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

NORTH CAROLINA GEOLOGICAL SURVEY

Base topographic map by USGS–TVA 1941
10,000-foot grid based on North Carolina rectangular coordinate system

SCALE 1:24 000

1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MN
3° 21'
1993 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Quadrangle location

Geology mapped 1977–1980.
Release date July, 1998.

Geologic Map of the Topton Quadrangle, North Carolina

by
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1998

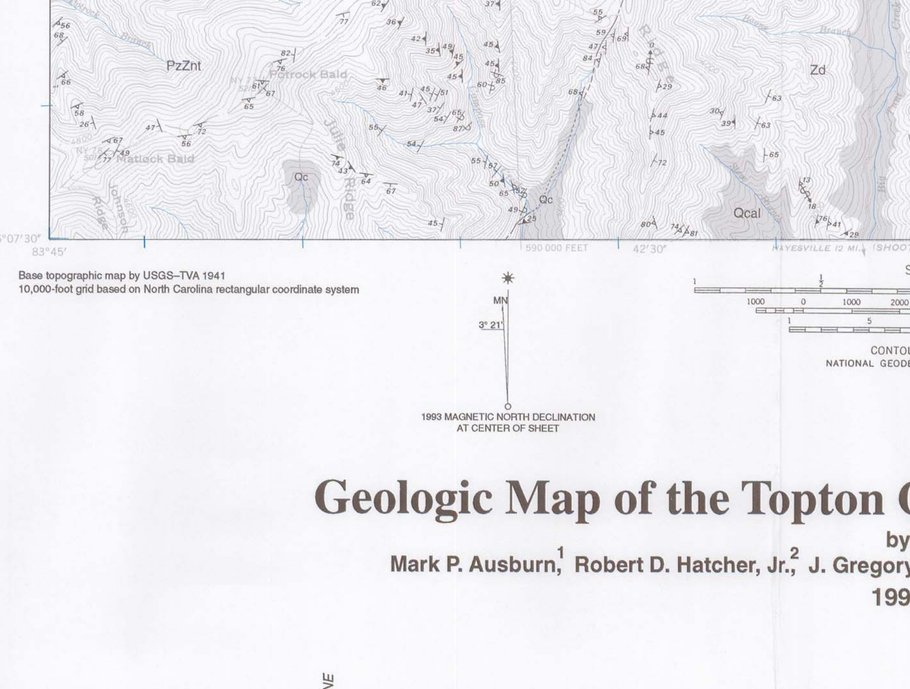

Figure 1. Distribution of metamorphic isograds in the Topton quadrangle.

Figure 2. Along-strike facies relationships among Ammons Formation units. Thicknesses in feet.

MAP UNITS

SURFICIAL DEPOSITS

Quaternary

- Qr — Deltaic Deposits in Nantahala Reservoir
- Qcal — Alluvium and Colluvium, undivided
- Qal — Alluvium
- Qc — Colluvium

Unconformity

MURPHY BELT ROCKS[7, 8]

Late Proterozoic or early Paleozoic

- PzZmb — Mineral Bluff Formation
- PzZn — Nottely Quartzite
- PzZmma — Andrews Formation and Murphy Marble, undivided
- PzZbt / PzZbts — Brasstown Formation, ZPbts–graphite-bearing
- PzZnt — Nantahala Formation

GREAT SMOKY GROUP

Late Proterozoic

- Zd — Dean Formation
- Za — Ammons Formation, undivided
- Zahb — Horse Branch Member
- Zags — Cross-biotite schist unit
- Zams — Phyllite-metagraywacke unit
- Zacb — Metasandstone-schist unit
- Zwe — Wehutty Formation
- Zch — Copperhill Formation

ROCKS OF THE HAYESVILLE THRUST SHEET

Middle or Late Proterozoic

- bgs — Biotite gneiss and schist

DESCRIPTION OF MAP UNITS[6]

SURFICIAL DEPOSITS

DELTAIC DEPOSITS IN NANTAHALA RESERVOIR—Unconsolidated crudely stratified and sorted clay, silt, sand, pebbles, cobbles, and boulders. Feeder streams carry material into Nantahala Reservoir and significant deposits, particularly in the upper reaches of the reservoir, have accumulated, and are exposed at low water.

