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Division of Energy, Mineral and Land Resources
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North Carolina Geological Survey
Open File Report 2024-04

CORRELATION OF MAP UNITS

WESTERN TUGALOO TERRANE

Spruce Pine Plutonic Suite

DEVONIAN
- Dspg granodiorite
- Dspp pegmatite

Ashe Metamorphic Suite

CAMBRIAN / NEOPROTEROZOIC (stratigraphic relations uncertain)
- Za undivided
- Zapm pegmatite and metasomatic schist
- Zakg kyanite gneiss
- Zaa amphibolite
- Zam marble
- Zacs chloritic schist
- Zah hornblende-biotite gneiss
- Zad dunite bodies
- Zau altered ultramafic bodies

WESTERN BLUE RIDGE ROCKS

Crossnore Complex
- Zbg Bakersville metagabbro

MESOPROTEROZOIC

Mesoproterozoic Basement Complex
- Ye Earlies Gap gneiss
- Yea Earlies Gap amphibolite

INTRODUCTION

The Micaville 7.5-minute quadrangle lies in Yancey and Mitchell counties, western North Carolina. Within the quadrangle is the town of Micaville and a portion of the Pisgah National Forest. U.S. Highway 80 E and N.C. Highway 197 are the major transportation corridors on the quadrangle. The major water features are the North Toe River and South Toe River. Total elevation relief is 2,390 feet (728 m) with a low of 2,190 feet (668 m) along the South Toe River and a high of 4,580 feet (1396 m) on the slopes of Bowlens Pyramid. Pisgah National Forest holdings are located in the northeast and southwest of the quadrangle.

GEOLOGIC OVERVIEW

Bedrock of the Burnsville quadrangle is within the Fries/Spruce Pine thrust sheet of the eastern Blue Ridge portion of the Tugaloo terrane and remobilized Grenville basement rock of the Pumpkin Patch thrust sheet (Trupe, 1997; Hatcher and others, 2007). The two sheets are separated by the Holland Mountain/Burnsville fault.

The Fries/Spruce Pine thrust sheet contains Neoproterozoic metasedimentary and mafic rocks of the Ashe Metamorphic Suite. 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. Amphibolite facies metamorphism associated with Acadian/Neoacadian orogenesis overprints older fabrics (Johnson and others, 2001).

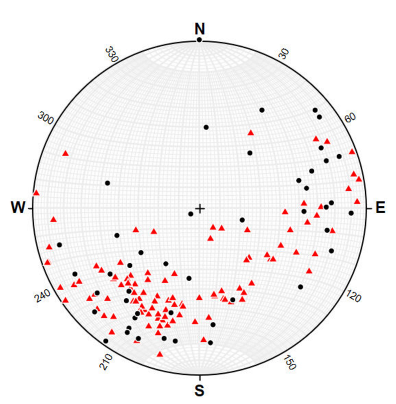
The Pumpkin Patch thrust sheet contains Mesoproterozoic metaplutonic and metavolcanic basement rocks (Merschat, 2003), possible paragneisses, and Neoproterozoic Bakersville plutonic rocks (Adams, 1995). These polydeformed gneissic layered rocks experienced amphibolite to granulite facies conditions. The metadiabase dikes in the Bakersville Intrusive Suite which cross-cut the gneissic layering have been metamorphosed.

Numerous Devonian-aged granodioritic bodies and pegmatites of the Spruce Pine Plutonic Suite intrude the Ashe Metamorphic Suite (Brobst, 1962; Kish, 1983, 1989). These bodies are typically concordant with, but locally cross-cut metamorphic foliation on the quadrangle. Xenoliths of foliated metasedimentary rocks are locally present within the bodies. Metasedimentary lithologies near pegmatites are commonly more micaceous and coarse-grained than those where pegmatites are absent.

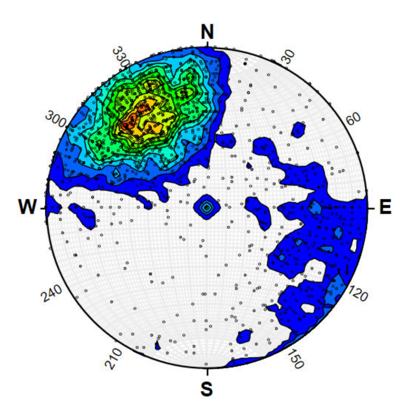
Brittle fractures of likely Mesozoic or younger age strike in all directions but display a prominent NW-SE orientation.

