GEOLOGY OF THE BLACKSBURG AREA, MONTGOMERY COUNTY, VIRGINIA

by

George Stephen Ritter

Thesis submitted to the Graduate Faculty of the

Virginia Polytechnic Institute

in partial fulfillment for the degree of

MASTER OF SCIENCE

in

Geology

APPROVED:

Chairman, Dr. C. G. Tillman	Dr. B. N. Cooper
Dr. W. D. Lowry	Dr. P. H. Ribbe

May 1969

Blacksburg, Virginia

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to the many people who provided guidance and assistance during the preparation of this study. Dr. C. G. Tillman served as the writer's major professor. Drs. B. N. Cooper, W. D. Lowry, and P. H. Ribbe served on the writer's committee.

TABLE OF CONTENTS

Page

ILLUSTRATIONS

INTRODUCTION

Location and Accessibility

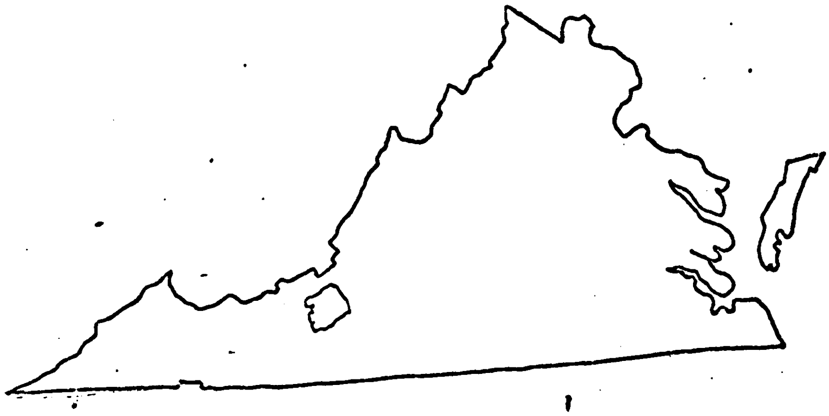
The study area (Figure 1) is in the central part of Montgomery County, Virginia, and is approximately the eastern half of the 1965 United States Geological Survey 7.5-minute Blacksburg, Virginia quadrangle. The area, which is bounded by meridians 80° 22' 30" and 80° 26' 15", and parallels 37° 15' and 37° 9' 50", comprises about 17 square miles.

U. S. Highway 460, which approximately bisects the area, runs north through Blacksburg. U. S. Route 460 Bypass (under construction in 1968-69) parallels the main route on the west. East-west roads include County Routes 685, 657, 785, and 603. Various other roads provide accessibility to almost all areas.

Topography and Drainage

The Blacksburg area lies entirely within the Valley and Ridge physiographic province. The eastern part is characterized by rough topography; elevations range from about 1500 feet to 2400 feet and local relief ranges up to 500 feet. The western part consists of low rolling hills and valleys with local relief of 100 feet. Elevations range from approximately 2000 feet to 2200 feet.

A major north trending drainage divide lies within the area. To the west of the divide, drainage is to the New River, and to the east it is toward the North Fork of the Roanoke River.



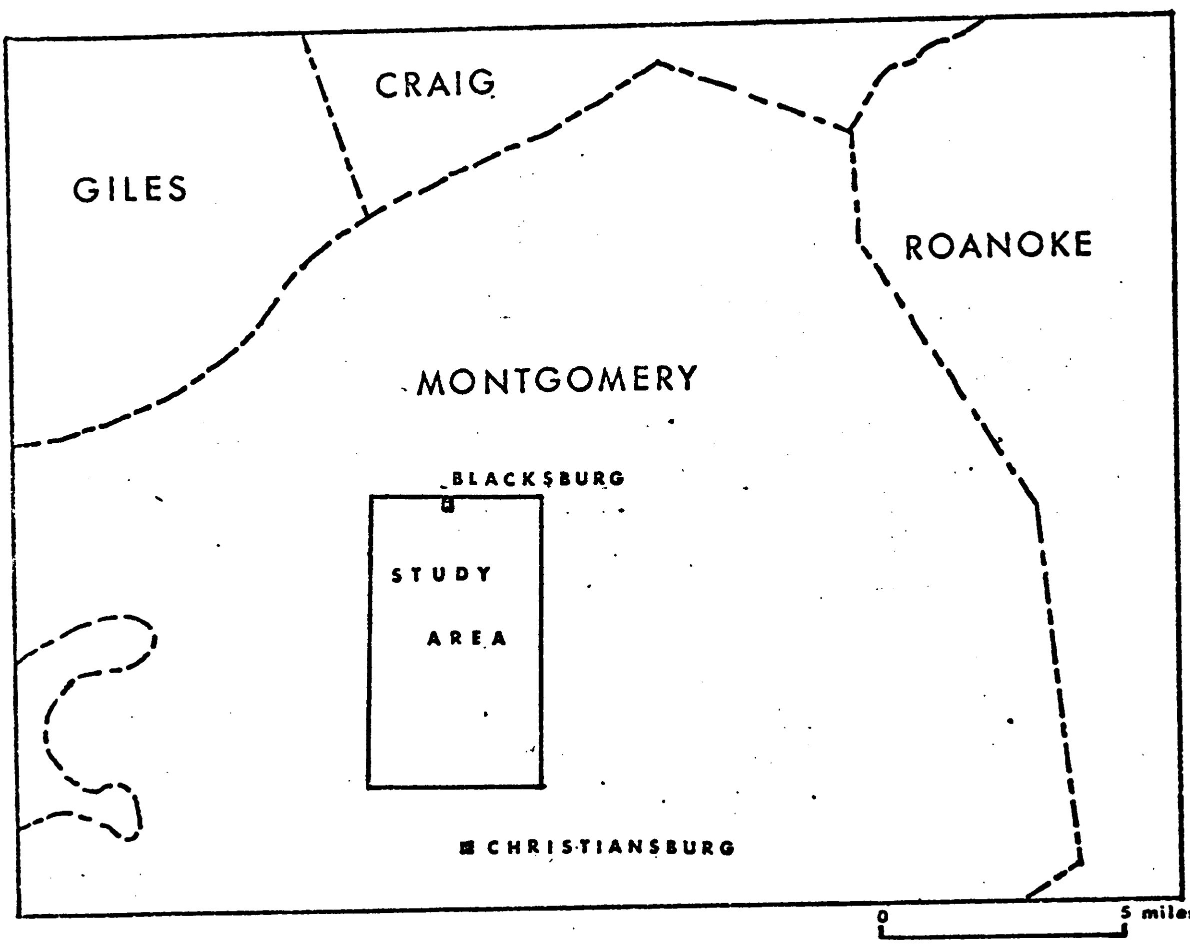


Figure 1. Location Map of the Study Area

Previous Work

The area as part of larger regions was mapped by Holden and Campbell (Campell and others, 1925), Waesche (1934) and Butts (1933, 1940). Cooper (1944) measured and described some of the Cambrian and Ordovician formations in the area. Hobbs (1957) and Dietrich, Hobbs and Lowry (1963) studied part of the Chepultepec Formation at the Virginia Polytechnic Institute quarry. Derby (1965) collected fossils from the Elbrook Formation in the area. Cooper (1961, 1963, 1964, 1968) included the area in maps with his texts. Eubank (1967) mapped the area adjacent on the east. Gilbert (1953) made a detailed study of the Middle Ordovician limestones in the outcrop belt just beyond the eastern border of the area. Aronson (1966) did a study of the Copper Ridge Formation northeast of the area.

