VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 2

GEOLOGY OF THE BLAIRS, MOUNT HERMON, DANVILLE, AND RINGGOLD QUADRANGLES, VIRGINIA

By WILLIAM S. HENIKA
Triassic System *by* PAUL A. THAYER

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

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FRONT COVER: Metamorphosed mafic and felsic volcanic rocks along Poplar Street in Danville near the north end of the bridge over the Dan River (Plate 2). Second-generation, recumbent fold nose with northeastward-trending axial plane. (Vertical height of outcrop in photograph about 2 feet or less than 1 m.)

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COMMONWEALTH OF VIRGINIA
DEPARTMENT OF PURCHASES AND SUPPLY
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Henika, W. S., 1977, Geology of the Blairs, Mount Hermon, Danville, and Ringgold quadrangles, Virginia, *with sections on the* Triassic System by Thayer, P. A.: Virginia Division of Mineral Resources Publication 2, 45 p.

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

Richmond, Virginia

MARVIN M. SUTHERLAND, *Director*
JERALD F. MOORE, *Deputy Director*

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GEOLOGY OF THE BLAIRS, MOUNT HERMON, DANVILLE, AND RINGGOLD QUADRANGLES, VIRGINIA

By

William S. Henika

ABSTRACT

The Blairs, Mount Hermon, Danville, and Ringgold 7.5-minute quadrangles are located in the Piedmont physiographic province, Pittsylvania County, Virginia just north of the Virginia-North Carolina boundary. Precambrian metamorphic rocks are divided into two areas by the Danville basin that contains Triassic sedimentary rocks assigned to the Dry Fork Formation. Southeast of the Danville basin the Precambrian Shelton Formation, exposed in antiformal and synformal folds, forms the core of a large, refolded nappe. Precambrian metamorphosed volcanic-sedimentary rocks overlie the Shelton Formation.

Northwest of the Danville basin the Precambrian metamorphosed Fork Mountain Formation is the major rock unit. It is part of a mass of rocks that have also been deformed in a refolded nappe. The Fork Mountain Formation and the metamorphosed volcanic-sedimentary rocks have been intruded by ultramafic rocks and granite dikes and sills.

Crushed stone and sand are produced. Other rocks and minerals of potential economic interest include shale, talc and soapstone, kyanite, sillimanite, and gold.

Environmental geology information for decisions concerning land use and modification is provided by derivative maps prepared from geologic data such as rock type, depth of weathering, soil type, and slope stability as well as present-day land-use patterns.

INTRODUCTION

The Blairs, Mount Hermon, Danville, and Ringgold 7.5-minute quadrangles are located in the Piedmont physiographic province, Pittsylvania County, Virginia just north of the Virginia-North Carolina boundary (Figure 1). They are bounded by 79°15′ and 79°30′ west longitudes and 36°45′ north latitude and the Virginia-North Carolina boundary. These quadrangles are within the West Piedmont Planning District and comprise approximately 207 square miles (536 sq km). Danville is the only city and is located along the Dan River mainly in the Danville quadrangle.

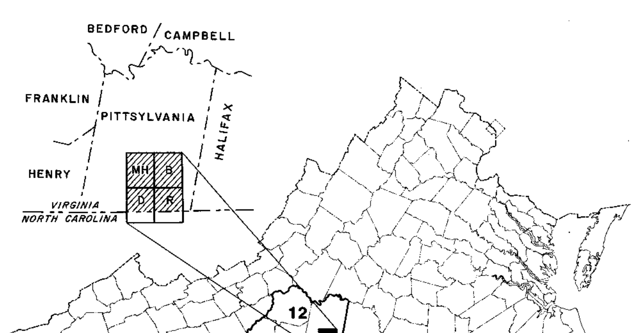

Figure 1. Index map showing location of the Blairs (B), Mount Hermon (MH), Danville (D), and Ringgold (R) quadrangles in Planning District 12, Virginia.

White Oak Mountain, a northeastward-trending ridge in the Mount Hermon quadrangle is the most prominent topographic feature. It is between 100 and 450 feet (30 and 137 m) higher than the surrounding Piedmont. The highest elevation in the report area is 1,150 feet (351 m) on the crest of White Oak Mountain (Plate 2) and the lowest point is about 355 feet (108 m) along the Dan River (Plate 1). The Dan River is the major drainage and flows generally eastward across the southern part of the mapped area. Major tributaries to the Dan include the Sandy River, Fall Creek, Sandy Creek, and Cane Creek.

Previously published data on the region includes Heinrich (1878), Fontaine (1879), Rogers (1884), Russell (1892), Kirk and others (1922), Roberts (1928), Jonas (1929), LeGrand (1960), Meyertons (1959, 1963), Thayer (1970), and Tobisch and Glover (1971).

Mapping of the Precambrian and associated rocks and sediments northwest and southeast of the Danville basin was done by William S. Henika between June 1972 and June 1974. Mapping of the Triassic and associated rocks and sediments of the Danville basin was done by Paul A. Thayer between June 1972 and December 1975.

James F. Conley, Ronald D. Kreisa, and Van Price visited the area while mapping was in progress and contributed valuable ideas and criticism. Judson Mitchell III worked in the North Carolina portion of the Danville and Ringgold quadrangles (Mitchell, 1973) and contributed to the understanding of the Virginia part of the area. Staff members of the Virginia Department of Highways and Transportation including D. H. Gauden, Jr., R. W. Schwartz, and Dave Wolley, provided engineering and geologic data. The University of North Carolina at Wilmington provided Paul A. Thayer with laboratory facilities and computer time. Richard Laws helped measure stratigraphic sections. J. A. Gutierrez provided chemical analyses and physical

test data for rocks from the Vulcan Materials Company quarry. James L. Calver and James F. Conley critically reviewed the manuscript.

Numbers preceded by "R" in parentheses (R-6006) correspond to sample localities (Plates 1, 2). The samples and thin sections are on file in the repository of the Virginia Division of Mineral Resources where they are available for examination.

STRATIGRAPHY

The rocks of the Blairs, Mount Hermon, Danville, and Ringgold quadrangles are assigned to 10 lithologic formations (Table 1, Plates 1, 2). Precambrian metamorphic rocks are exposed both to the northwest and to the southeast of the Danville basin that contains Triassic rocks. Southeast of the basin, major rock units include the Shelton Formation and metamorphosed volcanic-sedimentary rocks.

Table 1.—Geologic formations in the Blairs, Mount Hermon, Danville, and Ringgold quadrangles.

Age	Northwest of faults along northwestern margin of Danville basin	Southeast of faults along northwestern margin of Danville basin
Quaternary	Alluvium	
	Terrace deposits	
Triassic	Diabase dikes	
	Dry Fork Formation	
Precambrian or Paleozoic	Granite dikes and sills	
Precambrian	Rich Acres Formation	Ultramafic rocks
	Fork Mountain Formation	Metamorphosed volcanic-sedimentary rocks
	(not exposed at surface)	Shelton Formation

The Precambrian Fork Mountain Formation is the major unit northwest of the Danville basin. It consists of intensely metamorphosed Precambrian sedimentary rocks with minor amphibolite interlayers and has faulted contacts with the metamorphosed volcanic-sedimentary rocks and the Triassic Dry Fork Formation.

Precambrian metamorphosed ultramafic rocks that are correlated with the Rich Acres Formation have intruded the Fork Mountain Formation. Similar ultramafic rocks have intruded metamorphosed volcanic-sedimentary rocks to the southeast of the Danville basin. Precambrian or Paleozoic granite dikes and sills are present in higher grade metamorphic rocks of the Fork Mountain Formation and metamorphosed volcanic-sedimentary rocks. Cataclasite and microbreccia derived from both Precambrian metamorphic rocks and Triassic sedimentary rocks are localized along several shear zones. Triassic diabase dikes have intruded all the major units.

PRECAMBRIAN ROCKS

SHELTON FORMATION

The Shelton Formation was originally named the Shelton granite gneiss by A. I. Jonas (Virginia Geological Survey, 1928) for exposures at its type locality, a quarry 0.2 mile (0.3 km) west of Shelton, North Carolina in the southern part of the Danville quadrangle (Jonas, 1932), 0.4 mile (0.6 km) south of the Virginia-North Carolina boundary. The Shelton Formation of this report is restricted to a coarse-grained, granitic to quartz monzonitic gneiss. Other lithologic units originally included with the formation are now recognized as metamorphosed volcanic and sedimentary rocks that overlie the coarse granite gneiss at the type locality (Figure 2). The name is here changed from **Shelton granite gneiss to Shelton Formation.**

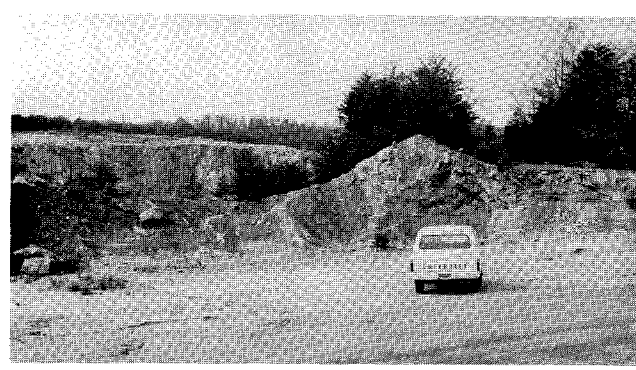

Figure 2. Type locality of the Shelton Formation; southward view of the quarry 0.2 mile (0.3 km) west of Shelton, North Carolina. Massive, jointed Shelton granite gneiss is exposed in the quarry on the left. Overlying interlayered felsic and mafic metavolcanic rocks are exposed on the northwestern rim of the quarry, directly in front of the truck. Primary layering of the metavolcanic rocks has a dip gently toward the northwest (to the right).

Seven outcrop areas of the Shelton Formation have been mapped southeast of the Danville basin (Plates 1, 2): four northeast and one northwest of Danville, one in the northern part of the city, and one south of the city just north of the Virginia-North Carolina boundary. One outcrop is present northwest of the basin about 6 miles (10 km) northwest of Danville. The rock is well exposed in three quarries: one the type locality south of Danville and the others northeast test data for rocks from the Vulcan Materials Company quarry. James L. Calver and James F. Conley critically reviewed the manuscript.

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The gneiss (R-6006) is gray to pink, poorly foliated, and has a well-developed lineation produced by streaks and bands of shiny black biotite or silvery gray muscovite. It contains amoeboid to elongate grains of quartz (1 to 5 mm); light-gray to pink, elongate to pencil-like grains of feldspar (2 to 5 mm in diameter and up to 30 mm in length); minor amounts of opaque minerals; brown sphene crystals; crystalline masses; and thin seams of purple fluorite. Rock from the abandoned quarry southeast of U. S. Highway 360 (Plate 1, abandoned quarry number 3, R-6007) has more of a cataclastic texture and a weakly developed planar foliation, primarily caused by flattened masses of biotite which enclose perthite and microcline augen. The groundmass is composed of ribbon bands of strained quartz and plagioclase that contain bent and offset twin lamelli. All samples contain minor amounts of chlorite, muscovite, pyrite, and fluorite, but such hydrothermal mineralization is more intense in rock with cataclastic texture (R-6007) from abandoned quarry number 3 (Plate 1).

Thin sections and stained rock slabs from various localities show some variation in the ratio of potassic feldspar (microcline and perthite) to plagioclase in composition ranging from quartz monzonite to granite.

METAMORPHOSED VOLCANIC-SEDIMENTARY ROCKS

Metamorphosed volcanic and sedimentary rocks overlie the Shelton Formation and are divided into a lower unit composed of alternating mafic and felsic metavolcanic layers and lenticular, psammitic and pelitic metasedimentary beds and an upper unit composed predominantly of felsic metavolcanic rock. The two units underlie most of the area southeast of the Danville basin, forming arcuate northeastward-trending bands that wrap around elongate areas of the Shelton. They range in metamorphic grade from lower greenschist (chlorite zone) in rocks adjacent to those of Triassic age in the Danville basin to upper amphibolite (sillimanite zone) at the easternmost part of the area (Henika, 1975).

Lower Unit

Rocks in the lower part of the lower unit, such as those exposed directly above the Shelton Formation (Figure 2), consist of light-gray to pink, massive, felsic metatuff beds 10 to 20 feet (3 to 6 m) thick and widely spaced, dark greenish gray, mafic layers less than 3 feet (1 m) thick. Rocks in the lower interval grade upward into much more regularly and closely spaced, alternating mafic and felsic layers with minor metagraywacke interbeds. This interval is exposed along Memorial Drive just north of George Washington High School in Danville. These rocks grade upward into metavolcanics which contain layers of fine- to medium-grained metagraywacke interdigitated with mica schist (locally graphitic), quartzite, and rare mafic layers as exposed along Cleveland Street east of the Langston Junior High School in Danville. The unit generally has a sharp upper contact with the predominantly felsic rocks of the upper unit.

Superimposed upon this stratigraphic succession of volcanic and sedimentary rocks is a metamorphic succession that follows the strong regional metamorphic gradient that increases in grade to the southeast. Mafic metavolcanic interlayers in the unit northwest of Danville are slaty to schistose (Figure 3) whereas to the southeast in the Danville area they are medium- to coarse-grained gneisses. Although the lithologic change from greenschist to amphibolite facies is progressive, major recrystallization seems to occur near the kyanite isograd where plagioclase in the mafic volcanic beds makes the transition from albite to oligoclase-andesine (Henika, 1975).

Greenschist facies metavolcanic and metasedimentary rocks of the lower unit (Figure 3) are typically exposed along State Road 864 approximately 0.6 mile (1.0 km) north of Mount Hermon. In this area the unit consists predominantly of alternating mafic and felsic metavolcanic layers with minor metagraywacke, mica schist, and quartzite beds. The mafic rocks contain chlorite and green fibrous amphibole (R-6008, R-6010, Figure 4) and include tuffs that have a fine-

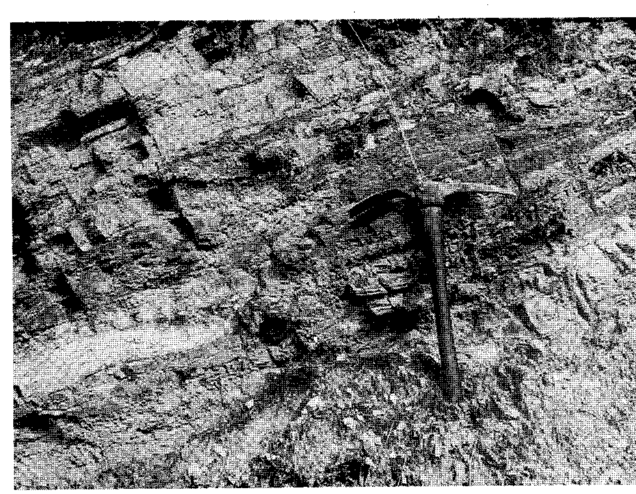

Figure 3. Weathered felsic and mafic metavolcanic rocks of the lower unit of the metamorphosed volcanic and sedimentary rocks along State Road 864 approximately 0.6 mile (1.0 km) north of Mount Hermon. The darker schistose layers, behind the head of the pick, are of mafic composition.

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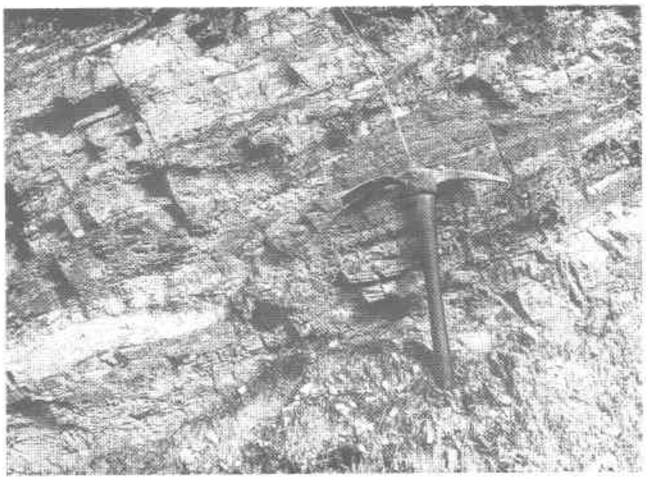

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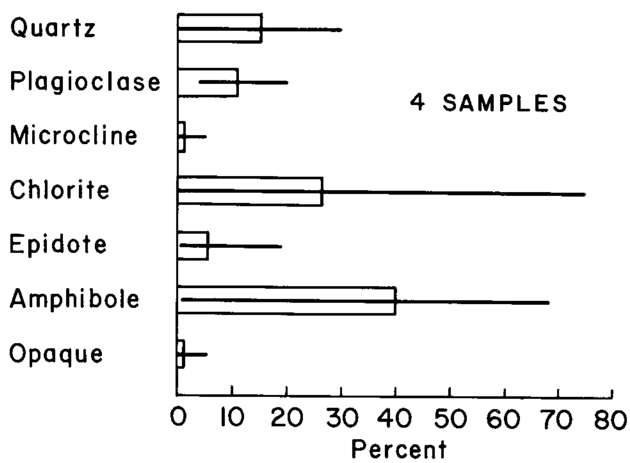


Figure 4. Mineral composition ranges (lines) and averaged estimated composition (bars) of amphibole-chlorite schist from the lower unit of the metamorphosed volcanic-sedimentary rocks.

grained, sandy, pyroclastic texture and amygdaloidal flows. Felsic beds are predominantly composed of granoblastic quartz-feldspar rocks including metamorphosed lapilli and crystal tuffs (R-6036, R-6037; Figure 5). These tuffs contain relic pumice fragments

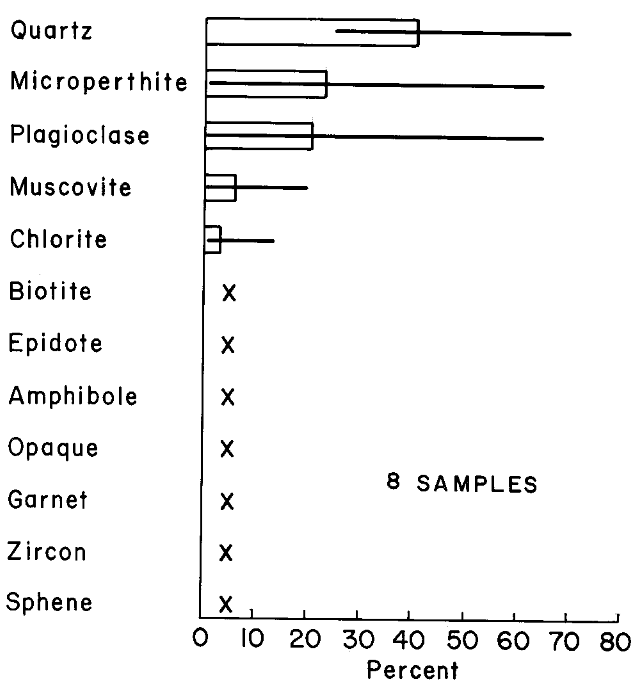


Figure 5. Mineral composition ranges (lines) and averaged estimated composition (bars) of felsic metatuff from the lower unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

and quartz and feldspar phenocrysts that retain straight-sided, geometric outlines of crystal faces, plainly visible to the naked eye (Figure 6). At greenschist facies the metagraywacke beds commonly contain relic sedimentary features including graded bedding (R-6020, R-6021; Figure 7). These metagraywacke beds in combination with silvery-gray mica schist (R-6026; Figure 8) and bluish-gray quartzite form separately mappable subunits (msq) at some localities in the Mount Hermon quadrangle.

Figure 6. Photomicrograph of felsic metatuff of the lower unit of the metamorphosed volcanic-sedimentary rocks that occurs interlayered with mafic metavolcanic rocks near Witt in the Mt. Hermon quadrangle (Plate 2, R-6036); corroded phenocrysts are plagioclase, microperthite, and quartz; fine matrix is probably crystallized glass. Crossed-polarized light.

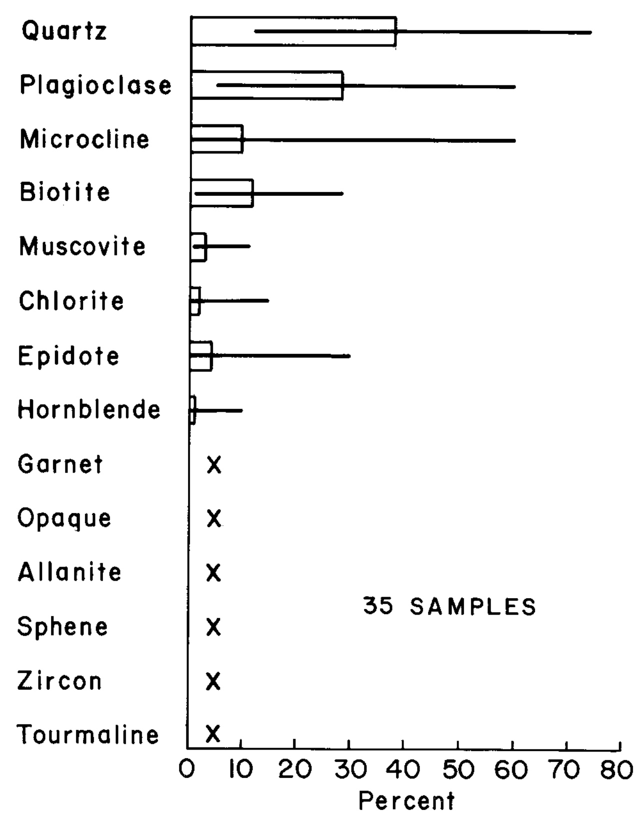
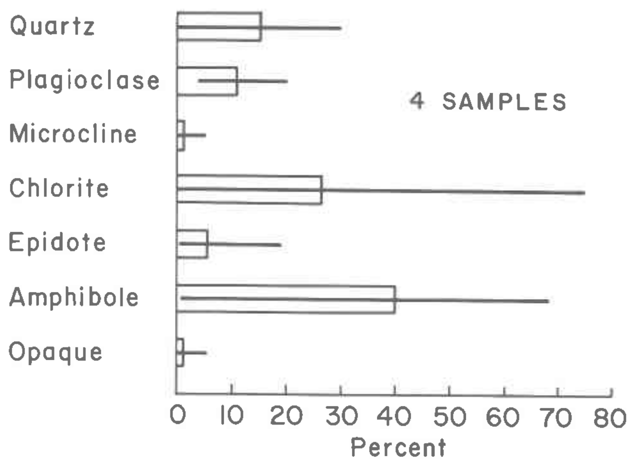


Figure 7. Mineral composition ranges (lines) and averaged estimated composition (bars) of metamorphosed graywacke and pebbly gneiss from the lower unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.



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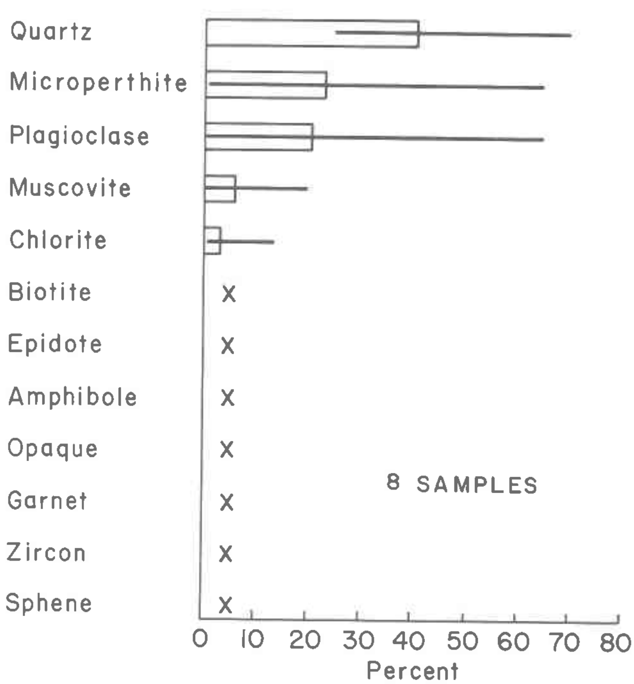

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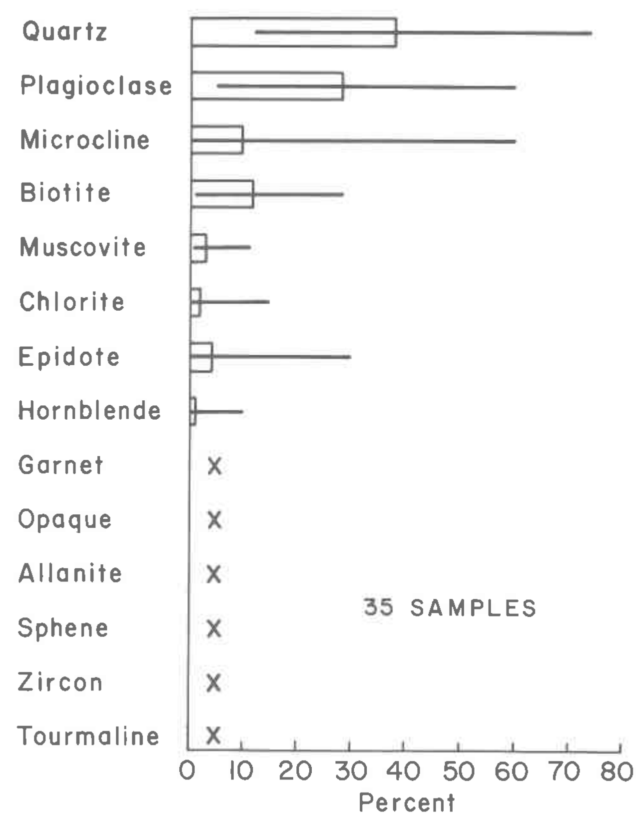

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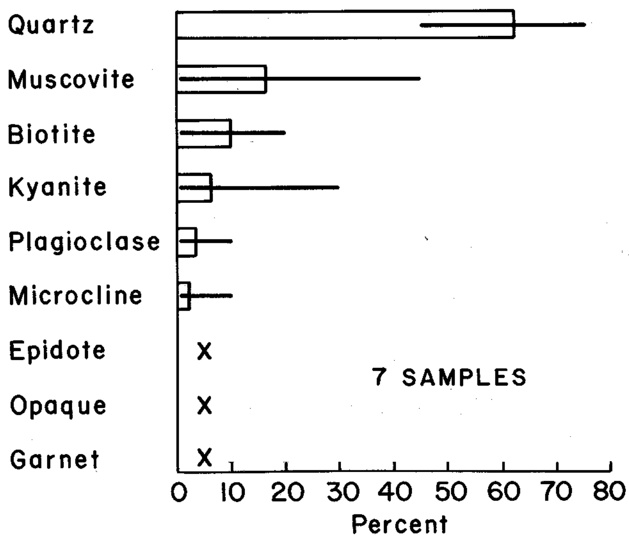

Figure 8. Mineral composition ranges (lines) and averaged estimated composition (bars) of mica schist from the lower unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

Amphibolite-facies metavolcanic and metasedimentary rocks are well exposed along the Dan River in Danville. The mafic layers are all strongly foliated and

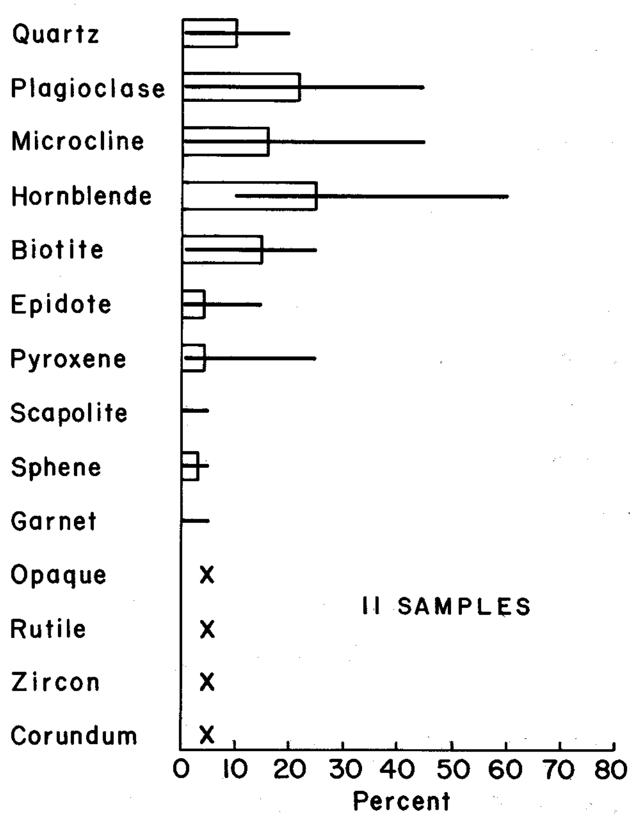

Figure 9. Mineral composition ranges (lines) and averaged estimated composition (bars) of biotite-hornblende gneiss from the lower unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

have nematablastic textures characteristic of amphibolites. At this grade, dark-green to black hornblende is diagnostic; however, pyroxene occurs at higher grade farther southeast in the Ringgold quadrangle. Three different kinds of metamorphic rocks—biotite-hornblende gneiss (R-6013, R-6014, R-6016, and Figure 9), hornblende gneiss (R-5413), and epidote-hornblende gneiss (R-6012, Figure 10)—have formed

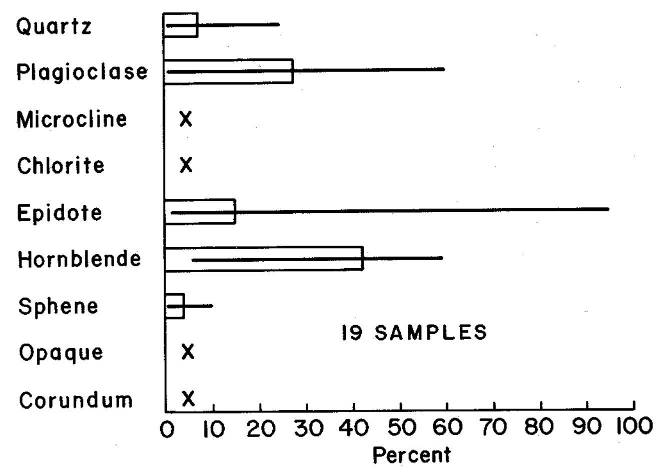

Figure 10. Mineral composition ranges (lines) and averaged estimated composition (bars) of epidote-hornblende gneiss and hornblende gneiss from the lower unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

from mafic tuffs, flows, and possibly mafic volcanic sandstones. Higher grade metasedimentary layers include pebbly gneiss that is gradational into black and white porphyroblastic biotite gneiss (R-6022, R-5417; Figure 7) that is exposed in the abandoned City of Danville quarry (Plate 1, number 4). Porphyroblastic biotite gneiss together with kyanite-mica schist interlayers (R-5397, R-6031, Figure 8) and sillimanite quartzite (R-5424; Figure 11) form a separate map subunit (gn on Plates 1, 2).

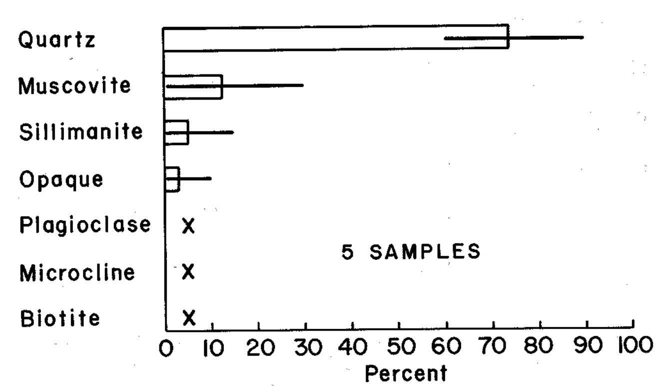

Figure 11. Mineral composition ranges (lines) and averaged estimated composition (bars) of quartzite from the lower unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

Upper Unit

The contact between the upper and lower units has been drawn above the last prominent mafic interlayer, where the heterogeneous, banded metavolcanic rocks are succeeded by a comparatively homogeneous sequence of dominantly felsic metavolcanic rocks (Figure 12). Three types of felsic metavolcanic rocks are recognized in the upper unit at greenschist facies as based on relic primary textures. These are schistose welded metatuff near the base, massive crystal metatuff in the middle, and schistose volcanic breccia near the top.

Figure 12. Outcrop of felsic metatuff of the upper unit near the contact between the upper and lower units of metamorphosed volcanic-sedimentary rocks along State Road 864 north of Mount Hermon. Slaty cleavage is a characteristic of the low-rank felsic metavolcanic rocks near this contact.