SCHMIDT EQUAL AREA STEREONET DATA

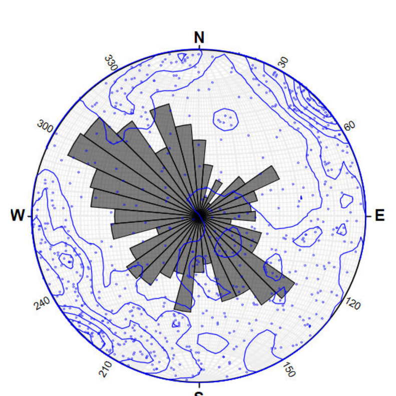
Stereonets created using Stereonet 10 (Allmendinger, et al., 2012; Cardozo and Allmendinger, 2013)



Bearing and plunge of fold hinges in black and mineral lineations in red. Fold hinge count = 76. Mineral lineation count = 108.



Contoured poles to foliation. Foliation count = 1838.



Contoured poles to joints and unidirectional rose diagram inset. Joint count = 693.

DESCRIPTION OF MAP UNITS[1]

WESTERN TUGALOO TERRANE
Spruce Pine Plutonic Suite

Dspg — **Granodiorite —** White to very light-gray, mottled; non-foliated to weakly foliated; coarse-grained; equigranular to inequigranular; granoblastic. Bodies are lenticular to tabular. Thickness of bodies ranges from decimeters to kilometers. Consists of plagioclase feldspar, quartz, potassium feldspar, and muscovite. Accessory minerals include biotite, garnet, apatite, epidote group minerals, thulite, pyrite, chalcopyrite, and pyrrhotite.

Dspp — **Pegmatite —** White to very light-gray, mottled; non-foliated to weakly foliated; very coarse-grained; equigranular to inequigranular; granoblastic. Bodies are lenticular to tabular. Thickness of bodies ranges from decimeters to tens of meters. Pegmatite occurs as sill-like or cross-cutting bodies within the Ashe Metamorphic Suite. Mineralogically similar to Spruce Pine granodiorite (Swanson and Veal, 2010). Consists of plagioclase feldspar, quartz, potassium feldspar, and muscovite. Accessory minerals vary greatly upon locality and include biotite, garnet, apatite, epidote group minerals, pyrite, chalcopyrite, pyrrhotite, beryl, samarskite, columbite, autunite, and torbernite.

Ashe Metamorphic Suite

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 metawacke, schistose metawacke, schist, 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.

Za — Metawacke — 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 Metawacke — 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.

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.

Zapm — **Pegmatite and metasomatic schist —** Heterogeneous mix of pegmatite, granodiorite, metasomatic schist, and other Ashe Metamorphic Suite lithologies. Pegmatite bodies range in size from sub-meter to decameter and are typically concordant with surrounding metasedimentary rocks. Pegmatite is white to light gray to light pink; coarse-grained; granoblastic; consists of plagioclase feldspar, quartz, potassium feldspar, muscovite, biotite, and minor amounts of opaque minerals, and garnet. Metasomatic schist is dark gray; medium- to coarse-grained; well foliated; inequigranular; lepidoblastic; consists of muscovite, biotite, quartz, plagioclase feldspar, potassium feldspar, garnet, and minor accessory minerals.

Zakg — **Kyanite gneiss —** Highly altered and heterogeneous unit characterized by an abundance of kyanite and/or muscovite porphyroblasts. Typical rock is mottled light-gray to brown; coarse-grained; foliated; equigranular to inequigranular; porphyroblastic; locally migmatitic; consists of biotite, plagioclase, quartz, muscovite, kyanite and/or sillimanite, garnet, and minor accessory and trace minerals; kyanite porphyroblasts up to 15 cm; felsic interlayers may be due to metasomatism or migmatization; interlayered with other Za lithologies.