ALLUVIUM AND COLLUVIUM, UNDIVIDED—Variably sorted deposits of unconsolidated clay, silt, sand, pebbles, cobbles, and boulders present in stream valleys and on hill slopes.

ALLUVIUM—Variably sorted deposits of unconsolidated clay, silt, sand, pebbles, cobbles, and boulders present in stream valleys.

COLLUVIUM—Hillslope deposits of unconsolidated clay, silt, sand, pebbles, cobbles, and boulders; grades into alluvium where present in floodplains.

MURPHY BELT ROCKS[7, 8]

MINERAL BLUFF FORMATION—Gray to greenish-gray muscovite-chlorite (or biotite) schist (or phyllite) and cross-biotite schist interlayered with metasandstone and metasiltstone. Schist layers range up to 0.5 m thick; metasandstone and metasiltstone layers range up to 15 cm thick. Minor rock types include calcsilicate granofels, quartzite, and feldspathic metasandstone. Garnet + staurolite may be present. The Mineral Bluff Formation is at least 400 m thick; the original total thickness is indeterminate because the top of the unit is not present.

NOTTELY QUARTZITE—Tan to white, thinly bedded quartzose metasandstone and interlayered muscovite schist. The metasandstone is locally micaceous and feldspathic, and is estimated to be 20-25 m thick (scaled from section E-E' of Van Horn, 1948).

ANDREWS FORMATION—Alternating layers of white to gray impure marble and gray, fine-grained cross-biotite schist with some calcareous schist. Based on Van Horn's (1948) outcrop width and his few dip determinations, the Andrews ranges in thickness from about 18 or 20 m up to 175 m at the west edge of the quadrangle. Hematite and limonite are locally abundant as lenses and concretions in residuum and soil derived from this unit (Van Horn, 1948).

MURPHY MARBLE—Impure calcitic to dolomitic marble, white calcareous quartzite, commonly leached at rare exposures, and calcareous schist; thickness varies from as little as 8 m to as much as 40 m thick in the Topton quadrangle (Van Horn, 1948).

BRASSTOWN FORMATION—Gray to light brown cross-biotite and garnet-bearing phyllite to fine-grained schist dominate and are interbedded with metasandstone, metasiltstone, and feldspathic metasandstone. Less abundant are calc-silicate granofels (pseudodiorite) and phyllite (either muscovite-rich, biotite-rich, or chlorite-rich); graphitic phyllite to metasiltstone is sparingly present. A 100 m-thick section of chloritic phyllite is present at an exposure of the top of the unit at Red Marble Gap directly beneath the Murphy Marble. Otherwise, the uppermost 330 to 660 m consists dominantly of porphyroblastic muscovite phyllite interbedded with lesser amounts of metasandstone, quartzose metasandstone, and metasiltstone. Beds of metasiltstone,metasandstone, and quartzose metasandstone increase in abundance downward in the unit and culminate in a 300 m-thick section of metasandstone and quartzose metasandstone from about 1000 to 700 m above the base of the unit. This section is resistant and forms part of the crest of the Snowbird Mountains. Beneath this coarser clastic unit is porphyroblastic phyllite interbedded with subequal amounts of metasandstone and metasiltstone. Also present in the lowest 1000 m are thin, discontinuous graphitic layers (PzZbts).

Phyllite is typically muscovite-rich and contains biotite and garnet porphyroblasts. Most phyllite contains relic silt-size grains and locally grades to metasiltstone. Opaque minerals include magnetite and finely disseminated graphite and pyrite or pyrrhotite, commonly coloring the phyllite the characteristic gray to dark gray. Phyllite typically exhibits fine laminations defined by alternating silty micaceous layers and graphite/pyrite- or pyrrhotite-rich layers. Two modal analyses of phyllite yielded an average of: muscovite 43.2%, quartz 31.7%, biotite 10.9%, plagioclase 6.6%, garnet 4.4%, opaque minerals 2.5%, chlorite 0.4%, tourmaline 0.2%, and apatite tr.