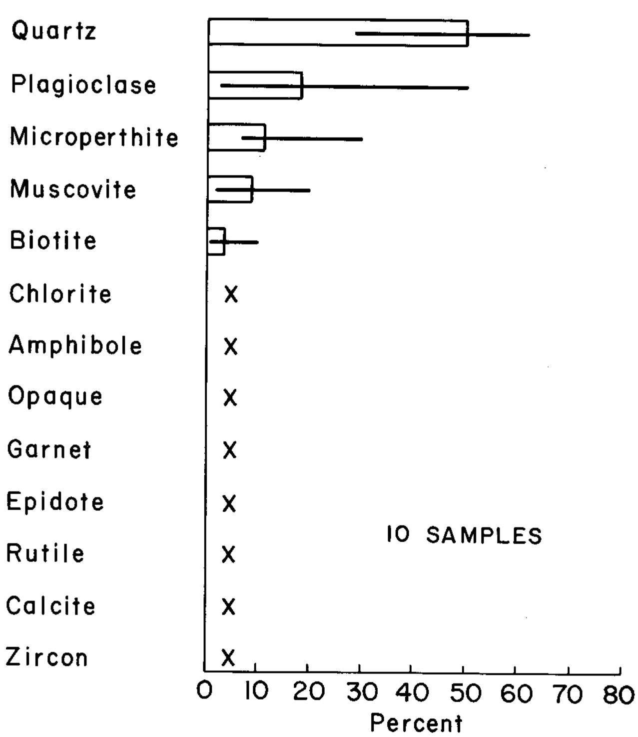

Figure 13. Mineral composition ranges (lines) and averaged estimated composition (bars) of schistose metatuff from the upper unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

The welded metatuff near the base is inequigranular, white to tan, mica-feldspar-quartz schist (Figure 13). Elongate, recrystallized pumice fragments in the rock matrix are contorted and molded around orthoclase and plagioclase phenocrysts (R-6044 through R-6046) producing a wavy foliate (eutaxic) structure characteristic of welded ash-flow tuffs (Smith, 1960, p. 151; Ross and Smith, 1961, Figure 32). Although the potassic feldspar phenocrysts have generally exsolved to microperthite there are some crystals that retain the hourglass twin pattern and small optical angles of volcanic orthoclase.

Massive crystal metatuff in the middle of the unit has a dense crystalline matrix and is rich in feldspar phenocrysts (Figure 14). Although generally devoid

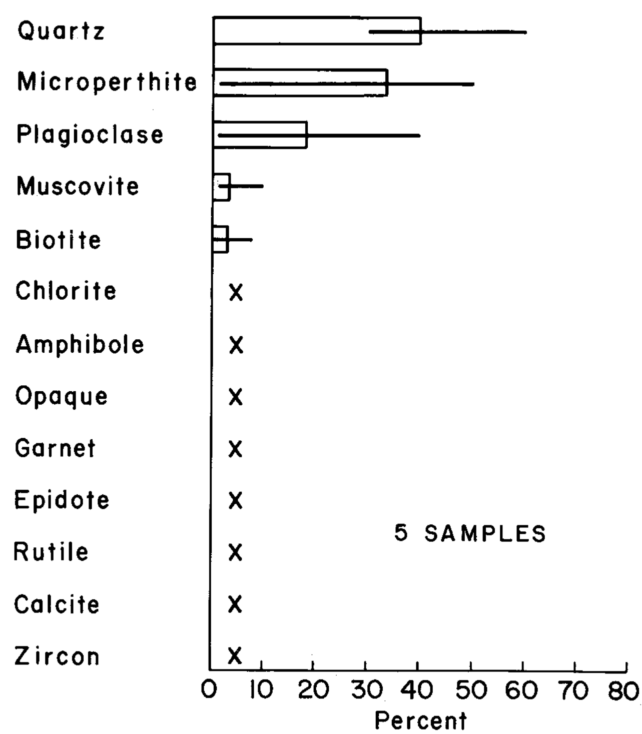

Figure 14. Mineral composition ranges (lines) and averaged estimated composition (bars) of crystalline metatuff from the upper unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

of layering it commonly has a strong fracture cleavage and a prominent lineation produced by stretched-out, recrystallized pumice fragments. Thin sections (R-6042, R-5401) of some massive crystal metatuffs from lower grade rocks northwest of the kyanite isograd show that a primary crystalline microtexture is preserved (Figure 15) and consists of a matrix of granophyric

Upper Unit

The contact between the upper and lower units has been drawn above the last prominent mafic interlayer, where the heterogeneous, banded metavolcanic rocks are succeeded by a comparatively homogeneous sequence of dominantly felsic metavolcanic rocks (Figure 12). Three types of felsic metavolcanic rocks are recognized in the upper unit at greenschist facies as based on relic primary textures. These are schistose welded metatuff near the base, massive crystal metatuff in the middle, and schistose volcanic breccia near the top.

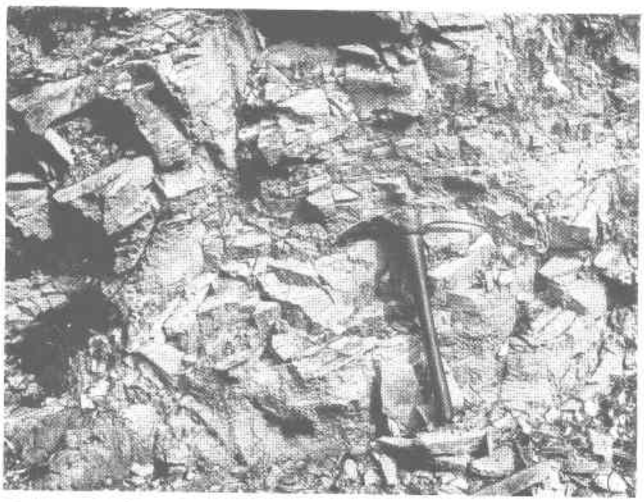

Figure 12. Outcrop of felsic metatuff of the upper unit near the contact between the upper and lower units of metamorphosed volcanic-sedimentary rocks along State Road 864 north of Mount Hermon. Slaty cleavage is a characteristic of the low-rank felsic metavolcanic rocks near this contact.

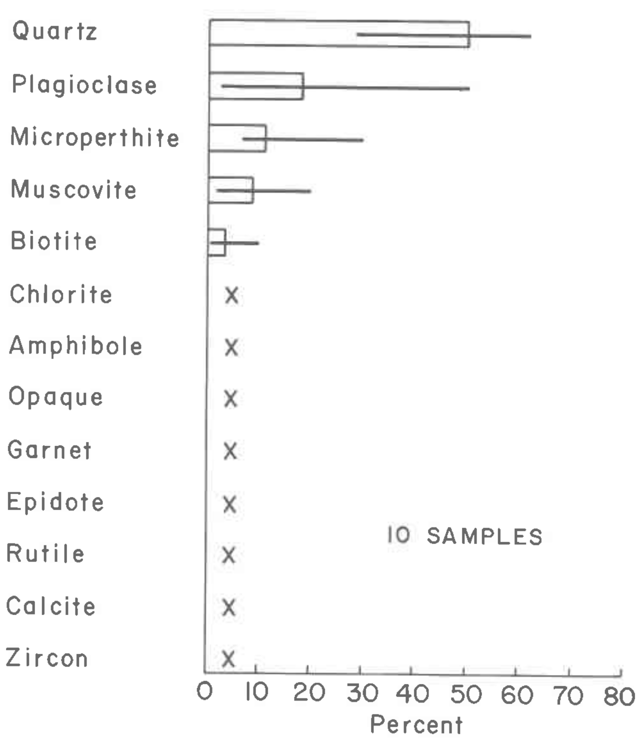

Figure 13. Mineral composition ranges (lines) and averaged estimated composition (bars) of schistose metatuff from the upper unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

The welded metatuff near the base is inequigranular, white to tan, mica-feldspar-quartz schist (Figure 13). Elongate, recrystallized pumice fragments in the rock matrix are contorted and molded around orthoclase and plagioclase phenocrysts (R-6044 through R-6046) producing a wavy foliate (eutaxic) structure characteristic of welded ash-flow tuffs (Smith, 1960, p. 151; Ross and Smith, 1961, Figure 32). Although the potassic feldspar phenocrysts have generally exsolved to microperthite there are some crystals that retain the hourglass twin pattern and small optical angles of volcanic orthoclase.

Massive crystal metatuff in the middle of the unit has a dense crystalline matrix and is rich in feldspar phenocrysts (Figure 14). Although generally devoid of layering it commonly has a strong fracture cleavage and a prominent lineation produced by stretched-out, recrystallized pumice fragments. Thin sections (R-6042, R-5401) of some massive crystal metatuffs from lower grade rocks northwest of the kyanite isograd show that a primary crystalline microtexture is preserved (Figure 15) and consists of a matrix of granophyric

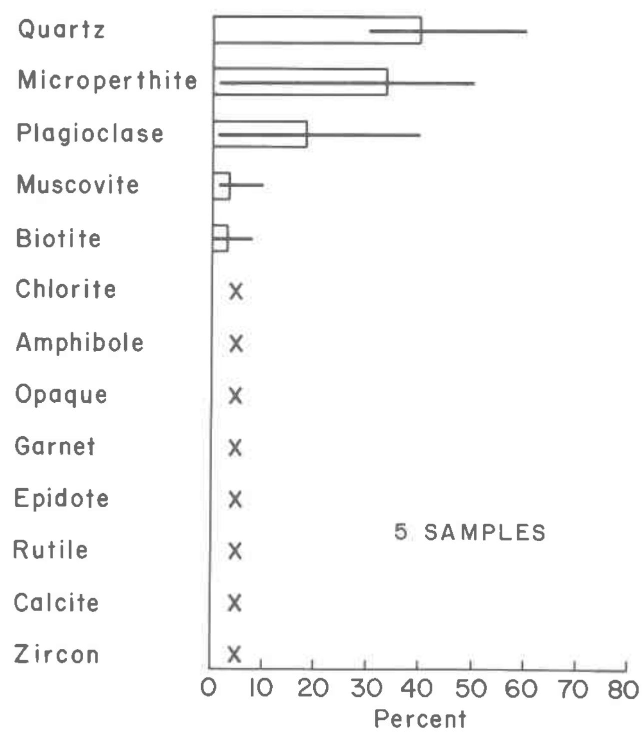

Figure 14. Mineral composition ranges (lines) and averaged estimated composition (bars) of crystalline metatuff from the upper unit of the metamorphosed volcanic-sedimentary rocks. Minor minerals indicated by X.

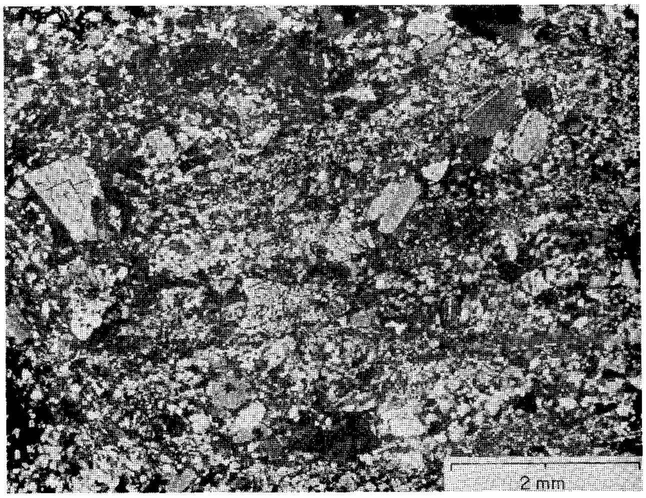

Figure 15. Photomicrograph of crystalline metatuff from the middle part of the upper unit of the metamorphosed volcanic-sedimentary rocks (R-6118) showing granophyric crystallization in the matrix. Cross-polarized light.

intergrowth of fine quartz and potassic feldspar between larger phenocrysts. Thus, crystallization within the hot central part of an ash-flow sheet is suggested (Smith, 1960, p. 152), possibly a single cooling unit.

The volcanic breccia near the top of the unit (R-6040, R-6041) is composed of approximately 50 percent poorly sorted lithic fragments and embayed and broken quartz phenocrysts in a fine matrix of quartz, feldspar, and sericite.

Greenschist-facies metatuffs in the upper unit are exposed nearly continuously as ledges along stream bottoms east and west of State Road 744 north of Witt (Plate 2), but are poorly exposed on the upland surface. Massive, blocky-jointed crystal metatuff, typical of rocks in the middle part of the unit, crops out along the Southern Railway south of State Road 863 (Plate 2). Similar exposures were noted along Sandy Creek southeast of State Road 640 at Chestnut Level (Plate 1) and along the Sandy River southeast of the Danville basin (Plate 2).

A thin persistant body of schistose metavolcanic breccia (R-6040, R-6041) that occurs near the top of the upper unit crops out in the stream bottom about 1.0 mile (1.6 km) north of Witt (Plate 2). Ledges formed by the breccia can be recognized by lithic fragments and blue quartz phenocrysts that stand out in relief on their waterworn surfaces.

Southeast of the kyanite isograd the upper unit has a predominantly metamorphic rather than volcanic character and consists of more homogeneous pinkish-gray to white quartz-feldspar gneiss with silvery-gray mica gneiss and mica schist interlayers. A rock that is equivalent to the recognizable crystal tuff but at higher metamorphic grade is exposed in Danville near the intersection of U. S. Highway 29 (Memorial Drive) and Park Road (R-6043). The rock is massive, fine- to medium-grained, inequigranular gneiss containing relic phenocrysts in a recrystallized, granoblastic matrix. Phenocrysts in the gneiss generally have rounded outlines by addition of a thin rim of microcline that separates them from the matrix (R-6042, R-5401). The gneiss contains dikes and sills of white granite along the Sandy River in Danville.

A silvery-gray mica gneiss and schist cut by granite sills and dikes is mapped as a separate facies (mgs) in the Danville area. It seems to have a stratigraphic position near the top of the upper unit and may be a higher grade equivalent of the micaceous metavolcanic breccia recognized near the top of the unit north of Witt.

FORK MOUNTAIN FORMATION

The Fork Mountain Formation is exposed in the northwestern part of the Mount Hermon quadrangle northwest of the Danville basin (Plate 2). It differs in the proportions and character of schist and gneiss which make up the unit from those at its type locality (Conley and Henika, 1973). It has been traced continuously, however, from the Martinsville area into the Mount Hermon quadrangle (Price, 1975).

The gneiss is black and white, coarse-grained, irregularly foliated, and formed by elongate masses of intergrown muscovite and biotite flakes up to 1 cm across. Masses of plagioclase and blebs of greasy-gray quartz are present (R-6055, R-6056). Garnet porphyroblasts are common. The gneiss is coarse and granular, containing rounded to irregular perthite masses wrapped by biotite and light bluish gray aggregates of sericite and quartz that may have replaced either kyanite or sillimanite (R-6057).

The unit is generally weathered to saprolite and underlies a gently rolling upland surface with characteristic sandy soils. Fresh rock occurs along Pudding Creek for about 1.0 mile (1.6 km) downstream and northward from State Road 838 (R-6055, Plate 2) and also along the unnamed creek that flows southward of the intersection of State Road 718 with State Highway 41.

Mica schist interlayered with the gneiss is coarse grained and silvery gray to dark gray. It contains folia of coarse muscovite and biotite, and discontinuous quartz feldspar stringers which are contorted by folds and wraparound garnet porphyroblasts. Kyanite-staurolite and kyanite-muscovite schist similar to that in the Fork Mountain Formation near Martinsville (Conley and Henika, 1973) have been recognized at only two localities: one is along State Road 865 about 0.25 mile (0.40 km) south-southeast of a gas pipeline

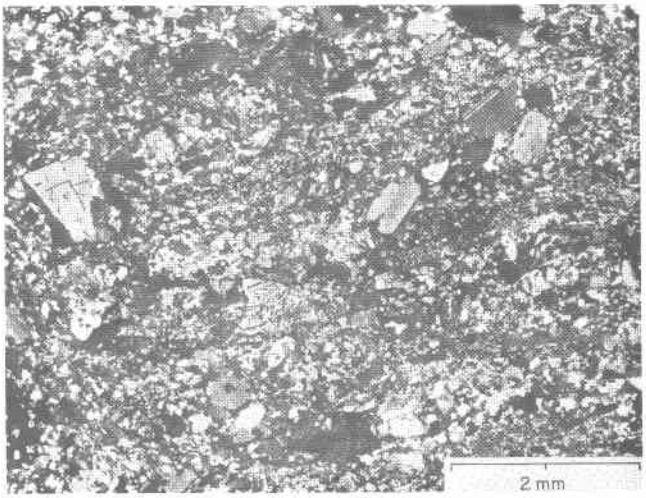

Figure 15. Photomicrograph of crystalline metatuff from the middle part of the upper unit of the metamorphosed volcanic-sedimentary rocks (R-6118) showing granophyric crystallization in the matrix. Cross-polarized light.

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The volcanic breccia near the top of the unit (R-6040, R-6041) is composed of approximately 50 percent poorly sorted lithic fragments and embayed and broken quartz phenocrysts in a fine matrix of quartz, feldspar, and sericite.

Greenschist-facies metatuffs in the upper unit are exposed nearly continuously as ledges along stream bottoms east and west of State Road 744 north of Witt (Plate 2), but are poorly exposed on the upland surface. Massive, blocky-jointed crystal metatuff, typical of rocks in the middle part of the unit, crops out along the Southern Railway south of State Road 863 (Plate 2). Similar exposures were noted along Sandy Creek southeast of State Road 640 at Chestnut Level (Plate 1) and along the Sandy River southeast of the Danville basin (Plate 2).

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The unit is generally weathered to saprolite and underlies a gently rolling upland surface with characteristic sandy soils. Fresh rock occurs along Pudding Creek for about 1.0 mile (1.6 km) downstream and northward from State Road 838 (R-6055, Plate 2) and also along the unnamed creek that flows southward of the intersection of State Road 718 with State Highway 41.

Mica schist interlayered with the gneiss is coarse grained and silvery gray to dark gray. It contains folia of coarse muscovite and biotite, and discontinuous quartz feldspar stringers which are contorted by folds and wraparound garnet porphyroblasts. Kyanite-staurolite and kyanite-muscovite schist similar to that in the Fork Mountain Formation near Martinsville (Conley and Henika, 1973) have been recognized at only two localities: one is along State Road 865 about 0.25 mile (0.40 km) south-southeast of a gas pipeline

(R-6060); the other, along the pipeline about 0.1 mile (0.2 km) southwest of State Road 718 (R-6061). The rock from the first locality (R-6060) contains dense nodular masses of kyanite, staurolite, garnet, and opaque minerals with minor amounts of pale-green chlorite and muscovite. Float found along the pipeline (R-6061, R-6062) has a coarse, bumpy surface texture because of elongate, crisscross kyanite blades, partly altered to sericite.

Amphibolite

Amphibolite and amphibole gneiss in the Fork Mountain Formation are separately shown on Plate 2 insofar as their extent is mappable; however, they could not be traced for any significant distance because of poor exposure. The amphibolite is well-exposed in saprolite along the east side of State Road 834 approximately 1.1 miles (1.7 km) northwest of White Oak Creek, but is not shown on the geologic map because it is only a few feet wide. The unweathered rock is medium-grained, well-foliated, dark-green to black and white gneiss. It contains elongate to subequant grains of hornblende with many inclusions of quartz and sphene. The hornblende is intergrown with partly epidotized and sericitized plagioclase (R-6056). Some plagioclase grains are strongly zoned, suggesting a volcanic origin.

RICH ACRES FORMATION

The Rich Acres Formation is exposed along the western margin of the Mount Hermon quadrangle (Plate 2) northwest of the Danville basin. It is dark-gray, medium-grained metadiorite to dark greenish gray, medium- to coarse-grained metamorphosed ultramafic rock occurring in a sill-like intrusion in the Fork Mountain Formation. This intrusion is nearly completely covered by thick residual and alluvial soils.

Relatively fresh metagabbro occurs as boulders in the woods along Sandy Creek about 1,000 feet (305 m) east of the quadrangle boundary (Plate 2, R-6065). The rock has a granular igneous texture and is composed primarily of plagioclase, pyroxene, hornblende, and biotite.

Metamorphosed ultramafic rock (R-6064) that contains relic olivine with the original crystal shapes outlined by opaque minerals is present near the probable base of the sill. The olivine crystals are altered to serpentine along cracks. Cummingtonite, talc, and carbonate minerals occur as irregular and fibrous masses that have grown in the spaces between the olivine crystals.

ULTRAMAFIC ROCKS

Metamorphosed ultramafic rock occurs in elongate lenticular bodies that generally have a trend parallel to the schistosity of the enclosing metavolcanic rocks. The largest of these bodies has been traced in a northeastward direction for several miles across the northern part of the Blairs quadrangle (Plate 1). Because of poor exposure, many smaller mafic and ultramafic bodies, some with relic igneous texture (R-6018), have been included with mafic metavolcanic rocks and are not separately mapped.

The most common rock type is granular to medium- and coarse-grained, dark greenish gray, schistose olivine-amphibole-chlorite rock that forms low rounded exposures which barely protrude above a deep, red clayey soil. It is composed of highly fractured olivine, mostly altered to fibrous and platy masses of antigorite and talc; large pseudomorphs of poikilitic pyroxene to cummingtonite, anthophyllite, and chlorite; and opaque minerals that are abundant in some specimens (R-6032).

The rock is poorly exposed, but float and saprolite derived from the unit occur along a logging road about 0.5 mile (0.8) km) northeast of the terminus of State Road 717. Exposures of the fresh rock occur along the bottom of a stream that traverses the ultramafic body 0.7 mile (1.1 km) southwest of the intersection of State Roads 662 and 713.

Medium- to coarse-grained, dark-green to black and white, granular amphibolite also occurs in association with the ultramafic rock approximately 200 feet (61 m) northwest of the end of State Road 717. Similar rocks occur at other localities as lenticular bodies associated with ultramafic rocks or as isolated masses within the metavolcanic rocks.

PRECAMBRIAN OR PALEOZOIC ROCKS

GRANITE DIKES AND SILLS

Dikes and sills of Precambrian or Paleozoic age are present in the upper and lower units of the metamorphosed volcanic-sedimentary rocks and the Fork Mountain Formation. None of these dikes and sills are shown separately on the geologic maps (Plates 1, 2) from the formations that they intrude because of limited exposure. Coarse, pink granite dikes and sills are present in the metamorphosed crystal tuffs of the upper unit of the metamorphosed volcanic-sedimentary rocks. They are generally similar in composition to the metatuffs and may represent subvolcanic sills or feeder dikes from which the overlying effusive units were derived. White pegmatitic dikes and sills in the lower unit of metamorphosed volcanic-sedimentary rocks and those in the Fork Mountain Formation most likely are associated with zones of migmatites which formed during high grade metamorphism.

A pink granite sill that has intruded metatuff is exposed along the Southern Railway approximately 0.75 mile (1.20 km) southeast of the State Road 745-railroad crossing (Plate 2). The rock has a cataclastic texture and appears to have been folded with the massive metatuff beds. A thin section of the rock consists of 50 percent quartz, 40 percent microcline and microperthite, 4 percent plagioclase, 4 percent muscovite, and less than 1 percent biotite and rutile (R-6122). The quartz has generally been polygonized and consists of individual grains and elongate aggregates. The feldspar is subrounded with crushed and broken grains. The muscovite is generally distributed along shear planes or as a sericitic alteration of feldspar.

White to light-gray pegmatite dikes and sills cut porphyroblastic biotite gneiss in the lower unit. They are exposed along the right bank of Oliver Creek about 1.1 miles (1.8 km) northeast of Kentuck (Plate 1) and in the abandoned quarry east of Danville (Plate 1, number 4). The dikes and sills are generally less than 10 feet (3 m) wide and most are less than 3 feet (1 m). The rock is coarse grained with complexly intergrown quartz and feldspar, greenish muscovite, pink garnet, and at some localities black tourmaline up to 2.4 inches (6.0 cm) in length. The pegmatites are generally richer in plagioclase (30 to 70 percent) and less rich in quartz (20 to 25 percent) and potassic feldspar (trace amounts to 30 percent) than the pink granites associated with the felsic metavolcanic rocks. Mica content in the pegmatites increases southeasterly with rising metamorphic grade.

TRIASSIC SYSTEM

DRY FORK FORMATION

By Paul A. Thayer

The Dry Fork Formation was named by Myertons (1963, p. 17-18) for coarse-grained sandstone, feldspathic conglomerate, and subordinate reddish-brown mudrock in the central and south-central parts of the Danville basin. The type section (Appendix I, Section 2) for the Dry Fork (Meyertons, 1963, p. 54-55) is located in the Mount Hermon quadrangle (Plate 2) along the Southern Railway, 0.5 mile (0.8 km) south of Dry Fork community (Chatham 7.5-minute quadrangle) and about 1,000 feet (305 m) south of the north boundary of the Mount Hermon quadrangle. Meyertons (1963, p. 27-30) assigned lithic conglomerate that is exposed along each basin margin to his Cedar Forest formation, which he interpreted to unconformably overlie the Dry Fork. Detailed mapping shows that the conglomerate is interbedded and intertongues with sandstone of the Dry Fork Formation, and that the Dry Fork and Cedar Forest are lateral facies equivalents. The Dry Fork Formation is here redefined to include basin margin conglomerate previously assigned to the Cedar Forest formation. The Cedar Forest formation is no longer considered valid.

Along the southeastern side of the Danville basin the Dry Fork Formation rests unconformably on and is locally in fault contact with the Shelton Formation and metamorphosed volcanic-sedimentary rocks. Along the northwest side of the basin the Dry Fork is in fault contact with the Fork Mountain Formation and rests unconformably on the Shelton Formation near the axis of the cross structure that follows Sandy Creek (Plate 2).

On the basis of texture, composition, color, and primary sedimentary structures the Dry Fork is divided into intertonguing sandstone, mudrock, and conglomerate facies.

Sandstone Facies

The sandstone facies forms almost 90 percent of the Dry Fork Formation. Its calculated stratigraphic thickness ranges from 5,200 feet (1,585 m) to 7,000 feet (2,134 m). Sandstone forms approximately 75 percent of the facies; mudrock, chiefly siltstone, 20 percent; and conglomerate, 5 percent. They are arranged in sequences that somewhat resemble fining-upwards fluvial cycles (Allen, 1965) described previously by Thayer (1970) in the contiguous Dan River basin, North Carolina. Stratigraphic sections 1 and 2 (Appendix I) illustrate these vertical sequences.

The sandstone and conglomerate are arranged in multistory sets with individual sandstone and conglomerate units stacked one above another and separated by sharp, minor erosional surfaces and mudrock units. Total thickness of these sets ranges from 10 to 180 feet (3 to 55 m).

More than three-fourths of the sandstone is gray, brownish gray, or greenish gray; the remainder is grayish pink, grayish red, and pale red (colors from Goddard and others, 1948). They weather yellowish orange, grayish orange, and yellowish brown, and form a sandy soil that contains numerous granules and pebbles of quartz and partially weathered feldspar.

Sandstone ranges from very fine to very coarse grained. Most, however, is medium to very coarse grained, and may contain granules and pebbles of quartz and potassic feldspar (Figures 16 and 17). Sandstone beds range from less than a foot (0.3 m) to a maximum of 80 feet (24 m) thick; average thickness is about 12 feet (4 m). Many of the sandstone beds contain thin, discontinuous conglomerate lenses, mudrock intraclasts, thin carbonaceous films, and irregularly shaped carbonized wood fragments up to 6 inches (15 cm) long. Minor sedimentary structures

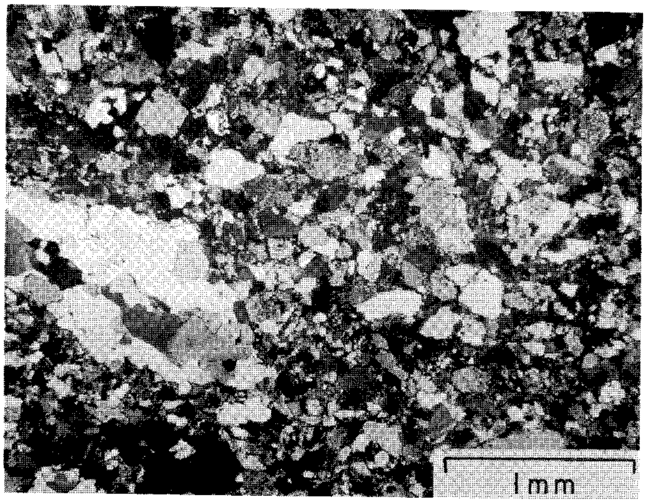

Figure 16. Photomicrograph of pebbly arkose (R-6691) of the sandstone facies of the Dry Fork Formation along U. S. Highway 29 on the top of White Oak Mountain in the Mount Hermon quadrangle. It is poorly sorted, medium grained, and densely packed. Crossed-polarized light.

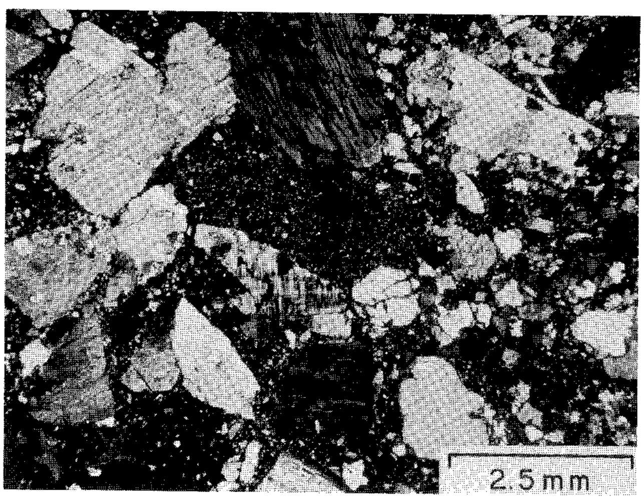

Figure 17. Photomicrograph of lithic arkose (R-6692) of the sandstone facies of the Dry Fork Formation. Angular and subangular clasts of microcline and perthite "float" in siltstone matrix. Along U. S. Highway 29 on top of White Oak Mountain in the Mount Hermon quadrangle. Crossed-polarized light.

include channels, medium- and large-scale tabular and trough cross-stratification, thick parallel laminations, silicified fragments and logs of araucarian conifers, and ripple-drift cross laminations.

Composition of 84 sandstone samples was determined by point-counting between 200 and 300 grains per thin section using a point distance slightly larger than mean grain diameter. Average composition for the samples is summarized in Table 2. The proportion of quartz, feldspar, and rock fragments (including grain size) for each sample has been recomputed to 100 percent and plotted on the triangular compositional diagram in Figure 18 (classification of McBride,

Table 2.—Composition of 84 sandstone samples from the sandstone facies of the Dry Fork Formation.

Mineral	Average (percentage)	Standard deviation (percentage)	Range (percentage)
Common Quartz	9.1	±7.5	0-37.3
Composite Quartz	36.6	±10.5	3-55.5
Sutured Quartz	0.6	±1.3	0-8.4
Orthoclase	4.3	±2.9	0-14.5
Microcline	4.8	±4.4	0-25.0
Perthite	9.2	±4.9	0-22.4
Plagioclase	13.1	±7.1	0-29.2
Detrital micas	1.3	±2.1	0-11.9
Coarse foliated rock fragments	4.3	±5.1	0-26.1
Coarse nonfoliated rock fragments	1.3	±1.9	0-9.8
Fine foliated rock fragments	0.6	±2.0	0-19.5
Authigenic chlorite	3.2	±7.0	0-45.4
Calcite cement	3.2	±5.4	0-30.3
Matrix	7.8	±10.7	0-42.2
Other	0.6	±1.5	0-10.9

1963). Of 84 samples 63 percent are arkoses, 22 percent are lithic arkoses, 11 percent are subarkoses, and the remainder are lithic subarkoses and feldspathic litharenites. The diagram (Figure 18) clearly shows the relationship between mean grain size and mineral composition of the sandstones. Generally, coarse- and

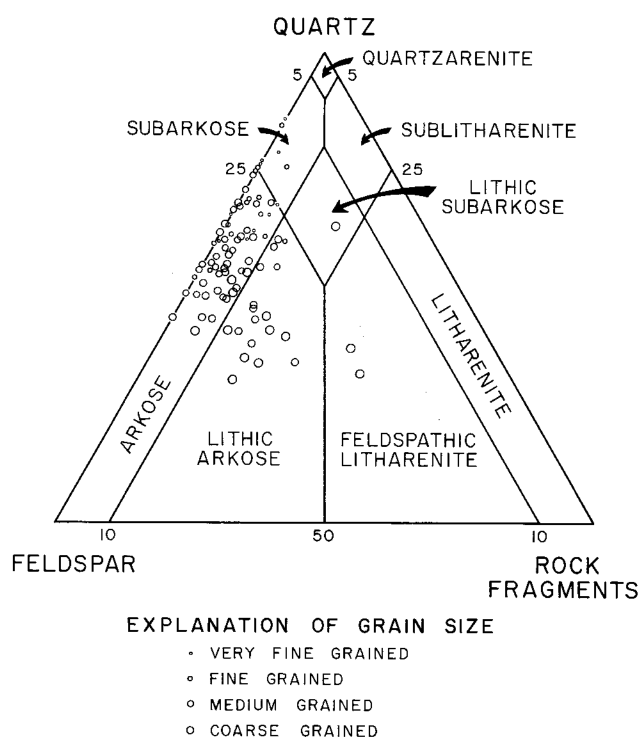

Figure 18. Triangular composition diagram (classification of McBride, 1963) for 84 sandstone samples from the sandstone facies of the Dry Fork Formation.