Zaa — **Amphibolite —** 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 opaque minerals. Interlayered with other Ashe Metamorphic Suite lithologies and locally intruded by pegmatite. Can occur as a minor rock type throughout the other map units, where it may represent a metamorphosed volcanic rock.

Zam — **Marble —** White; coarse grained; semi-massive; consists of dolomite with minor actinolite and diopside.

Zacs — **Chloritic Schist —** Heterolithic unit characterized by chlorite and/or actinolite. Chlorite and actinolite are found filling anastomosing shear zones and dilatant fractures. Chlorite is also retrogressed from biotite and garnet. Massive garnet-chlorite schist and garnet-chlorite-actinolite schist is dark-green; medium- to coarse-grained; foliated chlorite-bearing biotite schist and gneiss is Dark-gray, Dark-green, medium- to coarse grained, foliated actinolite schist. Felsic, medium- to coarse-grained, massive chlorite quartzofeldspathic, commonly sheared; interlayered with other Za lithologies. Description adapted from Borella (2000).

Zah — **Hornblende-biotite gneiss —** Dark gray; medium- to coarse-grained; well foliated; non-layered to well-layered; granoblastic to nematoblastic to lepidoblastic; consists of quartz, plagioclase, biotite, hornblende, potassium feldspar, and minor accessory minerals. Interlayered with amphibolite, calc-silicate, and felsic gneiss.

Zad — **Dunite —** Grayish-yellow-green; fine- to medium-grained; consists of forsterite, with minor enstatite and bronzite, and disseminated chromite; when altered, serpentine minerals, anthophyllite, talc, and vermiculite replace olivine as disseminated grains, and in interior veins and peripheral areas.

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.

WESTERN BLUE RIDGE ROCKS
Crossnore Complex

Zbg — **Bakersville metagabbro —** Dark-gray to black, fine- to very coarse-grained, massive to well-foliated, metagabbro, metadiabase, and metabasaltic dikes. Locally altered to amphibolite, epidote-biotite schist, or garnet-biotite schist. Consists of hornblende, plagioclase, garnet, relict clinopyroxene, epidote, sphene, biotite, and minor accessory minerals.

