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MASSIES CORNER QUADRANGLE

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

GEOLOGY OF THE MASSIES CORNER QUADRANGLE, VIRGINIA

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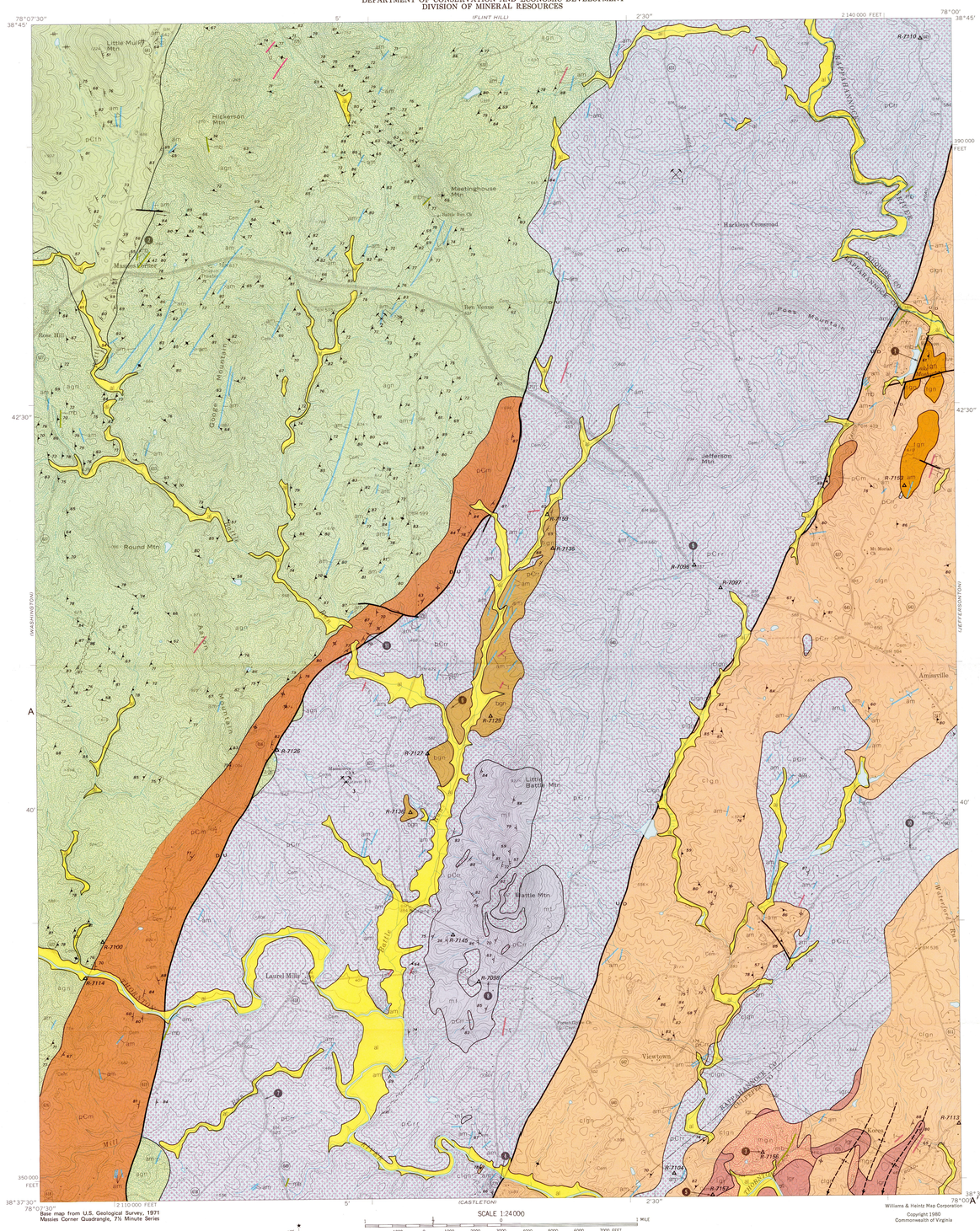
1980



Base map from U.S. Geological Survey, 1971
Massies Corner Quadrangle, 7½ Minute Series

