

GEOLOGIC MAP OF THE SPRING GARDEN QUADRANGLE, VIRGINIA

By
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EXPLANATION

UNIT CHARACTERISTICS

- QUATERNARY**
 - ae Alluvium: Silt, sand, and gravel with clay at base
 - te 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
 - di Diabase dikes: Fine- to medium-grained, dark gray to black diabase
 - ca Cataclastic rocks: Medium light-gray to light orange-pink protomylonite, mylonite gneiss, schist, and cataclaste
- MESOZOIC**
 - ts Triassic sedimentary rocks: The Cow Branch Formation divides the Stoneville and Pine Hill Formations. Where the Cow Branch is absent, the stratigraphy is undivided and the entire stratigraphic sequence is named the Dry Fork Formation. An inferred boundary is drawn where the Cow Branch pinches out to the southwest. Southwest of this line the upper and lower stratigraphic sequences can no longer be defined.
 - ts1 Dry Fork Formation, sandstone facies: red to gray mudstones. Thickness 5,400 to 10,500 feet (1546 to 3200 meters)
 - ts2 Stoneville Formation: medium- to coarse-grained green and brownish-red sandstones with subordinate reddish-brown mudstones
 - ts3 Cow Branch Formation: dark gray to black mudstones with subordinate gray sandstones and maroon mudstones. Thickness 200 feet (610 meters)
 - ts4 Pine Hill Formation: medium- to coarse-grained tan and gray sandstones with minor reddish brown mudstones. Thickness 1600 to 4000 feet (1008 to 1210 meters)

GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION

- Unconsolidated floodplain 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. Potential source of sand for aggregate in construction
- Unconsolidated deposits above stream level along slopes and hillsides. Cuts and steep slopes subject to sliding and sloughing. Layers with rapid percolation may overlie impermeable clay or residual resulting in seepage problems in cuts and on steep natural slopes
- 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
- Sheared and broken rocks. Yellowish-gray to light gray, sandy soils with angular quartz gravel near surface

INFERRED LITHOCLASTIC BOUNDARY

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- 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
- 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
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PRECAMBRIAN

- sh Shelton Formation: Light-orange-pink, coarse-grained, massive layered gneiss that ranges in composition from quartz monzonite to granite
- lg Leatherwood Granite: Coarse-grained to porphyritic gneiss; exhibits ophiolite structure (450 m.y.)
- ra Rich Acres Formation: Dark greenish-gray, massive to well-foliated metamorphosed gabbro, diorite, and coarse amphibolite

- Sandy residual soil with silt-clayey or clayey subsoil. Prominent rock outcrops on slopes and streams
- Sandy residual soil with silt-clayey and clayey subsoil. Prominent outcrops along slopes and streams
- Residual soil of variable thickness. Locally highly plastic and compressible clay residuum with high shrink-swell potential and low permeability

CONTACTS

- Exposed or approximate
- Covered or inferred

ATTITUDE OF ROCKS

- Strike and dip of inclined beds

FOLDS

- Antiform: Trace of fold and direction of plunge
- Synform: Trace of fold and direction of plunge
- Overturned antiform: Trace of fold and direction of plunge
- Overturned synform: Trace of fold and direction of plunge
- Minor Fold: strike and dip of axial surface and direction of plunge
- Minor Fold: strike and dip of axial surface, direction of plunge and symmetry of vergence
- Minor dome showing trend of major and minor axes

- Relatively deep, loamy residual soil with a clay-rich micaceous layer in the subsoil which may show moderate to low percolation. Subject to severe erosion on denuded slopes
- Deep, residual, sandy loams. Subsoil contains a clay layer that may locally show slow percolation. Denuded slopes subject to severe erosion

JOINTING

- Strike and dip of inclined joints
- Strike of vertical joints

JOINTING

- Strike and dip of inclined schistosity
- Strike of vertical schistosity
- Strike and dip of inclined compositional banding
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LINEATION

