U.S. DEPARTMENT OF THE INTERIOR
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Reconnaissance bedrock geologic map of the Red House, Madisonville, Aspen, and Charlotte Court House 7.5-minute quadrangles, Charlotte, Prince Edward, Appomattox, Campbell, and Halifax Counties, Virginia

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INTRODUCTION

A 1:48,000-scale geologic map was made of the Red House, Madisonville, Charlotte Court House, and Aspen 7.5-minute quadrangles, which are located in the Piedmont physiographic province, south-central Virginia. The map area lies mainly in Charlotte County, and it includes parts of Prince Edward, Campbell, Appomattox Counties, and a very small part of Halifax County on the north side of the Roanoke River. Topographic relief ranges from about 328 feet above sea level in the Roanoke River valley to 800 feet at Baker Mountain, about 2 ½ miles east of Madisonville. The easterly flowing Roanoke River and its southerly flowing tributaries form the principal drainage system for the report area.

The geologic mapping was a part of a larger project to map the geology of the Appomattox 30 X 60-minute quadrangle at 1:100,000 scale. Generally the report area is underlain by highly weathered rocks leaving deep weathering profiles and sparse fresh rock exposure. Previously workers have reported on various aspects of the geology within or near the study area (Laney, 1917; King, 1955; Espenshade and Potter, 1960; Tobisch and Glover, 1969, 1971; Tillman,1970; .Glover and Sinha, 1973; Henika, 1977,1980; Butler, 1980; Kolata, and Pavlides, 1980; Marr, 1980; Marr, 1980b; Kreisa, 1980; Gates and others, 1986; Baird, 1991; Horton and Zullo, 1991; Berquist, and others, 1993,; Horton and others, 1993; Virginia Division of Mineral Resources, 1993; Hibbard, 1993; Nelson, 1993; Wortman and others, 1995; Peper and others, 1996; Bradley, 1996; Ozdogan and others, 1997; Baird and Glover, 1997; Horton and others, 1998).

Appreciation is expressed to the land owners for their kind cooperation and in giving access to their properties within the report area. We want to thank Nick Evans of the Virginia Division of Mineral Resources for very informative field conferences, and also wish to acknowledge the other geologists of the U.S. Geological Survey working in nearby areas, for their helpful discussions and field conferences.

GENERAL GEOLOGY

The map area contains amphibolite-facies metamorphic rocks of two regional belts, the Western Piedmont and the Central Virginia Volcanic-Plutonic Belt, as shown on the Geologic Map of Virginia (Virginia Division of Mineral Resources, 1993). Unmetamorphosed rocks of the early Mesozoic Roanoke Creek basin occur near the southeastern corner of the map and occupy less than five percent of the area. In this part of Virginia, amphibolite facies rocks of the Central Virginia Volcanic-Plutonic Belt are commonly assigned to the Milton belt (Butler, 1980; Hibbard, 1993; Wortman and others, 1996) or Charlotte metamorphic belt (Horton and Zullo, 1991; Baird, 1991: "Charlotte belt" as used by Tobisch and Glover, 1969, 1997). Parts of this metamorphic belt may be amphibolite-facies equivalents of the Carolina slate belt (Tobish and Glover, 1969, 1971; Baird, 1991; Bradley, 1996), and if so, belong to the Carolina terrane of Secor and others (1983). Other parts may belong to a different terrane, the Milton terrane Horton and others, 1989; Bradley, 1996;

Wortman and others, 1996), although this interpretation is not universally accepted (Baird, 1991; Baird and Glover, 1997).

The protoliths for the rocks underlying most of the report area are interpreted to be primarily volcanic and volcaniclastic with lesser amounts of sedimentary and intrusive rocks. Earlier workers in nearby areas have assigned the mapped rock units of the Milton belt to either a Precambrian (Henika, 1977; Kreisa, 1980; Baird, 1991) or a Precambrian-Cambrian age (Tobisch and Glover, 1971). Glover and others (1971) reported a 740 Ma age for biotite gneiss just west of South Boston. However, Wortman and others (1995) analyzed a biotite gneiss collected from the same general area that contained a variety of zircon populations with wide ranging ages. They suggested that the gneiss is either a migmatitic orthogneiss with an Alleghanian component or is a paragneiss containing zircons of different ages. Wortman and others (1995) reported that a hornblende-biotite gneiss of the Milton belt has an upper intercept Late Precambrian zircon age of 618 Ma and a lower intercept Permian age of 323 Ma. Bradley (1996) suggested that the 618 Ma date represents the original crystallization of the zircon in the layered gneiss whereas the much younger 323 Ma age date reflects a crystallization age of granitic sills that form interlayers.

