VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 90 PART C

GEOLOGY OF THE ROCKY MOUNT, GLADEHILL, PENHOOK, AND MOUNTAIN VALLEY QUADRANGLES, VIRGINIA

James F. Conley

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES
Robert C. Milici, Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA
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FRONT COVER: Exposure of metabasalt lava flows on Ball Knob north of State Road 713, near the western city limits of Rocky Mount, Virginia, view looking northwest.

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1989

DEPARTMENT OF MINES, MINERALS AND ENERGY
RICHMOND, VIRGINIA
O. Gene Dishner, Director

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Part (C) Geology of the Rocky Mount, Gladehill, Penhook, and Mountain Valley quadrangles, Virginia, by James F. Conley.

GEOLOGY OF THE ROCKY MOUNT, GLADEHILL, PENHOOK, AND MOUNTAIN VALLEY QUADRANGLES, VIRGINIA

James F. Conley

ABSTRACT

The Rocky Mount, Gladehill, Penhook, and Mountain Valley quadrangles are located in the southwestern Virginia Piedmont. These four quadrangles are underlain by rocks contained in two major structures: the southeast limb of the Blue Ridge anticlinorium and the northwestern part of the Smith River allochthon. These two structures are separated from each other by the Bowens Creek fault, a southeastward dipping fault that shows both wrench and thrust movement, which has been mapped in reconnaissance southwestward into the Brevard zone and northeastward into the Mountain Run fault.

In the south-central part of the area the Smith River allochthon is truncated by the Bowens Creek fault. The allochthon is preserved in an upright broad gentle synformal warp and is shown by structural data and gravity and magnetic modeling to be a thin, sheet-like structure. The structure was emplaced on an almost flat (now folded) thrust, the Ridgeway fault, that bounds the allochthon on both its southeast and northwestern sides and predates the Bowens Creek Fault. The allochthon is composed of metasedimentary rocks subdivided into a lower Bassett Formation and an upper Fork Mountain Formation. These metasedimentary rocks were intruded locally by plutonic rocks of the Martinsville igneous complex. In the study area, the complex is a magma series composed of the Rich Acres Formation, a sequence of diorite-gabbro composition; and the Leatherwood Granite.

The southeastern limb of the Blue Ridge anticlinorium is underlain by rocks of the Lynchburg Group and the Candler Formation. The Lynchburg Group is subdivided into a lower gneiss sequence, Ashe Formation, and an upper schist and gneiss sequence, Alligator Back Formation. The Alligator Back Formation contains ultramafic-gabbro-basalt sequences that are thought to be ophiolites. Chemical analyses of stream sediments indicate anomalously high values for base and precious metals in the vicinity of these mafic and ultramafic rocks. Diabase dikes of Late Triassic-Early Jurassic age intrude rocks of both the Smith River allochthon and the Blue Ridge anticlinorium.

Rocks of both the Blue Ridge anticlinorium and the Smith River allochthon have been polydeformed. Rocks of the anticlinorium have been metamorphosed to greenschist and lower amphibolite facies, whereas the metasedimentary rocks of the allochthon have been polymetamorphosed.

INTRODUCTION

The Rocky Mount, Gladehill, Penhook, and Mountain Valley quadrangles (Publication 90, Parts A and B) are located in Franklin, Pittsylvania, and Henry counties in the southwestern Virginia Piedmont (Figure 1). The research on which this report is based was begun in 1972 by Paul Scheible, who collected stratigraphic and structural data and was able to define an oligoclase isograd in the Lynchburg Formation. The Rocky Mount and Gladehill quadrangles were mapped in detail by Michael B. McCollum (Part A). The Mountain Valley and the Penhook quadrangles were mapped in detail by James F. Conley, Robert G. Piepul, Gilpin R. Robinson, Jr, Earl Lemon, Jr., and Carl R. Berquist, Jr. (Part B). Stream samples for geochemical prospecting were collected by Michael B. McCollum around the Grassy Hill ultramafic body in the Rocky Mount quadrangle and analyses of these samples were made by Oliver M. Fordham, Jr. This report is a summary of the findings of the above mentioned workers.

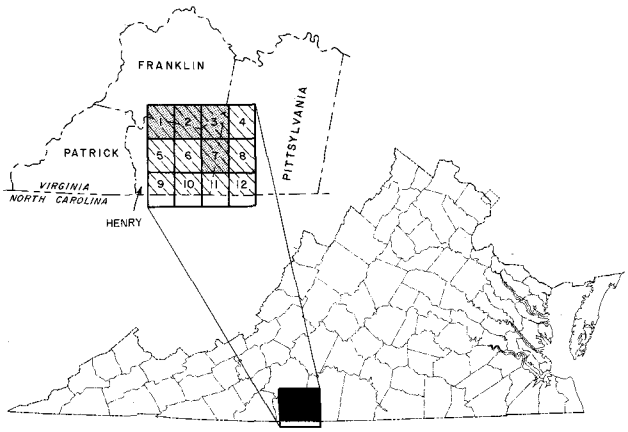

Figure 1. Map of Virginia showing location of study area.

Rocks of these four quadrangles are contained within two major structures; namely the northwestern edge of the Smith River allochthon and the southeastern limb of the Blue Ridge anticlinorium (Figure 2). These two structures are separated by the Bowens Creek fault, a southeastward-dipping, right-lateral wrench fault (Conley and Henika, 1970; Conley, 1988) that shows reactivation and thrust movement that post dates the right-lateral movement. This fault has been

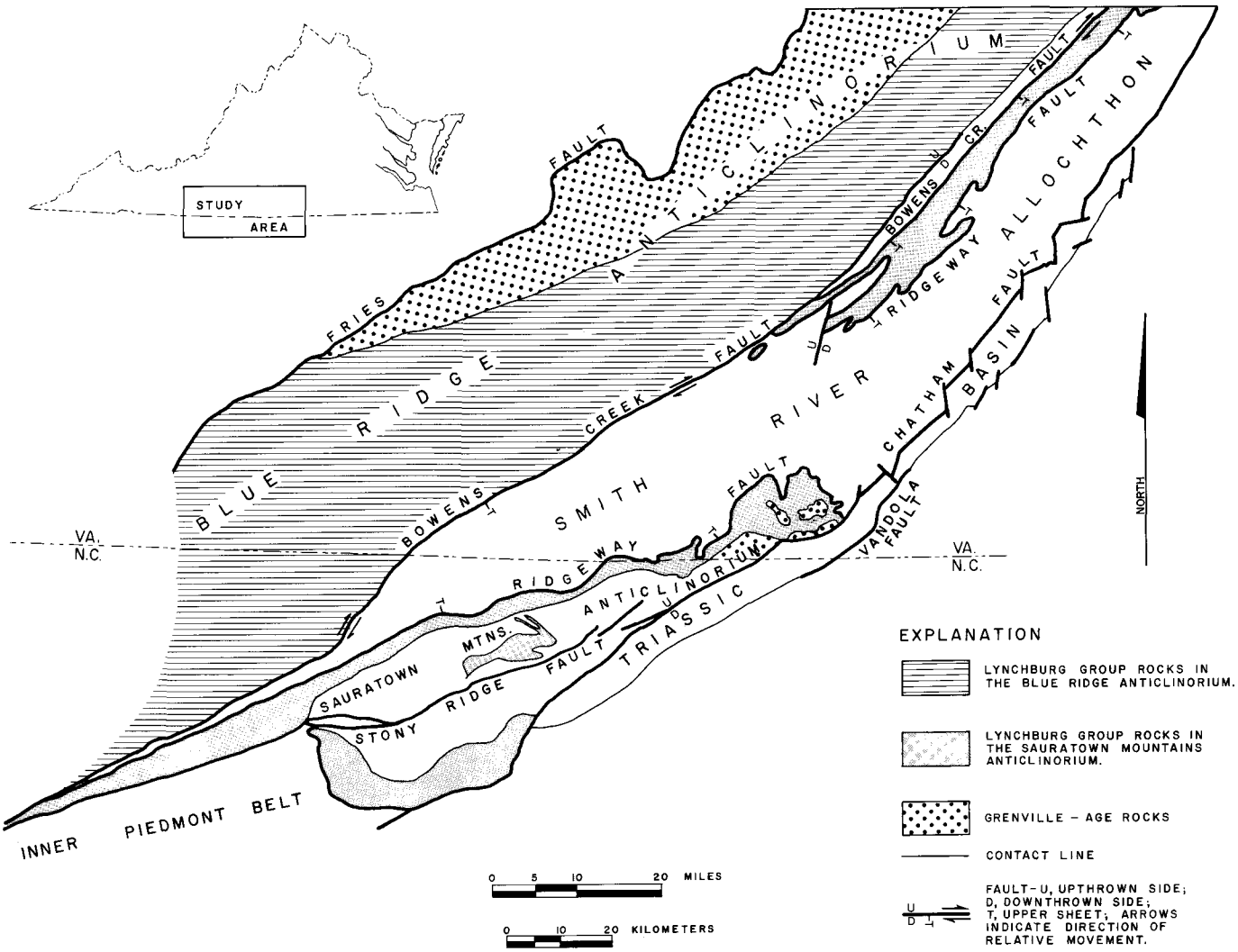

Figure 2. Regional geologic map of southwestern Virginia and northwestern North Carolina Piedmont and Blue Ridge.

traced southwestward by reconnaissance mapping into the Brevard zone of North Carolina (Conley and others, 1971; Espenshade and others, 1975) and northeastward into the Mountain Run fault of central and northeastern Virginia (Conley, 1987).