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MN GN 3° 124 MILS 1°50' 33 MILS
UTM GRID AND 1971 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1980

VIRGINIA
QUADRANGLE LOCATION

EXPLANATION

UNIT CHARACTERISTICS

QUATERNARY — al

Alluvium: *Stratified, unconsolidated, gray to grayish-yellow sand, silt, and local gravels*

TRIASSIC — d

Diabase dike: *dark-gray, medium-grained diabase.*

PRECAMBRIAN — mb

Metabasalt dike: *dark, grayish-green metabasalt.*

am

Amphibolite dike: *medium- to dark-gray, actinolite-amphibolite. Exposed (blue line), covered (gray line)*

mf

Felsite dike: *light-gray felsic igneous rocks.*

pCm

Mechum River Formation: *light-gray to grayish-brown arkosic sandstone and conglomerate. Local occurrences of boulder-sized clasts.*

pCrr, mf, pCrr

Robertson River Formation: *pCrr, light-gray to pinkish-gray biotite, hornblende-biotite, magnetite, and alkali granite rocks, mf, light- to dark-gray, magnetite-and biotite-bearing felsite.*

Precambrian Rocks (Uncertain other age)

bgn

Biotite gneiss: *Biotite-and hornblende-bearing granitoid, porphyritic, and gneissic rocks of quartz monzonite, quartz diorite, and granodiorite composition.*

lgr

Leucogranite: *Medium-grained, pinkish-gray to light-gray leucogranite containing moderate yellowish-brown quartz platelets.*

clgn

Coarse leucogneiss: *Coarse-grained, pinkish-gray to gray-green, biotite-bearing quartz monzonite gneiss with quartz-feldspar megacrysts.*

mgn

Migmatitic gneiss: *Intimately associated medium-grained leucogranite, coarse leucocratic quartz monzonite gneiss, and light- to medium-gray, finely banded biotite-bearing granodiorite gneiss.*

agn

Augen-bearing gneiss: *light- to dark-gray quartz monzonite gneiss; augens of potassium feldspar common.*

pCfh

Flint Hill Gneiss: *Light-to dark-gray quartz monzonite gneiss.*

fgn

Fine-grained gneiss: *Light-gray to greenish-gray, biotite-bearing quartz monzonite gneiss.*

KEY

CONTACTS
Exposed or approximate
Covered or inferred

FOLDS
Anticline: trace; arrow indicates direction of plunge
Syncline: trace; arrow indicates direction of plunge

FAULTS
U D
Exposed or approximate (black line); covered (gray line); U, upthrown side; D, downthrown side; arrows indicate direction of relative movement

SHEAR ZONE

ATTITUDE OF ROCKS
60 Strike and dip of beds

FOLIATION
73 Strike and dip of compositional layers
Strike of vertical compositional layers
85 Strike and dip of gneissic layers
Strike of vertical gneissic layers
65 Strike and dip of cleavage
Strike of vertical cleavage

QUARRIES
Active (intermittent)
1. Granite saprolite
Abandoned
2. Amphibolite
3. Granite saprolite

SAMPLE LOCATIONS
R-7100 R, repository number of rock sample on file at Virginia Division of Mineral Resources
Reference locality described in discussion

CROSS SECTION DESIGN
1. No vertical exaggeration.
2. Subsurface structure interpreted from surface measurements.
3. Thickness of alluvium diagrammatic.

STRATIGRAPHY

The rocks in the Massies Corner quadrangle lie in the core of the northeastward-plunging Blue Ridge anticlinorium and consist of plutonic igneous, metamorphic and metasedimentary rocks and unconsolidated alluvial sediments. The area is underlain largely by a complex of gneisses and granitic rocks of Precambrian age which are assigned to the Flint Hill Gneiss and Robertson River Formation and to units which are informally named fine-grained gneiss, augen-bearing gneiss, migmatitic gneiss, coarse leucogneiss, leucogranite and biotite gneiss. The stratigraphic relationships among some of these units are uncertain because many contacts are gradational or covered.

