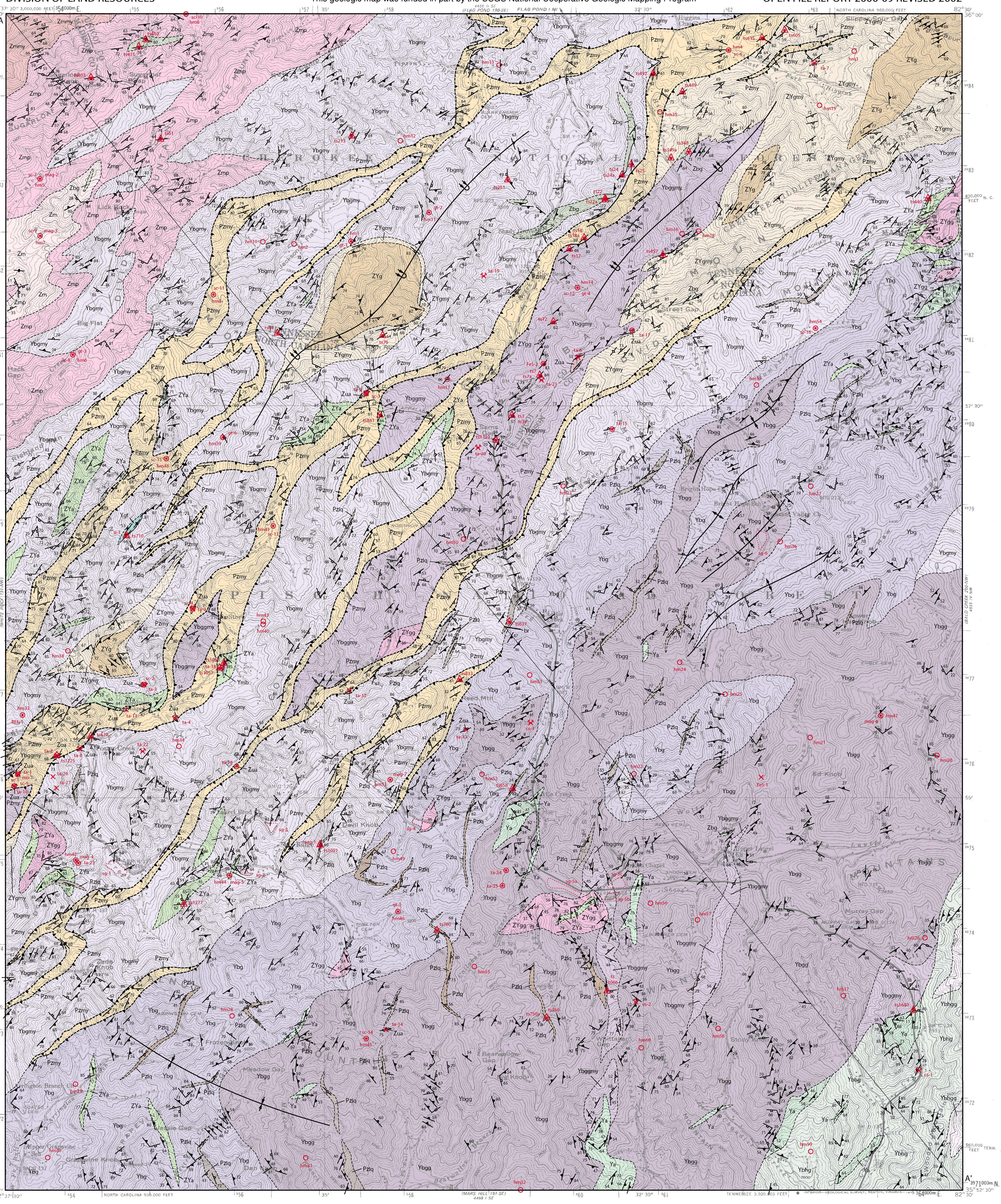
BEDROCK GEOLOGIC MAP OF THE SAMS GAP 7.5-MINUTE QUADRANGLE, NORTH CAROLINA AND TENNESSEE

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF LAND RESOURCES

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

NORTH CAROLINA GEOLOGICAL SURVEY
OPEN FILE REPORT 2000-09 REVISED 2002



MAP UNITS

CATACLASTIC AND MYLONITIC ROCKS

PALEOZOIC TO MESOZOIC?

- br — Brecciated zone
- Pzmy — Sericitic mylonite

META-INTRUSIVE ROCKS

MAX PATCH GRANITE

LATE PROTEROZOIC

- Zm — Max Patch Granite
- Zmp — Protomylonitic granite
- Zmmy — Mylonitic granite
- Zbg — Bakersville metagabbro

METAPLUTONIC AND METAVOLCANIC BASEMENT ROCKS

MIDDLE PROTEROZOIC

BIOTITE GRANITOID GNEISS

- Ybg — Biotite granitoid gneiss
- Ybgmy — Mylonitic biotite granitoid gneiss

LAYERED BIOTITE GRANITIC GNEISS

- Ybgg — Layered biotite granitic gneiss
- Ybggmy — Mylonitic layered biotite granitic gneiss

MIGMATITIC BIOTITE-HORNBLENDE GNEISS

- Ybhg — Migmatitic biotite-hornblende gneiss
- Ybhgg — Mafic granulite

ROCKS OF UNCERTAIN AFFINITY

- Pzlq — Leucocratic quartzofeldspathic rock
- Zua — Altered ultramafic rock

MIDDLE TO LATE PROTEROZOIC

- ZYg — Hornblende-bearing metagranite
- ZYgmy — Protomylonitic and mylonitic metagranite
- ZYa — Amphibolite
- ZYgg — Red and pink feldspar granitoid gneiss

- Ya — Amphibolite
- Ygf — Aluminous granofels
- Ymb — Marble

DESCRIPTION OF MAP UNITS[1]

CATACLASTIC AND MYLONITIC ROCKS

BRECCIATED ZONE (br) – Discontinuous zones of varying thickness (from centimeters to tens of meters) consist of coarse, angular fragments of aphanitic, grayish-pink granitic gneiss in a fine-grained, moderate-brown to grayish-red, limonitic or specular hematitic matrix. Cataclastic texture is typical. Zones are mappable in short segments.

SERICITIC MYLONITE (Pzmy) – Well developed mylonite characterized by the development of sericite, epidote group minerals, and chlorite; occurs within linear, northeast striking units in the northwestern one-half of the quadrangle. These units enclose blocks of locally unmylonitized to progressively mylonitized rock. Mylonite of felsic composition is medium gray to dark gray; fine- to medium-grained; equigranular to inequigranular; well foliated; lepidoblastic; mylonitic; thin- to medium-layered; consist of 16-70% quartz, a trace to 36% potassium feldspar, 12-43% plagioclase, and 2-20% biotite, with accessory zircon and ilmenite and other black opaque minerals. Mylonitic alteration minerals include 0-23% sericite and 0-2% epidote group minerals. Mylonites of mafic composition are greenish black to dark greenish gray; fine- to medium-grained; equigranular to inequigranular; well foliated; lepidoblastic; mylonitic; thin- to medium-layered; consist of about 1% quartz, 20% plagioclase, 26% hornblende, and 2% biotite, with accessory ilmenite and other black opaque minerals, and mylonitic alteration minerals, including chlorite, epidote group minerals, biotite, and carbonate.