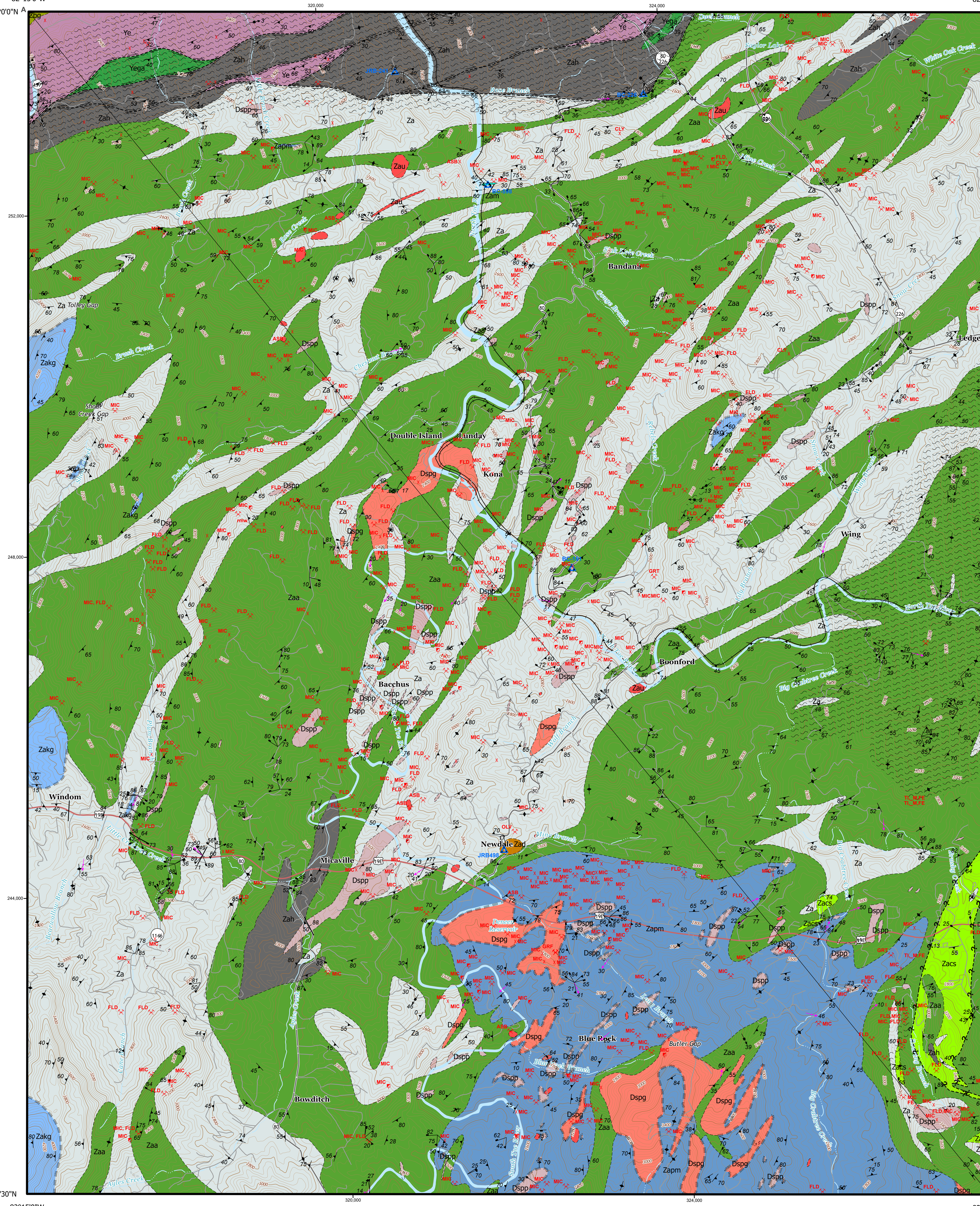
Mesoproterozoic Basement Complex

Ye — **Earlies Gap gneiss —** Heterogeneous unit of biotite-hornblende gneiss, granitic gneiss, biotite granitic gneiss, and layered biotite granitic gneiss, interlayered with magnetite-bearing granitic gneiss, amphibolite, and calc-silicate. Medium- to dark-gray to light-pinkish gray; coarse-grained; massive to well-foliated; equigranular; granoblastic to lepidoblastic; locally mylonitic, protomylonitic and migmatitic.

Yea — **Earlies Gap Amphibolite —** 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 opaque minerals.

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

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



Coordinate System: NAD 1983 StatePlane North Carolina FIPS 3200
Projection: Lambert Conformal Conic
Datum: North American 1983

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery....NAIP, September 2020 - September 2020
Roads....U.S. Census Bureau, 2016
Roads within US Forest Service Lands....FSTopo Data with limited Forest Service updates, Not Available
Names....GNIS, 1980 - 2022
Hydrography....National Hydrography Dataset, 2004 - 2021
Contours....National Elevation Dataset, 2022
Boundaries....Multiple sources; see metadata file 2017 - 2021
Wetlands....FWS National Wetlands Inventory Not Available

MN GN
6°59' 124 MILS
0°42' 12 MILS
UTM GRID AND 2019 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 500 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

CONTOUR INTERVAL 40 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This product was produced to conform with the National Geospatial Program US Topo Product Standard.

NORTH CAROLINA
QUADRANGLE LOCATION

Huntdale	Bakersville	Carvers Gap
Burnsville	Micaville	Spruce Pine
Mount Mitchell	Celo	Little Switzerland

ADJOINING QUADRANGLES

ROAD CLASSIFICATION
Expressway — Local Connector
Secondary Hwy — Local Road
4WD
US Route — State Route

Micaville, NC
2024

EXPLANATION OF MAP SYMBOLS

CONTACTS
Zone of Confidence: 300m

Contact—Identity and existence certain, location inferred.

Gradational contact—Identity and existence certain, location inferred

Right lateral fault—Identity and existence certain, location inferred.

Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location inferred.