Within the map area, radiometric dates for the rocks exposed in the Milton belt have not been made. Some of the mapped units have been interpreted to correlate with rock units of probable Precambrian age by Baird (1991) Henika (1997), Kriesa (1980), and Tobish and Glover (1969). Bradley (1996) indicated that biotite gneiss of the Milton belt is no younger than 323 Ma.

The youngest pre-Mesozoic stratified rocks in the study area are early Ordovician in age, as indicated by fossil assemblages in the Arvonia Formation (Oa) along strike to the northeast (Tillman, 1970; Kolata and Pavlides, 1986; Marr, 1980b; Virginia Division of Mineral Resources 1993). The Kyanite quartzite at Baker Mountain resembles kyanite quartzite northeast of the study area at Willis Mountain, which Marr (1980a) tentatively correlated with the Arvonia Formation, although other interpretations are permissible.

Rocks of the Milton belt (Charlotte metamorphic belt) in this area are interpreted on the Geologic map of Virginia as a "Heterogeneous layered assemblage [that] correlates with the Chopawamsic Formation and the Ta River Metamorphic Suite, on strike to the northeast" (Berquist and others, 1993, p. 45), and recent U-Pb geochronology indicates that the Chopawamsic Formation is Ordovician in age (Horton and others, 1998).

Farther to the southwest in the Milton belt, Henika (1977) mapped the geology of four 7.5-minute quadrangles near Danville, Va., which are underlain by metamorphosed sedimentary and volcanic rocks that he interpreted to be of Precambrian age. These rocks, which range from lower greenschist to upper amphibolite facies (Henika, 1977) probably correlate with similar upper amphibolite-facies rocks underlying this area. Kreisa (1980) mapped gneisses and schists that he considered to be Precambrian in age in the Omega 7.5-minute quadrangle south of the report area.

Much of the crystalline rock throughout the area has been chemically weathered to a deep saprolite. Where the saprolitization has been intense and the weathering profile is deep, it is difficult to distinguish some rock types. A variety of metamorphosed felsic to mafic volcanic and volcaniclastic rocks, and sedimentary and intrusive rocks, comprise the protoliths of the crystalline rocks underlying the study area.

ROCKS UNITS

Milton Belt (Charlotte Metamorphic Belt)

The Milton belt which underlies most of the map area consists mostly of metavolcanic rocks that have been polydeformed and metamorphosed to amphibolite facies gneisses and schists. They include variably layered, medium-grained, quartzofeldspathic biotite gneiss; locally porphyroblastic, fine-grained biotite quartz feldspar gneiss that is locally a well-layered metagraywacke; hornblende and hornblende-biotite gneiss; amphibolite; mica gneiss; mica schist; biotite schist; muscovitic quartzite; and granite to granodiorite gneiss. Small unmapped pegmatites and quartz veins intrude the mapped units, and variably sized quartzofeldspathic segregations are widespread.

Except for the Arvonia Formation (Oa) of Ordovician age, the ages and the stratigraphic relationships of the other rock units comprising the Milton belt are uncertain. The combination of deformation and recrystallization associated with metamorphism has destroyed or obscured primary features such as graded and cross bedding. The rocks have also been isoclinally folded and locally, folds are recumbent and layering has been transposed.

Interfingering of the different rock units is common at scales that could nor be resolved in reconnaissance mapping. Each mapped unit is actually a distinct rock assemblage that is characterized by one dominant rock type but which also includes varying proportions of other rocks. Almost all mapped units contain layers of biotite-quartz-feldspar gneiss along with small unmapped pegmatites, quartz veins, and variably sized quartzofeldspathic segregations.