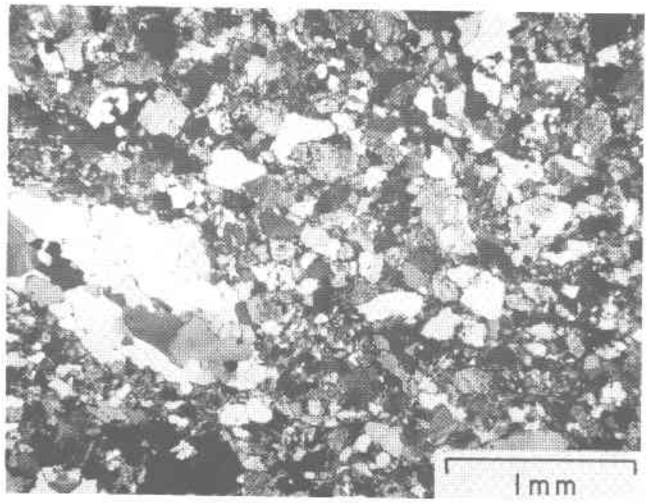

Figure 16. Photomicrograph of pebbly arkose (R-6691) of the sandstone facies of the Dry Fork Formation along U. S. Highway 29 on the top of White Oak Mountain in the Mount Hermon quadrangle. It is poorly sorted, medium grained, and densely packed. Crossed-polarized light.

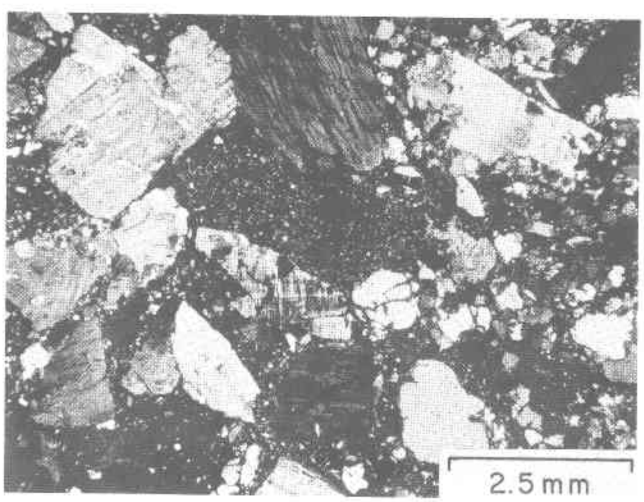

Figure 17. Photomicrograph of lithic arkose (R-6692) of the sandstone facies of the Dry Fork Formation. Angular and subangular clasts of microcline and perthite "float" in siltstone matrix. Along U. S. Highway 29 on top of White Oak Mountain in the Mount Hermon quadrangle. Crossed-polarized light.

include channels, medium- and large-scale tabular and trough cross-stratification, thick parallel laminations, silicified fragments and logs of araucarian conifers, and ripple-drift cross laminations.

Composition of 84 sandstone samples was determined by point-counting between 200 and 300 grains per thin section using a point distance slightly larger than mean grain diameter. Average composition for the samples is summarized in Table 2. The proportion of quartz, feldspar, and rock fragments (including grain size) for each sample has been recomputed to 100 percent and plotted on the triangular compositional diagram in Figure 18 (classification of McBride,

Table 2.—Composition of 84 sandstone samples from the sandstone facies of the Dry Fork Formation.

Mineral	Average (percentage)	Standard deviation (percentage)	Range (percentage)
Common Quartz	9.1	±7.5	0-37.3
Composite Quartz	36.6	±10.5	3-55.5
Sutured Quartz	0.6	±1.3	0-8.4
Orthoclase	4.3	±2.9	0-14.5
Microcline	4.8	±4.4	0-25.0
Perthite	9.2	±4.9	0-22.4
Plagioclase	13.1	±7.1	0-29.2
Detrital micas	1.3	±2.1	0-11.9
Coarse foliated rock fragments	4.3	±5.1	0-26.1
Coarse nonfoliated rock fragments	1.3	±1.9	0-9.8
Fine foliated rock fragments	0.6	±2.0	0-19.5
Authigenic chlorite	3.2	±7.0	0-45.4
Calcite cement	3.2	±5.4	0-30.3
Matrix	7.8	±10.7	0-42.2
Other	0.6	±1.5	0-10.9

1963). Of 84 samples 63 percent are arkoses, 22 percent are lithic arkoses, 11 percent are subarkoses, and the remainder are lithic subarkoses and feldspathic litharenites. The diagram (Figure 18) clearly shows the relationship between mean grain size and mineral composition of the sandstones. Generally, coarse- and

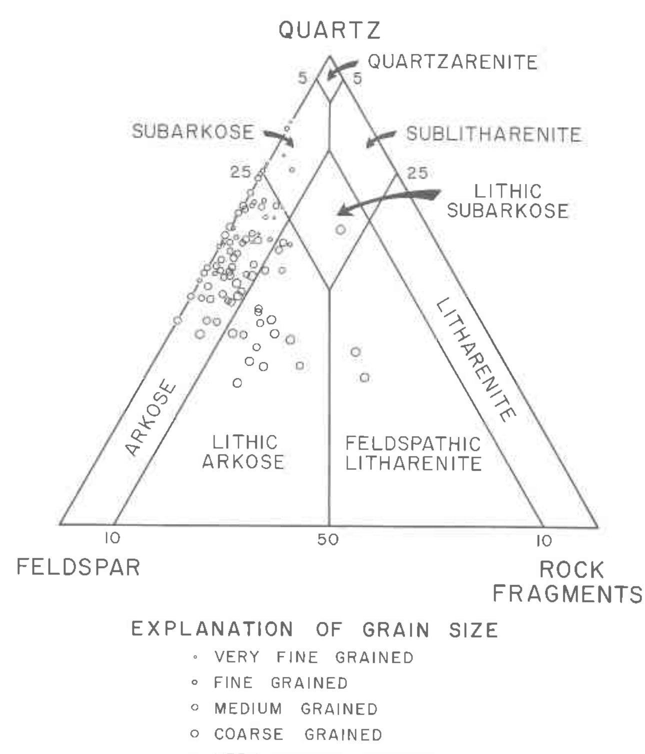

Figure 18. Triangular composition diagram (classification of McBride, 1963) for 84 sandstone samples from the sandstone facies of the Dry Fork Formation.

very coarse-grained sandstone contains a high percentage of feldspar and rock fragments and hence lies in the lithic arkose and feldspathic litharenite classes. In contrast, fine- and very fine-grained sandstone, which is composed mainly of quartz and feldspar with only minor rock fragments, falls into the arkose and subarkose fields.

Heavy minerals, which occur in trace amounts, include (in order of estimated abundance) opaque minerals, garnet, zircon, tourmaline, amphibole, epidote, kyanite, staurolite, and sillimanite. Most heavy mineral grains are euhedral or subhedral.

Abundant secondary chlorite and sericitized feldspar, and the presence of authigenic albite, potassic feldspar, quartz, and calcite show that the rocks of the sandstone facies have undergone considerable burial pressure and are in an advanced stage of diagenesis (Dapples, 1967). Coarse-grained, medium- to high-rank gneissic rocks found to the west of the Danville basin must have served as the major sources of detritus for the sandstone facies. Some quartz and feldspar may have been derived from the Shelton Formation on the east side of the basin, but the paucity of metavolcanic rock fragments in coarse sandstone and conglomerate shows that eastern source areas were relatively unimportant during deposition of the sandstone facies of the Dry Fork.

The sandstone facies is the most resistant rock unit in the Danville basin and exposures are abundant, especially on White Oak Mountain and along streams that cross the unit. Good exposures are located on the crest of White Oak Mountain on the west side of U. S. Highway 29; at the type section of the Dry Fork Formation along the Southern Railway; and at the Vulcan Materials, Incorporated quarry (Plate 2, active quarry number 6).

Conglomerate Facies

The conglomerate facies (cg on Plate 2) of the Dry Fork Formation consists of poorly sorted, sandy, lithic pebble to boulder conglomerate interbedded with subordinate, very coarse grained arkosic and lithic arkosic sandstone. The facies crops out discontinuously along both basin margins and grades laterally and vertically into the sandstone facies. The contact between the two facies (Plate 2) is placed where the proportion of conglomerate exceeds that of sandstone.

Conglomerate along southeastern basin margin: The conglomerate along the southeastern margin of the Danville basin is very well indurated and consists of multicolored clasts in a light- to medium-gray matrix. Fresh clasts are light bluish gray, very light gray, grayish orange, pink, pinkish gray, pale pink, and dark greenish gray. The conglomerate weathers pale yellowish orange and very pale orange, and forms clay-rich sandy soil that contains rounded clasts of quartz and quartzite.

Poorly sorted conglomerate along the southeastern margin of the basin consists of rounded and subrounded clasts in a very coarse grained arkosic and lithic arkosic sandstone matrix. Clast size rarely exceeds 12 inches (30 cm); an average size is between 2 and 4 inches (5 and 10 cm). Most conglomerate is clast supported and has an unordered fabric; long axis orientation of clasts is rare. The conglomerate is massive to thick and very thick bedded, and locally is interbedded with thick, trough cross-bedded sandstone. Silicified fragments and logs of araucarian conifers, as much as 6.6 feet (2.0 m) long and 11.8 inches (30.0 cm) wide, are abundant.

The sandstone matrix of conglomerate along the southeastern margin is poorly sorted and consists

Table 3.—Composition of 10 conglomerate samples from the conglomerate facies of the Dry Fork Formation.

	Northwestern margin, Danville basin			Southeastern margin, Danville basin		
Mineral	Average (percentage)	Standard deviation (percentage)	Range (percentage)	Mean (percentage)	Standard deviation (percentage)	Range (percentage)
Quartz	4.3	2.5	0.7-7.3	6.4	3.5	2.5-10.7
Feldspar	18.8	8.2	5.0-25.6	3.1	4.0	0-9.9
Mica schist	—	—	—	1.3	2.8	0-6.3
Biotite gneiss	4.6	6.0	0-15.0	4.1	8.9	0-20.0
Biotite augen gneiss	13.5	13.8	0.8-36.7	0.7	1.7	0-3.7
Quartz-feldspar gneiss	11.7	8.3	4.5-25.0	0.4	0.8	0-1.8
Metamorphosed felsic volcanic rock	—	—	—	24.8	13.3	9.0-45.3
Metamorphosed mafic volcanic rock	—	—	—	2.3	1.8	0-4.2
Pegmatite	3.4	7.0	0-15.8	0.7	1.7	0-3.7
Quartzite	1.0	1.6	0-3.6	1.2	2.2	0-5.0
Sandstone intraclasts	0.2	0.4	0-1.0	—	—	—
Sandy matrix	42.5	16.1	15-55.3	55.0	15.9	35.0-69.8

chiefly of subangular quartz, feldspar, and metavolcanic rock fragments that are tightly packed and cemented by authigenic chlorite, clay matrix, and silica cement. Porosity is very low due to dense grain packing and secondary mineral growth. Average composition for five conglomerate outcrops is shown in Table 3. An eastern source area for the conglomerate is a probability as the abundant metamorphosed felsic and mafic metavolcanic clasts are similar to rocks found only to the east of the Danville basin (Plates 1, 2). Also, many of the quartz and quartzite clasts are bluish white, similar to the colors of quartz and quartzite layers in the felsic metavolcanic rocks east of the basin. Some blue quartz grains less than 4 mm in diameter have subrounded beta-forms and these could only have been derived from the felsic metavolcanic rocks.

Conglomerate along northwestern basin margin: The conglomerate along the northwestern margin of the Danville basin consists of light-gray, moderate orangish pink, moderate reddish orange, and pinkish-gray clasts set in a medium-gray and medium dark gray matrix. The rock weathers dark yellowish orange and light brown and forms a clay-rich sandy soil.

Conglomerate along the northwestern margin is typically coarser grained than that on the southeastern margin. Maximum clast size commonly exceeds 20 inches (50 cm) and average size ranges from 6 to 10 inches (15 to 25 cm). Clasts are rounded and subrounded and most "float" without preferred long-axis orientation in a sandstone matrix. Coarse sandstone beds, which are thick and massive or thick and trough cross-stratified, are locally interbedded with the conglomerate.

Average composition for five conglomerate outcrops along the northwestern margin is shown in Table 3. Clasts are chiefly feldspar (mostly microcline), gneiss fragments, quartz, and pegmatite, with minor quartzite and sandstone intraclasts. All are set in a very coarse grained, poorly sorted, arkosic and lithic sandstone matrix. The matrix consists of angular and subangular quartz, feldspar, and rock fragments that are densely packed and locally cemented by authigenic chlorite and sparry calcite. The high proportion of coarse-grained gneiss and feldspar fragments show that the source area for the conglomerate was probably from feldspar-rich gneissic rocks exposed to the west of the basin.

Conglomerate along the western margin is extensively sheared (Figure 19), silicified, and cut by numerous quartz veins up to several hundred feet long and a foot wide. Toward the Chatham fault zone, the conglomerate becomes progressively more sheared and gradationally passes into cataclasite and microbreccia. The contact between the conglomerate facies and cataclastic rocks is placed where individual clasts in the conglomerate cannot be recognized because of extensive shearing.

Figure 19. Sheared augen gneiss clasts in a very poorly sorted lithic arkosic matrix in the conglomerate facies of the Dry Fork Formation near White Oak Creek, north-central Mount Hermon quadrangle (Plate 2). Coin is 2.4 cm (0.9 inch) in diameter.

Almost two-thirds of the areas of conglomerate bedrock are covered by terrace deposits (Plate 2) and much of the rest is obscured by deep soil and saprolite. Good exposures are found along small streams flowing across the outcrop belt. Fresh exposures are located in fields on the northwest side of State Road 835 at 0.8 mile (1.3 km) southwest of its intersection with State Road 718 and in fields on either side of State Road 864 between 250 and 1,600 feet (76 and 488 m) south of its intersection with State Road 863.

Mudrock Facies

The mudrock facies (mr on Plate 2) of the Dry Fork Formation occurs as a northeastward-trending lens within the Dry Fork sandstone facies in the north-central part of the Mount Hermon quadrangle (Plate 2). The contact is gradational and is placed where the proportion of well-bedded mudrock and sandstone exceeds that of crudely bedded sandstone. At its wide, southwestern end the trend of the mudrock facies is abruptly truncated by the Chatham fault and here Dry Fork mudrock is in fault contact with cataclasite and microbreccia. Calculated stratigraphic thickness ranges from near zero to a maximum of 1,600 feet (488 m).

The mudrock facies consists chiefly of well-bedded, medium- to dark-gray mudrock and shale with subordinate light- to medium light gray, medium-grained sandstone to conglomerate that is poorly exposed due to deep weathering and a widespread cover of terrace deposits. The mudrock weathers grayish orange and dark yellowish orange, and forms a clay-rich soil that contains abundant partially weathered shale chips. Interbedded sandstone and conglomerate weathers chiefly of subangular quartz, feldspar, and metavolcanic rock fragments that are tightly packed and cemented by authigenic chlorite, clay matrix, and silica cement. Porosity is very low due to dense grain packing and secondary mineral growth. Average composition for five conglomerate outcrops is shown in Table 3. An eastern source area for the conglomerate is a probability as the abundant metamorphosed felsic and mafic metavolcanic clasts are similar to rocks found only to the east of the Danville basin (Plates 1, 2). Also, many of the quartz and quartzite clasts are bluish white, similar to the colors of quartz and quartzite layers in the felsic metavolcanic rocks east of the basin. Some blue quartz grains less than 4 mm in diameter have subrounded beta-forms and these could only have been derived from the felsic metavolcanic rocks.

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Average composition for five conglomerate outcrops along the northwestern margin is shown in Table 3. Clasts are chiefly feldspar (mostly microcline), gneiss fragments, quartz, and pegmatite, with minor quartzite and sandstone intraclasts. All are set in a very coarse grained, poorly sorted, arkosic and lithic sandstone matrix. The matrix consists of angular and subangular quartz, feldspar, and rock fragments that are densely packed and locally cemented by authigenic chlorite and sparry calcite. The high proportion of coarse-grained gneiss and feldspar fragments show that the source area for the conglomerate was probably from feldspar-rich gneissic rocks exposed to the west of the basin.

Conglomerate along the western margin is extensively sheared (Figure 19), silicified, and cut by numerous quartz veins up to several hundred feet long and a foot wide. Toward the Chatham fault zone, the conglomerate becomes progressively more sheared and gradationally passes into cataclasite and microbreccia. The contact between the conglomerate facies and

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The mudrock facies consists chiefly of well-bedded, medium- to dark-gray mudrock and shale with subordinate light- to medium light gray, medium-grained sandstone to conglomerate that is poorly exposed due to deep weathering and a widespread cover of terrace deposits. The mudrock weathers grayish orange and dark yellowish orange, and forms a clay-rich soil that contains abundant partially weathered shale chips. Interbedded sandstone and conglomerate weathers moderate yellowish brown, and being more resistant than the mudrock, stands out as small ledges in ditches and stream banks (Figure 20).

Rocks of the mudrock facies have uniformly even, thin and medium, parallel bedding (Figure 20). Beds

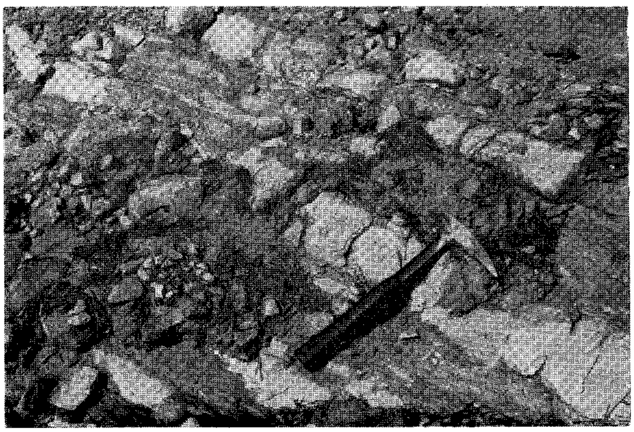

Figure 20. Sandstone and shale of Dry Fork mudrock facies. Note how resistant, thin, even-bedded sandstone stands out in relief as small ledges due to weathering. Outcrop in small stream valley about 0.5 mile (0.8 km) northeast of the intersection of State Roads 834 and 835, northeastern Mount Hermon quadrangle.

are from 1.2 to 11.8 inches (3.0 to 30.0 cm) thick and average thickness is about 4.7 inches (12.0 cm). Shale and mudstone beds are generally slightly thicker than sandstone beds, and many show thin and medium laminations. Sandstone beds commonly display an upward coarsening in grain size. The most common type is composed of silty claystone or shale at the bottom that is gradationally overlain by very fine grained, thinly laminated muddy sandstone. This grades upward into medium-grained sandstone, which in turn grades into very coarse-grained pebbly sandstone or granule conglomerate at the top. The contact with the overlying mudrock is sharp and planar. Minor sedimentary structures in this facies include oscillation and current ripple marks, small-scale tabular cross-stratification, burrow casts, primary current lineations, and carbonized wood chips.

Sandstone ranges from fine- to very coarse grained aikose and subarkose; most however, is fine and medium grained. It is moderately to poorly sorted and texturally submature and immature. The majority of grains are subangular with some larger subrounded grains. Porosity is low due to tight grain packing.

Average mineral composition for five samples of sandstone from the mudrock facies is shown in Table 4. The rocks are composed chiefly of quartz and feldspar with minor rock fragments, mica, and matrix. Potassic feldspar is more abundant than plagioclase, and the quartz to feldspar ratio averages 2.5. Except for microcline, much of the potassic feldspar and plagioclase is sericitized. Authigenic chlorite is present as a replacement of clay matrix and sparry calcite as a void filling in one sample. Other minerals include tourmaline, zircon, kyanite, staurolite, garnet, and opaque minerals. The light and heavy minerals composing the sandstone suggest a source area west of the basin because the Fork Mountain Formation contains such high-grade metamorphic minerals immediately west of the basin whereas metavolcanic rocks to the east do not.

Table 4.—Composition of five sandstone samples from the mudrock facies of the Dry Fork Formation.

Mineral	Average (percentage)	Standard deviation (percentage)	Range (percentage)
Common quartz	18.3	±10.0	3.5-27.5
Composite quartz	44.6	± 9.4	31.0-56.0
Sutured quartz	0.8	± 0.8	0 - 2.0
Orthoclase	4.5	± 2.2	1 - 6.5
Microcline	3.6	± 4.1	0 - 9.0
Perthite	8.6	± 3.6	4.7-13.5
Plagioclase	10.5	± 0.8	9.0-11.3
Detrital micas	0.6	± 1.3	0 - 3.0
Coarse foliated rock fragments	2.4	± 2.7	0 - 5.5
Coarse nonfoliated rock fragments	0.4	± 0.9	0 - 2.0
Fine foliated rock fragments	0.1	± 0.2	0 - 0.5
Authigenic chlorite	1.0	± 2.2	0 - 5.0
Calcite cement	0.2	± 0.4	0 - 1.0
Matrix	4.1	± 5.0	0.5-12.5
Others	0.3	± 0.4	0 - 1.0

The abundant clay- and silt-size particles in the mudrock facies show that considerable weathering and soil formation had taken place in the source area prior to the erosion and deposition of the facies. Fine-grain size, uniformly even stratification, and thin laminations plus the paucity of ripple marks and other current-produced sedimentary structures in the mudrock facies suggest deposition below wave base in a lake that was formed by damming the logitudinal drainage of the basin. The absence of burrows coupled with the presence of pyrite and delicate laminations imply reducing conditions noxious to bottom dwellers. Interbedded sandstone and fine conglomerate that display thin, uniformly even stratification and coarsening-upwards sequences are interpreted as deltaic deposits that formed along the lake margins.

The best exposures of this facies are found along small northwestward-flowing streams that cross the outcrop belt. Other exposures are located in a drainage ditch on the northeast side of State Road 834 north-moderate yellowish brown, and being more resistant than the mudrock, stands out as small ledges in ditches and stream banks (Figure 20).

Rocks of the mudrock facies have uniformly even, thin and medium, parallel bedding (Figure 20). Beds

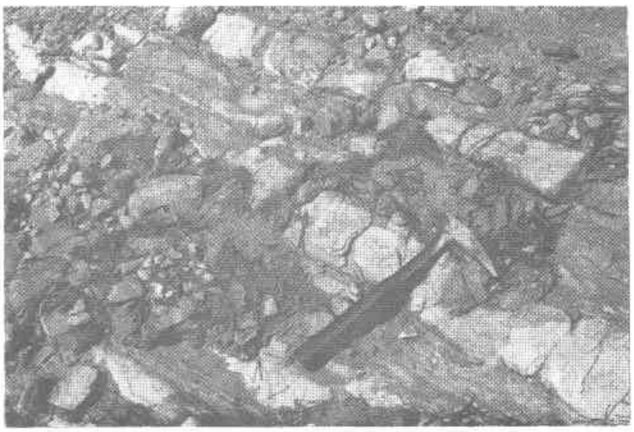

Figure 20. Sandstone and shale of Dry Fork mudrock facies. Note how resistant, thin, even-bedded sandstone stands out in relief as small ledges due to weathering. Outcrop in small stream valley about 0.5 mile (0.8 km) northeast of the intersection of State Roads 834 and 835, northeastern Mount Hermon quadrangle.

are from 1.2 to 11.8 inches (3.0 to 30.0 cm) thick and average thickness is about 4.7 inches (12.0 cm). Shale and mudstone beds are generally slightly thicker than sandstone beds, and many show thin and medium laminations. Sandstone beds commonly display an upward coarsening in grain size. The most common type is composed of silty claystone or shale at the bottom that is gradationally overlain by very fine grained, thinly laminated muddy sandstone. This grades upward into medium-grained sandstone, which in turn grades into very coarse-grained pebbly sandstone or granule conglomerate at the top. The contact with the overlying mudrock is sharp and planar. Minor sedimentary structures in this facies include oscillation and current ripple marks, small-scale tabular cross-stratification, burrow casts, primary current lineations, and carbonized wood chips.

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Table 4.—Composition of five sandstone samples from the mudrock facies of the Dry Fork Formation.

Mineral	Average (percentage)	Standard deviation (percentage)	Range (percentage)
Common quartz	18.3	±10.0	3.5-27.5
Composite quartz	44.6	± 9.4	31.0-56.0
Sutured quartz	0.8	± 0.8	0 - 2.0
Orthoclase	4.5	± 2.2	1 - 6.5
Microcline	3.6	± 4.1	0 - 9.0
Perthite	8.6	± 3.6	4.7-13.5
Plagioclase	10.5	± 0.8	9.0-11.3
Detrital micas	0.6	± 1.3	0 - 3.0
Coarse foliated rock fragments	2.4	± 2.7	0 - 5.5
Coarse nonfoliated rock fragments	0.4	± 0.9	0 - 2.0
Fine foliated rock fragments	0.1	± 0.2	0 - 0.5
Authigenic chlorite	1.0	± 2.2	0 - 5.0
Calcite cement	0.2	± 0.4	0 - 1.0
Matrix	4.1	± 5.0	0.5-12.5
Others	0.3	± 0.4	0 - 1.0

The abundant clay- and silt-size particles in the mudrock facies show that considerable weathering and soil formation had taken place in the source area prior to the erosion and deposition of the facies. Fine-grain size, uniformly even stratification, and thin laminations plus the paucity of ripple marks and other current-produced sedimentary structures in the mudrock facies suggest deposition below wave base in a lake that was formed by damming the logitudinal drainage of the basin. The absence of burrows coupled with the presence of pyrite and delicate laminations imply reducing conditions noxious to bottom dwellers. Interbedded sandstone and fine conglomerate that display thin, uniformly even stratification and coarsening-upwards sequences are interpreted as deltaic deposits that formed along the lake margins.

The best exposures of this facies are found along small northwestward-flowing streams that cross the outcrop belt. Other exposures are located in a drainage ditch on the northeast side of State Road 834 northwestward from its intersection with State Road 835 to the western edge of the basin and in roadcuts on both sides of State Road 835 at 1.2 miles (1.9 km) northeast of its intersection with State Road 834.

DIABASE DIKES

Diabase dikes intrude all major rock units and trend between N. 25° W. and N. 15° E. Mean (vector) orientation for all dikes is N. 4.7° W. with a standard deviation 9.1° (Figure 21). The dikes are up to 4.0 miles (6.4 km) long and have a maximum width of 550 feet (168 m). Most are less than a mile long and average width is about 75 feet (23 m). Because of their relatively high magnetite content in comparison with other rocks in the area the dikes produce narrow linear magnetic anomalies up to 500 gammas on the aeromagnetic map of the region (U. S. Geological Survey, 1971).

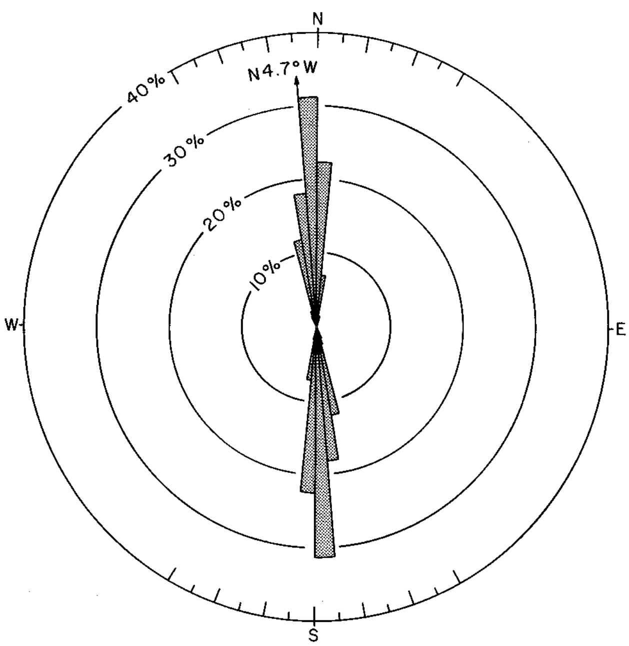

Figure 21. Rose diagram of 121 diabase dikes in Blairs, Danville, Mount Hermon, and Ringgold quadrangles.

The dikes generally weather to grayish-orange and dark yellowish orange, clayey soil in which spheroidally weathered boulders and cobbles of diabase are embedded. Fresh diabase is dark gray to black. Texture of the dike rocks is variable, ranging from aphanitic to very coarse grained. Near their chilled margins the dikes are aphanitic and become progressively coarser grained toward their interiors (R-5410). Thick dikes are always coarse and very coarse grained except for their thin outermost margins, which are aphanitic.

A sample from one of the dikes (R-6696) is a typical olivine diabase. The rock is coarse grained and composed of olivine, 2.7 percent; micropegmatite, 0.3 percent; plagioclase, 54.8 percent; augite, 30.9 percent; opaque minerals, 4.3 percent; and alteration products, 7.0 percent. The texture of the rock is subophitic to diabasic with optically noncontinuous augite crystals averaging 0.35 mm in length filling the interstices between euhedral plagioclase laths that average 0.85 mm long. Euhedral olivine crystals up to 0.5 mm long also occur between the plagioclase crystals. The plagioclase is partially altered to sericite and the mafic minerals are altered along cleavage planes and cracks to pale-green fibrous antigorite, iddingsite, and chlorite.

QUATERNARY SYSTEM

TERRACE DEPOSITS

Thin remnants of fluvial terrace deposits are preserved on gentle slopes and flat-topped hills above present-day streams. They are most extensive and best exposed along the lower flanks of White Oak Mountain at elevations of between 600 and 700 feet (183 and 213 m) (Plate 2), on flat-topped hills north of the Dan River including Mountain Hill (Plate 2), and along slopes on either side of Cane Creek east and north of Ringgold as far north as Kentuck.

The terrace deposits are composed of rounded pebbles and cobbles of quartz and quartzite mixed with varying amounts of sand and clay. Due to weathering, the upper part of the deposits is bleached white and many upper surfaces of quartz pebbles and cobbles are etched and pitted. Where present-day streams have eroded into these deposits, a layer of dark reddish brown clay with irregular light-gray mottles is exposed at the base of the bleached coarser zone. Deposits along the southeast side of White Oak Mountain contain angular cobbles and boulders of silicified wood derived from the Dry Fork Formation.

Terrace deposits at lower levels along the Dan River contain gray to yellowish-gray, fine sandy clay that at some localities has a well-developed red and gray mottling near the base. This material dries to a fine, slightly cemented gray, pebbly clayey sandstone.

ALLUVIUM

The valleys of most large streams are filled or partially filled with alluvium (Plates 1, 2), the base of which generally consists of poorly stratified and sorted pebble- to boulder-size quartz and quartzite clasts interbedded with coarse, poorly sorted sands and silts. At some localities the basal part contains mottled gray and yellow, micaceous or bluish-gray, sticky, silty clay.

The basal part grades upwards into medium-grained, cross-bedded sands that are overlain by very fine, laminated sands containing abundant organic debris. The sequence is capped by a thin soil zone.

Four exploratory borings located in the flood plain of the Dan River on the north side at the bridge of U. S. Highway 29 (Main Street) encountered from 5.7 to 11.8 feet (1.7 to 3.6 m) of alluvium overlying hornblende gneiss. Excavations for a sewer line that runs along the north side of the Dan River from Robertson Bridge downstream beyond the Main Street bridge, show that the alluvium between Riverside Drive and the river is from 15 to 25 feet (5 to 8 m) thick.

CATACLASTIC ROCKS

Cataclastic rocks consisting of cataclasite and microbreccia (Higgins, 1971) occur as discontinuous lenses adjacent to the margins of the Danville basin (Plate 2), along the shear zone at Ringgold (Plate 1), and along several minor shear zones that cut metamorphic rocks to the southeast of the Danville basin.

The lenses of cataclastic rock along the northwestern margin of the basin are up to a mile long and 1,000 feet (305 m) wide. Exposures of the cataclastic rocks along the Chatham fault are limited to a few roadcuts and stream bottoms because of an extensive cover of terrace deposits.