Metasandstone and metasiltstone are commonly micaceous, fine grained and well sorted, with thin and very even compositional layers. Compositions range from subgraywacke to graywacke. Muscovite is the most abundant mica, though biotite may occur in subequal amounts. Small garnet porphyroblasts are common in the more micaceous metasiltstone. Average modal analyses of metasandstone is: quartz 52.1%, plagioclase 18.9%, muscovite 18.4%, biotite 8.2%, apatite 0.1%, sphene 0.1%, opaque minerals (mostly hematite) 2.0%, and traces of tourmaline, epidote, and zircon. Thickness of the Brasstown Formation is estimated to be 1000 to 1300 m, although total thickness is uncertain because of pervasive internal deformation. Metasandstone and metasiltstone are commonly micaceous, fine grained and well sorted, with thin and very even compositional layers. Compositions range from subgraywacke to graywacke. Muscovite is the most abundant mica, though biotite may occur in subequal amounts. Small garnet porphyroblasts are common in the more micaceous metasiltstone. Average modal analyses of metasandstone is: quartz 52.1%, plagioclase 18.9%, muscovite18.4%, biotite 8.2%, apatite 0.1%, sphene 0.1%, opaque minerals (mostly hematite) 2.0%, and traces of tourmaline, epidote, and zircon. Thickness of the Brasstown Formation is estimated to be 1000 to 1300 m, although total thickness is uncertain because of pervasive internal deformation.

NANTAHALA FORMATION — Medium to dark gray graphitic and sulfidic phyllite, schist, and metasiltstone interbedded with subordinate to subequal amounts of quartzose metasandstone. The unit coarsens and becomes less well sorted downward. Maximum thickness is about 2500 m. The upper 1000 m consists principally of graphitic phyllite with thinner interbeds of graphitic metasiltstone and subordinate quartzose metasandstone. Graphitic phyllite becomes more silty down section where it grades to graphite-bearing micaceous metasiltstone. The basal 1500 m consists principally of graphitic metasiltstone interlayered with quartzose metasandstone and graphitic phyllite.

Graphitic phyllite is permeated by finely disseminated graphite and iron-sulfide minerals producing a characteristic dark gray to black color. Graphitic micaceous metasiltstone contains fine-grained quartz and plagioclase in a dominantly muscovite groundmass. Two modal analyses of fine-grained graphitic rocks yielded an average composition of: quartz 32.3%, muscovite 25.6%, opaque minerals (includes graphite and iron sulfides) 19.8%, biotite 13.5%, plagioclase 8.2%, chlorite 0.2%, tourmaline 0.2%, epidote 0.1%, and sphene tr. Graphite occurs mostly as dense, finely disseminated clots interstitial to clastic grains. Small garnet and biotite porphyroblasts occur in graphitic phyllites near the base of the formation.

White quartzose metasandstone commonly occurs interbedded with the graphitic metasiltstone producing a distinctive "zebra-striped" appearance. The quartz-rich interlayers and sequences range from a few meters to over 300 m in thickness and are distinctive, almost traceable layers in many areas. The quartzose metasandstone is typically white, fine-grained, well-sorted, and micaceous. Modal analysis of a representative metasandstone is: quartz 77%, plagioclase 4.7%, muscovite 15.5%, opaque minerals 2.4%, microcline 0.2%, biotite 0.2%, apatite 0.1%, and epidote tr. The most prominent metasandstone sequences occur near the base of the unit. Where mapped separately, white quartzose metasandstone at approximately this stratigraphic position is called the Tusquittee Quartzite (Keith, 1907). Individual metasandstone sequences commonly contain thin, wavy, graphitic partings and laminations that are thicker and more abundant toward the upper and lower contacts. Laminations commonly define delicate ripple cross laminations and ripple–drift structures. Low-angle planar cross bedding is occasionally observed in cleaner metasandstone layers. Compositional layering (transposed bedding) is easily observed in the more silty and quartzitic rocks whereas deformational structures are dominant in the phyllitic and schistose rocks.