STRATIGRAPHY

General Statement

The rocks within the Blacksburg area are predominantly marine sediments ranging in age from Lower Cambrian to Upper Mississippian. The sequence is at least 9600 feet thick.

The Cambrian System is composed primarily of shale and dolomite. Minor amounts of sandstone, limestone, and chert are present. The Ordovician System consists primarily of dolomite, limestone, and shale. Chert is present in minor amounts. No Silurian or Devonian rocks are exposed, but occur in the subsurface in the California Company's No. 1 Kipps well drilled in the Price Mountain anticline west of the area (Cooper, 1961). Silurian and Devonian rocks are also present in the Catawba syncline to the east (Eubank, 1967). The Mississippian System is represented by a thick sequence of sandstones and shales, and some coal. Deposits of alluvium, colluvium, and calcareous tufa are present locally. A major disconformity is present between the Lower and Middle Ordovician.

Cambrian System

Rome Formation

Name and Age

The oldest rocks exposed in the area belong to the Rome Formation of Early Cambrian age (Howell and others, 1944). The Rome Formation was named by E. A. Smith (1890) for exposures at Rome, Georgia.

Distribution and Thickness

Exposures of the Rome Formation are principally confined to a U-shaped belt which opens southward in the northwestern quarter of the study area (Plate 1). The western limb of the "U" extends from the western edge of the area to the western end of the Virginia Polytechnic Institute Airport. The eastern limb extends from Airport Road eastward to U.S. Route 460. The belt of Rome is bounded on the south by an east-trending line through the Virginia Polytechnic Institute Airport, and on the north by an east-trending line through Swanee Hollow Country Club. Two smaller exposures are present in the southern part of the area. One is located in the extreme southwestern corner, west of the Norfolk and Western Railway, and the other is located about 500 feet northwest of the intersection of County Routes 642 and 643.

Lithology

Locally, the Rome Formation is composed primarily of maroon, tan, and green siltstones and shales. Adjacent to the Max Meadows fault, these shales are often metamorphosed to a green chloritic phyllitic rock (Cooper, 1946). A similar type of rock occurs within the area where the Rome shales have been thrust over younger Cambrian rock along what may be the Max Meadows fault. These rocks, which have been described as a maceration of red and green phyllite or phyllite breccia, are usually highly crumpled and have a very granular, broken texture. Structures in this macerated rock are very erratic. Cooper (oral communication, August 17, 1969) states that this is not normal Rome, but fault line Rome.

Also present locally are buff-weathering, medium-grained, thin-bedded sandstones, and dark-grey fine- to medium-grained, thin- to thick-bedded dolomites and dolomitic limestones. The dolomites and dolomitic limestones are fractured and contain calcite veinlets. Some of these carbonates are siliceous.

Numerous outcrops, which were too small to map, occur within the Elbrook Formation south of Price Mountain, particularly along the Norfolk and Western Railway west of Yellow Sulphur. No thickness is given for the Rome Formation because it is interpreted as occurring in a thin veneer.

Elbrook Formation

Name and Age

The Elbrook Formation was named by G. W. Stose (1906) for exposures in a quarry near Elbrook, Pennsylvania. The age of the Elbrook is Middle and Late Cambrian (Howell and others, 1944).

Distribution and Thickness

The Elbrook is present in five separate areas (Plate 1). The largest belt is in the southern part of the area and extends from Yellow Sulphur west to the north-trending Norfolk and Western Railway at the southwestern corner of the map. It extends from the southern boundary of the map northward to the vicinity of Corning Glass. The Elbrook is also present from the Virginia Polytechnic Institute Airport north approximately 1000 feet, and east to U.S. Route 460. North of this is the occurrence in Blacksburg. This area extends from the intersection of Progress Street and Main Street south to Clay Street. From the Blacksburg High School, the area extends west to the western end of the Virginia Polytechnic Institute drillfield. The northern occurrence extends from an east-west line through the Swanee Hollow Country Club north and west of the mapped area. A north-west trending line approximately 4000 feet from the western edge of the map is the east boundary. The fifth occurrence is in an area approximately 1000 feet (N-S) by 500 feet (E-W) located where the northern part of U.S. Route 460 Bypass intersects the western edge of the map. No thickness is given for the Elbrook because of the folded and faulted nature of the rocks.

Lithology

The dominant rocks in the Elbrook Formation are medium-gray thin-bedded, argillaceous dolomites; medium-gray, buff-weathering dolomitic shales; and some blue-gray limestones. The argillaceous dolomites and dolomitic shales locally contain mud-cracks and stringers of black chert.

Also present within the Elbrook Formation are dark-gray, thick-bedded, fine-grained limestones and dolomitic limestones. Within the dolomitic limestones, stylolites are abundant. Pyrite crystals and fluorite may be found. Pyrite appears to be primary because it is disseminated through the rock. The occurrence of fluorite in fractures, however, suggests a secondary origin.

Breccias and crush conglomerates similar to those described by Cooper (1946), occur at Yellow Sulphur, locally east of the Virginia Polytechnic Institute Airport, in south Blacksburg, and on Route 460 Bypass where it crosses Toms Creek Road. Breccias and crush conglomerates composed of microscopic lithic fragments of Elbrook, enclosing large fragments of Elbrook Dolomite that show bedding make thick masses of cataclastic rock along the Pulaski fault zone. These large fragments appear to be randomly oriented. Fragments of rocks on Rome lithology occur in this breccia. This type of breccia has been generated in the Elbrook structurally underlying what may be the Max Meadows fault. Where the Elbrook is exposed bordering the Blacksburg window, it structurally overlies the Cambrian Copper Ridge Formation and the "dolomites of uncertain age."

Dolomites of Uncertain Age

Name and Age

This provisional name is applied to the succession of dolomites underlying beds identified by the writer as the Copper Ridge Formation. The age of these rocks is older than the Late Cambrian Copper Ridge Formation, and younger than the Early Cambrian Rome Formation because fossil evidence indicates a late Cambrian age for these dolomites. Thus, these dolomites appear to be more or less equivalent to either the Middle and Late Cambrian Elbrook, or the Middle and Late Cambrian Honaker and Nolichucky Formations. These dolomites do not resemble the Elbrook dolomites, and are sufficiently different from the Honaker dolomite to warrant use of the provisional name.

