COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES

# GEOLOGY OF THE PHILPOTT RESERVOIR QUADRANGLE, VIRGINIA

JAMES F. CONLEY
AND
WILLIAM S. HENIKA

REPORT OF INVESTIGATIONS 22

VIRGINIA DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA
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Commonwealth of Virginia
Department of Purchases and Supply
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Conley, J. F., and Henika, W. S., 1970, Geology of the Philpott Reservoir quadrangle, Virginia: Virginia Division of Mineral Resources Rept. Inv. 22, 46 p.

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# GEOLOGY OF THE PHILPOTT RESERVOIR QUADRANGLE, VIRGINIA

by

JAMES F. CONLEY AND WILLIAM S. HENIKA

## ABSTRACT

The Philpott Reservoir quadrangle is located in parts of Franklin, Patrick, and Henry counties in the southwestern Piedmont of Virginia. The southeastern part of the quadrangle is underlain by schist, gneiss, and amphibolite of uncertain age which are equivalent to the high-rank metamorphic rocks of the inner Piedmont belt of the Carolinas, and the northwestern part is underlain by Moneta gneiss and Lynchburg Formation. The schist unit is composed of sillimanite-mica schist, mica schist, schist containing altered staurolite and garnet, and staurolite schist. The Moneta gneiss is composed of muscovite-biotite gneiss and contains interbeds of gneiss, schist, calc-gneiss, calc-schist, marble, and actinolite gneiss and schist. The Lynchburg Formation unconformably overlies the Moneta gneiss and is composed of five lithologies: metagraywacke, muscovite-sericite and muscovite-biotite schist, metabasalt, graphite schist, and muscovite-chlorite-chloritoid schist. The Lynchburg Formation was intruded by diabase dikes and gabbro sills that are now metamorphosed; the Lynchburg and rocks of uncertain age have been intruded by felsite dikes and Triassic diabase dikes.

Two major fold systems, one developed in the rocks of uncertain age and the other in the Moneta gneiss and Lynchburg Formation, are present. The southeastern fold system is separated from the northwestern system by a linear high-angle thrust fault that may be part of a major wrench system.

Crushed stone, mica, iron ore, and gem stones have been produced in the quadrangle. Quartz suitable for decorative aggregate, rock from which flagstone could be obtained, and feldspar occur in the area. The gem stone, staurolite, is the only mineral commodity presently being produced.

## INTRODUCTION

The Philpott Reservoir quadrangle is located in parts of Patrick, Henry, and Franklin counties, Virginia (Figure 1). It has an area of approximately 60 square miles and is bounded by parallels 36°45′ and 36°52′30″ N. and by meridians 80°00′ and

80°07′30″ W. The quadrangle is located in the Piedmont province about 7 miles southeast of the Blue Ridge escarpment. Topography consists of narrow V-shaped valleys and steep-sided elongate and arcuate ridges in the central and northwestern parts of the area and rolling terrain in the southeastern part. Elevations range from less than 770 feet in the southeast to 1786 feet on Brown Hill, a prominent ridge in the north. Local relief averages approximately 230 feet. The western part of the town of Bassett is in the southeastern part of the quadrangle; Fairy Stone State Park is in the western part, and Philpott Reservoir, an impoundment on the Smith River, is almost wholly contained in the quadrangle.

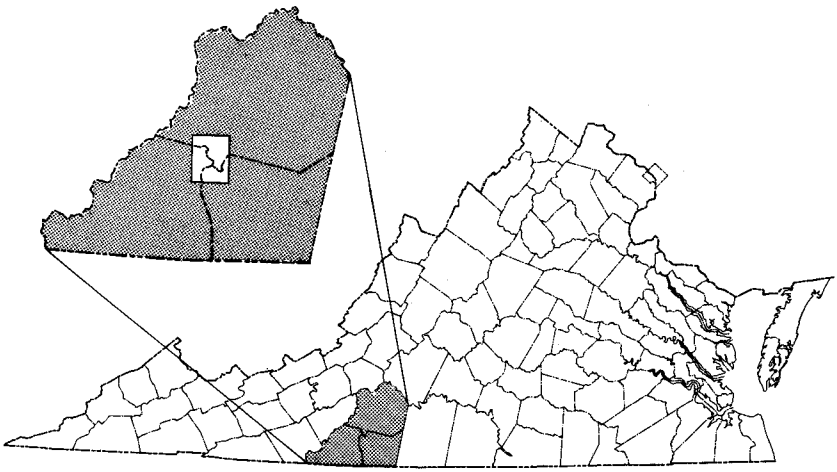

Figure 1. Index map showing location of Philpott Reservoir quadrangle.

Acknowledgment is gratefully made of assistance provided, during field investigations, by Mr. E. J. Cox, Superintendent of Fairy Stone State Park and by Mr. Maurice D. Ruddle, Reservoir Manager, U. S. Army Corps of Engineers. The courtesies extended by the citizens of Patrick, Henry, and Franklin counties are also greatly appreciated. The manuscript was critically reviewed by Dr. James L. Calver, State Geologist. Thomas M. Gathright II and Garnet A. Gatlin (deceased) introduced the senior writer to the geology of the area during their reconnaissance mapping of Fairy Stone State Park.

# STRATIGRAPHY

The rocks in the Philpott Reservoir quadrangle can be subdivided into three major sequences: schist, gneiss, and amphibolite of uncertain age, which correspond to the inner Piedmont belt in the Carolinas (King, 1955, p. 352-356); Moneta gneiss of probable middle Precambrian age; and Lynchburg Formation of late Precambrian age. Intrusive rocks include pegmatite dikes of Paleozoic(?) age, metadiabase dikes and metagabbro sills of Lynchburg age, felsite dikes of post-Lynchburg age, and diabase dikes of Triassic age.

## ROCKS OF UNCERTAIN AGE

### SCHIST

The schist is subdivided by mineralogical composition and physical appearance into four units: sillimanite-mica schist; mica schist, some of which contains minor amounts of sillimanite; schist containing altered staurolite and garnet; and staurolite schist containing relatively unaltered staurolite and garnet.

#### Sillimanite-Mica Schist

The sillimanite-mica schist occurs only in the southeastern part of the quadrangle and contains numerous amphibolite layers. It is in contact with granite gneiss to the southeast and mica schist to the northwest (Plate 1). Contacts with the granite gneiss are relatively definite and are gradational across a few tens of feet, whereas contacts with the mica schist may range from a few tens of feet to over a hundred feet in width. The sillimanite-mica schist is exposed on the right bank of the Smith River approximately 0.6 mile downstream from the Philpott Dam (Plate 1). The sillimanite-mica schist (R-3637, R-3660, R-3745, R-3765) is a medium-gray, foliated, generally banded rock in which the lighter colored layers are composed of muscovite, sillimanite, and quartz and the darker colored layers of biotite and chlorite. (Numbers in parentheses preceded by "R" refer to samples that are on file in the rock and mineral repository of the Division of Mineral Resources at Charlottesville where they are available for examination.) Accessory minerals are sillimanite and garnet; secondary minerals are chlorite, pyrite, and ilmenite. The sillimanite generally occurs as minute, disseminated, needle-like crystals, as bundles of fibrolite, and

as inclusions in quartz and biotite. The sillimanite in the quartz grains generally is not altered, whereas that in the matrix is partially converted to sericite.

Blue-gray masses and bands of sericite are common in the unit. Quartz occurs as lozenge-shaped (0.1-0.4 mm) masses of grains that show strain shadows and have sutured boundaries. Brown biotite occurs as porphyroblasts up to 1 mm in diameter. Some biotite is twinned and has penetrated and replaced quartz along grain boundaries. Muscovite occurs as grains in the matrix and as lath-shaped porphyroblasts up to 3 mm in diameter. Muscovite is intergrown with biotite and in some instances has replaced it (R-3745, R-3637). Chlorite has formed by alteration of biotite. Near its western contact, the sillimanite-mica schist unit (R-3660) is finer grained and has a more cataclastic texture.

## Mica Schist

Mica schist occurs as a narrow band, ranging from 0.1 to 0.4 mile wide, across the southeastern part of the quadrangle and is bounded on the southeast by the sillimanite-mica schist and on the northwest by schist containing altered staurolite and garnet (Plate 1). The contact with the sillimanite-mica schist is gradational, and sillimanite has been identified in thin section (R-3731) well within the mica schist unit.

The mica schist (R-3727) is exposed on the right bank of Smith River about 200 feet downstream from Philpott Dam. It is light gray, schistose, equigranular, fine grained, and is composed of quartz, muscovite, brown biotite, ilmenite, and trace amounts of plagioclase and sillimanite. Quartz occurs both as strained sutured masses of grains and as disseminated recrystallized unstrained grains. Muscovite is present as translucent equidimensional porphyroblasts and as needle-like pseudomorphs after sillimanite. It fills the interstices between quartz and biotite and is later than either of these. Some muscovite grew at the expense of biotite and has intergrowths of ilmenite and magnetite. Biotite has been partially altered to chlorite along cleavage and grain boundaries, and some grains have lost much of their brown color, probably due to loss of titanium during alteration. The rock is segregated into quartz-muscovite and muscovite-biotite bands, many of which are lens-shaped. The mica schist unit (R-3731) along State Road 604, 0.6 mile west of

Philpott contains porphyroblastic muscovite and biotite and minute grains of pyrrhotite and fibrolite.

### Schist Containing Altered Staurolite and Garnet

Schist containing altered staurolite and garnet forms a northeastward-trending band, 0.2 to 0.5 mile wide, in the southeastern part of the quadrangle (Plate 1). It is in contact with mica schist to the southeast and either the Lynchburg Formation or

Figure 2. Photomicrograph of staurolite-garnet schist (R-3709) from a locality 0.3 mile southeast of picnic area on Mize Point. Cataclastic texture is produced by transposition of schistosity by slip cleavage and rotation of garnet porphyroblasts. Plain light.

staurolite schist to the northwest. The contact between the schist and rocks that border it on the southeast is gradational over short distances, whereas the northwestern contact is better defined.

The schist (R-3672) is exposed at the boat ramp on the right bank of Bowens Creek. It is also well exposed along State Highway 57, just west of the Henry-Patrick county boundary. The unit (R-3672, R-3721, R-3752, R-3697) is medium gray,

Philpott contains porphyroblastic muscovite and biotite and minute grains of pyrrhotite and fibrolite.

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The schist (R-3672) is exposed at the boat ramp on the right bank of Bowens Creek. It is also well exposed along State Highway 57, just west of the Henry-Patrick county boundary. The unit (R-3672, R-3721, R-3752, R-3697) is medium gray,

schistose, and generally contains some thin quartz-rich bands. The rock has closely spaced slip cleavage planes and in some localities crinkle folds were formed (Figure 2). Abundant altered staurolite crystals that range from 1 to 4 cm in length occur in a narrow zone along the eastern contact with the mica schist. Toward the west, away from this zone, staurolite crystals are much smaller, averaging from 0.5 cm to 1 cm in length. The staurolite is light gray and diffuse grain boundaries indicate that it is partly altered to mica. Rotated garnets (R-3697) occur as porphyroblasts and as inclusions in the staurolite (Figure 3). These garnets are orange-red and range from 1 to 3 mm in size; some (R-3721) have alteration rims of chlorite.

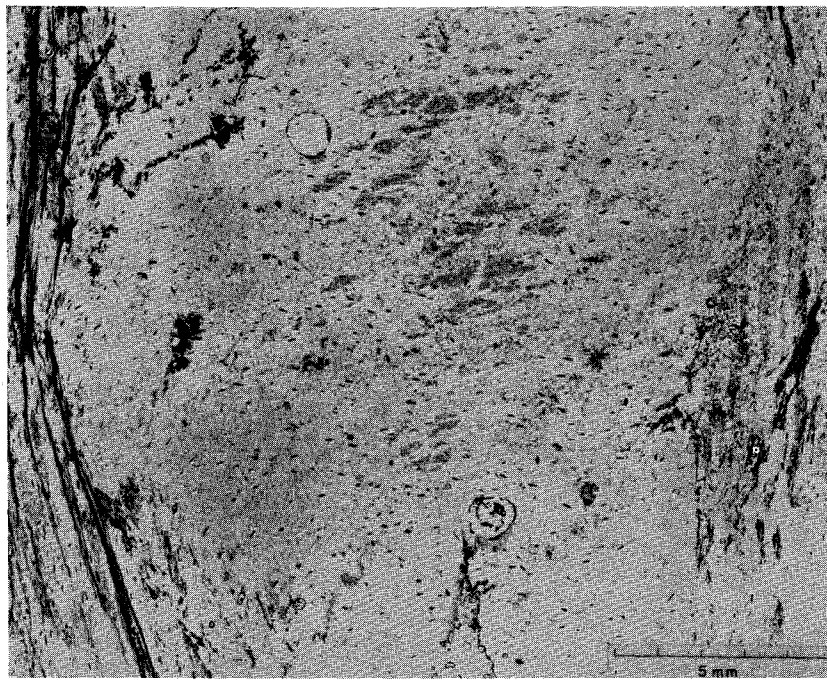


Figure 3. Photomicrograph of large sericitized rotated staurolite porphyroblast in staurolite-garnet schist (R-3697) from the northeast side of State Highway 57, 0.3 mile northwest of the Henry-Patrick county boundary. Foliation planes are bent around the highly altered staurolite porphyroblast containing garnet inclusions. Plain light.

Thin sections of the rock are composed of muscovite, biotite, quartz, staurolite, and garnet with accessory plagioclase, magnetite, ilmenite, and sphene. Secondary minerals include chlorite

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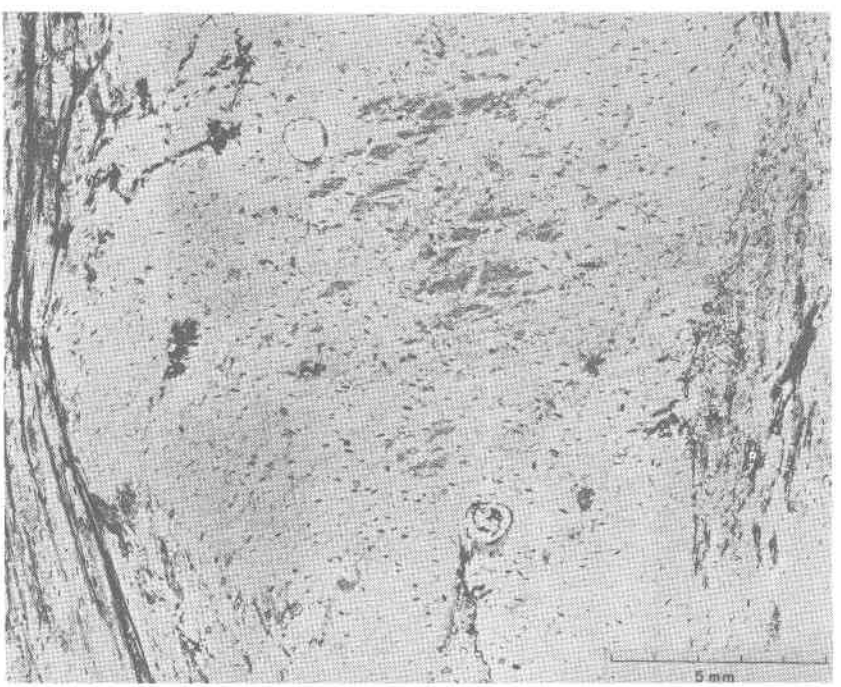


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Thin sections of the rock are composed of muscovite, biotite, quartz, staurolite, and garnet with accessory plagioclase, magnetite, ilmenite, and sphene. Secondary minerals include chlorite

after either biotite or garnet, sericite after staurolite, zoisite after plagioclase, and leucoxene after either ilmenite or sphene. The rock has an equigranular, cataclastic groundmass and contains porphyroblasts of staurolite and garnet and swirls of sericite. The foliation wraps around porphyroblasts of garnet and staurolite. Most of the staurolite has been altered to sericite. Staurolite and garnet have been rotated, as indicated by inclusions, and some garnets are enclosed in staurolite (R-3697) and have pinwheel structures (Figure 3). The rock has a well-developed schistosity that is cut by a closely spaced slip cleavage from which some crinkle folds were produced, but in most places slip cleavage has caused displacement of the schistosity (Figure 2). Slip cleavage transects the early formed minerals of the matrix and also the later porphyroblasts of garnet and staurolite, as well as the alteration minerals from these porphyroblasts.

