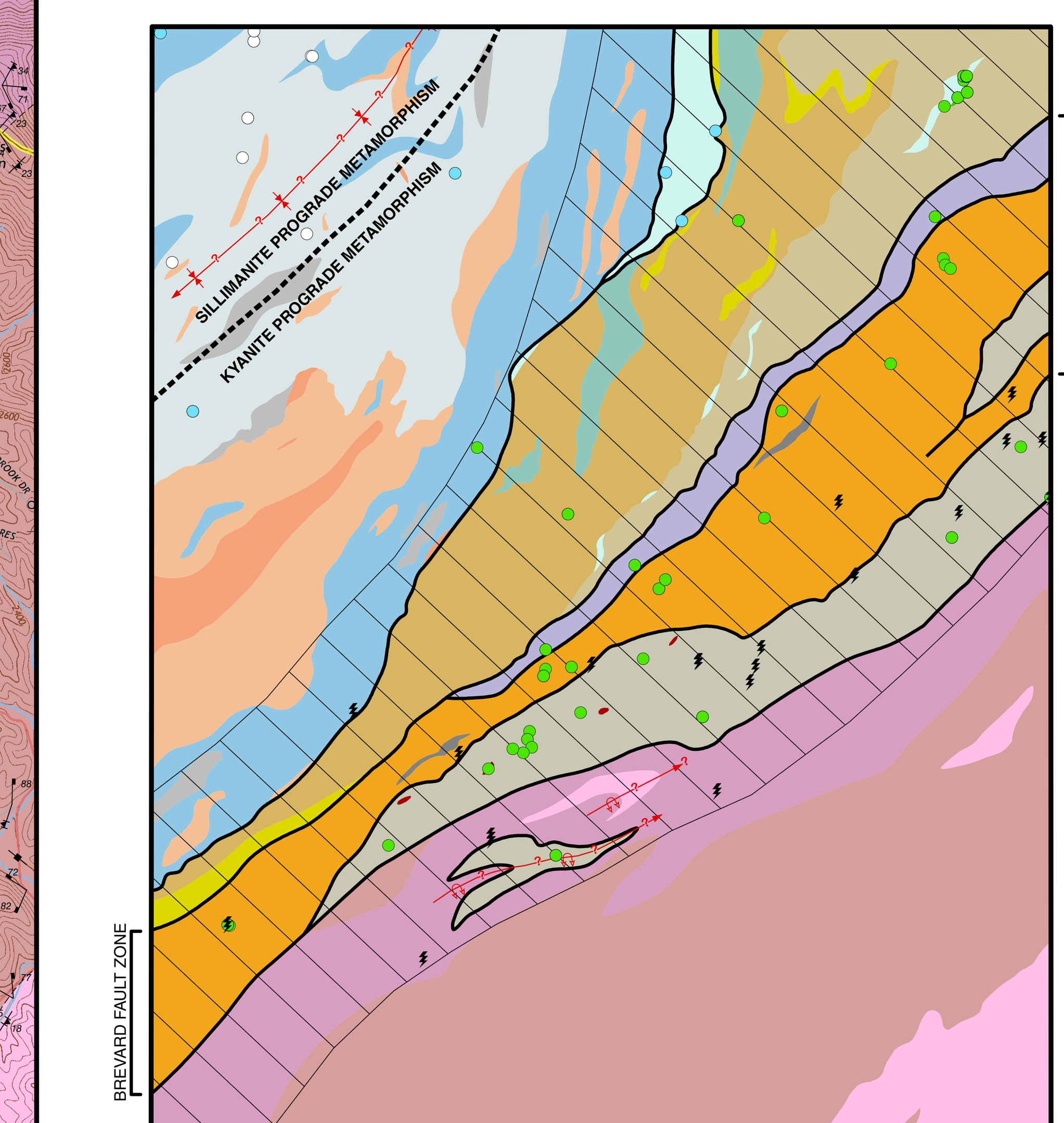
Abandoned open pit, quarry, or glory hole