Weathered microbreccia is exposed in a roadcut on the north side of State Road 834 between 350 and 500 feet (107 and 152 m) southeast of White Oak Creek (Plate 2). It weathers grayish orange and dark yellowish orange. The microbreccia and cataclasite are extremely well indurated and are medium light gray with very light gray porphyroclasts. The microbreccia (R-6698) is extensively fractured and composed chiefly of light-gray angular fragments greater than 0.5 mm long (Figure 22). The fragments are mainly intergrowths of strained quartz and microcline with minor perthite and plagioclase. Dark-gray to opaque aphanitic material, silt, and very fine grained, sand-sized angular fragments of quartz and feldspar form the mortar between larger fragments. Many fractures are filled with light-green, microcrystalline chlorite that contains numerous small crystals of pyrite, mostly altered to limonite. Quartz veins up to several feet long and an inch wide commonly cut the cataclastic rocks. The quartz, chlorite, and pyrite probably resulted from later hydrothermal mineralization selectively concentrated in the fault zones (Higgins, 1971).

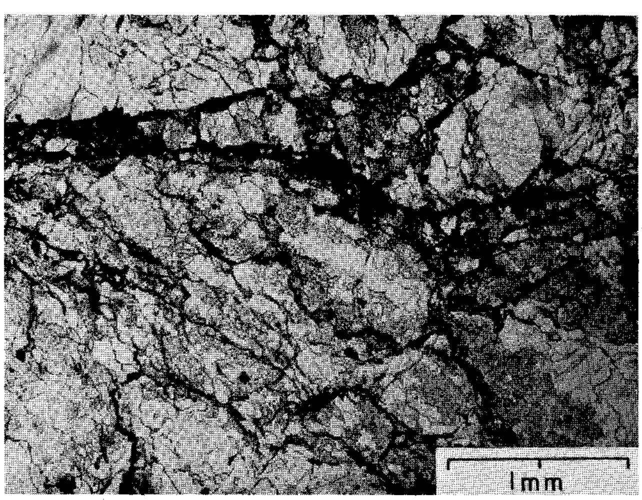

Figure 22. Photomicrograph of microbreccia (R-6698) showing angular quartz and feldspar fragments and abundant random fractures filled with chlorite (dark). From outcrop near White Oak Creek about 0.4 mile (0.6 km) northwest of Pleasant Gap, Mount Hermon quadrangle. Plane-polarized light.

The paucity of mica in the cataclastic rocks along the northwestern margin of the basin make it unlikely that they could have been derived from shearing of the Fork Mountain Formation. The gradual transition from cataclasite and microbreccia into Dry Fork conglomerate and sandstone and the abundance of coarse feldspar, quartz, and quartz-feldspar gneiss fragments in these rocks show that the cataclastic rocks were produced by intense shearing of Dry Fork conglomerate and sandstone.

Cataclastic rocks along the shear zone near Ringgold (Plate 1) occur in discontinuous lenses that are generally less than 30 feet (9 m) wide and a few hundred feet long. They are intergradational and have poorly defined margins with the enclosing sheared metavolcanic country rocks. Microbreccia, similar to that along the northwestern boundary of the Danville basin, is exposed in the bottom of a small stream about 700 feet (213 m) south of the intersection of State Roads 726 and 734 at Ringgold (R-5409, Plate 1). A similar body along the Southern Railway about 0.7 mile (1.1 km) northeast of Ringgold seems to be cut by a diabase dike swarm. New mineral growth, including chlorite, muscovite, and analcite may be related to contact metamorphism by the dikes. Late mineral growth is also associated with a microbreccia body at the Fairgrounds Shopping Center (Plate 2) in Danville. Calcite, epidote, and stilbite have been identified in a sample from this locality. Cataclasite is exposed in a creek bottom 100 feet (30 m) north of State Road 730, and about 0.7 mile (1.1 km) west along State Road 730 from its intersection with State Road 729. The rock is dull brick red mottled with greenish splotches. It is very fine grained, massive and compact, resembling jasper on the waterworn surfaces. The strong red coloration obscures mineral grains and angular fragments in hand specimens. A thin section shows, however, that the rock is composed of about 80 percent fine matrix (less than .02 mm) predominantly composed of quartz with some finely crushed mica, scattered, irregular masses of calcite, Four exploratory borings located in the flood plain of the Dan River on the north side at the bridge of U. S. Highway 29 (Main Street) encountered from 5.7 to 11.8 feet (1.7 to 3.6 m) of alluvium overlying hornblende gneiss. Excavations for a sewer line that runs along the north side of the Dan River from Robertson Bridge downstream beyond the Main Street bridge, show that the alluvium between Riverside Drive and the river is from 15 to 25 feet (5 to 8 m) thick.

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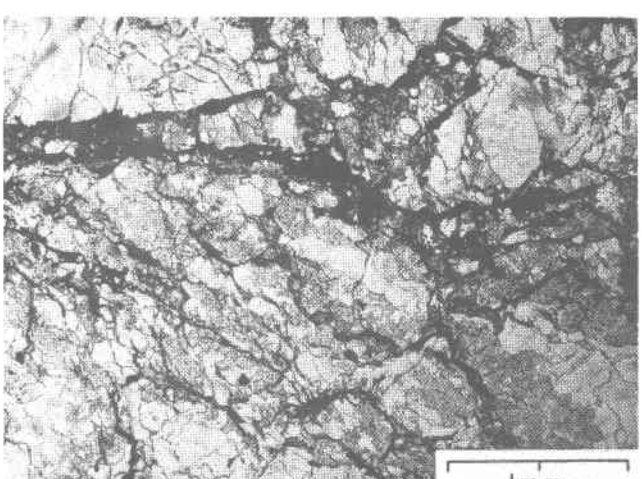

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STRUCTURE

SMITH RIVER ALLOCHTHON

The rocks in the northwestern part of the Mount Hermon quadrangle are part of the Smith River allocthon. In its type area this allochthon is bounded by the Bowens Creek fault to the northwest and the Ridgeway fault to the southeast (Conley and Henika, 1973). The Chatham fault (Plate 2) forms the southeastern boundary of the allochthon in the area west of Danville. The allochthon is probably a fault-bounded segment of a large nappe, characterized by large recumbent isoclinal folds in which stratified metamorphic rocks have been warped so that the axial planes of early folds are subhorizontal. These axial planes have in turn been folded. The antiforms and synforms delineated within the allochthon (Plate 2) during the present study are thought to be part of this later set of folds. They are open, arch- and trough-shaped structures delineated by reversals of schistosity in the Fork Mountain Formation. The axial traces of these folds are also arcuate, suggesting that they have been crosswarped by an even later series of folds.

FOLDS IN METAMORPHOSED VOLCANIC-SEDIMENTARY ROCKS

The metamorphosed volcanic-sedimentary rocks have complex, polyphase fold patterns similar to those delineated in the Smith River allochthon and may be part of a large nappe similar to that described in the Smith River allochthon. At least four separate generations of folds are present and have largely caused the complex outcrop patterns of these rocks. The axial traces of successive generations of folds and structural elements associated with them are shown symbolically on the geologic maps (Plates 1, 2).

Figure 23. First-generation, recumbent isoclinal folds with northwestward-trending axial plane. Saprolite exposure of metamorphosed mafic and felsic volcanic rocks in the northwestern part of the Ringgold quadrangle along spur line of Southern Railway at site of St. Regis school.

Figure 24. Broad third-generation antiform. Saprolite exposure of metamorphosed mafic and felsic volcanic rocks south of St. Regis school. Earlier recumbent isoclines occur higher in section and to right of center. Resistant layers are mafic in composition and probably these layers are the same bed repeated by earlier recumbent isoclines.

Smaller first-generation folds are extremely stretched-out isoclines with rounded hinges and gently inclined, originally northwestward-trending axial surfaces. They can be recognized in the primary layering of several outcrops (Front Cover, Figures 23-25). Because their

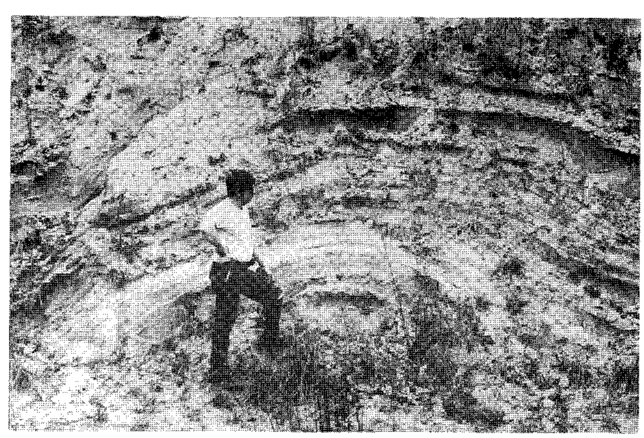

Figure 25. Third-generation, open, northeastward-trending antiform. Saprolite exposure of metamorphosed mafic and felsic volcanic rocks along Southern Railway south of St. Regis school. Earlier recumbent isoclinal fold at top center. Resistant layers are of mafic composition.

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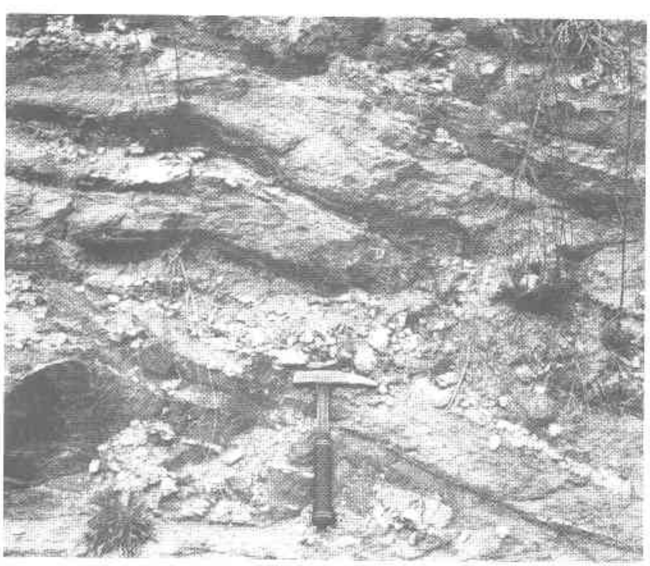

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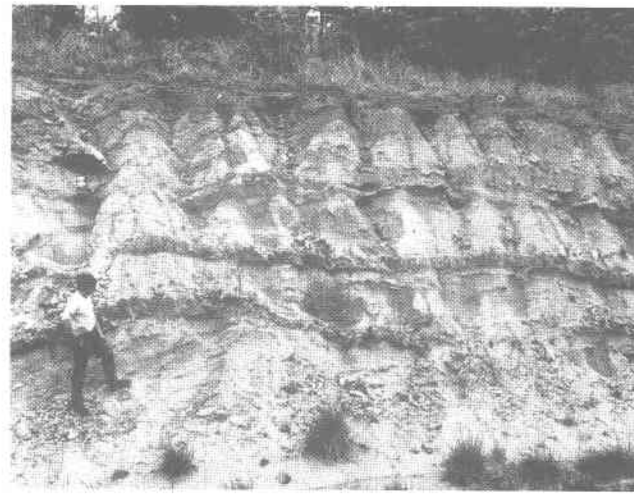

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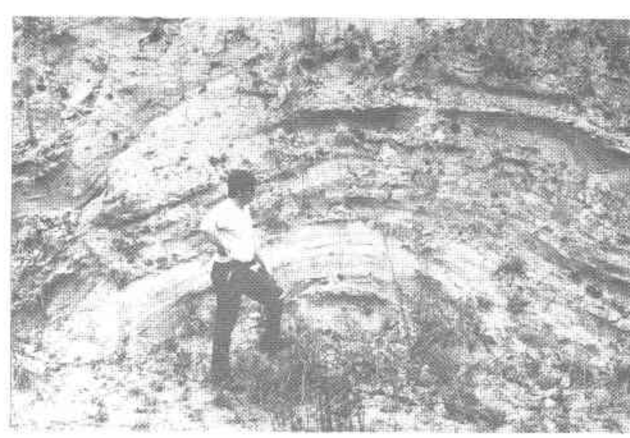

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northwestward-trending axial surfaces have been refolded about strongly developed northeastward-trending fold axes, the first generation folds are commonly delineated by closed cresent-shaped to mushroom-shaped interference patterns similar to those described as "type 2" patterns by Ramsay (1967, p. 525-530). Folds with this characteristic pattern are exposed in a spillway below the farm pond approximately 0.4 mile (0.6 km) south of the intersection of State Roads 743 and 744 (Plate 1). Larger first generation folds can be recognized by map patterns, such as the contact between the felsic upper unit and the interlayered mafic and felsic lower unit of metamorphosed volcanic-sedimentary rocks in the Glenwood section of the Ringgold quadrangle.

The second generation folds are tightly to moderately open with gently to moderately inclined northeastward-trending axial surfaces. Their hinges are generally more elongate and pointed than the earlier folds and in some localities a strong axial-plane slip cleavage can be traced through the hinge. Many second-generation fold hinges can be seen in cuts along the Dan River in Danville. One is especially well exposed at the southeastern end of a large cut behind Riverside Shopping Center. Second-generation folds also can be seen in the cuts along Poplar Street (Front Cover). Refolded second-generation folds are recognized by a characteristic hook-shaped pattern referred to as a "type 3" by Ramsay (p. 530-534). It results from interference between two fold systems that have parallel axes but the axial surfaces of the earlier folds are gently inclined, whereas axial surfaces of the latter are steeply inclined. Smaller folds with such patterns are exposed in a large cut along Riverside Drive in Danville approximately 0.2 mile (0.3 km) northeast of Robertson Bridge. A large-scale example of such a pattern is a second-generation synform bent around a third-generation synform, forming the hook-like outcrop pattern near the intersection of U. S. Highway 29 and State Road 726 (Plates 1, 2). Third-generation folds are northeastward-trending open structures with nearly vertical axial surfaces. They seem to be entirely postmetamorphic and do not have a strongly developed axial plane cleavage or schistosity. Small third-generation folds are exposed in deep cuts along the spur line of the Southern Railway near the site of St. Regis School in the northwestern part of the Ringgold quadrangle (Plate 1). Early isoclinal folds can be traced around hinges of third generation antiforms at this locality (Figures 24, 25).

Large third-generation folds are the most conspicuous structures in the area and generally determine the distribution of the major rock units. The Shelton Formation probably forms the crystalline core (Billings, 1972, p. 52, Figure 3-8) of a large, first-generation recumbent anticline, that has been refolded by second- and third-generation folds. The core of this nappe now has the configuration of dome- and basin-shaped bodies along the axial traces of large third-generation antiforms. The type locality of the Shelton south of Danville (Plate 2) is contained in one of these domes, and another dome is located in the central part of the Blairs quadrangle. Crescent- and mushroom-shaped basins typical of the "type 2" interference (Ramsay, 1967, p. 525-531) include the complex northwestward-verging basin which partly wraps around the southern culmination of the large dome in Blairs and Danville quadrangles and the mushroom-shaped basin delineated by metamorphosed volcanic-sedimentary rocks near Glenwood (Plate 1) that lies along the northeastern extention of the third-generation antiform at Shelton.

Tobisch and Glover (1971) proposed a large refolded nappe in the Milton 15-minute quadrangle that adjoins the study area along its eastern margin. They have traced this structure by reconnaissance into the Blairs quadrangle and outlined its culmination. Detailed mapping and structural analysis made during this study confirms the existence of such a fold. The detailed outcrop pattern is, however, not the same as that depicted by Tobisch and Glover (1971, Figure 2) or Tobisch (1972). The major difference involves the termination of the Shelton Formation, an equivalent to the quartz-monzonite gneiss of Tobisch (1972). The gneiss is not terminated in a simple northeastward-trending fold nose as previously proposed. The inverted anticlinal core (Tobisch and Glover, 1971, Figure 2; Tobisch, 1972) is continuous to the southwest in the Blairs quadrangle (Plate 1) and the nappe is terminated farther west in the Blairs and Danville quadrangles (Plates 1, 2) than shown by Tobisch and Glover (1971).

Fourth-generation folds are open, northwestward-trending shear structures associated with northwestward-trending, spaced cleavage. Smaller folds of this generation are poorly exposed but some have been noted in the Blairs quadrangle along the Southern Railway south of the crossing of State Road 721, at the stockyard south of State Road 721 east of Edward Branch, and in side ditches along State Road 695 north of Fall Creek.

The fourth-generation folds may be associated with post-Triassic block movement along northward- to northwestward-trending shear planes on both sides of the Danville basin. Examples include the broad northwestward-plunging cross-warp that has arched the northwestern flank of the Shelton Formation dome in the central part of the Blairs quadrangle; the arcuate trend of axial traces of folds in the Fork Mountain Formation northwest of the Danville basin in the Mount Hermon quadrangle; and the updoming of the Shelton Formation beneath the Triassic basin forming a colon cross structure (Reinemund, 1955) at the narrowest point of the Danville basin along Sandy Creek (Plate 2).

CHATHAM FAULT

Meyertons (1963, p. 38) named the Chatham fault, a high-angle normal fault that has a dip to the south and southeast and flanks the entire northwestern border of the Danville basin. He (1963, p. 38) suggested that the fault zone was only a few feet wide, and that movement took place predominantly along a single fault plane. However, numerous small fractures and shears, and broad bands of cataclasite and microbreccia, along the northwestern margin of the basin show that it is a wide zone.

The fault zone is made up of several intersecting faults whose individual traces are straight and have a trend between N. 25° E. and N. 55° E. The average trend is N. 45° E., which is parallel to the long axis of the basin and the strike of strata within it. The fault planes are not exposed within the mapped area, but Mayertons (1963, p. 38) believes that they have a dip of nearly 65° SE.

The normal faults that compose the Chatham fault zone are clearly postdepositional. They are believed to have formed to the southeast (i. e., towards the basin) of normal faults that bounded the northwest basin margin in Triassic time. Features that suggest this include the narrow outcrop belt of Triassic strata that is about half that of the rest of the basin and the truncation of the mudrock facies of the Dry Fork Formation by postdepositional faults along the northwestern basin margin (Plate 2).

The postdepositional faults probably formed concurrently with tilting of strata to the northwest after deposition; both resulted from updoming of the entire region in the Early Jurassic (Ballard and Uchupi, 1975). The faulting occurred basinwards of the original northwestern margin and downdropped the sedimentary wedge now preserved. Triassic strata on the upthrown blocks to the northwest were subsequently removed by erosion. The narrow outcrop width suggests greatest postdepositional uplift and erosion took place in the narrow part of the basin. The coarse clastic rocks we now see are the marginward-facies equivalents of finer-grained strata preserved in wider parts of the basin toward the southwest.

FAULTS ALONG SOUTHEASTERN MARGIN OF DANVILLE BASIN

A series of intersecting faults with a combined total length of about 5 miles (8 km) extends northeastward along the southeastern margin of the Danville basin from the Danville quadrangle to just southwest of Mount Hermon in the Mount Hermon quadrangle (Plate 2). The northward- to northeastward-trending fault traces are relatively straight, which suggest that they are normal faults. Meyertons (1963, p. 40) believes they are downthrown to the basin and have steep northwestward dips.

Evidence supporting a fault contact includes truncation of coarse cobble and boulder conglomerate beds along the basin margin; the straight contact between the conglomerate beds and adjacent metamorphic rocks; local shear zones in the conglomerate; and microbreccia in metamorphosed volcanic-sedimentary rocks along the southeastern border of the basin.

The time of formation of the faults along the southeastern margin of the Danville basin either coincided with greater fault movement along the northwestern margin, resulting in tilting of Triassic strata, or postdated the northwestward tilting. If the faults had formed prior to northwestward tilting they would have been rotated westward by an amount equal to the tilting and the fault planes would have a steep dip toward the southeast. It is clear in either case that these faults do not correspond to the original southeastern margin fault.

MAJOR SHEAR ZONE IN RINGGOLD QUADRANGLE

A linear band of cataclastic rock has been traced for more than 7 miles (11 km) along a trend of approximately N. 80° E. from just north of Glenwood through Ringgold to the eastern edge of the Ringgold quadrangle (Plate 1). Cataclastic rock of the shear zone is exposed discontinuously along the Southern Railway and in stream beds south of Ringgold.

Cross folding or kinking of structures in units traced across the Dan River in Danville show that rocks northwest of the shear zone have been laterally displaced toward the southwest relative to rocks southeast of the zone. No single fault trace has been recognized. Several minor faults along the zone have steep dips toward the northeast, to the southwest, or are vertical and show diverse movement. The shear zone must predate the emplacement of Mesozoic dikes that can be traced across the shear zone.

CROSS FAULTS AND SHEAR ZONES

A triangular-shaped horst is located in the west-central part of the Mount Hermon quadrangle (Plate 2) along the northwestern margin of the Danville basin. The structure is produced by a cross fault on the southwest side that has a trend of N. 50° W. and appears to have a steep dip to the northeast, by a seemingly vertical cross fault on the east side that has a trend of due north, and by an arcuate fault segment on the northwest side. The uplift and tilting associated with this horst has arched the floor of the Danville basin as shown by contacts of the Shelton Formation and the metamorphosed volcanic-sedimentary rocks, both northwest and southeast of the basin as well as by offsets of the faults along both the northwestern and the southeastern margins of the basin. About 400 feet (122 m) of throw is shown by the offset of the base of the Rich Acres sill along the southwestern cross fault. Although the individual fault planes are covered by thick residual soil and alluvium along Sandy Creek and its tributaries, microbreccia and cataclasite have been found in float along the traces of the faults along both the southwestern and eastern margins.

The arcuate fault segment that forms the northwest boundary of the horst appears to have a dip to the southeast as based on cleavage in schistose rocks adjacent to the fault. Metavolcanic rock of lower greenschist facies and graphitic mica schist has been thrust upon kyanite-bearing Fork Mountain schist across the fault. Thus, probably the metamorphosed volcanic-sedimentary rocks structurally underlie the Fork Mountain Formation along the northwestern margin of the Danville basin, although this relationship may result from a prior down-dropping of the floor of the basin at least 7,000 feet (2,134 m) along an ancestral fault of Triassic age. It is possible that the arcuate northwestern boundary fault of the horst is a reactivated segment of such a fault.

Similar block movements southeast of the Danville basin have produced large kink (fourth-generation) folds delineated by displaced contacts of metamorphosed volcanic-sedimentary rocks in the south-central part of the Mount Hermon quadrangle. Two shear zones, one along Sandy Creek and one along Little Sandy Creek may become cross faults at depth. Each is about 200 feet (61 m) wide and can be traced for more than a mile as topographic lineaments along a N. 12° E. trend. Rocks between the two shear zones seem to have been down-dropped, suggesting a graben structure. Slickensides along these shear zones have gentle plunges to the northeast or to the southwest and may be the result of lateral displacement. Deformation along these zones cannot be related to any particular plane within the zones but rather seems to have been concentrated along preexisting joints and cleavage.

DANVILLE BASIN

By Paul A. Thayer

After deposition the Triassic sediments within the Danville basin were tilted to the northwest, forming a northwestward-dipping monocline. The plots of 138 poles to stratification plotted and contoured on an equal-area net (lower hemisphere, Figure 26) clearly

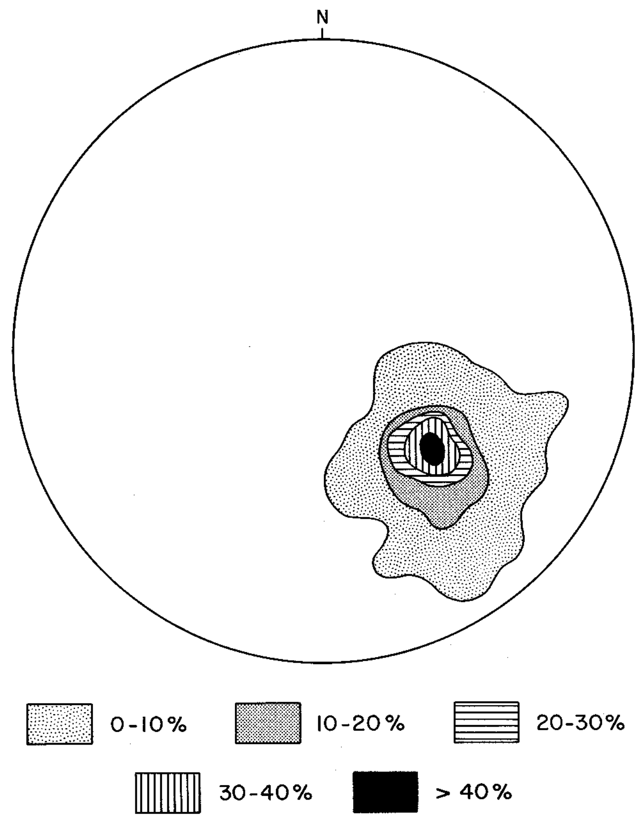


Figure 26. Contour diagram showing the attitude of stratification planes in the Dry Fork Formation. Lower hemisphere plot of 138 poles to bedding planes.

show that bedding attitudes are relatively uniform within this part of the Danville basin. The mean strike of bedding is N. 44° E. with a standard deviation of ± 11°. Bedding has a dip toward the northwest at an average of 44° with a standard deviation of ± 9°. The strike of bedding is generally parallel to the basin trend and the trace of the Chatham fault zone (Plate 2).

Meyertons (1963, p. 39) shows that older beds along the southeastern margin of the basin have a dip of about 5° steeper than younger beds near the northwestern fault margin. To test this a scatter plot of dip angle versus distance from the southeastern margin was prepared for the same 138 bedding attitudes shown in Figure 26 and a least-squares fit to the data points was computed (Figure 27). The scatter diagram shows that the angle of dip of Triassic strata remains relatively constant across the basin and actually steepens

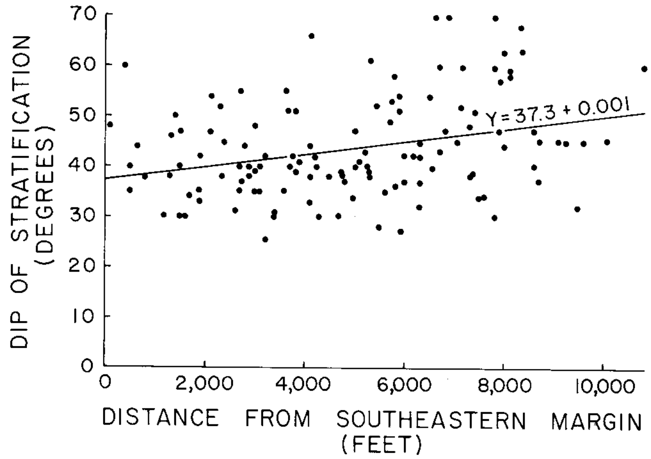


Figure 27. Scatter diagram of dip of stratification versus distance from southeastern margin of the Danville basin. Based on 138 measurements. Least-squares line is fitted to data points and equation (y on x) given above line.

slightly near the Chatham fault zone. However, in wider parts of the basin the dips progressively steepen toward the northwestern faulted margin.

Minor Faults

Normal faults with displacements ranging from a few inches to several feet are common in the Danville basin. Typically, they are marked by shear zones, quartz veins, and/or manganese-coated slickensides.

Two prominent sets of quartz veins, with average attitudes of N. 22° E., dip 55° SE. and N. 72° E., dip 60° SE. are present within 0.5 mile (0.8 km) of the western border of the Danville basin. Most are less than a foot (0.3 m) wide and 100 feet (30 m) long. These probably represent minor faults along which mineralizing solutions were later introduced.

Minor faults noted in the metamorphic rocks all show some movement, either displaced layering, crenulation, or grooves on a fault plane. The exact sense and amount of displacement is not shown for every fault. Where displacement along the small faults can be determined with certainly it is generally less than 6 feet (2 m).

An excellent exposure of several small faults occurs in a steep cut about 500 feet (152 m) south of the intersection of Riverside Drive with Arnett Boulevard along the north side of Poplar Street (Figure 28). A fault at this locality has laterally displaced the hinge of a recumbent fold. Grooves or slickensides on slip surfaces at this locality have a moderate plunge to the north.

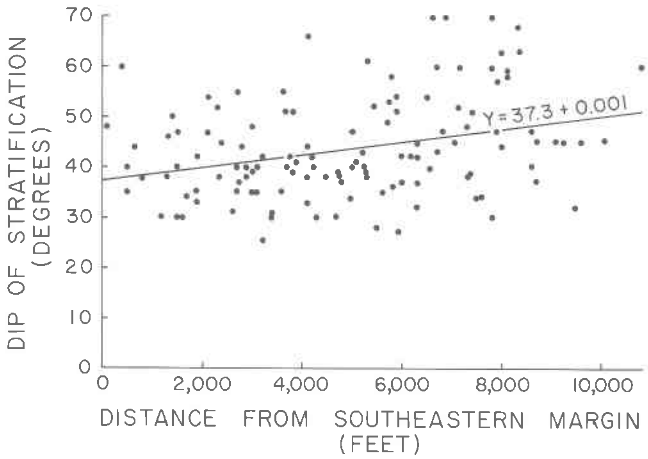
Joint Control of Diabase Dikes

Joint sets are well developed in all rock types of the Dry Fork Formation. A contour diagram (lower hemisphere) of 365 joint attitudes from widely scattered outcrops of the formation is shown in Figure 29. Two dominant and three minor joint sets are evident on the diagram. The attitudes of the major sets are N. 70° W., nearly vertical to vertical and N. 25° W., nearly vertical to vertical. Attitudes of the minor sets are N. 36° E., vertical; N. 55° E., vertical; and N. 85° E., vertical.

The joints are extension (tension) fractures that formed after the Triassic sedimentary rocks were tilted northwestward. If the joints had formed prior to monoclinal rotation of the beds, their attitudes would not be vertical or near vertical. The close correspondence between the attitudes of major joint sets (Figure 29) and the trend of diabase dikes (Figure 21) suggests that the dikes were injected along tensional fractures related to jointing. Because the dikes intrude relatively uniformly bedded rocks of considerable thickness and because the directions of the dikes do not change appreciably when they penetrate surrounding metamorphic rocks, there can be little doubt that the magma intruded tensional fractures.

Joints control many topographic features in the Danville basin. Dry Fork Creek in northeastern Mount Hermon quadrangle closely follows one of the major directions of jointing, and several of the right angle

Figure 28. Steeply southeastward-dipping fault plane. Outcrop of metamorphosed mafic and felsic volcanic rocks along Poplar Street south of Riverside Drive near north end of bridge over Dan River. Fault has displaced the hinges of first- and second-generation folds.



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Minor faults noted in the metamorphic rocks all show some movement, either displaced layering, crenulation, or grooves on a fault plane. The exact sense and amount of displacement is not shown for every fault. Where displacement along the small faults can be determined with certainly it is generally less than 6 feet (2 m).

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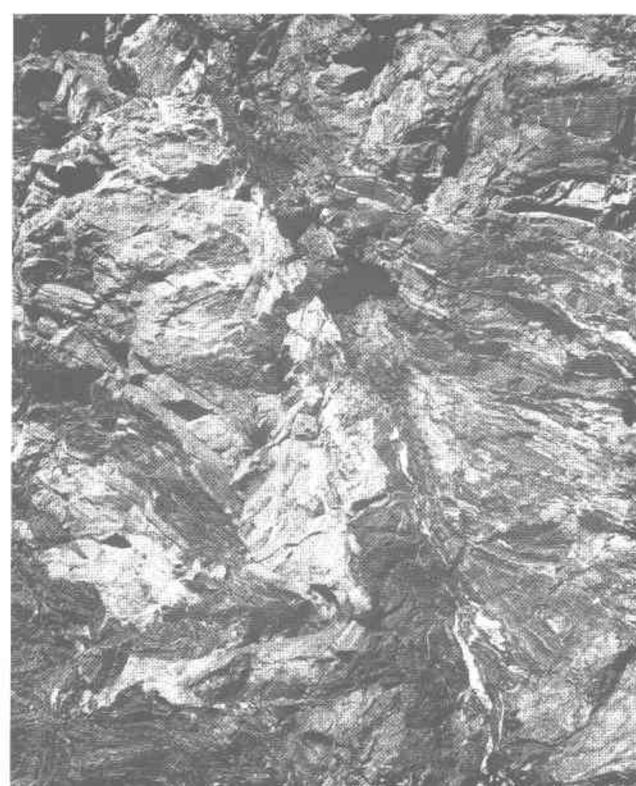

Figure 28. Steeply southeastward-dipping fault plane. Outcrop of metamorphosed mafic and felsic volcanic rocks along Poplar Street south of Riverside Drive near north end of bridge over Dan River. Fault has displaced the hinges of first- and second-generation folds.