### Staurolite Schist

A small band of schist, 0.1 to 0.2 mile wide and containing unaltered staurolite and garnet, is exposed for approximately 2.8 miles along strike in the southwestern part of the quadrangle (Plate 1). It is bounded on the southeast by schist containing altered staurolite and garnet and on the northwest by the Lynchburg Formation. Contacts on each side of this unit are well defined and discernible within a few feet. The staurolite schist unit is well exposed 0.6 mile due west of the head of Bowens Creek inlet. The rock (R-3639, R-3722) is light gray and has a salt-and-pepper appearance. It is composed of a fine-grained cataclastic matrix of quartz, white muscovite, chlorite, and ilmenite with dark-colored porphyroblasts of staurolite, biotite, garnet, and chloritoid (Figure 4). Quartz occurs as an equigranular mosaic of grains, and secondary muscovite has developed along foliation and slip cleavage planes. The largest of the porphyroblasts are the dark reddish-brown, euhedral, twinned crystals of staurolite that range from 0.4 to 1.5 cm in length. They are resistant to weathering and give the weathered rock a warty appearance. The staurolite porphyroblasts are generally fresh but have altered to mica along fracture planes (Figure 4). Biotite and chloritoid porphyroblasts formed partially by replacement and partially by expansive growth that pushed aside the matrix and distorted the foliation. Garnet is rotated and in some cases is enclosed by staurolite.

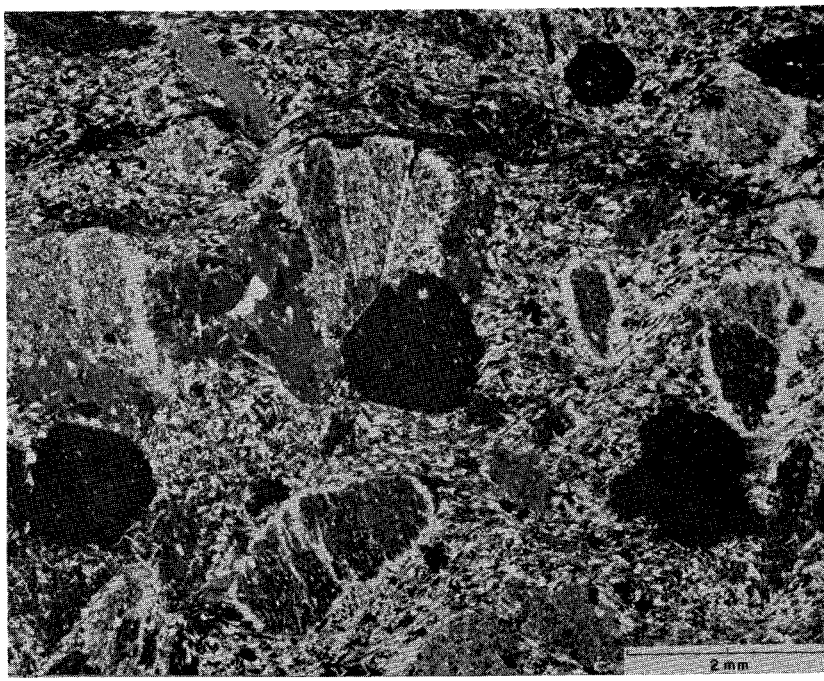
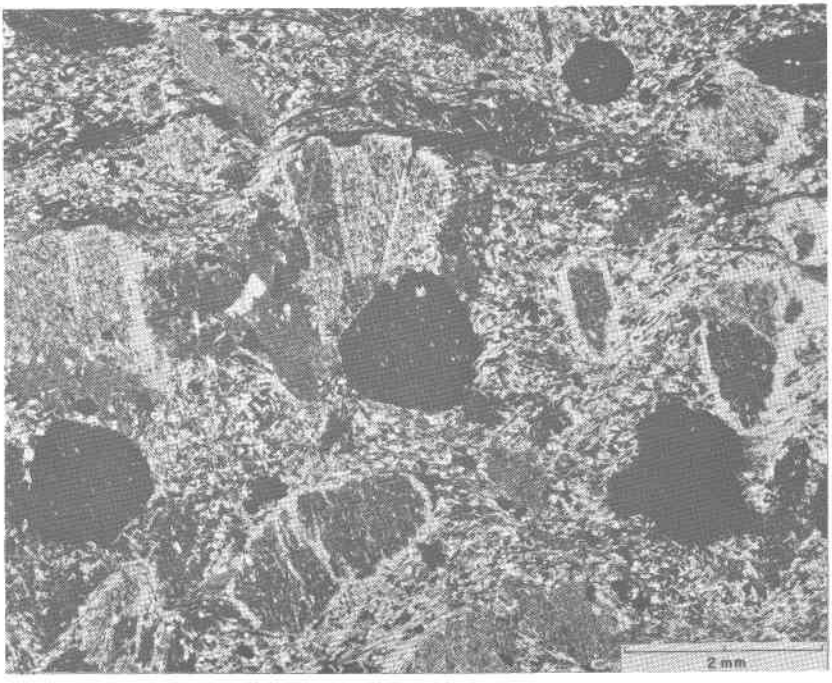



Figure 4. Photomicrograph of garnetiferous staurolite schist (R-3722) from 0.3 mile northwest of the head of Bowens Creek inlet on Philpott Reservoir. Staurolite (marginally altered to sericite) and euhedral garnet porphyroblasts are present in a matrix composed predominantly of mica. Mica is oriented parallel to shear direction along foliation and slip cleavage. Cross-polarized light.

## AMPHIBOLITE

Amphibolite occurs interlayered with the schist unit and as refractory bands and masses in the granite gneiss (Plate 1). Contacts with these units are generally well defined and in some exposures are knife edge. The amphibolite contacts are conformable with foliations in the schists, and the amphibolite beds can be traced around fold noses and used as stratigraphic markers.

The amphibolite is exposed southwest of New Light Church, west of Bassett. The rock (R-3640, R-3728, R-3729, R-3732) is generally foliated, medium to fine grained, equigranular, and dark gray because of a salt-and-pepper effect produced by intermixing of light and dark grains. It is composed of brown hornblende and plagioclase with accessory ilmenite and augite.

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The amphibolite is exposed southwest of New Light Church, west of Bassett. The rock (R-3640, R-3728, R-3729, R-3732) is generally foliated, medium to fine grained, equigranular, and dark gray because of a salt-and-pepper effect produced by intermixing of light and dark grains. It is composed of brown hornblende and plagioclase with accessory ilmenite and augite.

Secondary minerals are biotite, actinolite, chlorite, epidote, zoisite quartz, sphene, and leucoxene. The plagioclase is generally albite, except near contacts with granite gneiss where it increases in amount and labradorite is present (R-3732). Augite also occurs in accessory amounts in amphibolite (R-3640) near the granite gneiss contact. Most of the augite is altered to a fine-grained amphibole, probably hornblende.

A small band of amphibolite just northwest of Faith Church, about 2.5 miles southwest of Bassett, contains disseminated ovoid intergrowths of plagioclase, epidote, and quartz which resemble amygdules. These also occur in a large band of amphibolite (R-3729) that crops out where the power-transmission line crosses the drainage between State Road 666 and State Highway 57 northeast of West Bassett. Epidosite beds up to 2 feet thick are interlayered with the amphibolite at this locality. Fine-grained amphibolite (R-3734) is interlayered with schist containing altered staurolite and garnet just west of the boat ramp on Bowens Creek. This rock is composed of alternating light (plagioclase-rich) and dark (hornblende-rich) layers (Figure 5). It contains features that resemble graded bedding and cut-and-fill structures.

## GRANITE GNEISS

Granite gneiss underlies the southeastern part of the quadrangle, and a small mass of cataclastically deformed gneissose rock that resembles granite gneiss occurs at the campsite on the left bank of Bowens Creek (Plate 1). The granite gneiss is in contact with both schist and amphibolite, and in most instances, seems to be conformable with these units. In the areas west and southwest of Bassett the gneiss has partially assimilated the schist unit, leaving skialiths of more refractory amphibolite surrounded by granite gneiss.

The granite gneiss is exposed 0.2 mile northwest of Peoples Church, about 3.5 miles southwest of Bassett. The rock (R-3638, R-3730) is medium gray, fine grained, equigranular and has a rude foliation produced by orientation of finely disseminated biotite. Away from its periphery, the gneiss is lighter colored and coarser grained, apparently due to growth of feldspar. Minerals present are quartz, plagioclase, biotite, and muscovite with accessory garnet, sphene, and ilmenite. Sericite and epidote are secondary minerals. The rock contains thin (1 to 3 mm)

bands of coarse-grained quartz and feldspar (predominantly microcline) orientated parallel to foliation, and a few large microcline porphyroblasts. Quartz in the matrix has sutured boundaries, and biotite occurs as green, elongate, lath-shaped plates. The fabric of the rock is equigranular-gneissoid, except where large amounts of secondary microcline have developed resulting in a porphyroblastic texture.

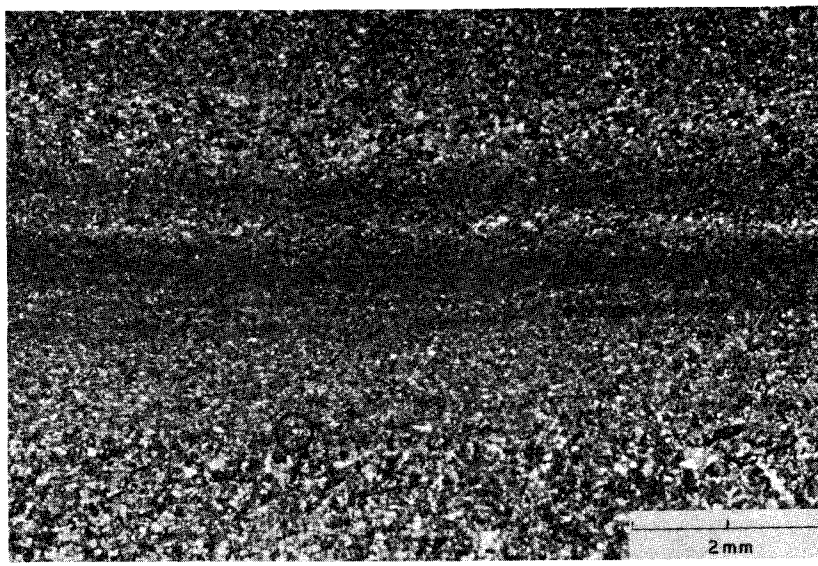


Figure 5. Photomicrograph of bedded metatuff from amphibolite unit (R-3734) on the southeast bank of Bowens Creek inlet, 0.1 mile west of the boat ramp. Graded bedding is preserved. Light areas are plagioclase rich; dark areas are hornblende rich. Cross-polarized light.

## PRECAMBRIAN ROCKS

### MONETA GNEISS

The Moneta gneiss is exposed in the northeastern and northwestern parts of the quadrangle (Plate 1). The gneiss in the northwestern part contains interlayered actinolite gneiss and schist, calc-gneiss, and calc-schist. In the northeastern part of the quadrangle, the unit is overlain by basal metagraywacke and metagraywacke conglomerate of the Lynchburg Formation. Along the southern edge of this exposure the rocks are deeply weathered, and the Moneta-Lynchburg contact is based on the last occurrence of metgraywacke conglomerates and graphite schists in the Lynchburg and the presence of light-tan, sandy

bands of coarse-grained quartz and feldspar (predominantly microcline) orientated parallel to foliation, and a few large microcline porphyroblasts. Quartz in the matrix has sutured boundaries, and biotite occurs as green, elongate, lath-shaped plates. The fabric of the rock is equigranular-gneissoid, except where large amounts of secondary microcline have developed resulting in a porphyroblastic texture.

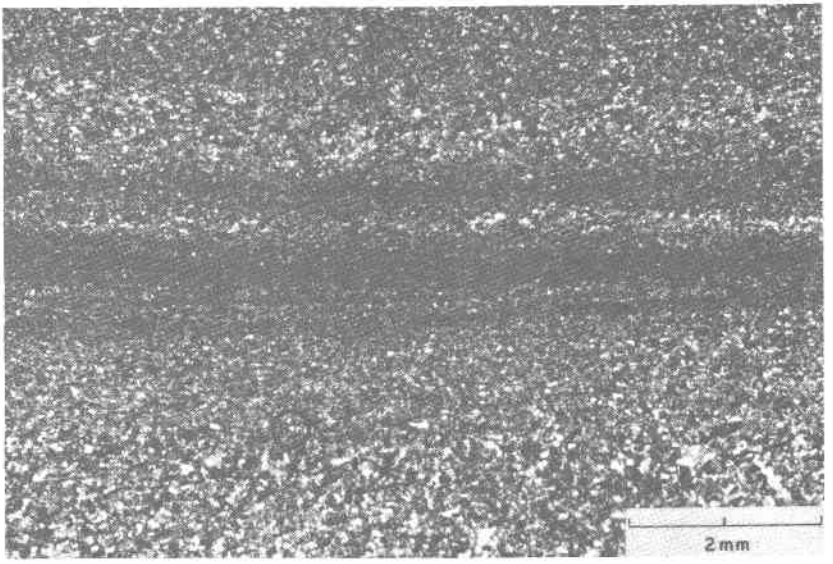


Figure 5. Photomicrograph of bedded metatuff from amphibolite unit (R-3734) on the southeast bank of Bowens Creek inlet, 0.1 mile west of the boat ramp. Graded bedding is preserved. Light areas are plagioclase rich; dark areas are hornblende rich. Cross-polarized light.

## PRECAMBRIAN ROCKS

### MONETA GNEISS

The Moneta gneiss is exposed in the northeastern and northwestern parts of the quadrangle (Plate 1). The gneiss in the northwestern part contains interlayered actinolite gneiss and schist, calc-gneiss, and calc-schist. In the northeastern part of the quadrangle, the unit is overlain by basal metagraywacke and metagraywacke conglomerate of the Lynchburg Formation. Along the southern edge of this exposure the rocks are deeply weathered, and the Moneta-Lynchburg contact is based on the last occurrence of metgraywacke conglomerates and graphite schists in the Lynchburg and the presence of light-tan, sandy

soils that are typically developed on the Moneta gneiss. The placement of the contact is further complicated by the fact that the basal Lynchburg graywackes, where they are better exposed to the north, have a matrix of similar composition to the Moneta (they may have been derived from the Moneta); thus the units have developed soils of similar appearance. The Moneta gneiss exposed in the northwestern part of the quadrangle is overlain by metabasalt in the basal part of the Lynchburg Formation. The Moneta is predominantly a coarse-grained, muscovite-biotite gneiss, but in the northwestern part of the quadrangle it has interlayered bands of actinolite gneiss and schist and a zone of calc-gneiss and calc-schist that contains impure marble.