The fine-grained gneiss is believed to be the oldest rock in the quadrangle and appears to be the country rock of the intrusive coarse leucogneiss. The coarse leucogneiss also intrudes the migmatitic gneiss and is itself intruded by the leucogranite and a magnetite-rich granite of the Robertson River Formation. The Robertson River Formation is the youngest of the large intrusive bodies in the area and intrudes the augen-bearing gneiss and biotite gneiss as well as the coarse leucogneiss. The Robertson River Formation is in fault contact with the Mechum River Formation, the coarse leucogneiss and augen-bearing gneiss. Metasedimentary rocks of the Precambrian(?) Mechum River Formation generally overlie the augen-bearing gneiss unconformably, but in places the two units are in fault contact.

Fine-Grained Gneiss

Fine-grained gneiss occurs in two small bodies which underlie an aggregate area of about one-half square mile (1.3 sq. km) east and southeast of Lake Mosby. The rock is characterized by interlayered dark and light bands 1 to 2 mm wide. The color variation is due to the relative abundance of biotite. Weathered exposures are greenish-gray; fresher surfaces are light gray and commonly tinted pink. Banding is generally less distinct on fresh surfaces. Grain sizes are uniform, averaging about 1 mm.

The fine-grained gneiss has a granoblastic texture and a quartz monzonite composition. In thin section (R-7153), the major constituents are quartz (33 percent), microperthite (29 percent), and plagioclase (28 percent). The plagioclase is saussuritized calcic oligoclase with albite twinning. Green biotite, commonly tinted, makes up 4 percent of the rock. Ilmenite, surrounded by rims of sphene-leucoxene, is a common accessory and zircon occurs in trace amounts.

The two bodies of fine-grained gneiss lie entirely within the coarse leucogneiss. It is inferred that the fine-grained gneiss is a remnant of the country rock that was intruded by the coarse leucogneiss. There are excellent exposures of the fine-grained gneiss on the hillside east of Lake Mosby (REFERENCE LOCALITY 1).

Flint Hill Gneiss

The Flint Hill Gneiss (Lukert and others, 1977) is exposed over an area of approximately 1.5 square miles (3.9 sq. km) in the northwestern corner of the quadrangle. The petrography of the rock, which has a composition of a quartz monzonite, has been described in detail (Lukert and Nuckols, 1976; Lukert and others, 1977). The Flint Hill Gneiss in outcrop is generally light to dark gray; it is composed of biotite-rich mafic layers commonly less than 2 mm thick interspersed with quartz- and feldspar-rich layers. The lighter-colored layers generally range from 2 to 5 mm in thickness. Grain sizes rarely exceed 2 mm. Strained and somewhat mortared quartz, microperthite and partially altered calcic oligoclase are the principal minerals. Biotite generally occurs in amounts up to 15 percent. Sphene and chlorite are common and may be more abundant than biotite in some samples. Accessory minerals include ilmenite (partly altered to sphene and leucoxene), magnetite, zircon, apatite and epidote.

The Flint Hill Gneiss is in gradational contact with the adjacent augen-bearing gneiss. The contact is defined on the basis of the presence or absence of large potassium feldspar megacrysts and is well exposed on the western slope of the hill northeast of Massies Corner (REFERENCE LOCALITY 2). The Flint Hill Gneiss is cut by mafic dikes and on the eastern flank of Little Mulky Mountain encloses small bodies of pinkish gray, medium-grained granitic material; these granites have not been mapped separately.

Zircons from the gneiss have yielded a concordant age of 1081 million years. The gneiss may actually be older because the date could represent a resetting of the uranium-thorium clocks during Grenville time (Lukert and others, 1977).

Augen-Bearing Gneiss

The augen-bearing gneiss trends northeastward in an area comprising approximately 14 square miles (36.3 sq. km) and lying mostly in the western part of the quadrangle. The rock is light to dark gray and is composed of potassium feldspar porphyroblasts set in a matrix of quartz, feldspar and biotite. The porphyroblasts are commonly as large as 2 inches (5 cm). Where they are abundant, many of the megacrysts have long axes which cut across the coarse gneissic foliation of the rock. The size and abundance of the porphyroblasts is generally uniform throughout the area, although their size diminishes somewhat to the southwest.