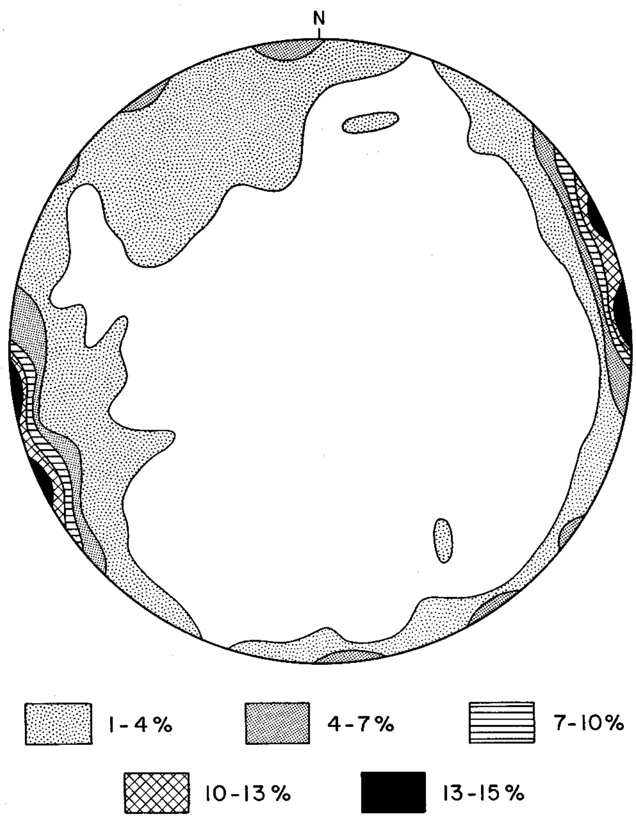

Figure 29. Contour diagram of poles to planes illustrating the attitude of joints in the Dry Fork Formation. Lower hemisphere pole to plane plot based on 365 attitudes.

bends in Sandy Creek near Lanier Mill are controlled by jointing. Many of the recesses in White Oak Mountain are parallel to joint sets.

ECONOMIC GEOLOGY

CRUSHED STONE

Rocks that are present or potential sources of crushed stone for coarse aggregate within the study area include Dry Fork sandstone, Shelton gneiss, and several rock types in the metamorphosed volcanic-sedimentary rock unit including massive felsic metatuff and felsic gneiss, massive biotite gneiss, hornblende gneiss, and epidote-hornblende gneiss.

The Vulcan Materials Company produces crushed stone from sandstone, conglomerate, and mudrock of the sandstone facies of the Dry Fork Formation in the extreme northeastern part of the Mount Hermon quadrangle on the northwestern side of White Oak Mountain (Plate 2, active quarry number 6). The long axis of the quarry is oriented northeast-southwest and closely follows the strike of the Dry Fork strata. Blasting along northwestward-facing dip slopes greatly facilitates removal of rock from the main quarry face, and the close proximity to U. S. Highway 29 allows easy access to nearby markets. Physical-test data for four samples from the quarry show the following (personal communication, Joe Gutierrez): specific gravity, 2.63 to 2.68; absorption, 0.3 to 0.8; and Los Angeless loss (500 revolutions), Grade A, 17.4 to 20.4 and Grade C, 19.9 to 28.5. The sandstone is chiefly arkose that is hard as a result of very dense packing of detrital grains and abundant secondary cementation by chlorite and calcite. Spherical concretions ("cannon balls" of quarrymen) between 4 and 6 inches (10 and 15 cm) long commonly occur within the sandstone and are so hard that they will not pass through the rock crusher. The concretions are composed of interlocking euhedral and subhedral calcite crystals up to several millimeters long that enclose and partially replace numerous smaller detrital grains.

Because of superior hardness, the sandstone facies of the Dry Fork Formation is a potential source of crushed stone throughout the Mount Hermon quadrangle. The most favorable areas are along the flanks of White Oak Mountain northeast of State Road 41, where steep slopes along the sides of the mountain could serve as natural quarry faces, thus facilitating blasting and removal of rock. Additionally, the close proximity to U. S. Highway 29 would provide easy access to nearby markets.

The Shelton Formation has been a favored source of crushed stone in the area because of its homogeneity, fresh exposures, small amount of overburden, and location close to a major population center. It has been quarried at two large abandoned quarries in the Blairs quadrangle (Plate 1, abandoned quarry numbers 1, 3) and crushed stone is currently produced from it by the Vulcan Materials Company at Shelton, North Carolina (just south of Danville along U. S. Highway 29). Standardized tests of materials from this quarry (personal communication, Virginia Department of Highways and Transportation, 1974) show specific gravity, 2.63; absorption, 0.3; Los Angeles loss, Grade B, 27.8; abrasion loss, Grade C, 29.8.

Massive felsic metatuff in the upper unit of metamorphosed volcanic-sedimentary rocks probably could be used for crushed stone. It has not been quarried probably because of its location away from the major transportation routes, the relatively deep chemical weathering of the rock, intense fracturing along the Danville basin, a cover of alluvial terrace deposits along White Oak Mountain and the resulting poor exposures, and competition with quarries near Danville (the major population center). The rock exposed in stream bottoms traversing the middle of the upper unit between Blairs and Mount Cross (Plate 1) is generally sound and hard due to the high quartz content of the crystal tuff. Samples of cuttings from water wells are very dense and have a conchoidal fracture. Because of its stratified nature, the felsic metatuff is not homogeneous over large areas and would require exploration to delineate massive beds suitable for quarrying. In the Blairs and Ringgold quadrangles, where the major interlayers of coarse mica schists occur in the gneiss, quarry sites would have to be carefully located to avoid these schist layers.

Massive biotite gneiss in the lower unit of the metamorphosed volcanic-sedimentary rocks has been quarried in the eastern part of Danville at the City Farm (Plate 1, abandoned quarry number 4; Steidtman, 1945, p. 77). The larger areas underlain by the massive to layered biotite gneiss are shown as a separate facies (gn) on Plates 1 and 2. The material is variable because of mica schist, quartzite, and mafic metavolcanic interbeds and development of a large quarry in this rock would require careful exploration to control quality of the stone.

Hornblende gneiss has been quarried by the City of Danville on a very small scale (Plate 1, abandoned quarry number 8). Similar material taken from cuts behind the shopping plaza at the old Danville Fairgrounds has been a local source of riprap. It is highly fractured and contains many veins of white granite as well as microbreccia, calcite, and zeolite. At other localities, such as along Cane Creek south of U. S. Highway 58, the hornblende-rich rocks are much more massive and are generally similar to the hornblende gneiss quarried by Vulcan Materials Company in Halifax County to the east of the report area.

Shale and Mudstone

Shale and mudstone of the Dry Fork Formation and their weathered products have previously been tested and evaluated for possible sources for brick, ceramic ware, and lightweight aggregate (Meyertons, 1963, p. 45-49). Results from other parts of the Danville basin show that the mudstone and shale of the Dry Fork mudrock facies are potential sources for such products. However, the limited outcrop area and high sand content of the mudrock facies within the study area are less favorable for commercial development.

Talc and Soapstone

Metamorphosed ultramafic rocks may be sources of soapstone and ornamental stone. The granular to schistose, greenish-gray rock is generally poorly exposed even in the larger bodies (such as that in Blairs quadrangle, Plate 1, R-6032) and would require extensive exploration to locate areas suitable for quarrying.

Kyanite and Sillimanite

Kyanite occurs as nodular masses in the Fork Mountain Formation (R-6061, R-6062) and kyanite and sillimanite are present locally in quartzite and quartz-rich mica schist layers in the lower unit of metamorphosed volcanic-sedimentary rocks. Although these rocks are poorly exposed and high concentrations of kyanite and sillimanite have been found at individual outcrops and as float from the unit, extensive exploration would be required to determine the potential of any particular area.

Sand

Sand deposits in the flood plains of the Dan River and the Sandy River have been worked intermittently for many years. The sand is extracted by draglines and generally trucked from the sites. One former producer used the sand in a concrete batch plant at the site (Plate 2, abandoned quarry number 10). The sand deposits generally occur where the flood plains of the rivers are widest and are subject to variation because of erosion and redeposition of sand during periods of flooding. Fine aggregate test data on sand from the Sandy River (personal communication, Virginia Department of Highways and Transportation, 1974) are specific gravity, 2.55; soundness loss 11.8.; sand equivalent, 94; and percent silica, 96.

Gold

Two areas not previously reported in the literature where gold has been prospected were found during the present study. Both contain several prospect pits that follow northeastward-trending quartz veins. At prospect 5 (Plate 2) sand and gravel in the stream below the prospect pits was panned and a few very small particles of gold were separated. Chips of mica schist and vein-quartz fragments were found on dumps around the prospect. A thin section of the mica schist (R-6052) consists almost entirely of fine sericite and seems to be an alteration of the country rock (biotite gneiss and mica schist of the Fork Mountain Formation).

Prospect 2 (Plate 1) in the metamorphosed volcanic-sedimentary rocks was not panned and no gold was visible at the various propects. According to local residents the area was prospected prior to the Civil War. A quartz vein that may be the source of the gold is exposed in a small creek southeast of the pits. The vein is parallel to the foliation of mica schist and gneiss beds in the lower unit of the metamorphosed volcanic-sedimentary rocks.

ENVIRONMENTAL GEOLOGY

The geology of a region involves studies of the physical, mineralogical, and chemical characteristics of the rocks and their stratigraphic relationships, structural attitude, and economic potential. Environmental geology may be defined as the application of geologic factors and principles to the problems created by human occupancy and use of the physical environment. To produce an overall long-range plan for the most efficient and beneficial use of the land, all factors of environmental science must be considered.[1]

The basic human requirements for food and shelter must be available from the physical environment. Areas where food can be found or produced depend on a variety of factors such as kind of soil as influenced by physical and chemical properties of the bedrock; presence, quality, and quantity of water; climate; and the topography of the land's surface. Living in a modern civilization requires mineral resources, stable building sites, and waste-disposal capability. To the older necessities, modern man has added the desire for recreational facilities with their special environmental problems.

Nine environmental geology units having similar properties of soil[2] residuum[3] and bedrock are tabulated in the explanations of Plates 1 and 2 and in Table 5. Observed lithology, slope stability, erodibility, and response to excavation were considered in the delineation of these units in conjunction with the geologic maps. Modified-land areas, the locations of sheared and brecciated rocks, rockfall areas, and liquid- and solid-waste disposal sites are outlined on the geologic maps (Plates 1, 2). Descriptions of soils were adapted from the soil survey of Pittsylvania County (Kirk and others, 1922) and unpublished soils data was furnished by the Virginia Department of Highways and Transportation.

Table 5.—Units with similar geologic factors affecting land modification in the Blairs, Mount Hermon, Danville, and Ringgold quadrangles.

Unit	Geologic formation
Unit 9	Alluvium
Unit 8	Terrace deposits
Unit 7	Diabase dikes
	Dry Fork Formation:
Unit 6	Mudrock facies
Unit 5	Conglomerate facies
Unit 5	Sandstone facies
	Metamorphosed volcanic-sedimentary rocks:
Unit 4	Upper unit
Unit 3	Fork Mountain Formation
Unit 2	Rich Acres Formation
Unit 2	Ultramafic rocks
	Metamorphosed volcanic-sedimentary rocks:
Unit 2	Lower unit
Unit 1	Shelton Formation

Plates 1 and 2 are guides to units with similar geologic factors affecting land modification. However, as some of these units vary internally, a detailed evaluation of individual sites by professional personnel is recommended. The maps and the descriptions of the units should be of use to planners, developers, conservationists, and others in making decisions concerning the long-range use of land within these four quadrangles.

UNIT 1

Unit 1 consists of bedrock, residuum, and soils derived from the Shelton Formation. It occurs in three elongate areas northeast of Danville (Plate 1) and along Sandy Creek northwest of Danville, in an area that underlies the northern part of the city, and southeast of the city along the Virginia-North Carolina boundary (Plate 2). The slopes developed on the unit are moderate to low in the broad interstream areas but may be moderate to steep along Birch Creek, Sandy Creek, Rutledge Creek, Little Fall Creek, and similar streams. Characteristically, numerous outcrops of massive, well-jointed gneiss occur on the rolling uplands, on slopes, and in most stream bottoms.

The soils that have developed on this unit are generally thin, light-colored sandy loams, 2 to 12 inches (5 to 30 cm) thick, that overlie a silty-clay residuum. The residuum, which is commonly encountered in shallow construction cuts for roads and foundations, is weakly to moderately plastic, has a much lower permeability than the loamy topsoil, and a moderate shrink-swell potential.

Because of the gentle slope and good drainage the

[1] Additional data on forestry, regional planning, soils, and water may be obtained from the following agencies: (1) Virginia Division of Forestry, P. O. Box 3758, Charlottesville, VA 22903; (2) Virginia Division of State Planning and Community Affairs, South 9th Street, Richmond, VA 23219; (3) Soil Conservation Service, U. S. Department of Agriculture, P. O. Box 10026. Richmond, VA 23240; (4) State Water Control Board, 5306A Peters Creek Road, Roanoke, VA 24019.

[2] Soil as used in this report is the lower unit of biologic activity (i. e., root penetration).

[3] Residuum as used in this report is the mantle of material formed in place by the decomposition and disintegration of rocks and the consequent weathering and loss of volume of the mineral materials. Where it preserves almost intact the structure of the original material it is commonly referred to as saprolite; but in some areas residuum is chaotic in structure or completely structureless.

topography developed on unit 1 seems to provide relatively good building sites for single- and multiple-family dwellings and industrial facilities, but such development will require careful planning because of moderate to severe limitations imposed by soil conditions. These include a high potential for erosion on natural and man-made slopes, limitations on the use of septic tank disposal systems because of moderate to poor permeability of the residuum, and localized rock outcrops. The residuum generally requires the addition of soil cement to bring plasticity and bearing capacity values to specifications required for fill and roadbed materials used under bituminous pavement. The residuum has at best moderate limitations with regards to compaction and load-bearing capability and at worst is subject to liquefaction.

Physical characteristics of the soil and residuum developed on unit 1 seem to be within engineering feasibility for solid-waste disposal sites; the relatively gentle slopes and broad flat areas on ridges are also favorable. Extensive exploration to ascertain the depth to bedrock, however would be required to insure adequate depth of soil to provide daily coverage of the solid waste.

The current use of the land underlain by the unit is predominantly agricultural except for the northern part of Danville. The soils have been among the most favored in the bright tobacco belt, and continued agriculture with careful management to avoid the severe hazard of erosion seems to be one of the most profitable ways to conserve a valuable resource.

UNIT 2

Unit 2 consists of soil and residuum that has developed on light- and dark-colored, metamorphosed volcanic rocks and associated mafic igneous rocks. The dark metavolcanic rocks are predominant in the unit and range from amphibole-chlorite schist to hornblende gneiss. The felsic metavolcanic rocks are interbeds that range from schist to granitic gneiss. Southeast of the Danville basin the unit occurs in relatively narrow bands along which some major stream valleys have developed and in a broad area in the southeastern part of the Ringgold quadrangle (Plate 1). Most of the area underlain by the unit consists of moderate to steep slopes including some of the very steep and gullied terrains along Cane Creek, Golden Branch, and the Dan River in the Ringgold quadrangle.

The rocks commonly crop out along the slopes of valleys and in the bottoms of streams. They are conspicuously layered and have well-developed cleavage and jointing. Minor faults are very common in the unit along the north side of the Dan River between Robertson Bridge and Fall Creek. Steep cuts in this unit, especially those that have undercut the cleavage, are susceptible to a severe hazard from rockfalls and small landslides.

The unit contains heterogeneous rocks and the soil types and depth of weathering commonly show widespread and abrupt variations over small areas. The association of soils on this unit are moderately deep to deep and the upper soil layers may range from about 6 to 14 inches (15 to 36 cm) deep. Where the bedrock consists of a mixture of quartz- and feldspar-rich rocks and hornblende gneiss the topsoil may contain small, light-colored quartz gravel scattered over the surface and may grade into a lower layer of fine, sandy loam or fine, sandy clay to depths of 18 to 30 inches (46 to 76 cm). Where the bedrock consists of massive, hornblende-rich gneiss or metamorphosed dark igneous rock, the topsoil layer may be darker gray or brown and pass directly into highly plastic impervious clay residuum. This residuum extends to a depth of 24 to 30 inches (61 to 76 cm) and is the common subsoil of all the soils included in the association. A surface gravel of dark-brown iron concretions, 0.25 to 0.50 inch (0.64 cm to 1.27 cm) in diameter is also indicative of the dark, iron-rich rocks beneath the soil. Roadcuts and ditches greater than 3 feet (1 m) deep commonly expose weathered bedrock that is dark green with light gray to white layers.

Use of land underlain by Unit 2 may be subject to severe limitation because of a combination of steep slopes, highly plastic and compressible clay residuum, and moderately to slowly permeable soil and residuum. The subsoil that may be encountered in virtually any excavation generally is not suitable for septic-tank drainage-field waste-disposal systems. After exposure, the unit has a tendency to dry and crack because of a moderate to high shrink-swell potential. In wet weather it is heavy and sticky making grading difficult.

Cuts greater than 3 feet (1 m) in depth such as is required for sanitary landfills may encounter weathered bedrock, including disintegrated rock that can be removed by ripping with heavy machinery but also layers of hard rock which may require blasting. Additionally, the moderate to steep slopes typically developed on unit 2 are generally adjacent to streams and thus landfill operations in the unit may have a high risk for surface runoff and resultant stream pollution.

Foundations of structures on the unstabilized soil and residuum may be subject to excessive settling or failure because of liquefaction and resultant total loss of bearing capacity (Figure 30). The unstabilized material may also be unsuitable for use as a base directly beneath bituminous pavement in construction of roads, and may be very susceptible to frost action.

Because of its rolling topography and poor work-

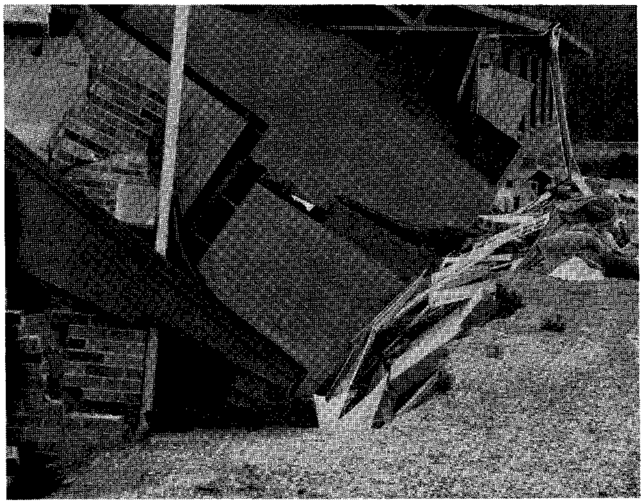

Figure 30. Rotational slump in area of fill derived from unit 2; after an extensive period of rain, Autumn, 1972. Escarpment produced by rotational slump is visible in front of building. This area was formerly used as a parking lot.

ability, especially in wet weather, the current use of land underlain by unit 2 within the study area is for woodland and pasture. Many of the wooded areas were formerly cultivated and there is evidence of extensive erosion and gullying that has been largely stabilized through natural reforestation. Extensive redevelopment of these areas could reverse the natural healing processes and should be approached with caution.

UNIT 3

Unit 3 is underlain mostly by gneiss and mica schist of the Fork Mountain Formation, which occurs northwest of White Oak Mountain. Gneiss, mica schist, and quartzite that are interlayered with the metavolcanic rocks southeast of White Oak Mountain have similar soils and residuum and thus are grouped with this unit. Northwest of White Oak Mountain unit 3 is characterized by rolling terrain and broad, flat ridges with moderate to gentle slopes. Steep slopes occur locally along stream valleys such as those of Pudding Creek and tributaries that form White Oak Creek in the Mount Hermon quadrangle (Plate 2). Southeast of White Oak Mountain the unit is restricted to narrow arcuate belts formed on interlayered metasedimentary rocks in the metavolcanic sequence. Here the unit generally forms knobs and ridgetops, some with steep slopes, especially along the Dan River, along Cane Creek, and in the Mountain Hill area.

Except for the abandoned City of Danville quarry (Plate 1, number 4), hard bedrock associated with this unit is generally exposed only in stream beds. Bedrock resistant to removal by ripping with heavy machinery may occur locally at depths of less than 10 feet (3 m) on the tops of knobs and narrow ridges and along stream valleys, but it is generally covered by more than 30 feet (9 m) of soil and disintegrated rock.

The soil developed on unit 3 consists of sandy loam with good surface drainage that has a clay layer in the subsoil at approximately 10 to 15 inches (25 to 38 cm) below the surface. In an area southwest of State Highway 41 northwest of White Oak Mountain the topsoil contains abundant angular quartz gravel.

Slope and soil conditions on unit 3 are moderately well suited to building sites for single- and multiple-family dwellings as well as small industrial facilities. There may be some limitations in the use of septic-tank disposal fields because of moderate permeability of the clay layer in the subsoil. The soil will probably require stabilization when used as a base for bituminous pavement in road construction. Permeability and thickness of soil and residuum in the area of the unit northwest of White Oak Mountain may be suited for solid-waste disposal.

The current land use of most of the area of unit 3 is agricultural with limited residential development in strips along state roads and highways. Denudation of the tree cover and exposures of the unit along moderate slopes by relatively dense residential development, as in Danville, has led to erosion and sedimentation problems. In areas where these slopes are forested, erosion problems do not seem to be severe. The broad ridges and flat areas between drainages are used for cultivation of tobacco and as pasture.

UNIT 4

Unit 4 contains soil and residuum developed on light-colored metamorphosed volcanic rocks. Broad discontinuous bands of the unit have a trend from northeast to southwest across part of the area southeast of White Oak Mountain. Low to moderate slopes are predominant from Ringgold southwest to U. S. Highway 58 and in the areas around Mount Hermon and around Keeling. Moderate to steep slopes occur along stream valleys and on ridges southwest of Danville.

In the most northwestern bands compact and flinty rocks are exposed at the surface. To the southeast unweathered bedrock is generally encountered only along steep slopes and streams, at depth of more than 10 feet (3 m) below the upland surface. The more schistose rock commonly can be excavated by heavy machinery to greater depths than the massive or gneissic layers.

The soils associated with unit 4 generally have good surface drainage because of rolling topography. They are moderately thick (0 to 7 inches or 0 to 18 cm), fine sandy loam that has a clay layer in the subsoil

Figure 30. Rotational slump in area of fill derived from unit 2; after an extensive period of rain, Autumn, 1972. Escarpment produced by rotational slump is visible in front of building. This area was formerly used as a parking lot.

ability, especially in wet weather, the current use of land underlain by unit 2 within the study area is for woodland and pasture. Many of the wooded areas were formerly cultivated and there is evidence of extensive erosion and gullying that has been largely stabilized through natural reforestation. Extensive redevelopment of these areas could reverse the natural healing processes and should be approached with caution.

UNIT 3

Unit 3 is underlain mostly by gneiss and mica schist of the Fork Mountain Formation, which occurs northwest of White Oak Mountain. Gneiss, mica schist, and quartzite that are interlayered with the metavolcanic rocks southeast of White Oak Mountain have similar soils and residuum and thus are grouped with this unit. Northwest of White Oak Mountain unit 3 is characterized by rolling terrain and broad, flat ridges with moderate to gentle slopes. Steep slopes occur locally along stream valleys such as those of Pudding Creek and tributaries that form White Oak Creek in the Mount Hermon quadrangle (Plate 2). Southeast of White Oak Mountain the unit is restricted to narrow arcuate belts formed on interlayered metasedimentary rocks in the metavolcanic sequence. Here the unit generally forms knobs and ridgetops, some with steep slopes, especially along the Dan River, along Cane Creek, and in the Mountain Hill area.

Except for the abandoned City of Danville quarry (Plate 1, number 4), hard bedrock associated with this unit is generally exposed only in stream beds. Bedrock resistant to removal by ripping with heavy machinery may occur locally at depths of less than 10 feet (3 m) on the tops of knobs and narrow ridges and along stream valleys, but it is generally covered by more than 30 feet (9 m) of soil and disintegrated rock.

The soil developed on unit 3 consists of sandy loam with good surface drainage that has a clay layer in the subsoil at approximately 10 to 15 inches (25 to 38 cm) below the surface. In an area southwest of State Highway 41 northwest of White Oak Mountain the topsoil contains abundant angular quartz gravel.

Slope and soil conditions on unit 3 are moderately well suited to building sites for single- and multiple-family dwellings as well as small industrial facilities. There may be some limitations in the use of septic-tank disposal fields because of moderate permeability of the clay layer in the subsoil. The soil will probably require stabilization when used as a base for bituminous pavement in road construction. Permeability and thickness of soil and residuum in the area of the unit northwest of White Oak Mountain may be suited for solid-waste disposal.

The current land use of most of the area of unit 3 is agricultural with limited residential development in strips along state roads and highways. Denudation of the tree cover and exposures of the unit along moderate slopes by relatively dense residential development, as in Danville, has led to erosion and sedimentation problems. In areas where these slopes are forested, erosion problems do not seem to be severe. The broad ridges and flat areas between drainages are used for cultivation of tobacco and as pasture.

UNIT 4

Unit 4 contains soil and residuum developed on light-colored metamorphosed volcanic rocks. Broad discontinuous bands of the unit have a trend from northeast to southwest across part of the area southeast of White Oak Mountain. Low to moderate slopes are predominant from Ringgold southwest to U. S. Highway 58 and in the areas around Mount Hermon and around Keeling. Moderate to steep slopes occur along stream valleys and on ridges southwest of Danville.

In the most northwestern bands compact and flinty rocks are exposed at the surface. To the southeast unweathered bedrock is generally encountered only along steep slopes and streams, at depth of more than 10 feet (3 m) below the upland surface. The more schistose rock commonly can be excavated by heavy machinery to greater depths than the massive or gneissic layers.

The soils associated with unit 4 generally have good surface drainage because of rolling topography. They are moderately thick (0 to 7 inches or 0 to 18 cm), fine sandy loam that has a clay layer in the subsoil at about 7 to 22 inches (18 to 56 cm) below the surface. Good building sites for single- and multiple-family dwellings and for small industrial facilities seem to be suited to land of this unit because of many broad, flat areas. Planning for these structures should include limitations imposed by soil conditions. In some areas a clay layer located relatively near the surface may reduce the rate that water can seep into the subsoil, thus producing a condition not suitable for septic-tank disposal systems. Additionally, the subsoil materials may show good to poor bearing strength depending on their plasticity and potential of liquefaction. Therefore, foundations should be either situated on disintegrated bedrock below the clayey soil layer or steps should be taken to insure adequate drainage of foundations to eliminate the possibility of liquefaction. The soil will probably require stabilization when used as a base for bituminous pavement in road construction.

The current land use of most of the area of the unit is agricultural. A large part of Danville, suburban development southwest and west of the city, and recent industrial development east of it have been on land underlain by unit 4. Much of the suburban development southeast of the city has been in areas with moderate to steep slopes near the Dan River and erosion has begun on road embankments and homesites left for appreciable periods of time without vegetative cover.

UNIT 5

Unit 5 consists of bedrock, residuum, and soil formed on the sandstone and conglomerate of the Dry Fork Formation. The unit is exposed in a northeasterly-trending belt approximately 2 miles (3 km) wide. It underlies White Oak Mountain where many of the slopes are covered by alluvial-terrace and colluvial deposits.

Slopes in this area are moderate to steep and because the sandstone is massive, but extensively jointed, sloughing and minor slides depend on the direction and amount of dip of joint planes as much as bedding planes in relationship to the slope of the land surface. The bedding generally has gentle to moderate dips toward the northwest whereas the joints have steep dips to the northeast, southeast, northwest, and southwest or are vertical (Figure 29). If joint surfaces or bedding planes are undercut by erosion or excavation, then the potential for rockfalls or landslides is greatly increased and the hazard created should be removed from cut faces. One roadcut, where U. S. Highway 29 traverses White Oak Mountain, is a potentially hazardous area. Similar hazardous conditions may develop in other areas where deep cuts are made in this unit.

The soil that is developed on the steeper slopes of White Oak Mountain is a thin, stony, fine sandy loam, whereas similar fine sandy loam that is deeper and less stony is present on the more gentle slopes. Both soil types have good surface drainage. Hard bedrock generally is at less than 5.0 feet (1.5 m) below the surface on the steep slopes and along streams but soil and disintegrated sandstone may occur at greater depths on the more gentle slopes. The surface soil consists of 6 to 8 inches (15 to 20 cm) of fine sandy loam that grades into a more clayey loam and then into a moderately friable clay layer similar to the residuum that is developed on the metamorphic rocks. Most of the area underlain by unit 5 is not good for building sites because of steep slopes. Even more gentle slopes are subject to some limitations because of the clay-rich residuum that has moderate permeability and fair to poor bearing capability.

On the steeper slopes the proximity of hard rock to the surface causes increased construction costs because blasting is required. On gently rolling terrain, soil and disintegrated rock may be removed by ripping with heavy machinery but there is a possibility of encountering large unweathered sandstone boulders intermixed with the soil and disintegrated bedrock.

Unit 5 is predominantly used for agriculture, although some residential development has taken place along State Road 750. Most of White Oak Mountain is wooded; however, the more gentle slopes are used for pasture and wheat, corn, and tobacco.

UNIT 6

Unit 6 consists of a small area in the northeastern part of the Mount Hermon quadrangle and is underlain by shale, mudrock, and lesser amounts of sandstone and conglomerate of the Dry Fork Formation. This unit occurs along the northwestern flank of White Oak Mountain and is characterized by steep slopes. The rocks are conspicuously layered and closely jointed. The shale is generally more deeply weathered and more easily excavated with heavy machinery than the sandstone of unit 5.

The topsoil of the unit consists of 8 to 10 inches (20 to 25 cm) of fine sandy loam that is underlain by fine sandy loam slightly richer in clay than the surface soil and grades downward into a plastic clay at 14 to 20 inches (36 to 51 cm). This clay subsoil is similar to that developed on unit 2 and is sticky when wet, yet hard and brittle when dry. Percolation in the subsoil is very slow, and the material, similar to most of the fine-grained soils in the area, is highly susceptible to erosion. Freshly graded slopes will require immediate cover to prevent it. Most cuts are subject to sliding and sloughing.

UNIT 7

Unit 7 is underlain by diabase dikes. Hard bedrock in these bodies is generally found only along stream valleys, but the rounded boulders formed by weathering along multiple sets of joint planes are commonly found at the surface in the residuum overlying the dikes. Slumping and failure may occur in deep cuts particularly when the face of the cut is made parallel to the trend of the dike and cuts across the contact between the dike and surrounding rock. Such failure occurs because surface and ground-water drainage may be channeled along the contact zone acting both as a lubricant for slides and as a wetting agent decreasing the bearing capacity of soil and disintegrated rock in cuts. Topsoil formed on the dikes is fine clay, 18 to 30 inches (46 to 76 cm) thick, that overlies highly plastic, impervious clay residuum similar to that associated with unit 2. The dikes are commonly weathered to depths greater than 10 feet (3 m) on the upland surface and may be partially excavated by heavy machinery. Because spheroidal weathering is characteristic of the rock, there generally will be large boulders enclosed in the soil near the surface on the dikes and blasting may be required during excavation. The highly plastic clay subsoil associated with deeply weathered dikes is sticky and slippery when wet and is hard and brittle when dry. It has a high shrink-swell potential and very low permeability, thus imposing moderate to severe limitations for septic-tank drainage systems. Most of the dikes are narrow enough to be avoided at any particular site but soil that is developed on wider dikes may cause construction problems because of poor bearing capability and unsuitability for use as foundations or as a base directly beneath bituminous pavements without special measures to insure adequate drainage and stabilization.

UNIT 8

Unit 8 consists of unconsolidated terrace deposits of pebbles in a clay or sandy clay matrix along the Dan River, the Sandy River, White Oak Creek, Sandy Creek, Cane Creek, and coalescing alluvial fans along the flanks of White Oak Mountain. Many of these deposits are greater than 10 feet (3 m) in thickness, have been extensively weathered, and have deep soil developed on them. The upper part of the topsoil is generally composed of 2 to 10 inches (5 to 25 cm) of loamy sand to fine sandy loam with intermixed cobbles and pebbles of rounded quartz or sandstone. Below this there may be about 7 to 15 inches (18 to 38 cm) of a more clay-rich sandy loam or fine sandy loam that contains more scattered rounded cobbles and pebbles than the upper part. The subsoil is generally a friable sandy clay that may have a mottled structure and may also contain scattered pebbles and boulders. The clay-rich subsoil is relatively impermeable and will inhibit the downward movement of water, yet the upper soil zone will readily permit lateral movement of water. This situation constitutes a possible hazard in the use of septic-tank drainage-field systems. Lateral migration of liquid waste above the clayey subsoil in the terrace deposits may lead to seepage along slopes and artificial cuts and resultant pollution.