## Muscovite-Biotite Gneiss

The muscovite-biotite gneiss is exposed 0.3 mile west of Calico Rock on Rennet Bag Creek. The rock (R-3654, R-3742, R-3753, R-3761, R-3763) is generally coarse grained, equigranular, light gray, and indistinctly banded. It is composed of muscovite,

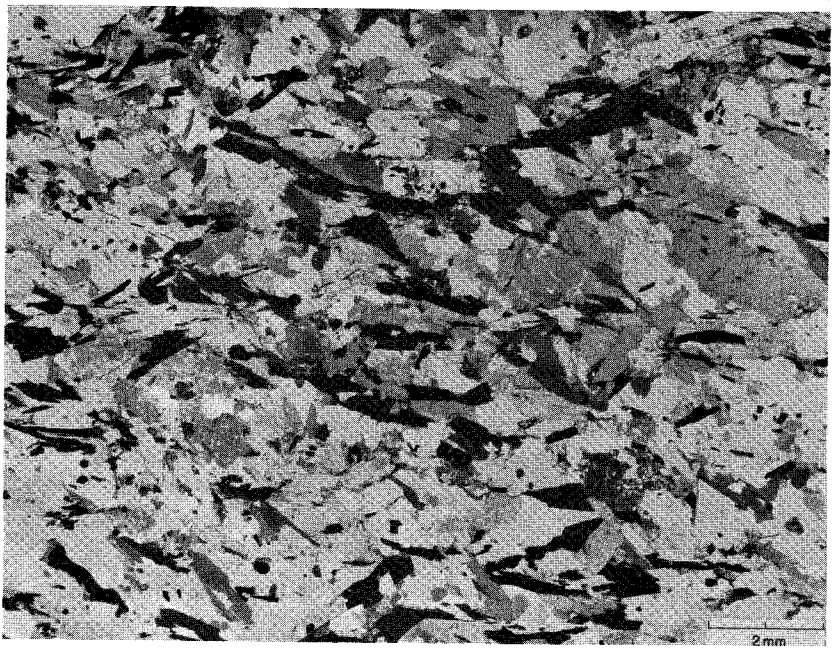


Figure 6. Photomicrograph of muscovite-biotite (Moneta) gneiss (R-3654) from 0.3 mile west of Calico Rock along Rennet Bag Creek. Gneissose fabric is produced by oriented biotite and muscovite plates with interspersed quartz, plagioclase, and epidote. Cross-polarized light.

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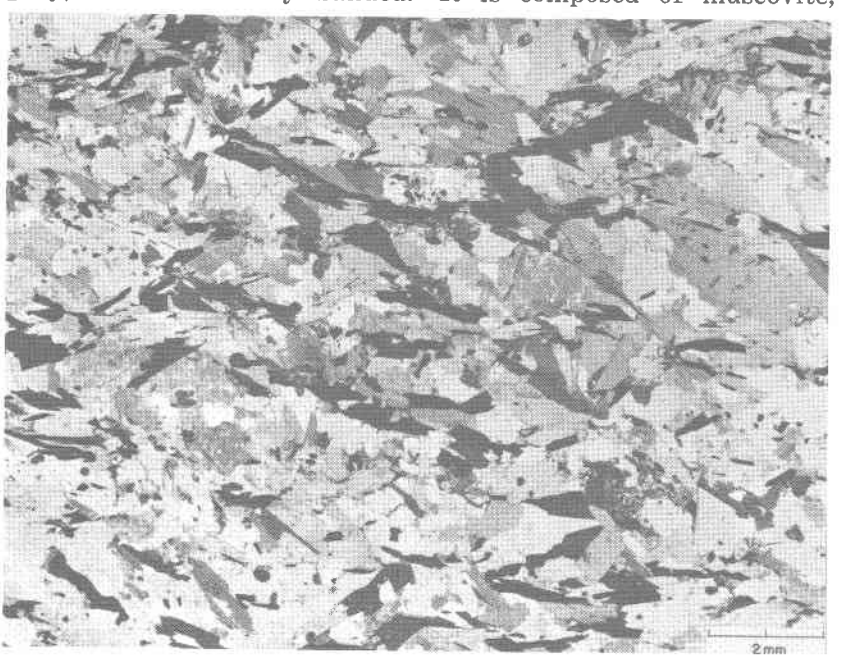


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biotite, plagioclase, and quartz with accessory microcline, ilmenite, magnetite and apatite. Secondary minerals are sphene and zoisite. Quartz grains are sutured and show strain shadows. Mineral lineation is well developed on some foliation planes; brown biotite gives the rock (R-3654) a speckled appearance and produces the very fine banding parallel to foliation (Figure 6). This foliation is more apparent on weathered surfaces because feldspars are etched out leaving mica-rich bands in relief. The muscovite-biotite gneiss is not uniform in composition.

An exposure on the left bank of Town Creek, approximately 0.5 mile southeast of Prilliman, contains dark-gray flaser gneiss (R-3758) composed of feldspar augen up to 1.5 cm in diameter and mica porphyroblasts that have been reduced to satiny lensoidal buttons. The matrix has a fine-grained cataclastic texture and contains minor crinkle folds produced by slip cleavage. In this exposure, near the contact with the Lynchburg Formation, the cataclastic gneiss is criss-crossed by several thin zones (up to 7.5 cm) of red banded mylonite (R-3757). These mylonite bands are oriented at a slight angle to the foliation of the gneiss.

## Calc-Gneiss and Calc-Schist

Calc-gneiss and calc-schist containing impure marbles are exposed as discontinuous, concordant bands in the Moneta gneiss in the northwestern part of the quadrangle (Plate 1). The unit (R-3655) is well exposed across the inlet from the Rennet Bag public-use area at the end of State Road 785. It is a light-gray, medium- to coarse-grained, equigranular rock composed of calcite, quartz, andesine, muscovite, biotite, and trace amounts of ilmenite, sphene, pyrite, and epidote. Calcite predominates in the impure marbles (R-3743) and constitutes up to 72 percent of the rock. Mica and subordinate calcite predominate in the calc-schist, and quartz and plagioclase are the major minerals in the calc-gneiss. Ovoid quartz grains with sutured boundaries are intergrown with plagioclase, and both have been partially replaced by calcite (especially in the marbles). Mica porphyroblasts are bent and some wrap around plagioclase grains. Biotite is brown and contains pyrite inclusions. Banding of biotite and muscovite is accentuated by weathering of the adjacent carbonate material (Figure 7). The mica porphyroblasts produce a warty surface parallel to foliation. Lens-shaped masses and thin

beds of impure calcite occur throughout the rock. Due to its susceptibility to weathering, fresh exposures of this unit occur only along the reservoir although it can be recognized elsewhere in a weathered condition by its banded appearance.

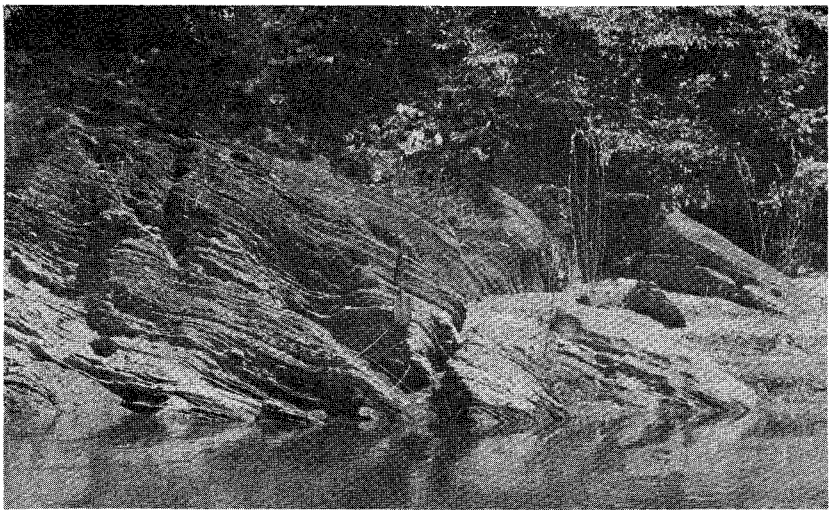

Figure 7. Calc-gneiss and calc-schist in Moneta gneiss across the inlet from the boat ramp at the Rennet Bag public-use area. Laminar structure accentuated by differential weathering is characteristic of this unit.

## Actinolite Gneiss and Schist

Three bands of intermixed actinolite gneiss and schist are conformably interlayered with the muscovite-biotite gneiss in the northwestern part of the quadrangle (Plate 1), and a number of small actinolite schist bodies, too small to be shown on the map, occur throughout the area. These rocks (R-3656) are exposed on the left bank of Rennet Bag Creek. Other exposures (R-3765) are on the hill on the right bank of Rennet Bag Creek due west and southwest of Calico Rock and on State Road 785, about 0.2 mile west of its termination at the public boat-launching ramp.

The unit is composed of recrystallized dark greenish-gray rocks that have a well-defined orientation of needle-like amphibole crystals and ranges from gneiss to schist depending on the percentage of epidotized feldspar. Minerals composing the rock (R-3656) are actinolite, quartz, chlorite, clinozoisite, and feldspar. Plagioclase is generally replaced by clinozoisite and pale-green chlorite.

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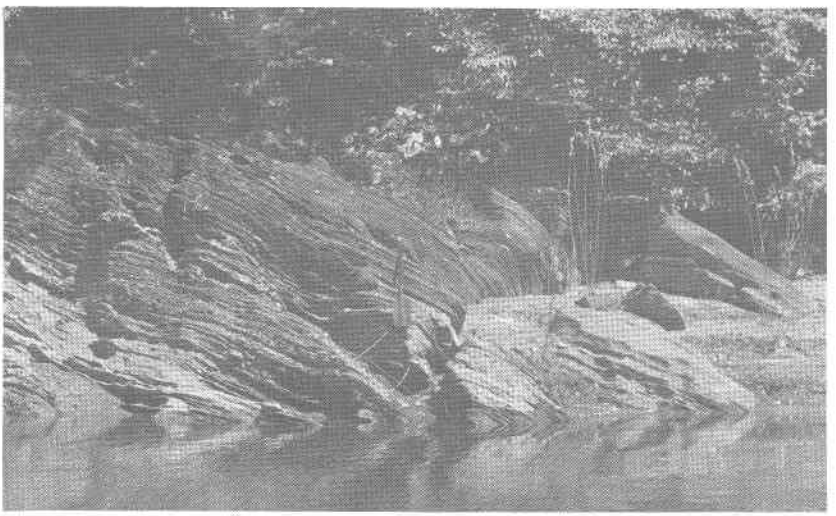

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## LYNCHBURG FORMATION

The Lynchburg Formation overlies the Moneta gneiss, and the top of the Lynchburg is not present in the quadrangle. The basal part of the Lynchburg in the northeastern portion of the quadrangle is composed of quartzite and conglomeratic and feldspathic metagraywacke (Figure 8), whereas in the northwestern portion it is composed of metabasalt. These basal units are overlain by muscovite-sericite and muscovite-biotite schist of sedimentary origin. These schists are interbedded with (to the west) and overlain by (to the east) metabasalt and interbedded metagraywacke and metagraywacke conglomerate. These rocks are overlain by graphite schist containing metagraywacke and quartzite beds. The top of the graphite schist unit is in contact with a narrow band of muscovite-chlorite-chloritoid schist that is probably of tectonic origin. The basal part of the Lynchburg is cut by metadiabase dikes that may have been feeders for the metabasalt. The sequence is cut by metagabbro sills.

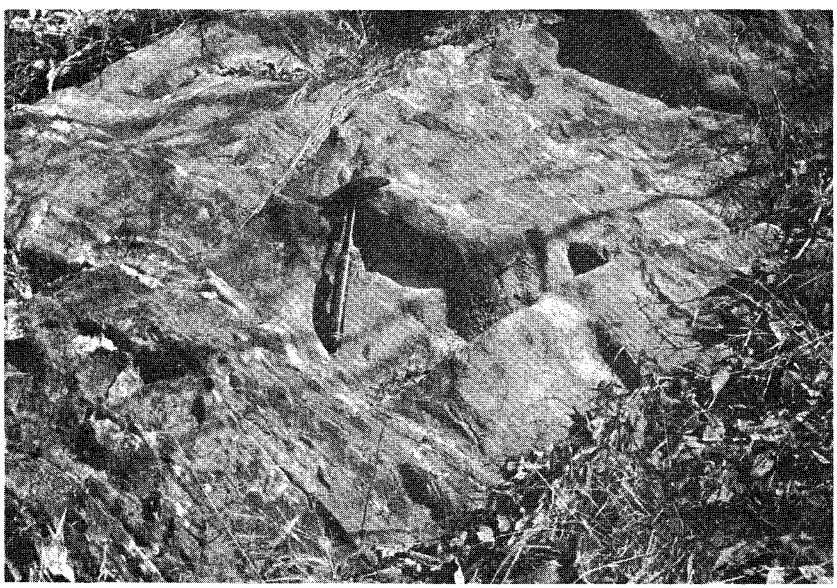

Figure 8. Conglomeratic metagraywacke and interbedded schistose metagraywacke in the basal part of the Lynchburg Formation above the contact with Moneta gneiss along Town Creek, 0.2 mile southeast of Prilliman Church.

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## Metagraywacke

Metagraywacke, metagraywacke conglomerate, and interbedded quartzite are present at the base of the Lynchburg Formation in the northeastern part of the quadrangle (Plate 1) and are also interbedded with the other lithologies of this formation. Most of the metagraywackes in the Lynchburg Formation would be classified as arkosic metagraywacke (Williams, Turner, and Gilbert, 1954, p. 94-95, and 314) because the parent rock was poorly sorted and consisted of feldspar and quartz grains in a clay matrix. Much of the metagraywacke is medium to

Figure 9. Photomicrograph of arkosic metagraywacke from the Lynchburg Formation (R-3750) on the west shore of Roland Branch inlet, 0.2 mile north of Twin Ridge Marina. Granule-size quartz and feldspar in sand-size matrix of quartz, feldspar, biotite, and muscovite. Cross-polarized light.

fine grained and schistose; it contains interbeds of coarse-grained feldspathic material (R-3750) that has a gneissose texture. (Figure 9) . A typical exposure of this metagraywacke (R-3646) is near the Fairy Stone Lake dam. The large particles of the conglomerate range in size from coarse sand to fine pebbles and are composed of milky and blue quartz and pale-pink

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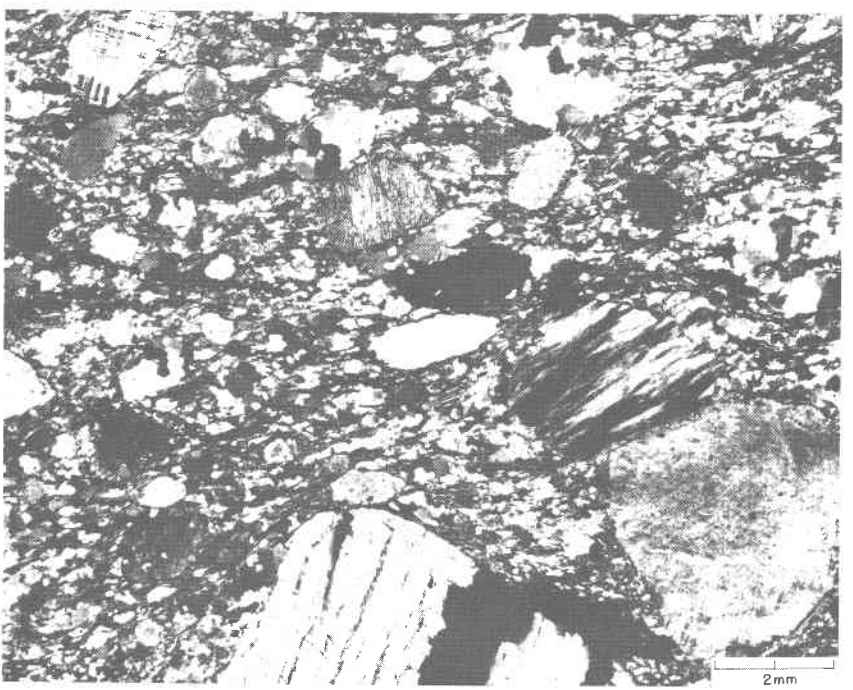


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and white feldspar stretched into elongate rods. Quartz, microcline, plagioclase, muscovite, and biotite compose the matrix that also contains epidote, sphene, ilmenite, garnet, chlorite, and magnetite (R-3699, R-3700, R-3701, R-3702, R-3715). On the north shore of Philpott Reservoir between Beech Point and Horseshoe Point near the mouth of Cooper Creek, the metagraywacke contains dark, schistose lithic fragments. Impure quartzite and quartzite conglomerate (R-3648), such as that exposed across from Beech Point on Philpott Reservoir, also occur in the metagraywacke.