META-INTRUSIVE ROCKS

MAX PATCH GRANITE

MAX PATCH GRANITE (Zm) – Light gray, mottled with pale pink and pale green; coarse-grained; equigranular to slightly megacrystic; granoblastic; weakly foliated to massive; consists of potassium feldspar, plagioclase, quartz, biotite, hornblende, and epidote group minerals. The green coloration of the plagioclase is a result of saussuritization. Probably quivalent to the Max Patch Granite of Keith (1904).

PROTOMYLONITIC GRANITE (Zmp) – Medium gray, with moderate orange pink megacrysts of potassium feldspar and moderate yellow green epidote alteration of plagioclase; inequigranular; medium- to coarse-grained; weakly foliated to massive; protomylonitic to locally strongly mylonitic. Composition varies from granitic to dominantly granodioritic; consists of 16-30% quartz, 19-23% potassium feldspar, 24-29% plagioclase, 12-25% biotite, with accessory ilmenite and other black opaque minerals. Mylonitic alteration minerals vary from a trace to 7% epidote group minerals, sericite, and chlorite. Blue quartz grains are common. Sericite content increases with mylonitization.

MYLONITIC GRANITE (Zmmy) – Medium gray with moderate orange pink megacrysts of potassium feldspar and moderate yellow green epidote alteration of plagioclase; inequigranular; medium- to coarse-grained; weakly foliated to massive; protomylonitic to weakly mylonitic, but locally strongly mylonitic.

BAKERSVILLE METAGABBRO (Zbg) – Typically brownish black to greenish black; medium- to very coarse-grained; slightly foliated to massive; locally altered to amphibolite and biotite-chlorite schist; weathers spheroidally. Texture is subophitic to blastophitic, modified to nematoblastic, locally lepidoblastic; mylonitic. Primary minerals include 10-46% plagioclase, 4-13% pyroxene, 1-3% ilmenite and other black opaque minerals, a trace to 4% quartz and a trace of sphene. Where porphyritic, the phenocrysts are plagioclase. Metamorphic and mylonitic alteration minerals include hornblende, biotite, chlorite, epidote group minerals, and sericite. Numerous small dikes and sills are locally present, but most are too small to depict at map scale.

METAPLUTONIC AND METAVOLCANIC BASEMENT ROCKS

BIOTITE GRANITOID GNEISS

BIOTITE GRANITOID GNEISS (Ybg) – Light gray, mottled with pinkish gray to pale reddish brown; equigranular to inequigranular; granoblastic to lepidoblastic; weakly foliated to well foliated; thickly layered to massive; locally migmatitic and pegmatitic; consists of about 49% plagioclase, 40% quartz, 8% potassium feldspar, 3% epidote group minerals, 2% ilmenite and other black opaque minerals, and traces of biotite and hornblende; thinly interlayered locally with amphibolite.

MYLONITIC BIOTITE GRANITOID GNEISS (Ybgmy) – Light pinkish gray to light brownish gray; inequigranular; granoblastic to lepidoblastic; mylonitic; poorly layered to well layered, with thicknesses ranging from tens of centimeters to tens of meters; interlayered locally with amphibolite. Granodiorite gneiss layers consist of 22-48% quartz, 1-49% potassium feldspar, 15-29% plagioclase, and 2-10% biotite. Accessory minerals include carbonate, ilmenite and other black opaque minerals, garnet, sphene, and zircon. Mylonitic alteration minerals include 3-27% sericite, 2-13% epidote group minerals, and a trace to 1% chlorite. A cross-cutting mylonized mafic rock in this unit consists of 31% quartz, 26% plagioclase, 36% epidote group minerals, 5% biotite, and 3% sphene and ilmenite and other black opaque minerals.

LAYERED BIOTITE GRANITIC GNEISS

LAYERED BIOTITE GRANITIC GNEISS (Ybgg) – A thick, monotonous, and repetitive sequence of layered rocks of variable composition ranging from biotite granitic gneiss to quartz dioritic gneiss. Intergraded and interlayered at all scales with retrograde amphibolite, biotite schist, amphibolite, protomylonite and mylonite. Calc-silicate granofels occurs locally. Layered biotite granitic gneiss to quartz dioritic gneiss, the dominant rock type of the unit, is very light gray to pale orange to medium light gray; equigranular; granoblastic to lepidoblastic; inequigranular where mylonitized; thicknesses of layers range from millimeters to meters. Rocks consist of about 49% plagioclase, 40% quartz, 8% potassium feldspar, 3% epidote group minerals, 2% ilmenite and other black opaque minerals, and traces of biotite, hornblende, sericite, garnet, sphene, apatite, and zircon.

MYLONITIC LAYERED BIOTITE GRANITIC GNEISS (Ybggmy) – Medium gray to very pale orange; equigranular to inequigranular; granoblastic to lepidoblastic; mylonitic; poorly layered to well layered, with thicknesses ranging from less than a centimeter to several meters. Felsic layers range from granitic to tonalitic in composition, with 0-40% potassium feldspar, 27-38% quartz, 11-39% plagioclase, and a trace to 37% biotite. Common accessory minerals include garnet, ilmenite and other black opaque minerals, and apatite. Mylonitic alteration minerals include 0-23% sericite, 0-1% epidote group minerals, and 0-1% carbonate. Interlayered mylonitic (retrograded) amphibolites consist of 1-5% quartz, 11-21% plagioclase, 29-39% hornblende, and 18-36% biotite. Accessory minerals include ilmenite and other black opaque minerals, and apatite. Mylonite alteration minerals include 16-24% epidote group minerals, chlorite, and sericite.

METAPLUTONIC AND METAVOLCANIC BASEMENT ROCKS (continued)

MIGMATITIC BIOTITE-HORNBLENDE GNEISS

MIGMATITIC BIOTITE-HORNBLENDE GNEISS (Ybhg) – Unit consists of mafic and felsic rock types interlayered and gradational at all scales. In general, the rocks are low in quartz and contain almost no muscovite or aluminosilicate minerals Mafic layers are dark brown to greenish black; fine- to medium-grained, but locally coarse-grained; equigranular; nematoblastic to granoblastic; locally protomylonitic and mylonitic; well foliated; thin- to thick-layered; vary in composition between gabbro and diorite. Felsic layers range in color from light purplish gray to light pinkish gray; medium- to coarse-grained;equigranular; granoblastic to lepidoblastic; well foliated to massive; medium- to thick-layered; vary in composition from granite to granodiorite.

MAFIC GRANULITE (Ybhgg) – Regionally, this unit includes rocks ranging from amphibolite to biotite-hornblende gneiss to mafic granulite. On the Sams Gap Quadrangle, the rock is an amphibolite, which is dark greenish gray to greenish black; medium- to coarse-grained; nematoblastic to granoblastic; well foliated to massive; consists of hornblende, plagioclase, quartz, biotite, and accessory epidote group minerals, and ilmenite and other black opaque minerals.

ROCKS OF UNCERTAIN AFFINITY

LEUCOCRATIC QUARTZOFELDSPATHIC ROCK (Pzlq) – Characterized by thin to thick zones of "sugary"-textured rock that cut across earlier foliations. The rock is light gray to grayish orange pink; equigranular; aphanitic; granoblastic; locally mylonitic; foliated to massive; composition ranges from granitic to tonalitic; consists of 16-34% quartz, 24-40% potassium feldspar, 22-58% plagioclase, and 1-7% biotite. Accessory minerals include a trace to 4% epidote group minerals, a trace to 1% garnet, 0-2% sphene, and a trace of apatite. Magnetite, which comprises up to 2% of the rock, is also a characteristic accessory mineral. 0-5% sericite is the predominate mylonitic alteration mineral. Thickness varies from a few tens of centimeters to tens of meters; larger areas are shown, others are too small to depict at map scale.

