GEOLOGY OF YANCEY COUNTY

GEOLOGIC NOTE NO. 5

by

Carl E. Merschat

NORTH CAROLINA GEOLOGICAL SURVEY

DIVISION OF LAND RESOURCES

Charles H. Gardner, Director and State Geologist

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DIVISION OF LAND RESOURCES

**DEPARTMENT OF ENVIRONMENT, HEALTH
AND NATURAL RESOURCES**

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PREFACE

This publication is intended to present a brief introduction to the physiography, geology, and mineral resources of Yancey County. It also introduces a digital geologic map of the county.

The text contains many geologic terms; some terms are defined within the text, while others are in bold and italicized print and are defined in the glossary. ***Mineral*** names are used throughout the text, but are not defined because they can be found in most elementary mineralogy textbooks. Figure 1 serves as a location map for many of the familiar geographic places and features referred to in this report. In addition, it contains the location of the active mines and a few of the many inactive mines within the county. Figure 2 shows the physiographic provinces and geologic belts of North Carolina. A brief elaboration of these provinces and belts is included in appendices A and B.

PHYSIOGRAPHY

Yancey County is located in the Blue Ridge Mountains ***Physiographic Province*** of the Appalachian Mountain system. The county consists primarily of mountain ranges and ***intermontane valleys***. Its mountains are the highest in the eastern United States, with Mount Mitchell at 6,684 feet, being the tallest peak. The most prominent intermontane valley is the straight, narrow, steep-sided, east-west trending Laurel Creek trench valley. Laurel Creek, for which the trench valley is named, lies in neighboring Madison County but the feature extends across all of Yancey County. The valleys of Bald Creek and Little Crabtree and several low drainage divides form the Laurel Creek trench valley in Yancey County. U.S. Highway 19E is built along this feature.

Topography, the general configuration of the land surface, is controlled by a rock's resistance to weathering and erosion. For example, quartzite (a metamorphosed quartz sandstone) is the most resistant ***rock*** type found in the county, and caps the rugged Flat Top Mountain area. ***Metagraywacke*** is the second-most resistant rock type throughout the remainder of the county, followed by ***granitoids*** and other ***felsic*** rocks. The Black Mountain range which contains Mount Mitchell owes its prominence to the numerous, massive, metagraywacke layers that underlie it. ***Mafic*** and ***ultramafic*** rocks are the least resistant, but locally any rock type may form a high topographic area.

In addition to rock type, ***jointing***, ***faulting***, and thickness of layering contribute to rock resistance. Abundant and closely spaced joints, fractures, and faults increase the exposed surface area of a rock. This subsequently causes the rock to become less resistant, to weather and erode more easily and to form topographic lows. The Laurel Creek trench valley is probably a result of jointing, fracturing, and faulting across different rock types.

Similarly, the thicker and more massive layers are usually more resistant than thin-layered rocks. Massively layered granitoids beneath the Bald, Cane, and Green Mountains form the high peaks, while the more thinly layered granitoids through the same areas underlie the valleys.

GENERAL GEOLOGY

Geologic maps are scaled representations of the geology of the earth at its surface. They are the fundamental database for the earth sciences and are