Three mapped units, biotite gneiss (mm,) muscovitic gneiss and schist (bmgr), and hornblende gneiss (hbf) (see map and accompanying rock descriptions), form three dominant rock assemblages underlying the study area. The biotite gneiss (mm) is widespread in the report area, and is characterized mostly by well layered biotite felsic gneiss, interlayered with lesser mica gneiss and mica schist, and with irregularly dispersed thin layers of muscovitic quartzite, hornblende gneiss and amphibolite. The muscovitic gneisses and schists have a higher alumina content than the other assemblages and may represent original pelitic layers in a sedimentary sequence. Some of these muscovitic gneisses and schists correlate with rocks that Baird (1991) mapped as pelitic schists. Some of the mapped rock units also correlate with a biotite gneiss of Precambrian age mapped by Kreisa (1980) near South Boston. Kreisa considered that part of the biotite gneiss had a sedimentary origin because of its high alumina content and the inclusion of what seemed to be sedimentary clasts in the gneiss.

Hornblende-biotite gneiss (hbf) is a prominent rock type in the rock assemblage underlying a large part of the Charlotte Court House quadrangle where it trends northeast across the central part of the quadrangle, and westerly into the Aspen quadrangle. These rocks are probably Precambrian in age. Bradley (1996) cited preliminary zircon age data on a similar hornblende-biotite gneiss sampled by Wortman and others (1996), where zircons have an upper intercept age of 618 Ma which is interpreted to represent the crystallization age of the mafic gneiss.

Tectonostratigraphic assignment of the hornblende gneiss unit (hbf) to the Milton terrane belt has been questioned. Bradley, (1996), and Wortman and others, (1996) consider it to be part of the Carolina terrane. The hornblende gneiss (hbf) continues along strike to the south and southwest into the Conners Lake, Nathalie, and Scottsburg quadrangles (Nelson and Nelson 1997). Along the southern part of the Scottsburg quadrangle a separate body of the hornblende gneiss strikes southwesterly into the adjoining Omega quadrangle where Kreisa (1980) mapped these rocks as gneiss (hbgn), considering them to be Precambrian in age. Kreisa also included amphibolite, layered biotite gneiss, and some mica gneisses in the hgbn unit and showed that these rocks are in fault contact to the southeast with the Hyco Formation of the Carolina slate belt.

Bradley (1996) mapped the same hornblende gneiss as his Zgn unit south of the study area, and considered it to be a higher grade equivalent of rocks in the Carolina slate belt. He cited Wortman and others (1996), who indicated that Nd isotopic content from a sample of high grade hornblende gneiss (hbf) collected in the Carolina metamorphic belt near South Boston, is more like that of the mafic rocks of the Carolina slate belt, and their volcanic progenitors and probably has a similar crustal history. Bradley (1996) interpreted the hornblende gneiss to be thrust over rocks that form the bmgr map unit in the Nathalie area (Nelson and Nelson, 1997). Bradley's map also shows several areas where rocks equivalent to the bmgr of the lower plate appears to have interfingering stratigraphic contacts with the hornblende gneiss of the upper plate.

Western Piedmont

Two map units (m, and bfg), which underlie the northwest part of the map, are part of the The Western piedmont, a dominantly metasedimentary terrane. Map unit (m) is an Early Cambrian metagraywacke and phyllite that is generally medium to dark gray, and fine-to medium-grained. The principal minerals are quartz, plagioclase, biotite, and muscovite. The biotite and muscovite contents vary widely. The rocks have locally been deformed and contain both ductile and brittle fabrics that form discontinuous mylonitic and cataclastic zones which may be related to deformation associated with the Brookneal shear zone (Gates and others, 1986).

Biotite felsic gneiss (bfg) interlayered with lessor amounts of biotite schist and muscovite schist underlie the northwest corner of the map. The biotite felsic gneiss is medium to light gray, mostly granoblastic, and fine- to medium-grained. Principal minerals are quartz, feldspar, and biotite.

Plutonic Rocks

Biotite granite gneiss to biotite granodiorite gneiss (Late Precambrian to Ordovicain) is present as lenses and larger bodies within mapped units bfx, bmgr, and hbf of the Milton belt. They are generally light to medium gray, have granoblastic textures, are fine-to medium-grained, and foliated. Principal minerals are quartz, feldspar, and biotite, lessor minerals are chlorite, epidote and magnetite.