STRATIGRAPHY

SMITH RIVER ALLOCHTHON

The Smith River allochthon is a major structural feature in the southwestern Virginia Piedmont. Structural data and computer modeling of magnetic and gravity data by Greenberg (1975) indicate that the allochthon is a thin, sheet-like structure. It is composed of a metasedimentary sequence of rocks that has been intruded by rocks of the Martinsville igneous complex. The metasedimentary rocks are subdivided into a lower Bassett Formation and an upper Fork Mountain Formation. These metasedimentary rocks have been metamorphosed on a regional scale at amphibolite grade and later retrograded to greenschist facies (Figure 3). In addition, after retrograde metamorphism occurred, these rocks were intruded locally by plutons of the Martinsville igneous complex. A contact metamorphic aureole developed in the metasedimentary rocks that were in contact with the igneous plutons. As a result of this contact metamorphism, the country rock recrysallized under static conditions, migmatites developed, and sillimanite grew in the vicinity of the plutons. Contact metamorphism dies out in short distances

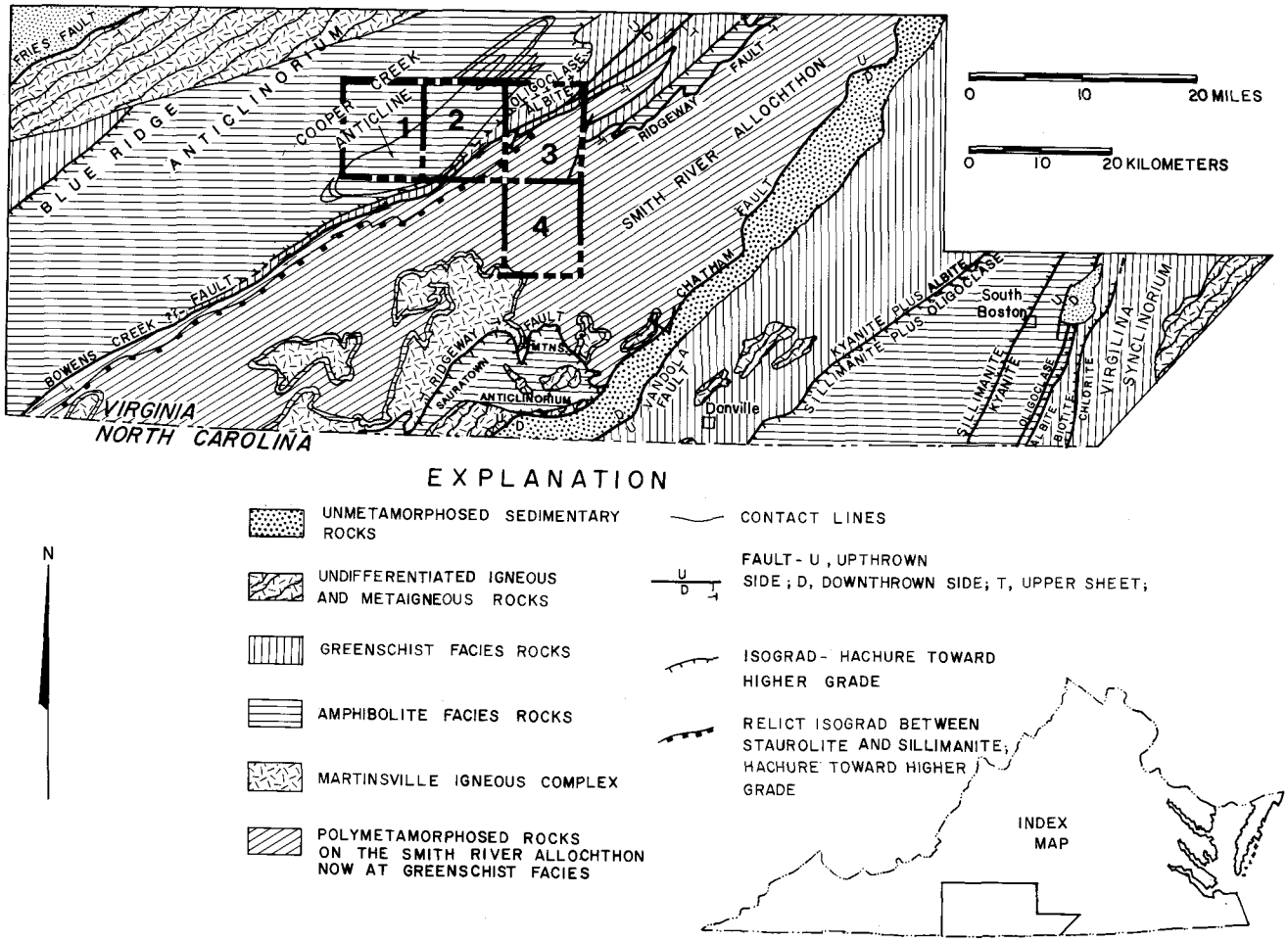

Figure 3. Regional geologic map showing metamorphic grade.

from the plutons. Chloritoid developed on a regional scale in high-alumina pelitic rocks of the Fork Mountain Formation. The development of the chloritoid occurred after the retrograde metamorphism and under static conditions, and probably is coeval with the contact metamorphism. This is indicated by growth of chloritoid porphyroblasts across foliation as unoriented crystals in sites of former retrograde, high-grade, high-alumina minerals.

Rocks of the Smith River allochthon have been correlated with rocks of the Inner Piedmont belt of the Carolinas. The correlation is based on lithologic similarities and on similar age dates of the igneous rocks that intrude the allochthon and the Inner Piedmont belt (Conley and Toewe, 1968; Rankin, 1975; Odom and Russell, 1975; Lemmon, 1981).

Bassett Formation

The lowest unit and probably the oldest stratigraphic unit in the Smith River allochthon is the Bassett Formation. The Bassett occupies several polydeformed domes in the Gladehill, Penhook, and Mountain Valley quadrangles (Plate 1 and Parts A and B). It is subdivided into a lower biotite gneiss unit and an upper amphibolite unit.

Biotite Gneiss

The biotite gneiss, which makes up the lower part of the Bassett, is for the most part a homogenous, equigranular, medium-grained, light- to medium-gray rock. A medium-to-fine banding is shown by the interbedding of quartzo-feldspathic and biotite-rich quartzo-feldspathic layers. Quartz-rich layers (approximately 50 % quartz) and epidote quartzites occur sparingly in the unit. An average composition of the gneiss is about 30 percent quartz, 25 percent oligoclase, 15 percent biotite, 15 percent microcline, and trace amonts (1 to 5 %) of epidote, opaque minerals, zircon, and apatite. In the southern part of the Mountain Valley quadrangle (Plate 1 and Part B), the rocks reached a higher metamorphic grade. In this area, the biotite gneiss locally has developed microcline porphyroblasts and contains coarse quartz-feldspar melt zones parallel to foliation. Along the northwestern boundary of the allochthon, in the Penhook quadrangle (Plate 1 and Part B), the biotite gneiss locally contains disseminated hornblende

grains and thin amphibolite interlayers near the contact with the overlying amphibolite.

Podiform masses of altered ultramafic rocks and elongate bodies of metagabbro occur in profusion in the biotite gneiss that is exposed in the large dome located in the southeastern half of the Penhook and in the northwestern corner of the Mountain Valley quadrangles (Plate 1 and Part B). Gabbros, but not the altered ultramafic rocks, occur in the gneiss exposed in the domes in the southern part of the Mountain Valley quadrangle (Plate 1 and Part B). This melange of gabbros and altered ultramafic rocks shows concordant relationships with layering in the biotite gneiss. The altered ultramafic rocks may contain relict olivine and augite, but are altered predominantly to talc, tremolite, chlorite, serpentine, anthophyllite, opaque minerals, and vermiculite. Some of the bodies are zoned and have an outer shell composed of coarse chlorite that may be altered to vermiculite. The metagabbros are composed of clinopyroxene, orthopyroxene, garnet, hornblende, and plagioclase. Garnets may be surrounded by a corona of plagioclase and have symplectic intergrowths of plagioclase and plagioclase-pyroxene. Such a variety of concordant small mafic and ultramafic bodies in the Bassett Formation suggests the possibility that the melange deposits containing exotic mafic and ultramafic blocks was derived from oceanic crust.