GREAT SMOKY GROUP

DEAN FORMATION—The Dean Formation is a generally fining-upward metaclastic sequence. Light gray to tan phyllite with conspicuous biotite porphyroblasts ("cross-biotite schist") is a characteristic rock type in the upper part of the formation. The lower portion consists mostly of repetitive layers of thick sequences of interbedded gray to tan metasandstone and pebble metaconglomerate interlayered with thinner layers of schist and phyllite. Phyllite dominates in the upper portion of the unit and occurs in thick sequences with thinner interbeds of metasandstone and metaconglomerate. Feldspathic metasandstone and calc-silicate granofels occur in thin layers and lenses throughout. Graphitic phyllite is also present, occurring as discontinuous thin beds, lenses, and pods intermittently throughout the unit, but more abundantly toward the top. The top of the unit consists of a 6- to 10-m-thick layer of massively bedded quartzose metasandstone. In a few places, the Dean-Nantahala boundary is gradational over a stratigraphic interval of up to 160 m that is marked by gradual decrease in the size and abundance of biotite porphyroblasts, and a concomitant increase in graphite content upward into the Nantahala. The Dean-Nantahala contact was mapped at the base of the first laterally continuous, distinctive graphitic unit going up section.

Phyllite within the Dean Formation ranges from from highly micaceous to silty. Micaceous phyllite commonly contains large well-developed porphyroblasts, is indistinctly bedded, and breaks along well-developed foliation planes. Silty phyllite is commonly laminated, contains no porphyroblasts in places and many in others, and is strongly foliated.

Biotite and garnet porphyroblasts occur in all but the most silty schist and phyllite. Staurolite porphyroblasts up to 5 cm occur in aluminous horizons east of the staurolite isograd. They are typically poikiloblastic, commonly twinned, and may contain inclusions of previously formed garnet and biotite porphyroblasts, as well as quartz and feldspar grains. The matrix of the schist and phyllite is almost entirely muscovite, except in the garnet zone where chlorite may occur in amounts subequal to muscovite. Chlorite also replaces biotite and forms reaction rims around garnet and staurolite. Modal analyses of three phyllite samples average: muscovite 60.7%, biotite 14.2%, quartz 13.8%, plagioclase 3.4%, opaque minerals (hematite, magnetite, graphite) 3.1%, chlorite 2.6%, garnet 1.3%, staurolite 0.3%, tourmaline 0.3%, epidote 0.2%, and apatite 0.1%.

Metasandstone, typically coarse grained, and metaconglomerate are commonly poorly sorted. Most metaconglomerate is matrix-supported with well-rounded quartz and plagioclase pebbles (some quartz is blue) and forms graded beds up to 2 m thick. Compositionally, most of the metasandstone is subgraywacke to graywacke. Detrital grains mostly preserve their original shape, although internally they consist of smaller recrystallized polygonal grains. Plagioclase is commonly twinned and exhibits little compositional variation outside the range An_{25} to An_{30}. The metasandstone groundmass is commonly biotite rich, weakly recrystallized, and well foliated. Three modal analyses of metasandstone yielded the following average composition: quartz 52.8%, muscovite 16.2%, plagioclase 15.8%, biotite 11.2%, opaque minerals (magnetite dominant) 2.1%, chlorite 2.0%, zircon 0.1%, and traces of apatite, allanite, and sphene.

The thickness ranges from 1100-1300 m, except in the northern part of the quadrangle where it decreases to approximately 450 m.

Ammons Formation

Ammons Formation, undivided—In the southern part of the quadrangle, Ammons Formation strata beneath the Horse Branch Member could not be subdivided into mappable units.

Horse Branch Member—Composed principally of gray to tan interlayered graphitic and nongraphitic metasiltstone, phyllite, and schist; porphyroblastic schist and phyllite; and graphitic to nongraphitic metaconglomerate and fine-grained metagraywacke. Minor rock types include feldspathic quartzose metasandstone, calc-silicate granofels, and tourmaline-bearing cross-biotite schist. Beds range from 0.5 to 3 m in thickness, but commonly are 0.5 to l m. Although graphitic layers comprise no more than one-fourth of the Horse Branch, they are present throughout and distinguish this member from adjacent units. Graphitic layers are interbedded with thickly bedded nongraphitic phyllite and thinly bedded metasiltstone and metasandstone and range from 0.5 to 3 m thick, but may thicken to 10 m in the thicker portions of the unit.