In contrast, metagraywacke interbedded with the overlying graphite schist and chlorite schist is light gray with a slight greenish cast and generally contains less biotite. Metagraywackes (R-3661) interbedded with the graphite schists are exposed 0.7 mile east of the intersection of State Highway 57 and State Road 822. These metagraywackes (R-3661, R-3750) are lenticular, and contain about equal amounts of coarse sand-size particles of quartz and feldspar, much of which is microcline; the matrix consists of fine sand-size particles of quartz, feldspar, muscovite, and biotite. Foliation is outlined by oriented micas and stretched grains of quartz and feldspar. The micas generally wrap around the larger quartz and feldspar grains (R-3648). Generally the rock is poorly sorted, massive, and uniform in mineral composition; most of the particles are angular. An indistinct foliation is present parallel to compositional banding and is crossed at an acute angle by an incipient slip cleavage.

### Muscovite-Sericite and Muscovite-Biotite Schist

The muscovite-sericite and muscovite-biotite schist unit (R-3645) is exposed northward from the Mill Creek area through Prilliman in the northeastern portion of the quadrangle and in the vicinity of Calico Rock in the northwest (Plate 1). In the northwestern part of the quadrangle the unit is interbedded with metabasalt near the base of the Lynchburg Formation; in the northeastern part of the quadrangle, it is interbedded with basal metagraywacke.

The unit is a light-gray, well-foliated schist that in some areas is medium gray due to graphite. It is composed of muscovite, quartz, biotite, garnet, plagioclase, and ilmenite (R-3645). Muscovite occurs as porphyroblasts and as fine-grained white sericite with a pearly luster. Biotite is generally dispersed throughout

the rock as porphyroblasts ranging up to 0.5 mm in diameter. Rotated garnet is present as porphyroblasts averaging about 2 mm in diameter. Dark-green, columnar-shaped aggregates of chlorite are oriented parallel to foliation. Schistosity is well developed and is generally transected by slip cleavage, producing crinkle folds on foliation planes. The rock has a schistose texture and has been cataclastically deformed.

### Metabasalt

Metabasalt is most prevalent in the north-central part of the quadrangle but also is present in the eastern, northwestern, and southwestern parts (Plate 1). It occurs as interbeds in the Lynchburg sequence from the basal part of the formation to the base of the graphite schist unit. Amygdaloidal metabasalt (R-3651) is well exposed on Beards Creek, and coarse pyroclastic breccia (R-3652) is exposed 0.2 mile west of Beards Creek; mafic metatuff containing graded beds (R-3741) is exposed on the east side of State Road 623 in the northern portion of the quadrangle. Much of the rock mapped as metabasalt (R-3744, R-3746, R-3747, R-3754) is relatively structureless actinolite schist; it is considered of volcanic origin because of its association with rocks containing recognizable flow structures, amygdules, collapsed vessicles, and pyroclastic textures (R-3451, R-3652, R-3741).

The interbedded amygdaloidal metabasalt (R-3651) is dark grayish green, fine grained, and has a pronounced foliation. Amygdules composed of epidote range from 1 to 3 mm in diameter and are somewhat flattened parallel to foliation. In thin section these rocks are composed predominantly of actinolite, with variable amounts of chlorite, epidote, albite, and quartz. The actinolite occurs as elongate needle-like crystals and is intermixed with porphyroblasts of chlorite and flattened, epidote-filled amygdules.

A coarse pyroclastic breccia (R-3652) exposed on a hill above the right bank of Beards Creek is composed of dark purplish-black, angular, amygdaloidal lithic fragments up to 15 cm in diameter in a matrix of small angular lithic fragments, collapsed scoria, crystals, and a light-gray aggregate of fine tuff (Figure 10). The lithic fragments contain light-colored, fine-grained reaction rims, possibly indicating partial fusion and welding of the pyroclastic breccia. Microscopic examination indicates that

the rock is composed of, in order of abundance, actinolite, epidote, chlorite, quartz, and plagioclase.

The bedded metatuffs (R-3741) are medium grayish green, massive to well foliated, and fine grained. Graded bedding is evident in sawed slabs. The beds are 1 to 2 inches thick and grade upward from coarse crystals and rock fragments into fine crystals and tuff fragments. With the exception of altered relic

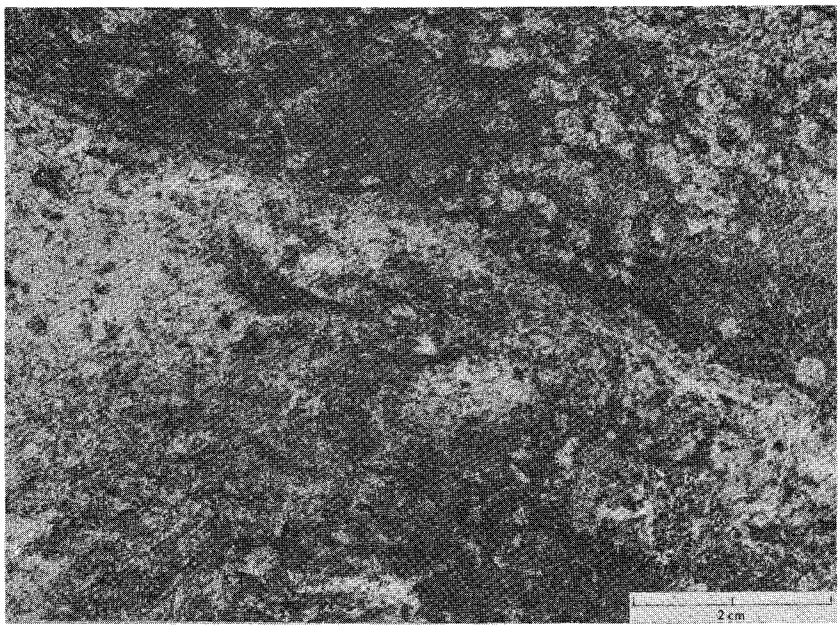


Figure 10. Sawed slab of lithic metatuff breccia (R-3652) from 0.2 mile west of Beards Creek. Contact between large amygdaloidal basalt fragment (top) and altered fragmental matrix (bottom) is across the photograph from upper left to lower right. Note reaction rim around basalt fragment and wispy masses of flattened scoria fragments in the matrix; both are characteristic of welded tuffs.

feldspar crystals, individual mineral grains cannot be identified with the unaided eye. Thin sections of it are composed of about equal amounts of pale-green actinolite-tremolite and epidote with accessory chlorite and quartz. All primary minerals including feldspar have been partially to totally replaced.

## Metadiabase

Three metadiabase dikes occur near Prilliman (Plate 1). The discordant nature of these dikes is readily observed in two

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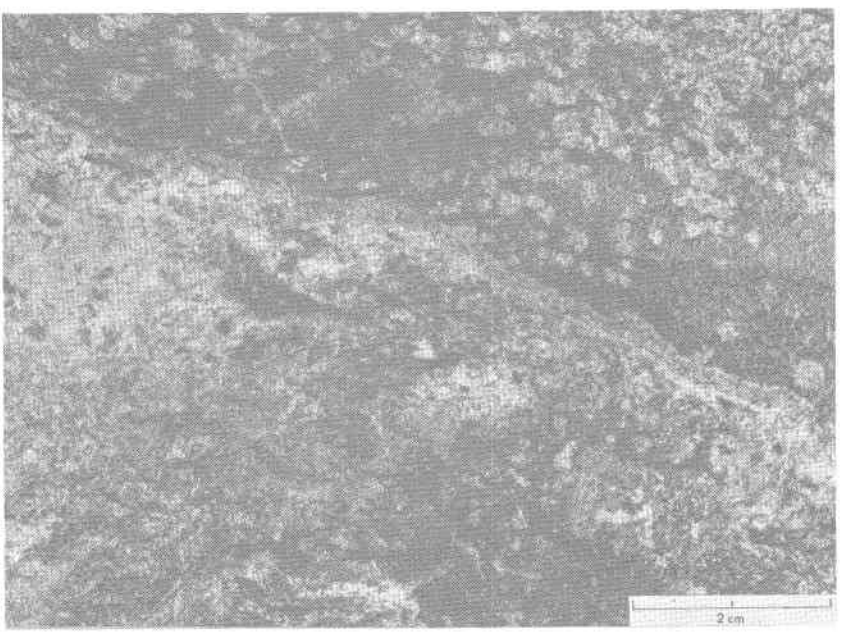


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exposures on the northeast side of State Road 767 just south of Prilliman (Figure 11). These dikes have altered the enclosing Lynchburg Formation for as much as 3 inches away from the contacts; however, no alteration was observed along the contact of the dike that intrudes the Moneta gneiss 0.5 mile southeast of Prilliman.

Figure 11. Metadiabase dike, intrusive into Lynchburg Formation on north side of State Road 837, just below Norfolk and Western Railway bridge south of Prilliman. Blocky weathering of metadiabase contrasts with foliated saprolite of Lynchburg Formation.

The metadiabase (R-3657, R-3760) is dark greenish gray to almost black. It is fine grained and is composed of actinolite, epidote, and quartz with accessory amounts of plagioclase, chlorite, sphene, and apatite. Quartz occurs as veinlets and as interstitial grains. Relic subophitic texture is preserved, and schistosity is poorly developed, even though some of the amphibole grains are oriented parallel to the plane of foliation. The metadiabase dikes resemble the metabasalt flows in appearance, composition, and metamorphic grade (greenschist), thus indicating that they might be feeder dikes for the flows.

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## Graphite Schist

The graphite schist is present in the eastern, southeastern, west-central, and northwestern parts of the quadrangle (Plate 1). It overlies the interbedded metagraywackes and metabasalts. The graphite schist is generally coarse grained; it has a flaggy appearance at the base, but higher in the unit it is finer grained and more schistose because of a decrease in quartz and increase in mica. Coarse-grained graphite schist (R-3642) is well exposed on the right bank of Smith River at the Union Church Bridge. It is a medium- to dark-gray, well-jointed, equigranular rock typically having flaggy foliation. Compositional layering, consisting of alternating quartz-rich and mica-graphite-rich bands 2 to 6 mm thick, is deformed into chevron and isoclinal folds with axial planes that intersect foliation at a slight angle, producing rodding (Figure 12). In thin sections the coarse-

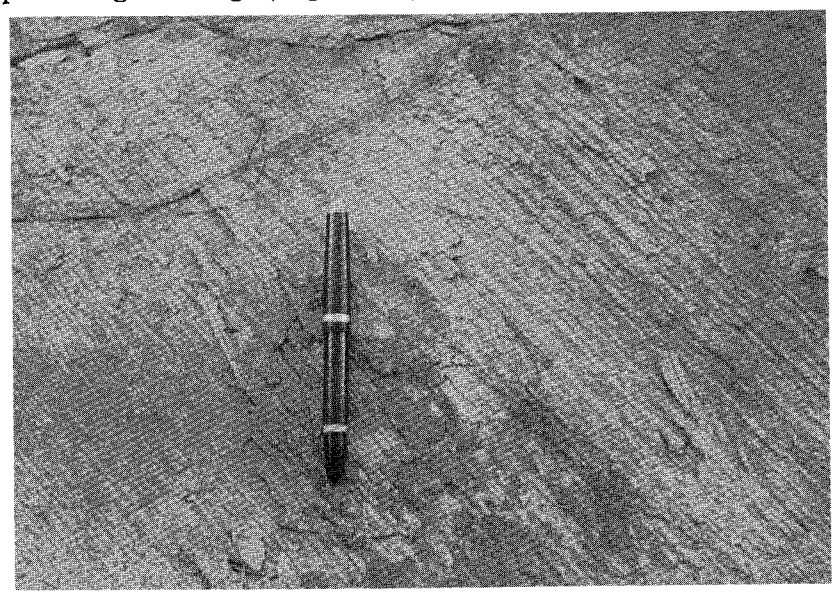

Figure 12. Rodding in quartzose graphite schist (Lynchburg) along road-cut at Ryans Branch campsite. Lineation plunges steeply toward the northwest.

grained schist is composed of quartz; about equal amounts of graphite and muscovite; accessory pyrite; and alteration minerals chlorite, probably from biotite, and limonite from pyrite.

The more schistose upper part of the unit is exposed along State Road 822, 0.9 mile southwest of Little Mountain. It

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The graphite schist is present in the eastern, southeastern, west-central, and northwestern parts of the quadrangle (Plate 1). It overlies the interbedded metagraywackes and metabasalts. The graphite schist is generally coarse grained; it has a flaggy appearance at the base, but higher in the unit it is finer grained and more schistose because of a decrease in quartz and increase in mica. Coarse-grained graphite schist (R-3642) is well exposed on the right bank of Smith River at the Union Church Bridge. It is a medium- to dark-gray, well-jointed, equigranular rock typically having flaggy foliation. Compositional layering, consisting of alternating quartz-rich and mica-graphite-rich bands 2 to 6 mm thick, is deformed into chevron and isoclinal folds with axial planes that intersect foliation at a slight angle, producing rodding (Figure 12). In thin sections the coarse-

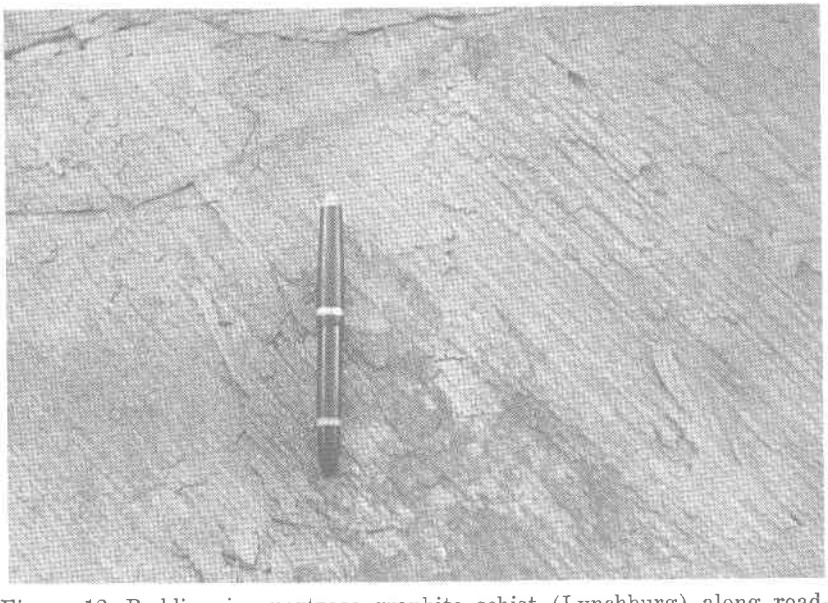

Figure 12. Rodding in quartzose graphite schist (Lynchburg) along roadcut at Ryans Branch campsite. Lineation plunges steeply toward the northwest.

grained schist is composed of quartz; about equal amounts of graphite and muscovite; accessory pyrite; and alteration minerals chlorite, probably from biotite, and limonite from pyrite.

The more schistose upper part of the unit is exposed along State Road 822, 0.9 mile southwest of Little Mountain. It

(R-3643) is medium to dark gray, fine grained, schistose, and has crinkle folds. The graphite schist (R-3643, R-3644, R-3707) is composed predominantly of quartz and muscovite in about equal amounts; accessory minerals include graphite, biotite, ilmenite, and garnet, and secondary chlorite and leucoxene are present. The schist is equigranular and contains quartz-muscovite-biotite bands, alternating with muscovite-quartz-chlorite bands, both of which have been sheared along foliation and slip cleavage into lens-shaped boudins. Slip cleavage is well developed in the micaceous bands.