Amphibolite

The upper part of the Bassett Formation is composed of basaltic lava flows that have been metamorphosed into amphibolite. Interlayering of the amphibolite with the upper part of the biotite gneiss along the northwestern part of the allochthon in the Penhook quadrangle (Plate 1 and Part B) indicates a conformable contact between the two units. The amphibolite is thickest along the northwestern boundary of the allochthon (in the Penhook quadrangle) and thins to the southeast, and apparently is absent in the southeastern part of the Mountain Valley quadrangle (Plate 1 and Part B). Where the amphibolite is present, it makes a distinctive horizon marker between the Bassett and the overlying Fork Mountain Formations. The Fork Mountain locally contains thin amphibolite layers, indicating that vulcanism continued across the stratigraphic contact between the Fork Mountain and Bassett Formations.

The amphibolite is a dark greenish-black, foliated, medium- to coarse-grained rock that has a well developed nematoblastic texture. It is composed of about 70 percent hornblende, 15 to 30 percent plagioclase, and may also contain biotite, apatite, actinolite, chlorite, epidote, ilmenite, rutile, magnetite, and sphene. The chemistry of major and trace elements of these rocks are similar to that of continental basalts (Paul C. Ragland, personal communication, 1979; Achaibar and Misra, 1984). Because of the mobility of elements during metamorphism, however assigning these rocks to a continental origin is questionable (Paul C. Ragland, personal communication, 1981).

Fork Mountain Formation

The Fork Mountain Formation is composed of two units: mica schist and biotite gneiss. The contact between the mica schist and biotite gneiss seems to be gradational to intertonguing over relatively short distances. The biotite gneiss is a wedge-shaped mass that thins to the northwest and thickens to the southeast. The mica schist and the biotite gneiss are presumed to be laterally equivalent to each other and may represent a change from pelitic sediments to the northwest to psammitic sediments to the southeast. Along the northwestern boundary of the allochthon, the Fork Mountain is composed almost entirely of mica schist, although even there interlayers of biotite gneiss ranging from 0.5 to 1 m thick have been observed. In the southeastern half of the Gladehill quadrangle (Plate 1 and Part A), the biotite gneiss overlies the Bassett Formation and in turn is overlain by the mica schist unit. In the central part of the Mountain Valley and in the central part of the Penhook quadrangle (Plate 1 and Part B), the biotite gneiss is absent (wedges out?) and the schist unit directly overlies the Bassett Formation.

Mica Schist

The mica schist is a light- to medium-gray, porphyroblastic, fine- to medium-grained, high-alumina metapelite that (because it is a high-alumina rock) is an excellent indicator of metamorphic grade. The mineralogy of the rock is variable and is dependent on grade of regional metamorphism, the amount of alteration that has occurred during subsequent regional retrograde metamorphism, and later contact metamorphism around plutons of the Martinsville igneous complex.

The mica schist defines a regional relict metamorphic isograd that separates staurolite (partially to totally altered to sericite and chlorite) along the northwestern boundary of the allochthon from sillimanite (partially to totally altered to sericite) to the southeast of the isograd. The sinuous trace of the isograd indicates that it has been folded.

Quartz-rich and mica-rich lens-shaped masses occur throughout the mica schist and are interpreted to be pelitic and psammitic beds that have been transposed during metamorphism. High-alumina minerals are, for the most part, confined to the mica-rich layers and some of these layers may be composed of over 50 percent high-alumina minerals. The quartz in the quartz-rich layers occurs as polygonal aggregates, indicating that it has been strained and annealed. Quartzite in thin, generally lens-shaped layers occurs locally in the mica schist. Also present in the mica schist are quartz-mica gneiss interlayers.

The mica schist is composed of muscovite, quartz, garnet, and high-alumina minerals with accessory plagioclase, magnetite and ilmenite. Ilmenite and magnetite in anomalously high concentrations may be present in some layers in the schist. Garnet is ubiquitous and locally concentrated in bands in the staurolite zone. Northwest of the sillimanite isograd, the staurolite crystals that formed during regional metamorphism are large (1 to 7 cm), generally twinned, and are partially to totally altered to pseudomorphous sericite. Southeast of the sillimanite isograd, fibrolite bundles have developed and are approximately the same size as the staurolite crystals indicating that fibrolite formed from staurolite with increasing metamorphic grade. These fibrolite bundles have also been partially to completely altered to sericite. Locally, post-tectonic chloritoid porphyroblasts have nucleated and grown in these sites of sericite after staurolite and sericite after sillimanite. Biotite occurs in the rock, but southeast of the staurolite-sillimanite isograd biotite is almost universally altered to chlorite. This alteration of biotite to chlorite to the southeast indicates that the later regional retrograde alteration in these rocks was more intense to the southeast. In this same region, the biotite in the underlying biotite gneisses of the Bassett Formation and biotite in the biotite gneiss unit of the Fork Mountain Formation are not appreciably altered to chlorite.

Biotite Gneiss

The biotite gneiss of the Fork Mountain Formation is a high-alumina, medium-gray, compositionally-banded rock composed of interlayered quartzo-feldspathic gneiss and garnetiferous muscovite-biotite gneiss. Epidote-quartz boudins, ranging from 5 to 20 cm thick, are scattered throughout the gneiss and may represent original carbonate-rich sandstones. Also present are masses of quartzite, feldspathic gneiss, and epidote-quartz rocks that appear to be floating in a matrix of biotite gneiss. Rankin (1975) has compared this rock with the diamictite facies of the Wissahickon Formation (Conowingo gneiss), which is considered to be submarine slide breccia.

The biotite gneiss is composed of about equal amounts of quartz (some of which is blue quartz) and plagioclase and varying amounts of biotite, muscovite, microcline, garnet, and high-alumina minerals. The high-alumina minerals are partially to totally altered to pseudomorphous sericite. Other minerals identified (generally in trace amounts) are epidote, allanite, zircon, tourmaline, spinel, hornblende, rutile, and opaque minerals. Garnet and high-alumina minerals are found primarily in the biotite-rich layers, indicating that they probably were originally more alumina-rich pelitic layers, whereas the quartzo-feldspathic layers were probably of arkosic or graywacke composition.

Where the biotite gneiss was intruded by rocks of the Martinsville igneous complex in the south-central and southwestern parts of the Mountain Valley quadrangle (Plate 1 and Part B), numerous quartz-feldspar pegmatites and local migmatite zones developed.

Martinsville Igneous Complex

The Martinsville igneous complex, informally named by Ragland (1974), is composed of three units: the Rich Acres Formation (Conley and Henika, 1973), the Leatherwood Granite (Jonas, 1928), and an unnamed younger norite. The Leatherwood Granite has a U/Pb age of 450 m.y. determined from zircons (Rankin, 1975) and a Rb/Sr whole-rock age of 457 $\pm$ 16 m.y. (Odom and Russell, 1975). A. K. Sinha (personal communication, 1988) recently has dated the Leatherwood as being Cambrian age using the U/Pb method. Field evidence (Conley and Toewe, 1968; Conley and Henika, 1973) and strontium isotopic ratios (Ragland and others, in preparation) indicate that the Rich Acres and Leatherwood are a co-genetic rock series that form a relatively uncommon high-potassium calc-alkaline, Andean trench type plutonic sequence, which because of the coexistence of orthopyrexene and biotite indicates emplacement at a pressure range equivalent to 25 to 30 km of burial (Allison and others, 1984; Paul C. Ragland, 1988, personal communication). These rocks show alteration at greenschist grade and some development of a shear foliation, indicating that they were subjected to retrograde metamorphism and shearing. In contrast, the unnamed norite was derived from a separate magma and was emplaced in a post-tectonic environment (Ragland and others, in preparation). The Leatherwood occurs along the southern boundary of the Mountain Valley quadrangle (Plate 1 and Part B) and the Rich Acres crops out in the extreme southwestern corner of the quadrangle. The norite has not been identified in the area of study.

Rich Acres Formation

In the extreme southwestern part of the Mountain Valley quadrangle (Plate 1 and Part B), rocks of the Rich Acres Formation have intruded the biotite gneiss of the Fork Mountain Formation. The two separate outcrop areas of the Rich Acres are connected to the south beyond the southern border of the quadrangle and are part of the same pluton (Price and others, 1980). This pluton is concordant to slightly discordant. The rock is medium grained, dark greenish gray with an ophitic to subophitic texture. Rocks of the formation are in general of a borderline composition between gabbro and diorite. These rocks are composed of plagioclase, green hornblende, reddish-brown biotite, pale-green clinopyroxene, and uralite, and may contain vermicular intergrowths of quartz in hornblende and plagioclase.

Leatherwood Granite

The Leatherwood Granite occurs in several small plutons along the southern boundary of the Mountain Valley quadrangle (Plate 1 and Part B). The Leatherwood is a porphyritic, light-gray biotite granite that generally shows rapakivi texture, but may be partially composed of coarse, equigranular leucocratic granite. An average composition of the rock is 40 percent microcline, 20 percent plagioclase (oligoclase), 25 percent quartz (some of which is blue quartz), 10 percent biotite, and 5 percent muscovite. Also present may be minor amounts (greater than 2 percent) of epidote, clinozoisite, apatite, sphene, zircon, and opaque minerals. Microcline phenocrysts occur in a xenomorphic-granular muscovite-biotite-plagioclase-quartz-microcline matrix. Cataclastic textures are locally developed in the Leatherwood and it may contain distinct shear zones. Microcline phenocrysts and their rapakivi rims are locally embayed by post tectonic (unsheared) globular masses of intergrown vermicular quartz and albite.