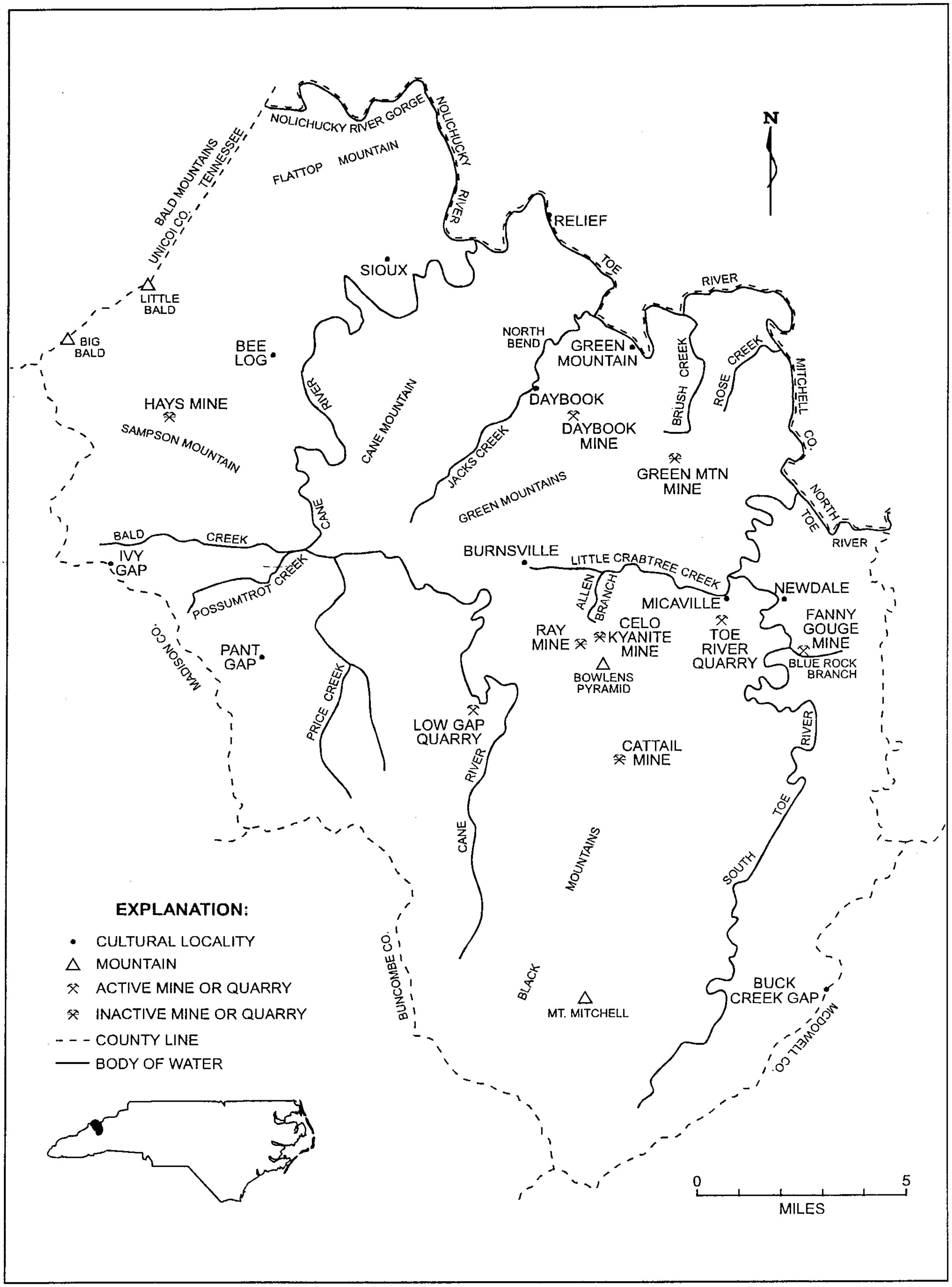

Figure 1: Location Map

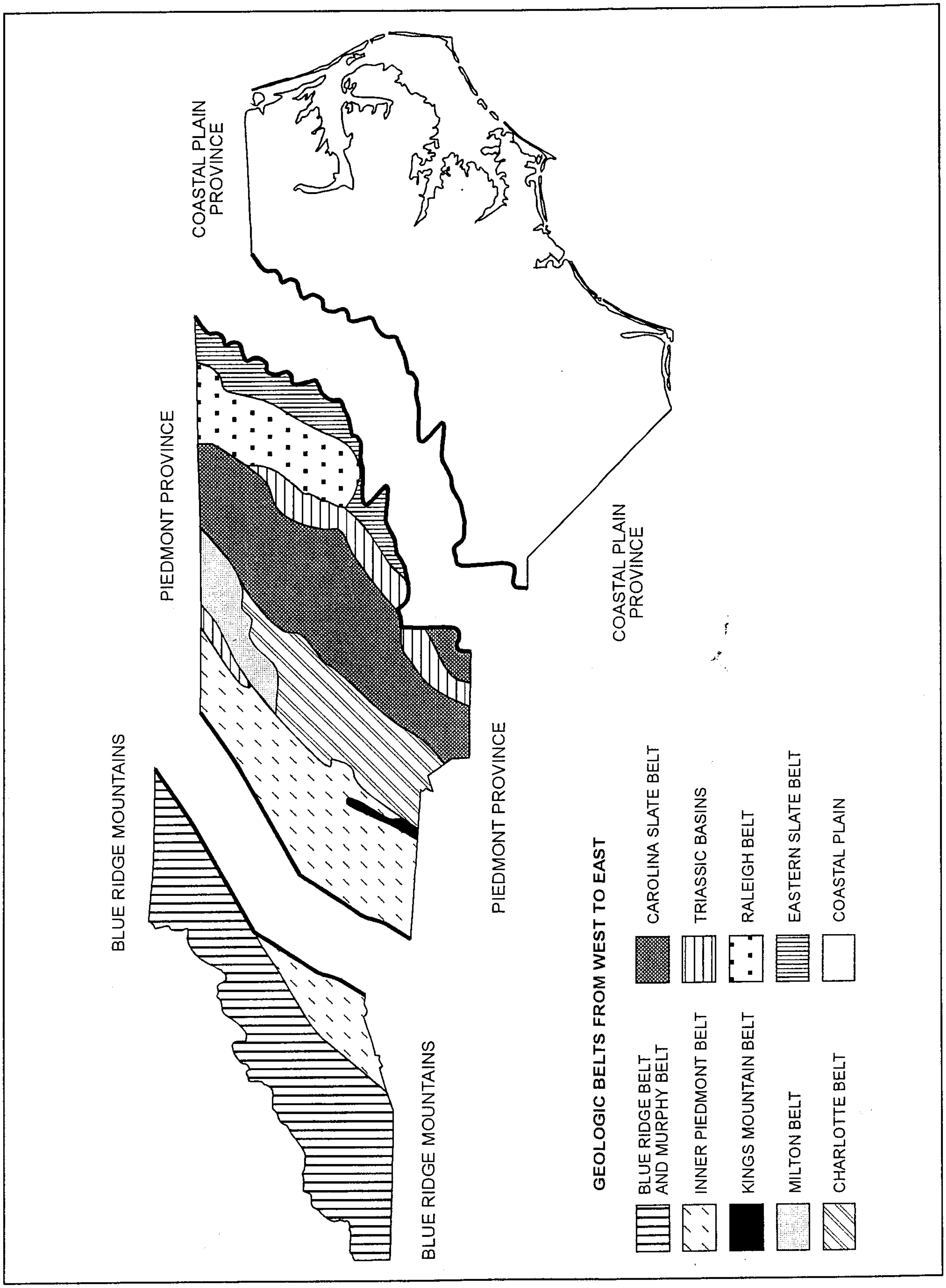

Figure 2: North Carolina Physiographic Provinces and Geologic Belts

used for engineering, environmental, hydrologic, mineral and energy resources, and other pertinent scientific and societal issues. Plate 1 is the geologic map of Yancey County. It shows the distribution of the different rock types, their structure, relative age, ***metamorphism*** and mineral resources. ***Metamorphic*** rock is, by far, the most abundant class of rock in the county. ***Igneous*** rock is also present, but true ***sedimentary rock*** is not. Metamorphosed sedimentary rocks are quite common, however. Many have been altered so little that their sedimentary character is still quite obvious. Most of the rocks range in age from 600 million years to over a billion years (figure 3). They are multiply metamorphosed, folded, and faulted. Only the youngest igneous intrusives, the 390-million-year-old alaskites and pegmatites, have escaped metamorphism. The older metamorphosed intrusive rocks vary widely in age and composition. Most of the intrusive rocks of Yancey County have been economically important as sources of feldspar, mica, and olivine.

STRUCTURAL SETTING

Yancey County is located in the Blue Ridge geologic belt. The regional rock outcrop pattern shown on the geologic map is controlled by large structural features. Historically, the overall pattern was interpreted as a large ***anticlinorium***. Today, many of the contacts separating the major rock sequences are mapped as ancient thrust faults, which are low-angle breaks in the rock along which there has been movement.

The regional map pattern is now depicted as a pile of stacked thrust sheets. Yancey County is part of a large transported area that has been moved northwestward along major thrust faults at least 30 miles and probably more than 125 miles.

Three major thrust faults control the map pattern in Yancey County.

The youngest — and most northwestern thrust fault — is the Stone Mountain fault (plate 1). This fault occurred about 240 to 290 million years ago. It is the southeastern boundary of the late Precambrian-age Snowbird and Cambrian-age Chilhowee rocks that underlie Flat Top Mountain.

East of the Stone Mountain fault is the Fork Ridge fault (plate 1). Its trace extends from northwest of Little Bald Mountain through Sioux. About 300 to 370 million years ago, this thrust carried biotite granitic gneiss and migmatitic biotite-hornblende gneiss units over and onto the granodiorite gneiss unit.

The Holland Mountain thrust fault, the easternmost thrust fault (plate 1), formed just before or during the second metamorphism about 475 million years ago. This fault is the oldest and least obvious of the three major faults in Yancey County. It carried the Ashe Metamorphic Suite and Alligator Back Formation over the older migmatitic biotite-hornblende gneiss unit. Its trace is mapped in a line from just west of Paint Gap and Burnsville to the Toe River.

In eastern Yancey County alaskite ***intrusives*** modify the outcrop pattern of the rocks. These alaskites are the only intrusive bodies large enough to significantly modify the outcrop pattern shown on the map.

At the outcrop scale, folds are the most recognizable structural feature. The style of folds visible in Yancey County indicates that at one time these rocks were very hot and behaved quite plastically.

METAMORPHISM

The metamorphic history of the rocks of Yancey County is quite complex, for many have been metamorphosed two or three times. The first metamorphism occurred over one billion years ago and affected rocks that crop out in the northwestern half of the county. These rocks include the migmatitic biotite-hornblende gneiss unit, the biotite granitic gneiss unit, and possibly the granodiorite gneiss unit. This metamorphism was characterized by very high temperatures and pressures. Evidence for this metamorphism is the presence of the mineral hypersthene. Metamorphic rocks containing hypersthene are called granulite.