Modal and chemical analyses have been made on samples of augen-bearing gneiss from the Linden and Flint Hill quadrangles (Lukert and Nuckols, 1976). The dominant mineral constituents are quartz, microperthite, calcic oligoclase, and green biotite. Some of the quartz is granulated and mixed with fine biotite, epidote, and sericite. Biotite abundance is variable, but generally exceeds 10 percent. The amount of plagioclase generally ranges between 15 and 40 percent but one sample (R-7100) was found to contain only one percent plagioclase. Accessory minerals include magnetite, ilmenite, sphene-leucoxene, zircon, epidote, chlorite, apatite, and muscovite. The augen-bearing gneiss has the composition of a quartz monzonite.

The augen-bearing gneiss contains local concentrations of thorium. Six areas of thorium-rich gneiss in the quadrangle are shown as sites of anomalously high natural thorium radioactivity on the Sperryville 15-minute aeroradiometric contour map (Virginia Division of Mineral Resources, 1975). Most of the anomalies are aligned in a northeast-trending zone near the contact with the Mechum River Formation.

Samples of gneiss from these sites have a mean concentration of 38 parts per million (ppm) thorium as determined by X-ray fluorescence analysis (O. M. Fordham, Jr., personal communication, 1978). Augen-bearing gneiss from other areas in the quadrangle generally has no thorium above the X-ray fluorescence detection limit of 7 ppm.

Minute, vitreous, reddish-orange crystals of thorite or thorogummite were identified in a gneiss sample with a thorium concentration of 74 ppm, which was collected 0.7 mile (1.1 km) west of Aaron Mountain. Except for the presence of these crystals, the thorium-rich gneiss appears texturally and mineralogically identical to gneiss with no detectable thorium.

Rare-earth element concentrations in augen-bearing gneiss with and without detectable thorium are low; however, rare-earth-bearing granitic rocks intrusive into the gneiss were found near two of the aeroradiometric anomalies. About 0.7 mile (1.1 km) southeast of Ben Venue, a pegmatitic rock contains monazite, allanite and bastnaesite associated with magnetite, hematite and sphene. The rock is high in cerium, neodymium, lanthanum, and yttrium, but contains no detectable thorium. On the west side of State Road 729, 2 miles (3.2 km) south of Ben Venue, a granitic dike, 12 inches (30 cm) wide, cuts the augen-bearing gneiss. The dike is significantly higher in rare-earth elements than the surrounding gneiss, but has no detectable thorium. The gneiss, however, contains 40 ppm thorium.

Rare-earth elements and thorium occur together at Red Oak Mountain, which is located about 5 miles (8 km) southwest of Laurel Mills (Halladay, 1978). The elements are in pegmatite, quartz-magnetite-apatite rock, and residual nodules of metamict minerals in soil and saprolite.

The augen-bearing gneiss is in gradational contact with the Flint Hill Gneiss. It is faulted against the Robertson River Formation, for a short distance, north of U. S. Highway 211 but elsewhere the Robertson River Formation appears to intrude the augen-bearing gneiss. The augen-bearing gneiss is overlain unconformably by the Mechum River Formation. The straightness of this boundary along much of its length reflects a nearly vertical contact. Small patches of augen-bearing gneiss are separated from the main body of the unit by the narrow strip of Mechum River rocks, and these are interpreted as being in fault contact with the Mechum River Formation.

The gneiss is cut by numerous amphibolite and metabasalt dikes. Two diabase dikes cut the augen-bearing gneiss on the northeastern slopes of Mickerson Mountain. A few felsic dikes also intrude it. Most outcrops of the augen-bearing gneiss contain linear bodies of aplitic material which range in width from approximately 2 inches (5 cm) up to as much as 12 inches (30 cm). Most of these aplitic bodies are short (2 to 5 feet, 0.6 to 1.5 m), but some can be traced for 10 to 20 feet (3 to 6 m).