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
- 36 Minor inclined fault—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
- 39 Compositional layering—Showing strike and dip

LINEAR FEATURES

- 4 Inclined crenulation lineation (1st option)—Showing bearing and plunge
- 22 Inclined fold hinge of generic (type or orientation unspecified) small, minor fold (1st option)— 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
- 12 Inclined generic (origin or type not known or not specified) lineation or linear structure—Showing bearing and plunge

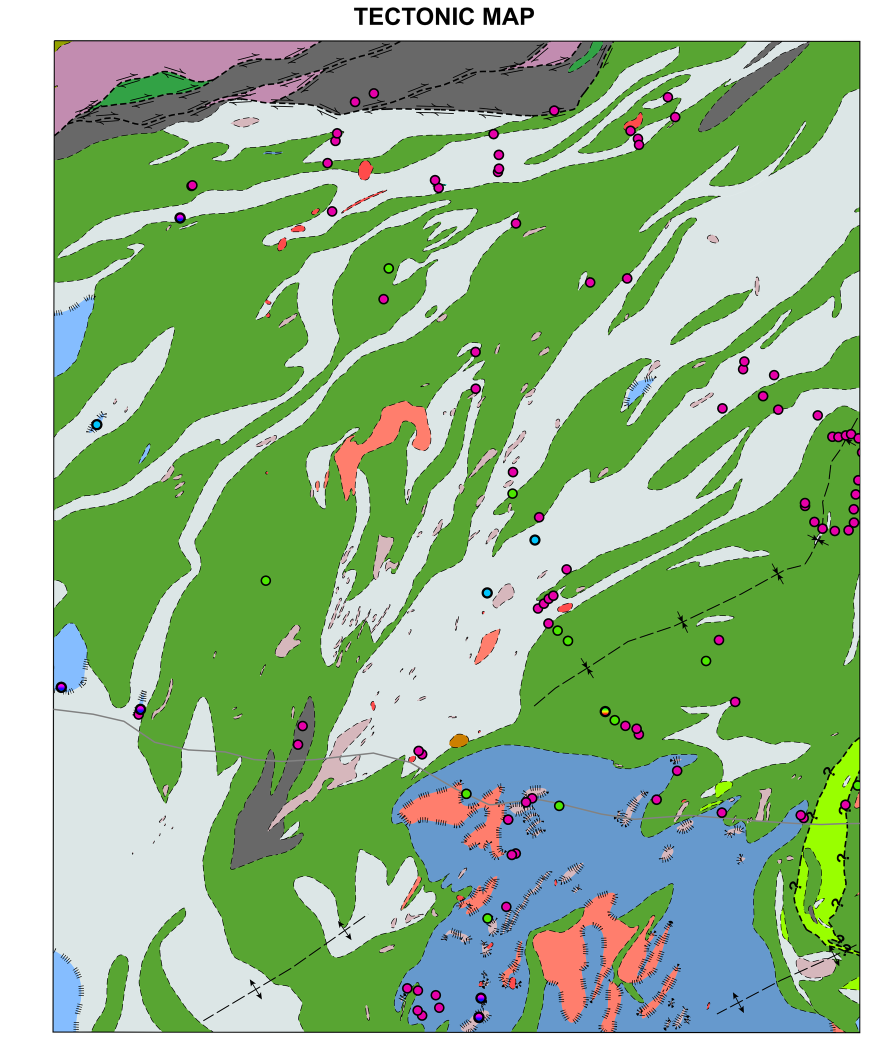
OTHER FEATURES

- Burnsville Fault Shear Zone
- Float station
- 20SI135B 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
- Abandoned adit or tunnel entrance

NATURAL RESOURCES

MIC - Mica SDG - Sand and gravel STN_C - Crushed stone STN - Stone
TLC - Talc CU - Copper FLD - Feldspar BE - Beryl MN - Manganese MBL - Marble