Muscovite-biotite-quartz-microcline pegmatites cut both the Rich Acres and the Leatherwood. Some of the pegmatites are sheared and others are not. The sheared pegmatites are probably associated with the Leatherwood, and the unsheared pegmatites are post Leatherwood and were emplaced as post-tectonic intrusions.

BLUE RIDGE ANTICLINORIUM

Rocks of the Blue Ridge anticlinorium underlie the Rocky Mount, the major part of the Gladehill (Plate 1 and Part A), and the northwestern half of the Penhook quadrangles (Plate 1 and Part B). In these quadrangles, the anticlinorium is composed of rocks of the Lynchburg Group and the Candler Formation. The Lynchburg was raised to group status by Furcron (1969) and in the study area (Plate 1 and Parts A and B) includes a lower unit, the Ashe Formation named by Rankin (1970) and an upper unit, the Alligator Back Formation named by Rankin and others (1973).

Lynchburg Group

Ashe Formation

The Ashe Formation is a massive gneiss exposed in the core of the Cooper Creek anticline. This rock was previously correlated with the Moneta Gneiss (Conley and Henika, 1970); however, present mapping indicates that the Moneta Gneiss contains rocks of both the Ashe and overlying Alligator Back Formations. Therefore, the validity of the Moneta is questionable and it is here abandoned as a stratigraphic term.

The Ashe Formation is composed primarily of two-mica plagioclase gneiss that is uniform in composition, except for gneissic banding produced by oriented micas. The Ashe is unlike the overlying Alligator Back Formation, which is composed of a heterogenous mixture of interlayered gneisses, schists, marbles, quartzites, metabasalts, metagabbros, and ultramafic rocks. The top of the Ashe Formation is in contact with ultramafic rocks, metagabbros, and metabasalts that are located at the base of the Alligator Back. Graphite, which is ubiquitous in the metasedimentary rocks of the Alligator Back Formation, is almost totally absent from the Ashe Formation. Oligoclase is the common feldspar in the plagioclase gneiss of the Ashe and microcline is rarely observed in the unit. This is in contrast to the Alligator Back, which contains rounded clasts of both microcline and plagioclase. The Ashe contains quartz-feldspar pegmatites and small granitoid intrusions not observed in the Alligator Back.

Much of the Ashe Formation in this area is porphyroblastic with plagioclase porphyroblasts ranging up to 6 cm across. Some of the porphyroblasts are sheared and attenuated, and locally have been bent by crenulation cleavage. At the contact with the overlying Alligator Back Formation, the Ashe has developed a flaggy foliation that appears to be parallel to the contact between the two rock units. Thin mylonite zones are also present in this plagioclase gneiss near its contact with the overlying Alligator Back.

The Ashe contains 30 to 45 percent quartz, 35 to 40 percent plagioclase and up to 20 percent biotite. Muscovite is not present in all samples, but in a few thin sections it makes up as much as 15 percent of the rock. Other minerals that may be present are clinozoisite cored by allanite, sphene, apatite, and opaque minerals. An x-ray analysis from material about 1 mile north of Sontag in the Gladehill quadrangle indicates the presence of rutile and ilmenite.

Alligator Back Formation

The Alligator Back Formation is composed of metamorphosed ultramafic rocks, gabbros, and basalts, and a clastic sequence of interlayered metagraywacke conglomerates, graphitic schists, and pelitic schists. It also contains muscovite-sericite schist, impure marble and quartzite. With the exception of the metabasalts, stratigraphic horizon markers are not traceable over great distances and lithologic units tend to be lenticular. Metaigneous, metavolcanic, and metasedimentary rocks occur in sequences (from bottom to top) in the Alligator Back section and appear to be repetitive. Metamorphic grade in the rocks ranges from upper greenschist in the northeastern part of the area to lower amphibolite in the southwestern part (Figure 3).

Meta-igneous Rocks

Sequences of metagabbro overlain by metabasalt occur at the base and higher in the section of metasedimentary

rocks that make up the Alligator Back Formation. McCollum mapped small bodies of ultramafic rock within the metasedimentry rocks in the Rocky Mount quadrangle (Plate 1 and Part A). Three large bodies of ultramafic and mafic metaigneous rocks underlie Grassy Hill (Plate 1 and Part A), Jacks Mountain (Plate 1 and Part B), and Brier Mountain (Plate 1 and Part A). All three of these mountains are underlain by ultramafic rock, metagabbro and metabasalt.

Ultramafic rocks: The ultramafic rocks consist of metamorphosed dunites and metapyroxenites. They are almost totally altered to serpentine, talc, chlorite, and tremolite but may contain relict olivine and augite. Opaque minerals occur in accessory amounts. Chlorite is altered to vermiculite around the margins of the ultramafic bodies, and these bodies may be cut by veins of anthophyllite.

Metagabbro: The metagabbros are composed of actinolite (that in part is uralitic amphibole), albite, epidote, chlorite, and minor amounts of zircon, quartz, sphene, ilmenite, magnetite, and the relict minerals augite and epidotized calcic plagioclase. Some of the metagabbro is layered. The metagabbro bodies are generally coarser grained and lighter colored toward the center and locally show relict ophitic textures. The metagabbros may be sheared and altered to actinolite schist near contacts with metasedimentary rocks. Thin, massive, magnetite-bearing quartzites overlay the metagabbros in the area just west and southwest of Rocky Mount (Plate 1 and Part A). The metagabbros are intruded by amphibolite dikes that could have been feeders for the overlying metabasalts. Magnetite deposits occur at or near the perimeters of the metagabbros and were mined for iron ore in the 18th and 19th centuries.

The contact between the ultramafic-mafic body that forms Grassy Hill and the underlying metasedimentary rocks of the Ashe Formation was exposed during field mapping of the area. No contact metamorphism could be detected in the underlying metasedimentary rocks and the metaigneous rocks at this contact were sheared into chloritic phyllonites in a zone about 1 meter wide. If a gabbroic and ultramafic pluton the size of the Grassy Hill body had intruded the sedimentary rocks, it should have produced a recognizable hornfels zone in the surrounding sedimentary rocks (Jaeger, 1964). Both the igneous and sedimentary rocks have been regionally metamorphosed at relatively low grade and such a metamorphic contact, at least as a relict, should be preserved. In fact the writer has found preserved metamorphic auroles at the contact between gabbro and metasedimentary rocks of the Lynchburg Group at Schuyler in central Virginia and west of Culpeper in north-central Virginia. At Grassy Hill, however, neither the ultramafic rocks nor the metagabbros have produced contact metamorphism, which should have been preserved in the adjacent low metamorphic rank metasedimentry rocks. The lack of a metamorphic aureole around the Grassy Hill pluton may indicate that these metaigneous rocks did not intrude as a hot molten magma into the metasedimentary rocks that now surround them, but rather that the metasedimentary and metaigneous rocks were brought in contact with each other by tectonic transport after the metaigneous rocks had cooled and solidified. The contcts between metasedimentary and metaigneous rocks are narrow shear zones (1 to 3 feet across). Probably Taconic metamorphism erased much of the evidence for tectonic transport of these metaigneous bodies.

Metabasalt: Dark greenish-black basalts that are metamorphosed to foliated, fine-grained amphibolites generally overlie the metagabbros. The metabasalts are, in turn, interlayered with and overlain by metasedimentary rocks. The amphibolites are composed of nematoblasts of actinolite and variable amounts of epidote, chlorite, albite, and quartz. The metabasalts are generally massive but locally contain sparse, small (2-3 mm), flattened masses filled with intergrown epidote, albite, and quartz that might be amygdules, and lens-shaped structures that could represent transposed flow banding, pillow structures, or both.

Metasedimentary Rocks

Metagraywacke: The metagraywackes in the Alligator Back are gray gneissic rocks composed of sand- to granule-size clasts of quartz and feldspar in a finer-grained, quartz-feldspar-mica matrix. Graded bedding is common in the metagraywackes. The basal bed of some graded cycles is a structureless granule conglomerate that, near its top, grades upward into mica schist. These rocks are generally interlayered with mica and graphite schists and are variable in thicknesses. The graphite schists occur sparingly throughout the metagraywackes as distinct layers that generally occur on top of graded metagraywacke beds. Locally, the metagraywackes may be either thick repetitive sequences of graded beds, or thin lenses and interbeds. The lower parts of the metagraywacke layers are composed of quartz, microcline, perthite, plagioclase, muscovite, and biotite. The metagraywackes may also contain small amounts (generally 5 percent) of epidote, sphene, ilmenite, calcite, garnet, chlorite, zircon, and magnetite. The metagraywackes on the northwestern flank of the Cooper Creek anticline and in a second area in the northwestern part of the Rocky Mount quadrangle (Plate 1 and Part A), are medium grained and contain large amounts of interlayered quartz-mica schist.