Distribution and Thickness

The "dolomites of uncertain age" are present in two separate belts (Plate 1). The eastern belt extends eastward approximately 1500 feet from Yellow Sulphur, and eastward approximately 3500 feet from Hightop Mission Church. North of New Hope Church, the belt narrows to approximately 1000 feet and roughly parallels U.S. Route 460. This belt probably extends to near the base of Brush Mountain on the north, and for an unknown distance south of the area. The western belt extends from approximately 1000 feet north of the Virginia Polytechnic Institute Airport north to Clay Street. The area extends from the Virginia Polytechnic Institute Coliseum east approximately 1500 feet.

A total thickness cannot be given because the lower contact of these dolomites is a fault. However, where the dolomites are best exposed east of the intersection of County Routes 642 and 643, their thickness appears to be at least 1900 feet.

Lithology

The dominant lithology in these beds is light- to medium-gray, fine- to coarse-grained, thick-bedded dolomites.

Large masses of gnarly black algal chert are present near the contact with the overlying Copper Ridge Formation and persist downward for at least a hundred feet. Silicified algal structures, as much as 1 foot in diameter, occur in outcrops in the creek bed at Yellow Sulphur Springs.

Derby (1965) reported the occurrence of Nolichucky age fossils approximately 0.5 mile southeast of the intersection of U.S. Route 460 and County Route 603 (Plate 1; Derby's Locality 4). These were found in silty dolomite and dolomitic shales and siltstones. He reports the following fossils:

Llanoaspis modesta

Pemphigaspis sp.

Terranovella dorsalis

Oboloid brachiopod

Graptolite fragments

These fossils are in the *Crepicephalus* zone, which is in the Dresbachian stage.

The contact with the overlying Copper Ridge Formation is placed at the base of the first sandstone occurrence.

Copper Ridge Formation

Name and Age

The term Copper Ridge chert was used by E. O. Ulrich (1911) for exposures on Copper Ridge in northeastern Tennessee. Ulrich (1924) later changed the name to Copper Ridge dolomite. The writer prefers the Copper Ridge Formation as used by Aronson (1966). The age of the Copper Ridge is Late Cambrian. C. G. Tillman (oral communications, Nov. 7, 1968) states that Tellerina found just below the upper sandy unit in Blacksburg indicates Trempealeau age. The Copper Ridge is the oldest formation of the Knox Dolomite Group.

Distribution and Thickness

The Copper Ridge Formation is present in two separate belts in the area (Plate 1). The western belt is approximately 1000 feet wide (E-W) and extends from north of the Virginia Polytechnic Institute Airport to the Blacksburg High School. A north-south line just west of Margaret Beeks Elementary School marks the eastern boundary at this belt. The eastern belt narrows from an outcrop width of approximately 4000 feet in the north to 1500 feet in the south. This belt is roughly north trending and occurs just east of Yellow Sulphur, just west of High Knob, west of the Blacksburg Country Club, and east of U.S. 460 at the top of the map. The belt continues to the north of the mapped area, but to the south the outcrop belt probably is terminated by a fault. The Copper Ridge is well exposed along County Route 603 from 1.5 to 2.1 miles east of the intersection with U.S. 460. The Copper Ridge is approximately 1300 feet thick.

Lithology

The Copper Ridge is predominantly light-gray, medium- to coarse-grained, thin- to thick-bedded dolomites. These beds weather to somewhat rounded masses which exhibit welts and furrows. Ripple marks occur in these dolomites directly above the contact with the Elbrook on Route 603, 1.5 miles east of the intersection with U.S. 460. Locally chert is abundant in these dolomites. Algal chert, commonly containing dolomolds, occurs throughout much of the formation. Oolitic cherts are present and tend to be restricted to the lower part of the formation. White cauliflower chert occurs near the middle of the formation. Blocky weathering chert is also present, especially in the upper part of the formation.

Sandstone beds occur at the base and at the top of the formation. These are light- to medium-gray, medium-grained, well-rounded, dolomite-cemented feldspathic sandstones, some of which contain fine-grained, medium-gray tabular dolomite clasts as much as one inch in length. The weathered rock is commonly iron stained and contains vugs from the weathering of the dolomite clasts. Cross-bedding in the Copper Ridge sandstones is common and ripple marks were seen on a large piece of displaced sandstone.

A section of the lower sandstone on County Route 603 approximately 0.5 mile south of the intersection with U.S. Route 460 has a minimum thickness of 18 feet. The same sandstone exposed along the Norfolk and Western tracks east of Yellow Sulphur has fine-grained dolomite interbeds as much as 2 feet in thickness.

Intraformational breccia was noted in a coarse-grained dolomite in the lower part of the formation approximately 0.1 mile east of the intersection of Route 603 and Route 460. The clasts were tabular and fine-grained. Dark-gray, fine-grained limestones with crinkled argillaceous laminae were noted locally, but are uncommon. Red weathering shales occur sporadically as thin beds in the lower part of the formation along the railroad at Yellow Sulphur.

Derby (1965) reports the occurrence of _Prosaukia stosei_ and _Triarthropsis limbata_ from the railroad cut approximately 2900 feet east of Yellow Sulphur (Derby's Locality 5; Plate 1). These occur 27 feet below the upper sandstone unit, and are Trempealeau in age.

The contact with the overlying Ordovician Chepultepec Formation is placed at the top of the uppermost sandstone.

Ordovician System

Chepultepec Formation

Name and Age

The Lower Ordovician Chepultepec Formation was named by Ulrich (1911) for exposures near Allgood (Chepultepec), Blount County, Alabama.

Distribution and Thickness

The Chepultepec Formation is present in the eastern part of the area (Plate 1) in a continuous north-trending outcrop belt. This belt thins from a width of approximately 1.5 miles (E-W) at the northern border of the map to 0.25 mile (E-W) at the southern edge of the area. The western limit of this belt is 1200 feet east of the Blacksburg town limits on U.S. 460 north, at High Knob, and approximately 0.5 mile to the east of Yellow Sulphur. The Chepultepec is exposed along County Route 785. The thickness of the formation is approximately 400 feet.

Lithology

The Chepultepec is composed of light-gray, coarse-grained, thick-bedded dolomites and medium-gray, fine-grained, medium-to thin-bedded limestones. The lower and upper parts of the formation are primarily dolomite, whereas the limestones are restricted to a 50 foot zone stratigraphically near the middle of the formation. These limestones are well exposed in the old Virginia Polytechnic Institute quarry on County Route 785. At the Cupp Quarry on Valleyview Drive east of Blacksburg, maroon and pink dolomites are present. Black and white nodular chert are common in the Chepultepec; black chert is the dominant type in the lower part of the formation.

The contact with the overlying Longview Formation is placed at the first limestone occurrence above the upper dolomite part of the Chepultepec.

Longview Formation

Name and Age

The Longview Formation of Early Ordovician age was named by E. O. Ulrich (1924) for exposures near Longview, Shelby County, Alabama.

Distribution and Thickness

The Longview is present at the eastern edge of the map area in a relatively narrow north trending outcrop belt (Plate 1). This belt is continuous from the north approximately 0.5 mile east of Davis Chapel on County Route 785, 0.5 mile east of High Knob, and crosses the Norfolk and Western tracks approximately 1.0 mile east of Yellow Sulphur. A minor fault offsets the belt east of High Knob. The Longview is approximately 100 feet thick, and is well exposed east of Davis Chapel along Indian Run.