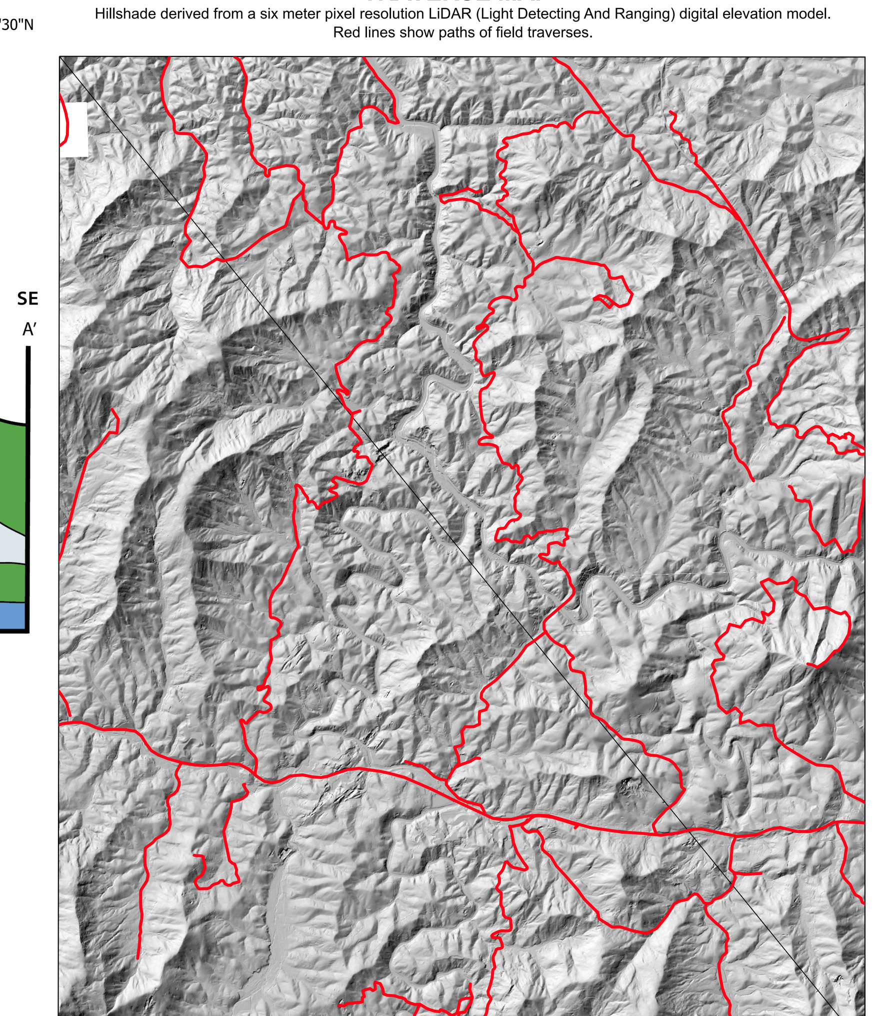
TECTONIC MAP



- Location where chlorite was observed
- Location where garnet was observed
- Location where kyanite was observed
- Location where garnet and kyanite were observed
- Location where chlorite and garnet were observed
- Anticline—Identity and existence certain, location approximate
- Syncline—Identity and existence certain, location approximate

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.



WHOLE ROCK ICP ANALYSIS OF SELECTED SAMPLES

Sample	Rock Type	Map Unit	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	LOI	Sum
BC-161	Pegmatite	Dspp	68.39	15.84	2.06	0.27	0.09	1.35	10.24	0.1	<0.01	0.02	<0.002	1.1	99.96
JRB498	Dunite	Zad	39.29	0.21	8.01	45.05	0.13	<0.01	<0.01	<0.01	<0.01	0.1	0.401	5.7	99.24
BC-226	Amphibolite	Zah	72.1	13.53	3.63	0.76	4.77	3.44	0.3	0.26	0.04	0.07	0.01	0.9	99.81
JRB-241	Felsic Gneiss	Zah	68.33	14.28	5.38	0.13	2.45	3.32	4.45	0.45	0.06	0.06	<0.002	0.6	99.58
BC-598	Marble	Zam	1.07	0.2	0.25	20.8	30.33	<0.01	0.05	<0.01	0.02	0.01	<0.002	47	99.71