Migmatitic Gneiss

The rocks in the southeastern corner of the quadrangle mapped as migmatitic gneiss include leucogranite, coarse leucogneiss and light-gray, finely banded gneiss in intimate association with each other. Quartz in the finely banded phase is strained and potassium feldspar is microperthite. Plagioclase is saussuritized calcic oligoclase. Muscovite and epidote are accessories. In addition to apatite, trace minerals include ilmenite (commonly altered to sphene-leucoxene), zircon, hematite and magnetite. The light-gray, finely banded gneiss somewhat resembles the fine-grained gneiss mapped in the northeastern part of the quadrangle near Lake Mosby as discussed earlier. In thin section (R-7156), however, the finely banded phase of the migmatitic gneiss can be distinguished from the rocks near Lake Mosby by:

1. dominance of plagioclase over potassium feldspar,
2. presence of Carlsbad and pericline twins in addition to albite twins in the plagioclase,
3. generally greater amounts of biotite (approximately 10 percent),
4. accessory amounts of apatite not noted in thin sections of the fine-grained gneiss.

Contacts with adjacent rocks are not exposed, but a gradation into the leucogranite and coarse leucogneiss is inferred. The migmatitic gneiss is cut by amphibolite dikes. Exposures of the finely banded phase occur in the fields north of State Road 626 approximately 0.8 miles (1.3 km) west of Korea (REFERENCE LOCALITY 3).

Coarse Leucogneiss

The coarse leucogneiss underlies an aggregate area of approximately 8 square miles (21 sq. km) in the eastern and southeastern part of the quadrangle. The rock is pinkish-gray to greenish-gray coarsely foliated quartz monzonite and is characterized by the presence of large, polycrystalline megacrysts. The megacrysts are predominantly potassium feldspar and quartz and are subrounded to elongate with maximum dimensions of 5 inches (13 cm). The remainder of the rock is quartz, potassium feldspar, plagioclase and biotite. There are excellent exposures in the south bluff of the Thornton River 500 feet (152.4 m) east of State Road 729 (REFERENCE LOCALITY 4), in pastures north of State Road 626 about 0.4 miles (0.6 km) east of Korea, and in the south bluff of the Rappahannock River north of Lake Wilson.

In thin section, the coarse leucogneiss is dominated by quartz and feldspar (R-7113). Microperthite is generally more abundant than plagioclase, which is highly saussuritized calcic oligoclase and displays albite, Carlsbad, and pericline twinning. Undulatory extinction is characteristic of the quartz grains. Green biotite is common in abundances of less than 10 percent. Granulated cataclastic(?) material of fine-grained quartz, epidote, biotite and sericite occurs locally. Accessory minerals include ilmenite, sphene-leucoxene and zircon.

Along its western margin, the coarse leucogneiss is in fault contact with the Robertson River Formation and in the southeastern corner of the quadrangle the gneiss is intruded by a separate body of the Robertson River Formation. Small areas of fine-grained, greenish-gray gneiss and of medium-grained migmatitic gneiss within the coarse leucogneiss may represent rocks into which the coarse gneiss was intruded. At places near Lake Wilson and Lake Mosby, the fine-grained gneiss is in fault contact with the coarse leucogneiss. Irregular bodies of leucocratic granite within the leucogneiss in the southeastern corner of the quadrangle lack most of the orientational fabric of the coarse leucogneiss, suggesting that they may have been intruded into the coarse leucogneiss. The coarse leucogneiss is also intruded by both felsic and mafic dikes. Many, if not most, of the mafic dikes are probably Catoctin feeders. About one mile (1.6 km) north of the intersection of State Road 645 and U. S. Highway 211, a small body of metasedimentary rock unconformably overlies the coarse leucogneiss.

Leucogranite

Pinkish-gray to light-gray, medium-grained leucogranite is exposed in the southeastern part of the quadrangle, where several small areas of the leucogranite are separated by other lithologies. The rock contains two types of quartz: a gray to grayish-blue variety with equant grains and a yellowish-brown variety with tiny platelet-shaped grains. Grain sizes average from 3 to 4 mm and there is a faint gneissic foliation in some outcrops.

In thin sections (R-7157), the quartz displays undulatory extinction; feldspars are microperthite and saussuritized calcic oligoclase. The plagioclase exhibits albite twinning and most grain boundaries have been altered to albite. Some green biotite is present and ilmenite, zircon, and magnetite are accessory minerals. The texture is alliotriomorphic-granular.