Groundmass in phyllitic and schistose rocks is predominantly muscovite. Quartz is the dominant detrital component; plagioclase is a less abundant detrital and also occasionally occurs as porphyroblasts. Biotite and garnet porphyroblasts up to one centimeter occur in graphitic phyllite. Graphite is the dominant opaque mineral and occurs as finely disseminated grains or irregularly shaped masses interstitial to detrital grains, commonly concentrated along strongly transposed layers. Where the unit is thinnest in the southern part of the quadrangle, graphite is restricted to phyllite and metasiltstone layers. Modal analysis of two graphitic phyllite samples from the Horse Branch Member yielded the following average composition: muscovite 61.3%, quartz 16.2%, opaque minerals (including graphite) 9.4%, biotite 6.5%, plagioclase 4.8%, chlorite 1.4%, tourmaline 0.2%, epidote 0.2%, zircon tr., and apatite tr.

Metasandstone is similar both texturally and compositionally to the underlying phyllite-metagraywacke unit. Modal analysis of a representative metasandstone sample from the Horse Branch Member yielded the following: quartz 47.3%, plagioclase 31.3%, biotite 12.9%, opaque minerals 2.8%, garnet 3.5%, chlorite 1.5%, muscovite 0.6%, scapolite 0.2%, and epidote tr.

The thickness of this unit varies considerably ranging from 1300 down to 330 m as it thins rapidly toward the southern part of the quadrangle.

Phyllite-metagraywacke unit — Gray to tan laminated phyllite and fine-grained schist interbedded with lesser amounts of metagraywacke. Laminations in phyllite and schist are defined by alternating micaceous and silty layers or by alternating biotite-rich and muscovite-rich layers. Thick sequences of light-red-dish-brown muscovite-biotite phyllite dominate this unit. Less abundant, but also present throughout, is thinly bedded, silty, light-gray phyllite to micaceous metasiltstone. Dark-reddish-brown to nearly black fine-grained porphyroblastic schist is present near the base of the unit and is interbedded with thinner layers of non-porphyroblastic phyllite and metasandstone. Porphyroblasts are principally biotite and garnet. Thin beds of feldspathic quartzose metasandstone occur sparingly throughout the unit and thin beds of tourmaline-quartz schist are also sparingly present. Near the top of the unit are thin, discontinuous beds of variably graphitic phyllite. Modal analyses of two representative phyllite and schist samples are: muscovite 67.5%, biotite 14.5%, quartz 14.3%, opaque minerals (mostly iron-oxide minerals and minor graphite) 2.7%,plagioclase 0.3%, garnet 0.3%, apatite 0.2%, tourmaline 0.1%, chlorite 0.1%, scapolite tr., and zircon tr.

Metagraywacke is light gray to rusty dark gray, fine- to coarse-grained, and commonly poorly sorted. Metagraywacke occurs in lenticular beds ranging from a few tens of centimeters to several meters thick. This metagraywacke is generally coarser and more poorly sorted than metasandstone in other parts of the Ammons Formation. Modal analyses of two metagraywacke samples yielded the following average composition: quartz 46.6%, plagioclase 24.4%, biotite 17.9%, muscovite 8.3%, opaque minerals (mostly iron oxide minerals) 1.9%, epidote 0.45, chlorite (alteration after biotite) 0.2%, apatite 0.2%, tourmaline 0.2%, and carbonate tr. Quartz and plagioclase are the dominant detrital minerals in the metagraywacke and commonly retain their original subangular to well-rounded shape, although the quartz mostly has a recrystallized, polygonal microstructure. Plagioclase is commonly twinned and ranges in composition from An_{16} to An_{30}. Notable is the paucity of epidote in comparison to metasandstone in the remainder of the Ammons Formation. Weathered metagraywacke is commonly dark colored, largely from staining by iron- and manganese-oxide minerals.