Table 1. GEOLOGIC TIME SCALE FOR NORTH CAROLINA

EON	ERA	PERIOD	EPOCH		GEOLOGIC EVENTS IN NORTH CAROLINA	AGE*
PHANEROZOIC	CENOZOIC	**Quaternary**	Recent		Deposition of sediments in Coastal Plain. Erosion of Piedmont and Blue Ridge Mountains to their present rugged forms.	
			Pleistocene			1.7
		Tertiary	Pliocene			5
			Miocene		Phosphate deposited in Coastal Plain.	24
			Oligocene		Limestone deposited in Coastal Plain. Weathering and erosion continue in Piedmont and Mountains.	
			Eocene			
			Paleocene			66
	MESOZOIC	**Cretaceous**	Late		Deposition of estuarine and marine sediments in Coastal Plain. Continued erosion of Piedmont and Mountains.	
			Early		Sediments deposited in northern half of Coastal Plain. Present-day coastal features begin to develop. Piedmont and Mountains eroded.	138
		Jurassic	Late		Marine sediments deposited on outer continental shelf. Piedmont and Blue Ridge Mountains eroded.	
			Middle		Weathering and erosion of Blue Ridge Mountains and Piedmont areas. Emplacement of diabase dikes and sheets in these areas.	
			Early			205
		Triassic	Late		Faulting and rifting creates Triassic basins. Basins fill with continental clastic sediments known as "red beds."	
			Middle		Formation of the Atlantic Ocean as North America and Africa rift apart. Weathering and erosion of Piedmont and Mountains.	
			Early			240
	PALEOZOIC	**Permian**			Final collision of North America and Africa plates. Thrust faulting in west; deformation in eastern Piedmont.	290
		Pennsylvanian		Emplacement of igneous intrusions	Time of uplift and erosion throughout state.	330
		Mississippian			Time of uplift and erosion throughout state.	360
		Devonian			Emplacement of lithium, mica, and feldspar-rich pegmatites in Mountains and Piedmont. Metamorphism in eastern Piedmont. Period of erosion throughout state.	410
		Silurian			Period of uplift and erosion throughout state.	435
		Ordovician			Continental collision and beginning of mountain-building processes — faulting, folding, and metamorphism of pre-existing rocks.	500
		Cambrian			Sandstone, shale, and limestone deposited in Mountain area. Continued deposition of volcanic and sedimentary rocks in Piedmont. Gold deposits of Piedmont form.	570
PROTEROZOIC	PRECAMBRIAN	**Late**			Sedimentary and volcanic rocks deposited in Mountains and Piedmont. Local intrusions of igneous rocks throughout Mountains and Piedmont.	900
		Middle			Sedimentary, volcanic, and igneous rocks formed and emplaced in Blue Ridge Mountains and subsequently metamorphosed to gneisses and schists.	1600
		Early			Oldest dated rock in North Carolina is 1,800 million years.	2500
					Oldest known rock in U.S. is 3,600 million years. Oldest known rocks in world are 3,850 million years. Formation of the Earth was 4,500 million years ago.	

*Estimated age in millions of years.

A second metamorphism occurred about 475 million years ago and affected all of the rocks in Yancey County, except for the intrusive alaskite and pegmatite which were emplaced much later, about 390 million years ago. This event was a ***retrogressive*** event on the three map units affected by the earlier higher grade Precambrian metamorphism.

The last metamorphism occurred about 300 million years ago — this was a very low grade event and its effects are not very pronounced. It is best evidenced by rare chlorite replacing biotite, hornblende, and garnet in some of the rock units in the northwestern part of the county.

ROCK DESCRIPTIONS

The following rock descriptions are an elaboration of the map units described on the geologic map (plate 1). They are intended to more thoroughly describe the rocks of Yancey County and help explain some of the local variations observed throughout the county, because a geologic map is only a scaled representation of the earth's surface. A representative outcrop of each map unit is designated on the geologic map (plate 1). At this location each map unit may be more closely examined. The outcrop is selected for its accessibility and ease of parking for more than one vehicle. Nonetheless, most are located along narrow, curvy state highways and roads. A high level of caution should be used when examining the rocks.

PEGMATITE

Pegmatite is an exceptionally coarse-grained igneous rock, usually composed of feldspar, quartz, and mica. It commonly occurs as irregular ***dikes*** and ***sills*** at the margins of very large intrusive igneous rock bodies.

Thousands of small bodies of pegmatite rock occur throughout much of Yancey County. They exist in all map units, except the Chilhowee and the Snowbird Groups.

The Spruce Pine pegmatite in the Micaville area is mineralogically similar and closely associated with the larger alaskite bodies. These pegmatites consist of 40 percent oligoclase feldspar, 25 percent quartz, 20 percent microcline, and 15 percent muscovite and were derived from the same parental ***magma*** as the alaskites. The Spruce Pine pegmatite is a light colored, unlayered, massive intrusive rock characterized by an exceptionally coarse grain size.

Other pegmatites found in Yancey County are almost mineralogically identical to the Spruce Pine pegmatite, but formed through local melting during metamorphism. Most, regardless of age, vary in size from a few inches to 2,000 feet in length and from a few inches to 1,000 feet in width, but most are too small to map and show at standard map scales.

Several of the large mica mines occurring in pegmatite bodies in Yancey County include the Ray, Cattail, Fanny Gouge, and Green Mountain mines.

SPRUCE PINE SCHIST

The Spruce Pine ***schist*** is an informal map unit that consists of rocks altered by ***metasomatism*** surrounding the intrusive alaskite bodies. Spruce Pine schist formed when alaskite magmas intruded favorable host rocks, such as fine-grained mica schists and interlayered, ***feldspathic***, biotite and muscovite-bearing ***gneiss***. Existing mica flakes in the host rock coarsened and a general homogenization of the rock took place. As a result, original layering is no longer distinct. Lithologically, the rock ranges from a very coarse-grained, finely layered mica schist to a micaceous ***lit-par-lit*** gneiss to a coarse-grained mica gneiss. Mica schist is the characteristic rock type, with either muscovite or biotite locally dominant.

Spruce Pine schist is gradational over a few feet to thousands of feet into both the alaskites and the intruded parent rocks. Usually the larger the alaskite, the thicker or wider the alteration halo or ***aureole***. ***Amphibolite*** and very quartz-rich parent rocks are unfavorable host rocks and show only minor alteration for a short distance. The Spruce Pine schist is exposed intermittently in road cuts along 19E east of Micaville to the Yancey-Mitchell County line.

SPRUCE PINE ALASKITE

Alaskite, as the term is used locally, is a medium- to coarse-grained, light colored, non-foliated to weakly foliated, massive igneous rock. Its mineral composition averages about 40 percent oligoclase (sodium/feldspar), 25 percent quartz, 20 percent microcline (potassium/feldspar) and 15 percent muscovite. Garnet, rare biotite, and many other minerals, some of them exotic, are minor accessories.

Nine small bodies of alaskite have been mapped east of Micaville, but exposures of alaskite are rare in road cuts along N.C. highways in Yancey County. The margins of the bodies are usually finer grained, somewhat more layered (as shown by an alignment of mica flakes) and often contain pieces of host or country rock. Scattered irregularly throughout the alaskites are pegmatitic masses, thin dikes, and sills with very sharp or gradational boundaries.

Alaskite is relatively resistant to weathering. It commonly forms exfoliation surfaces and rock pavements. One small weathered body that occurs near Newdale has been mined periodically for scrap mica.

CHILHOWEE GROUP - UNICOI FORMATION

The Unicoi Formation, the lowest formation in the Chilhowee Group, crops out in a small, nearly inaccessible area of Yancey County in the Nolichucky River Gorge near the Tennessee state line. This formation, a variable sequence of ***clastic*** sedimentary rocks, is divided into an upper and a lower map unit. Both units are weakly metamorphosed.

The lower unit consists of coarse, ***vitreous***, feldspathic ***sandstone*** and ***conglomerate*** with interbeds of ***siltstone***, and ***shale***. It is exposed on the northwest side of Flat Top Mountain in the Nolichucky River Gorge.

Interbedded in the conglomerate of the lower part of this map unit are three thin, weakly metamorphosed ***basalt*** flows. The vitreous quartz sandstone, feldspathic sandstone, and conglomerate do not weather easily and form high, rocky ridges and cliffs. The shale, siltstone, and basalt flows weather much faster and seldom crop out.