Lithology

The Longview consists primarily of interbedded dark-gray, coarse-grained, thick-bedded dolomites and dark-gray, fine-grained, thick-bedded limestones. The dolomite locally contains large masses (as much as several inches) of sparry calcite. Lecanospira and a small trochospirally-coiled gastropod are evident on weathered surfaces of the limestone. White, block-weathering chert is present. Impressions of Lecanospira and Syntrophynella have been found on the chert along Indian Run by the writer.

A thin bed of intraformational breccia was noted along County Route 642 at the eastern edge of the area. Tabular clasts of limestone (as much as 1 inch) are present in a limestone matrix.

The upper contact of the Longview was mapped as the last limestone below the dolomites of the Mascot-Kingsport respectively.

Mascot-Kingsport Formation

Name and Age

The Mascot-Kingsport Formations of Early Ordovician age were named by Rodgers (1943).

Distribution and Thickness

The Mascot-Kingsport Formation occurs at the eastern edge of the map area (Plate 1). This belt varies from 0 to 1500 feet thick and continues into the area to the east. The formations are approximately 400 feet thick.

Lithology

Medium-gray, coarse-grained, thick-bedded dolomites are the dominant lithologies. Bedded light tan cherts, as much as 10 feet in thickness, weather into iron-strained blocks. The Mascot-Kingsport Formations are overlain, on an erosional disconformity, by the Middle Ordovician limestones. Gilbert (1953) reports relief on the erosional surface up to 225 feet east of the mapped area.

Middle Ordovician Limestones

Middle Ordovician limestones are present in three separate localities in the area, one 500 feet north of Yellow Sulphur Springs, one approximately 2000 feet south-southwest of Yellow Sulphur, and another in the southeastern corner of the area along County Route 723. The rocks at all three localities have a general north strike and east dip, and an exposed thickness up to 200 feet. The occurrences at Yellow Sulphur Springs and Yellow Sulphur are along the Yellow Sulphur fault.

The limestones at Yellow Sulphur Springs and in the southeast are light- to dark-gray, coarse-grained, and thick-bedded. The limestones south-southwest of Yellow Sulphur are dark-gray, fine-grained, thin-bedded, and argillaceous. The limestones commonly form knobby outcrops with solution cavities.

Gilbert (1953) divided these limestones into four different formations: the New Market limestone, the Whistle Creek limestone, the Lincolnshire limestone, and the Botetourt limestone. The Middle Ordovician limestones have been mapped as one unit because of the small thickness, the limited occurrence, and the poor exposure. Overlying the limestones conformably is the Liberty Hall Formation.

Liberty Hall Formation

Name and Age

The Middle Ordovician Liberty Hall Formation was named by H. D. Campbell (1905) for a historic ruin near Lexington, Virginia. Cooper and Cooper (1946) refer to the black limestone and shale as the Liberty Hall facies of the Edinburg limestone.

Distribution and Thickness

The Liberty Hall Formation is present only in narrow fault slices and in a small westernmost portion of the Catawba Valley belt of the formation. Since one or both contacts are faults, the thickness of the Liberty Hall cannot be measured. In an adjoining area, Eubank (1967) reported thickness estimates ranging between 1200 and 1800 feet.

Lithology

Dark-gray, calcareous shales dominate the lithology in the formation. These commonly weather to light-tan chips. The graptolite *Climacograptus* sp. was collected at the Yellow Sulphur Springs locality. The shales at the Yellow Sulphur Springs locality are highly cleaved. The shales in the southeast corner are cleaved and calcite-veined.

Overlying the Liberty Hall Formation to the east in continuous sequence are the Ordovician Bays and Martinsburg Formations, the Silurian Tuscarora, the Devonian Ridgeley Sandstone, Huntersville Chert, Needmore Shale, Millboro Shale, Braillier, and "Chemung" Formations, and the Mississippian Price Formation (Eubank, 1967).

Mississippian System

Price Formation

Name and Age

The Price Formation of Early Mississippian age (Butts, 1940) was named by Campbell (1894) for exposures on Price Mountain, Montgomery County, Virginia.

Distribution and Thickness

The Price Formation is exposed in the center of the Price Mountain anticline (Plate 1). The formation occurs north, south, and east of Merrimac, Virginia, for approximately 3000 feet along County Routes 657 and 643. As the base of the formation is not exposed, a thickness cannot be given. Cooper (1961) reports thickness ranging from 500 to 800 feet in the Blacksburg-Pulaski area.

Lithology

The Price Formation is composed primarily of olive-drab to buff, medium-grained, thin- to medium-bedded sandstones. These sandstones are commonly cross-bedded. Spheroidal weathering and flaggy weathering are common. Plant fragments are abundant in some beds.

Buff and green shales are present locally. These commonly occur as interbeds between the dominant sandstone lithologies. Maroon shales occur at the top of the formation, interbedded with olive-drab sandstones.

Coal beds are present. *Lepidodendron* was collected from an old mine dump south of Merrimac.

The Price is overlain by the Mississippian Stroubles Formation. The contact is placed at the base of the thick section of maroon shales of the Stroubles. This contact appears to be vertically gradational.

Stroubles Formation

Name and Age

The term Stroubles was introduced by Cooper (1961) to replace the term Maccrady misapplied by Campbell (1925) to the thick section of red beds in Montgomery and Pulaski Counties. The Stroubles is probably Middle and Upper Mississippian (Cooper, 1961).

Distribution and Thickness

The Stroubles is present in the Price Mountain window as a wide outcrop belt at the outer margin of the window (Plate 1). The Stroubles occurs in a roughly U-shaped outcrop belt which extends from the upper contact of the Price Formation north, south, and east approximately 6000 feet from the intersection of County Routes 657 and 643. As the upper contact of the Stroubles is a fault, the original thickness of the formation cannot be given. Approximately 1100 feet are present. The Stroubles on Price Mountain reappears along U.S. 460 on Brush Mountain to the northeast of Blacksburg (Cooper, 1961).

Lithology

The Stroubles Formation is primarily maroon and green siltstones, shales, and fine-grained sandstones. The maroon siltstones are commonly mottled green. Light green calcareous siltstones are present locally, but are uncommon. Graphite-appearing films are present on some shear planes in the shales and siltstones.

The upper unit of the formation, exposed east of U.S. Route 460 just south of the intersection with County Route 643, contains a conglomeratic bed, a thin coal, and fossiliferous sandstones and shales. G. A. Cooper of the Smithsonian Institution (written communication to W. D. Lowry, May 9, 1966) stated about the fossils sent to him from this area that: "Dr. Yochelson identified two snails in the collection: Sinuitina and Euphemites. Two other creatures, generically identifiable are Chonetes and the pelecypods, Nuculana and Palaeaneilo." Cooper (1961) states that these may be the youngest rocks overridden by the Pulaski thrust sheet. Campbell (1925) and Butts (1933) show these beds as part of the Price Formation which requires the Price to have been folded by drag into a tight overturned syncline at the eastern end of the Price Mountain window. The writer has concluded that the fossiliferous beds are the uppermost part of the Stroubles and that the succession of beds between U.S. Route 460 and the east end of the window are a normal succession with all beds right side up.