Mica Schist: In the southwestern part of the Rocky Mount quadrangle (Plate 1 and Part A) light-gray, quartz-mica schist that has a silvery luster occurs both as interlayers in the metagraywackes and as a distinct mappable unit containing interlayered metabasalts . The rock is composed of varying amounts of biotite, muscovite, and quartz and minor amounts of tourmaline, garnet, plagioclase, microcline, and ilmenite.

It contains disseminated graphite and may contain thin layers of graphite schist.

Graphite Schist: Graphite schist occurs as a distinct mappable unit across the central part of the Rocky Mount quadrangle (Plate 1 and Part A) and as lens-shaped masses in the Penhook quadrangle (Plate 1 and Part B). This rock is gray to grayish black and is composed of varying amounts of graphite, muscovite, chlorite, and quartz. Locally, it may contain enough quartz to be a fine grained quartz-graphite schist. Accessory minerals include pyrite, ilmenite, and garnet. Biotite may replace chlorite at higher metamorphic grade.

Marble: White and gray, fine-to coarse-grained marbles are interlayered with the metagraywackes in the northeastern part of the Rocky Mount quadrangle and in the northwestern part of the Gladehill quadrangle (Plate 1 and Part A). Small lenses of marble also occur in the metagraywackes in the central part of the Penhook quadrangle (Plate 1 and Part B). Most of the marble is gray, finely laminated, and contains thin, quartz-rich layers and numerous mica schist partings.

Quartzite: Gray, massive quartzite overlies metagabbro just west of Rocky Mount. The rock is composed of quartz and accessory magnetite. Upon weathering, it decomposes to friable grains of rusty-brown saccharoidal quartz.

Ophiolites?

The repeated stratigraphic sequences consisting of altered ultramafic rocks overlain by metagabbros, overlain by metabasalts that interfinger with overlying metasedimentary rocks within the Alligator Back is stratigraphic evidence that these sequences might represent ophiolites and their cover rocks (Conley, 1981; 1985). If these sequences of ultramafic and mafic rocks are ophiolites, they are generally incomplete; the ultramafic rocks are most likely to be absent. Some sections contain metagabbro overlain by metabasalt; however, in a number of localities metabasalt may be the only representative of what could have been an ophiolite sequence. Small lens-shaped masses of gabbro cored by ultramafic rock are mapped by McCollum west and northwest of Rocky Mount (Plate 1 and Part A) and might represent dismembered and overturned ophiolite sequences.

Shear zones are detectable at the base of some of the ultramafic-metagabbro-metabasalt units in the Alligator Back, including those that directly overlie the Ashe Formation. Ultramafic rocks in these shear zones have been converted to chlorite, vermiculite or both. In the Gladehill quadrangle (Plate 1 and Part A), a flaggy foliation is developed in the rocks at the top of the Ashe Formation, just below their contact with the overlying Alligator Back. This foliation is parallel to the contact with the ultramafic-metagabbro-metabasalt (ophiolite?) sequence at the base of the Alligator Back Formation and probably formed at the same time as the development of the shear zones at the base of the mafic igneous rocks in the Alligator Back. These shear zones probably developed during later Paleozoic tectonic events. Because of their relationship to the metaigneous units, however, they might have formed in part during emplacement of the ophiolites and their cover rocks.

Age of the Lynchburg Group

The Lynchburg Group has been considered to be of Late Precambrian age since the discovery of the Rockfish conglomerate at its base by Nelson (1932). This basal conglomerate proved that the Lynchburg unconformably overlies Grenville age plutonic rocks and was not intruded by them (Jonas and Stose, 1939). Fullagar and Dietrich (1976) found that Sr/Rb whole-rock age dates in the Lynchburg are 520 to 583 m.y. north of latitude 36° 52' N; however, they record an age of 350 to 402 m.y. south of this latitude. They propose that rocks south of this latitude have been affected by a younger metamorphic event. They further propose, that to the north, rocks affected by the younger event are present, but lie buried beneath rocks that record the older event. This interpretation would, therefore, imply that rocks that record the younger event have been overthrust by rocks that record the older event. Mose and Conley (1983) find that the Ashe Formation and Alligator Back Formation both yield Sr/Rb whole-rock ages of 520 to 580 m.y. at greenschist metamorphic grade; in areas of higher metamorphic grade, they yield ages of about 350 m.y. This work confirmed the previous findings of Fullagar and Dietrich (1976) and indicates a later, higher-grade metamorphic overprint to the south. Mose and Conley (1983) conclude that sedimentary and volcanic rocks can be isotopically homogenized during metamorphism that is higher in rank than a previous metamorphism; also rocks that have been previously metamorphosed at higher rank are not homogenized during a later, lower grade metamorphism. As both the Ashe and Alligator Back Formations were affected by both the older and the younger metamorphic events they were probably deposited in the Late Precambrian and were affected later by both an older and a younger tectonic event. The younger (Acadian?) event probably affected the whole Lynchburg Group, and was intense enough to isotopically homogenize the Lynchburg south of latitude 36° 52' N, and thus reset the isotopic clocks south of this parallel of latitude.

The presence of possible ophiolites at different horizons in the Alligator Back (Conley, 1985) indicates that the metasediments which make up the majority of the formation were deposited on oceanic crust. The formation now is composed of fault repeated sequences of oceanic crustal rocks overlain by sedimentary rocks. It is thought that this thrusting occurred at the end of the sedimentary cycle in latest

Precambrian or earliest Cambrian time. The Lynchburg had to be emplaced onto the eastern edge of the North American craton before the vast outpouring of continental basalts of the Catoctin Formation, which occurred in the initial stages of the rifting event that produced the Iapetus Ocean (Reed, 1955; Dewey and others, 1973; Conley, 1978). The older (520 to 583 m.y.) radiometric dates obtained from the Lynchburg north of latitude 36 52 N by Fullagar and Dietrich (1976) and the younger dates (350 to 402 m.y.) obtained from the Lynchburg south of this latitude can possibly also be explained by later deep burial of the Lynchburg rocks to the southwest during the Acadian event. Major crustal shortening, on the order of 150 to 200 miles, was proposed by Harris and others (1982) along the Interstate Highway 64 VIBROSEIS traverse. They found that rocks that were traceable into known occurrences of the Lynchburg underlay much of the Virginia Piedmont as far east as Richmond. Palinspastic reconstruction of the Interstate Highway 64 VIBROSEIS traverse would extend Lynchburg rocks eastward at least to the present coast line. In addition, the Lynchburg and its equivalent rocks are exposed from northern Virginia to Alabama (Williams, 1978; Conley, 1978), which gives some indication of the vast size of the basin in which the Lynchburg was deposited.

Candler Formation

Rocks of the Candler Formation are exposed in the northeast part of the Penhook quadrangle (Plate 1 and Part B). In central Virginia, the Candler Formation overlies the predominantly continental basalts of the Catoctin Formation, which, in turn, overlie rocks of the Lynchburg Group (Conley, 1978). Further to the southwest, in the area northeast of the City of Lynchburg, the Candler directly overlies the Lynchburg without a detectable unconformity (Patterson, 1987). In the area of study, the Candler is in fault contact with the Lynchburg (Berquist, 1980), both at its base and top (PLate 1 and Part B).

The Candler exposed in the Penhook quadrangle (Plate 1 and Part B) is a highly deformed medium- to dark-gray and greenish-gray sericite-chlorite phyllite that weathers to a moderate pink and pale red-purple saprolite. Porphyroblasts of magnetite and chloritoid occur locally and have grown across foliation. Quartzite layers, up to 3 cm thick, occur sparingly throughout the unit. Some thin sections reveal thin layers of quartzite, only a single grain thick, interlayered with 1 to 5 mm thick phyllite layers. Some of the unweathered phyllites in the Candler are dark gray and resemble graphite phyllites. Investigations by C. R. Berquist, Jr. (personal communication) and by the writer, however, indicate that the dark-gray color is not due to graphite but rather is due to chlorite.

Diabase Dikes

Swarms of north to northwesterly and rarely northeasterly trending, generally en echelon diabase dikes occur throughout the area. These dikes are of Late Triassic or Early Jurassic age (Dallmeyer, 1975). The dikes are medium gray to black. They may contain medium-grained gabbro in the centers of larger intrusive bodies. The diabases are moderately resistant to chemical weathering, which begins along joint surfaces and proceeds inwardly into the rock. Weathering produces spheroidally weathered boulders and ocherous saprolite.

The diabases are composed of about 50 percent calcic plagioclase (An) and about 30 percent augite. Olivine may be present and magnetite is the major accessory mineral. At contacts with country rock, the minerals chlorite, as an alteration of pyroxene, and sericite, as an alteration of feldspar, may occur. Zeolites are rare in the diabases examined in thin section.