Metasandstone-schist unit—Light gray to tan fine-grained, mica-rich metasiltstone and mica schist are dominant; metasandstone is present; metaconglomerate is rare. Fhythmic layering on all scales is most characteristic of this unit. Large-scale layering is defined by alternating one-half- to several-meters-thick, sandy and schistose layers. Most range from one-half to 3 m thick; metasandstone layers are generally thicker.

Mica schist grading to metasiltstone is typically muscovite-rich, well crystallized, crenulated, and nonporphyroblastic. At some places schist layers exhibit internal laminations 0.25 to l cm thick defined by alternating muscovite-rich and biotite-rich laminae. Three mica schist samples yielded an average modal composition of: muscovite 65.8%, biotite 15.4%, quartz 9.4%, plagioclase 6.2%, epidote 1.3%, opaque minerals (mostly magnetite) 1.2%, garnet 0.2%, kyanite 0.2%, chlorite 0.1%, apatite 0.1%, allanite 0.1%, and traces of carbonate, tourmaline, and zircon. Quartz and plagioclase have mostly retained their original detrital shapes and sizes. Polygonization of quartz is common, but there is no evidence of widespread remobilization. Plagioclase commonly exhibits internal fractures and albite twinning, and ranges from An_{17} to An_{25}, slightly more calcic than that in the underlying Wehutty Formation. Porphyroblastic plagioclase is rare. Rare microcline is maximum microcline.

Near the base of the unit, discontinuous aluminous schist, up to 60 m thick, contains large kyanite, garnet, biotite, and muscovite porphyroblasts in a muscovite-rich groundmass. Most of the kyanite has been extensively retrograded to muscovite and sericite. Biotite is commonly altered to chlorite or sericite, but garnet is generally free of alteration. Laminations in this schist are defined by alternating porphyroblast-rich and porphyroblast-poor layers that range from 2 to 15 cm in thickness.

Metasandstone is mostly light gray and fine grained, but gray, medium- to coarse-grained, poorly sorted metasandstone is also present. Sandy layers contain laminations 0.25 to 2 cm thick defined by alternating mica-rich and mica-poor layers. Metasandstone composition ranges from subgraywacke to graywacke. Average modal composition of three representative metasandstone samples is: quartz 43.3%, plagioclase 19.3%, muscovite 17.7%, biotite 13.3%, epidote 3.6%, opaque minerals (mostly magnetite) 1.0%, carbonate 0.4%, allanite 0.3%, apatite 0.3%, microcline 0.2%, sphene 0.2%, tourmaline tr., and zircon tr. The mica-rich groundmass contains subequal amounts of biotite and muscovite. Magnetite is concentrated in large quantities along some layers, imparting a dark-gray color.

Ripple cross-laminations and current bedding are common primary structures in the metasandstone-schist member and sandy layers throughout are commonly graded. Soft-sediment deformation features are also abundant,including folds and faults, load casts, slumps, laminations, flame, and chaotic structures. Primary structures are more abundant near the base of the unit.

Calc-silicate is less abundant in the Ammons Formation than in the underlying Wehutty Formation, and occurs as pods, lenses, and discontinuous layers from 2 to 20 cm thick.

The thickness of this unit, including the cross-biotite schist map unit, ranges from 2200 to 3000 m.

The metasandstone-schist unit may be in part correlative with the Grassy Branch Formation mapped on the Noland Creek quadrangle to the north (Mohr, 1975).

Cross-biotite schist — Thick sequences of light-gray, nonporphyroblastic schist and conspicuous cross-biotite schist interlayered with thin beds of metasandstone, metasiltstone, and calc-silicate granofels. Schist is generally fine grained and commonly quite silty, grading into micaceous metasiltstone. Laminations range from 1 to 3 cm thick, and are defined by alternating silty and micaceous layers. The distinctive light-gray color results in part from the presence of abundant magnetite. Muscovite is the dominant groundmass mineral; biotite occurs mostly as porphyroblasts. Modal analyses of two representative cross-biotite schist samples average: muscovite 55.8%, quartz 15.3%, biotite 14.6%, opaque minerals (mostly magnetite) 7.2%, plagioclase 6.5%, epidote 0.4%, scapolite 0.2%, allanite 0.1%, sphene 0.1%, and traces of apatite, tourmaline, and zircon.