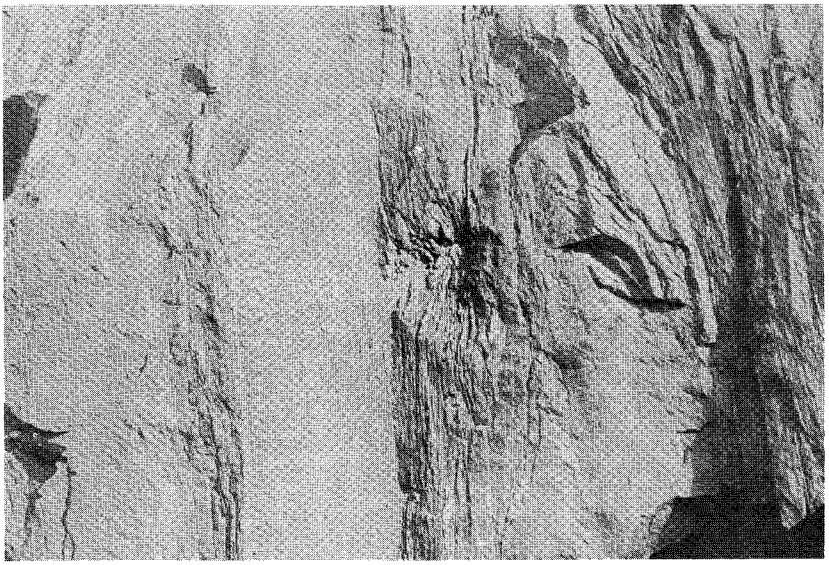

Figure 13. Isoclinally folded quartzite in the Lynchburg Formation (R-3650) along State Highway 57, 0.4 mile northwest of the intersection with State Road 822. Ten-inch-thick quartzite bed left of center is repeated to the right of center; note the steeply plunging fold nose just right of center.

Thin calcareous zones occur in the graphite schist. One of these zones is exposed near the intersection of State Highway 57 and State Road 822 in the southeastern part of Fairy Stone State Park. It is generally a dark-gray, planar-foliated, slightly banded rock (R-3644). Calcite occurs as almost pure bands, ranging from 1 to 5 mm in thickness and as disseminated porphyroblasts ranging from 0.5 to 1 mm in diameter which give the rock a knobby appearance on foliation planes. The dominant mineral is muscovite, followed in order of abundance by quartz and equal amounts of calcite and graphite; accessory minerals are

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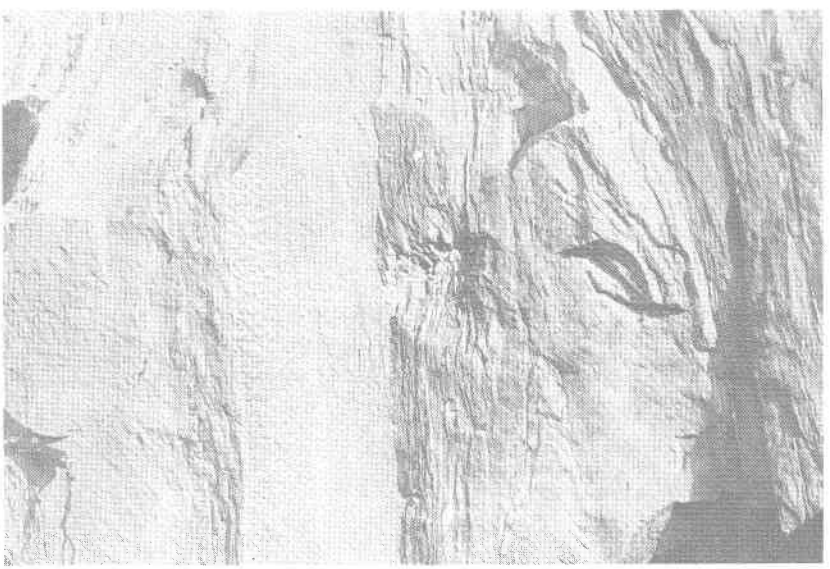

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ilmenite and a trace of epidote. Calcite is a secondary mineral that has partially replaced sphene; bent mica crystals are peripheral to calcite porphyroblasts. Calcite has formed by replacement and growth along foliation planes.

Quartzite occurs in the graphite schist as discontinuous beds (Figure 13). The quartzite is exposed on the north side of State Highway 57 (R-3650) and where Green Branch enters Fairy Stone Lake (R-3649). Another exposure is on the west side of State Road 823 on the southeast part of Stuarts Knob (R-3704). The rock is generally white to cream, is foliated, and has an incipient foliation that transects the first at an acute angle. Thin sections of the rock (R-3649, R-3650, R-3703, R-3704, R-3749,) are composed predominantly of quartz, with accessory sphene, muscovite, plagioclase, amphibole, biotite, and ilmenite; secondary minerals are chlorite and leucoxene. The quartz is equigranular, angular, recrystallized, and has no relic sedimentary structures. It is generally sheared into lens-shaped masses, and recrystallized streaks of optically continuous quartz occur parallel to secondary foliation.

### Muscovite-Chlorite-Chloritoid Schist

A unit that consists of muscovite-chlorite-chloritoid schist and phyllonite with intercalated beds of metagraywacke and graphite schist occurs in the southeastern part of the quadrangle (Plate 1). This unit, which is about 0.3 mile wide, is in contact with relatively undeformed graphite schist on the northwest and tectonically deformed and retrogressed schists on the southeast. The rock (R-3641) is exposed on the north side of State Highway 57, approximately 0.5 mile northwest of the Henry-Patrick county boundary. It is a greenish-gray schistose rock in which foliation is transected by two slip cleavages that intersect each other at almost right angles. Sheared, lens-shaped, light-colored bands occur parallel to foliation and, in some outcrops, the structure approaches that of a button schist.

The rock (R-3641, R-3723) is composed mainly of sericite, quartz, and chlorite; accessory minerals are chloritoid, sphene, and epidote. Quartz occurs as granular lens-shaped masses in fine-grained, wispy foliation bands composed of mica and mica-chlorite. Chloritoid porphyroblasts, which are twinned and pleocroic in olive and anomalous purple, have been fractured and rotated. Graphite generally occurs along the northwest contact

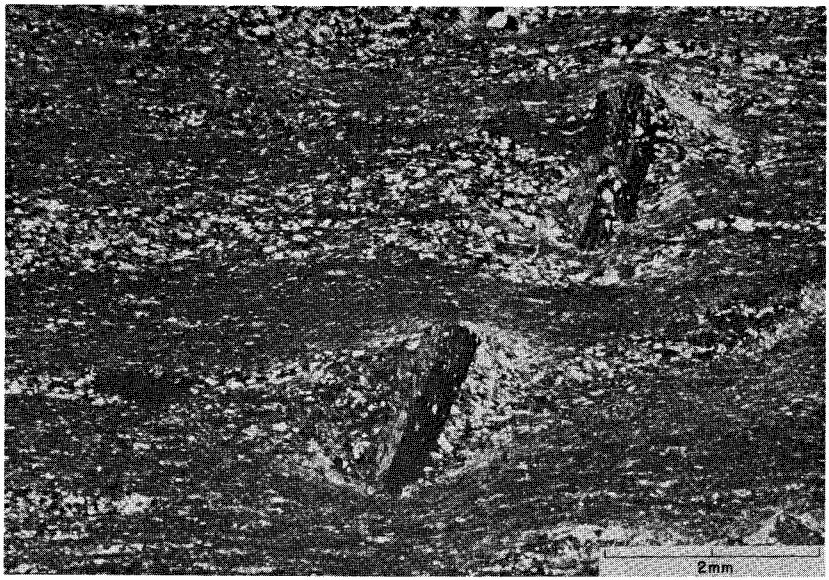
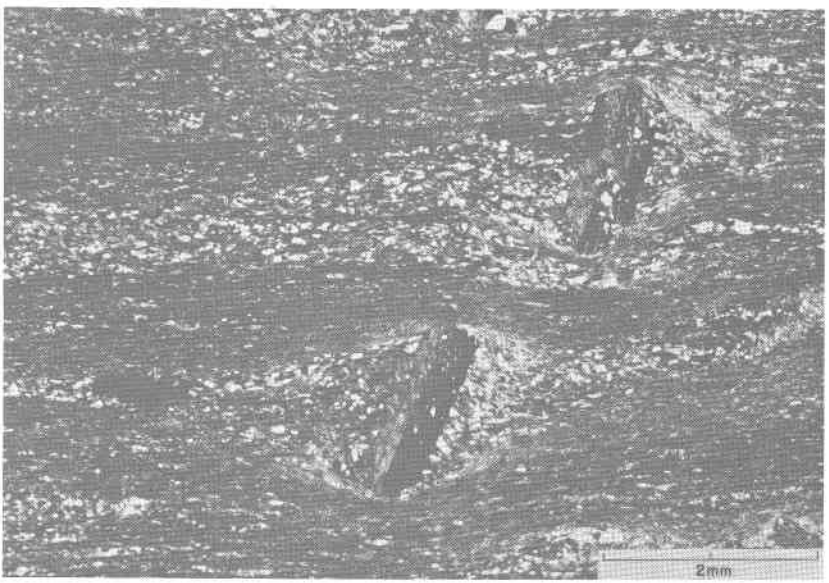



Figure 14. Photomicrograph of rotated chloritoid porphyroblasts in phyllonite of the muscovite-chlorite-chloritoid schist unit (R-3641) exposed along State Highway 57, 0.6 mile northwest of the Henry-Patrick county boundary. Twinned porphyroblasts are enclosed by cataclastic, schistose matrix. Cross-polarized light.

with the graphite schist unit and increases in amount along strike in a northeasterly direction. The rock is recrystallized and has a fine-grained cataclastic texture (Figure 14).

## Metagabbro

Sill-like bodies of metagabbro which are concordant to local foliation are present in the Lynchburg Formation. The metagabbro (R-3658) is exposed on the right bank of Goblintown Creek where it enters Fairy Stone Lake. This lithology is generally coarse grained and has an ophitic texture; because of retrograde metamorphism it is in the greenschist facies (Figure 15). The metagabbro (R-3712, R-3724, R-3736, R-3738, R-3767) is composed of actinolite (in part uralitic amphibole), albite, epidote, chlorite, and sphene. Minor amounts of zircon, quartz, ilmenite, magnetite, labradorite-bytownite, and pyroxene are also present.

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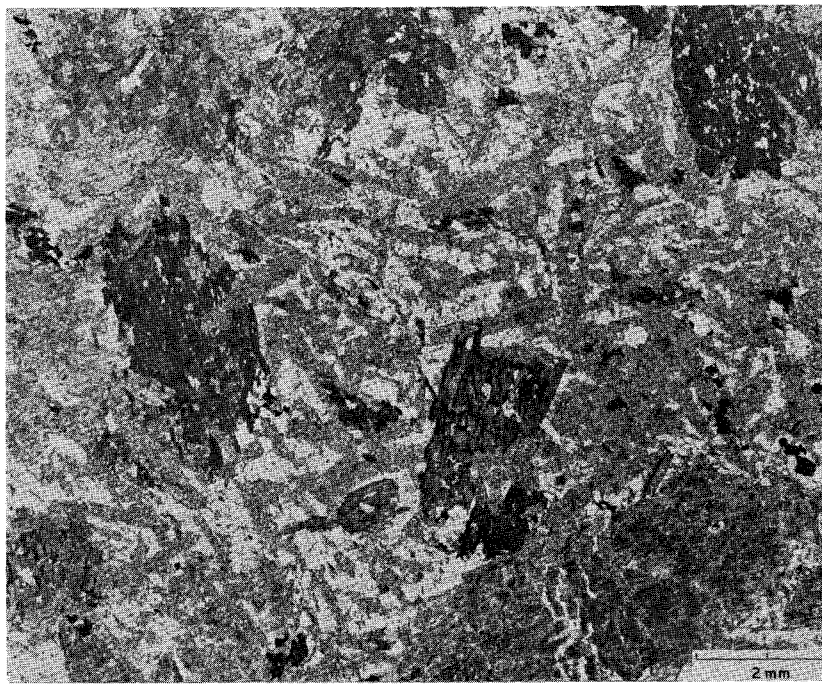
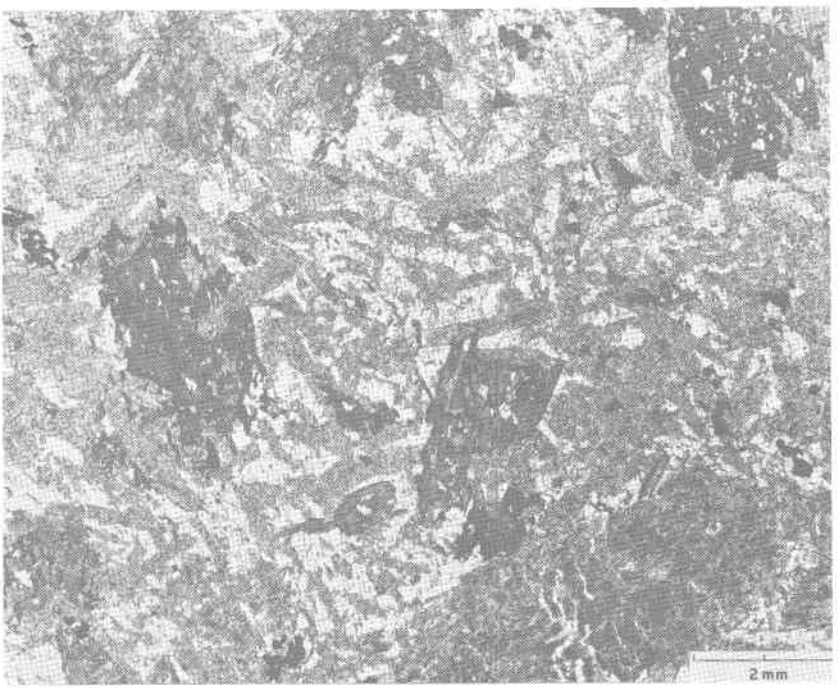



Figure 15. Photomicrograph of metagabbro (R-3658) from the right bank of Goblintown Creek, at the ridge where State Road 623 spans the creek. Much of the original ophitic texture is preserved, although large uralitic amphibole porphyroblasts seem to have replaced plagioclase and earlier amphibole. Cross-polarized light.

The metagabbro bodies are generally coarser-grained and more abundant in feldspar near their centers and are finer grained and more abundant in mafic minerals away from their centers. In some light-colored zones (R-3658, R-3724) feldspar is the predominant mineral. A dark-colored, amphibole-rich metagabbro (R-3712) is exposed in the northern part of the large sill on the south bank of Philpott Reservoir east of Union Church Bridge. The perimeters of the metagabbros are generally actinolite and chlorite schists. Magnetite deposits are associated with the metagabbro sills on Stuarts Knob and also on the right bank of Goblintown Creek. Although the quartzites in contact with metagabbros seem to have been little affected by contact metamorphism, the graphite schists in contact with the top of the large sill north of Fairy Stone State Park have been altered into dense black hornfels (R-3737).

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## PALEOZOIC(?) ROCKS

### PEGMATITE DIKES

Pegmatite dikes and sill-like bodies occur in the rocks of uncertain age (Plate 1). Pegmatites are exposed northeast of the service road that leads to Philpott Dam. These pegmatites range from 10 to 30 feet in width, are light colored, generally are vertical to slightly inclined, and are either conformable to regional foliation or transect it at a slight angle. They are composed of microcline, perthite, quartz, muscovite, biotite, and tourmaline. Greisen is associated with these pegmatites and is composed of quartz, intergrown muscovite and biotite, and accessory tourmaline. Both zoned and unzoned pegmatites occur; the larger bodies seem to be unzoned, whereas the smaller ones generally have a quartz-mica core.