Area of sand and gravel pits

NATURAL RESOURCES

CS - Crushed stone S - Sulfides SG - Sand and gravel Mi - Mica

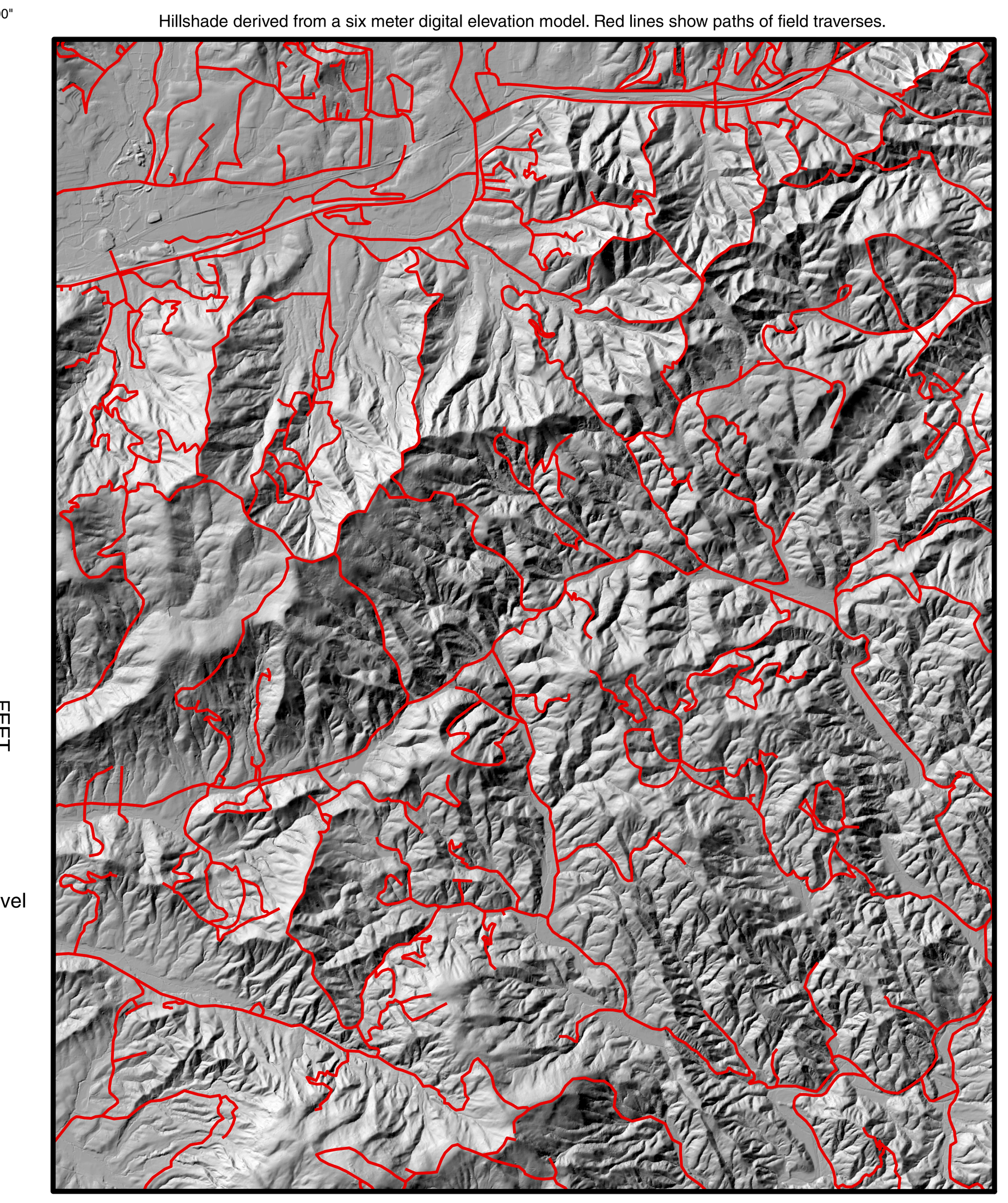
METAMORPHIC AND TECTONIC CONDITIONS



Location where sillimanite was observed in hand sample
Location where kyanite was observed in hand sample
Location where chlorite was observed in hand sample
Areas of brecciation
Area of chlorite retrograde metamorphism
Fault
Overturned antiform—Identity and existence questionable, location accurate. Arrows show dip direction of limbs.
Synform—Identity or existence questionable, location accurate.

TRAVERSE MAP

Hillshade derived from a six meter digital elevation model. Red lines show paths of field traverses.