Sample	Ba	Ni	Sc	Be	Co	Cs	Ga	Hf	Nb	Rb	Sn	Sr	Ta	Th	U	V	W	Zr	Y	La	Ce	Pr	Nd
BC-161	4392	<20	<1	<1	1	1.1	11.4	0.2	4.3	201.3	<1	229.5	0.2	0.7	0.3	15	<0.5	6.3	3.2	5.9	4.7	1.2	4.6
JRB498	3	2520	3	<1	118.6	<0.1	<0.5	<0.1	0.7	0.1	<1	2.3	<0.1	<0.2	<0.1	<8	<0.5	1.2	<0.1	0.2	0.2	<0.02	<0.3
BC-226	126	<20	7	3	6.1	<0.1	14.1	12.5	10.1	3.7	1	539.8	0.4	4.7	2.1	41	<0.5	578.2	19.8	30.4	59.9	8.41	31.6
JRB-241	868	<20	<1	<1	2.2	<0.1	28.3	32.9	90.3	68.2	5	448.7	4.9	25.5	3.2	18	<0.5	1438.3	102.5	243.4	494.4	55.99	208.4
BC-598	10	<20	<1	<1	<0.2	<0.1	<0.5	0.1	0.2	1.9	<1	68.1	<0.1	<0.2	<0.1	<8	<0.5	4.2	2.3	1.6	3.7	0.35	1.3

Sample	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Mo	Cu	Pb	Zn	Ni	As	Cd	Sb	Bi	Ag	Au	Hg	Tl	Se
BC-161	0.99	1.09	0.77	0.09	0.59	0.1	0.24	0.03	0.24	0.02	0.7	1.1	12.2	31	1.9	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.2	<0.5
JRB498	<0.05	<0.02	0.06	<0.01	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	0.5	1	<0.1	23	2329.5	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
BC-226	5.55	1.33	4.22	0.6	3.56	0.7	2.13	0.33	2.22	0.37	1.2	4.3	3.5	26	10.6	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
JRB-241	33.06	4.64	26.31	3.73	20.06	3.87	10.85	1.51	9.34	1.41	0.6	3.8	1.4	15	2.5	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
BC-598	0.25	0.07	0.3	0.05	0.27	0.06	0.17	0.02	0.11	0.03	0.1	0.3	3.8	5	0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5

Whole Rock Inductively Coupled Plasma - Atomic Emission/Mass Spectrometer analysis conducted by Bureau Veritas, 9050 Shaughnessy St, Vancouver, BC Canada V6P 6E5.
Sample numbers correspond to thin section and whole rock sample localities shown on geologic map.
State Plane Coordinate System
LOI = Loss on ignition in percent
SUM = Sum total in percent
PPM = Parts per million. Ni analyzed by Bureau Veritas LF200 and AQ200 procedures.
Oxide values are in weight percent and trace element values are in PPM.

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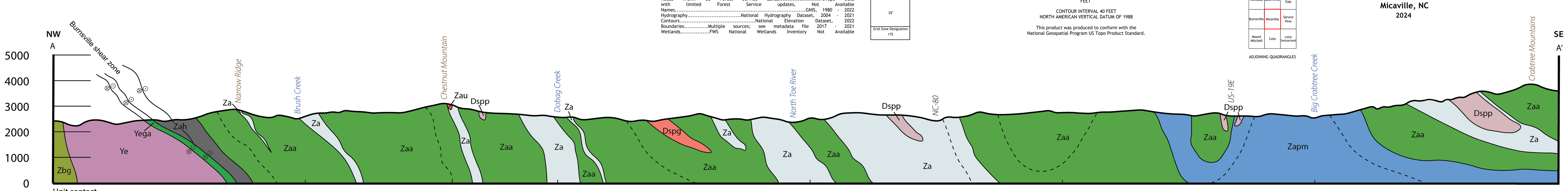

Unit contact
Right lateral fault
Form lines — interpretive patterns of subsurface foliation and orientations based upon surficial structural measurements

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Bedrock Geologic Map of the Micaville 7.5-minute Quadrangle, Yancey and Mitchell Counties, North Carolina

By
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Geology mapped from August 1996 to May 1998 and August 2022 to December 2023. Additional structural measurements from Brobst (1962).
Portions of map modified from Waters (1999) and Brobst (1962).
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