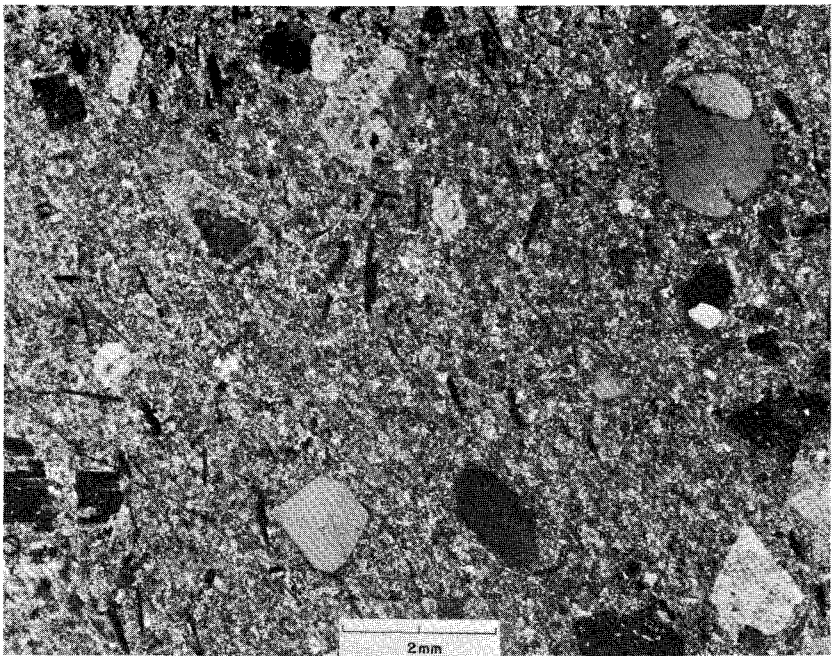


Figure 16. Photomicrograph of porphyritic felsite (R-3659) from a dike located along State Road 727, 0.3 mile west of its intersection with State Road 604. Phenocrysts of bipyramidal quartz, twinned feldspar, and lath-like plates of biotite are enclosed in finely crystalline quartz-muscovite-feldspar matrix. Cross-polarized light.

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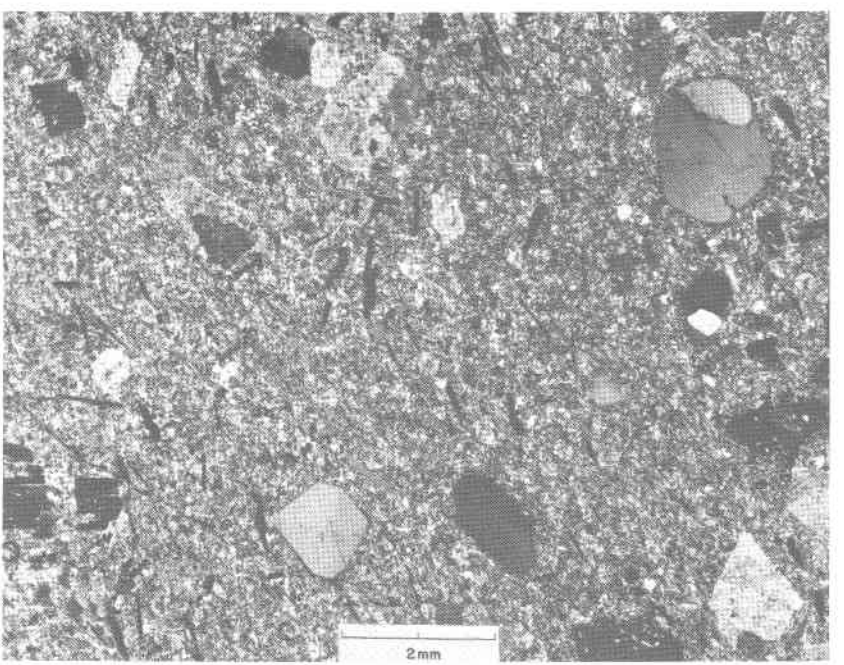


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### FELSITE DIKES

Northeastward-trending, vertical felsite dikes occur predominantly in the southeastern part of the quadrangle in the Lynchburg Formation and schist of uncertain age (Plate 1). A dike (R-3659) is exposed along State Road 727, 0.3 mile west of its junction with State Road 604 on the left bank of Smith River. The dikes are light cream to light gray and have a porphyritic texture. Phenocrysts consist of euhedral biotite and beta quartz, subhedral clear feldspar, and large anhedral tan feldspar; the matrix is light colored and granular.

Thin sections of samples from felsite dikes (R-3659, R-3696) indicate that they are variable in composition. Alpha quartz constitutes 38.5 to 63 percent of the rock; plagioclase makes up 14.8 to 38 percent and ranges from oligoclase-andesine to albite in composition. Accessory minerals are biotite, orthoclase, perthitic orthoclase, and muscovite. Sphene, apatite, and zircon occur in trace amounts, and secondary minerals are zoisite, sericite, and hematite stains around grain boundaries. Some of the phenocrysts of quartz and feldspar are embayed. The matrix is composed of fine-grained, equigranular quartz, feldspar, and mica (Figure 16).

## TRIASSIC SYSTEM

### DIABASE DIKES

Northwestward-trending, generally vertical diabase dikes occur predominantly in the southeastern half of the quadrangle (Plate 1). A diabase dike is exposed along State Road 604 just south of where it crosses Mill Creek, 1.5 miles northwest of Philpott; another dike is well exposed in a sharp bend of this road 0.3 mile south of the creek. The dikes generally average 15 to 20 feet in width; the widest dike mapped in the quadrangle (along State Road 604 on the hill just south of where the road crosses Mill Creek) is about 160 feet. These dikes, for the most part, occur in an *en echelon* pattern, generally offset to the northeast. The dikes are dark gray to black, fine to medium grained, equigranular to inequigranular, and have an ophitic texture. They are generally composed of labradorite, augite, and magnetite.

## QUATERNARY SYSTEM

### COLLUVIUM

Colluvial deposits occur on the slopes of a number of hills in the quadrangle (Plate 1). They consist of two types: one is a deep-red, unsorted mixture of angular rock fragments, fine sand, silt, and clay such as that typically exposed along State Road 604, 0.2 mile south of the intersection with State Road 603, 1.1 miles southeast of Union Chapel; the other type is an accumulation of angular blocks as is typically exposed on the right bank of Smith River in the northwestern portion of the quadrangle. Much of the upper weathered zone on the flanks of hills has probably been moved to some extent by soil creep, but such material is not shown on the geologic map (Plate 1) as colluvium. In addition, individual talus boulders are common on steep hillsides and in floodplains of steep-sided valleys.

### ALLUVIAL TERRACE DEPOSITS

Remnants of fluvial deposits are preserved as terraces along slopes and on flat-topped hills throughout the quadrangle (Plate 1). They consist of rounded cobbles and pebbles of quartz in a dark-red matrix of sand, silt, and iron oxide. The pebbles and cobbles have etched surfaces, especially upper surfaces, because of continued exposure to weathering. In some cases the finer material has been removed leaving only a thin accumulation of rounded cobbles and pebbles on the land surface. Exposures of terrace deposits on the west side of State Road 604, in a sharp bend of the road approximately 200 feet north of the intersection with State Road 727, 0.8 mile west-northwest of Philpott contain phantom outlines of decomposed rounded lithic fragments.

### ALLUVIUM

The floors of many of the streams of the area are partially to totally covered with alluvial deposits (Plate 1). The base of these deposits is composed of poorly sorted pebbles and gravel intermixed with sand and clay. Above this the deposits consist of gray to brown interlayered pebbly sands, sands, and clayey sands. The upper part of the deposits is composed of organic silts and silty clayey sands, the top of which is a shallow soil zone.

## STRUCTURE

### FOLIATION

Regional geologic structure is based on the geometric configuration of stratigraphic units and the attitude of foliations that include bedding, schistosity, and fracture cleavage (Plate 2). Schistosity is the predominant planar structure of the micaceous metasedimentary rocks and is equivalent to gneissic banding in the coarse-grained quartzo-feldspathic metasedimentary rocks. Compositional banding is probably sedimentary bedding that is accentuated by mimetic recrystallization. Both schistosity and gneissic layering are generally parallel to compositional banding in the structurally competent units but are not always parallel to recognizable compositional banding in the more schistose metasedimentary rocks that have been tightly folded.

Fracture cleavage (Plate 2) includes slip cleavage that shows displacement and development of crinkle (drag) folds and also cleavage with little or no visible displacement. Slip cleavage is well developed along the steeply dipping Bowens Creek fault (Figure 17). Gentle undulatory fracture cleavage occurs southeast and northwest of this shear zone. Along State Highway 57 in the area east of Faith Church, between State Roads 942 and 838, low-angle fracture cleavage in sillimanite-mica schist and granite gneiss consists of many closely spaced displacements, each of which is small, but which collectively may represent a significant amount of movement.

### FOLDS

Two fold systems occur in the quadrangle, one in the southeastern part of the area and the other in the northwestern part. These fold systems seem to be independent of each other and are separated by a major thrust fault. The major folds are several miles in length and on the order of 1 mile across; the intermediate folds are subsidiary structures on the major folds and range in size from several hundred feet to over 1000 feet across (Plate 1, Sections A-A' and B-B'). Because these subsidiary folds are discontinuously exposed and rarely affect the configuration of stratigraphic units, their axes are not shown on Plate 2. Minor folds, that consist of small-scale flowage and drag folds visible in a single outcrop, are present on the limbs and noses of intermediate and major folds (Plate 2).

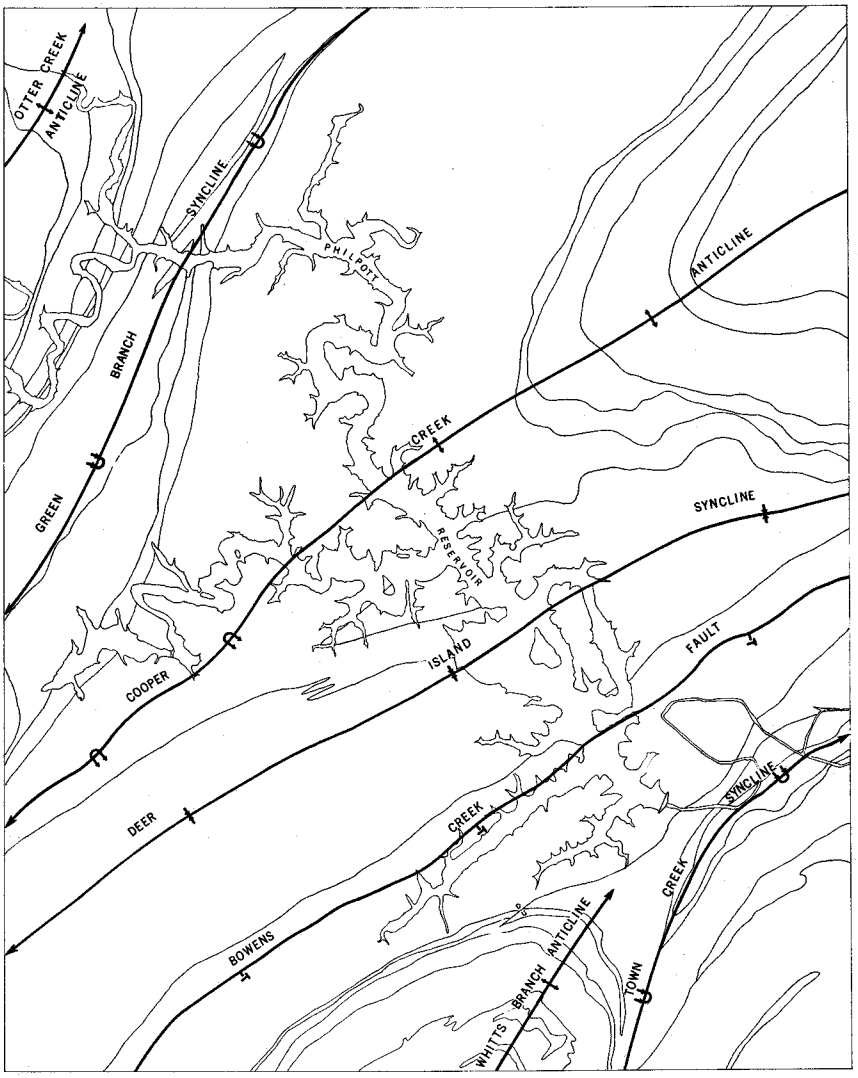


Figure 17. Generalized geologic map showing the locations of major structural features.

## SOUTHEASTERN FOLD SYSTEM

Portions of three major folds have been mapped in rocks exposed in the southeastern part of the quadrangle (Plate 2). These consist of from east to west (Figure 17 and Plate 2) the northwestern limb of an anticlinal structure; the nose of a narrow overturned syncline, named the Town Creek syncline for Town Creek, the mouth of which is near the axis of the structure; and the nose of a broad anticline, named the Whitts Branch

anticline for Whitts Branch, a stream that crosses the nose of the structure.

In the southeasternmost portion of the quadrangle, the northwest limb of an anticlinal structure, which includes an infolded syncline of sillimanite-mica schist and amphibolite with a vertical axial plane, is present in the granite gneiss unit. Along the linear ridge immediately southwest of Bassett, the outcrop belt of the infolded sillimanite-mica schist forms a series of discontinuous, pod-shaped masses surrounded by granite gneiss, indicating that the plunge of the syncline is undulatory.

The Town Creek syncline (Figure 17) can be traced from approximately 1 mile south of the community of West Bassett to an area 0.5 mile east of the community of Philpott. Its axial trace is arcuate and has a trend of N. 15° E. near West Bassett to N. 70° E. east of Philpott; its axial plane is inclined steeply toward the southeast. Foliation has a steep dip toward the southeast on both limbs of the structure. The syncline contains sillimanite-mica schist with intercalated amphibolite beds and is outlined by curving bands of amphibolite. In the area just north of Mt. Hermon Church, south of State Highway 57, minor folds in sillimanite-mica schist have a steep easterly plunge toward the axis of the trough. Minor flowage folds, located southeast of the major synclinal axis, are overturned toward the axis of the trough, indicating plastic flowage of the schist into the deep narrow syncline. These minor folds are exposed in a stream valley at West Bassett approximately 0.4 mile south of the intersection of State Highway 57 and State Road 666 and in another outcrop 1.2 miles north-northeast of West Bassett, 200 feet west of the intersection of State Road 666 and State Road 674.

The axis of the Whitts Branch anticline (Figure 17 and Plate 2) can be traced in a northeasterly direction from an area about 0.8 mile south of Faith Church to a point 0.5 mile north of Mt. Hermon Church. The axial trace of the fold has a trend of approximately N. 45° E. and the axial plane of the structure is nearly vertical. The symmetry of the nose of the anticline indicates that it has a steep plunge to the northeast near Mt. Hermon Church. Its maximum width within the area is approximately 2 miles, and it contains granite gneiss in the center portion, surrounded by sillimanite-mica schist and curved bands of amphibolite. Low-amplitude anticlines and synclines that range in width from 600 to 1200 feet can be recognized by

opposing dips of foliation planes along the contact between granite gneiss and amphibolite near Faith Church, approximately 0.4 mile northwest of, and parallel to, State Highway 57. These structures have gentle plunges and indicate that the granite gneiss unit has flowed plastically away from the axis of the Whitts Branch anticline. Similar flowage folds are present on the nose of the anticline and produce arcuate contacts between sillimanite-mica schist and granite gneiss in this area (Plate 2). Minor folds that also exhibit flowage away from the center portion of the major anticline are present in a stream valley along the contact between the sillimanite-mica schist and granite gneiss unit, approximately 0.3 mile south of Faith Church 0.2 mile south of the junction of State Highway 57 and State Road 838, and in a roadcut approximately 0.6 mile southwest of Mt. Hermon Church 100 feet west of State Road 775, 0.4 mile south of its junction with State Road 881. Recumbent minor flowage folds are exposed on the nose of the Whitts Branch anticline at the contact between sillimanite-mica schist and granite gneiss in a stream valley 0.8 mile southwest of Mt. Hermon Church on the west side of State Road 775, 0.5 mile southwest of its junction with State Road 881.