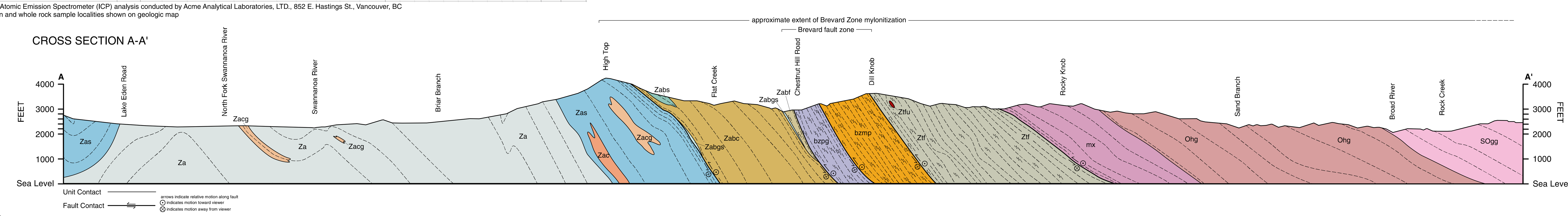


WHOLE ROCK ICP ANALYSIS[1] OF SELECTED SAMPLES

SAMPLE[2]	COORDINATES (State Plane NAD 83 m)	ROCK TYPE	MAP UNIT	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ba	Cu	Zn	Ni	Co	Sr	Zr	Ce	Y	Nb	Sc	LOI[4]	SUM[5]
				OXIDES IN PERCENT											ELEMENTS IN PPM[3]												
NB163	207,436N; 308,619E	garnet-tourmaline-muscovite schist	Zabs	47.8	30.33	8.46	2.72	0.29	1.38	3.68	0.88	0.04	0.06	0.01	18	812	219	23	<20	172	155	81	23	28	22	4.1	99.93
NB25	207,262N; 311,093E	sericite-biotite-quartzo-feldspathic gneiss	bzpg	71.48	14.76	2.37	0.6	1.89	3.26	3.63	0.3	0.1	0.05	0.002	5	578	56	<20	<20	145	150	55	21	12	4	1.4	100
NB24	207,461N; 310,951E	biotite-quartzo-feldspathic gneiss	bzpg	70.22	13.9	4.94	1.25	2.25	3.63	1.96	0.61	0.04	0.03	0.006	28	635	82	<20	<20	336	249	54	8	9	7	1	100
BC33	205,635N; 313,504E	schistose metagraywacke	Ztf	64.8	17.69	4.75	1.13	0.69	3.68	3.34	0.61	0.11	0.07	0.002	16	603	77	<20	<20	223	343	106	21	17	10	3	99.99
NB272	200,838N; 307,347E	biotite granititc orthogneiss	Ohg	72.38	14.12	2.44	0.55	1.64	4.01	3.61	0.36	0.1	0.05	<0.002	6	589	50	<20	<20	151	233	86	24	17	5	0.6	100
BC229	204,309N; 308,630E	biotite-muscovite-quartzo-feldspathic gneiss	Ztf	71.77	14.54	2.44	0.52	2.04	3.59	3.81	0.27	0.13	0.03	<0.002	14	927	39	<20	<20	284	196	51	5	<5	3	0.7	100.01
NB97	205,252N; 310,272E	altered metagabbro	Ztfu	42.68	18.09	16.21	7.03	7.3	0.97	0.04	2.1	0.07	0.18	0.013	84	26	131	61	34	375	44	<30	12	6	28	5	99.77
NB524	204,067N; 308,385E	altered peridotite	Ztfu	14.14	33.56	33.4	9.15	0.33	0.06	0.38	3.28	<0.01	0.2	0.063	16	238	680	261	80	44	22	<30	<3	<5	34	5.1	99.77
NB442	199,067N; 314,415E	quartzo-feldspathic gneiss	SOgg	76.32	12.85	1.07	0.14	0.82	2.69	5.2	0.12	0.01	0.02	<0.002	8	517	15	<20	<20	135	77	35	12	<5	1	0.7	100.02
NB326	203,953N; 308,416E	altered metagabbro	Ztfu	46.82	19.14	8.15	9.9	9.28	2.3	0.34	0.45	0.01	0.13	0.018	153	80	68	91	40	454	16	<30	6	<5	18	3.2	99.84
NB192	203,151N; 310,303E	quartzo-feldspathic gneiss	mx	74.17	13.83	1.11	0.22	1.16	2.6	6.12	0.15	0.05	0.03	<0.002	10	425	20	<20	<20	188	93	37	10	20	3	0.5	100.01

[1]Whole Rock Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP) analysis conducted by Acme Analytical Laboratories, LTD., 852 E. Hastings St., Vancouver, BC
[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'



Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G13AC00204. This map and explanatory information is submitted for publication with the understanding that the United States Government is authorized to reproduce and distrubute reprints for governmental use. 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 express or implied, of the U.S. Government.

Bedrock Geologic Map of the Black Mountain 7.5-minute Quadrangle, North Carolina

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

Geology mapped from September 2013 to May 2014. Field assistance by Wilson M. Bonner. Additional data from J.R. Butler.
Map preparation, digital cartography and editing by G. Nicholas Bozdog, Bart L. Cattanach and Richard M. Wooten.
2014

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.