Lineated biotite granite gneiss (Late Precambrian to Ordovician) is present as relatively large bodies within the biotite gneiss (mm) of the Milton belt. These rocks characteristically have a strong lineation formed by alined recrystallized quartz ribbons, are medium gray, and fine-to medium-grained. They principally consist of quartz, feldspar, and biotite with lessor amounts of muscovite, chlorite , epidote and magnetite, The biotite content varies widely.

The Melrose granite (Cambrian) is exposed along the west border of the map in the northwestern part of the study area. It is light gray, medium-grained, has a granoblastic texture and principally contains quartz, feldspar, and biotite along with lessor chlorite, epidote, and magnetite. Commonly the Melrose is strongly sheared and displayes a prominent mylonitic foliation.

Granitic gneiss of the Shelton Formation (Ordovician, 463+/-14 Ma, U-Pb, zircon, Hund, 1987) underlies a large northeast trending area in the Milton belt in the west to northwestern part of the map. The gneiss is light to medium gray coarse-to medium-grained quartz monzonitic to granitic gneiss with a granoblastic texture. Quartz, feldspar, muscovite, and biotite form the principal minerals, minor amounts of chlorite and epidote are also present.

Bioitite granite gneiss and leucogranite gneiss are pinkish to very light gray, generally medium-grained, well foliated and have a gneissic layering. They consist of plagioclase, quartz, pinkish gray potassium feldspar, lessor biotite (mainly in segregation bands) and muscovite (<5%). Concordant interlayers of amphibolite and hornblende gneiss are sparse. Foliation locally grades into mylonitic foliation having associated subhorizontal mineral-elongation lineation. Quartz ribbons and concordant, strongly foliated quartz veins are present near the Roanoke Creek basin.

Unit is poorly exposed in southeastern corner of map; description is based on observations in the adjacent Saxe 7.5 minute quadrangle (J. Wright Horton, Jr., written communication, 1999).

Early Mesozoic Rocks

The early Mesozoic Roanoke Creek basin in the southeastern part of the map is underlain by poorly exposed, highly weathered arkose, and conglomerate that is undivided on the map. Some relatively thin Jurassic diabase dikes intrude the crystalline rocks of the Charlotte metamorphic belt.

Surficial Deposits

Quaternary surficial deposits, although not shown on the map, are widespread in the area. A thin veneer of unconsolidated coarse to fine-textured bouldery and cobbly gravel, sand, and clay forms alluvial deposits in stream valleys. Colluvium, which is not mapped separately, is commonly mixed with alluvium along steep valleys and is widespread along steep hillsides.

DEFORMATION

Structural Fabrics

Foliation is well developed in the pre-Triassic crystalline rocks. Where layering and foliation are both present, they appear to be parallel. The foliation is commonly wavy and is defined by thin, alternating, discontinuous felsic aggregates and biotite and locally chlorite streaks. Felsic layers, and lenses range from several mm to as much as 2 cm or more in thickness. The biotite and or chlorite zones or streaks are more discontinuous, in places wisp-like, much thinner, and commonly range from 1-2 mm in thickness. The felsic layers consist principally of bluish-gray quartz and feldspar, which is mostly microcline and plagioclase. Prominent augen of microcline and (or) quartz-feldspar aggregates are present in some gneisses. A faint later cleavage is present in some schists where the schistosity is folded. These folds, especially those in close proximity to the observed later cleavage, have fold axes whose strikes are almost parallel to the strike of the later cleavage..

Some rocks in the study area display a distinct linear fabric in the foliation plane. This fabric is formed by the parallel orientation of mineral streaking and or stretching within the foliation plane and the parallel orientation of minute crinkles that are parallel to the fold axes of small folds.

A compositional layering is present in some garnet-bearing biotite felsic gneisses but is not easily observed elsewhere. As far as could be determined, the compositional layering in these gneisses is parallel to foliation. Except for some small folded areas in a layered biotite felsic gneiss, almost all layering strikes north to northeast and dips gently.