ALTERED ULTRAMAFIC ROCK (Zua) – Small bodies of soapstone, occurring as small, discontinuous lenses and pods within or adjacent to Paleozoic mylonite units, are interpreted to be altered ultramafic rock. The soapstone is medium gray to light greenish gray; fine- to medium-grained; lepidoblastic; mylonitic foliation is characterisitic; consists of about 55% chlorite, 44% talc, and 2% carbonate.

HORNBLENDE-BEARING METAGRANITE (ZYg) – Grayish pink to moderate pink to moderate red, weathers very light gray to white; medium- to coarse-grained; equigranular to inequigranular; granoblastic; locally mylonitic; poorly foliated to massive; consists of about 48% potassium feldspar, 24% quartz, 15% plagioclase, 10% hornblende, 3.0% biotite, and traces of sphene, ilmenite and other black opaque minerals, and epidote group minerals. Metamorphic effects are typically not obvious. Similar to parts of the Beech Granite of Keith (1903).

PROTOMYLONITIC AND MYLONITIC METAGRANITE (ZYgmy) – The mylonitic equivalent of hornblende-bearing metagranite, rocks of this unit are medium gray to pinkish gray to very pale orange; granoblastic to lepidoblastic; mylonitic; variably megacrystic. Thickness of layers varies from centimeters to tens of meters. Mylonitization is quite thorough throughout the unit, although areas of unmylonitized hornblende-bearing metagranite and other interlayered minor rock types do occur. Composition represents both the unmylonitized and mylonitized rock types within this map unit, and consists of 1-35% quartz, 13-66% plagioclase, 16-32% potassium feldspar, 1-22% biotite, and 0-14% hornblende. Accessory minerals include ilmenite and other black opaque minerals, garnet, and apatite. Mylonitic alteration minerals include 1-10% sericite and 0-9% epidote group minerals. Modal compositions range from granite to granodiorite to monzodiorite.

AMPHIBOLITE (ZYa) – Mappable layers, lenses, and pods of amphibolite are dark greenish gray to greenish black; equigranular; nematoblastic to lepidoblastic; weakly foliated to well foliated; consists of 27-94% hornblende, 1-2% epidote group minerals, a trace to 2% ilmenite and other black opaque minerals, 0-81% tremolite and actinolite; 0-17% talc, 0-3% plagioclase, and 0-1% biotite. The rock is locally sheared and lineated, giving the rock a "streaked" appearance. This unit may be either metamorphosed igneous rock or interlayered retrograded metamorphic rock.

RED AND PINK FELDSPAR GRANITOID GNEISS (ZYgg) – Grayish pink to moderate pink to moderate red, mottled; equigranular; granoblastic to lepidoblastic; locally mylonitic; poorly foliated to massive. Epidotization is widespread; epidote and specular hematite commonly fill fractures. Larger areas are shown; the rock is also locally interlayered with biotite granitoid gneiss, layered biotite granitic gneiss, and their protomylonitic and mylonitic equivalents, but the layers are too small to depict at map scale.

AMPHIBOLITE (Ya)– Dark greenish gray to greenish black; equigranular; nematoblastic to lepidoblastic; hornblende and garnet may be poikiloblastic; poorly foliated to well foliated; consists of 58-72% hornblende, 7-34% plagioclase, 0-34% garnet, 2-18% quartz, a trace to 13% epidote group minerals, 3-7% biotite, a trace to 6% ilmenite and other black opaque minerals, 0-4% potassium feldspar, 0-1% sphene, and a trace of apatite. 0-1% sericite is the predominant alteration mineral. Variable amounts of diopside also present locally. Larger areas of amphibolite are shown, but amphibolite is also commonly interlayered with other rock types of the biotite granitoid gneiss, layered biotite granitic gneiss, and their protomylonitic and mylonitic equivalents. These layers are too small to depict at map scale.

ALUMINOUS GRANOFELS (Ygf) – Medium light gray, mottled moderate brown when partially weathered; inequigranular; granoblastic to lepidoblastic; weakly foliated; massive; consists of about 34% garnet, 18% quartz, 16% potassium feldspar, 12% sillimanite, 7% biotite, 2% plagioclase, and a trace of ilmenite and other black opaque minerals; 11% sericite is the predominant mylonitic alteration mineral.

MARBLE (Ymb) – One small body of marble occurs along Foster Creek. Marble is light gray to pinkish gray; fine- to medium-grained; equigranular; granoblastic; massive; consists of about 80% calcite, 14% diopside, 3% epidote group minerals, traces of potassium feldspar and plagioclase, and 3% talc as an alteration mineral; grades into calc-silicate granofels, which is light gray to greenish gray; medium- to coarse-grained; equigranular; nematoblastic; weakly foliated to massive; consists of about 81% tremolite, 17% talc, 2% epidote group minerals, and a trace of diopside.

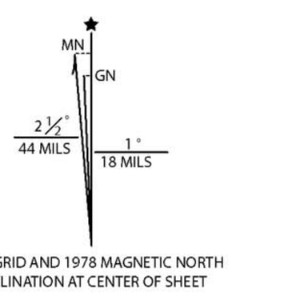
[1]Mineral percentages are based on modal analyses of selected samples.

References Cited

Keith, A., 1903, Description of the Cranberry Quadrangle: U.S. Geological Survey Atlas, Folio 90, 9 p.

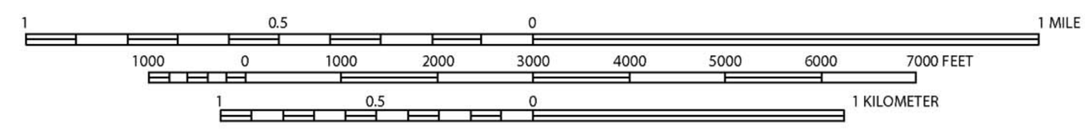
Keith, A., 1904, Description of the Asheville Quadrangle: U.S. Geological Survey Atlas, Folio 116, 10 p.

This Open-File report is preliminary and has not been reviewed for conformity with the North Carolina Geological Survey editorial standards or with the North American Stratigraphic Code. Further revisions or corrections to this preliminary map may occur prior to its release as a North Carolina Geological Survey map.



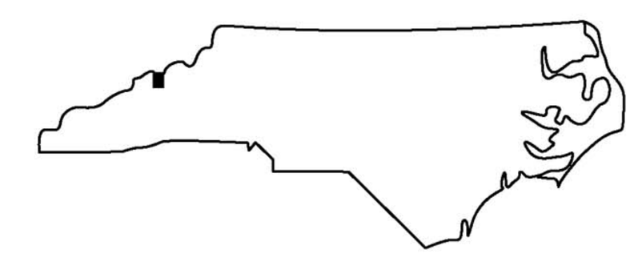
UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE APPROXIMATELY 1:24000



Contour interval 40 feet with 20 foot contours shown by broken line.
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION



BY
CARL E. MERSCHAT, MARK W. CARTER
AND LAUREN K. HEWITT
2002

Geology mapped from October 1999 – August 2000.
Map preparation and editing by Mark W. Carter, Carl Merschat and Sigrid Ballew.
Digital cartography by Mark W. Carter and Lauren K. Hewitt.

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number 99HQPA0002. 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.