STRUCTURE

FOLDS

Smith River Allochthon

The Smith River allochthon is a structure which underlies the Mountain Valley and the southeastern parts of the Penhook and Gladehill quadrangles (Plate 1 and Parts A and B). It is a northeastward-trending, polydeformed, rootless structure preserved in an open synform (Figure 2).

The earliest folds (F_1) are seen at outcrop scale. These folds are extremely transposed and their limbs are parallel to the plane of foliation. For this reason they probably do not greatly affect the outcrop patterns of rock units. Many of the observed F_1 folds as seen in both outcrop and thin section are hook-shaped, rootless fold noses. A second set of folds (F_2) can be observed at map scale and are the major folds of the allochthon. An example of an F_2 fold is the antiform cored by gneisses of the Bassett Formation with rocks of the Fork Mountain Formation on either limb, located in the southeastern half of the Penhook quadrangle (Plate 1 and Part B). These folds have a trend that is about N45°E ; they have been warped into basin and dome structures by the later, more northerly trending F_3 folds. The axial planes of F_2 folds dip to the southeast and they have developed a penetrative cleavage, which is the major schistosity observed in the allochthon.

A later set of more northerly trending upright folds (F_3) has refolded the F_2 folds. The F_3 folds warp both the rocks of the thrust sheet and those of the Blue Ridge anticlinorium. Examples of F_3 folds are the window and half-window located in the west-central part of the Penhook quadrangle (Plate 1 and Part B).

Blue Ridge Anticlinorium

The earliest folds recognized in the Blue Ridge anticlinorium (F_1) are steeply plunging isoclines. These structures have been refolded by a set of gently plunging folds (F_2). The F_1 and F_2 folds have been warped by large gently plunging, open, northeast-trending structures (F_3) that are thought to be similar to the F_3 structures observed in the Smith River allochthon.

In the area of study, the major structure in the Blue Ridge anticlinorium is the Cooper Creek anticline, which occupies the northwestern corner of the Penhook, the central part of the Gladehill and the southeastern part of the Rocky Mount quadrangles (Plate 1 and Parts A and B). The anticline is cored by the Ashe Formation with rocks of the Alligator Back Formation dipping off both its southeastern and northwestern limbs. The structure is an interference fold produced by refolding of F_1 and F_2 structures by open F_3 folds.

Large northwest-trending open folds (F_4), first recognized by Conley and Toewe (1968), have warped the rocks of both the Smith River allochthon and the Blue Ridge anticlinorium. These folds have gently folded preexisting northeast-trending structures and can be recognized by an undulatory map pattern produced by the harmonic gentle folding of the axial surfaces of older northeast trending-folds. These northwest-trending folds have warped the Cooper Creek anticline in the east-central part of the Rocky Mount quadrangle (Plate 1 and Part A).

FAULTS

Ridgeway Fault

The Ridgeway fault was first observed in the southeastern part of the Martinsville West quadrangle (Conley and Henika, 1973), where it was recognized as a folded northwest-dipping tectonic slide surface that is the bounding fault of the Smith River allochthon (Figure 2). It is the thrust fault on which rocks of the Smith River allochthon were emplaced over the rocks of the Sauratown Mountains anticlinorium. These rocks of the Sauratown Mountain anticlinorium underlie the allochthon and extend beyond the northwestern boundary of the allochthonin the northeastern part of the Penhook quadrangle (Figure 2, Plate 1 and Part B). In the west-central and central parts of the Penhook quadrangle (Plate 1 and Part B), the Ridgeway fault is exposed in an elongate northeast-trending window located along Walker Creek west of Dickenson and in a parallel elongate northeast-trending half-window that can be traced in a northeasterly direction from Dickenson to the Pigg River, where both the Ridgeway fault and the half-window are truncated by the younger Bowens Creek fault. In both the window and the half-window, rocks of the underlying Lynchburg Group make up the footwall of the Ridgeway fault and are overlain by rocks of the Smith River allochthon in the hanging wall (Figure 2). In the Penhook quadrangle (Plate 1 and Part B) the Lynchburg rocks that underlie the allochthon (and are the cover rocks that unconformably overlie Grenville basement in the Sauratown Mountains anticlinorium to the south) are at a higher metamorphic grade than rocks of the Lynchburg Group found in the Blue Ridge anticlinorium (Figures 2 and 3). These rocks are at amphibolite grade, whereas Lynchburg rocks are at greenschist grade northwest of the Bowens Creek fault in the adjacent Blue Ridge anticlinorium.

The fault plane of the Ridgeway is marked by a narrow zone of cataclastic rocks that ranges from 5 to 10 m across. The actual fault zone has been observed only in a few places and is almost impossible to detect in saprolite. The presence of the fault is generally determined by an abrupt change in rock type and an abrupt change in structural style from recumbent folds with sub-horizontal fold axes in the allochthon to rather constant, high-angle southeastward dipping foliation in the rocks of the underlying Sauratown Mountains anticlinorium. The fault is also marked by an abrupt change in metamorphic gradient, from high-rank rocks of the allochthon now retrograded to greenschist grade but containing metastable upper amphibolite relict assemblages, to footwall rocks of the Sauratown Mountain anticlinorium that exhibit a single prograde, upper greenschist to lower amphibolite grade rocks of metamorphism. As previously noted, rocks both above and below the fault surface have been folded by a later fold system, indicating that this folding took place during or after emplacement of the allochthon.

Bowens Creek Fault

In the area of study (Plate 1 and Figure 2) the Bowens Creek fault separates rocks of the Blue Ridge anticlinorium to the northwest from rocks that compose the Smith River allochthon and underlying rocks of the Sauratown Mountains anticlinorium to the southeast. The Bowens Creek fault was first described by Conley and Henika (1970) and was traced by Conley and others (1971) into the Brevard zone. Later work (Conley and Henika, 1973; Marr, 1984; Conley, 1987; Berquist, 1988), shows that this fault can be traced as a fairly straight line in a northeasterly direction into the Mountain Run fault system of north-central Virginia. The Bowens Creek is a steeply southeastward-dipping zone of shear and cataclasis that, in the Gladehill quadrangle (Plate 1 and Part A), is up to 0.48 km across. In the Gladehill quadrangle (Plate 1 and Part A), McCollum has recognized several back-limb splay thrusts that have developed in the hanging wall of the fault above the major zone of shearing and cataclasis.

A number of researchers have recognized that the Bowens Creek has a thrust component (Conley and Henika, 1970; Rankin and others, 1972; Conley and Henika, 1973;

Espenshade and others, 1975; Marr, 1984; Berquist, 1988). Conley and Henika (1970), however, were the first reseachers to propose that the Bowens Creek fault had a lateral component and postulated that the fault could have been produced by differential movement along a wrench fault system. This latest component was confirmed by Gates (1987). Bobyarchick (1984, 1987), and Edelman and others (1987) also have shown that the Brevard zone, the on-strike extension of the Bowens Creek fault (Conley and others, 1971), has a wrench component in a right-lateral sense. In addition, Edelman and others (1987) present evidence that the fault originally developed as a right-lateral shear zone during the Alleghanian orogeny and developed its thrust component at a later time during the Alleghanian.

The Bowens Creek fault lies along the western border of the Smith River allochthon to about the central part of the Penhook quadrangle (Figures 2 and 3, Plate 1, and Part B). Along strike to the northeast this fault seperates low rank (greenschist facies) rocks of the Lynchburg Group and overlying Candler Formation of the Blue Ridge anticlinorium from high-rank (lower amphibolite facies) rocks of the Lynchburg Group to the southeast. These higher rank, lower amphibolite grade rocks of the Lynchburg Group underlie the Smith River allochthon and are exposed in the Sauratown Mountains anticlinorium where they unconformably overlie Grenville basement rocks (Figure 2).

Unnamed Normal Fault

A normal fault separates the Candler Formation on its hanging wall to the southeast from the rocks of the Lynchburg Group on its foot wall to the northwest (Figure 2, Plate 1, and Part B). The fault surface dips southeastward at angles of about 50 degrees and merges with the Bowens Creek fault in the northeastern part of the Penhook quadrangle. At their juncture, these two faults entirely cut out the Candler Formation and it is not exposed to the southeast along strike. Southwestward from this juncture only a single fault, the Bowens Creek fault, can be traced to the southwest along strike. Exposures of the Lynchburg-Candler contact indicate that this fault might extend northeastward to the City of Lynchburg, but to the northeast no fault has been observed at the base of the Candler (Patterson, 1987).

Turkeycock Creek Fault

A major silicified mylonite zone that occurs in the southeastern corner of the Penhook and northeastern corner of the Mountain Valley quadrangles (Plate 1 and Part B) was named the Turkeycock Creek fault by Berquist (1988). This fault, which has been traced across the adjoining Sandy Level quadrangle (Berquist, 1988), has displaced the Bowens Creek fault and the unnamed fault that bounds the southeastern contact of the Candler Formation a few tens of meters. Locally, the Turkeycock Creek fault trace is not silicified. Mapping in the area of study and mapping by Berquist in the adjoining Sandy Level quadrangle indicates that the structure is a nearly vertical rotational fault. To the northeast, along strike, the fault is up to the east, whereas in the area of study it is up to the west and places the biotite gneisses of the Bassett Formation to the west against the mica schists of the Fork Mountain Formation to the east. To the south, the fault is bounded on both sides by schists of the Fork Mountain Formation. Although they are tectonically deformed, these schists are not silicified and have not developed recognizable mylonite zones as seen in the gneissic rocks to the northeast. The fault apparently dies out to the southwest in the schists of the Fork Mountain Formation in the Mountain Valley quadrangle (Plate 1 and Part B).