The upper unit of the Unicoi Formation is characterized by white vitreous quartz sandstone interbedded with iron-oxide cemented sandstone, feldspathic sandstone, and dark-gray to green siltstone, and shale. The vitreous quartz sandstone of this unit is very resistant and results in a strong topographic expression. It also crops out on the northwest side of Flat Top Mountain in the Nolichucky River Gorge. Blocks and boulders from this unit commonly form colluvial (gravity) deposits known as boulder fields and talus.

META-ULTRAMAFIC ROCK

Small, local occurrences of unaltered and altered ultramafic rock are present in several areas of Yancey County. The occurrence at Day Book that is currently being mined is a relatively unaltered ultramafic rock called ***dunite***. In western North Carolina, dunite is composed almost entirely of forsterite olivine and therefore is very rich in magnesium. Iron is also present with trace amounts of nickel and cobalt. Dunite bodies in Yancey County are commonly surrounded and crossed by ***alteration zones*** of serpentine, talc, anthophyllite, and vermiculite.

Altered ultramafics of Yancey County consist chiefly of the above alteration zone minerals and very little olivine. Altered ultramafics occur along Price Creek, Rose Creek, Blue Rock Branch, and elsewhere in the county. Although altered, these rocks remain high in magnesium, thus are quite susceptible to chemical weathering and do not readily crop out.

SNOWBIRD GROUP

The Snowbird Group caps the top of Flat Top Mountain on the south side of the Nolichucky River at the Tennessee line. It is the oldest sedimentary rock unit found above the old granitic ***basement*** in Yancey County. The material that makes up these sediments was derived directly from the old granitic basement.

The Snowbird Group consists of poorly to well-sorted, variably feldspathic, locally cross-bedded quartzite with interbeds of pebbly, feldspathic layers common to the lower portion of the group. Rare interbeds of metamorphosed siltstone and dark-gray metamorphosed shale (slate) occur in the upper part. The quartzites, feldspathic quartzites, and conglomeratic quartzites are resistant units and are commonly ridge formers. These ridge-forming rock types frequently cause the buildup of talus, boulder fields, and other colluvial deposits on the slopes of portions of Flat Top Mountain.

ALLIGATOR BACK FORMATION

The Alligator Back Formation crops out in the southeastern edge of the county in a band just east of N.C. 80 from Micaville to Buck Creek Gap. It is subdivided into two map units based on rock type. One map unit is dominated by gneiss; the other map unit is dominated by amphibolite. Amphibolite and schist occur as minor interlayers within the gneiss unit, and gneiss and schist are minor interlayers within the amphibolite. The amphibolite is mapped in only one small area along 19E near the Mitchell County line.

The gneiss unit is more extensive and consists of thin- to very thin-layered, fine-grained felsic gneiss with thin partings of muscovite and biotite. It is interlayered with micaceous (muscovite-biotite) schist and amphibolite, either of which may be locally dominant. The gneiss is commonly sulfidic and locally contains rare lenses of ***calc-silicate granofels***.

Gneiss and schist of the Alligator Back Formation probably represent a metamorphosed sedimentary rock sequence of sandstones and shales. Where metamorphic effects are not pronounced, the rocks retain their original sedimentary character and are more suitably called thin-layered metagraywacke. The higher the quartz content, the more resistant the gneiss and schist layers are to weathering.

The amphibolite unit of the Alligator Back Formation is equigranular, fine- to coarse-grained and thinly to thickly layered. The amphibolite was most likely an extrusive volcanic rock. Such rocks weather easily because they are high in iron and magnesium.

ASHE METAMORPHIC SUITE

The Ashe Metamorphic Suite crops out in a broad northeast-southwest trending band that underlies a large portion of the County. The Ashe Metamorphic Suite is subdivided into three map units—muscovite-biotite gneiss, amphibolite, and metagraywacke. Each map unit is dominated by, but not limited, to a single rock type.

Muscovite-biotite gneiss, the most widespread of the three map units, is a heterogeneous unit dominated by a thick sequence of originally marine clastic sedimentary rocks. The ***protolith*** was chiefly a graywacke containing numerous shale partings. The gneiss is typically medium-light-gray to medium-dark-gray, fine- to medium-grained, thin- to thick-layered, and sulfidic. Where the quartz content is high, the gneiss retains much of its sedimentary character. It is interlayered and intergraded with mica schist at all scales. Amphibolites are mapped locally within the unit. The gneiss unit is well exposed along U.S. 19E east of Burnsville and N.C. 197 north and south of Burnsville. The muscovite-biotite gneiss unit is relatively resistant to weathering. Layers high in feldspar and mica content are more susceptible to weathering than those with a higher quartz content.

The amphibolite unit consists of equigranular, massive to well-foliated amphibolite, garnet-amphibolite, and hornblende gneiss layers, lenses, and ***pods***. It is usually conformable and variably interlayered with gneiss, metagraywacke, and mica schist. Amphibolite bodies occur toward the northeast edge of the outcrop belt of the Ashe Metamorphic Suite near the Mitchell-Yancey County line. Amphibolite, a rock unit rich in iron- and magnesium-bearing minerals, weathers rapidly and deeply into a reddish-brown to orange soil.

The metagraywacke unit underlies a large area of the most rugged and mountainous terrain in Yancey County. Mt. Mitchell of the Black Mountain range is underlain by this unit. The metagraywacke unit is medium-light-gray to medium-dark-gray, fine- to coarse-grained, massive to thinly layered, weakly foliated to well foliated.

Metagraywacke layers are interlayered and gradational with sulfidic schists, muscovite-biotite gneisses, rare metaconglomerate, and graphite-bearing schists. The conglomerate pebbles are dominantly quartz and, locally, are highly deformed, but still recognizable.

The high quartz content of the graywackes and the resulting massive character makes this rock very resistant. It is this resistance that causes Mt. Mitchell and the rest of the Black Mountain range to be an area of higher elevation.

BAKERSVILLE METAGABBRO

The Bakersville ***Metagabbro*** intrudes map units northwest of Burnsville and commonly occurs in dikes and sills so thin and small that they cannot be shown accurately at standard map scales.

Southwest of Day Book along Jacks Creek, and along NC. 197 between Green Mountain and the bridge over the Toe River into Mitchell County, numerous road cuts contain dikes and sills of Bakersville Metagabbro. Large outcrops of exfoliating metagabbro and rounded boulders littering the sideslopes characterize the map unit.

Bakersville Metagabbro can be divided into two distinct phases based on grain size — a dark-greenish gray, fine-grained phase and an olive-black, coarse-grained phase. Both phases range in texture from ***granoblastic*** to locally ***porphyritic***. ***Chilled margins*** are locally visible.

The extent of metamorphic alteration and ***foliation*** (layering) development varies in the Bakersville metagabbro. In areas where water was deficient, metamorphic recrystallization was inhibited and the original igneous textures still persist in outcrops. Where fluids were available, recrystallization progressed and caused destruction of the original textures and development of new minerals and a metamorphic foliation. Typically, metamorphic recrystallization is more extensive on the edges of some of the dikes and sills than in the center. Where completely altered, the dikes and sills are now amphibolites. Since gabbros are mafic igneous rocks, they are rich in ferro-magnesium and weather rapidly.

GRANODIORITIC GNEISS

The granodioritic gneiss unit crops out in a band trending northeast from the Tennessee-North Carolina State line through Sioux to the Nolichucky River. Historically, these rocks have been called the Cranberry Granite, Beech Granite, and unakite. Unakite is known for its bright pink, red, dark-green, and white to bluish-gray colors. Samples of unakite are sought by collectors who often polish their specimens into attractive lapidary pieces.