MINERAL RESOURCES

- Occurrence
- Prospect
- Abandoned mine or quarry
- Inactive mining area

COMMODITY LETTER SYMBOLS:

- cs Crushed Stone
- FeS Iron Sulfides
- gt Garnet
- mag Magnetite
- mo Molybdenite
- REE Rare Earth Elements
- sc Scheelite
- sg Sand and Gravel
- si Sillimanite
- ta Talc

cs-2: Mineral resource number, referred to in accompanying Mineral Resource Summary. Commodity indicated by letter symbol.

hm34: Stream sediment heavy mineral and scintillation sample site. Sample numbers correspond to stream sediment heavy mineral analyses listed in table at lower right.

ts17: Thin section and whole rock geochemistry sample site. Sample numbers correspond to whole rock geochemical analyses listed in table below.

STRUCTURAL FEATURES

CONTACTS

Solid line - located in field to within 15 meters;
long-dashed - approximately located to within 75 meters;
short-dashed - inferred; querried where uncertain

- Thrust Fault (teeth on upper plate)
- Stratigraphic Contact

STRIKE AND DIP OF PLANAR FEATURES

Observation sites are centered on the strike bar, or are at the intersection point of multiple symbols.

- 61 Mylonitic Foliation
- Vertical Mylonitic Foliation
- 32 Foliation(s) (compositional layering parallels foliation)
- Vertical Foliation(s)
- 56 Joint
- Vertical Joint

BEARING AND PLUNGE OF LINEAR FEATURES

- 64 Lineation
- 32 Small Fold

AXES OF MAP SCALE FOLDS

- Open Antiform
- Open Synform
- Overturned Synform

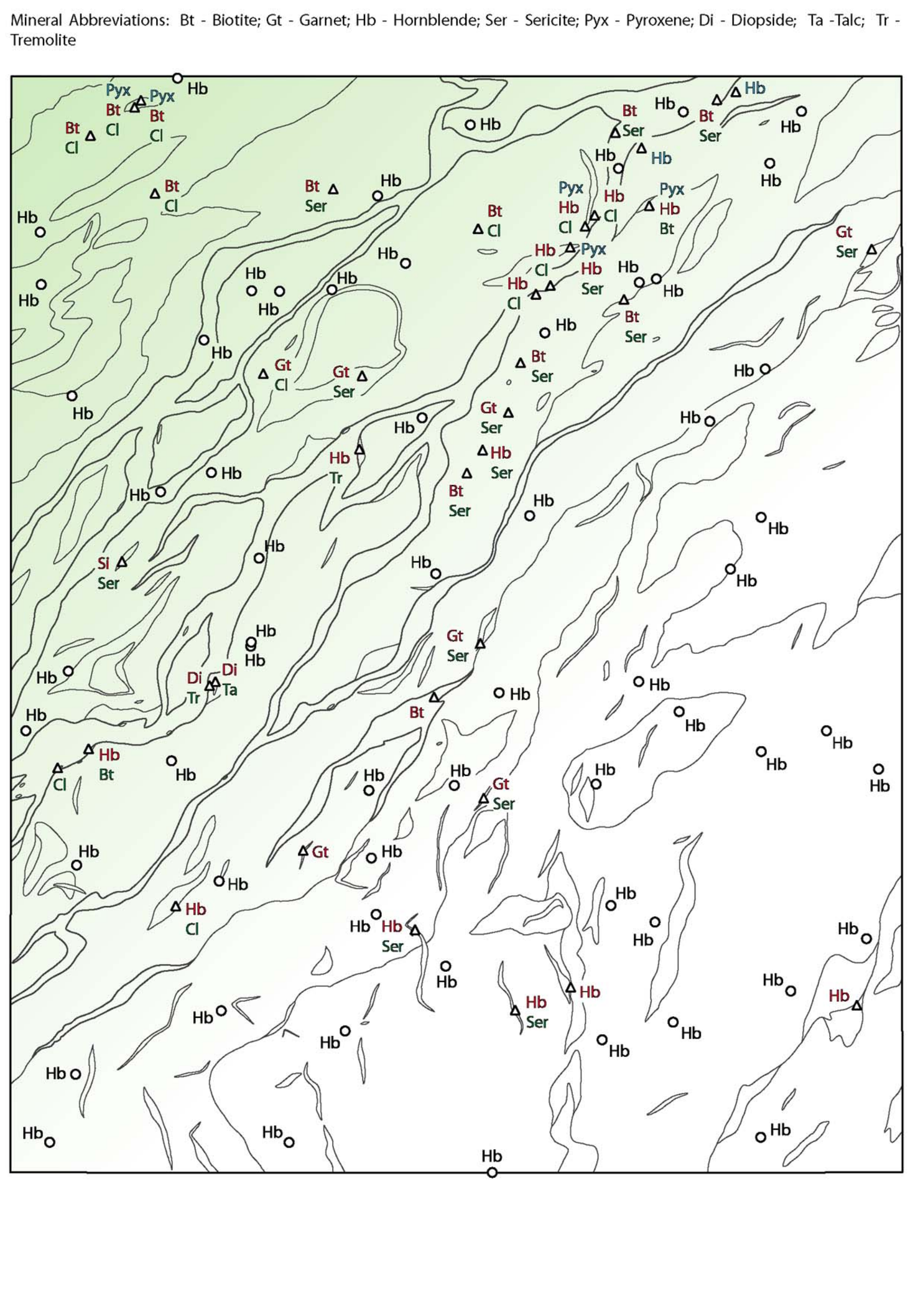
SKETCH MAP SHOWING ELEMENTS OF IGNEOUS AND METAMORPHIC CONDITIONS

Metamorphic and primary igneous mafic minerals observed in stream sediment heavy mineral samples and thin sections shown.

- Stream sediment heavy mineral sample site (sample site localities shown on geologic map)
- Thin section sample site (sample site localities shown on geologic map)
- Area of intense metamorphic retrogression (Less Intense – More Intense)

Color Designations: Red - Prograde metamorphic minerals observed in thin sections; **Black** - Prograde metamorphic minerals observed in stream sediment heavy mineral samples; **Green** - Retrograde metamorphic minerals observed in thin sections; Blue - Highest temperature primary igneous mafic mineral observed in thin section. Igneous or metamorphic origin of hornblende in stream sediment heavy mineral samples undetermined.

Mineral Abbreviations: Bt - Biotite; Gt - Garnet; Hb - Hornblende; Ser - Sericite; Pyx - Pyroxene; Di - Diopside; Ta -Talc; Tr - Tremolite