ECONOMIC GEOLOGY

IRON ORE

John Wilcox in 1753 described iron deposits southeast of Grassy Hill. He states that a bloomery was built on Furnace Creek in 1773 that utilized local pyrrhotite deposits at Rocky Mount and magnetite ore from south of Barfoot (Lesley, 1859). Mining of these sources continued until the end of the Civil War (Lesley, 1882). Some exploration occurred during the 1880s as a result of renewed interest in development of the iron ores after completion of the Norfolk and Western Railway (Lesley, 1882; Fontaine, 1883; Nitze, 1892; Rutland, 1976).

PRECIOUS METALS, BASE METALS, AND STRATEGIC METALS

Fontaine (1883) reported the presence of copper and alluvial gold in the vicinity of Rocky Mount. Sweet and Lovett (1985) stated that the Redwood mine, located 0.32 km north of the Gladehill quadrangle boundary in the adjoining Redwood quadrangle, produced enough gold from a quartz vein at the site to fill a pint jar. A quartz vein, possibly a continuation of the gold-producing vein, was assayed by Iron King Assay and contained no gold, but did contain 0.6 ounce of silver per ton of quartz. During field mapping, McCollum collected forty-five 80 to 230 mesh stream sediment samples primarily from drainage systems that either originated in, or flowed across ultramafic-gabbro-metabasalt sequences that underlie Grassy Hill in the Rocky Mount quadrangle (Plate 1 and Part A). These samples were analyzed by O. M. Fordham, Jr., Division of Mineral Resources, and the results of these analyses are presented in Table 1. Fourteen of the samples are anomalous for most of the elements for which analyses

Table 1. Geochemistry of stream samples from the Rocky Mount quadrangle; Oliver M. Fordham, Jr., Analyst. Analyses of forty-five 80 to 230 mesh stream sediment samples collected by Michael B. McCollum from the Rocky Mount quadrangle. Samples were analyzed by atomic absorption spectrophotometry using a selective, hot, hydrochloric acid method of attack. Compared with many other stream sediment samples taken from the Virginia Piedmont and analyzed in a like manner, there are a number of anomalous samples in the Rocky Mount quadrangle. The table presented below shows values for samples which have concentrations above the threshold (i.e., mean plus two standard deviations) for stream sediment samples collected from the Virginia Piedmont. Any samples showing Ag above 1 ppm or Cd above 0.5 ppm are anomalous. No anomalous samples were detected for the elements Li, Mn, Fe, or Sr. Samples with anomalous Cr, Ni, or Co concentrations usually indicate mafic and ultramafic rocks. High concentrations of Cu, Pb, Zn, Ag, or Cd, as in samples R-7386, R-7389, and R-7390, indicate base metal sulfide mineralization.

Repository Number	Element Concentration (ppm)							
	Cr	Ni	Co	Cu	Pb	An	Ag	Cd
R-7385	146	39	19		75			
R-7386	118	28		19	32		1.6	
R-7387	75	20						
R-7388			15	23				
R-7389	50	20	14	55	92	67	2.6	0.7
R-7390	44		15	30	46	60		
R-7391		26		18				
R-7392			13	32				
R-7393	231	31	14					
R-7394	218	41						
R-7395	97	18						
R-7396	47		16	20				
R-7397				19				
R-7398	62							
Piedmont Values								
Mean	16	8	6	6	9	27	-	-
Std. Dev.	14	5	4	6	4	13	-	-
Threshold	44	18	13	17	16	54	1.0	0.5

were made; exceptions are the elements Li, Mn, Fe, and Sr. These analyses indicate that the areas underlain by mafic and ultramafic rocks might be areas suitable for a more detailed examination. The presence of massive sulfide deposits in the Gossan Lead mining district, which occurs in rocks of the Lynchburg Group on strike to the southwest, is a further indication that the rocks in the present study area could also contain such deposits. Submarine exhalant deposits that were laid down adjacent to ancient valcanically active mid-oceanic ridges, are commonly associated with ophiolites (Coleman, 1977). If the Lynchburg contains ophiolites, strata-bound massive sulfide deposits that occur in this group would be xpected to be exhalants deposited along mid-oceanic spreading centers.

ASBESTOS, SOAPSTONE AND VERMICULITE

Anthophyllite asbestos occurs as veins cutting the ultramafic bodies in the Alligator Back Formation on Grassy Hill, Jack Mountain, and Bries Mountain. Some of these bodies are partially altered to talc and have been quarried for soapstone by local farmers for use in construction of domestic fireplaces. These deposits have not been developed for commercial purposes, although forty tons were produced in 1907 (Bowles, 1937). Metapyroxenite bodies in the Bassett Formation are locally altered to almost pure talc. These bodies have also been locally quarried from small pits for domestic use in fireplace construction. Vermiculite occurs around the outer perimenters of the ultramafic bodies but has not been found in mineable quantities.

STONE

Massive gneissic metagraywackes of the Lynchburg Group have been quarried for dimension stone in the area adjacent to Rocky Mount in the Rocky Mount quadrangle (Plate 1 and Part B). The dates of the quarrying operation and the use made of the stone are not known, but enough time has elapsed since production of stone to allow large trees to grow in the abandoned quarrie that measures at least 100 m by 50 m and 25 m in depth. The biotite gneiss of the Fork Mountain Formation has been extensively quarried in the Martinsville area to the southwest for crushed stone, but no quarrying of this rock is known to have occurred in the area of this study.

MICA

Mica pegmatites occur in the mica schist of the Fork Mountain Formation on Chestnut Mountain in the southeastern corner of the Gladehill quadrangle (Part A). These pegmatites are, for the most part, dikes that show cross-cutting relationships to local schistosity. Pegau (1932) reports that the pegmatites are composed of orthoclase or microcline (rarely albite) as well as muscovite, garnet, and tourmaline. In contrast, Brown (1962) reports that the primary feldspar is plagioclase and secondarily perthite. He also notes that beryl occurs in a few pegmatites, near their quartz cores. Museum specimens of green beryl are reported from the Chestnut Mountain area (Virginia Division of Mineral Resources, Economic Section, County Files). The pegmatites are deeply weathered, and in the zone of weathering the feldspars have decomposed and are altered to kaolinite. This alteration allows the mica books to be extracted from their matrix without being damaged. Much of the mica contains black

einclusions of biotite and is deformed (Pegau, 1932; Brown, 1962), thus making it primarily usable only for scrap mica. Brown (1962) reports that considerable electrical-grade mica was produced during the early days of mining and Pegau (1932) states that one pegmatite yielded over 400 tons of mica. Extensive mining of these mica deposits was carried out between 1917 and 1920 (Pegau, 1932). Mining of mica in this area by various companies was continued on a smaller scale until 1944 (Brown, 1962).

CLAY

Two samples of clay from the area of study have been evaluated and found potentially suitable for use in making ceramic products. One of these samples (Division of Mineral Resources Repository Sample: R-2007) is a kaolinitic residuum from a pegmatite on Turkeycock Mountain and has potential use as a paint and plastic filler and, if beneficiated, could be made into ceramic whiteware (Sweet, 1976). The second sample (Division of Mineral Resources Repository Sample: R-6952) is an alluvial white to gray clay collected along the North Fork of Little Chestnut Creek (Sweet, 1982). If fired to 1250 C, it has a potential use for the manufacturing of structural clay products (such as building brick).

INFLUENCE OF SAPROLITE ON GROUNDWATER AND CONSTRUCTION

Saprolite is thoroughly decomposed rock that has chemically weathered in place. It retains much of the original rock structure and is a volume for volume replacement of fresh minerals by weathered minerals. Composition of saprolite varies with the composition of the parent material. A saprolite cover has developed over most of the rocks in the area of study and locally may be as much as 33 m thick. It is deepest and best developed on feldspathic rocks, especially gneissic rocks, and is thin to non-existent on highly micaceous rocks. Grain size of the micas is an important factor in saprolite development; highly micaceous phyllites have deeper saprolite development than coarse-grained mica schists, which are generally covered by less than 1 m of this material. Ultramafic rocks, although unstable when exposed to chemical weathering, are generally massive and non-foliated and therefore, are not easily chemically weathered. They also develop a thin clay-rich soil (B soil horizon) that apparently armors the rock and protects it from further weathering and saprolite development. Granites that intrude gneissic rocks are generally less susceptible to saprolitization than the enclosing gneiss, whereas gabbros and diorities (such as the Rich Acres Formation) produce saprolites that are generally thicker than the gneisses. This might be a function of both composition and grain size.