In Yancey County, much of the granodiorite gneiss unit is highly ***mylonitized*** (sheared) and granulated as a result of faulting. This mylonitization is quite common and tends to mask and obliterate many of the original features. The mylonitic foliation overprints earlier foliations. The intensity of mylonitization is variable. New minerals formed through mylonitization include sericite, muscovite, chlorite, and epidote. Large broken grains of previous minerals still exist in the mylonitized rocks. They commonly include microcline, perthite feldspar, plagioclase, and muscovite.

Where not mylonitized, the granodioritic gneiss unit consists of massive and layered gneiss. The massive gneiss is greenish-gray to pinkish-green, coarse-grained, poorly foliated to well-foliated, and thick-layered to medium-layered. It ranges in composition from granite to quartz diorite, but most commonly is granodioritic.

Rocks of the layered gneiss are usually darker colored and have a higher portion of mafic minerals. Both the massive and layered gneiss are locally ***migmatitic***. Mafic dikes and granitoid pegmatites intrude both gneisses. The protolith of much of the granodiorite gneiss was probably of igneous origin. The more massive gneiss is moderately resistant to weathering, while the layered and mylonitized gneisses are comparatively less resistant to weathering.

BIOTITE GRANITIC GNEISS

Biotite granitic gneiss crops out in a narrowing band from the Madison County line eastward to the Nolichucky River. The biotite granitic gneiss, a very heterogeneous map unit, is massive to thinly layered, biotite-bearing granite to quartz diorite.

Most of the outcrops consist of quartz monzonite, a light-colored igneous rock with equal amounts of potash feldspar and plagioclase feldspar. Good exposures of this unit occur along 19W and SR 1417 northeast and southwest of Ramseytown. Mylonitization occurs locally; zones of mylonitization commonly show a progression of increasing intensity which are locally mappable. The biotite granitic gneiss unit is moderately resistant to weathering. Where layering is thicker, resistance to weathering increases.

Amphibolite and calc-silicate layers, lenses, and pods also occur as inclusions in this unit. They vary in thickness from a few inches to several tens of feet. The layers are commonly ***conformable***, but some amphibolites appear to be dike-like. Amphibolite layers in this unit are discontinuous, dark green to black, equigranular, and poorly foliated to well foliated. Amphibole content of the amphibolites varies from body to body, with some consisting almost entirely of hornblende. Where mylonitized, amphibole minerals alter to chlorite. The protoliths for these rocks probably were mafic igneous rocks. Since many are conformable, they were most likely mafic lava flows from ancient volcanoes. Amphibolite is weakly resistant to chemical weathering.

MIGMATITIC BIOTITE-HORNBLENDE GNEISS

The rocks within this map unit trend northeastward, from Ivy Gap and Paint Gap near the Madison County line, to the Toe River just southeast of Relief and northwest of Brush Creek. This map unit is highly variable and complex. It consists of layered mafic and felsic rock units that are interlayered and gradational at all scales. This unit is well exposed along 19E between Ivy Gap and Cane River and along Jack's Creek from Day Book to the Toe River.

The various layers of rock range from inches to mappable subunits more than a thousand feet thick. They are low in quartz content and contain almost no muscovite or ***aluminosilicate*** minerals. Rock types found within this unit are numerous and include, but are not limited to, biotite granitic gneiss, amphibolite, calc-silicate granofels, biotite gneiss, biotite-hornblende gneiss, hypersthene-biotite-hornblende gneiss, hypersthene granitic gneiss, pyroxene granulite and plagioclase-rich pyroxene granulites, and rare marble.

Hypersthene-bearing granulite rocks in this unit are known to occur in only a few areas of western North Carolina. In Yancey County, these rocks crop out near the headwaters of Possum Trot Creek and the North Bend area of Jack's Creek. Here, they are commonly interlayered with amphibolite. Diopside and hornblende are two calcium-bearing silicate minerals that are common constituents of these rocks. The soils that develop above them may be enriched in calcium.

High mafic mineral and low quartz content of many of the layers makes the migmatitic biotite-hornblende gneiss unit weakly resistant to chemical weathering.

MINERAL RESOURCES

The first to mine minerals in Yancey County were undoubtedly native Americans, who used local clays for pottery, soapstone for bowls and other vessels, and quartz for arrowheads, other weapons, and tools. Mica was worked into ornaments that were often traded.

Since this early beginning, Yancey County has continued to produce important mineral commodities. For example, corundum was mined from an altered ultramafic rock before 1895 at the Hays Mine on the northwestern slopes of Sampson Mountain near Bee Log. In other areas, altered ultramafic rocks consist mainly of talc and chlorite. This rock, known as soapstone, is very soft and can easily be cut, carved, and engraved. It was mined and used locally for fireplace hearth stones, gravestones, markers, bowls, and smoking pipes.

Mica, feldspar, and quartz were also mined in the 19th century in Yancey County. These three minerals occur as very large grains in pegmatites. They were hand worked — that is, broken, separated, and sorted. Mineable deposits of pegmatite are scattered throughout the southeastern half of Yancey County, where they mainly intrude the Ashe Metamorphic Suite and the Alligator Back Formation. Muscovite, the clear, colorless variety of mica, was quite valuable when it occurred in large books. The large, thick, books were hand split into thin sheets and used initially for windows, wood stove windows, and as insulators for radio tubes.

Mining for sheet muscovite in western North Carolina ended by 1960. Foreign suppliers with low-cost labor are now meeting the demand.

Both microcline and plagioclase feldspar were frequently co-produced (with the same labor-intensive hand work) from muscovite-bearing pegmatites. The feldspars were and still are used in a large variety of products, such as glass, cleanser, ceramics, dentures, and porcelains.

The third industrial mineral mined from these pegmatites was quartz. Quartz mining was much more sporadic and only provided small quantities of byproduct quartz for special and unique requests.

In the past, waste mica from sheet mica mining and processing operations was ground in plants and sold as scrap mica. Scrap mica has been produced in Yancey and neighboring Mitchell County since 1901. Today North Carolina leads the nation in scrap mica production. It is used in paints, plastics, cosmetics, gypsum plasterboard cement, electronics and drilling muds. Most of it comes from neighboring Mitchell County as a co-product of the feldspar mining of alaskites.

The switch from labor intensive, hand worked pegmatite mining to alaskite mining and more technological processing of feldspar and mica never took place in Yancey County (as it did in neighboring Mitchell County). Fine-grained, more uniform alaskites that are better suited to technological processing are not as large in Yancey County and therefore have never been mined.

At the end of World War II, however, scrap mica production shifted from processing waste material from the sheet mica industry to direct mining of weathered alaskite and altered schist. Locally these rocks were weathered to a depth of about 100 feet. The altered schists were more productive than the alaskites because of higher concentration of mica. Twenty-three scrap mica deposits were reported to occur in Yancey County. Many were mined extensively, while others were only prospected. Located in weathered material, these deposits could be mined easily (they were mined hydraulically or by power driven equipment, or a combination of both).

Hard rock deposits were seldom economical, because of high mining and milling costs. In the sixties, an increase in production of feldspar and co-product mica from alaskites, along with environmental concerns, caused the scrap mica industry to slow down. Today there is no scrap mica production in Yancey County.

Other important mineral commodities previously and currently mined in Yancey County include kyanite, olivine, crushed stone, and sand and gravel.

Kyanite is a light-gray to blue, long, thin-bedded, alumino-silicate metamorphic mineral formed at medium temperature and high pressure. It was mined at the Celo Kyanite Mine at the head of Allen Branch on the northern slopes of Bowlens Pyramid. The mine first opened in 1931, and was worked more or less continuously until January, 1944. Kyanite is used in refractory ceramics, such as spark plugs.