- Trend and direction of plunge of lineation

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QUARRY

- Abandoned crushed-stone quarry

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SAMPLE LOCATIONS

- R-92-249 R. Virginia Division of Mineral Resources

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FAULTS

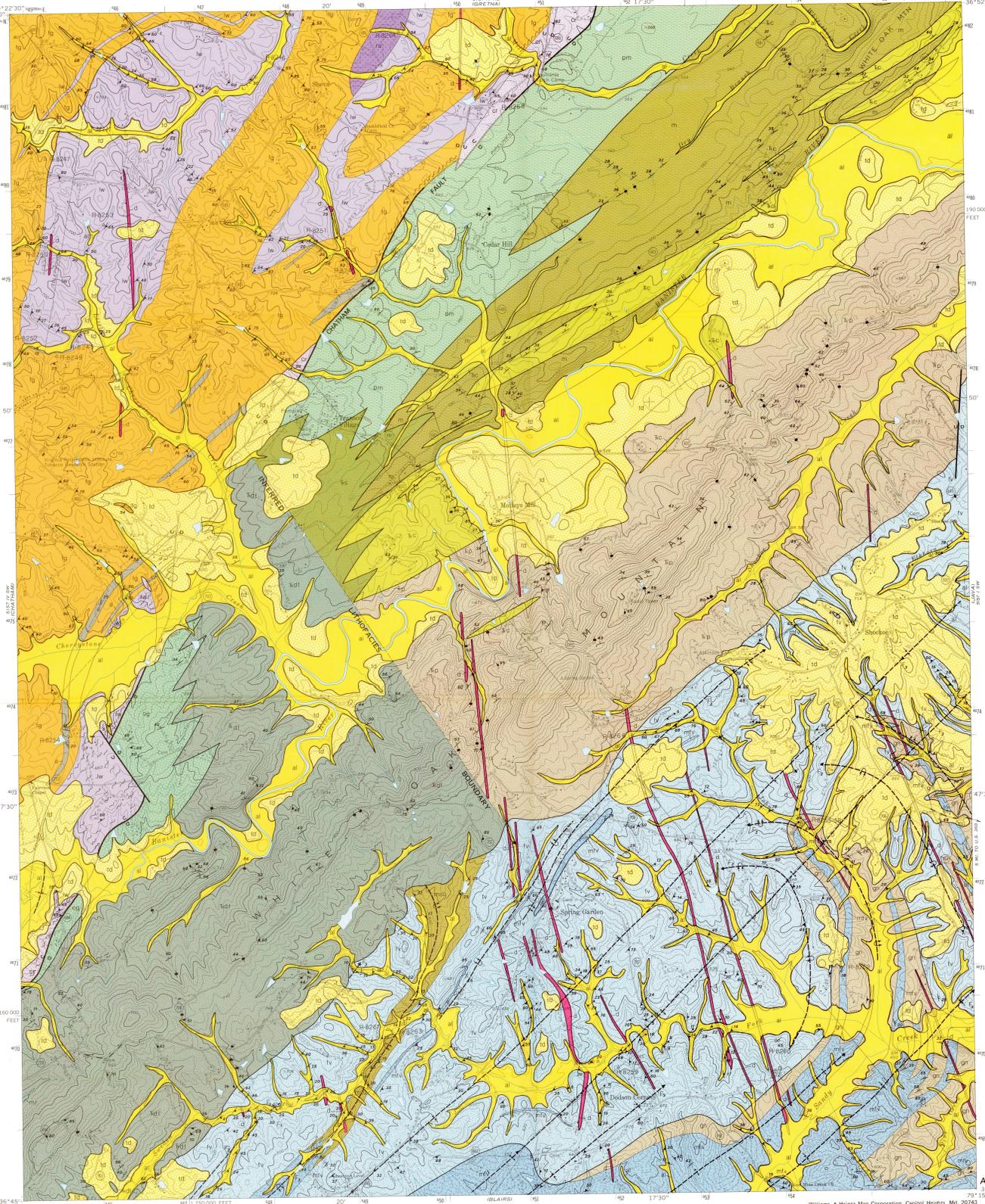
- Exposed or approximate (black); covered or inferred (gray): U, upthrown; D, downthrown block. Arrows indicate relative direction of movement.