Folds

Some widely separated rock and saprolite exposures along both natural and artificial cuts show that the rocks are polydeformed and recumbently folded. The recumbent fold limbs were subsequently gently folded around east to northeasterly trending axes. In these folded exposures, the layering and foliation surfaces are parallel. The map shows that the foliation and layering in the Milton belt characteristically dips gently over relatively large areas. The foliation attitudes and the regional distribution of map units help define a large overturned anticline whose axial trace strikes northeast across the southeast part of the map. This fold continues to the south and then trends more to the west south southwest (Nelson and Nelson, 1997).

If the style of multiple folding of relatively small overturned folds observed in outcrop reflects the regional structure, then the fold attitudes with the relatively gentle dips probably represent second or third generation folds superposed onto the limbs of a large recumbent fold. This style of folding for this general area has been previously described (Baird, 1991; Tobisch and Glover, 1971). Tobisch and Glover (1971) reported that a large recumbent nappe forms a major structure in the Charlotte belt south of the study area.

Brookneal Shear Zone

The Brookneal shear zone (Gates and others, 1986; Gates, 1997; Baird and Glover, 1997) is a dextral fault zone of late Paleozoic age that cuts the Melrose granite of Cambrian age. This shear zone is 4 km wide near Brookneal, which is approximately four miles west of the southern part of the study area. The Melrose granite was emplaced along a suture fault zone between the Western Piedmont of North American affinity and Milton belt volcanic terrane (Gates, 1997). Within the report area the Melrose is exposed along the west side of the northwest trending fault of the suture fault zone.

Most of the results of shearing in the Brookneal zone are shown by the mylonitic and cataclastic fabrics and shear bands displayed in the deformed Melrose granite and the other rocks of the Western Piedmont. The shearing seems to be most intense in the rocks near the eastern border of the Western Piedmont but, shearing associated with the Brookneal shear zone has also effected some of the rocks in the Milton belt as well, especially the Arvonia Formation. Small discontinuous zones of ductile fabrics as well as faint shear bands are sparsely distributed over wide areas of the Milton belt and may also result from Brookneal shearing.

Rocks associated with the Brookneal shear zone commonly display two foliations. The first foliation curves into the second or later foliation and is displaced with a dextral sense of movement. These planar fabrics are high in mica, chlorite and opaque minerals. Some fractured feldspar grains are present within unfractured mylonite matrix and suggest early brittle followed by later ductile deformation. Where porphyroclasts are common, the shear foliation anastomoses around the clasts; locally shear bands are present Deformed rocks include mylonite, blastomylonite, and protomylonite.

Faults

A fault separates rocks underlying the Early Messozoic Roanoke Creek Basin from amphibolite-facies gneisses and schists of the Milton belt. A 0.75 mile wide zone of the Milton belt rocks adjacent to the fault has been sheared and consists of discontinuous anastomosing mylonites and cataclastic rock. This fault projects northeastward into the southeastern part of the early Mesozoic Farmville basin. Faults associated with the Farmville and Roanoke Creek basins may belong to a regional fault system coincident with the Spotsylvania lineament along strike to the northeast (Pavlides, 1988; Marr, 1980a; Virginia Division of Mineral Resources, 1993). This fault also appears to lie along the northern projection of the late Paleozoic Hyco shear zone as defined by Hibbard (1993), and another fault, separating rocks of the Slate Belt from those of the Milton belt in the Omega quadrangle (Kreisa 1980) south of the study area along the west side of the early Mesozoic Scottsberg basin.

The northern boundary of the hornblende gneiss unit (hbf) in the southwest part of the map area is interpreted to be a fault or zone of movement (tectonic slip) that formed during deformation.

Elsewhere in the pre-Triassic rocks, some exposures show small faults with displacements measured in centimeters. These faults, however, do not appear to be related to any major structure, and other major faults have not been observed.

METAMORPHISM

The crystalline rocks in the Charlotte metamorphic belt were mostly prograded to the sillimanite and kyanite zones of the amphibolite facies during regional metamorphism. Southwest of this area sillimanite is commonly observed in rocks that also contain layers or veinlets of metamorphosed granitic rock, suggesting that some sillimanite formed as a result of the high temperatures related to emplacement of the granitic rocks (Nelson and Nelson, 1997).