### NORTHWESTERN FOLD SYSTEM

Portions of four major fold structures have been mapped in the northwestern part of the quadrangle. These include, from southeast to northwest, a synclinal trough named Deer Island syncline for Deer Island in Philpott Reservoir; a complex anticline named Cooper Creek anticline for Cooper Creek which enters Philpott Reservoir near the axial trace of the structure; an overturned syncline, named the Green Branch syncline for Green Branch, a tributary to Fairy Stone Lake; and the nose of an anticline named the Otter Creek anticline for Otter Creek, a tributary to Rennet Bag Creek (Figure 17 and Plate 2).

The Deer Island syncline can be traced southwestward from an area about halfway between Philpott and Mill Creek through Deer Island and Little Mountain to the headwaters of Blackberry Creek. The axial trace of the syncline has a trend of N. 40° E. to N. 80° E. across the southeastern portion of the quadrangle. From outcrop patterns and distribution of the intensely folded graphite schist, the structure becomes wider and deeper toward the southwest. Discontinuous quartzite and

metagraywacke beds interlayered with graphite schist partially outline a tightly compressed series of subsidiary folds in the major syncline (Plate 1, Sections A-A′ and B-B′). Numerous minor folds associated with the syncline are exposed in the graphite schist along State Highway 57 between the Henry-Patrick county boundary and along Hale Creek in the southwestern part of the quadrangle. These are drag folds developed in incompetent units during folding of the major structures. The schist generally contains chevron folds that have steep plunges and well-developed axial plane cleavage. The massive metagraywackes and quartzites interbedded with less competent schists form round-nosed isoclinal folds, some of which have a vertical plunge.

The Cooper Creek anticline can be traced diagonally across the center of the quadrangle in a southwesterly direction from near Mill Creek crossroads and Beech Point, through Fairy Stone State Park and across Hale Creek. The axial trace of the anticline has a trend of N. 55° E. and the structure has a plunge to the southwest. In the northeastern part of the quadrangle the Moneta gneiss is exposed in the center of the broad symmetrical portion of the Cooper Creek anticline; southwestward along the structure, metabasalt and metagraywacke of the Lynchburg are folded into tight pointed arches or chevrons. Farther to the southwest, where Lynchburg graphite schists are exposed along the axial trace of the anticline, it is tightly compressed and the axial plane is inclined to the southeast. Minor recumbent folds along the axis of the structure in the adjacent Charity quadrangle to the west indicate that it is probably recumbent near Elamsville. The complex pattern of the contacts between metabasalt and metagraywacke on the northwest flank of the anticline and between metagraywacke and graphite schist on the southeast flank is due in part to tightly compressed isoclinal folds developed on the larger structure and in part to interfingering of stratigraphic units (Plate 1, Section B-B′).

The southwestward-plunging Green Branch syncline can be traced from approximately 1 mile northeast of Union Church Bridge across Smith River to the area just northwest of Stuarts Knob. The axis, which has a N. 30° E. to N. 50° E. trend, lies within the graphite schist unit of the Lynchburg Formation. These schists have been deformed into many smaller asymmetrical folds, characterized by steeply dipping foliations and sheared limbs. Steeply plunging minor chevron folds occur in graphite

schist approximately 1.4 miles north-northeast of Stuarts Knob, along State Road 623, 0.4 mile southeast of its junction with State Road 712. These chevron folds are approximately 2 feet across and have a steep plunge to the southeast, toward the axis of the syncline. Quartz veins at this locality are sheared and stretched into boudins that are striated parallel to the axes of the chevron folds.

The northeastward-trending axis of the Otter Creek anticline occurs in the area west of Calico Rock (Figure 17 and Plate 1). The axial trace of the anticline trends approximately N. 55° E., and the nose of the fold has a steep plunge to the northeast. The center portion of the anticline is composed of Moneta gneiss that contains concordant beds of calc-gneiss, calc-schist, and actinolite gneiss and schist, all of which wrap around the nose of the fold (Plate 1, Section B-B′). Minor flowage folds in actinolite schist, which are overturned away from the nose of the Otter Creek anticline, are exposed along the right bank of Rennet Bag Creek approximately 0.4 mile downstream from its confluence with Otter Creek.

## LINEATIONS

Lineations caused by preferred growth orientation of mineral porphyroblasts, such as actinolite or sillimanite, and those caused by mechanical means, such as crinkle folds, boudinage, and rodding, were designated with separate symbols on Plate 2. Mineral lineations in rocks of the southeastern fold system are directly related to local minor folds that are in turn related to the major fold system. They generally have a plunge toward minor fold troughs, indicating tectonic transport at nearly right angles to the axes of these structures. Mechanically produced lineations are well developed in rocks of both the southeastern and northwestern fold systems. There seems to be two preferred orientations in the southeastern fold system, steeply plunging northeastward-trending lineations and gently plunging southwestward-trending lineations (Plate 2). In the Lynchburg Formation boudinage, crinkle folds, and rodding are oriented parallel to the trend of larger structural axes but generally diverge from the plunge of the major folds, probably due to the variation in competency of the different lithologies within the formation.

## FAULTS AND SHEAR ZONES

A major thrust fault, here named the Bowens Creek fault, is parallel to a portion of Bowens Creek and has been traced completely across the southeastern part of the quadrangle (Figure 17; Plate 2). Movement along the fault has thrust rocks of uncertain age over the Lynchburg Formation and has cataclastically deformed the rocks adjacent to the fault. The zone of cataclastically deformed rocks averages 4000 feet in outcrop width and has a linear N. 50° E. trend. The northwest boundary of the cataclastic zone corresponds to the northwest contact of the muscovite-chlorite-chloritoid schist, a unit that was probably derived from the Lynchburg Formation. This is indicated by relics of Lynchburg lithology within the unit and a gradational contact between muscovite - chlorite - chloritoid schist and the Lynchburg to the northwest. The most intense cataclasis which probably occurred along the major plane of slippage, is localized along the southeast contact of the muscovite-chlorite-chloritoid schist. The southeast border of the zone is marked by cataclasis and retrograde metamorphism; there is a gradational contact between the retrogressed mica schist unit and the undeformed sillimanite-mica schist. This contact can also be delineated by the pegmatite dikes that occur in the sillimanite-mica schist and are absent in rocks to the west of these units.

Schistosity generally has a steep dip toward the southeast, but localized minor folds have produced some northwesterly dips; it has been transposed by later slip cleavage in the muscovite-chlorite-chloritoid schist and the schist containing altered staurolite and garnet (Figure 2). These units contain many rotated chloritoid porphyroblasts and sigmoidal and pinwheel staurolite and garnet porphyroblasts (Figures 3, 15). Where slip cleavage is intensely developed in porphyroblastic schist, the interconnecting slip planes envelop the rotated porphyroblasts and produce lentils of rhomboidal cross section at intersections with schistosity (Figure 2). The resulting lineation is parallel to the trend of the fault zone and has a gentle plunge either toward the northeast or the southwest. Lineations are also produced by the axes of minor folds as well as crinkle folds within the shear zone and in the rocks adjacent to the zone. These fold axes are parallel to the trend of the fault and have moderate plunges toward the southwest. Mineral lineations, streaks, and grooves are poorly developed along the fault zone. The mineral lineations observed in the zone have a steep plunge toward the

southeast; this fact, combined with the gently plunging fold axes, rotated porphyroblasts, and cleavage intersections, indicates that tectonic transport was to the northwest at a high angle.

A major dislocation is indicated by width of the fault zone, intensity of the cataclasis, steep metamorphic gradient across the zone, a linear trace in an area characterized by arcuate fold structures, and retrogression of sillimanite to sericite pseudomorphs as far as 1 mile away from the zone. Most of these features have been cited (Reed and Bryant, 1964) as indicative of large wrench faults. Within the quadrangle, the orientation of lineation, small-scale steeply plunging folds, and shear foliation indicate that movement took place from the southeast toward the northwest along a high-angle thrust fault that could have been produced by differential movement along a regional wrench fault system.

A significant shear zone that has a trend of approximately N. 40° E. has been traced in a southwesterly direction from a point 1 mile north of Fairy Stone Lake to the quadrangle boundary; it is generally parallel to the southeast contact of the metagabbro sill exposed along the west shore of Fairy Stone Lake (Plate 1). The metagabbro along this zone has been sheared and recrystallized into actinolite and chlorite schist. Similar shear zones occur in places along the contact of the metagabbro sill in the northeastern part of the quadrangle and also along smaller shear zones within the sill (Plate 1).

Two shear zones are exposed in metabasalt along State Road 772 on the southeast side of Brown Hill southwest of Prilliman. Both zones have a trend of approximately N. 30° W. and are nearly vertical. Minor drag folds are developed in metabasalt where the southwestern most zone is exposed along State Road 772. Both zones are outlined by subtle topographic depressions and drainage development along the hillslope, as well as abrupt changes in the strike of foliations.

Two minor faults displace amphibolite and sillimanite-mica schist southeast of Bowens Creek (Plate 1). The larger fault, located just south of the head of Cow Branch inlet about 0.6 mile north of the intersection of State Highway 57 and State Road 838, has a trend of N. 55° E. and is delineated by apparent thickening of an amphibolite layer. It seems to have rotated counterclockwise in an almost vertical plane. The other structure is a high-angle reverse fault that truncates a belt of amphibolite in the nose of the Town Creek syncline; it is exposed

in roadcuts just north of the intersection of State Road 904 and State Highway 57, 0.3 mile west of West Bassett.

## GEOLOGIC HISTORY

The oldest rock unit exposed northwest of the Bowens Creek fault is the Moneta gneiss. This unit was derived from ancient feldspathic and calcareous sediments that had been interlayered or intruded by mafic volcanic or plutonic rocks. These sediments were probably deposited in a Precambrian geosyncline, the depositional basin of which was destroyed by orogeny. During this orogeny the deeply buried sediments and ancestral rocks were totally recrystallized under conditions of high temperature and pressure, to form the Moneta gneiss.

In late Precambrian time another period of crustal downwarping and sedimentation began. The coarse clastic metasedimentary rocks of the Lynchburg Formation developed in a rapidly subsiding geosynclinal basin. That a source rock other than the Moneta gneiss was providing sediments for this basin is indicated by the abundance of microcline in the Lynchburg Formation and its absence in the Moneta gneiss. The initial clastic sedimentation in the northeast was followed by basaltic lava flows and deposition of massive graywacke beds. Diabase feeder dikes were probably injected into the Moneta gneiss and Lynchburg Formation near Prilliman during the time of major basaltic extrusion. This sequence grades vertically and probably laterally into medium- to fine-grained carbonaceous clastic metasedimentary rocks, indicating the decline of vulcanism coincidental with the initiation of deposition of fine to medium organic-rich sediments in quiet deep water of a stagnant basin.

Gabbroic magma was forced upward into the sedimentary and volcanic rocks that filled the trough. Folding of the Lynchburg Formation and refolding of the Moneta gneiss were caused by rising vertical forces that destroyed the geosyncline in late Precambrian time. This upward component warped the Moneta gneiss so that it formed the center portions of broad anticlines. Higher stratigraphic units of the Lynchburg Formation were stretched on the limbs of these folds and were thickened during flowage into the synclinal troughs between the rising anticlines. Compressional forces were sufficient to cause overturning of the higher stratigraphic units along portions of the southwest-

ward-plunging anticline in the central part of the quadrangle (Plate 1, Section B-B′ between Spring Branch and Little Mountain). During this orogeny, rocks of the Lynchburg Formation developed upper greenschist metamorphic mineral assemblages, and the Moneta gneiss that had previously recrystallized was retrogressively metamorphosed to the upper greenschist facies.

The rocks of uncertain age were deposited as high-alumina clays, basalt flows, and sandy beds in a large geosynclinal trough. Sedimentation was terminated during an orogeny in which rocks in the lower levels of the geosyncline were metamorphosed at high temperatures and medium to high pressures. Later the rocks of uncertain age were thrust faulted into contact with the Lynchburg Formation, possibly by differential upward movement along a major lateral fault. The shear zone between the two crustal blocks, now exposed, was deeply buried at the time of movement as indicated by the extreme shearing and recrystallization along the zone. Undeformed felsite dikes that postdate the period of thrusting have intruded the shear zone along the Bowens Creek fault, as well as the schist units southeast of the zone and the Lynchburg Formation northwest of the zone.

During Triassic time, southwestward-trending diabase dikes were emplaced in rocks of the quadrangle. Since Late Triassic time the region has undergone a prolonged period of erosion. In late Tertiary or Pleistocene time, thick flood-plain deposits covered the stream courses. After a period of uplift, dissection of the alluvial deposits began. The present streams are eroding material in the foothills of the Blue Ridge to the northwest and are depositing sand and silt along the course of the Smith River and its tributaries.

## ECONOMIC GEOLOGY

### IRON ORE

Several abandoned iron-ore mines and prospect pits, known collectively as the Hairston mine, are located southwest of Fairy Stone Lake and along Goblintown Creek (Plate 1). The ore seems to be localized in bands of actinolite and chlorite schist in metagabbro. Watson (1907, p. 474) stated that the ore veins in the area consisted of magnetite and ranged from 3 to 6 feet in width. Two adits (Plate 1, Nos. 2 and 3) and several prospect pits (Plate 1, No. 4) are present along the right bank of

Goblintown Creek. They apparently intersect a 3-foot-wide lateral drift that followed the ore vein parallel to the creek. Thin magnetite veins can be observed in the portal of the northern adit. An open pit (Plate 1, No. 5) on Stuarts Knob is now partially filled; the ore veins were not observed, although magnetite was found on the dumps of the old workings.

A gossan was traced along the northwest contact of the metagabbro sill west of Fairy Stone Lake. The zone is less than 2 feet wide and is exposed in two pits (Plate 1, Nos. 6 and 7) approximately 250 feet apart. It is composed of limonite and opaline silica in quartz-rich graphite schist, the wall rock of the metagabbro intrusion.

## MICA AND FELDSPAR

Mica mines and prospect pits occur in pegmatite dikes and sills associated with the schist unit in the southeastern part of the quadrangle (Plate 1). The major prospects and abandoned mines are now filled with debris, but have been described in detail by Griffitts, Jahns and Lemke (1953) and Brown (1962). The Merriman and Greer mines (Plate 1, No. 8) were the largest producers of mica in the quadrangle; Brown (1962, p. 148) described large perthite-rich zones in these mines and suggested that these zones in the Merriman mine might be a commercial source of potassic feldspar.

## STONE

Some of the lenticular veins of translucent to milky quartz (Plate 1) in the area may be of suitable quality and occur in sufficient quantity to warrant consideration as sources for decorative aggregate. These quartz veins are oriented both parallel to the foliation of the country rocks and also across the foliation along northwestward-trending fracture zones. They range in width from 2 to 10 feet and are either steeply inclined or are vertical. The largest continuous vein crops out approximately 1000 feet west of Calico Rock on Rennet Bag Creek. It has a northwesterly trend and can be traced for approximately 1000 feet. Small ilmenite veinlets were observed in float from this vein on the left bank of Rennet Bag Creek.

There are no active commercial producers of crushed stone or dimension stone within the quadrangle. In the past, stone from the metabasalt unit of the Lynchburg Formation was

quarried at a locality along Hale Creek (Plate 1, No. 1). Parts of the granite gneiss unit, the amphibolite unit, and the Lynchburg Formation are potential sources of crushed stone. At several localities in the northwestern part of the quadrangle, cleavage is well developed in quartzose graphite schist that may be a possible source of flagstone. Metabasalt that might be used as flagstone is exposed in a stream valley along the power-transmission line 0.8 mile southwest of Dodson, 2000 feet northwest of the intersection of State Roads 623 and 712. Quartzose graphite schist that might be used as flagstone occurs just southwest of Union Church Bridge.

A relatively thin zone of calc-gneiss and calc-schist containing impure marble is present in the Moneta gneiss along Rennet Bag Creek. The individual calcareous layers range from 30 to 50 feet in outcrop width. The zone is 200 to 300 feet wide and was traced along strike for more than 3 miles within the quadrangle; however most of it is within the reservation boundary surrounding Philpott Reservoir. The actinolite and chlorite schists along the contacts and shear zones in the metagabbro plutons are locally talcose and contain soapstone.