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CROSS SECTION DESIGN

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



INTRODUCTION

The Spring Garden quadrangle comprises an area of approximately 60 square miles within the Piedmont province in Pittsylvania County, in south-central Virginia. White Oak Mountain, a prominent northeast-trending hogback ridge, composed of well-indurated Triassic felspathic sandstone, is the most conspicuous topographic feature in the region. Elevation ranges from 890 feet on White Oak Mountain to 480 feet along Banner River. The Triassic rocks of the Danville basin divide a group of metamorphic rocks lying northwest of the basin. The area has undergone considerable uranium exploration activity in recent years.

STRATIGRAPHY

Late Precambrian - Paleozoic Rocks
Fort Mountain Formation
The Fort Mountain Formation (fm) was named by Conley and Henika (1973) from exposures of garnet-mica schist and garnet-biotite gneiss along Fort Mountain near Martinsville, Virginia. In the Martinsville area these metamorphic rocks are intruded by a large pluton composed of mafic and felsic rocks named the Martinsville igneous complex by Ragland (1974). The granitic phase of this complex was dated radiometrically at 450 my by the U. S. Geological Survey (Rankin, 1975). This date provides a minimum (Paleozoic) age for the Fort Mountain Formation. To maximum age has been established, although the formation is part of the Smith River Altonian which is thought to be about 600 million years old. Precambrian rocks in the Swanton Mountain anticline (Conley and Henika 1973). Exposures of garnet-mica schist and garnet-biotite gneiss show a polydeformed fabric and sillimanite porphyroblasts which are similar to those in the Martinsville area. They appear to be limited to the area northeast of the elliptical plume of Leathewood Granite mapped in the northeast corner of Spring Garden quadrangle. The unit to the southwest is predominantly a planar layered, medium- to fine-grained biotite gneiss with thin silvery-gray muscovite schist. The planar-layered gneiss contains contact amphibolite and amphibole gneiss layers (a) along the northwestern margin of the Danville Triassic basin. The amphibole gneiss is thought to be of volcanic origin although diagnostic amphibole minerals and textures similar to those preserved in amphibolite layers of the Fort Mountain near Pilot Point in the Martinsville area (Conley and Henika, 1970) are lacking.

Upper Triassic Sedimentary Rocks

The Upper Triassic sedimentary rocks are red, reddish-gray, or gray continental clastic deposits consisting of interbedded conglomerate (cg), sandstone, and mudstone (m, pm, ml). Individual units are characterized by abrupt lateral and vertical changes in texture, color, composition, and thickness. Coarse-grained chert rocks dominate the margins of the basin, whereas fine-grained rocks are in the central part of the basin. Based on outcrop width and average dip, estimates of total thickness of Triassic strata in the mapped area range from 3,600 feet in the narrowest part of the basin to 15,300 feet in the widest part.

Triassic sedimentary rocks in the northeastern part of the area are divisible into three formations, which are (from top to bottom) the Pine Hill, Cow Branch, and Stoneville formations (Thayer, 1970). The three formations interfinger, but in most places the Pine Hill, Cow Branch, and Stoneville formations occur above the other. Southwest of Motley Mill in the central part of the quadrangle these units intertongue with Dry Fork Formation (Meyertons, 1963), which occupies the entire central and south-central part of the Danville basin. The Dry Fork is synchronous with Pine Hill, Cow Branch, and Stoneville formations, and in this report is separated from them by an inferred lithologic boundary drawn southwest of Motley Mill, beyond which the distinctive beds of the formation do not extend.

Cataclastic Rocks

These rocks (ca) are extensively brecciated and have a shear foliation locally along the fault zone forming the northeast border of the Triassic basin. The rock is siliceous and cut by multiple fractures, many of which are filled with quartz. Banded or true mylonitic textures are not common. The largest body of cataclastic rocks is more than a mile long and more than 1,000 feet wide. Rock at the northwestern margin of the cataclastic rock body is gradational with protomylonite rocks derived from the Leathewood Granite. To the southeast where the cataclastic rock is adjacent to Triassic sedimentary rocks, it is derived from Triassic conglomerate. Rock samples from the middle of the body contain elongate masses of biotite amphibole (red-brown) and apatite. This mineralogy is similar to the altered tuffaceous sediments described from Triassic rocks in the southwestern portion of the Danville basin (Allen, 1967). Because of poor exposure, the fibrolite-bearing rock was not mapped separately from the remainder of the cataclastic rock unit, but it does seem to have characteristic aeromagnetic signature and underlies a positive aeromagnetic anomaly (Virginia Division of Mineral Resources, 1968).