The Stroubles in this area appears to be of marine and nonmarine origin. The fossils found east of Route 460 indicate a marine environment. The occurrence of Archimedes and other bryozoans along New River (Cooper, 1961) indicates a marine environment. The thick section of red beds, plant fossils, the coal bed, and absence of fossils in the lower part of the formation seem to indicate a nonmarine origin.

Quaternary System

Surficial Deposits

Surface deposits of alluvium, colluvium, and calcareous tufa are present locally, but were not mapped. The alluvium consists of well-rounded pebble- to cobble-size pieces of quartzite and vein quartz, which must have had their source in the Blue Ridge. These occur somewhat sporadically on the western side of the drainage divide. In the eastern part of the area of study, the gentle west slopes toward Stroubles Creek are largely covered with a thick cherty soil containing chert and sandstone pieces. This matter has drifted westward by creep and has mantled the Rome breccias in the Town of Blacksburg. Until deep cuts were made in the surficial deposits the nature of the bedrock was undetected.

Chemically precipitated calcareous tufa is present along streams of the eastern side of the drainage divide. Eubank (1967) reports the occurrence of plant and animal remains in similar deposits to the east.

STRUCTURE

Regional Structure

The area is situated astride the east end of the Price Mountain anticline and window, in the Blacksburg-Pulaski synclinorium in which two thrust sheets have been downfolded with the overridden strata.

The Pulaski fault was named by Campbell (1925) for Pulaski, Virginia. Cooper (1961) states that the Pulaski fault is at least 350 miles long, and extends from Rockingham County, Virginia, into Tennessee. The age of the Pulaski fault is younger than the Chesterian rocks which are overridden by the Pulaski thrust sheet (Cooper, 1961). Campbell and Holden (1925) and Butts (1940) state that the Pulaski fault was originally a low angle thrust fault along which as much as 20 miles of movement may have occurred.

The Salem fault was named by Campbell (1925) for exposures near Salem, Virginia. The fault extends from Barringer Mountain near Christiansburg to northeast of Roanoke.

Lowry (1964) states that the Pulaski, Salem, and Blue Ridge faults may be a genetically related system which he referred to as the Pusabre mass.

The Price Mountain anticline and window, south of Blacksburg, Virginia, was recognized by Campbell and Holden (1925). This is a doubly plunging anticline which trends east-west. The anticline, within an elliptically shaped window in the Pulaski thrust sheet, is approximately 7 miles long and 2 miles wide (Butts, 1933). The window exposes the overridden Devonian-Mississippian rocks of the Saltville block (Cooper, 1961).

The Catawba syncline (Campbell, 1925) is a large doubly plunging synclinal structure that extends from Blacksburg to a point north of Roanoke (Butts, 1933). Throughout much of its length, the southeast limb of the syncline is overturned to the northwest (Eubank, 1967; Amato, 1968; Hazlett, 1968). The syncline contains rocks as young as Mississippian.

Structural Elements

The area can be divided into six structural elements (Figure 2). These are the Catawba block, the Pulaski-Max Meadows thrust blocks, the Blacksburg window, the Price Mountain window, the Yellow Sulphur fault, and the Salem fault block.

Catawba Block

The Catawba block comprises the eastern half of the map area (Figure 2). The Catawba block is bounded on the north by a high angle reverse fault believed by Campbell (1925) and Butts (1933) to be the Pulaski fault but which the writer calls the Catawba fault, on the west by the same fault where it is largely concealed except where it forms the east frame of the Price Mountain window, and on the southeast by the Salem fault. The western edge of this fault

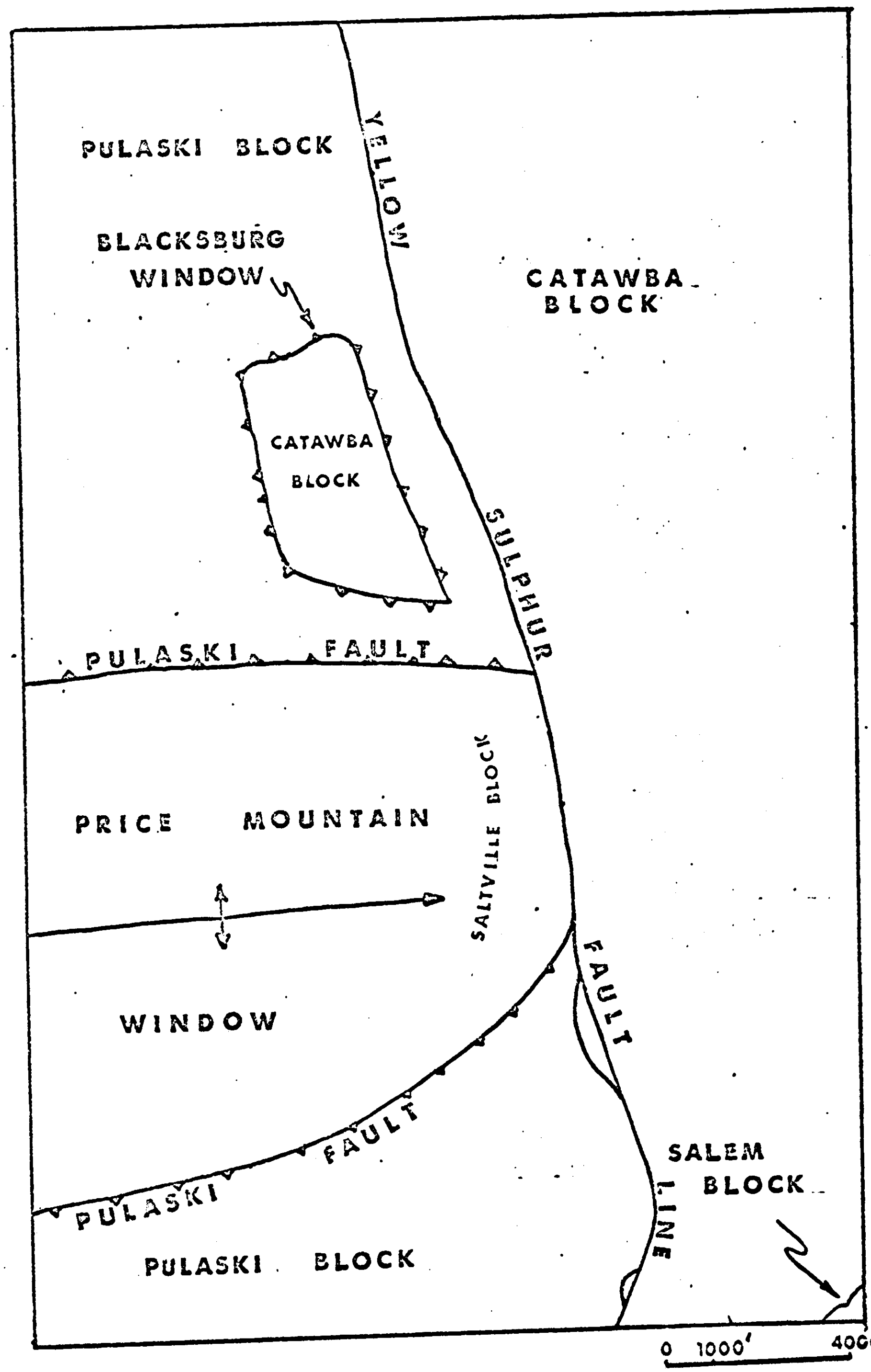


Figure 2. Structural Subdivisions of the Area

is concealed beneath the Max Meadows-Pulaski thrust sheets except where it is exposed to form the east border of the Price Mountain window. How far west the thrust block extends in the synclines on either side of the Price Mountain window is conjectural.