Under moderate rainfall conditions areas of steep slope underlain by this unit may be subject to soil creep. During periods of high rainfall the materials may be so lubricated that there may be landslides. If the toe of moderate to steep slopes in this material is cut, there may be soil creep. The unit generally has a high potential for sheet wash. Lawns and fields cleared of cobbles and pebbles on the surface may become stony again after several years because of erosion of the fine matrix of the terrace deposit, leaving the cobbles which were once buried as lag deposits on the surface.

UNIT 9

Unit 9 is composed of unconsolidated flood-plain deposits along the Dan River, the Sandy River, Sandy Creek, Birch Creek, Fall Creek, and Cane Creek. The major soils in this unit include large areas that are well drained and other areas that are poorly drained and swampy. The thickness ranges from less than 10 to about 20 feet (3 to 6 m). The natural slopes are gentle and stable, whereas deep artificial cuts and excavations are subject to slides and sloughing after heavy rainstorms when they are saturated with water. Percolation ranges from very rapid to slow because of isolated clay deposits. The unit is generally not recommended for building sites or waste-disposal facilities because of periodic flooding.

Current land use of the unit in the Danville area includes shopping centers and waste-disposal facilities. Several stores have been flooded in recent years, and continued development in these areas is not recommended. The potential of extensive damage to costly facilities by flooding may counterbalance the relative ease of acquisition and construction on this land. It seems better suited to uses not requiring expensive structures which may be damaged during flooding, such as recreational facilities. Other suggested uses are for agricultural purposes. The better drained areas have been considered prime agricultural land and extensively used for growing corn.

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APPENDIX I

STRATIGRAPHIC SECTIONS

By Paul A. Thayer

Section 1: Dry Fork Formation, Sandstone Facies

Measured in roadcut from south to north on west side of U. S. Highway 29 on top of White Oak Mountain (Plate 2). Base of section (bed 1) is located at 151.3 feet (46.1 m) north of intersection of U. S. Highway 29 and State Road 1032.

		Thickness in feet (meters)
77	Sandstone, arkose, pale-red (5 R 6/2); weathers grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) spots of limonite. Medium- to coarse-grained, poorly sorted, very well indurated. Massively thick bedded. Well jointed. Thin section (R-6695) from middle of unit contains quartz, 49.1 percent; K-feldspar, 16.6 percent; plagioclase 15.6 percent; detrital micas, 1 percent; rock fragments, 7.3 percent; matrix, 7.3 percent; calcite cement, 2.1 percent; and others, 1 percent. Upper contact covered, lower sharp and planar	4.6 (1.4)
76	Muddy sandstone, arkose, medium light gray (N 6); weathers moderate yellowish brown (10 YR 5/4). Very fine-to fine-grained, very poorly sorted, and very well indurated. Massively medium bedded. Thin section (R-6694) from middle of unit contains quartz, 35.3 percent; K-feldspar, 9.8 percent; plagioclase, 2.9 percent; detrital micas, 2.9 percent; rock fragments, 4.0 percent; matrix, 42.2 percent; and authigenic chlorite, 2.9 percent. Lower contact sharp and planar	0.8 (0.2)
75	Sandstone, arkose, light gray (N 7); weathers in places to moderate yellowish brown (10 YR 5/4). Medium- to coarse-grained, poorly sorted, very well indurated. Thick to very thick bedded with faint medium trough cross-beds. Thin section (R-6693) from middle of unit contains quartz, 52.0 percent; K-feldspar, 16.0 percent; plagioclase, 19.2 percent; rock fragments, 3.2 percent; and calcite cement, 9.6 percent. Well jointed. Lower contact sharp and uneven	15.8 (4.8)
74	Sandy siltstone grading into silty, fine-grained lithic arkose near top of unit. Fresh color is grayish red (5 R 4/2) to pale red (5 R 6/2). Very poorly sorted with angular granules of K-feldspar to 0.2 inch (4 mm) long scattered throughout. Massive and very well indurated; abundant joints. Thick bedded. Thin section (R-6692) from middle of unit contains: quartz, 47.3 percent; K-feldspar, 18.2 percent; plagioclase, 5.5 percent; detrital micas, 1.8 percent; rock fragments, 9.0 percent; and matrix, 18.2 percent. Lower contact gradational	15.4 (4.7)
73	Sandstone, arkose, medium light gray (N 6), medium-grained, poorly sorted, very well indurated. Becomes finer grained near top. Faint medium trough cross-bedding. Numerous, randomly oriented, elongate carbonized plant debris up to 6 inches (15 cm) long and 0.2 inch (5 mm) wide. Thin section (R-6691) from near top of unit contains quartz 45.5 percent; K-feldspar, 18.1 percent; plagioclase, 27.3 percent; rock fragments, 3.6 percent; and calcite cement, 5.5 percent. Lower contact gradational	5.7 (1.8)
72	Sandy pebble conglomerate. Dark gray (N 3), angular and subangular mudrock intraclasts and medium-light gray (N 6) subrounded quartz-feldspar gneiss clasts are set in a light-gray (N 7), medium- to coarse-grained lithic arkose matrix. Clasts display unordered fabric. Very poorly sorted, very well indurated. Grades upward into massively bedded, medium-grained, very poorly sorted pebbly arkose near the top of the unit. Well jointed. Lower contact sharp and wavy	9.0 (2.8)
71	Sandstone, lithic arkose, medium light gray (N 6) with grayish red (10 R 4/2) laminae. Medium- to coarse-grained, poorly sorted, very well indurated. Medium-scale trough cross-bedding with medium laminations. Thin section (R-6690) from 2.5 feet (0.8 m) above the base contains quartz, 40.0 percent; K-feldspar, 18.2 percent; plagioclase, 20.9 percent; rock fragments, 14.5 percent; and authigenic chlorite, 6.4 percent. Well jointed. Lower contact sharp and very wavy	13.0 (3.9)
70	Muddy sandstone, arkose, grayish red (10 R 4/2); weathers in places to moderate reddish brown (10 R 4/6). Fine-grained, poorly sorted, very well indurated. Massively thick bedded. Thin section (R-6689) from middle of unit consists of quartz, 54.5 percent; K-feldspar, 14.6 percent; plagioclase, 18.2 percent; rock fragments, 1.8 percent; and matrix, 10.9 percent. Well jointed. Lower contact sharp and planar ..	8.8 (2.7)
69	Sandstone, arkose, medium light gray (N 6). Coarse- to very coarse grained, with thin lenses of pebble conglomerate. Very poorly sorted, well indurated. Massively medium bedded. Thin section (R-6688) from middle of unit contains quartz, 52.7 percent; K-feldspar, 16.4 percent; plagioclase, 12.7 percent; detrital micas, 1.8 percent; rock fragments, 3.6 percent; calcite cement, 9.2 percent; and others, 3.6 percent. Well jointed. Lower contact gradational	1.5 (0.5)
68	Muddy sandstone, arkose, medium dark gray (N 4). Fine grained, poorly sorted, very well indurated. Massively thick bedded. Well jointed. Lower contact gradational	3.3 (1.0)

	Thickness in feet (meters)
67 Sandstone, arkose, medium light gray (N 6); weathers pale yellowish orange (10 YR 8/6) with dark yellowish orange (10 YR 6/6) limonite spots. Medium- to coarse-grained with minor lenses of pebbly conglomerate. Poorly to very poorly sorted, very well indurated. Thin section (R-6687) from middle of unit consists of quartz, 44.7 percent; K-feldspar, 19.7 percent; plagioclase, 21.4 percent; rock fragments, 5.4 percent; and calcite cement, 8.8 percent. Massively very thick bedded. Lower contact gradational	88.5 (27.0)
66 Muddy sandstone, arkose, medium-gray (N 5), with dark-gray (N 3), even, thick parallel laminations. Fine to medium grained, poorly sorted, very well indurated. Well jointed. Lower contact sharp and uneven	0.7 (0.2)
65 Intraformational conglomerate; medium light gray (N 6) matrix with dark-gray (N 3) siltstone clasts. Intraclasts are poorly sorted, angular to subrounded, bent due to compaction, and up to 6 inches (15 cm) long. Matrix is poorly sorted, medium- to coarse-grained arkose. Well indurated and massively medium bedded. Lower contact sharp and wavy	1.0 (0.3)
64 Sandstone, arkose, medium light gray (N 6). Coarse-grained, poorly sorted, very well indurated. Massively medium bedded. Well jointed. Lower contact gradational	1.2 (0.4)
63 Intraformational conglomerate; medium light gray (N 6) matrix with dark gray (N 3) siltstone intraclasts. Matrix is poorly sorted, coarse-grained arkose. Intraclasts are massive siltstone fragments that are angular to subrounded, up to 8 inches (20 cm) long, and arranged with their long axes parallel to bedding. Massively medium bedded, very well indurated, and well jointed. Lower contact sharp and wavy	1.6 (0.5)
62 Sandstone, arkose, medium light gray (N 6). Medium to coarse grained, poorly sorted, very well indurated. Massively medium bedded. Well jointed. Lower contact gradational	1.7 (0.5)
61 Intraformational conglomerate. Dark gray (N 3) siltstone intraclasts are up to 6 inches (15 cm) long, and parallel to bedding; they are set in a medium- to coarse-grained, poorly sorted, medium light gray (N 6) arkosic sandstone matrix. Subangular to angular siltstone clasts are bent due to compaction. Very well indurated and well jointed. Lower contact sharp and planar	0.8 (0.2)
60 Sandstone, arkose, light olive gray (5 Y 6/1); weathers in places to moderate yellowish brown (10 YR 5/4). Coarse to very coarse grained, very poorly sorted, and very well indurated. Medium to thick bedded with faint medium laminations in lower 2.6 feet (0.8 m). Thin section (R-6686) from middle of unit contains quartz, 54.4 percent; K-feldspar, 24.6 percent; plagioclase, 12.3 percent; rock fragments, 3.5 percent; and calcite cement, 5.2 percent. Well jointed, lower contact gradational	26.0 (7.9)
59 Intraformational mudrock conglomerate. Dark gray (N 3), angular to subrounded mudrock intraclasts are set in a medium light gray (N 6), medium-grained, poorly sorted arkosic sandstone matrix. Elongate intraclasts are parallel to bedding and are up to 1.6 feet (0.5 m) long; most are between 4 and 8 inches (10 and 20 cm) long. Very well indurated, abundant joints. Lower contact sharp and undulatory	1.7 (0.5)
58 Sandstone, arkose, light-gray (N 7); weathers in places to dark yellowish orange (10 YR 6/6). Very coarse- to coarse-grained with scattered granules and pebbles of quartz and K-feldspar; very poorly sorted. Massively thick bedded; very well indurated. Well jointed. Lower contact sharp and planar	10.5 (3.2)
57 Sandstone, arkose, light-gray (N 7); weathers in places to dark yellowish orange (10 YR 6/6). Medium-grained, poorly sorted, and very well indurated. Massively thick bedded. Well jointed. Lower contact sharp and planar	5.7 (1.8)
56 Sandstone, lithic arkose, medium-gray (N 5). Medium to coarse grained, very poorly sorted; very coarse sandy granule conglomerate in lowest 1-2 inches (3-5 cm). Thin section (R-6685) from middle of unit contains quartz, 27.2 percent; K-feldspar, 18.2 percent; plagioclase, 12.1 percent; detrital micas, 1.5 percent; rock fragments, 9.1 percent; calcite cement, 30.3 percent; and matrix, 1.6 percent. Massively thick bedded; very well indurated. Well jointed. Lower contact sharp and wavy	4.6 (1.4)
55 Sandy mudrock, dark reddish brown (10 R 3/4). Massive and thick bedded. Very well indurated. Well jointed. Lower contact sharp and planar. .	11.2 (3.4)
54 Sandstone, arkose, medium light gray (N 6); weathers dark yellowish orange (10 YR 6/6). Poorly sorted lithic conglomerate in lower 2.6 feet (0.8 m) consists of subrounded feldspar, quartz, and quartz-feldspar gneiss clasts set in a coarse-grained, poorly sorted arkosic sandstone matrix. This is succeeded by coarse-grained, poorly sorted arkosic sandstone that grades upward into fine-grained, moderately sorted arkosic sandstone near the top of the unit. Thin section (R-6684) from 4 feet (1 m) above the base contains quartz, 43.6 percent; K-feldspar, 18.2 percent; plagioclase, 16.4 percent; rock fragments, 1.8 percent; and calcite cement, 20.0	

Thickness in feet (meters)

percent. Overall the unit is very well indurated, massively thick bedded, and well jointed. Lower contact sharp and wavy 7.9 (2.4)

53 Sandy siltstone, subarkose, medium dark gray (N 4); weathers grayish red (10 R 4/2). Sand is fine-grained, with some granules of angular K-feldspar. Overall the unit is poorly sorted. Thin section (R-6683) from 2.6 feet (0.8 m) above the base consists of quartz, 33.4 percent; K-feldspar, 5.0 percent; plagioclase, 3.3 percent; detrital micas 5.0 percent; rock fragments, 1.7 percent; authigenic chlorite, 3.3 percent; and matrix, 48.3 percent. Very well indurated, well jointed. Massively thick bedded. Lower contact covered 5.3 (1.6)

52 Covered 81.7 (24.9)

51 Mudrock, grayish-red (10 R 4/2). Massive, very thick bedded. Burrow mottled in places. Very well indurated; spheroidally weathered in parts. Lower contact sharp and planar 7.6 (2.3)

50 Sandstone, lithic arkose, grayish red (10 R 4/2); weathers dark yellowish orange (10 YR 6/6). Pebbly, very coarse, poorly sorted sandstone in lower 8 inches (20 cm); medium- to fine-grained sandstone with even, parallel, medium laminations from 8 inches (20 cm) to 40 inches (102 cm) above base. Upper part of unit is massive, medium-grained, poorly sorted sandstone. Unit is very well indurated, well jointed, and thick bedded. Lower contact very sharp and undulatory 7.6 (2.3)

49 Muddy sandstone, lithic arkose, grayish-red (10 R 4/2); weathers dark yellowish orange (10 YR 6/6). Fine to medium grained with very coarse, angular K-feldspar grains throughout. Extremely poorly sorted near base; contains less mud and becomes better sorted near the top of unit. Thin section (R-6682) from 4.3 feet (1.3 m) above the base consists of quartz, 29.2 percent; K-feldspar, 10.8 percent; plagioclase, 6.2 percent; detrital micas, 4.6 percent; rock fragments, 7.7 percent; and matrix, 41.5 percent. Massively very thick bedded. Well indurated. Lower contact concealed 4.9 (1.5)

48 Covered 139.4 (42.5)

47 Sandstone, arkose, grayish-red (10 R 4/2), with dark yellowish orange (10 YR 6/6) limonite specks. Lower 1.5 feet (0.5 m) is poorly sorted, pebbly sandstone; upper part is medium-grained, poorly sorted sandstone that grades into fine-grained, moderately sorted sandstone at the top. Thin section (R-6681) from 3.3 feet (1.0 m) above the base contains quartz, 29.1 percent; K-feldspar, 16.4 percent; plagioclase, 14.5 percent; authigenic chlorite, 1.8 percent; authigenic albite, 10.9 percent; and matrix, 27.3 percent. Massively thick bedded. Well indurated. Upper and lower contacts covered 6.6 (2.0)

46 Sandstone, arkose, grayish-red (5 R 4/2); weathers dark yellowish orange (10 YR 6/6). Coarse-grained and poorly sorted. Thick bedded with minor thick laminations. Unit poorly exposed, highly weathered and friable at lower half. Thin section (R-6680) from 4.3 feet (1.3 m) above the base composed of quartz, 41.5 percent; K-feldspar, 23.1 percent; plagioclase, 29.2 percent; and matrix, 6.2 percent. Lower contact concealed 5.9 (1.8)

45 Fine sandy siltstone, lithic arkose, dark reddish brown (10 R 3/4) with mottles of dark yellowish orange (10 YR 6/6) limonite. Very poorly sorted, with scattered granules and pebbles of angular K-feldspar. Massively thick bedded. Very well indurated, well jointed. Thin section (R-6679) from 7 feet (2 m) above base consists of quartz, 25.0 percent; K-feldspar, 10.0 percent; plagioclase, 3.3 percent; rock fragments, 5.0 percent; and matrix, 56.7 percent. Lower contact gradational 15.8 (4.8)

44 Sandstone, lithic arkose, medium light gray (N 7); weathers moderate yellowish orange (10 YR 7/6) with mottles of dark yellowish orange (10 YR 6/6) limonite. Coarse- to very coarse-grained, with angular granules and pebbles of weathered K-feldspar; very poorly sorted. Massively thick bedded. Poorly indurated. Manganese-coated slickensides in places. Lower contact sharp and planar 17.1 (5.2)

43 Pebbly, micaceous sandy siltstone, grayish-red (10 R 4/2); with mottles of dark yellowish orange (10 YR 6/6) limonite. Extremely poorly sorted with angular and subangular granules and pebbles of K-feldspar, quartz, and quartz-feldspar gneiss. Massively thick bedded. Well jointed and well indurated. Lower contact covered 12.1 (3.7)

42 Muddy sandstone, arkose, grayish-red (10 R 4/2); weathers spheroidally to light brown (5 YR 6/4) with dark yellowish orange (10 YR 6/6) limonite mottles. Fine grained, very poorly sorted, and well indurated. Unit poorly exposed. Massively thick bedded with some burrow mottles. Thin section (R-6678) from 4.9 feet (1.5 m) above base contains quartz, 38.3 percent; K-feldspar, 18.3 percent; plagioclase, 1.7 percent; and matrix, 41.7 percent. Lower contact gradational. 9.5 (2.9)

41 Sandstone, arkose, medium light gray (N 6) in lower half grading upward into grayish red

	Thickness in feet (meters)
(10 R 4/2) in upper part. Lower part weathers dark yellowish orange (10 YR 6/6) with moderate yellowish brown (10 YR 5/4) limonite mottles; upper half weathers moderate yellowish orange (10 YR 7/6). Very coarse grained and very poorly sorted at base grading into medium- to fine-grained, poorly sorted sandstone at the top. Lower part is moderately indurated; upper is well indurated. Massively thick bedded throughout. Lower contact sharp and planar ..	37.7 (11.5)
40 Sandy siltstone, highly weathered to greenish gray (5 GY 6/1) chips. Soft, fissile, and massively medium bedded. Lower contact sharp and wavy.	1.6 (0.5)
39 Muddy sandstone, subarkose, medium dark gray (N 4); weathers pale red (10 R 6/2). Fine to medium grained, poorly sorted, massively medium bedded, and moderately indurated. Thin section (R-6677) from 8.2 feet (2.5 m) above base contains quartz, 58.3 percent; K-feldspar, 5.4 percent; plagioclase, 1.8 percent; detrital micas, 1.8 percent; authigenic chlorite, 1.8 percent; and matrix, 30.9 percent. In lower 3 feet (0.9 m) contains angular granules and pebbles of K-feldspar and quartz. Several thin beds of highly weathered, greenish-gray (5 G 6/1) shale in upper half. Lower contact sharp and planar	10.8 (3.3)
38 Shale, dark reddish brown (10 R 3/4); fissile, and highly weathered. Thin to medium bedded. Poorly indurated; breaks into small chips. Lower contact sharp and even	3.3 (1.0)
37 Sandstone, arkose, grayish-red (10 R 4/2); weathers in places to dark yellowish orange (10 YR 6/6). Lower 1.0 foot (0.3 m) is very coarse grained and poorly sorted with thin layers of dark gray (N 7) mudrock. Thin section (R-6697) from 6 inches (15 cm) above the base consists of quartz, 53.3 percent; K-feldspar, 19.9 percent; plagioclase, 15.0 percent; rock fragments, 6.8 percent; authigenic chlorite, 3.3 percent; and matrix, 1.7 percent. Upper part consists of poorly sorted, medium- to fine-grained muddy sandstone with angular to subrounded pebbles of K-feldspar, quartz, and quartz-feldspar gneiss. Medium bedded, well jointed, very well indurated. Lower contact sharp and wavy	3.1 (0.9)
36 Shale, highly weathered, fissile, greenish-gray (5 GY 6/1). Breaks into small chips. Lower contact sharp and even	0.4 (0.1)
35 Sandstone, lithic arkose, medium light gray (N 6). Coarse grained and poorly sorted, with angular pebbles and granules of K-feldspar. Very well indurated, well jointed. Massively thick bedded. Thin section (R-6676) from 1.6 feet (0.5 m) above the base consists of quartz, 56.0 percent; K-feldspar, 13.3 percent; plagioclase, 12.0 percent; rock fragments, 10.7 percent; calcite cement, 6.7 percent; and others, 1.3 percent. Lower contact very gradational	3.3 (1.0)
34 Muddy sandstone, arkose, brownish-gray (5 YR 4/1); weathers in small patches to dark yellowish orange (10 YR 6/6). Fine grained, poorly sorted very well indurated, and fractures conchoidally. Thin section (R-6675) from 2.6 feet (0.8 m) above the base contains quartz, 30.8 percent; K-feldspar, 9.3 percent; plagioclase, 3.1 percent; detrital micas, 3.1 percent; rock fragments, 1.5 percent; authigenic chlorite, 1.5 percent; calcite cement, 13.8 percent; and matrix, 36.9 percent. Massively thick bedded. Lower contact gradational	5.3 (1.6)
33 Muddy sandstone, arkose, grayish-red (5 R 4/2); weathers grayish orange pink (10 R 8/2). Fine to medium grained, very poorly sorted, and very well indurated. Massive, medium bedded. Thin section (R-6674) from 0.8 feet (0.24 m) above the base consists of quartz, 47.2 percent; K-feldspar, 16.4 percent; plagioclase, 7.3 percent; authigenic chlorite, 1.8 percent; calcite cement, 10.9 percent; and matrix, 16.4 percent. Lower contact very gradational	1.6 (0.5)
32 Sandstone, arkose, pale-red (10 R 6/2); weathers grayish orange pink (10 R 8/2). Coarse-grained, poorly sorted, and very well indurated. Massive, lenticular medium bedding. Thin section (R-6673) from 1.0 foot (0.3 m) above the base contains quartz 47.4 percent; K-feldspar, 21.4 percent; plagioclase, 16.0 percent; detrital micas, 1.5 percent; rock fragments, 3.8 percent; authigenic chlorite, 0.8 percent; calcite cement, 6.9 percent; matrix, 1.4 percent; and others, 0.8 percent. Well jointed. Lower contact sharp and wavy ..	2.3 (0.7)
31 Sandy mudstone, arkose, dark reddish brown (10 R 3/4); weathers dark yellowish orange (10 YR 6/6) in places. Sand is very fine to fine grained, with minor granules and pebbles of fresh, angular K-feldspar; very poorly sorted. Thin section (R-6672) from middle of the unit contains quartz, 12.8 percent; K-feldspar, 9.0 percent; plagioclase, 1.3 percent; detrital micas, 1.3 percent; authigenic chlorite, 3.8 percent; calcite cement, 1.3 percent; and matrix, 70.5 percent. Massively thin bedded. Very well indurated and well jointed. Lower contact gradational	0.3 (0.1)
30 Sandstone, arkose, medium-gray (N 5); weathers very pale orange (10 YR 8/2) with specks of dark yellowish orange (10 YR 6/6) limonite. Lower 3.3 feet (1.0 m) contains abundant angular to subrounded, dark-gray (N 3) mudrock intraclasts up to 1.2 inches (3 cm) long that are parallel to layering. These are set in a very	

Thickness in feet (meters)

coarse, poorly sorted arkosic sandstone matrix. The upper 10.5 feet (3.2 m) is medium- to coarse-grained, poorly sorted arkose with medium-scale tabular cross-bedding. Pebble layers up to 4 inches (10 cm) thick are common in the upper part. Thin section (R-6671) from 11 feet (3 m) above the base consists of quartz, 41.6 percent; K-feldspar, 20.0 percent; plagioclase, 28.3 percent; calcite cement, 5.0 percent; and others, 5.1 percent. Overall, the unit is very well indurated and well jointed. Lower contact sharp and wavy 13.8 (4.2)

29 Fine sandy mudstone, subarkosic. Lower 10 feet (3 m) is dark reddish brown (10 R 3/4), massive, very well indurated, conchoidally fracturing, and thick bedded. Thin section (R-6670) from 7 feet (2 m) above the base consits of quartz, 40.0 percent; K-feldspar, 5.0 percent; plagioclase, 3.3 percent; detrital micas, 1.7 percent; calcite cement, 3.3 percent; and matrix, 46.7 percent. Upper 3.6 feet (1.1 m) is coarse sandy mudstone with angular and subangular granule and pebble size clasts of K-feldspar. Thin, 8 inch (20 cm), very dark red (5 R 2/6) fissile shale at 7 feet (2 m) above base. Lower contact gradational .. 13.6 (4.2)

28 Sandstone, arkose. Lower 3.5 feet (1.1 m) is massively thick bedded, coarse- to very coarse grained, poorly sorted, grayish orange pink (10 R 8/2) pebbly sandstone. Thin section (R-6669) from 3.3 feet (1.0 m) above the base contains quartz, 45.4 percent; K-feldspar, 18.2 percent; plagioclase, 18.2 percent; rock fragments, 3.6 percent; and calcite cement, 14.6 percent. Upper 2.6 feet (0.8 m) is medium-grained, poorly sorted, pale-red (10 R 6/2) sandstone with medium-scale tabular cross-beds. Overall, the unit is very well indurated and well jointed. Lower contact sharp and even 6.1 (1.9)

27 Muddy sandstone, arkose. Grayish red (5 R 4/2) in lower 3 feet (1 m); medium gray (N 5) in middle; and grayish red (10 R 4/2) in upper 6.2 feet (1.9 m). Fine grained with subordinate coarse- and very coarse grained angular K-feldspar grains floating in fine matrix; very poorly sorted and very well indurated. Thin bed of fissile, chippy-weathering, greenish-gray (5 GY 6/1) shale at 6.6 feet (2.0 m) above base. Thin section (R-6668) from 8.5 feet (2.6 m) above the base contains quartz, 54.5 percent; K-feldspar, 14.5 percent; plagioclase, 9.1 percent; rock fragments, 5.5 percent; matrix, 12.8 percent; and others, 3.6 percent. Massively thick bedded. Well jointed. Lower contact very gradational .. 12.1 (3.7)

26 Sandstone, arkose, light-gray (N 7); weathers moderate yellowish orange (10 YR 7/6) and very pale orange (10 YR 8/2). Coarse and very coarse grained with lenses of granule and pebble K-feldspar conglomerate up to 10 inches (25 cm) thick. Very poorly sorted and very well indurated. Thin section (R-6667) from 6.6 feet (2.0 m) above the base consists of quartz, 49.1 percent; K-feldspar, 9.1 percent; plagioclase, 27.3 percent; rock fragments, 3.6 percent; authigenic chlorite, 1.8 percent; and calcite, 9.1 percent. Massively thick bedded with faint, tabular, medium cross-beds in middle of unit. Well jointed. Lower contact gradational 15.4 (4.7)

25 Fine sandy mudrock, medium dark gray (N 4); weathers spheroidally to grayish orange (10 YR 7/4) and dark yellowish orange (10 YR 6/6). Lower 13 inches (34 cm) is laminated mudrock and light-gray (N 7), medium-grained, poorly sorted arkosic sandstone; laminations are uniform in thickness and range between 0.5 and 1.0 inch (12.7-25.4 mm). Upper part of unit is sandy mudrock containing granules and pebbles of angular K-feldspar, and lenses of very coarse, poorly sorted arkosic sandstone. Well jointed. Lower contact concealed 2.6 (0.8)

24 Sandstone, arkose, grayish-red (10 R 4/2) to pale-brown (5 YR 5/2); weathers grayish orange (10 YR 7/4) with specks of dark yellowish orange (10 YR 6/6) limonite. Medium- to coarse-grained with lenses of pebbly sandstone up to 1.0 foot (0.3 m) thick in upper half; very poorly sorted. Thin section (R-6666) from 11 feet (3 m) above the base contains quartz, 45.4 percent; K-feldspar, 29.1 percent; plagioclase, 12.7 percent; rock fragments, 7.3 percent; and matrix, 5.5 percent. Massively thick bedded with faint, thick cross-beds in upper half. Moderately indurated; friable in places. Lower contact sharp and planar 21.0 (6.4)

23 Fine sandy mudrock, very weathered and poorly exposed; weathered color is dark greenish gray (5 GY 4/1). Poorly indurated, breaks readily into small chips. Lower contact sharp and even . 2.0 (0.6)

22 Sandstone, arkose, medium dark gray (N 4) to dark-gray (N 3); weathers in places to grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) limonite spots. Medium to coarse grained and poorly sorted. Lower 2 feet (1 m) contains angular K-feldspar clasts up to 0.6 inches (15 mm) long "floating" in sandstone matrix. Massively very thick bedded in lower 15 feet (5 m); uppermost part is massive and medium bedded. Very well indurated and well jointed. Lower contact covered 16.4 (5.0)

21 Sandstone, arkose and subarkose, greenish-gray (5 GY 6/1); weathers grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) limonite spots. Medium to coarse grained with lenses of pebbly coarse sandstone, and fine-grained, grayish-red (10 R 4/2) sandstone. Poorly sorted. Thin section (R-6665) from 13 feet

		Thickness in feet (meters)
	(4 m) above the base consists of quartz, 41.9 percent; K-feldspar, 9.1 percent; plagioclase, 3.6 percent; and authigenic chlorite, 45.4 percent. Massively thick and very thick bedded. Well indurated. Poorly exposed due to slumping. Well jointed. Lower contact gradational	32.2 (9.8)
20	Sandstone, arkose, grayish-red (10 R 4/2) and dark reddish brown (10 R 3/4); weathers dark yellowish orange (10 YR 6/6). Medium to coarse grained, poorly sorted, and massively thick bedded. Well indurated. Poorly exposed due to slumping. Lower contact gradational ...	7.2 (2.2)
19	Sandstone, arkose, medium light gray (N 6); weathers pale yellowish brown (10 YR 6/2). Coarse and very coarse grained, with subordinate angular granules and pebbles of K-feldspar; very poorly sorted. Two foot (0.6 m) thick, fine-grained, poorly sorted sandstone containing angular and subrounded clasts of quartz and K-feldspar up to 2 inches (5 cm) long is present 5.0 feet (1.5 m) above base. Thin cross-beds in lower half; massively thick bedded in upper part. Very well indurated. Well jointed. Lower contact gradational	10.2 (3.1)
18	Muddy sandstone, subarkose, medium dark gray (N 4); weathers dark yellowish orange (10 YR 6/6). Fine-grained and poorly sorted. Contains minor pyrite. Massively medium bedded and well indurated. Lower contact sharp and wavy	1.6 (0.5)
17	Sandstone, lithic arkose, moderate yellowish brown (10 YR 5/4); speckled with dark yellowish orange (10 YR 6/6) limonite. Coarse- to very coarse-grained, very poorly sorted and moderately indurated. Thin section (R-6664) from 2.0 feet (0.6 m) above the base consists of quartz, 30.4 percent; K-feldspar, 32.1 percent; plagioclase, 19.6 percent; and rock fragments, 17.9 percent. Thick bedded with thick, discontinuous, even, parallel laminations. Lower contact sharp and even	4.0 (1.2)
16	Sandy siltstone, arkosic, weathers pale yellowish brown (10 YR 6/2). Sand is fine to very fine grained. Poorly sorted overall. Thin section (R-6663) from middle of unit is composed of quartz, 43.1 percent; K-feldspar, 10.8 percent; plagioclase, 10.8 percent; detrital micas, 3.1 percent; authigenic chlorite, 16.8 percent; and matrix, 15.4 percent. Lower contact sharp and even	1.0 (0.3)
15	Sandstone, arkose, medium light gray (N 6); weathers grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) limonite stains on joint surfaces. Medium to very coarse grained, with numerous granules and pebbles of angular to subrounded quartz and K-feldspar; poorly sorted. Thin, even, parallel beds of dark-gray (N 5) massive mudrock occur in the lower 8 feet (2 m) and at 15.1 feet (4.6 m) above the base. Intraformational conglomerate zones, up to 2.0 feet (0.6 m) thick, consisting of angular to subrounded clasts of dark gray (N 3) mudrock occur above the base at 19.7 feet (6.0 m), 24.0 feet (7.3 m), and 30.0 feet (9.2 m). Mudrock intraclasts in these zones are up to 16 inches (41 cm) long and their long axes are parallel or subparallel to bedding; they are set in a very coarse grained arkosic sandstone matrix. Thin section (R-6662) of coarse sandstone from the middle of the unit contains quartz, 58.4 percent; K-feldspar, 15.4 percent; plagioclase, 18.5 percent; and calcite cement, 7.7 percent. Sandstones in the unit have medium-scale trough cross-bedding with medium to very thick laminations marked by clay films. Unit is very well indurated and well jointed. Lower contact is sharp and wavy	46.3 (14.1)
14	Very fine sandy siltstone, arkosic, dark reddish brown (10 R 3/4); weathers dark yellowish orange (10 YR 6/6). Poorly sorted, well indurated. Thin section (R-6661) from 2.3 feet (0.7 m) above the base contains quartz, 36.4 percent; K-feldspar, 5.5 percent; rock fragments, 1.8 percent; authigenic chlorite, 5.4 percent; and matrix, 50.9 percent. Fissile shale occurs 1.2 feet (0.4 m) above the base. Uniformly even, thin and medium bedding. Lower contact gradational	3.2 (1.0)
13	Sandstone, arkosic, and interbedded lithic pebble conglomerate. Highly weathered to moderate yellowish brown (10 YR 5/4) crumbly sand with specks of dark yellowish orange (10 YR 6/6) limonite. Sandstone is medium to very coarse grained and poorly sorted. Thin section (R-6660) from middle of the unit contains quartz, 40.0 percent; K-feldspar, 27.2 percent; plagioclase, 25.5 percent; rock fragments, 5.5 percent; and matrix, 1.8 percent. Conglomerate consists of subrounded, granule- and pebble-size clasts of quartz, muscovite schist, and quartz-feldspar gneiss, which are set in a coarse-grained arkosic sandstone matrix. Massively thick bedded. Lower contact sharp and even	33.6 (10.2)
12	Fine sandy siltstone, lithic arkose, dark reddish brown (10 R 3/4); weathers in places to dark yellowish orange (10 YR 6/6). Poorly sorted, with scattered angular clasts of K-feldspar up to 0.2 inches (0.5 cm) long "floating" in finer grained siltstone. Several thin shale beds up to 1.2 inches (3.0 cm) thick occur in the upper half of unit. Thin section (R-6659) from 4.6 feet (1.4 m) above the base contains quartz, 31.0 percent; K-feldspar, 10.9 percent; plagioclase, 1.8 percent; rock fragments, 5.5 percent; and matrix, 50.8 percent. Massively thick bedded and well indurated. Lower contact sharp and even..	9.2 (2.8)