Olivine is a translucent to transparent olive-green to yellow-green magnesium silicate with special refractory properties. It is found in dunite, an olivine-rich variety of ultramafic rock, that occurs scattered throughout Yancey County. Olivine was first mined in the County about 1936, and initially production was somewhat intermittent. Since about 1942, however, olivine production has been almost continuous.

Today, the Daybook Mine, owned by Unimin Corporation, is the only operating olivine mine in Yancey County. The mine produces a molding and casting sand for the foundry industry and a sand used by the sandblasting industry to prevent silicosis. Washington is the only other state in the country that produces olivine.

Other minerals associated with olivine that have some mineral resource potential include chromite, talc, vermiculite, anthophyllite, serpentine, and corundum.

Crushed stone is another mineral commodity currently being produced in Yancey County. It is mined near Burnsville along the Cane River and near Micaville along the South Toe River. Both mines are centrally located in the county near developing areas to insure low cost to the user. Gneiss and amphibolite of the Ashe Metamorphic Suite are being crushed and screened into different sizes; each size fraction has a slightly different use. Crushed stone is the primary natural aggregate used in Yancey County. It is used in nearly all residential, commercial and industrial building construction and in most public works projects, such as roads and highways, bridges, railroad beds, dams, airports, tunnels, and water and sewer systems. Historically, sand and gravel was an important type of natural aggregate produced in the county, but it is currently not being mined. Collectively, crushed stone and sand and gravel are low-value, high-volume commodities whose statewide total value exceeds all other mineral resources.

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GLOSSARY

Alteration zones — area of mineralogic change in a rock brought about by physical or chemical means.

Aluminosilicates — a silicate mineral enriched in aluminum, such as kyanite, sillimanite, and muscovite.

Amphibolite — a metamorphic rock composed mostly of an amphibole mineral (usually hornblende) and plagioclase feldspar.

Anticlinorium — a series of upfolds and downfolds in the rocks that form a general arch.

Aureole — a zone surrounding an igneous intrusion in which the country rock shows the effects of contact metamorphism.

Basement — the old rocks that underlie all other rocks in an area.

Basalt — a volcanic igneous rock consisting chiefly of plagioclase feldspar and pyroxene.

Calc-silicate granofels — a metamorphic rock consisting mainly of calcium-bearing silicate minerals.

Chilled margins — the border area of an igneous intrusion characterized by finer grain size than the interior of the rock mass, owing to more rapid cooling.

Clastic — pertaining to a rock or sediment that contains fragments of pre-existing rocks and minerals.

Conformable — said of the contact of an intrusive body when it is aligned with the internal structures of the surrounding rocks.

Conglomerate — a clastic sedimentary rock containing numerous rounded pebbles or larger cobbles.

Dikes — tabular igneous intrusions that cut across foliation (layering) in rocks.

Dunite — an ultramafic igneous rock composed almost entirely of olivine.

Faulting — the process of fracturing that produces displacement of rocks.

Felsic — a rock in which light-colored minerals, chiefly feldspar, predominate.

Feldspathic — a rock containing variable amounts of feldspar.

Foliation — a parallel or nearly parallel surface (or layer) in metamorphic rocks along which it tends to break or split.

Gneiss — a coarse-grained metamorphic rock with alternating bands of different minerals.

Granitoids — a field term for a granitic looking rock.

Granoblastic — a common metamorphic rock texture in which the mineral grains are equidimensional.

Igneous rock — formed by the solidification of molten silicate materials.

Intermontane valley — a narrow, low area surrounded by mountains.

Intrusives — an igneous rock body that originated from solidification of magma emplaced in older rocks.

Jointing — the presence of fractures in a rock along which there has been no displacement.

Lit-par-Lit — the penetration of layered rock by numerous, thin, roughly parallel sheets of igneous material.

Mafic — a rock in which iron and magnesium minerals dominate.

Magma — molten silicate materials beneath the earth's surface.

Metagabbro — metamorphosed intrusive igneous rock consisting of plagioclase feldspar and pyroxene.

Metagraywacke — a metamorphosed, dark-gray, firmly indurated coarse-grained sandstone, that consists of poorly sorted, angular to subangular grains of quartz and feldspar with a variety of dark rock and mineral fragments embedded in a complex clayey matrix.

Metamorphic rock — formed within the earth's crust through recrystallization of a pre-existing rock in a solid state without melting and as a result of an increase in heat and pressure.

Metamorphism — changes in mineral composition, arrangement of minerals, or both that took place in the solid state within the earth's crust at high temperatures, high pressures, or both.

Metasomatism — a replacement process where chemically active fluids from within or from an external source cause new or existing minerals to grow.

Migmatitic — a metamorphic rock showing localized melting of the light-colored materials.

Mineral — a naturally occurring inorganic compound or element having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.

Multiply metamorphosed — metamorphosed more than once.

Mylonitized — a rock deformed by extreme granulation and shearing. Commonly associated with faulting.

Physiographic province — a region whose pattern of relief features or similar land forms differs significantly from that of adjacent regions; all parts are usually similar in geologic structure.

Pods — metamorphic rock bodies that are long in one dimension and short in two dimensions with their long axis most commonly parallel to layering.

Porphyritic — igneous rock texture in which larger crystals are set in a finer-grained ground mass.

Protolith — the pre-existing rock from which a given rock was formed.

Retrogressive — metamorphic minerals of a lower grade (temperature and pressure) that are formed at the expense of those at a higher grade.

Rock — an aggregate of one or more minerals.

Sandstone — a clastic and sedimentary rock consisting predominantly of sand-sized particles.

Schist — a finely layered metamorphic rock composed primarily of platy (flaky) minerals such as mica.

Sedimentary Rocks — formed by cementation of sediment or other process acting at temperatures and pressures too low to cause metamorphism.

Serpentine — a secondary mineral formed from olivine.

Shale — a very thinly layered clastic sedimentary rock composed primarily of clay-and silt-size particles.

Sills —tabular igneous intrusions that parallel foliation (layering) in rocks.

Siltstone — a clastic sedimentary rock consisting predominantly of silt-size particles.

Ultramafic — a plutonic rock composed chiefly of mafic minerals, frequently monomineralic rocks.

Vitreous — having the appearance and luster of glass.

REFERENCES

Bradley, F. H., 1874, On unakite, an epidote rock from the Unaka Range, on the border of Tennessee and North Carolina: American Journal of Science, 3rd series, v. 8, p. 519.

Brobst, D. A., 1962, Geology of the Spruce Pine District, Avery, Mitchell, and Yancey Counties, North Carolina: U.S. Geological Survey Bulletin 1122-A, 26 p.

Hack, J. T., 1982, Physiographic divisions and differential uplift in the Piedmont and Blue Ridge: U.S. Geological Survey Professional Paper 1265, 49 p.

Hadley, J. B., and Nelson, A. E., 1971, Geologic map of the Knoxville Quadrangle, North Carolina, Tennessee and South Carolina: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-654, scale 1:250,000.

Keith, Arthur, 1907, Description of the Roan Mountain Quadrangle [Tennessee-North Carolina]: U.S. Geological Survey Geological Atlas, Folio 151, 12 p.

King, P. B., and Ferguson, H. W., 1960, Geology of northeasternmost Tennessee, with a section on the description of the basement rocks by Warren Hamilton: U.S. Geological Survey Professional Paper 311, 136 p.

Lowry, Jean, 1950, The southwest end of the Mountain City window [Ph.D. dissertation]: Hartford, Yale University, 147 p.