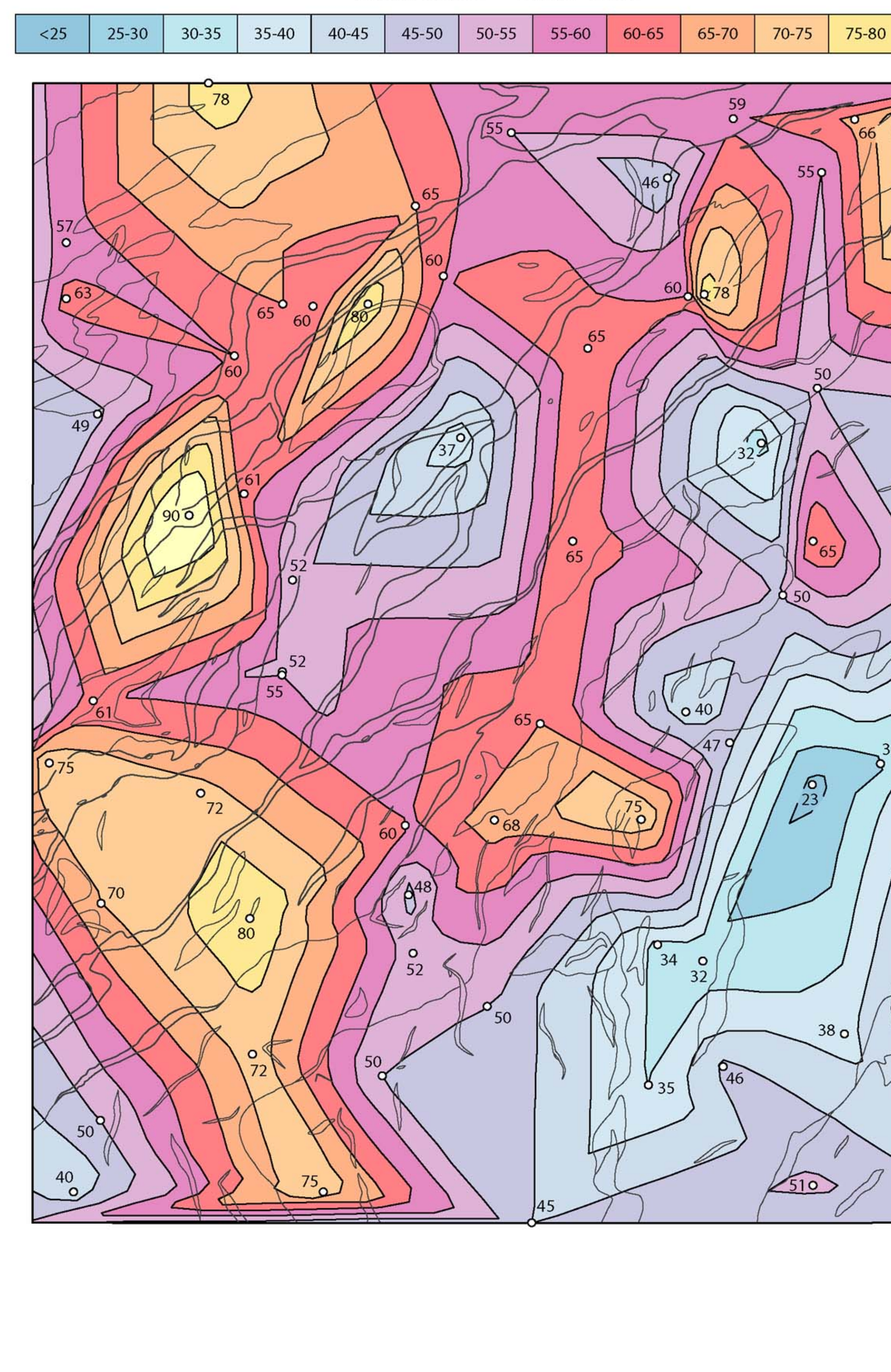
SKETCH MAP SHOWING CONTOURED SCINTILLATION READINGS

Gamma radiation readings recorded at ground level using a Mount Sopris SC-132 Scintillation Counter with a 1.5" x 1.5" sodium iodide crystal from October 1999 – December 1999. Gamma radiation results from the disintegration of Uranium[238] in radioactive oxides and soluble radioactive salts, emanation of radon gas, and cosmic radiation. Values are not corrected for background cosmic radiation or radon gas emissions. Contouring by triangulation using RockWorks99® by RockWare®.