Metasandstone is similar in both appearance and composition to metasandstone throughout the rest of the Ammons Formation.

Calc-silicate granofels is abundant and exhibits a range in composition from calcareous metasandstone with abundant epidote, to more typical calc-silicate granofels found elsewhere in the Ammons Formation.

The cross-biotite schist map unit does not exceed 300 m in thickness.

WEHUTTY FORMATION—Composed of dark gray, graphitic, iron-sulfide-bearing, muscovite-biotite schist interbedded with lesser amounts of fine-grained to conglomeratic metasandstone and calc-silicate granofels. Most weathered surfaces are stained yellow by decomposition products of iron sulfide minerals.

Characteristic and most abundant is graphitic sulfidic schist, generally occurring in layers a few tens of centimeters to several meters thick and ranging in color from silvery-gray to black depending on the amount of graphite present. Two representative schist samples yielded the following average modal composition: muscovite 58.1%, biotite 19.0%, quartz 10.1%, plagioclase 4.4%, kyanite 4.0%, opaque minerals 3.8%, garnet 0.3%, apatite 0.1%, chlorite 0.1%, and traces of tourmaline, epidote, zircon, and sphene. Large kyanite porphyroblasts, up to 2 cm long and commonly twinned, are frequent, and are usually concentrated in discrete layers up to 15 cm thick. Euhedral garnet porphyroblasts and chlorite are present in smaller amounts. Twinned plagioclase is An_{17} to An_{25}. Retrograde metamorphism has variably altered porphyroblasts in schists. Kyanite shows the most intense alteration exhibiting random accumulations of sericite. Chlorite, commonly occurring as matted clusters elongated parallel to the primary foliation, and sericite replace biotite to varying degrees. Garnet appears to be most resistant to alteration. Kyanite may be kinked and broken by microfaults that overprint the primary foliation. Biotite and muscovite may also be kinked, although not as intensely as kyanite. Lenticular quartz crystals may be bent around the noses of microscopic crenulation folds.

Metasandstone and metaconglomerate occur in beds a few centimeters to 3 m thick. Fine- to medium-grained metasandstone is most common; metaconglomerate increases in abundance toward the base of the unit. Beds are rarely graded, and other primary sedimentary features are mostly lacking. Metasandstone ranges from subgraywacke to graywacke. Two metasandstones yielded the following average modal composition: quartz 57.0%, plagioclase 19.8%, biotite 12.8%, opaque minerals 3.8%, muscovite 3.5%, garnet 2.4%, chlorite 0.4%, sphene 0.2%, sillimanite 0.1%, zircon 0.1%, and traces of apatite, epidote, and tourmaline. Anorthite content of twinned plagioclase is An_{25} to An_{30}. Garnet frequently assumes skeletal poikiloblastic shapes and is a common accessory constituent. Sillimanite occurs as clusters of minute crystals (fibrolite) at grain boundaries and as inclusions in quartz, plagioclase, and biotite. Graphite is almost ubiquitous, ranging up to a few volume percent. Weathered metasandstone is commonly very friable owing to the high feldspar content.

Calc-silicate granofels is common in the Wehutty Formation, particularly near the top, occuring in lenses and pods up to a few tens of centimeters thick. Hornblende, clinozoisite, and sphene are abundant and form large crystals in calc-silicate granofels. Plagioclase ranges up to An_{50}; garnet commonly has a skeletal poikiloblastic habit.

Quartz is the dominant detrital mineral throughout the Wehutty Formation. It commonly exhibits some internal unrecovered strain, yet original detrital grain shapes and sizes are still preserved. Quartz also occurs as small irregularly shaped masses within kyanite porphyroblasts elongated parallel to the primary foliation. Plagioclase occurs both as large, irregular poikiloblastic porphyroblasts and as recrystallized detrital grains within sandstone and schist. Detrital plagioclase frequently exhibits albite twinning and less commonly pericline twinning.

The thickness of the Wehutty Formation ranges from 800-1000 m; an accurate determination could not be made because of pervasive penetrative deformation and complex folding.