Diabase Dikes

The dikes (d) range from medium to coarse grained and have a characteristic subophitic texture. They are composed predominantly of diopside and clinopyroxene, with lesser amounts of olivine and opaque minerals. Secondary minerals include biotite, hematite, calcite, chlorite, and a turbid clay-like mineral. Olivine contains rounded calcite crystal masses up to 0.4 inch across. The thickest dike, which occurs south of Spring Garden, has a maximum width of approximately 200 feet. Some of the dikes can be traced for several miles by the presence of rounded exfoliation boulders and dark reddish-orange clayey soil.

STRUCTURE

Rocks within the area have a complex deformational history. There is evidence that the older metamorphic and Paleozoic rocks have undergone as many as four periods of folding (Henika, 1977 and 1980). F₁ folds, which occur as elongate, isoclinal, antiformal folds, are in the Fort Mountain gneiss along a tributary stream to Mill Creek 1.4 mile west of Shava and along a stream 1.25 mile west of Coker Hill. F₂ folds are prominent in the Leathewood Granite and in the lower unit of the Rich Acres Formation lying southeast of the Triassic rocks, such as along Sweden Fork Creek about 1.4 miles southwest of State Road 713. The larger folds, F₃ and F₄ folds, determine the major outcrop patterns. The F₃ folds southeast of the Danville basin are tight-sharp, asymmetric, interference structures (mesoseismic) along northeast-trending folds. The resulting outcrops are knob-shaped. Outcrop patterns in the northwestern part of the basin involving F₁, F₂ and F₃ folds are along Sweden Fork Creek. The major folds in the northwestern part of the Triassic basin are probably F₃ structures (Marr, 1968, personal communication). F₄ folds are the broad, open, regional warps.

Danville Triassic Basin

The Triassic sedimentary rocks in a faulted half graben. The strata are deformed by broad gentle folds (F₁) whose axes are transverse to the longitudinal axis of the basin. Generally, dips along the southern margin of the basin are steeper than those on the northwestern side. Strata of the Cow Branch Formation and the mudrock facies of the Stoneville Formation have the lowest dips of any unit in the basin.

Chatham Fault Zone
The Chatham fault zone (cfz) forms the contact between Triassic and pre-Triassic metamorphic rocks along the northwestern side of the basin. Meyertons states that the fault is normal and that individual faults have dips of about 65 degrees to the southeast; no fault planes were observed in the Spring Garden quadrangle.

The trace of the fault zone generally trends N 40 E. In the southwestern part of the quadrangle, the fault zone is broken into step-like series of normal faults trending northeast and N 20 E. The normal faults that compose the Chatham Fault zone are clearly post-depositional. They are believed to have formed to the southeast (i.e. towards the basin) of normal faults that bounded the northwestern basin margin in Triassic time. Features that suggest this include the narrow outcrop belt of Triassic strata in the Mount Hermon quadrangle (Henika, 1977), the truncation of the mudrock facies of the Dry Fork Formation by post-depositional faults along the northwestern basin margin in the Lewis Hermon quadrangle, and the truncation of conglomerate units in the Spring Garden quadrangle.

Basin History

- Initial subsidence of the Danville basin took place along a major fault zone on its northwestern side, and was accompanied by downwarping along a non-faulted hinge line on the eastern side.
- Erosion of metamorphic-igneous borderlands on both sides of the basin provided detritus to the basin. During the early stages of basin-filling, coarse clastics were deposited by braided streams throughout the basin. (Pine Hill Formation in the north and the lower portion of Dry Fork Formation in the south). Fossils of the longitudinal drainage of the basin, probably caused by subsidence along a transverse segment of the original border fault zone, gave rise to the thick lacustrine sequence (Cow Branch Formation) in the central part of the quadrangle. Subsidence in the basin was not asymmetric to the south and coarse fluvial clastics of the middle portion of Dry Fork Formation accumulated there at the same time that lake sediments were being deposited to the northeast. During the last stages of basin-filling, fluvial sediments accumulated throughout the basin. (Stoneville Formation in the northeast and Dry Fork Formation in the southwest).
- Postdepositional faulting tilted Triassic strata westward and deformed the beds into broad gentle folds; both probably resulted from doming of the entire region in the Early Triassic (Ballard and Upton, 1973). The faulting occurred basinward of the original northwestern margin and downwarped the sedimentary rocks now preserved, producing the extensive cataclastic zones in both Triassic sedimentary beds and pre-Triassic metamorphic rocks on both sides of the Chatham Fault Zone.
- Emplacement of diabase dikes along tensional fractures that transect regional structures.
- Differential uplift of the entire region with subsequent erosion of an unknown amount of Triassic rocks.