70 Scintillation sample site and counts per second

Counts per second
Isometric interval = 5 count per second

<25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	>80



WHOLE ROCK ICP ANALYSIS[1] OF SELECTED SAMPLES

SAMPLE[2]	COORDINATES (State Plane, NAD 27, in feet)	ROCK TYPE	MAP UNIT	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cr_2O_3	Ba	Cu	Zn	Ni	Co	Sr	Zr	Ce	Y	Nb	Sc	Ta	LOI[4]	SUM[5]
				OXIDES IN PERCENT											ELEMENTS IN PPM[3]													
ts492	601,045N; 3,023,272E (TN)	granodioritic mylonite	Pzmy	76.05	10.39	3.88	1.90	0.27	2.65	2.27	0.46	0.02	0.09	0.001	557	<20	52	<20	<20	129	126	67	19	<10	8	<20	1.9	100.00
ts833	812,047N; 944,556E (NC)	biotite quartz monzonitic mylonite	Pzmy	76.85	11.25	2.56	0.12	0.74	2.80	4.19	0.17	0.02	0.03	<0.001	163	23	23	<20	<20	124	695	116	118	139	<1	<20	1.0	99.91
ts615	602,571N; 3,027,437E (TN)	quartz-rich granitiod mylonite	Pzmy	93.08	2.82	1.68	0.16	0.03	0.05	0.50	0.24	0.02	0.03	0.001	148	<20	<20	20	<20	<10	175	45	<10	<10	3	<20	1.4	100.07
ts18	594,658N; 3,020,788E (TN)	mafic mylonite	Pzmy	57.60	15.53	9.71	3.06	5.51	3.04	1.84	2.11	0.26	0.13	0.003	817	<20	57	<20	21	534	223	76	19	20	14	<20	1.0	100.01
ts18a	594,658N; 3,020,788E (TN)	amphibolitic mylonite	Pzmy	45.66	15.67	14.20	6.08	8.39	3.13	0.64	3.40	0.40	0.17	0.004	190	<20	238	47	43	272	206	75	25	27	19	<20	2.1	99.99
ts637	814,207N; 946,558E (NC)	mylonitic biotite granite	Pzlq	76.74	11.91	1.24	0.07	1.23	3.36	4.36	0.07	<0.01	0.01	<0.001	36	20	<20	<20	<20	19	312	107	125	105	<1	<20	0.9	99.99
ts658	807,776N; 946,448E (NC)	mylonitic biotite granite	Pzlq	76.00	10.82	3.58	0.06	1.05	3.87	3.67	0.14	<0.01	0.03	<0.001	81	<20	399	<20	<20	77	2321	298	564	455	<1	23	0.2	99.98
ts750	798,889N; 947,452E (NC)	mylonitic biotite monzogranite	Pzlq	72.87	13.69	1.82	0.59	1.23	2.76	5.80	0.24	0.05	0.02	0.002	1610	<20	<20	<20	<20	264	177	21	<10	<10	2	<20	0.6	99.91
ts1091	805,875N; 938,933E (NC)	mylonitic quartz monzodiorite	Pzlq	73.84	11.79	5.14	0.04	0.31	3.64	3.96	0.25	<0.01	0.06	<0.001	37	<20	357	<20	<20	16	2004	70	85	193	<1	<20	0.5	99.90
ts61	597,872N; 3,004,303E (TN)	protomylonitic granitic gneiss	Zmp	65.31	14.47	5.77	1.25	2.10	3.23	4.66	1.04	0.38	0.08	0.001	1574	<20	116	<20	<20	342	698	397	42	23	9	<20	1.3	99.98
ts403	835,836N; 931,147E (NC)	biotite granodioritic gneiss	Zmp	64.04	15.64	5.37	1.15	2.16	3.11	5.32	1.00	0.31	0.07	<0.001	2498	<20	61	<20	<20	434	583	234	37	28	8	<20	1.4	100.03
ts22	596,214N; 2,021,558E (TN)	metagabbro	Zbg	47.97	14.70	15.46	4.17	7.62	2.81	1.62	3.66	0.55	0.20	0.005	694	<20	134	41	36	479	234	62	31	17	22	<20	0.9	99.88
ts24	597,138N; 3,022,179E (TN)	metagabbro	Zbg	47.21	15.93	14.55	5.19	8.23	2.78	1.13	2.34	0.47	0.18	<0.001	387	<20	108	36	39	560	153	45	26	12	19	<20	1.7	99.88
ts348	598,076N; 3,024,786E (TN)	amphibolite	Zbg	47.15	14.36	12.79	7.12	8.81	2.84	1.41	2.60	0.44	0.19	0.045	492	<20	133	127	48	345	206	112	26	33	24	<20	1.9	99.84
ts24a	597,138N; 3,022,179E (TN)	mylonitic chloritic rock	Zbg	50.68	15.38	10.77	5.07	6.67	4.02	0.88	2.06	0.29	0.15	0.011	323	<20	71	44	31	433	162	60	24	25	17	<20	4.0	100.13
ts410	601,714N; 3,003,607E (TN)	mylonitic mafic rock	Zbg	46.58	14.33	16.49	7.13	6.68	2.38	1.11	2.73	0.51	0.20	0.008	304	<20	126	62	60	323	163	59	29	12	17	<20	1.7	99.99
ts411	601,411N; 3,003,323E (TN)	mylonitic mafic rock	Zbg	46.84	14.33	15.76	6.42	7.12	2.53	1.21	2.91	0.39	0.19	0.008	369	<20	159	60	53	453	173	43	30	10	19	<20	2.1	99.97
ts1225	809,658N; 928,868E (NC)	talc-chlorite schist	Zua	46.81	1.90	7.09	32.26	0.54	<0.01	<0.04	0.01	0.07	0.11	0.298	7	<20	56	1470	83	<10	17	<20	<10	<10	7	<20	10.5	99.83
ts349a[6]	597,849N; 3,024,050E (TN)	hornblende granite	ZYgmy	71.28	13.32	4.32	0.06	1.20	3.02	5.59	0.38	<0.01	0.08	0.002	56	<20	111	<20	<20	17	753	686	66	58	1	<20	0.4	99.88
ts76	590,607N; 3,013,142E (TN)	mylonitic granodioritic gneiss	ZYgmy	71.48	13.04	3.42	0.95	1.85	2.01	4.85	0.48	0.04	0.04	0.001	1099	<20	35	<20	<20	340	213	135	12	<10	5	<20	1.6	99.98
ts457	798,800N; 916,452E (NC)	granitic gneiss	ZYgmy	75.57	11.60	3.42	0.05	0.06	3.31	4.39	0.16	<0.01	0.02	0.001	37	<20	263	<20	<20	21	1641	205	71	214	<1	<20	1.0	99.91
ts489	600,436N; 3,024,393E (TN)	biotite-hornblende monzodiorite	ZYgmy	59.80	16.29	8.15	0.39	2.50	6.75	3.27	0.55	0.04	0.17	0.001	1708	53	620	<20	<20	172	327	155	23	122	1	21	1.7	99.99