Merschat, C. E. (in progress), Geologic map and mineral resources summary of the Huntdale Quadrangle, North Carolina and Tennessee: North Carolina Geological Survey.

North Carolina Geological Survey, 1985, Geologic Map of North Carolina, North Carolina Geological Survey, Raleigh, 1 sheet, scale 1:500,000.

Olson, J. C., 1944, The economic geology of the Spruce Pine pegmatite district, N.C.: North Carolina Department of Conservation and Development, Mineral Resources Division, Bulletin 43, 67 p.

Parker, J. M., III, 1952, Geology and structure of part of the Spruce Pine District, North Carolina: North Carolina Department of Conservation and Development, Division of Mineral Resources Bulletin No. 65, 26 p., 1 plate.

APPENDIX A
GENERAL SUMMARY OF NORTH CAROLINA PHYSIOGRAPHY

North Carolina can be divided into three physiographic provinces, the Coastal Plain, the Piedmont, and the Blue Ridge Mountains. Each province is characterized by different types of landforms.

The **Coastal Plain Province** covers about 45 percent of the state, and is characterized by flat land to gently rolling hills and valleys. Elevations range from sea level near the coast to about 600 feet in the Sand Hills of the southern Inner Coastal Plain.

The **Piedmont Province** lies between the Coastal Plain and the Blue Ridge Mountains. It occupies about 45 percent of the area of the state. Along the border between the Piedmont and the Coastal Plain, elevations range from 300 to 600 feet above sea level. To the west, elevations gradually rise to about 1,500 feet above sea level at the foot of the Blue Ridge. The Piedmont is characterized by gently rolling, well rounded hills and long low ridges with a few hundred feet of elevation difference between the hills and valleys. It includes some relatively low mountains including the South Mountains, Brushy Mountains, and the Uwharrie Mountains.

The **Blue Ridge Mountains Province** is a deeply dissected mountainous area of numerous steep mountain ridges, intermontane basins, and trench valleys that intersect at all angles and give the area its rugged mountain character. The Blue Ridge contains the highest elevations and the most rugged topography in the Appalachian Mountain system of eastern North America. The North Carolina portion of the Blue Ridge is about 200 hundred miles long and ranges from 15 to 55 miles wide. It contains an area of about 6,000 square miles, or about 10 percent of the area of the state.

Within North Carolina, 43 peaks exceed 6,000 feet in elevation and 82 peaks are between 5,000 and 6,000 feet. In the west, the Great Smoky Mountains is the dominant range with several peaks that reach more than 6,000 feet. In the eastern side of the North Carolina Blue Ridge, the highest range is the Black Mountains which extend for some 15 miles and contain a dozen peaks that exceed 6,000 feet in elevation. This group includes Mount Mitchell. At an elevation of 6,684 feet, it is the highest peak in eastern North America. Other prominent ranges from northeast to southwest are the Pisgah Mountains, Newfound Mountains, Balsam Mountains, Cowee Mountains, Nantahala Mountains, Snowbird Mountains, and the Valley River Mountains.

APPENDIX B
GEOLOGIC BELTS OF NORTH CAROLINA

The three major classes of rocks common to North Carolina are igneous, metamorphic and sedimentary. North Carolina has a long and complex geologic history. Although much remains to be learned, detailed geologic studies provide a general understanding of regional geological relationships. The state's geology is best described in belts; that is, areas with similar rock types and geologic history.

Blue Ridge Belt: This mountainous region is composed of rocks that originally formed over one billion to about one-half billion years ago. This complex mixture of igneous, sedimentary and metamorphic rock has repeatedly been squeezed, fractured, faulted and twisted into folds. In most locations, this has altered the nature and appearance of the original rocks. The Blue Ridge belt is well known for its deposits of feldspar, mica and quartz which are basic materials used in the ceramic, paint and electronic industries. Olivine is mined for use as refractory material and foundry molding sand.

Inner Piedmont Belt: The Inner Piedmont belt is the most intensely deformed and metamorphosed segment of the Piedmont. Its metamorphic rocks range from 500 to 750 million years in age. They include gneiss and schist that have been intruded by younger granitic rocks. The northeast-trending Brevard fault zone forms much of the boundary between the Blue Ridge and Inner Piedmont belts. Although this zone of strongly deformed rocks is one of the major structural features in the southern Appalachians, its origin is poorly understood. Crushed stone for road aggregate and building construction is the principal commodity produced.

Kings Mountain Belt: The belt consists of moderately deformed and metamorphosed volcanic and sedimentary rocks. The rocks are about 400 to 500 million years old. Lithium deposits here provide raw materials for chemical compounds, ceramics, glass, greases, batteries, and TV glass.

Milton Belt: This belt consists of gneiss, schist and metamorphosed intrusive rocks. The principal mineral resource is crushed stone for road aggregate and for building construction.

Charlotte Belt: The belt consists mostly of igneous rocks such as granite, diorite and gabbro. These are 300 to 500 million years old. The igneous rocks are good sources for crushed and dimension stone for road aggregate and buildings.

Carolina Slate Belt: This belt consists of heated and deformed volcanic and sedimentary rocks. It was the site of a series of oceanic volcanic islands

APPENDIX B — GEOLOGIC BELTS OF NORTH CAROLINA (*Cont'd*)

about 550 to 650 million years ago. This belt is known for its numerous abandoned gold mines and prospects. (North Carolina led the nation in gold production before the California Gold Rush of 1849.) In recent decades, only minor gold mining has taken place, but mining companies continue to show interest in the area. Mineral production is crushed stone for road aggregate and pyrophyllite for refractories, ceramics, filler, paint and insecticide carriers.

Triassic Basins: The basins are filled with sedimentary rocks that formed about 200 to 190 million years ago. Streams carried mud, silt, sand and gravel from adjacent highlands into rift valleys similar to those of Africa today. The mudstones are mined and processed to make brick, sewer pipe, structural tile and drain tile.

Raleigh Belt: The Raleigh belt contains granite, gneiss and schist. In the 19th century, there were a number of small building stone quarries in this region, but today the main mineral product is crushed stone for construction and road aggregate.

Eastern Slate Belt: This belt contains slightly metamorphosed volcanic and sedimentary rocks similar to those of the Carolina slate belt. Rocks in this belt are poorly exposed and partially covered by Coastal Plain sediments. The metamorphic rocks, 500 to 600 million years old, are intruded by younger, approximately 300-million-year-old, granitic bodies. Gold was once mined in the belt, and small occurrences of molybdenite, an ore of molybdenum, have been prospected here. Crushed stone, clay, sand and gravel are currently mined in this belt.

Coastal Plain: The Coastal Plain is a wedge of mostly marine sedimentary rocks that gradually thickens to the east. The Coastal Plain is the largest geologic belt in the state, covering about 45 percent of the land area. The most common sediment types are sand and clay, although a significant amount of limestone occurs in the southern part of the Coastal Plain. In the Coastal Plain, geology is best understood from studying data gathered from well drilling. The state's most important mineral resource in terms of dollar value is phosphate, an important fertilizer component, mined near the town of Aurora in Beaufort County. Industrial sand for making container glass, flat glass and ferrosilicon, and used for filtration and sandblasting, is mined in the Sand Hills area. The Coastal Plain also produces sand and gravel for construction aggregates.