		Thickness in feet (meters)
11	Sandstone, arkose, medium-gray (N 5) to blackish-red (5 R 2/2) with dark yellowish orange (10 YR 6/6) limonite specks. Medium to very coarse grained with minor rounded, dark gray (N 3), intraformational mudrock clasts up to 1.0 inch (2.5 cm) long. Thin section (R-6658) from middle of the unit contains quartz, 50.9 percent; K-feldspar, 21.8 percent; plagioclase, 5.5 percent; rock fragments, 3.6 percent; and matrix, 18.2 percent. Even, uniformly medium bedded with medium and thick parallel laminations. Well indurated. Lower contact sharp and even	3.9 (1.2)
10	Muddy sandstone, arkose, grayish-red (10 R 4/2); weathers in places to moderate yellowish brown (10 YR 5/4). Fine grained, very poorly sorted, and well indurated. Thin section (R-6657) from middle of the unit contains quartz, 40.0 percent; K-feldspar, 10.9 percent; plagioclase, 5.5 percent; detrital micas, 3.6 percent; rock fragments, 3.6 percent; and matrix, 36.4 percent. Contains several thin beds of fissile silty shale. Even, parallel medium bedding. Burrow mottled in places. Lower contact sharp and even.	7.2 (2.2)
9	Sandstone, arkose, medium light gray (N 7), with specks of dark yellowish orange (10 YR 6/6) limonite. Lower 2 feet (0.6 m) is very coarse grained, poorly sorted, and massively thick bedded. Thin section (R-6656) from 1.6 feet (0.5 m) above the base consists of quartz, 43.6 percent; K-feldspar, 30.9 percent; plagioclase, 18.2 percent; and rock fragments, 7.3 percent. Above 2 feet (61 cm) the unit is fine to medium grained, poorly sorted, and medium cross-bedded with thin to thick laminations. Thin section (R-6655) from 13 feet (4 m) above the base contains quartz, 58.7 percent; K-feldspar, 14.3 percent; plagioclase, 13.5 percent; detrital micas, 1.8 percent; rock fragments, 0.4 percent; authigenic chlorite, 0.4 percent; calcite cement, 3.7 percent; and matrix, 7.2 percent. Overall very well indurated, and well jointed. Lower contact sharp and even	18.0 (5.5)
8	Muddy sandstone, subarkose, medium light gray (N 6); weathers light brown (5 YR 6/4). Fine to medium grained with numerous shale laminae to 0.5 inch (13 mm) thick; poorly sorted and very well indurated. Thin section (R-6654) from middle of the unit contains quartz, 53.3 percent; K-feldspar, 1.5 percent; plagioclase, 7.4 percent; detrital micas, 11.9 percent; authigenic chlorite, 4.4 percent; and matrix, 21.5 percent. Even, parallel, thin and medium bedding. Numerous joints. Lower contact sharp and wavy	3.1 (1.0)
7	Sandstone, arkose, brownish-black (5 YR 2/1); weathers pale yellowish orange (10 YR 8/6) to grayish orange (10 YR 7/4). Medium to very coarse grained with angular to subrounded granules and pebbles of K-feldspar and quartz-feldspar gneiss. Thin section (R-6653) from 1.3 feet (0.4 m) above the base contains quartz, 50.9 percent; K-feldspar, 16.4 percent; plagioclase, 5.5 percent; detrital micas, 7.3 percent; rock fragments, 5.5 percent; calcite cement, 3.6 percent; matrix, 9.0 percent; and others, 1.8 percent. Massively thick bedded. Well jointed. Lower contact sharp and wavy	3.0 (0.9)
6	Shale, highly weathered, olive-gray (5 Y 4/1). Thin bedded, fissile, and poorly indurated. Lower contact sharp and wavy	0.3 (0.1)
5	Sandstone, subarkose, brownish-gray (5 YR 4/1); weathers moderate yellowish crange (10 YR 7/6) in places. Medium to very coarse grained, poorly sorted, and very well indurated. Thin section (R-6652) from middle of the unit contains quartz, 66.7 percent; K-feldspar, 10.8 percent; plagioclase, 5.4 percent; rock fragments, 5.4 percent; and matrix, 11.7 percent. Massive, uniformly medium bedded. Very well indurated and well jointed. Lower contact sharp and even ...	1.5 (0.5)
4	Shale, highly weathered, olive-gray (5 Y 4/1). Thin bedded, fissile, and very poorly indurated. Lower contact sharp and even	0.2 (0.1)
3	Muddy sandstone, arkose, grayish red (5 R 4/2); weathers grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) limonite stains. Fine to very fine grained, poorly sorted, and very well indurated. Thin section (R-6651) from 2.6 feet (0.8 m) above the base contains quartz, 31.6 percent; K-feldspar, 9.1 percent; plagioclase, 13.3 percent; detrital micas, 2.5 percent; rock fragments, 5.1 percent; authigenic chlorite, 0.9 percent; calcite cement, 5.8 percent; and matrix, 31.7 percent. Massively thick bedded. Well jointed. Lower contact gradational	5.9 (1.8)
2	Sandstone, arkose, pinkish-gray (5 YR 8/1); weathers grayish orange (10 YR 7/4). Coarse to very coarse grained, with granules and pebbles of angular K-feldspar in uppermost 0.3 feet (0.1 m); poor to very poor sorting. Thin section (R-6650) from 6.6 feet (2.0 m) above the base consists of quartz, 39.3 percent; K-feldspar, 26.3 percent; plagioclase, 11.5 percent; and rock fragments, 22.9 percent. Lower 10 feet (3 m) is massively thick bedded; upper 8 feet (2 m) is medium cross-bedded with curved, nonparallel medium laminations. Well indurated and jointed.	18.0 (5.5)
1	Lower contact covered	
	Total Thickness of Measured Section	936.8 (285.5)

Section 2: Type Section, Dry Fork Formation, Sandstone Facies

Measured in cut along east side of Southern Railway on White Oak Mountain. Top of section (bed 38) is located 5,415 feet (1,651 m) south of intersection of railroad tracks and State Road 718. This is Meyertons' (1963) type section of the Dry Fork Formation.

		Thickness in feet (meters)
38	Fine sandy mudrock, subarkose, grayish-red (5 R 4/2), weathers pale-red (5 R 6/2). Poorly exposed. Poorly sorted, very well indurated, slightly jointed. Massive, even, parallel thick bedding. Lower contact covered	2.1 (0.6)
37	Sandstone, arkose, light-gray (N 7); weathers grayish orange (10 YR 7/4) with specks of dark yellowish orange (10 YR 6/6) limonite. Medium to coarse grained in lower 14 feet (4.3 m) grading into pebbly, very coarse-grained sandstone above. Poor to very poor sorting, very well indurated. Massively thick bedded. Well jointed. Lower contact covered	18.5 (5.6)
36	Muddy sandstone, subarkose, medium-gray (N 5) to medium dark gray (N 4); weathers pale brown (5 YR 5/2). Fine to very fine grained and poorly sorted. Massive, thick, even bedding. Very well indurated, breaks conchoidally; slightly jointed. Lower contact sharp and planar	7.1 (2.2)
35	Sandstone, lithic arkose, light-gray (N 7); weathers grayish pink (5 R 8/2). Very poorly exposed. Coarse- and very coarse-grained with scattered subangular granules and pebbles of K-feldspar. Moderately indurated. Massively thick bedded. Lower contact covered	3.9 (1.2)
34	Sandstone, arkose, medium light gray (N 6); weathers grayish pink (5 R 8/2). Fine to coarse grained, poorly sorted, well indurated. Thick trough cross-bedding, with thin and medium, curved, nonparallel laminations, marked by accumulations of micaceous mud. Well jointed. Lower contact gradational	2.8 (0.9)
33	Sandstone, arkose, medium light gray (N 6); weathers grayish pink (5 R 8/2) with patches of moderate orange pink (10 R 7/4) weathered feldspar. Medium to very coarse grained with minor granules and pebbles of subangular K-feldspar; poorly sorted. Massively very thick bedded. Very well indurated, highly jointed. Lower contact gradational	14.2 (4.3)
32	Sandstone, lithic arkose, medium light gray (N 6); weathers grayish pink (5 R 8/2) with patches of moderate orange pink (10 R 7/4) weathered feldspar. Coarse and very coarse grained with abundant granules and pebbles of subangular K-feldspar and some dark-gray (N 3) mudrock intraclasts up to 8 inches (20 cm) long; very poorly sorted. Massive and very thick bedded. Abundant joints; very well indurated. Lower contact sharp and planar	3.9 (1.2)
31	Very fine sandy siltstone, grayish-red (5 R 4/2); weathers in spots to dark yellowish orange (10 YR 6/6). Poorly sorted, massively thick bedded. Very well indurated, fractures conchoidally. Lower contact sharp and even	3.3 (1.0)
30	Conglomeratic sandstone, lithic arkose, medium light gray (N 7) with angular, pinkish-gray (5 YR 8/1) K-feldspar granules and pebbles; weathers dark yellowish orange (10 YR 6/6). Very coarse-grained, poorly sorted, very well indurated. Silicified in places. Massively thick bedded. Well jointed. Lower contact sharp and planar	13.8 (4.2)
29	Very fine sandy siltstone, subarkose, grayish-red (5 R 4/2); weathers grayish brown (5 YR 3/2). Contains several beds of silty shale up to 1 foot (31 cm) thick, 5.7 feet (1.7 m) above the base. Several thin beds of very coarse-grained pebbly arkose also occur. Poorly sorted, very well indurated, and highly jointed. Massively thick and very thick bedded. Lower contact covered	9.2 (2.8)
28	Sandstone, arkose, brownish-gray (5 YR 4/1); weathers pale yellowish orange (10 YR 8/6) with dark yellowish orange (10 YR 6/6) limonite spots. Coarse-grained with scattered angular granules and pebbles of K-feldspar; poorly sorted. Massively thick bedded. Very well indurated, and highly jointed. Lower contact sharp and even	4.3 (1.3)
27	Very fine sandy siltstone, subarkose, grayish-red (5 R 4/2); weathers grayish orange (10 YR 7/4) with specks of dark yellowish orange (10 YR 6/6) limonite. Poorly sorted, and massively thick bedded. Very well indurated, breaks conchoidally. Lower contact sharp and planar	5.0 (1.5)
26	Muddy sandstone, lithic arkose, medium light gray (N 6); weathers in places to grayish orange (10 YR 7/4) and dark yellowish orange (10 YR 6/6). Medium to very coarse grained with subordinate granules and pebbles of angular K-feldspar; very poorly sorted with abundant chlorite matrix. Massively thick bedded. Very well indurated, abundant joints. Lower contact covered	13.5 (4.1)

	Thickness in feet (meters)
25 Very fine sandy siltstone, arkose, medium-gray (N 7); weathers in the lower half to grayish red (5 R 4/2). Poorly sorted with subordinate angular clasts K-feldspar up to 0.8 inch (2.0 cm) long. Massive to very thick bedded. Very well indurated, breaks conchoidally into shard-like masses. Lower contact sharp and planar	8.5 (2.6)
24 Sandstone, lithic arkose, medium light gray (N 6) and greenish-gray (5 GY 6/1); in places, weathers grayish orange (10 YR 7/4) with specks of dark yellowish orange (10 YR 6/6) limonite. Very coarse-grained and conglomeratic in lower 1.8 feet (0.6 m) grading upward into medium-grained sandstone near the top. Very poorly sorted, very well indurated. Massive and very thick bedded. Well jointed. Lower contact sharp and wavy	10.6 (3.2)
23 Very fine sandy siltstone, subarkose, grayish-red (10 R 4/2); weathers moderate reddish orange (10 R 4/6) with moderate reddish brown (10 R 4/6) limonite stains. Poorly sorted, very well indurated. Massive to very thick bedded. Well jointed. Lower contact gradational	7.1 (2.2)
22 Sandstone, arkose, grayish-orange (10 YR 7/4); weathers pale yellowish orange (10 YR 8/6) with dark yellowish orange (10 YR 6/6) limonite specks. Coarse to very coarse grained with lenses of conglomeratic sandstone consisting of granules and pebbles of angular and subangular K-feldspar set in coarse sandstone; poorly sorted. Very well indurated, well jointed. Massive and very thick bedded. Lower contact sharp and planar	29.8 (9.1)
21 Very fine sandy siltstone, subarkose, grayish-red (10 R 4/2); weathers moderate reddish orange (10 R 6/6). Poorly sorted, moderately indurated. Massively thick bedded. Unit contains minor thin beds of fissile silty shale. Well jointed. Lower contact covered	7.1 (2.2)
20 Sandstone, arkose, medium light gray (N 6); weathers moderate reddish orange (10 R 6/6) with moderate reddish brown (10 R 4/6) limonite spots. Basal 1.6 feet (0.5 m) is poorly sorted, highly weathered lithic pebble conglomerate; succeeded by very coarse, poorly sorted sandstone which grades into fine-grained, moderately sorted sandstone near the top. Sandstone is moderately indurated, and massively thick bedded. Well jointed. Lower contact covered ..	18.5 (5.6)
19 Fine sandy siltstone, subarkose, grayish-red (5 R 4/2); unweathered. Poorly sorted. In upper half of unit grades into silty, very fine grained sandstone. Very well indurated, well jointed. Massively very thick bedded in lower 12 feet (4 m); thick, even, parallel bedding above. Lower contact sharp and planar	20.6 (6.3)
18 Sandstone, arkose, medium light gray (N 6); weathers grayish orange (10 YR 7/4). Lithic pebble conglomerate in lowermost 1.0 foot (0.3 m) consisting chiefly of subrounded clasts of quartz-feldspar gneiss up to 2.4 inches (6.1 cm) long. Sandstone above is poorly sorted. and very coarse grained with scattered angular K-feldspar granules and pebbles. Massive and very thick bedded. Extremely well lithified with abundant secondary chlorite and epidote(?). Well jointed. Lower contact sharp and planar ..	11.2 (3.4)
17 Very fine sandy siltstone, subarkose, grayish-red (5 R 4/2); weathers spheriodally to pale red (5 R 6/2). Poorly sorted. Massive and thick bedded, with very thin silty shale partings in middle of unit. Moderately indurated to soft in lower 3 feet (0.9 m); well indurated above. Lower contact covered	3.7 (1.1)
16 Sandstone, arkose, weathers spheroidally to very pale orange (10 YR 8/2) and pale yellowish brown (10 YR 6/2) with mottles of dark yellowish orange (10 YR 6/6) limonite. Coarse to very coarse grained, and pebbly in places; poorly sorted. Massively very thick bedded. Moderately indurated and poorly exposed. Lower contact covered	10.8 (3.3)
15 Sandstone, arkose, dark greenish gray (5 GY 4/1); slightly weathered to grayish orange (10 YR 7/4). Medium grained, poorly sorted; in places, contains subrounded pebbles of K-feldspar and quartz-feldspar-mica gneiss. Massively thick bedded. Poorly exposed. Very well indurated, few joints. Lower contact gradational ...	5.1 (1.6)
14 Sandstone, arkose; weathers grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) limonite mottles. Very poorly exposed. Medium and coarse grained, poorly sorted, moderately indurated. Massively thick bedded. Contains scattered angular pebbles of pale-red (10 R 6/2) siltstone in the upper third of unit. Thin bed of grayish-red (10 R 4/2) fissile silty shale 13.9 feet (4.2 m) above base. Lower contact covered	33.4 (10.2)
13 Covered	10.4 (3.2)
12 Very fine, slightly sandy siltstone, arkose, grayish-red (5 R 4/2); weathers moderate reddish brown (10 R 4/6). Poorly sorted, becomes more	

		Thickness in feet (meters)
	sandy near top of unit. Massive and very thick bedded. Very well indurated, breaks conchoidally; slightly jointed. Lower contact gradational	28.4 (8.7)
11	Sandstone, arkose, light olive gray (5 Y 6/1); weathers dark yellowish orange (10 YR 6/6). Coarse and very coarse grained; in places, contains subangular pebbles and granules of K-feldspar. Poorly sorted, very well indurated, and well jointed. Massive and very thick bedded. Lower contact gradational	4.8 (1.5)
10	Sandstone, arkose, medium light gray (N 6); weathers grayish red (10 R 4/2). Coarse grained, very poorly sorted pebbly sandstone in basal 8 inches (20 cm); fine- to medium-grained, poorly sorted sandstone above. Massive to very thick bedded. Very well indurated, extensively jointed. Lower contact sharp and even	5.1 (1.6)
9	Sandstone, lithic arkose, pale-red (5 R 6/2); weathers pale yellowish orange (10 YR 8/6) with abundant dark yellowish orange (10 YR 6/6) limonite mottles. Medium to very coarse grained, with scattered granules and pebbles of angular K-feldspar; poorly sorted. Massive to very thick bedded with faint, thick trough cross-bedding. Very well indurated; numerous joints. Lower contact gradational	25.8 (7.9)
8	Very fine sandy siltstone, subarkose, grayish-red (10 R 4/2); weathers in places to dark yellowish orange (10 YR 6/6). Contains thin beds of fine muddy sandstone in upper half of unit. Poorly sorted, well indurated. Massively medium bedded with several very thin beds of silty shale. Unit poorly exposed in lower 7.2 feet (2.2 m); well indurated and well jointed above. Lower contact covered	33.9 (10.4)
7	Sandstone, arkose, light-gray (N 7); weathers pale yellowish orange (10 YR 8/6) with mottles of dark yellowish orange (10 YR 6/6) limonite. Fine- to very fine-grained, poorly sorted, and moderately indurated. Massively thick bedded. Well jointed. Lower contact covered	4.8 (1.5)
6	Sandstone, lithic arkose, light-gray (N 7); weathers grayish orange (10 YR 7/4) with dark yellowish orange (10 YR 6/6) mottles of limonite. Coarse and very coarse grained with scattered granules and pebbles of angular K-feldspar; very poorly sorted. Massive and very thick bedded. Moderately to well indurated, highly jointed. Lower contact covered	10.6 (3.2)
5	Sandstone, arkose, light olive gray (5 YR 6/1); weathers pale yellowish orange (10 YR 8/6) with patches of dark yellowish orange (10 YR 6/6) limonite. Poorly exposed. Fine to coarse grained, with scattered pebbles and granules of angular K-feldspar; very poorly sorted. Massive and very thick bedded. Moderately indurated, highly jointed. Lower contact gradational	34.1 (10.4)
4	Sandstone, lithic arkose, medium light gray (N 6); weathers very pale orange (10 YR 8/2) and pale yellowish orange (10 YR 8/6), with mottles of dark yellowish orange (10 YR 6/6) and light brown (5 YR 5/6) limonite throughout. Poorly exposed. Medium to very coarse grained with numerous granules and pebbles of angular K-feldspar; poorly sorted. Contains thin and medium beds of pebble and granule conglomerate. Sandstones are massively and very thick bedded. Conglomerate beds are moderately to poorly indurated; sandstones well indurated. Well jointed. Lower contact covered	55.4 (16.9)
3	Sandstone, arkose, light olive gray (5 Y 6/1); weathers pale red (5 R 6/2). Very poorly exposed. Fine and very fine grained, poorly sorted, moderately indurated. Massive and very thick bedded. Lower contact concealed	9.2 (2.8)
2	Sandstone, lithic arkose, pale-red (10 R 6/2); weathers moderate orange pink (5 YR 8/4). Coarse and very coarse grained, with scattered granules and pebbles of angular K-feldspar; very poorly sorted. Contains lenses of granule and pebble conglomerate with a matrix of very poorly sorted, coarse-grained arkosic sandstone. Conglomerate lenses moderately indurated; sandstones well indurated. Massive and very thick bedded. Well jointed. Lower contact covered ..	34.8 (10.6)
1	Sandstone, arkose, light-gray (N 7); weathers light brown (5 YR 6/4). Poorly exposed. Fine and medium grained, poorly sorted, moderately to well indurated. Massive and thick bedded. Well jointed. Lower contact covered	4.9 (1.5)
	Total Thickness of Measured Section	530.2 (161.6)

APPENDIX II

ROAD LOG

The following road log is a guide to important geologic features that can be seen along or near highways in the Blairs, Mount Hermon, Danville, and Ringgold 7.5-minute quadrangles. Distances between points of interest as well as cumulative mileage, are shown, and the stops are places where features such as formational contacts, structures, and interesting rocks types or minerals may be observed. *Permission should be obtained from the owner before entering and collecting any samples from private property. Failure to obtain permission to enter violates trespass laws and is punishable under law.*

Cumulative miles (km)	*Distance*	*Explanation*
0.0 (0.0)	0.0 (0.0)	Begin road log at intersection of U. S. Highways 29 and 58, Holiday Inn in Danville. Proceed westward on U. S. Highway 58 (Riverside Drive).
0.3 (0.5)	0.3 (0.5)	Note the flood plain on the north side of the Dan River which has undergone extensive commercial development. In this area several large stores have been damaged by floods in recent years. Cross Sandy River.
1.4 (2.3)	1.1 (1.8)	Turn right on exit ramp to U. S. Highway 29 south (Park Avenue).
1.5 (2.5)	0.1 (0.2)	Cross Dan River, note old hydroelectric dam on right (upstream).
1.8 (3.0)	0.3 (0.5)	Turn right at south end of Robertson Bridge across Dan River and follow U. S. Highway 29 south (Memorial Drive).
2.0 (3.3)	0.2 (0.3)	Dan River Park on right. It is developed in flood plain and has been flooded in recent years, but the type of development is such that it is not seriously threatened by periodic floods.
2.7 (4.4)	0.7 (1.1)	Turn right at top of hill following U. S. Highway 29 (West Main Street).
5.0 (8.1)	2.3 (3.7)	Turn left onto State Road 1157.
5.1 (8.3)	0.1 (0.2)	Turn right onto State Road 1156.
5.3 (8.6)	0.2 (0.3)	Turn right to Vulcan Materials Company quarry road and cross Virginia-North Carolina boundary.
5.5 (8.9)	0.2 (0.3)	Cross railroad tracks, asphalt plant on right.
5.8 (9.4)	0.3 (0.5)	Quarry office. Obtain permission from Vulcan Materials Company to enter quarry, turn right, following haulage road to quarry.
6.2 (10.0)	0.4 (0.6)	*STOP 1.* Quarry, the type locality of Shelton Formation. Shelton gneiss at this locality is a homogeneous, coarse-grained, gray to pinkish granitic gneiss. Feldspar is pervasively rodded. No primary layering has been recognized but there are widely spaced and discontinuous mica-rich zones which tend to weather to a more pinkish hue than surrounding rocks. Millimeter thick seams of purple fluorite were found in one of these zones exposed in the southeastern wall of the quarry at the lowest level in 1972. Continue along access road to northwest.
6.4 (10.3)	0.2 (0.3)	Contact with conspicuously layered metamorphosed volcanic-sedimentary rocks is exposed in a cut just northwest of northwestern rim of the quarry (Figure 2). The material in the cut consists of a light-gray to white saprolite with dark

Cumulative miles (km)	*Distance*	*Explanation*
		greenish gray interbands that show the rocks have a gentle dip to the northwest. The saprolite is derived from epidote-hornblende and hornblende schist interlayered with fine quartz-feldspar gneiss. In deeply weathered exposure the contact between the Shelton and the overlying metamorphosed volcanic-sedimentary rocks has been placed at the first dark-green, mafic metavolcanic layer. The fresh rock is exposed along U. S. Highway 29, approximately 1,000 feet (305 m) to the northwest. Reverse direction and return by way of the quarry office.
7.2 (11.6)	0.8 (1.3)	Turn left onto State Road 1156.
7.4 (11.9)	0.2 (0.3)	Turn right onto U. S. Highway 29 south.
7.9 (12.7)	0.5 (0.8)	Cross boundary from Virginia into North Carolina.
8.3 (13.3)	0.4 (0.6)	*STOP 2.* Turn right at entrance to South Drive-In Theater. The contact between massive Shelton gneiss and conspicuously layered metamorphosed volcanic-sedimentary rocks has been traced from the Shelton quarry to the southern exit of the theater. The contact is sharp and concordant. Relatively fresh Shelton gneiss is exposed in roadcuts along U. S. Highway 29 to the south and metamorphosed volcanic-sedimentary rocks are exposed discontinuously in a cut along the highway between the drive-in theater and the Virginia-North Carolina boundary. The rocks exposed in this section are part of the lower unit of the metamorphosed volcanic-sedimentary rocks. Near the contact with the Shelton Formation on U. S. Highway 29 the lower unit contains widely spaced, thin, mafic interbeds in fine-grained, massive, quartz-feldspar gneiss. This is poorly exposed along U. S. Highway 29, but fairly well exposed in the bottom of a stream southwest of the drive-in theater. This basal interval grades upward into very regular and closely spaced interlayers of hornblende schist, quartz-feldspar gneiss, and fine-grained biotite gneiss, which crops out in the cuts along U. S. Highway 29. More fine-grained biotite gneiss and kyanite-bearing mica schist occurs in the lower unit to the west of U. S. Highway 29. After examining the roadcuts along U. S. Highway 29, reverse direction, and head north, toward Danville on U. S. Highway 29.
8.9 (14.3)	0.6 (1.0)	Cross North Carolina-Virginia boundary.
9.3 (14.9)	0.4 (0.6)	Danville city limits. Contact between lower and upper units of metamorphosed volcanic-sedimentary rocks just north of Virginia House Motel. Lack of outcrops on the upland surface and light-colored sandy soils is characteristic of the upper unit.
10.8 (17.3)	1.5 (2.4)	Diabase boulders occur on both sides of U. S. Highway 29. The trace of the diabase dike is inferred to cross the highway at Forest Lawn Church.
11.4 (18.3)	0.6 (1.0)	Turn left onto U. S. Highway 29 Bypass (Memorial Drive).
12.3 (19.8)	0.9 (1.5)	Turn left at stop light onto Robertson Bridge over Dan River (Park Road).
12.5 (20.1)	0.2 (0.3)	Turn right onto U. S. Highway 58 east (Riverside Drive). Exposures above River Drive Restaurant are hornblende and biotite gneiss of the lower unit of the metamorphosed volcanic-sedimentary rocks.

Cumulative miles (km)	*Distance*	*Explanation*
12.9 (20.7)	0.4 (0.6)	Turn left into Riverside Shopping Center at Riverview Drive.
13.1 (21.0)	0.2 (0.3)	Turn right onto road behind Riverside Shopping Center.
		STOP 3. Deep cut in bedrock behind Shopping Center has exposed metamorphosed volcanic-sedimentary rock. Rock types are hornblende gneiss and epidote-hornblende gneiss with interlayers of biotite gneiss. Prominent layering and round quartz and feldspar grains appear to be of sedimentary origin. Recumbent isoclinal fold exposed in southeastern end of cut. Minor faults are exposed in cut on vacant lot northeast of Advance Auto Store.
13.4 (21.5)	0.3 (0.5)	Leave parking lot onto Riverview Drive.
13.5 (21.7)	0.1 (0.2)	Turn right on Westover Drive (State Highway 51).
13.6 (21.9)	0.1 (0.2)	Turn left onto U. S. Highway 58 east. Microbreccia dike in metamorphosed volcanic-sedimentary rocks exposed behind McDonalds restaurant.
13.9 (22.4)	0.3 (0.5)	Cross Sandy River. Continue eastward along U. S. Highway 58.
14.3 (23.0)	0.4 (0.6)	Cross Sandy Creek.
14.4 (23.2)	0.1 (0.2)	Turn left on U. S. Highway 29 at Holiday Inn, and immediately turn left into entrance to King's Fairground Plaza. Turn right, following service road behind Kroger food store.
		STOP 4. Metamorphosed volcanic-sedimentary rocks exposed in highwall embankment at King's Fairground Plaza. Section is located parallel to Sandy Creek from U. S. Highway 29 Bypass on the northwestern end to U. S. Highway 29 (Piney Forest Road) at the southeastern end. Badly sheared upside-down Shelton gneiss occurs in the core of a synform northwest of U. S. Highway 29 Bypass. The lower part of the lower unit exposed at the northwestern end of the cuts at King's Fairground Plaza is generally similar to the section southwest of the Drive-In Theater at stop 2. It consists of fine-grained quartz-feldspar gneiss with thin, mafic metavolcanic layers. Several conspicuous faults offset the mafic layers at the northwest end of the section described previously. The rocks are deeply weathered. Interlayered hornblende gneiss and schist become much more prominent toward the middle of the cuts. Several complex recumbent folds are exposed in hornblende gneiss near the southeast end of the section behind the Kroger store. Microbreccia is exposed along a shear zone in this area. Calcite, drusy quartz, and zeolite zones occur in sheared hornblende gneiss. Continue on and toward the shopping center entrance.
14.9 (24.0)	0.5 (0.8)	Turn right onto U. S. Highway 29 (Piney Forest Road); turn immediately to the left at intersection with U. S. Highway 58 east (Riverside Drive).
15.3 (24.6)	0.4 (0.6)	Earth embankments along north side of Riverside Drive have been cut in saprolite of the metamorphosed volcanic-sedimentary rocks.
15.9 (25.6)	0.6 (1.0)	Turn right onto Poplar Street and park on side of road west of entrance to Dan River Mills.