ts605	602,901N; 3,028,212E (TN)	biotite-hornblende monzodiorite	ZYgmy	62.00	17.75	5.45	0.28	2.21	7.65	2.72	0.37	0.10	0.12	0.001	2141	23	66	67	<20	480	258	115	22	80	1	22	1.0	100.03
ts670	810,385N; 930,178E (NC)	mylonitic amphibolite	ZYa	43.33	9.47	21.04	11.87	7.98	0.67	0.30	2.24	0.41	0.25	0.002	59	<20	152	168	98	30	155	61	30	14	16	<20	2.5	100.16
ts1277	803,749N; 933,563E (NC)	mylonitic amphibolite	ZYa	48.61	15.63	14.59	4.14	7.63	3.18	1.10	3.60	0.44	0.19	0.004	384	26	153	43	38	546	183	56	38	17	21	<20	0.6	99.90
ts841	822,383N; 941,840E (NC)	amphibolite	ZYa	52.34	4.63	11.23	15.98	12.01	0.50	0.28	0.20	0.05	0.36	0.435	34	27	207	515	47	31	21	<20	30	<10	10	<20	2.0	100.14
ts1057	812,838N; 935,292E (NC)	calc-silicate granofels	ZYa	54.16	10.34	3.41	10.93	17.77	1.56	0.31	0.09	0.06	0.17	<0.001	93	<20	102	<20	<20	257	81	78	39	<10	5	<20	1.1	99.98
ts22a	596,160N; 2,021,563E (TN)	biotite granitic gneiss	Ybgmy	66.19	16.02	3.69	1.23	3.37	3.51	3.66	0.46	0.15	0.05	0.001	2360	20	<20	<20	<20	754	133	54	<10	<10	5	<20	1.3	100.02
ts44	509,574N; 3,009,060E (TN)	biotite granodioritic gneiss	Ybgmy	73.76	13.42	2.58	0.45	1.49	3.26	3.39	0.27	<0.01	0.03	0.001	1281	<20	52	<20	<20	286	129	128	<10	<10	4	<20	1.1	99.98
ts251	596,839N; 3,017,737E (TN)	biotite granodioritic gneiss	Ybgmy	66.35	13.98	4.86	1.07	2.58	3.25	4.56	1.28	0.30	0.04	0.001	1952	<20	54	<20	<20	322	1081	358	44	38	4	<20	1.2	99.94
ts440	596,612N; 3,034,054E (TN)	biotite granodiorite gneiss	Ybgmy	62.76	14.69	10.20	0.86	3.53	3.11	2.06	1.04	0.37	0.13	0.001	1306	<20	137	<20	<20	394	782	200	79	58	13	22	0.9	100.02
ts213	598,275N; 3,011,684E (TN)	mylonitic granodiorite	Ybgmy	81.99	8.92	2.12	0.88	0.02	0.08	3.24	0.34	0.01	0.01	<0.001	377	<20	<20	<20	<20	13	135	40	<10	<10	3	<20	2.2	99.88
ts25	597,570N; 3,022,527E (TN)	mylonitic mafic rock	Ybgmy	47.54	15.62	13.75	5.17	7.44	3.01	1.07	2.86	0.40	0.19	<0.001	364	<20	86	40	36	526	134	41	25	15	18	<20	2.8	100.01
ts1066	799,804N; 949,798E (NC)	mylonitic biotite tonalite	Ybgg	75.66	11.49	4.09	0.17	2.01	4.73	0.41	0.17	<0.01	0.03	<0.001	61	<20	200	<20	<20	246	1879	176	266	249	<1	<20	0.8	99.97
ts3	587,688N; 3,018,246E (TN)	bioite granitic gneiss	Ybggmy	77.15	11.48	1.64	0.07	1.17	2.96	4.41	0.15	0.01	0.02	0.003	54	<20	84	27	<20	21	589	170	138	105	<1	<20	0.8	100.02
ts12	591,361N; 3,019,715E (TN)	bioite granitic gneiss	Ybggmy	74.47	13.61	1.63	0.52	0.69	3.32	4.85	0.21	0.04	0.02	0.004	854	<20	<20	27	<20	142	349	105	<10	<10	2	<20	0.5	100.04
ts7a	589,282N; 3,019,248E (TN)	biotite tonalite gneiss	Ybggmy	70.60	11.23	7.86	1.79	1.88	2.07	2.48	0.54	0.22	0.32	0.006	458	21	73	64	<20	189	165	57	76	<10	20	<20	0.9	100.03
ts1793	821,290N; 946,276E (NC)	biotite tonalite gneiss	Ybggmy	69.09	14.83	4.17	1.69	1.33	4.77	2.33	0.36	0.15	0.07	0.006	582	<20	20	<20	<20	221	116	54	18	16	7	<20	1.0	99.92
ts7	589,282N; 3,019,248E (TN)	biotite schist	Ybggmy	59.71	18.43	7.74	2.50	1.01	1.26	5.78	0.98	0.15	0.11	0.020	1248	<20	82	55	<20	114	125	86	35	<10	20	<20	2.1	100.00
ts3a	587,688N; 3,018,246E (TN)	retrograded amphibolite	Ybggmy	45.40	15.35	14.62	6.23	8.54	2.34	1.96	2.87	0.42	0.20	0.001	246	23	275	65	52	409	141	43	20	12	20	<20	1.9	99.99
ts17	594,217N; 3,020,240E (TN)	retrograded amphibolite	Ybggmy	49.26	13.69	16.22	4.38	8.10	2.99	1.01	2.81	0.37	0.33	0.002	336	51	147	<20	34	274	91	55	42	22	40	<20	0.8	100.10
ts750a	798,889N; 947,452E (NC)	mylonitic biotite amphibolite	Ya	48.58	15.22	14.51	5.47	9.06	2.75	0.55	2.95	0.49	0.20	0.005	93	<20	137	53	40	356	171	42	33	14	22	<20	0.4	100.31
ts760	802,435N; 943,402E (NC)	amphibolite	Ya	50.19	14.26	13.74	4.88	7.69	2.99	1.16	3.60	0.48	0.19	0.003	663	<20	110	25	41	423	239	62	37	18	23	<20	0.6	99.98
ts1640	798,644N; 961,610E (NC)	amphibolite	Ya	51.77	13.94	12.01	7.91	11.33	1.01	0.29	0.33	0.06	0.19	0.033	50	107	50	93	42	40	<10	<20	11	<10	46	<20	1.0	99.93
ts710	818,108N; 931,856E (NC)	sillimanite-garnet granitic gneiss	Ygf	52.53	20.87	14.89	3.88	0.34	0.44	3.18	1.75	0.04	0.22	0.025	843	41	178	<20	23	62	335	113	76	26	40	<20	1.6	99.98
ts1058	813,025N; 935,467E (NC)	siliceous marble	Ymb	35.79	3.64	2.63	7.29	30.94	0.36	1.96	0.16	0.07	0.25	<0.001	2654	<20	54	<20	<20	91	60	44	12	11	2	<20	16.6	100.02