Glover and others (1983) and Baird and Glover (1997) indicated that the rocks underlying tbe Charlotte metamorphic belt and the Carolina slate belt were regionally metamorphosed during the Taconic orogeny (450-435 Ma). Kunk and others (1995) reported that a 313 Ma argon-argon cooling age for homblende near the eastern border of the Charlotte metamorphic belt and a 323 Ma cooling age for hornblende collected near the center of the belt was evidence for prograde metamorphism during the Alleghanian deformation. Ozdogan and others (1997) offered additional evidence that these rocks were deformed and metamorphosed during the Alleghanian orogeny. Biotite formed in axial-plane schistosity surfaces during a late stage of minor folding in the Charlotte metamorphic belt. This fabric is not extensively developed and is believed to have formed during the Alleghanian prograde event after the temperature peak but while the temperatures were high enough for biotite to form. Kunk and others (1995) reported that rocks of the Carolina slate belt also contain Alleghanian white mica, but that igneous homblende from the greenschist facies Carolina slate belt dated at 586 Ma shows no evidence for an Acadian or Taconic event based upon argon geochronology.

ECONOMIC GEOLOGY

At the time of the field work, there were no quarrying operations within the study area. Immediately south of the map area, however, east of South Boston, Va., the Vulcan Materials Company extracts crushed stone from layered homblende-biotite gneiss. These rocks extend into the study area and could be a source of crushed stone. In addition, amphibolite gneiss, granitic gneiss, and felsic gneiss are potential sources of crushed stone. Kyanite was previously mined by power shovel in a large opencut at Baker Mountain, east of Madisonville, but at the time of field work mining operations had ceased. At Baker Mountain the kyanite occurs in several layers of quartzite that are interlayered with schist. The kyanite rich quartzite layers are deformed by irregularly trending minor folds.

Sand and (or) gravel for use as construction material might be obtained from wide alluvial covered areas in flood plains of the Roanoke River and its tributaries. Borrow pits could be developed in granite gneiss and felsic gneiss regolith.

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EXPLANATION

Stratigraphic relations between layered rock units southeast of the Arvonia Formation are uncertain. They commonly display variably sized granite pegmatite layers, pods, lenses, and veinlets; quartz veins, pods and lenses are widespread.

Jd Diabase dikes, dark gray to black, massive, mostly fine-grained but thick dikes are medium-grained, commonly have diabasic textures and some large dikes have gabbroic interiors, principal minerals are labradorite and pigeonite with a subophitic texture. Weathers to a dark-red saprolite and spherodially weathered boulders are common. The dikes intrude the crystalline rock units. The paucity of exposures and deep weathering precludes showing the dike widths accurately, they are shown by a line on the map — Jurassic

Trs Arkosic conglomerate, reddish-brown, massive, containing angular metamorphososed fragments in a sandy to clayey matrix. Includes lessor amounts of reddish-brown sandstone, siltstone, and shale of the Roanoke Creek Mesozoic basin — Triassic

WESTERN PIEDMONT

(Cambrian)

Ꞓm Melrose Granite is light gray, medium-grained granite with a granoblastic tecture, contains principally biotite-feldspar-quartz granite, with lessor chlorite, epidote and magnetite. It is locally sheared

m Metagraywacke and phyllite, undivided-(Early Cambrian?). Metagraywacke is dark gray, mostly medium-grained, containing quartz, feldspar, biotite and lessor muscovite. Biotite content varies in abundance, it is widely dispersed and is also concentrated in biotite rich streaks. The phyllites are dark greenish gray, fine- to medium-grained, contains quartz,,feldspar, and locally has high concentrations of biotite or biotite and muscovite, chlorite and epidote are less common. Some rocks have been locally deformed by ductile and brittle deformation, and some narrow discontinuous mylonitic and cataclastic zones are present

bfg Interlayered biotite felsic gneiss, biotite schist, and mica schist- The felsic gneisses are medium to light gray, fine-to medium-grained and have a granoblastic principal minerals are biotite, plagioclase, and quartz

MILTON BELT

(Ordovician)