Contacts with adjacent units are not exposed, but the leucogranite seems to be gradational with both the coarse leucogneiss and the migmatitic gneiss. In the Orlean quadrangle, which is northeast of the Massies Corner quadrangle, leucogranite intrudes coarse leucogneiss (J. W. Clarke 1976, personal communication). An excellent exposure of the leucogranite occurs in a roadcut on State Road 626 just north of its intersection with State Road 640. (REFERENCE LOCALITY 5).

Biotite Gneiss

North and west of Little Battle Mountain, an area of approximately 0.5 square mile (1.3 sq. km) is underlain by an assemblage of rocks, designated biotite gneiss, that have been intruded and partially digested by granitic rocks of the Robertson River Formation. This assemblage includes a considerable range of compositions and textures. The dominant rock type is fine-grained biotite gneiss of quartz diorite composition, but feldspathization has produced rocks ranging from granodiorite to quartz monzonite.

These rocks have a higher content of ferromagnesian minerals than does the surrounding Robertson River Formation. Biotite, or hornblende and biotite, in excess of 20 percent is common (R-7127, R-7138) and in some rocks exceeds 50 percent (R-7129). The biotite is green and commonly rutilated. The hornblende is also green and some grains are zoned. Perthitic microcline ranges from nil to 40 percent, but is usually subordinate to plagioclase. Calcic oligoclase is generally present in amounts greater than 30 percent, has Carlsbad and albite twinning and is commonly saussuritized. Strained quartz ranges in abundance from 10 to 30 percent. Accessory minerals include epidote, clinozoisite, ilmenite, sphene-leucoxene, zircon, chlorite, apatite and muscovite.

Textures include gneissic (R-7159), compositionally layered (R-7135) and porphyritic (R-7127). In all cases grains of the felsic minerals tend to be larger (4 to 18 mm) than those of the ferromagnesian minerals (1 to 2 mm). Some, and perhaps all, of the biotite gneiss is metamorphosed igneous rock. In some outcrops porphyritic material grades into rocks with a nearly granioid texture. On the northeast side of Battle Run, 0.6 mile (1.0 km) northeast of the intersection of State Roads 622 and 729, fine-grained, dark-green, quartz diorite xenoliths and partially assimilated biotite gneiss rocks occur in the Robertson River Formation (REFERENCE LOCALITY 6). From these relationships it is interpreted that the biotite gneiss unit predated the granite, and that the gneiss is a roof pendant in it. The biotite gneiss, however, does not closely resemble any other rocks in the quadrangle and its stratigraphic relationships with other units could not be determined.

Robertson River Formation

Rocks of the Robertson River Formation occur in two areas in the quadrangle. The main body underlies a northeast-trending strip about 2.5 miles (4.0 km) wide across the quadrangle. A smaller, irregularly shaped body intrudes the coarse leucogneiss in the southeastern portion of the quadrangle. The aggregate area of exposure in the quadrangle is about 25 square miles (65 sq. km).

Within the quadrangle the Robertson River Formation includes four mineralogically and texturally distinct granitic rock types. These are: biotite and biotite-hornblende granite; felsite; alkali granite; and magnetite granite. The boundaries among these varieties are usually gradational, and small masses of one type may be present within another. Isolated outcrops of alkali granite occur mainly within areas of biotite granite, and small bodies of this rock, and others, are also contained within felsite. Medium- to coarse-grained magnetite granite, found primarily in the southeastern part of the quadrangle, grades into biotite and biotite-hornblende granite. Only the felsite was mapped separately.

The biotite and biotite-hornblende granite most closely resembles the type Robertson River Formation described by Allen (1963). The rock is typically medium- to coarse-grained, light to medium gray and weathers pinkish gray. The predominant minerals are feldspar and gray quartz. The most common mafic mineral is biotite which is accompanied by hornblende in some samples. In thin section the quartz displays undulatory extinction, the potassium feldspar is perthite and gridiron- and Carlsbad-twinned microcline, and the plagioclase is calcic oligoclase with both albite and Carlsbad twinning. Pleochroic green biotite rarely occurs in abundances greater than 5 percent and hornblende, when present, is green and strongly pleochroic. Both biotite and hornblende are absent in some samples (R-7110, R-7126). Accessory minerals include sericite, magnetite, epidote, zircon, and rutile.