The rocks composing this block form an essentially continuous homoclinal sequence around the western nose of the Catawba syncline. The age of these rocks ranges from Cambrian to Mississippian, although only Cambrian to Middle Ordovician rocks are exposed within the area of study wherein the beds strike roughly north and dip eastward from 10 to 70 degrees.

The axis of the Catawba syncline trends roughly northwest in the northern part of this block (Plate 1). The nose of this eastward plunging synclinal structure is reflected in the strike of beds which changes from north-northeast along County Route 785 to north-northwest near the Blacksburg Country Club.

The axis of the Slate Lick Run anticline (Eubank, 1967) appears to project into the area. Strikes change from north-northwest along County Route 603 to north-northeast along County Route 642. The axis extends roughly between these two roads. The anticlinal axis appears to be continuous with that of the Price Mountain anticline.

Pulaski Thrust Block

The Pulaski thrust block as herein used (Figure 2) includes all the rocks of the Pulaski overthrust sheet <u>sensu stricto</u> and of the closely associated Max Meadows thrust sheet. The Max Meadows-Pulaski sheets include all the rocks west of the Yellow Sulphur fault with the exceptions of the Price Mountain window and the Blacksburg window and possibly the two Middle Ordovician slices. In the windows, rocks of the underlying Saltville block are exposed.

In the area of study, the rocks exposed on this thrust sheet are exclusively of the Rome and Elbrook Formations. Both formations have a brecciated nature, and generally show very erratic structures. Within the thrust sheet, the Rome structurally overlies the Elbrook Formation. These formations are separated by the Max Meadows fault. The Elbrook has overridden the rocks of the Saltville block and also those of the western part of the Catawba block, and the Elbrook has subsequently been overridden by the Rome.

The Pulaski-Max Meadows sheets at one time must have extended farther to the east. After the Yellow Sulphur fault raised the Catawba block, the Pulaski thrust sheet was probably eroded from this block.

Blacksburg Window

The name Blacksburg window (Figure 2) is applied to the exposure of the Cambrian Copper Ridge Formation and "dolomites of uncertain age" west of the Yellow Sulphur fault. These homoclinally dipping beds are exposed from approximatley 1000 feet north of the Virginia Polytechnic Institute Airport north to Clay Street. The exposures extend east-west from Airport Road to a point just east of the Virginia Polytechnic Institute Coliseum.

These rocks are exposed through a window in the rocks of the Pulaski thrust sheet. The Cambrian Rome and Elbrook Formations bound the window.

In the window, strikes trend roughly north, and dips vary between 50 and 70 degrees east. The similarity in trend and lithology of these beds suggest that they were at one time continuous with the beds of the Catawba block. This suggests that the Catawba syncline was thrust westward over the Price Mountain anticline, prior to movement along the Yellow Sulphur fault. The thrust fault, which is not exposed at the surface, would place Cambrian rocks over Mississippian rocks. This interpretation would have the Catawba syncline as a displaced part of the Saltville block, rather than a part of the Pulaski thrust sheet.

Price Mountain Window

Price Mountain (Figure 2, Plate 1) is in a window in the Pulaski thrust sheet (Campbell, 1925). This window in the southwestern part of the area extends eastward from the western edge of the area to approximately U.S. Route 460. The window also extends northward to the Virginia Polytechnic Institute Airport and southward to a northeast trending line north of the Corning Glass plant.

The window is an erosional feature (Campbell, 1925), and exposes the overridden Upper Devonian and the Mississippian Price and Stroubles formations of the Saltville block (Cooper, 1961). Cooper's cross-section shows that the Mississippian rocks exposed on Price Mountain are downfolded to the north in a broad synclinal structure concealed by the Pulaski thrust sheet, and then reappear on Brush Mountain.

The rocks exposed within the window are folded into a doubly plunging anticline. The axis of this anticline trends east through Merrimac, Virginia.

Minor east-west trending folds are present north of the main Price Mountain anticlinal axis. The southern limb of the anticline, however, appears to be uniform in strike and dip.

Catawba Fault

The geologic relations evidenced in and around the Blacksburg window indicate that prior to overthrusting of the Elbrook sheet and subsequently the Rome sheet along the Pulaski and Max Meadows faults, respectively, the Catawba block rode westward and northward up over Mississippian rocks including those comprising the Price Mountain window. The Catawba block, at least the western edge of it, was then overridden progressively by the Elbrook and it in turn by the Rome. The fault along the southeast base of Brush Mountain constitutes the exposed part of the fault trace which Cooper (1961) suggested might be the Tract Mountain Fault. Near U.S. Route 460, this fault passes beneath the Max Meadows-Pulaski thrust rocks, and its position to the west and south is unknown. The segment of the north-south fault line, which bounds the east side of the Price Mountain window may be the Catawba Fault.

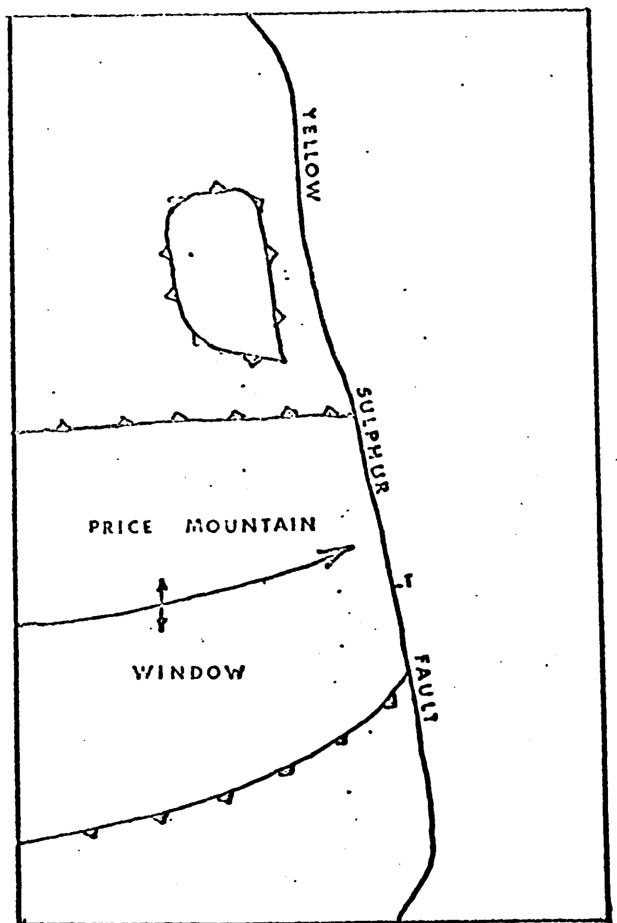
This fault was the first one to develop and represents a reverse fault along which rocks as old as pre-Copper Ridge rode up northward and westward over the Mississippian formations. The position of the fault south of Price Mountain is unknown.