Oa Arvonia Formation (Late Ordovician): Lignt to dark greenish gray, medium-to coarse-grained garnet-quartz- mica schist, with some chlorite, locally schist is deformed to phyllonite and locally schistosity is crinkled. No fossils have been found, but to the northeast the Arvonia contains brachiopods, bryozians, crinoids, pelecypods and trilobites of Middle or Late Ordovician age (Darton, 1892; Dale, 1906; Watson and Powell, 1911; Smith, Milici, and Greenberg, 1964; Brown , 1969; and Tillman, 1970)

Osgrp Granitic gneiss of the Shelton Formation (Ordovician): Light to medium gray with granoblastic texture, medium-to coarse-grained with some fine-grained zones interstitial to larger mineral grains; contains mostly muscovite, biotite, quartz, and plagioclase which is locally sericitic, and which ranges from oligoclase an_{15} to andesine $an_{14,}$ and potassium feldspar. Contains minor chlorite and epidote. Prominent foliation contains a lineation defined by alined quartz ribbons

gab Gabbro, dark gray, medium-grained, consists mostly of subequal amounts of plagioclase and greenish hornblende with minor quartz; massive to weakly foliated

grb Lineated biotite granite gneiss, medium gray, mostly granoblastic but is locally faintly lepidoblastic and in places sheared, fine-to medium-grained; contains biotite, muscovite, quartz, oligoclase an_{13} and oligoclase an_{30}, potassium feldspar, with minor chlorite, epidote, and magnetite, biotite ranges from about 5 to 20 percent of rock; commonly recrystallized quartz ribbons are alined to form a strong lineation

gr Biotite granite gneiss, fine-to medium-grained, medium gray, mostly granoblastic but is locally faintly lepidoblastic and in places sheared; principally contains biotite, quartz, and feldspar, with minor chlorite, epidote, and magnetite

bg Biotite granite gneiss and leucogranite gneiss, pinkish to very light gray, medium-grained, well foliated, consists of quartz, locally as ribbons, plagioclase, potassium feldspar, biotite, and muscovite. Interlayered with sparse hornblende gneiss and amphibolite. Foliation locally grades into mylonitic foliation. Poorly exposed in southeast corner of the map

bfgs Biotite-feldspar gneiss, interlayered with lessor amounts of biotite schist, garnet mica schist, amphibolite, and quartzite undivided; biotite gneiss is medium gray, fine-grained, granoblastic, containing biotite, muscovite, plagioclase, potassium feldspar, quartz, and minor epidote, chlorite, and opaque minerals; small discontinuous narrow shear zones in the biotite gneiss trend northeast

Cambrian

hbfa Amphibolite highly mixed with hornblende biotite gneiss and some thin interlayers of mica schist; amphibolite is dark greenish gray to dark gray, fine-to medium-grained, containing mostly hornblende, plagioclase, minor quartz, epidote and opaque minerals, weathers to thin slabs

mm Biotite-quartz-plagioclase gneiss containing interlayered biotite-muscovite schist, muscovite quartz schist, manganiferous-biotite schist, thin (5-18 cm thick) irregularly distributed mucsovitic quartzite layers, and less commonly amphibolite and hornblende gneiss, biotite gneiss is light to medium gray, fine-to medium-grained, granoblastic, and contains biotite, plagioclase and quartz, thin to thickly layered, Schists are mostly dark gray, fine-to medium-grained, with lepidoblastic texture, containing mostly muscovite, biotite, quartz, feldspar and some magnetite

k kyanite quartzite is light bluish gray, fine-to medium-grained, in layers up to 10 feet thick, consists mostly of quartz with variable amounts of kyanite, and with several percent of muscovite, rutile and pyrite, commonly stained with limonite coating; locally interlayered with thin layers of garnetiferous biotite gneiss. Kyanite quatzite is present in map units fm and hbfa

bfx Felsic gneiss and biotite gneiss are light to medium gray, fine-grained, and consists of quartz, feldspar, biotite, and muscovite, the bioitite gneiss contains more biotite and is slightly darker than the felsic gneiss. These rocks are interlayered with lessor amounts of granite gneiss, dioritic gneiss, biotite schist, muscovite schist, thin layers of amphibolite, and rare hornblende gneiss