This biotite and biotite-hornblende granite is most characteristic of the western part of the main outcrop belt of the Robertson River Formation. Excellent exposures of the granite are present along State Road 618 near Mill Run in the southwestern part of the quadrangle (REFERENCE LOCALITY 7).

The felsite variant of the Robertson River Formation occurs on and around Battle and Little Battle mountains in the south-central part of the quadrangle. The total area of exposure is somewhat greater than one square mile (2.6 km).

The felsite ranges from gray to dark gray and contains pleochroic green biotite and disseminated magnetite grains (R-7098). Commonly, there is enough magnetite to deflect a compass needle. The rock is composed of slightly strained quartz, perthite, and plagioclase of undetermined composition, with accessory amounts of epidote, zircon, and sericite. Grain sizes are commonly less than 1 mm.

The felsite seems to be texturally gradational with the granite to the west. In addition, there are zones of biotite granite, biotite-hornblende granite, and alkali granite in intimate association with the felsite. The intimate relationships between the felsite and the coarser-grained varieties are well exposed south of Battle Mountain along State Road 729 between its intersections with State Roads 640 and 618 (REFERENCE LOCALITY 8). The texture of these rocks suggests formation under hypabyssal conditions.

The alkali granite is characteristically medium grained and light to medium gray. It is composed predominantly of quartz and feldspar and contains scattered, prismatic crystals of sodium amphibole or pyroxene (or both) and elongate aggregates of biotite flakes. In thin section, the major constituents are strained quartz, patch perthite and calcic oligoclase (R-7096). The plagioclase has albite and Carlsbad twins and generally comprises less than 15 percent of the rock. Magnetite abundances range from one to five percent (R-7097), and biotite content is usually less than two percent. The peralkaline nature of the granite is indicated by chemical analyses (Rankin, 1976), and is manifested mineralogically by the occurrence of aegirine and riebeckite, each generally present in amounts of less than one percent (R-7145). Aegirine crystals are surrounded by rims of riebeckite. Fluorite, epidote and zircon are common accessory minerals and in a few places the rock contains hematite and allanite.

The granite body in the southeastern part of the quadrangle is characterized by magnetite abundances of about 5 percent (R-7104). In some samples, there is more magnetite than biotite and hornblende. The rock is medium gray and ranges from medium- to coarse-grained. The magnetite is dispersed in a quartzo-feldspathic matrix. In thin section, the rocks commonly show effects of cataclasis such as granulated quartz and fractured feldspar grains.

Perthitic microcline is the dominant feldspar, making up to 50 to 80 percent of the magnetite granite. Carlsbad twins are common. The plagioclase is albite-twinned, calcic oligoclase which ranges in abundance from approximately 5 to 15 percent. The rock may contain green biotite and the accessory minerals epidote, zircon, ilmenite, sphene-leucoxene, muscovite, and chlorite. Pyrite and fluorite are visible in the granite at the junction of State Roads 642 and 611 (REFERENCE LOCALITY 10).

The Robertson River Formation is in fault contact with the Mechum River Formation and with coarse leucogneiss along the western and eastern boundaries, respectively, of the main outcrop belt. A short fault southwest of Round Mountain and the other located one mile (1.6 km) southeast of Laurel Mills, were traced for about one mile (1.6 km) each.

Faults: Three faults were mapped in the quadrangle which are parallel to the general northeast-southwest structural trend of the rocks. One of these, which may have regional extent, separates the main outcrop area of the Robertson River Formation from the coarse leucogneiss. This fault was traced southwestward using high-altitude aerial photographs to near the town of Boston, approximately seven miles (11 km) from the southern boundary of the quadrangle. The fault extends to the northeast into the Orlean quadrangle (J. W. Clarke, personal communication, 1977). The straight fault trace reflects a fault plane that is nearly vertical. The Robertson River Formation is less extensive on the east side of the fault and it is inferred that this side moved down relative to the western block.