Yellow Sulphur Fault Line

The name Yellow Sulphur Fault Line is proposed for a traceable line of structurally discordant contacts between various rock formations where available field evidence is insufficient to establish the precise nature and geometry of faults and where two alternative explanations of structure are offered as possible interpretations. This line runs approximately north-south, and part of it forms the east border of the Price Mountain window (Plate 1).

North of the Price Mountain window the line is marked by the contact of Rome macerated phyllite breccia with the dolomites of uncertain age to the east. North of the Polyscientific, Inc., plant the contact is between the Elbrook and dolomites of uncertain age. The fault trace that continues northward from the Rome belt is probably the Pulaski fault.

The segment of the Yellow Sulphur Fault Line that is formed by the contact of Rome phyllite breccia with dolomites of uncertain age, down to the proximity of the northeast corner of the Price Mountain window may be interpreted in one of two ways. It could be: (1) a relatively high-angle reverse fault dipping eastward, which has brought dolomites of uncertain age up in contact with or upon Rome phyllite breccia, or (2) the fault line could represent the trace of a low-angle thrust fault between overriding Rome phyllite breccia and overridden dolomites of uncertain age. Under interpretation (1), the fault is



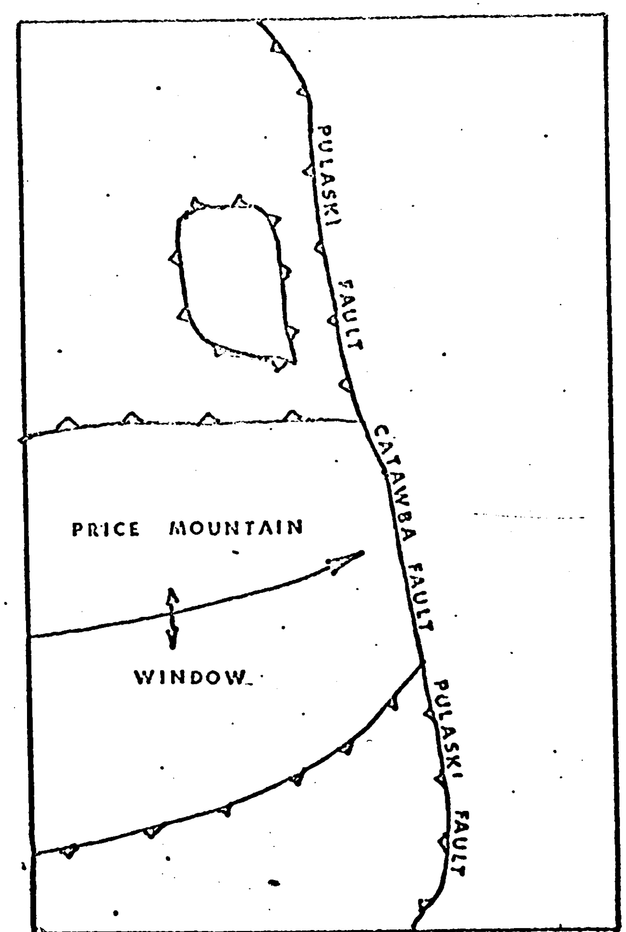


Figure 3. Alternate Interpretations of the Yellow Sulphur Fault

younger than the Catawba, Pulaski, and Max Meadows faults; under interpretation; (2) the fault trace could represent a portion of the Max Meadows fault.

The portion or segment of the Yellow Sulphur Fault Line bordering the Price Mountain window cannot dip westward, probably is not vertical, and therefore must dip eastward at some unknown angle. The fact that the fault brings dolomites of uncertain age into overriding position with respect to the plunging end of the Price Mountain anticline indicates that the fault is reverse and that it is most easily reckoned as a portion of the Catawba fault, particularly the convex-upward portion of the surface of the Catawba fault where it overrode the east-plunging nose of the Price Mountain anticline. If this identification is correct the subsurface trace of the Catawba fault north of Price Mountain window projects beneath the Pulaski and Max Meadows sheets under or to the west of the Blacksburg window and emerges as the fault trace that runs along the southeast base of Brush Mountain northeast of U. S. Route 460. There is no available evidence where the Catawba fault would run south of Price Mountain.

From the southeast corner of the window to and beyond the southern border of the area shown on Plate 1, the Yellow Sulphur Fault Line is either (1) the trace of the Pulaski fault, or (2) it is reverse fault dipping eastward and a continuation of the fault conceptualized under interpretation (2) for the segment north of Price Mountain window and possibly also even a continuation of the same fault that borders the window on the east.

Certain evidence favors the identification of the fault line north of Price Mountain as the Pulaski and/or Max Meadows faults, namely, the breccias and crush conglomerates along the contact line from the by-pass of U. S. Route 460 north of Blacksburg to the north-east corner of the Price Mountain window.

The segment south of Price Mountain window bears a fault slices or slivers of Ordovician black graptolitic shale (Liberty Hall Formation) identical to detached slivers of the same shale in a fault chaos zone north of the Christiansburg window, in the lower portion of the Pulaski overthrust block. It would be extremely difficult to derive these slivers from the overridden buried Price Mountain rocks because of the higher angle of the overriding fault block. Therefore, based on these fault slices, the fault trace south of Price Mountain window is probably best explained as being the emerging Pulaski fault. This portion of the fault line in question is the locus of a thick zone of crush conglomerate that is well exposed on the N and W Railway just east of Yellow Sulphur Station or crossing. Also, to the west of this crossing and bordering the crush conglomerate zone on the west side is a body of intensely crumpled, autobrecciated Elbrook dolomite. The crush conglomerate and autobreccia are normal phases of the Pulaski fault zone.

The segment south of the Price Mountain window could be a continuation of the high-angle reverse fault posed as an alternative interpretation on the east side of the window to the north and also north of the Price Mountain window. The writer's choice among the interpretations is for the Yellow Sulphur Fault Line to be a high-angle reverse fault dipping to the east and cutting the lower-dipping earlier-formed Catawba fault.

Waesche's "Blacksburg Fault" shown approximately also on Butts (1933) Geologic Map of the Appalachian Valley of Virginia is interpreted to approximate the Yellow Sulphur Fault Line recognized in this report. The differences in stratigraphic determinations are explicable as the result of only a limited number of exposures and an inferior base map.