Topography is secondary in importance to rock composition for development of deep saprolite. Generally, saprolite is deeper on flat interfluves, thinner on slopes, and thin to absent in stream valleys. The contact between saprolite and hard rock is strikingly abrupt and can normally be placed in a zone on the order of about 15 cm. Where saprolite-rock contacts were observed in quarry faces beneath flat interfluves, they
were nearly horizontal. Foliations and joint surfaces do not seem to influence the depth of saprolite development to any major degree.

Saprolite has unique characteristics that profoundly influence its stability. Saprolite is massive and is surprisingly stable in vertical cuts. However, inclined fault surfaces, which are recogniz able as manganese-coated slickensided surfaces, may readily produce unstable conditions and are the chief cause of failure of vertical cuts in saprolite.

Because saprolite is highly porous and permeable, water is absorbed rather than being dissipated as runoff. A perched water table occurs at the base of the saprolite zone and the saprolite acts as a reservoir to store meteoric water and provide a source of recharge of fractures. Hand dug and bored wells, which are used for domestic water supplies, are sunk to bedrock and water production is from the stored meteoric water. Such wells have a limited recharge area and can become dry during long periods of drought. Because of its lack of cohesiveness, saprolite in fresh exposures not protected by overlying soil and vegetative cover is subject to rapid erosion. This is especially true at times when the unprotected saprolite is exposed to heavy rainstorms and the water supply exceeds the rate at which it can be absorbed by the saprolite.

The load-bearing capacity of saprolite is dependent on local conditions and each site must be evaluated individually. If site conditions are favorable and if proper engineering design is used, saprolite can have a relatively high load-bearing capacity for building purposes.

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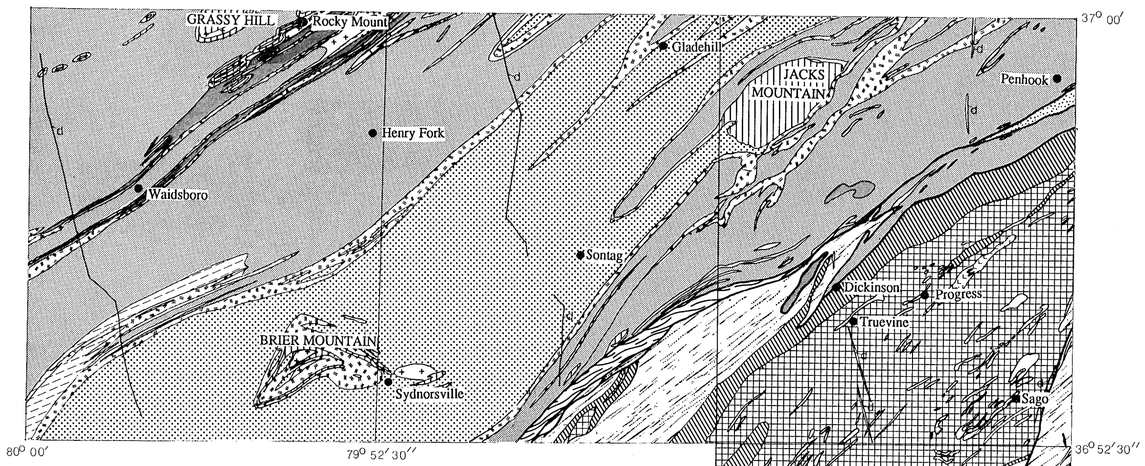
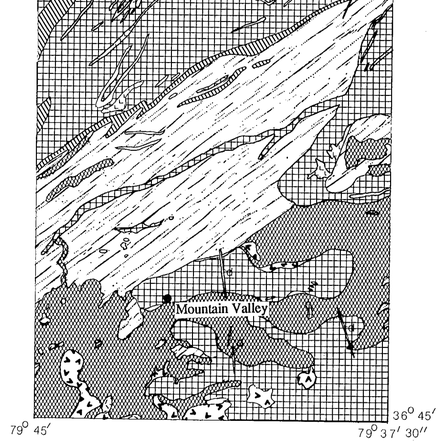
GEOLOGIC AND STRUCTURAL MAPS OF THE ROCKY MOUNT, GLADEHILL, PENHOOK, AND MOUNTAIN VALLEY QUADRANGLES





EXPLANATION

JURASSIC

- d — diabase dikes

PALEOZOIC

- cataclastic schist
- Martinsville Igneous Complex
  - Leatherwood Granite
  - Rich Acres Formation

PRECAMBRIAN-PALEOZOIC

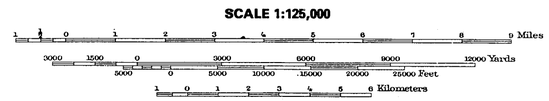
- Candler Formation
- Fork Mountain Formation
  - mica gneiss
  - mica schist
- Bassett Formation
  - amphibolite
  - metagabbro
  - ultramafic rocks
  - biotite gneiss

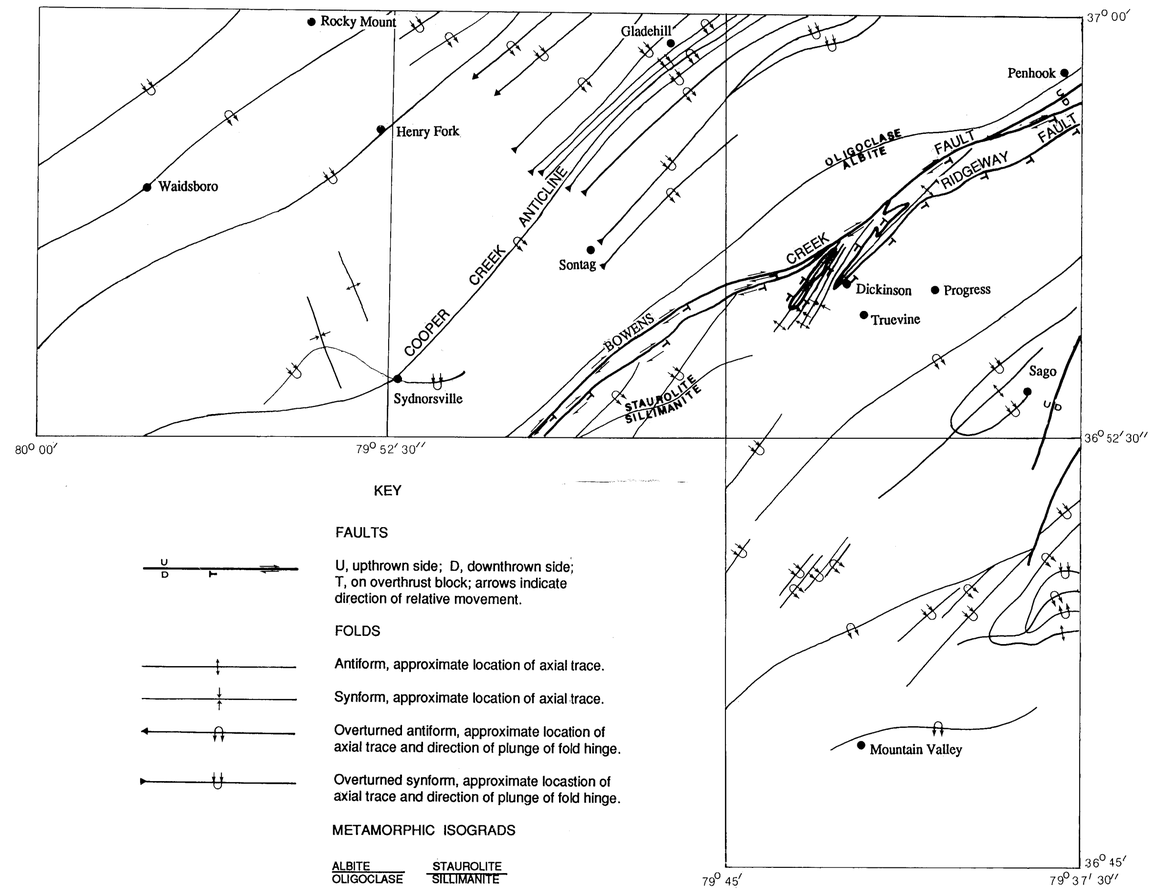
LATE PRECAMBRIAN

- Lynchburg Group
  - Alligator Back Formation
    - graphite schist
    - metagraywacke
    - marble
    - mica schist and metagraywacke
    - metabasalt
    - metagabbro
    - ultramafic rocks
- Ashe Formation

NORTH

SCALE 1:125,000





KEY

FAULTS

U, upthrown side; D, downthrown side; T, on overthrust block; arrows indicate direction of relative movement.

FOLDS

Antiform, approximate location of axial trace.

Synform, approximate location of axial trace.

Overturned antiform, approximate location of axial trace and direction of plunge of fold hinge.

Overturned synform, approximate locastion of axial trace and direction of plunge of fold hinge.

METAMORPHIC ISOGRADS

ALBITE / OLIGOCLASE — STAUROLITE / SILLIMANITE