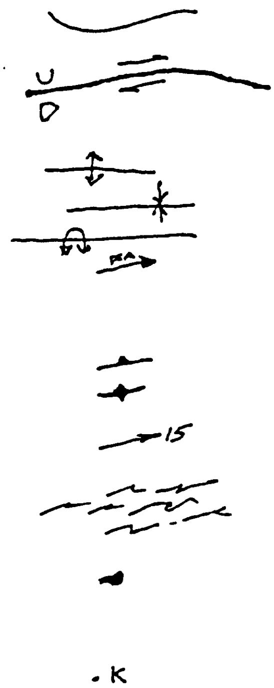
bmgr Undivided assemblage of mica gneisses and schists, with unmappable, at map scale, units of feldspathic gneiss, muscovitic quartzite, amphibolite, and hornblende gneiss, thin layers of granitic gneiss are widespread. Mica gneisses and schists are most dominant rock types; least abundant is hornblende gneiss. Biotite gneiss is medium to dark gray, fine-to medium-grained, granoblastic and thin to thickly layered, contains quartz, plagioclase An25-28, biotite, locally variable amounts of hornblende, minor muscovite, epidote, and microcline. Schists range from medium to dark gray are strongly lepidoblastic, locally porphyroblastic, and variably layered, they include biotite schist, biotite-muscovite-quartz-plagioclase-garnet-sillimanite schist and some thin layered muscovitic quartzite. Feldspathic gneiss is light to medium gray, fine-to medium-grained, consisting mostly of quartz, feldspar and biotite, locally contains fragmental lens-like aggregates of feldspar and quartz in a very fine-grained quartz-feldspar matrix. Granitic gneiss is medium to light gray, fine-to-medium grained, with some feldspar porphyroblasts locally, and mostly contains plagioclase, microcline, quartz, biotite and muscovite; biotite varies from 1-10 percent, and in places rock has alternating light colored felsic rich and darker biotite-rich bands. Contains several unmapped bodies of float that is light to medium gray, very fine-grained and faintly layered granoblastic aggregates of diopside,epidote, and plagioclase with thin tremolite porphyroblasts. A few narrow discontinuous zones of mylonite and protomylonite are present near the early Mesozoic Roanoke Creek basin where the rocks are strongly lineated and sheared; some rocks are cataclastic. Contacts between other units of biotite gneiss are gradational

Cambrian to Proterozoic Z

fm Biotite felsic gneiss, medium to dark gray, fine-grained, consisting of quartz feldspar, biotite, and lessor muscovite, variably layered, interlayered with thin amphibolite layers, some granitic gneiss, biotite schist, and thin (5-18cm thick) rare muscovite-quartz schist layers and hornblende gneiss

hbf Hornblende-biotite gneiss, medium to dark gray, mostly medium-grained, and granoblastic. Contains highly variable amounts of hornblende (10 to 90 percent) and biotite, plagioclase ranging from oligioclase (An_{28}) to andesine (An_{43}), quartz, magnetite, and epidote. Some hornblende is chloritized. Hornblende concentrations vary widely to produce alternating dark hornblende-rich bands that are gradational into hornblende- poor felsic-rich light-gray bands. Interlayered fine-medium grained biotite-quartz-plagioclase-microcline gneiss, biotite schist, and rare muscovite schist are wide spread but occur in distinctly lessor amounts. The most abundant exposures of these schists and gneisses is along the southeastern border of the rock unit. Contains a small ferruginous quartzite, fq. Undivided biotite-quartz-feldspar gneiss and granite gneiss layers and/or lenses, and rare pyroxenite-rich ultramafic pods are also present

MAP SYMBOLS



Contact-Approximately located

Fault-Approximately located, movement direction shown by arrows; U, upthrown side, D, downthrown side

Folds (direction of plunge shown where known)

- Upright anticline showing trace of axial plane
- Upright syncline showing trace of axial plane
- Overturned anticline showing trace of axial plane
- Fold axis of minor fold

Foliation

- Strike sand dip of inclined foliation
- Strike of vertical foliation

Strike and dip of lineation showing plunge when known

Sheared rocks, diagrammatically shown

Isolated saprolite exposure or disrupted rock fragments in residuum which are characterestic of a rock unit and inferred to be at or near site of origin

Occurrence of metamorphic index mineral

g, garnet; st, staurolite; k, kyanite; s, sillimanite

CORRELATION OF MAP UNITS