COPPERHILL FORMATION—Gray to tan, medium- to coarse-grained graded metasandstone, metaconglomerate, and nongraphitic pelitic schist. Metasandstone layers range in thickness from 20 cm up to 3 m; schist layers range from a few centimeters to a meter thick. Metasandstone is similar in composition to that of the overlying Wehutty Formation. Schist is similar in composition to the nongraphitic schist in the overlying unit. Microcline may be slightly more abundant in the metasandstone, and muscovite is the dominant mica in both the metasandstone and pelitic schist. Several discontinuous layers of clay-ball metaconglomerate occur in the upper part of the Copperhill Formation along the Nantahala River arm of Nantahala Reservoir. Some of these layers may actually occur in the overlying Wehutty Formation. Total thickness of the Copperhill Formation is undetermined because the base is not preserved.

ROCKS OF THE HAYESVILLE THRUST SHEET

BIOTITE GNEISS AND SCHIST—Biotite gneiss, pelitic schist, amphibolite, and calc-silicate granofels, locally migmatitic. Biotite gneiss consists of quartz, plagioclase, and biotite with subordinate amounts of epidote, apatite, zircon, and magnetite. Schist is composed of muscovite, quartz, biotite, and plagioclase with lesser amounts of clinozoisite, zircon, and magnetite. Total thickness of the unit is undetermined in the Topton quadrangle because the base and top are not present.

The biotite gneiss and schist unit may be correlative with parts of the Tallulah Falls Formation and Coweeta Group to the east (Hatcher, 1988), or possibly with the Middle Proterozoic basement, to the north (Merschat and Wiener, 1988).

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[6]Modal analyses based on approximately 1000 points per thin section (from Ausburn, 1983). Individual totals may not equal 100 percent because of independent rounding. Clinozoisite and epidote included as "epidote" in descriptions.

[7]Significant changes in stratigraphic nomenclature and interpretation of the Murphy belt rocks have been proposed while this map was in preparation. Tull and others (1991) concluded that Mineral Bluff strata unconformably overlie the Murphy, Andrews, and Nottely Formations, and that the Mineral Bluff represents a post-Murphy clastic assemblage. Tull and others (1991) also suggested that the stratigraphic terminology be revised. They proposed that a newly named unit, the Hiwassee River Group, include the Nantahala Formation, Tusquitee Formation, Brasstown Formation, and Murphy Marble. They suggested elevating the Mineral Bluff to group status and extending its base downward to include strata previously assigned to the Nottely Quartzite and the Andrews Formation. Tull and others (1993) reported an echinoderm fragment from near the base of their Mineral Bluff Group (at the stratigraphic level of the Andrews Formation of this map), indicative of a Paleozoic age between Ordovician and Devonian.

[8]The Murphy Marble, Andrews Formation, and Nottely Quartzite are poorly exposed in this quadrangle and much of the knowledge about them is derived from earlier regional studies by Keith (1907) and Van Horn (1948).

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STRUCTURAL FEATURES AND SYMBOLS

CONTACTS

Lithologic contact, dashed where approximately located, short-dashed where concealed.

Thrust fault, dashed where approximately located, short -dashed where concealed. Saw teeth on upper plate.

K — Klippe

PLANAR STRUCTURES

37 / 53 — Strike and dip of bedding or compositional layering; inclined, overturned, vertical
67 — Strike and dip of foliation; inclined, vertical
67 — Strike and dip of schistosity; inclined, vertical

LINEAR STRUCTURES

17 — Trend and plunge of mineral lineation
14 — Trend and plunge of crenulation axis
27 — Trend and plunge of mesoscopic tight to overturned fold
14 — Trend and plunge of mesoscopic open antiform
22 — Trend and plunge of mesoscopic open synform

(NOTE: Where structural symbols are combined, the intersection marks the point of observation.)

MINERAL RESOURCES

- Abandoned mine or quarry
- X — Prospect
- Occurrence
- 3 — Map numbers refer to descriptions in Mineral Resources Summary
- cs — Crushed stone
- fl — Flagstone
- ta — Talc
- Fe — Brown iron ore