### GEM STONES

Gem stones are the only mineral commodity currently being produced in the quadrangle. Abundant sericite pseudomorphs after twinned staurolite crystals occur in the residual soil overlying the schist containing altered staurolite and garnet (Plate 1). These pseudomorphs are collected locally and filed to the shape of a perfect cruciform twinned saturolite crystal. Known as "fairy stones," they are mounted on display boards and sold as souvenirs and good-luck charms.

## AEROMAGNETIC SURVEY

Part of an aeromagnetic survey (Virginia Division of Mineral Resources, 1966) covers the southwestern portion of the Philpott Reservoir quadrangle. The northeastern part is included in an aeromagnetic survey that was made in 1969. Figure 18 is a composite map that has contours depicting total magnetic intensity superimposed on a generalized geologic map. Rock units of minor areal extent such as diabase, pegmatite, and felsite dikes were omitted from the map, and some lithologic units have been combined and generalized.

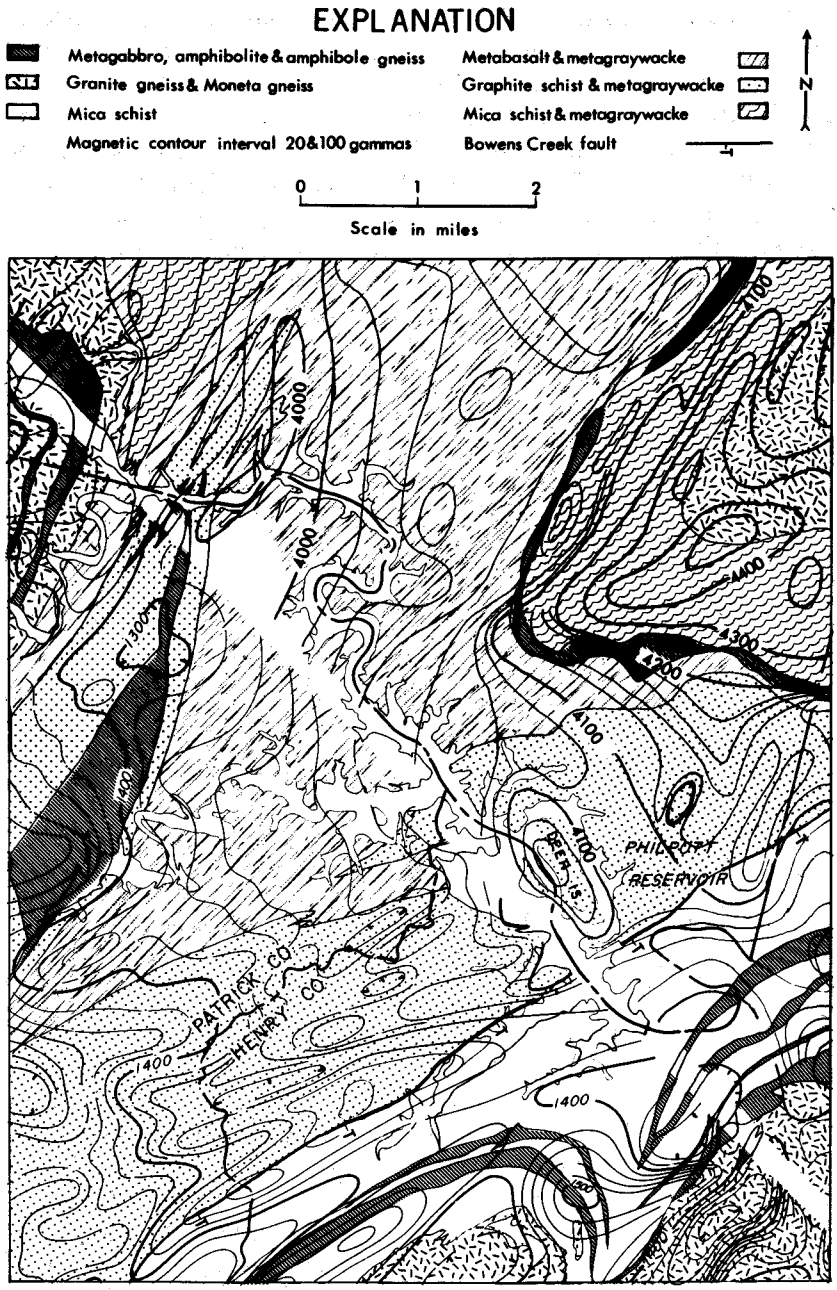


Figure 18. Aeromagnetic contours superimposed on a generalized geologic map of Philpott Reservoir quadrangle.

Linear magnetic anomalies delineate the trend and outcrop pattern of amphibolite of uncertain age and actinolite gneiss in the Moneta, whereas metabasalt of the Lynchburg Formation is marked by a gentle high. Granite gneiss, the schist units, and the metasedimentary units in the Lynchburg Formation are characterized by broad areas of lower magnetic intensity, with scattered, irregularly shaped highs and lows especially well developed on the sillimanite-mica schist. The shear zone along Bowens Creek seems to correspond to a linear magnetic trough. The shear zones and associated magnetite deposits along Fairy Stone Lake are localized on the edge of an area of low magnetic intensity northwest of the broad high associated with metabasalt in the Lynchburg Formation.

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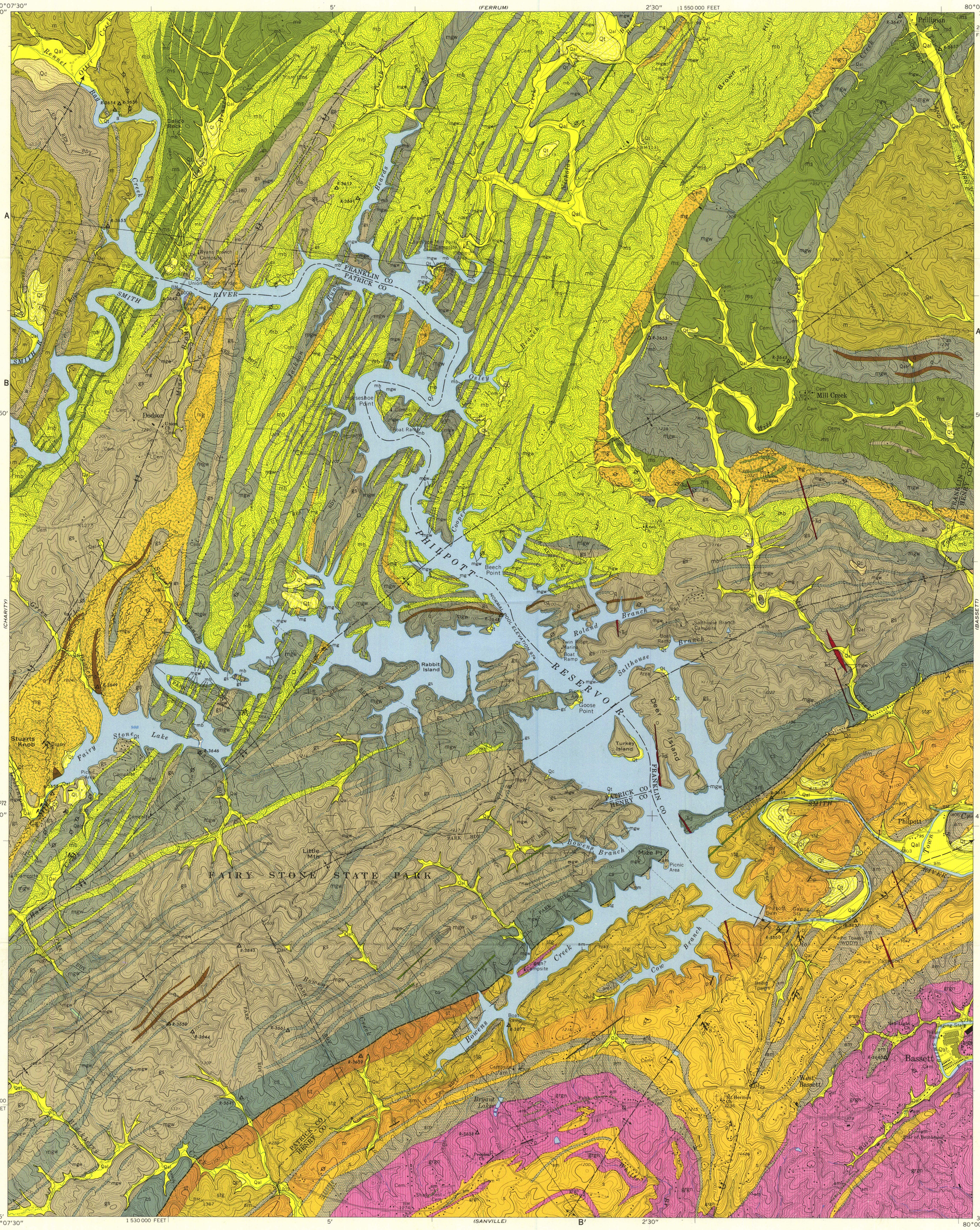
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist






Base from U. S. Geological Survey, 1967
Philpott Reservoir Quadrangle 7½ Minute Series

Williams & Heintz Map Corporation

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# GEOLOGIC MAP OF THE PHILPOTT RESERVOIR QUADRANGLE, VIRGINIA

Geology by James F. Conley and William S. Henika

3½° Magnetic North True North
1967 MAGNETIC DECLINATION

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
CONTOUR INTERVAL 20 FEET

VIRGINIA
QUADRANGLE LOCATION

1969

## EXPLANATION

### CENOZOIC — QUATERNARY

**Qal** — Alluvium
*Gray silts and sands containing cobbles at base.*

**Qt** — Alluvial terrace deposits
*Rounded cobbles and boulders in red clay and silt matrix.*

**Qc** — Colluvium
*Angular cobbles and boulders in red silt and sand matrix and talus boulder beds.*

### MESOZOIC — TRIASSIC

**Td** — Diabase dikes

**f** — Felsite dikes

**p** — Pegmatite dikes
*Feldspar-quartz-muscovite-biotite dikes, some containing tourmaline.*

### PRECAMBRIAN

**mgw, cs, gs, q, ms, mg, mb** — Lynchburg Formation
*cs, muscovite-chlorite-chloritoid schist; gs, graphite schist; q, quartzite; mb, metabasalt; mg, metagabbro; ms, muscovite-sericite and muscovite-biotite schist; mgw, metagraywacke and metagraywacke conglomerate.*

**md** — Metadiabase
*Discordant bodies of actinolite schist containing relic diabasic texture.*

**a, c, m** — Moneta gneiss
*a, actinolite gneiss and schist; c, calc-gneiss and calc-schist; m, muscovite-biotite gneiss.*

### ROCKS OF UNCERTAIN AGE

**grgn** — Granite gneiss
*Light gray medium to fine grained, equigranular feldspar-quartz-biotite-muscovite gneisss.*

**st, stg, m, s** — Schist
*st, staurolite schist; stg, schist containing altered staurolite and garnet; m, mica schist, containing some sillimanite, s, sillimanite-mica schist.*

**am** — Amphibolite

### CONTACTS

exposed
approximate
covered or inferred

### FOLDS

Anticline—trace of axial plane and direction of plunge of axis.
Overturned anticline—trace of axial plane and direction of plunge of axis.
Syncline—trace of axial plane and direction of plunge of axis.
Overturned syncline—trace of axial plane and direction of plunge of axis.

### FAULTS

THRUST
T overthrust side

NORMAL
U upthrown side
D downthrown side

### SHEAR ZONE

### SAMPLE LOCATIONS

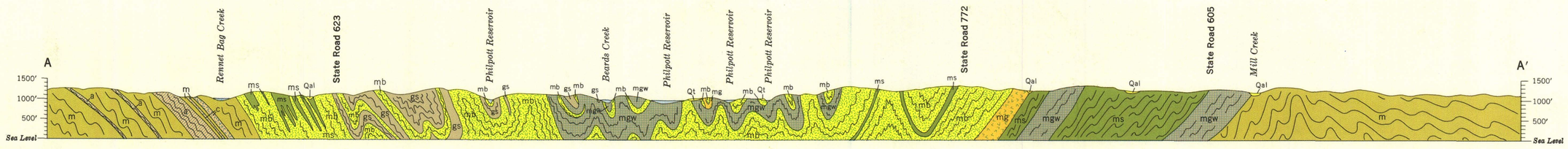
R-3637 Location and repository number of sampled lithology.

### QUARRIES, MINES, AND PROSPECTS

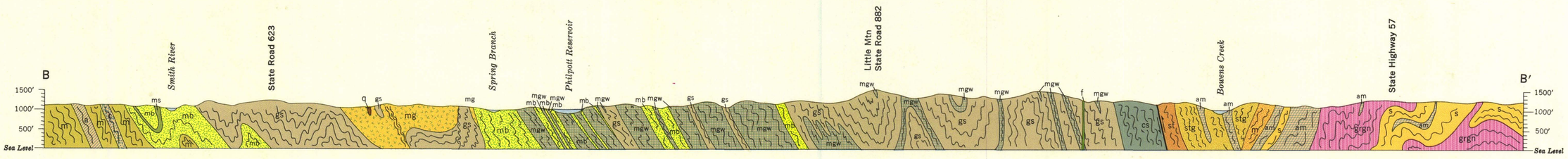
ABANDONED QUARRY OR MINE
1. Metabasalt
2. Magnetite
3. Magnetite
5. Magnetite
8. Mica
9. Mica
10. Mica

PROSPECT
4. Magnetite
6. Gossan
7. Gossan

QUARTZ VEIN
Unoriented
Strike of vein




No Vertical Exaggeration



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# STRUCTURE MAP OF THE PHILPOTT RESERVOIR QUADRANGLE, VIRGINIA

By James F. Conley and William S. Henika

## EXPLANATION

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*Discordant bodies of actinolite schist containing relic diabasic texture.*

**a, c, m** — Moneta gneiss
*a, actinolite gneiss and schist; c, calc-gneiss and calc-schist; m, muscovite-biotite gneiss.*

### ROCKS OF UNCERTAIN AGE

**grgn** — Granite gneiss
*Light gray medium to fine grained, equigranular feldspar-quartz-biotite-muscovite gneisses.*

**st, stg, m, s** — Schist
*st, staurolite schist; stg, schist containing altered staurolite and garnet; m, mica schist, containing some sillimanite, s, sillimanite-mica schist.*

**am** — Amphibolite

## CONTACTS

- exposed
- approximate
- covered or inferred

## FOLDS

- Anticline—trace of axial plane and direction of plunge of axis.
- Overturned anticline—trace of axial plane and direction of plunge of axis.
- Syncline—trace of axial plane and direction of plunge of axis.
- Overturned syncline—trace of axial plane and direction of plunge of axis.
- 23 — Direction and angle of plunge of minor anticline.
- 16 — Direction and angle of plunge of minor syncline.
- 29, 49 — Direction and angle of plunge of minor overturned anticline, also showing inclination of axial plane.
- 42 — Inclination of axial plane of nonplunging overturned anticline.

## FAULTS

### THRUST

- T — overthrust side

### NORMAL

- U — upthrown side
- D — downthrown side

## SHEAR ZONE

## FOLIATIONS

- 80 — Strike and dip of inclined beds.
- 66 — Strike and dip of overturned beds.
- 72 — Strike and dip of inclined compositional banding.
- Strike of vertical compositional banding.
- 79 — Strike and dip of inclined foliation.
- Strike of vertical foliation.
- 12 — Strike and dip of inclined fracture cleavage.

## LINEATIONS

- 11 — Bearing and plunge of mineral lineation.
- Bearing of horizontal mineral lineation.
- 23 — Bearing and plunge of rodding, boudinage, and crinkle folds.
- Bearing of horizontal rodding, boudinage, and crinkle folds.

## QUARTZ VEIN

- Unoriented
- Strike of vein

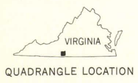
1967 MAGNETIC DECLINATION

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

CONTOUR INTERVAL 20 FEET




QUADRANGLE LOCATION

1969