Cumulative miles (km)	*Distance*	*Explanation*
		STOP 5. Hornblende gneiss and epidote-hornblende gneiss similar to southeast part of cut at stop 4. Recumbent folds and minor faults that have steep dips are exposed in cut on north side of Poplar Street at north end of bridge.
16.1 (25.9)	0.2 (0.3)	Turn left on Henry Road.
16.2 (26.1)	0.1 (0.2)	Turn left on the Riverside Drive (U. S. Highway 58 west).
17.2 (27.7)	1.0 (1.6)	Turn right at Holiday Inn onto U. S. Highway 29 (Piney Forest Road).
17.9 (28.8)	0.7 (1.1)	Turn right onto U. S. Highway 29 Bypass.
20.4 (32.8)	2.5 (4.0)	Turn left on State Highway 41 (Franklin Turnpike).
22.4 (36.0)	2.0 (3.2)	Mount Hermon School on left. The Mount Hermon area is a high, rolling plain underlain by quartz-feldspar gneiss of the upper unit of the metamorphosed volcanic and sedimentary rocks. Alluvial terrace deposits occur on some hilltops and the clay-rich soils associated with the deposits may be responsible for severe limitation with regards to septic-tank drainage-field waste-disposal systems.
23.9 (38.4)	1.5 (2.4)	Mount Hermon Church on left.
24.0 (38.6)	0.1 (0.2)	Turn right on State Road 864.
24.2 (38.9)	0.2 (0.3)	*STOP 6.* Outcrop of saprolite derived from quartz-feldspar gneiss (upper unit, metamorphosed volcanic-sedimentary rocks). Well-developed schistosity and lack of layering is characteristic of the unit. Continue along State Road 864. White Oak Mountain, a prominent ridge, is underlain by the Dry Fork Formation, which is visible to the northwest.
24.7 (39.7)	0.5 (0.8)	*STOP 7.* For reference there is a farm pond on the right side of road and rock is exposed in low roadcuts on west side of road. This outcrop is located near the contact between the upper and lower units of metamorphosed volcanic-sedimentary rocks. Metamorphic grade at this locality is much lower than at the stops in this unit in Danville. Note slaty cleavage, primary layering of mafic and felsic rocks, and phenocrysts in felsic layers. Silvery-gray quartz-muscovite schist occurs interbedded in the lower unit near the upper contact. The schist may be seen in drainage ditches toward the southwest along the sides of State Road 864 near the crest of the hill. Turn around in driveway and retrace route to State Highway 41.
25.2 (40.5)	0.5 (0.8)	Pass outcrop at stop 6.
25.4 (40.8)	0.2 (0.3)	Turn right onto State Highway 41.
25.8 (41.4)	0.4 (0.6)	Outcrops of felsic metavolcanic rock on right side of road (upper unit, metamorphosed volcanic-sedimentary rocks).
26.3 (42.2)	0.5 (0.8)	Approximate contact between Dry Fork Formation and metamorphosed volcanic-sedimentary rock. In this area a narrow strip of mafic and felsic metavolcanic rock, with mica schist interlayers separates the Dry Fork Formation

Cumulative miles (km)	*Distance*	*Explanation*
		from the felsic metavolcanic rocks. Turn right from State Highway 41 onto gravel farm road. Terrace deposits with round boulders of Dry Fork sandstone crops out in drainage ditches on side of road.
26.4 (42.4)	0.1 (0.2)	Barn road on left, continue to top of small hill.
26.6 (42.8)	0.2 (0.3)	Walk across field for approximately 1,320 feet (402 m) north to exposures of conglomerate near small stream.
		STOP 8. Basal conglomerate of Dry Fork Formation approximately 100 feet (30 m) northwest of the eastern margin of the Danville basin. The conglomerate facies is in fault contact with metamorphosed mafic and felsic volcanic rocks, exposed a short distance southeast of here (Plate 2).
		Thickness of the conglomerate in this area is 150 feet (46 m), and dip is to the northwest at 35 degrees. The conglomerate is very well indurated and poorly bedded. The rock is a cobble conglomerate in which rounded and subrounded clasts (4 mm-31 cm diameter, average 65 mm) float in a matrix of very poorly sorted arkose. The clasts are moderately well sorted with a sorting value of 0.58 (scale after Folk, 1974). Quartz-feldspar gneiss clasts in the conglomerate at this stop are identical to rocks of the metamorphosed felsic volcanic unit exposed less than a mile southeast of this stop. Rounded, bluish-gray waxy to vitreous quartz clasts are similar to quartzite layers in the metamorphosed mafic and felsic volcanic units exposed southeast of here.
		The high proportion of metamorphosed mafic and felsic volcanic clasts show an eastern source area for the conglomerate. The conglomerate is interpreted as alluvial fan deposits that accumulated along fault scarps which formed the eastern basin margin. Return to car and turn around.
26.8 (43.0)	0.2 (0.3)	Turn right on State Highway 41.
27.0 (43.3)	0.2 (0.3)	Approaching Pleasant Gap, a wind gap through White Oak Mountain.
28.0 (44.9)	1.0 (1.6)	Turn right on State Road 835 in Pleasant Gap.
28.7 (46.0)	0.7 (1.1)	Turn left on State Road 834, exposures of mudrock facies of Dry Fork Formation in drainage ditch on right. Sequence here consists of very dark gray shale with medium- to coarse-grained sandstone interbeds.
29.1 (46.6)	0.4 (0.6)	*STOP 9.* Saprolite of sheared conglomerate facies of Dry Fork Formation adjacent to (southeast of) the Chatham fault. Rocks in northwest end of roadcut are crush breccia, microbreccia, and cataclasite. Conglomerate can be recognized in the southeast end of cut. Continue along State Road 834.
29.3 (46.9)	0.2 (0.3)	Cross White Oak Creek, which marks the approximate trace of the Chatham fault.
29.5 (47.2)	0.2 (0.3)	*STOP 10.* Saprolite of Fork Mountain Formation exposed along road. The saprolite consists of deeply weathered mica schist interlayers with mica gneiss, cut by white pegmatitic granite dikes and sills. The rock has been metamorphosed to amphibolite facies and contains abundant rusty weathered clumps of garnet. This is typical of exposures northwest of the Danville basin.
29.8 (48.0)	0.3 (0.5)	Cross gas pipeline, saprolite of Fork Mountain Formation, exposed in roadcuts along State Road 834 for next mile.

Cumulative miles (km)	*Distance*	*Explanation*
31.3 (50.4)	1.5 (2.4)	Turn right on State Road 718. Typical reddish-brown soil of Fork Mountain Formation on both sides of the road.
32.2 (51.8)	0.9 (1.4)	Cross gas pipelines. Garnet-, kyanite-, and staurolite-rich nodules have been found in weathered Fork Mountain schist along the pipeline to the southwest.
32.7 (52.6)	0.5 (0.8)	Cross White Oak Creek.
33.2 (53.4)	0.5 (0.8)	Cross approximate trace of Chatham fault, which is contact between the Fork Mountain Formation and the Dry Fork Formation.
34.1 (54.8)	0.9 (1.4)	Cross Southern Railway at Dry Fork. Type locality for the Dry Fork Formation is located approximately 0.5 mile (0.8 km) to the south along the railway.
34.7 (55.4)	0.6 (1.0)	Turn right onto U. S. Highway 29 south. Note Vulcan Materials Company quarry on right at base of White Oak Mountain.
35.1 (56.5)	0.4 (0.6)	Quarry access road exits to right.
35.5 (57.1)	0.4 (0.6)	State Road 825 exits to left.

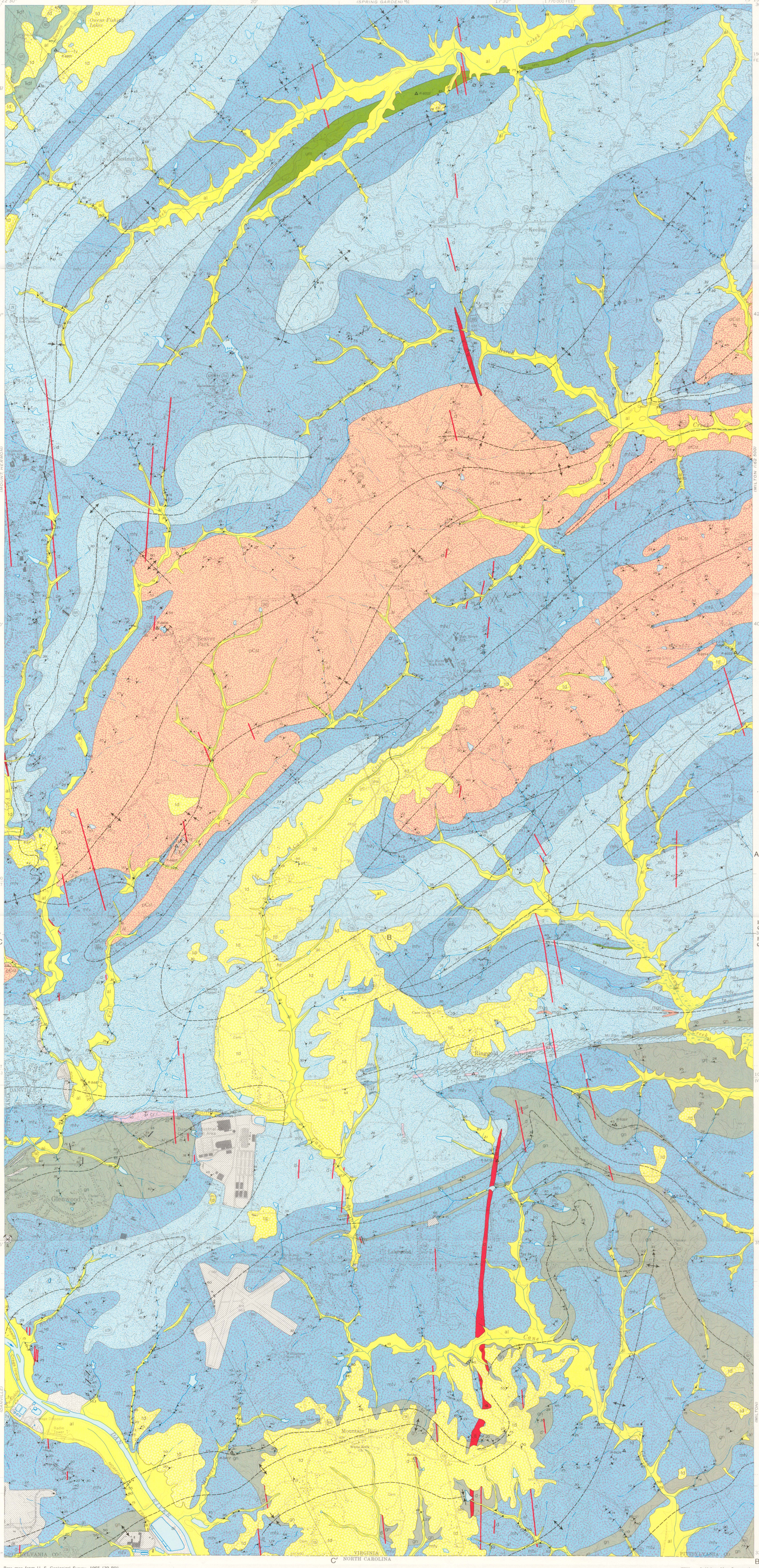
STOP 11. Sandstone facies, Dry Fork Formation. Long continuous exposure of the facies along the west side of U. S. Highway 29 on the crest of White Oak Mountain in extreme northeastern Mount Hermon quadrangle (stratigraphic section 1, Plate 2). *WATCH FOR CARS* as this is a busy road. The sequence at this exposure is described in detail in Stratigraphic section 1 (Appendix I). The section consists of irregularly interbedded well-indurated sandstone, conglomerate, and mudrock (chiefly siltstone). Sandstone makes up 78 percent of the section; mudrock, 15 percent; and conglomerate, 7 percent. The sandstone is chiefly medium- to coarse-grained, poorly sorted, gray arkose and lithic arkose. Minor fine- and very fine grained sandstone is subarkose. The sandstone is typified by high grain angularity and very dense packing. It is massive to thick bedded and generally contains thin conglomerate lenses, reddish-brown and dark-gray mudrock (siltstone) intraclasts and thin carbonaceous films, and carbonized wood chips and debris. A few medium- and coarse-grained sandstone beds have thick horizontal laminations, and medium- and large-scale tabular and trough cross stratification. Sandstone beds range from less than a foot to a maximum of 80 feet (24 m) thick; average thickness is 11 feet (3 m). Gray granule and pebble conglomerate is poorly sorted and contains abundant feldspar (chiefly salmon-colored microcline), dark-gray siltstone intraclasts, and minor quartz-feldspar gneiss clasts. The matrix is a coarse and very-coarse, poorly sorted lithic arkose. The conglomerate is massive to thick bedded. Thickness of beds range from less than a foot to 10 feet (3 m); average thickness is approximately 4 feet (1 m). Mudrock is chiefly massive to thick-bedded, reddish-brown and dark-gray siltstone, with dark-gray and dark greenish gray shale. Individual beds range from less than a foot to a maximum of 15.8 feet (5 m); average thickness is about 6 feet (2 m). Some siltstone contains angular quartz and potassic feldspar granules and pebbles in the finer silty-clay matrix. These rocks owe their hardness to dense grain packing (in sandstones) and abundant secondary "cementation" by calcite, chlorite, quartz, and untwinned potassium feldspar.

END OF LOG

INDEX

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

PUBLICATION 2
BLAIRS AND RINGOLD QUADRANGLES
PLATE 1



Base map from U. S. Geological Survey, 1965 (70 PR) Ringold and 1964 Blairs Quadrangles, 7½-minute series

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EXPLANATION

ROCK CHARACTERISTICS / GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION

		ROCK CHARACTERISTICS	GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION
QUATERNARY	al	Alluvium: *Silt, sand, and gravel with clay at base.*	Unconsolidated flood-plain deposits along streams subject to periodic flooding. Cuts and excavations subject to sliding and sloughing. Ranges from very rapid percolation to slow because of isolated clay deposits. Source of sand for aggregate in construction. (Unit 9 in text.)
QUATERNARY	td	Terrace deposits: *Rounded pebbles and cobbles in a clay or sandy clay matrix. Terraces at lower levels contain gray to yellowish-gray and red fine sandy clay.*	Unconsolidated deposits above stream level along slopes and on hilltops. Cuts and steep slopes subject to sliding and sloughing. Layers with rapid percolation may overlie impermeable clay or residuum, resulting in seepage problems in cuts and on steep natural slopes. (Unit 8 in text.)
TRIASSIC	d	Diabase dikes: *Fine- to medium-grained, dark-gray to black diabase.*	Clay-rich residual soil with rounded boulders overlies vertical sheets of hard bedrock. Contacts may be subject to seepage, slides, and sloughing when exposed in cuts and deep excavations. (Unit 7 in text.)
TRIASSIC	Ꞧdf	Dry Fork Formation: *Predominantly gray, brownish-gray, and greenish-gray sandstone; lesser amounts of mudstone and conglomerate.*	Slopes covered by colluvial deposits; thin stony residual soil and rock outcrops. Massive bedrock is closely jointed; slides common on steep cuts. Source of crushed stone for construction. (Unit 5 in text.)
PRECAMBRIAN	um	Ultramafic rocks: *Granular to schistose olivine-amphibole-chlorite rock.*	Residual soil of variable and rapidly lateral-changing thickness; locally highly plastic and compressible clay residuum with high shrink-swell potential, slow percolation. (Unit 2 in text.)
PRECAMBRIAN	fv, mgs	Metamorphosed volcanic-sedimentary rocks: fv, *massive to layered felsic metatuff; includes slaty, schistose, and gneissic lithofacies dependent on metamorphic grade; rare mafic flows (upper part).* mgs, *mica gneiss and schist.*	Relatively deep, loamy residual soil with a clay-rich or micaceous layer in the subsoil, which may show moderate to slow percolation. Subject to severe erosion on denuded slopes. (Unit 4 in text.)
PRECAMBRIAN	mfv, gn	mfv, *interlayered mafic and felsic metavolcanic rocks with psamittic and pelitic metasedimentary rocks. Includes slaty, schistose, and gneissic lithofacies dependent on metamorphic grade (lower part).* gn, *porphyroblastic biotite gneiss with kyanite-mica schist and sillimanite quartzite.*	Residual soil of variable and rapidly lateral-changing thickness; locally, highly plastic and compressible clay residuum with high shrink-swell potential and slow percolation. Subject to severe erosion on denuded slopes. (Unit 2 in text.)
PRECAMBRIAN	p€st	Shelton Formation: *Massive, lineated gneiss that ranges in composition from quartz monzonite to granite.*	Sandy residual soil with silty-clayey or clayey subsoil. Prominent rock outcrops on upland surface and on slopes. Source of aggregate (crushed stone). (Unit 1 in text.)
	cr	Cataclastic rocks: *Fine- to coarse-grained, vitreous to fragmental cataclastic rock; fine-grained and compact greenish-gray and brick-red cataclastic rock.*	Sheared and broken rocks. Minor faults may be common. Slides and sloughing may occur in cuts and deep excavations.

OTHER LAND-MODIFICATION FACTORS

Modified land: *Extensive cut and fill due to grading.*

Rockfalls: *Area of actual or potential rockfalls.*

Solid-waste disposal site.

Liquid-waste disposal site.

CONTACTS

Approximate

FOLDS

Antiform—trace and direction of plunge

Synform—trace and direction of plunge

Refolded isocline—trace

5 Direction and angle of plunge of minor antiformal fold hinge

23 Direction and angle of plunge of minor synformal fold hinge

60 Direction and angle of plunge of hinge line of minor asymmetric fold showing shear

6 Direction and angle of plunge of hinge line of minor reclined or recumbent isocline

41 39 Direction and angle of plunge of hinge line of minor reclined or recumbent isocline showing strike and dip of axial plane

40 45 Direction and angle of plunge of hinge line of minor asymmetric fold showing shear, and strike and dip of axial plane

25 Direction and angle of plunge of fold hinge of crenulation

Direction of major hinge of domal antiform

FAULTS

U D 70 Strike and dip of minor fault; U, upthrown side; D, downthrown side

U D Strike of minor vertical fault; U, upthrown side; D, downthrown side

Strike of minor vertical fault

30 Strike and dip of minor strike-slip fault; arrows indicate direction of relative movement

70 Strike and dip of minor fault plane

BLAIRS QUADRANGLE
36°37'30"
RINGGOLD QUADRANGLE

SHEAR ZONE

ATTITUDE OF ROCKS

60 Strike and dip of beds

FOLIATION

60 Strike and dip of compositional layering

Strike of vertical compositional layering

30 Strike and dip of schistosity

Horizontal schistosity

Strike of vertical schistosity

72 Strike and dip of cleavage

LINEATION

12 Direction and angle of plunge of inclined mineral lineation, mineral streaks, and slickensides

Direction of horizontal mineral lineation, mineral streaks, and slickensides

26 Direction and angle of plunge of inclined rodding

Direction of horizontal rodding

QUARTZ VEINS AND PEGMATITE DIKES

55 Strike and dip of quartz vein

Strike of vertical quartz vein

Strike of vertical pegmatitic granite dike

QUARRIES AND PROSPECT

3 Abandoned quarry

1. Crushed stone quarry (gneiss)
3. Crushed stone quarry (gneiss)
4. City of Danville (biotite gneiss)

2 Prospect

2. Five abandoned gold prospects

SAMPLE LOCATIONS

R-6014 R, repository number of sample

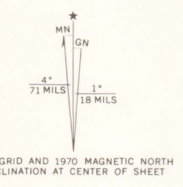
GEOLOGIC MAP OF THE BLAIRS AND RINGGOLD QUADRANGLES, VIRGINIA

Geology by William S. Henika and Paul A. Thayer

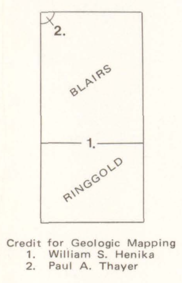
SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

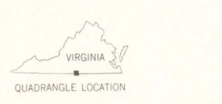
1977



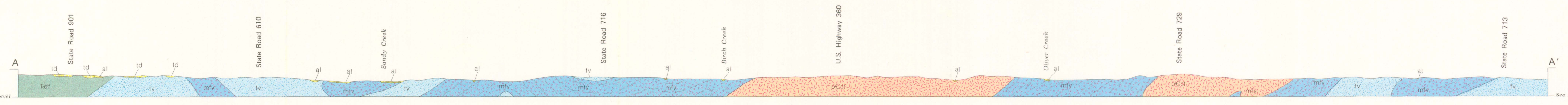
UTM GRID AND 1970 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

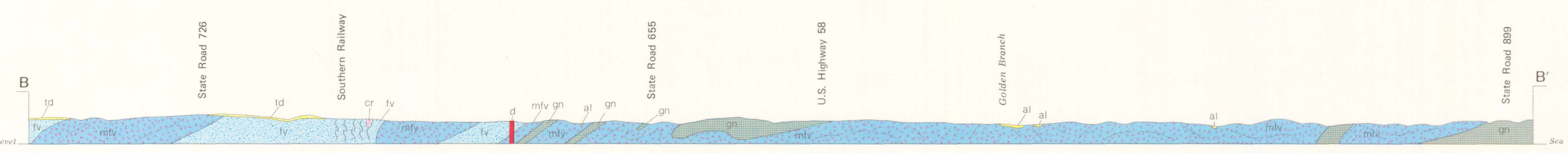


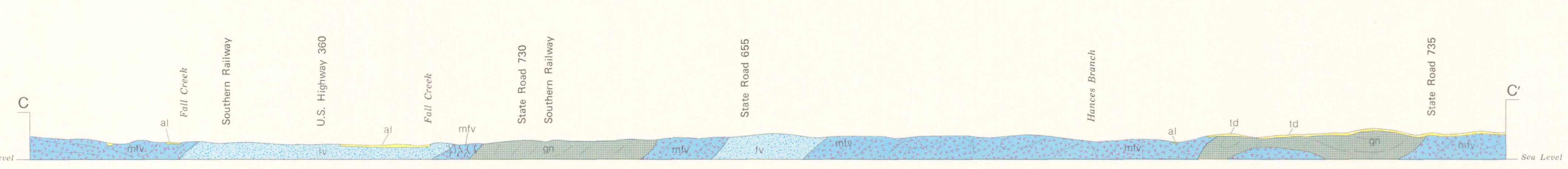
Credit for Geologic Mapping
1. William S. Henika
2. Paul A. Thayer



QUADRANGLE LOCATION





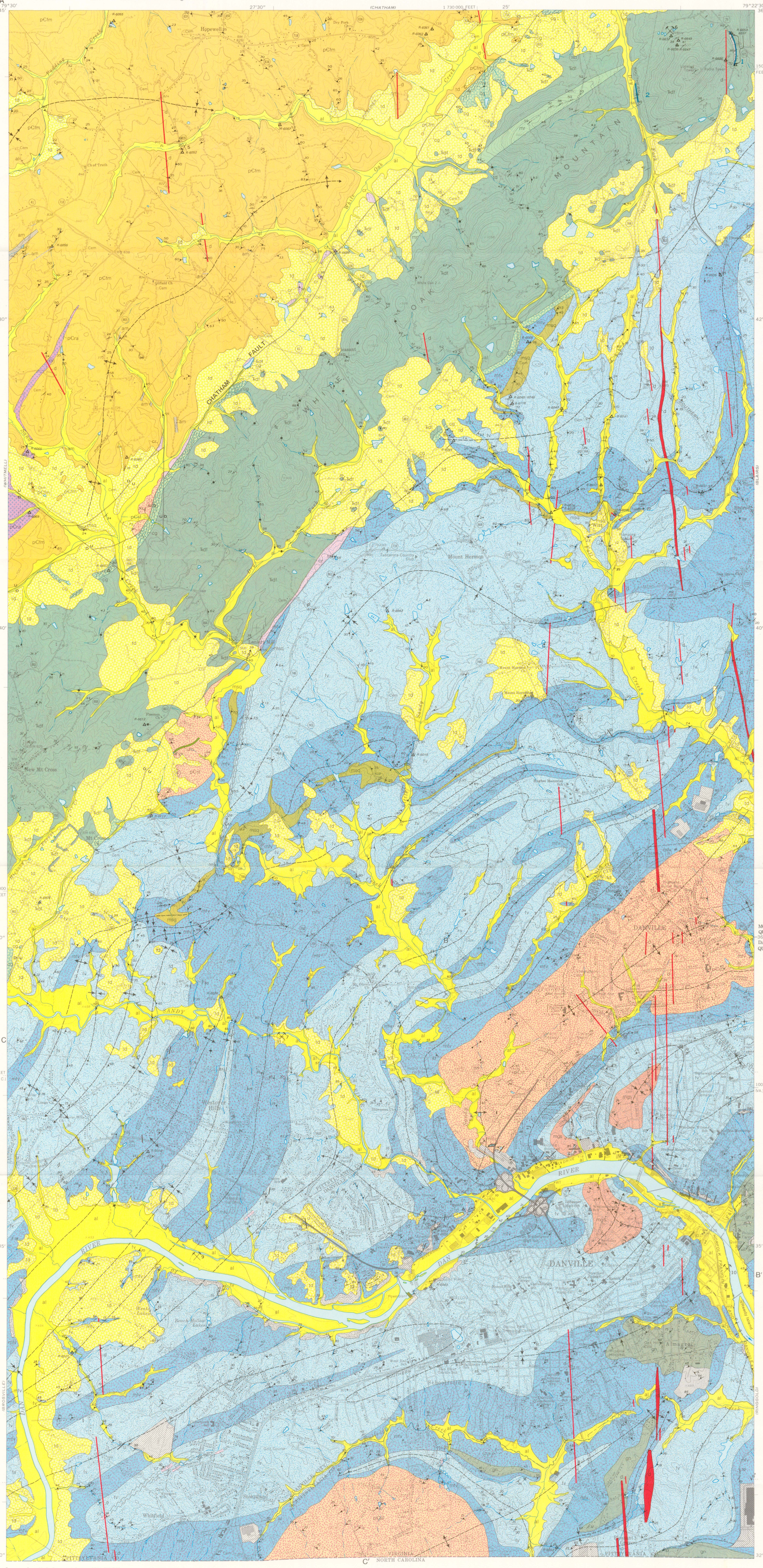


CROSS SECTION DESIGN:

1. No vertical exaggeration.
2. Subsurface structure interpreted from surface measurements.
3. Thickness of terrace deposits and alluvium diagrammatic.

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

PUBLICATION 2
MOUNT HERMON AND DANVILLE QUADRANGLES
PLATE 2



Base map from U. S. Geological Survey, 1964 (70 PR) Mount Hermon, and 1965 (70 PR) Danville Quadrangles, 7½-minute series

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EXPLANATION

ROCK CHARACTERISTICS / GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION

	Unit	Rock characteristics	Geologic and economic factors affecting land modification
QUATERNARY	al	Alluvium: *Silt, sand, and gravel with clay at base.*	Unconsolidated flood-plain deposits along streams subject to periodic flooding. Cuts and excavations subject to sliding and sloughing. Ranges from very rapid percolation to slow because of isolated clay deposits. Source of sand for aggregate in construction. (Unit 9 in text.)
QUATERNARY	td	Terrace deposits: *Rounded pebbles and cobbles in a clay or sandy clay matrix. Terraces at lower levels contain gray to yellowish-gray and red fine sandy clay.*	Unconsolidated deposits above stream level along slopes and on hilltops. Cuts and steep slopes subject to sliding and sloughing. Layers with rapid percolation may overlie impermeable clay or residuum, resulting in seepage problems in cuts and on steep natural slopes. (Unit 8 in text.)
TRIASSIC	d	Diabase dikes: *Fine- to medium-grained, dark-gray to black diabase.*	Clay-rich residual soil with rounded boulders overlies vertical sheets of hard bedrock. Contacts may be subject to seepage, slides, and sloughing when exposed in cuts and deep excavations. (Unit 7 in text.)
TRIASSIC	₮df, mr, cg	Dry Fork Formation: *Predominantly gray, brownish-gray, and greenish-gray sandstone; lesser amounts of mudstone and conglomerate.* cg, *predominantly poorly sorted, sandy conglomerate interbedded with very coarse grained sandstone.*	Steep slopes covered by colluvial deposits; thin stony residual soil and rock outcrops. Massive bedrock is closely jointed; slides common on steep cuts. Source of crushed stone for construction. (Unit 5 in text.)
TRIASSIC		mr, *medium- to dark-gray shale and mudrock with lesser amounts of light- to medium light gray, medium-grained sandstone and conglomerate.*	Variable permeability, clay-rich residual soil. Cuts subject to sliding and sloughing. Potential source of clays for brick and ceramic ware, and expandable shale for lightweight aggregate. (Unit 6 in text.)
PRECAMBRIAN	um	Ultramafic rocks; *Granular to schistose olivine-amphibole-chlorite rock.*	Residual soil of variable and rapidly lateral-changing thickness; locally highly plastic and compressible clay residuum with high shrink-swell potential, slow percolation. (Unit 2 in text.)
PRECAMBRIAN	p€ra	Rich Acres Formation: *Massive to schistose, olivine-amphibole chlorite rock with minor amounts of metagabbro.*	Residual soil of variable thickness. Locally highly plastic and compressible clay residuum with high shrink-swell potential and slow percolation. (Unit 2 in text.)
PRECAMBRIAN	p€fm, am	Fork Mountain Formation: *Garnetiferous muscovite-biotite gneiss with interlayered, garnetiferous muscovite-biotite schist.* am, *amphibolite and amphibole gneiss.*	Deep, residual, sandy loams. Subsoil contains a clay layer that may locally show slow percolation. Denuded slopes subject to severe erosion. (Unit 3 in text.)
PRECAMBRIAN	fv, mgs, mfv, msq, gn	Metamorphosed volcanic-sedimentary rocks: fv, *massive to layered felsic metatuff; included slaty, schistose, and gneissic lithofacies dependent on metamorphic grade, rare mafic flows (upper part).* mgs, *mica gneiss and schist.*	Relatively deep, loamy residual soil with a clay-rich or micaceous layer in the subsoil which may show moderate to slow percolation. Subject to severe erosion on denuded slopes. (Unit 4 in text.)
PRECAMBRIAN		mfv, *interlayered mafic and felsic metavolcanic rocks with psamittic and pelitic metasedimentary rocks. Includes slaty, schistose, and gneissic lithofacies dependent on metamorphic grade (lower part).* gn, *porphyroblastic biotite gneiss with kyanite-mica schist and sillimanite quartzite.* msq, *mica schist with quartzite interlayers.*	Residual soil of variable and rapidly lateral-changing thickness; locally, highly plastic and compressible clay residuum with high shrink-swell potential and slow percolation. Subject to severe erosion on denuded slopes. (Unit 2 in text.)
PRECAMBRIAN	p€sl	Shelton Formation: *Massive, lineated gneiss that ranges in composition from quartz monzonite to granite.*	Sandy residual soil with silty-clayey or clayey subsoil. Prominent rock outcrops on upland surface and on slopes. Source of aggregate (crushed stone). (Unit 1 in text.)
	cr	Cataclastic rocks: *Fine- to coarse-grained, vitreous to fragmental cataclastic rock; fine-grained and compact greenish-gray and brick-red cataclastic rock.*	Sheared and broken rocks. Minor faults may be common. Slides and sloughing may occur in cuts and deep excavations.

OTHER LAND–MODIFICATION FACTORS

Modified land: *Extensive cut and fill due to grading.*

Rockfalls: *Area of actual or potential rockfalls.*

Solid-waste disposal site.

Liquid-waste disposal site.

CONTACTS

Approximate

FOLDS

Antiform—trace and direction of plunge

Synform—trace and direction of plunge

Refolded isocline—trace

40 Direction and angle of plunge of minor antiformal fold hinge

16 Direction and angle of plunge of minor synformal fold hinge

30 Direction and angle of plunge of hinge line of minor asymmetric fold showing shear

20 Direction and angle of plunge of hinge line of minor reclined or recumbent isocline

30 14 Direction and angle of plunge of hinge line of minor reclined or recumbent isocline showing strike and dip of axial plane

25 45 Direction and angle of plunge of hinge line of minor asymmetric fold showing shear, and strike and dip of axial plane

FAULTS

U D Black line where exposed or approximate; gray line where covered or inferred; U, upthrown side; D, downthrown side

U D 80 Strike and dip of minor fault; U, upthrown side; D, downthrown side

U D Strike of minor vertical fault; U, upthrown side; D, downthrown side

Strike and dip of minor vertical strike-slip fault; arrows indicate direction of relative movement

Strike of minor vertical fault

78 Strike and dip of minor strike-slip fault; arrows indicate direction of relative movement

80 Strike and dip of minor fault plane

SHEAR ZONE

ATTITUDE OF ROCKS

35 Strike and dip of beds

FOLIATION

75 Strike and dip of compositional layering

Strike of vertical compositional layering

15 Strike and dip of schistosity

Horizontal schistosity

Strike of vertical schistosity

45 Strike and dip of cleavage

Strike of vertical cleavage

JOINTING

66 Strike and dip of joints

Strike of vertical joints

LINEATION

19 Direction and angle of plunge of inclined mineral lineation, mineral streaks, and slickensides

Direction of horizontal mineral lineation, mineral streaks, and slickensides

11 Direction and angle of plunge of inclined rodding

Direction of horizontal rodding

QUARTZ VEINS AND PEGMATITE DIKES

70 Strike and dip of quartz vein

Strike of vertical quartz vein

Strike of vertical pegmatitic granite dike

QUARRIES AND PROSPECT

6 Active quarry

6. Vulcan Materials, Inc. (sandstone, mudrock, and conglomerate)
9. Kendall Sand Works (sand)

7 Abandoned quarry

7. Kendall Sand Works (sand)
8. City of Danville (hornblende gneiss)
10. Marshall Sand and Gravel Co. (sand)

5 Prospect

5. Abandoned gold prospect

SAMPLE LOCATIONS

R-6783 R, repository number of sample

2 Location of measured stratigraphic section

GEOLOGIC MAP OF THE MOUNT HERMON AND DANVILLE QUADRANGLES, VIRGINIA

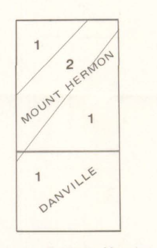
Geology by William S. Henika and Paul A. Thayer

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1977

UTM GRID AND 1965 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



Credit for Geologic Mapping
1. William S. Henika
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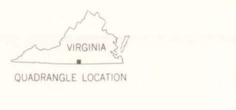

QUADRANGLE LOCATION

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