The contact between the Mechum River Formation and the main outcrop area of the Robertson River Formation is marked by zones of shear, brecciation, mylonitization, and abundant vein quartz. It is inferred, therefore, that the contact is faulted for most if not all of its length in the quadrangle, but over short distances the fault may not coincide with the contact. The sinuous character of the fault may reflect folding of the fault plane; probably folding would have developed during Paleozoic tectonism.

Because zones of abundant brecciation and vein quartz occur in granitic rocks near the contact, it is likely that the fault is multiple in places. The fault extends for only a short distance north of U. S. Highway 211.

A third northeast-trending fault separates the coarse leucogneiss from the fine-grained gneiss near Lake Wilson and Lake Mosby. The sense of movement on this high-angle fault, which is of undetermined extent, is believed to be down on the east side. The fault is itself displaced by a west-southwest striking right-lateral fault.

Other faults transverse to the regional structural trend include a nearly east-west right-lateral fault located about 2.5 miles (4.0 km) south of Ben Venue; it displaces the Mechum River belt about 400 feet (120 m). A right-lateral fault two miles southwest of Amissville offsets the contact between the coarse leucogneiss and the Robertson River Formation. A felsic dike and a portion of the contact between the coarse leucogneiss and the fine-grained gneiss are each displaced a short distance by a left-lateral fault located approximately two miles (3.2 km) north of Amissville. Another east-west trending left-lateral fault, located about 0.5 mile (0.8 km) north of Massies Corner, has offset the contact between the Flint Hill Gneiss and augen-bearing gneiss.

ECONOMIC GEOLOGY

Quarries: Mineral resources in the area have been little used. Of the three quarries in the quadrangle, two are abandoned. The active quarry (Quarry No. 1) is in the Robertson River Formation on an access lane west of State Road 637, approximately one-half mile (0.8 km) northwest of Hackleys crossroad. Weathered granite, which provides a gravelly aggregate with clay binder, is quarried intermittently by the property owner and is used for surfacing farm lanes and for fill.

The largest of the three quarries (Quarry No. 3) is located about 1700 feet (518 m) west of the intersection of State roads 729 and 622. The granite saprolite at this quarry was used for fill and for road-surface material during the 1920's and 1930's. About 0.6 miles (1.0 km) west of the intersection of State Road 729 and U. S. Highway 211, rock from an amphibolite dike was quarried (Quarry No. 2).

Alluvium: There are some potential sources of sand and gravel in the quadrangle, particularly on flood-plains and on insides of meander bends of the Thornton and Rappahannock rivers. The limited volume of the deposits may restrict development.

GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION

The environmental and engineering characteristics of the granite and gneissic rocks in the quadrangle are generally similar. Differences are related primarily to steepness of slope or depth of weathering. Residual soils developed on these rocks contain moderate amounts of clay, are generally well-drained, and have moderate to rapid percolation. Deep cuts in highly weathered rock are subject to slumping.

Fresh metabasalt, amphibolite and diabase dike rocks are dense, relatively impermeable, and may require blasting in construction projects. These rocks yield clay-rich, reddish residual soil. Felsic dikes may be slightly more permeable than mafic ones due to a greater degree of fracturing, but felsic dikes are often sufficiently coherent to require blasting.

Areas of alluvium along streams are subject to slump and flooding; percolation is generally poor because of the relatively high water table. Alluvium is a possible source of sand and gravel for construction purposes.

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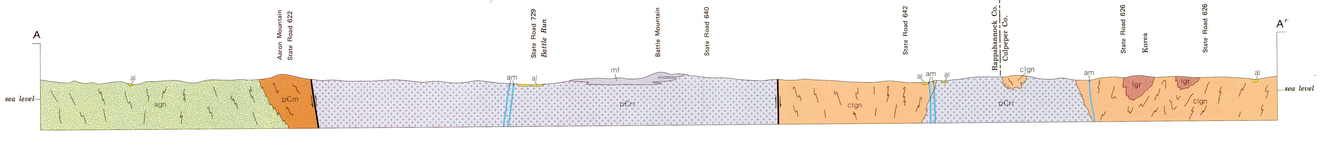
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