[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
[6]Sample taken from a colluvial boulder at these coordinates

STREAM SEDIMENT HEAVY MINERAL ANALYSIS

Stream sediment heavy mineral analysis was conducted from October 1999 – December 1999 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 (scintillation data are also collected at the sample site). 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-voilet Products Inc. Model UVGL-48 Mineralight Lamp. Magnetite is removed with an alnico 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: Mag-magnetite; Ilm-ilmenite and other black opaque minerals; Hb-hornblende; Zr-zircon; Ep-epidote group minerals; Lcx-leucoxene; Hem-hematite and other red opaque minerals; Gt-garnet; Spn-sphene; Und-unidentified; Dp- diopside; Rt-rutile.

SAMPLE[1]	COORDINATES (State Plane, NAD 27, in feet)	MAP UNITS DRAINED[2]	%HM IN SAMPLE[3]	Mag	Ilm	Hb	Zr	Ep	Lcx	Hem	Gt	Sp	Und	Dp	Rt
				PERCENT HEAVY MINERALS IN SAMPLE[4]											
hm1	594,198N; 3,011,798E (TN)	ZYg, ZYgmy, Ybgmy	1.17	32.66	37.37	4.38	1.01	1.01	5.39	0.67	17.17	–	–	–	–
hm2	594,052N; 3,009,611E (TN)	Ybgmy, Pzmy, ZYgmy	0.51	5.17	39.35	16.12	3.79	9.01	9.96	3.79	11.85	0.95	–	–	–
hm3	602,256N; 3,030,973E (TN)	ZYgmy, ZYg, Pzmy	1.49	9.17	24.98	16.80	2.72	37.69	5.00	0.91	1.36	0.91	–	–	–
hm4[5]	602,106N; 3,026,083E (TN)	Pzmy	0.68	14.22	42.89	11.58	3.43	5.58	13.72	0.43	8.15	–	–	–	–
hm5[5]	831,996N; 929,040E (NC)	Zmp, Ybgmy, Zm	5.90	58.11	20.11	2.93	2.30	2.72	12.15	1.05	–	0.63	–	–	–
hm6[5]	825,146N; 930,039E (NC)	Ybgmy, Zmp	1.12	21.84	26.57	trace	4.30	6.25	16.02	–	24.62	0.39	trace	–	–
hm7[5]	829,815N; 928,958E (NC)	Zmp, Zm, Ybgmy	6.03	67.17	16.91	1.97	2.95	2.79	7.55	0.33	0.33	–	–	–	–
hm8[5]	602,767N; 3,005,084E (TN)	Zmp, Ybgmy, Zbg	2.82	16.67	50.42	5.00	2.92	3.33	20.83	0.83	–	–	–	–	–
hm9[5]	591,927N; 3,006,554E (TN)	Pzmy, Ybgmy	0.75	1.87	33.36	19.14	5.40	9.81	26.50	1.96	0.49	1.47	–	–	–
hm10	594,042N; 3,008,462E (TN)	Zmp, Ybgmy, Pzmy	0.65	19.27	27.04	2.83	10.90	8.88	27.04	2.83	1.21	–	–	–	–
hm11	595,387N; 3,014,800E (TN)	Ybgmy, ZYg, ZYgmy	2.21	13.22	39.05	13.45	2.60	6.51	9.98	3.04	11.28	0.43	–	–	–
hm12	598,153N; 3,013,573E (TN)	Ybgmy, Zmp	0.81	8.52	40.25	3.20	9.15	6.86	22.87	7.78	1.37	–	–	–	–
hm13	601,221N; 3,017,283E (TN)	Ybgmy, Pzmy	0.77	12.09	29.45	1.76	1.76	7.91	32.97	11.43	2.64	trace	–	–	–
hm14[5]	592,686N; 3,020,616E (TN)	Ybgmy, ZYgmy	1.93	2.14	38.66	36.21	0.98	8.81	0.98	2.45	8.32	0.98	–	–	–
hm15	600,097N; 3,029,731E (TN)	ZYgmy, ZYg, Ybgmy	1.51	11.48	15.93	46.03	2.21	17.70	1.33	2.21	1.33	1.77	–	–	trace
hm16	594,934N; 3,024,516E (TN)	Ybggmy, ZYgmy	0.98	0.77	34.73	41.18	1.98	15.38	1.49	3.97	0.50	–	–	–	–
hm17	589,013N; 3,015,709E (TN)	Ybgmy, Pzmy, Ybggmy	1.40	16.00	49.56	14.28	1.68	10.08	5.46	2.10	0.84	–	trace	–	–
hm18	595,097N; 3,025,192E (TN)	ZYgmy, Ybgmy, Pzmy	0.99	27.20	18.20	6.19	13.10	30.94	1.09	1.46	1.46	0.36	–	–	–
hm19	823,140N; 956,418E (NC)	Ybgmy, ZYgmy, Pzmy	1.05	9.18	27.70	33.60	9.08	14.98	2.72	2.27	0.45	trace	trace	–	–
hm20	808,457N; 962,862E (NC)	Ybgg	0.83	3.05	31.51	9.21	20.36	29.08	2.42	0.97	3.39	–	–	–	–
hm21	809,396N; 958,033E (NC)	Ybgg, Ybg	4.16	6.08	52.60	23.48	10.80	6.10	0.94	–	–	–	–	–	–
hm22	808,227N; 951,164E (NC)	Ybgg, Ybg, Pzlq	0.65	9.70	37.02	9.48	7.68	35.22	0.45	0.45	trace	trace	trace	–	–
hm23	819,474N; 948,820E (NC)	Ybgmy, Ybggmy, Pzmy	0.43	12.50	42.00	15.31	9.19	13.56	3.50	3.50	0.44	–	–	–	–
hm24	812,458N; 953,099E (NC)	Ybgg, Pzlq, Ya	1.10	7.23	39.43	17.63	5.10	26.44	1.86	2.32	–	–	–	–	–
hm25	811,163N; 954,723E (NC)	Ybg, Ybgg	1.48	10.17	38.18	12.58	12.58	22.01	1.80	0.90	0.45	1.35	–	–	–
hm26	801,450N; 962,150E (NC)	Ybhg, Ybgg, Ybhgg	1.52	2.83	22.83	50.53	2.43	16.03	0.97	2.43	1.94	–	–	–	–
hm27	819,059N; 958,386E (NC)	Ybg	3.21	11.97	25.97	40.93	4.84	16.29	–	–	0.44	0.44	–	–	–
hm28	799,415N; 935,301E (NC)	Ybg, Pzlq	0.89	56.08	6.59	9.66	1.54	23.49	0.22	1.98	–	0.44	–	–	–
hm29	796,988N; 929,143E (NC)	Ybg, Pzmy, Ybgmy	2.15	7.37	25.94	31.49	4.63	27.33	1.39	1.39	–	0.46	trace	–	–
hm30	794,207N; 927,985E (NC)	Ybg, ZYa	4.09	6.25	74.53	5.16	3.28	9.38	0.94	–	0.47	–	–	–	–
hm31	793,852N; 937,911E (NC)	Ybgg, Ya	1.33	21.21	16.15	35.85	3.94	19.30	1.18	2.76	–	0.39	–	–	–
hm32	792,280N; 946,196E (NC)	Ybgg	2.47	11.07	52.91	25.34	2.67	6.67	0.44	1.33	–	–	–	–	–
hm33	811,308N; 927,611E (NC)	Ybgmy, Pzmy	2.56	5.69	54.23	26.88	0.94	8.96	1.41	0.94	0.94	–	trace	–	–
hm34	809,860N; 933,625E (NC)	Ybgmy, Pzmy	0.50	0.73	34.25	20.35	6.95	25.81	4.96	3.47	0.99	2.48	–	–	–
hm35	599,651N; 3,023,507E (TN)	ZYgmy, Ybggmy, Pzmy	1.08	5.31	54.45	9.94	9.47	9.94	8.05	1.89	0.47	0.47	trace	–	–
hm36	816,980N; 957,068E (NC)	Ybg	0.27	11.90	14.54	17.62	5.29	45.37	1.32	3.08	0.88	trace	–	–	–
hm37	799,363N; 958,928E (NC)	Ybgg	6.02	2.46	2.93	81.93	5.36	6.34	–	0.49	0.49	trace	–	–	–
hm38	813,736N; 929,457E (NC)	Ybgmy, Pzmy, ZYa	2.26	16.71	61.22	9.58	3.33	5.41	2.92	0.83	trace	–	–	–	–
hm39	821,752N; 935,710E (NC)	Ybgmy, Pzmy	1.70	3.66	66.47	3.37	2.89	3.85	8.67	5.30	5.78	–	trace	–	–
hm40	814,501N; 937,054E (NC)	Ybgmy	2.23	6.82	50.32	19.10	2.33	8.85	7.92	2.80	1.86	–	–	–	–
hm41[5]	818,156N; 937,543E (NC)	Ybgmy, Pzmy, ZYa	2.54	9.55	48.84	24.87	0.45	7.24	4.97	1.36	2.71	–	trace	–	–
hm42	805,647N; 929,519E (NC)	ZYgg, Ybgmy, ZYa	4.88	29.12	47.85	12.05	1.06	1.42	3.19	4.61	0.71	–	trace	–	–
hm43	814,641N; 937,096E (NC)	Ybgmy	3.82	1.03	46.02	32.16	0.99	4.95	11.38	2.97	0.49	–	–	–	–
hm44	804,785N; 935,414E (NC)	Ybg, Ybgmy, Pzlq	2.55	48.90	13.03	13.03	2.55	16.35	2.55	2.30	1.02	0.26	–	–	–
hm45[5]	798,376N; 940,380E (NC)	Ybgg, Pzlq, Zua	3.97	4.27	44.51	36.85	1.91	8.14	1.91	1.91	–	–	–	–	–
hm46	803,188N; 941,854E (NC)	Ybg, Pzlq, Ya	3.21	3.27	43.53	27.09	1.45	6.77	6.29	4.84	6.29	–	–	–	–
hm47	810,149N; 960,772E (NC)	Ybgg, Pzlq	7.20	27.52	37.69	10.87	8.34	11.96	2.17	0.36	0.36	0.72	–	–	–
hm48[5]	821,007N; 933,545E (NC)	Ybgmy, Pzmy, ZYa	1.95	3.16	34.38	30.51	5.33	12.59	11.14	2.42	0.48	–	trace	–	–
hm49	805,527N; 941,754E (NC)	Ybg, Ybgmy, Pzlq	3.34	16.20	35.20	21.37	8.32	12.15	2.09	0.42	–	–	–	–	–
hm50	817,223N; 944,837E (NC)	Ybggmy	0.18	12.82	16.13	6.10	23.10	31.82	2.18	3.92	3.49	–	–	–	–
hm51	812,177N; 947,271E (NC)	Ybg, Pzlq, Pzmy	0.53	17.86	13.14	6.57	6.16	47.64	3.29	3.29	0.41	0.41	–	–	–
hm52	808,384N; 945,283E (NC)	Ybgg, Ybg, Pzmy	1.74	22.15	18.30	20.24	7.79	54.52	1.56	3.11	–	0.39	–	–	–
hm53	808,323N; 941,751E (NC)	Ybgmy, Pzmy, Ybg	7.08	46.83	23.39	16.22	2.39	6.65	2.39	1.86	–	–	–	–	–
hm54[5]	825,217N; 958,800E (NC)	Ybgmy, Pzlq, Ya	0.67	1.61	20.17	10.82	20.66	37.39	5.90	2.95	–	0.49	trace	trace	–
hm55	800,934N; 944,667E (NC)	Ybgg, Pzlq	0.89	7.33	30.58	11.12	9.27	34.75	2.78	3.71	0.46	–	–	–	–
hm56	803,165N; 951,605E (NC)	Ybgg	1.63	8.47	28.37	11.44	8.69	39.36	2.29	1.37	–	–	trace	–	–
hm57	802,449N; 953,408E (NC)	Ybgg, Ybggmy	1.98	3.83	14.91	35.10	7.69	35.58	1.92	0.96	–	–	trace	–	–
hm58	798,255N; 954,016E (NC)	Ybgg, Ybggmy	0.89	9.18	10.90	13.17	10.44	52.67	1.82	1.82	–	–	–	–	–
hm59	793,360N; 957,464E (NC)	Ybhg, Ya	1.50	6.14	17.83	35.20	5.63	28.16	1.88	1.88	2.35	0.94	trace	–	–
hm60	797,611N; 951,027E (NC)	Ybgg	2.34	7.64	11.54	41.56	1.39	36.48	0.92	0.46	–	–	–	trace	–

[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 percentage of heavy minerals in heavy liquid separate
[5]Samples in which scheelite was observed with short-wave ultraviolet illumination

CROSS SECTION A-A'