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Division of Land Resources
PO Box 27687
Raleigh, NC 27687-7611

Contact numbers

(919) 733-2423 (voice)
(920) 733-0900 (facsimile)
e-mail: jeff_reid@mail.ehnr.state.nc.us
http://www.ehnr.state.nc.us/EHNR/DLR/JEFF/rock1.htm

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ncs1440@interpath.com

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT,
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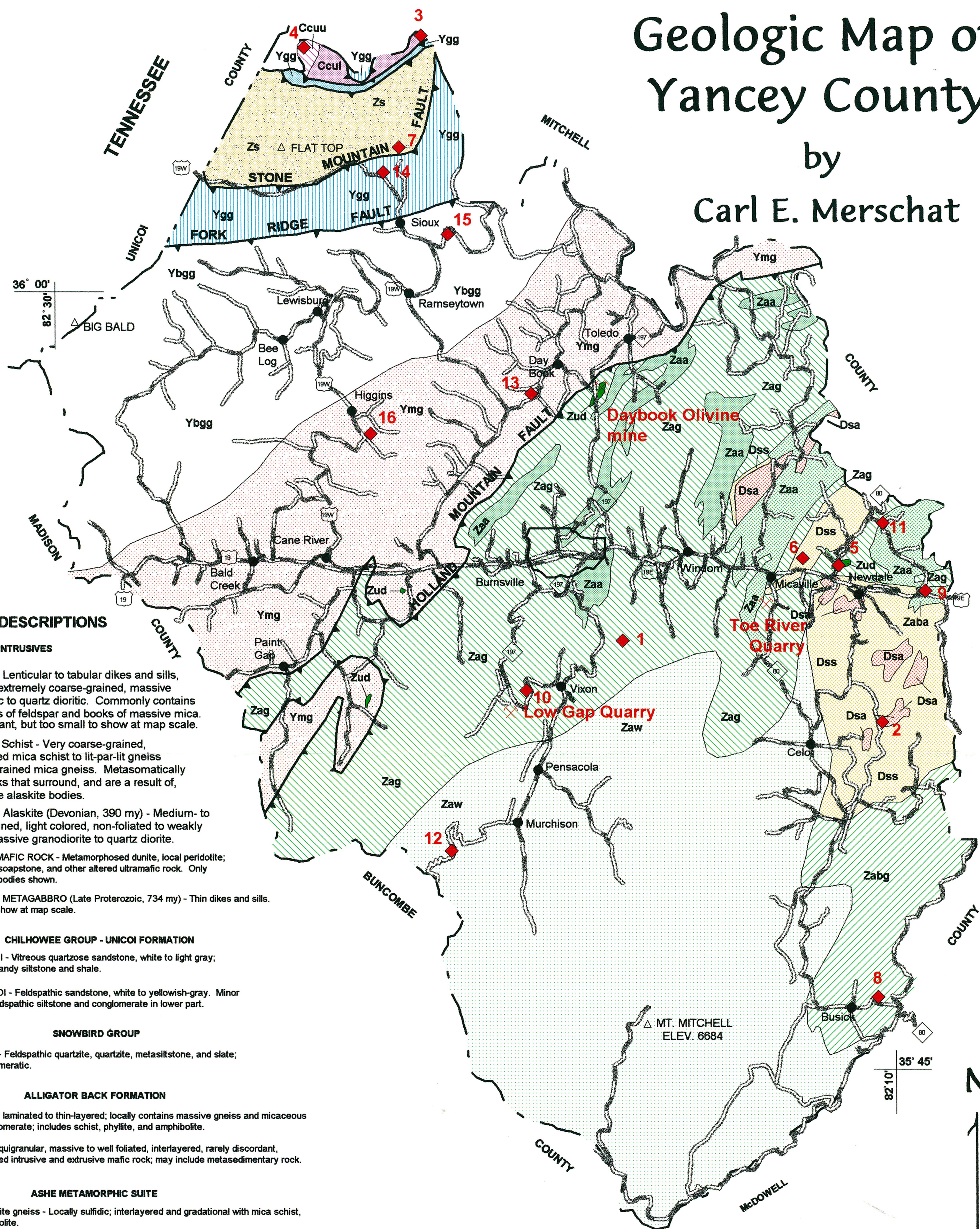
NORTH CAROLINA GEOLOGICAL SURVEY
DIVISION OF LAND RESOURCES

Plate 1

Geologic Map of Yancey County

by

Carl E. Merschat



ROCK DESCRIPTIONS

INTRUSIVES

Pegmatites - Lenticular to tabular dikes and sills, unfoliated, extremely coarse-grained, massive granodioritic to quartz dioritic. Commonly contains large blocks of feldspar and books of massive mica. Very abundant, but too small to show at map scale.

Dss — Spruce Pine Schist - Very coarse-grained, finely foliated mica schist to lit-par-lit gneiss to coarse-grained mica gneiss. Metasomatically altered rocks that surround, and are a result of, the intrusive alaskite bodies.

Dsa — Spruce Pine Alaskite (Devonian, 390 my) - Medium- to coarse-grained, light colored, non-foliated to weakly foliated, massive granodiorite to quartz diorite.

Zud — META-ULTRAMAFIC ROCK - Metamorphosed dunite, local peridotite; serpentinite, soapstone, and other altered ultramafic rock. Only larger dunite bodies shown.

BAKERSVILLE METAGABBRO (Late Proterozoic, 734 my) - Thin dikes and sills. Too small to show at map scale.

CHILHOWEE GROUP - UNICOI FORMATION

Ccuu — UPPER UNICOI - Vitreous quartzose sandstone, white to light gray; interbedded sandy siltstone and shale.

Ccul — LOWER UNICOI - Feldspathic sandstone, white to yellowish-gray. Minor silty shale, feldspathic siltstone and conglomerate in lower part.

SNOWBIRD GROUP

Zs — Metasediment - Feldspathic quartzite, quartzite, metasiltstone, and slate; locally conglomeratic.

ALLIGATOR BACK FORMATION

Zabg — Gneiss - Finely laminated to thin-layered; locally contains massive gneiss and micaceous granule conglomerate; includes schist, phyllite, and amphibolite.

Zaba — Amphibolite - Equigranular, massive to well foliated, interlayered, rarely discordant, metamorphosed intrusive and extrusive mafic rock; may include metasedimentary rock.

ASHE METAMORPHIC SUITE

Zag — Muscovite-biotite gneiss - Locally sulfidic; interlayered and gradational with mica schist, minor amphibolite.

Zaa — Amphibolite - Equigranular, massive to well foliated, interlayered, rarely discordant, metamorphosed intrusive and extrusive mafic rock; may include metasedimentary rock.

Zaw — Metagraywacke - Foliated to massive, locally conglomeratic; interlayered and gradational\ with mica schist, muscovite-biotite gneiss, and rare graphitic schist. interlayered amphibolite and calc-silicate rock.

BASEMENT COMPLEX

Ygg — GRANODIORITIC GNEISS (Middle Proterozoic, 1175 my) - Greenish-gray to pinkish-gray, porphyraoclastic to mylonitic; epidote, sericite, and chlorite common.

Ybgg — BIOTITE GRANITIC GNEISS (Late to Middle Proterozoic, 950 - 1250 my) - Pinkish-gray to light-gray, massive to well foliated, granitic to quartz monzonitic; includes variably mylonitized orthogneiss and paragneiss,

Ymg — MIGMATITIC BIOTITE-HORNBLENDE GNEISSES (Middle Proterozoic, 1214 my) - Layered biotite-granite gneiss, biotite-hornblende gneiss, amphibolite, calc-silicate rock; locally contains relict granulite facies rock.

STRUCTURAL FEATURES

Contact

Thrust fault - sawteeth on upper plate

MINERAL RESOURCES

Active mine (2 crushed stone - 1 olivine)

Representative outcrops of map units.

Scale

0 — 5 miles

Digital representation by Robert H. Carpenter