ECONOMIC GEOLOGY

Crushed Stone

The Fort Mountain and mudrocks are currently being quarried for crushed stone from White Oak Mountain in the adjacent Mount Hermon quadrangle. Lithologically identical rocks in the part of White Oak Mountain lying in the mapped area are potentially useful as a source for crushed stone. The area contains potential sites for quarrying operations because of steep local relief (folds may be an aid to quarrying) and close proximity to U. S. Highway 29 and the Southern Railway at Chatham.

Portions of the Leathewood Granite and porphyroblastic gneiss layers in the Fort Mountain Formation may prove to be potential sources of crushed stone. Another location of porphyroblastic gneiss layers that may prove useful is in the felsic gneiss units southeast of the Danville Triassic basin. A small quarry, units transported by the Virginia Department of Highways for production of road stone many years ago. The rock at this area is fresh, medium to coarse-grained gneissic granite with interlayers of Fort Mountain biotite gneiss.

Clay

The results of tests made on weathered shales of the Stoneville and Cow Branch formations north and northeast of Motley Mill along the Banner River (Meyertons, 1968) indicate that these shales may have potential use for the manufacture of building brick and structural ware. Siltly shale from the Cow Branch Formation (R-3667), east of Chatham on State Road 683 has a potential use as a structural clay product including sewer pipe and possible use as a foundry soil (Sweet, 1973). Because the water table stands within the upper bedrock is high, only elevated areas on the northwest side of the river should be considered as potential sources.

Lightweight Aggregate

Some 15 miles to the southwest, in the Draper quadrangle, Virginia Solite Company utilizes black shales and mudrocks of Cow Branch Formation for the manufacture of lightweight aggregate. Similar shales occur in the Spring Garden quadrangle, and in the northwestern part of the adjacent Jax quadrangle. Most of the rock near Motley Mill are beneath alluvium and terrace deposits along Banner River, occur an area subject to flooding. Small areas of Cow Branch strata occur above the floodplain on the north side of the river.

Uranium

The Danville Triassic basin was targeted for uranium exploration (Drivas, 1978) because of the location of the basin near possible granitic sources of uranium. The probable existence of stratigraphic traps in areas of the basin, and indications of uranium from airborne surveys. The Shelton Formation and its associated strata are within the upper felsic gneiss unit provides a possible source southeast of the basin, and the Leathewood granite provides a possible northern source of uranium. Concentration in the sedimentary rocks of the basin may come from leaching the granitic rocks and deposition along potential red flow or by deposition of detritus from these rocks or by both means. Interfingering shale and sandstone near Motley Mill form a potential stratigraphic trap to concentrate uranium-bearing solutions.

Henika and Johnson (1980) outline another uranium depositional model, that of granitic "ponding" adjacent to diabase dikes and at impermeable cataclastic rocks. Anomalous radiocesium concentrations within the upper felsic gneiss unit at the northern quadrangle boundary may be explained by this latter process. A detailed gamma-ray spectrometry survey, which was conducted during geologic mapping indicated that radioactive elements are concentrated along steeply dipping fractures that cut the mylonitic rocks.

Marine Uranium Corporation announced on July 21, 1982, the discovery of a significant concentration of uranium mineralization along the Chatham fault zone. According to the announcement, a reserve report prepared by Henika, Allen, and Henika, an independent mining engineering firm, indicates higher grade geological reserves totaling approximately 30 million pounds of four pounds per ton or more. In addition, larger quantities of lower-grade geological reserves were also identified (Virginia Division of Mineral Resources, 1983).

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