Salem Fault Block

The Salem fault block is located in the southeastern corner of the area, approximately 0.2 mile southeast of Wilson Creek. The Salem fault bounds the Salem fault block on the northwest. The Elbrook Formation of Cambrian age has overridden the Middle Ordovician Liberty Hall Formation in the Catawba syncline.

Sequence of Formation of Faults

The areal geology of the Blacksburg area studied by the writer indicates the sequence of development of several faults. The first fault to form was the Catawba fault which may be completely unexposed but nonetheless necessarily present below the surface in the general area mapped by the writer, or which is exposed only along the east edge of the Price Mountain window. The movement of the Catawba block was west-northwest. After this faulting occurred the Pulaski-Max Meadows Sheets of Elbrook and Rome rode out over the Price Mountain rocks and the rocks that had previously overridden the later from the east.

If the Yellow Sulphur Fault Line is the trace of a discreet high-angle reverse fault, as the writer is inclined to believe, then the Yellow Sulphur Fault is younger than the Catawba, Pulaski, and Max Meadows faults.

Significance of the Blacksburg Window

The presence of the Blacksburg window exhibits several things about faulting in the Blacksburg area. The fact that Cambrian rocks of the window overlie Mississippian rocks of the Price Mountain anticline and the fact that the Cambrian rocks of the Blacksburg window correlate with those of the Catawba syncline indicate an eastward-dipping reverse fault with 10,000 feet of stratigraphic displacement. This fault, the Catawba fault, has displaced the Catawba syncline westward over Mississippian rocks of the same fault block. This rules out the possibility of the Catawba syncline being part of the Pulaski thrust block.

REFERENCES CITED

Amato, R. V., 1968, Structural Geology of the Salem Area, Roanoke County, Virginia: unpublished M. S. thesis, Va. Poly. Inst., 118p.

Aronson, D. A., 1966, Stratigraphy, Petrography, and Origin of the Copper Ridge Formation in the Blacksburg Area, Montgomery County, Virginia: unpublished M. S. thesis, Va. Poly. Inst., 163p.

Butts, Charles, 1933, Geologic Map of the Appalachian Valley of Virginia: Va. Geol. Survey Bull. 42, map.

Butts, Charles, 1940, Geology of the Appalachian Valley of Virginia: Va. Geol. Survey Bull. 52, 568p.

Campbell, M. R., 1894, Paleozoic Overlaps in Mountgomery and Pulaski Counties, Virginia: Geol. Soc. Amer. Bull., v. 5, p. 171-190.

Campbell, H. D., 1905, The Cambro-Ordovician Limestones in the Middle Portion of the Valley of Virginia: Amer. Jour. of Sci. 4th, v. 20, pp. 445-447.

Campbell, M. R., et. al., 1925, The Valley Coal Fields of Virginia: Va. Geol. Survey Bull. 25, 322p.

Cooper, B. N. and Cooper, G. A., 1946 Lower Middle Ordovician Stratigraphy of the Shenandoah Valley, Virginia: Geol. Soc. Amer. Bull., v. 57, pp. 35-113.

Cooper, B. N., 1944, Industrial Limestones and Dolomites in Virginia: New River - Roanoke River District: Va. Geol. Survey Bull. 62, 98p.

Cooper, B. N., 1961, Geologic Guidebook No. 1, Grand Appalachian Excursion: Va. Poly. Inst. Engineering Experiment Extension Series, 187p.

Cooper, B. N., 1946, Metamorphism Along the "Pulaski" Fault in the Appalachian Valley of Virginia: Amer. Jour. of Sci., v. 244, pp. 95-104.

Cooper, B. N., 1964, Relation of Stratigraphy to Structure in the Southern Appalachians _in_ Techtonics of the Southern Sppalachians: Va. Poly. Inst. Dept. of Geol. Sci. Memoir 1, W. D. Lowry, ed., pp. 81-114.

Cooper, B. N., 1968, Profile of the Folded Appalachians of Western Virginia: University of Missouri at Rolla Jour. 1, pp. 27-64.

Derby, J. R., 1966, Paleontology and Stratigraphy of the Nolichucky Formation in Southwestern Virginia and Northeastern Tennessee: unpublished Ph.D. Dissertation, Va. Poly. Inst., 465p.

Dietrich, R. V., Hobbs, B. and Lowry, W. D., 1963, Dolomitization Interrupted by Silicification: Jour. Sed. Petrology, v. 33, no. 3, pp. 646-663.

Eubank, R. T., 1967, Geology of the Southwestern End of the Catawba Syncline, Montgomery County, Virginia: unpublished M. S. thesis, Va. Poly. Inst., 91 p.

Gilbert, R. C., 1953, Middle Ordovician Limestones in the Valley of the North Fork of the Roanoke River, Montgomery County, Virginia: unpublished M. S. thesis, Va. Poly. Inst., 37p.

Hobbs, C. R. B., 1957, Petrology and Origin of Dolomite-Bearing Carbonate Rocks of Ordovician Age in Virginia: Va. Poly. Inst. Engineering Experiment Sta. Bull., v. 50, no. 5.

Howell, B. F., _et. al._, 1944, Correlation of the Cambrian Formations of North America: Geol. Soc. Amer. Bull., v. 55, pp. 993-1004.

Lowry, W. D., 1964, Is Imbrication Along the Blue Ridge the Result of Basement Deformation Accompanied by Crustal Sliding? (abstract): Geol. Soc. Amer. Special Paper 82, p. 304.

Rodgers, J., 1943, Geologic Map of Copper Ridge District, Hancock and Grainger Counties, Tennessee: U. S. Geol. Survey Strategic Minerals Inv. Prelim. Map.

Smith, E. A., 1890, Alabama Geol. Survey Report on Cababa Coal Field, p. 149.

Stose, G. W., 1906, The Sedimentary Rocks of South Mountain, Pennsylvania: Jour. Geol., v. 14, p. 201-220.

Ulrich, E. O., 1911, Revision of the Paleozoic System: Geol. Soc. Amer. Bull., v. 22, p. 281-680.

Ulrich, E. O., 1924, *in* Marble Deposits of East Tennessee: Tenn. Div. of Geol. Bull. 28, p. 34.

Waesche, H. H., 1934, The Areal Geology of the Blacksburg Region: unpublished M. S. thesis, Va. Poly. Inst., 68p.

The vita has been removed from the scanned document

Abstract

This 17 square mile area, on the western plunge of the Catawba syncline and the eastern plunge of the Price Mountain anticline, consists of the Cambrian Rome and Elbrook Formations thrust over younger Cambrian, Ordovician, and Mississippian rocks. The more or less autochthonous rocks are the Cambrian "dolomites of uncertain age" and Copper Ridge Formation, the Ordovician Chepultepec, Longview, and Mascot-Kingsport Formations, the Middle Ordovician limestones, and the Liberty Hall Formation; and the Mississippian Price and Stroubles Formations.

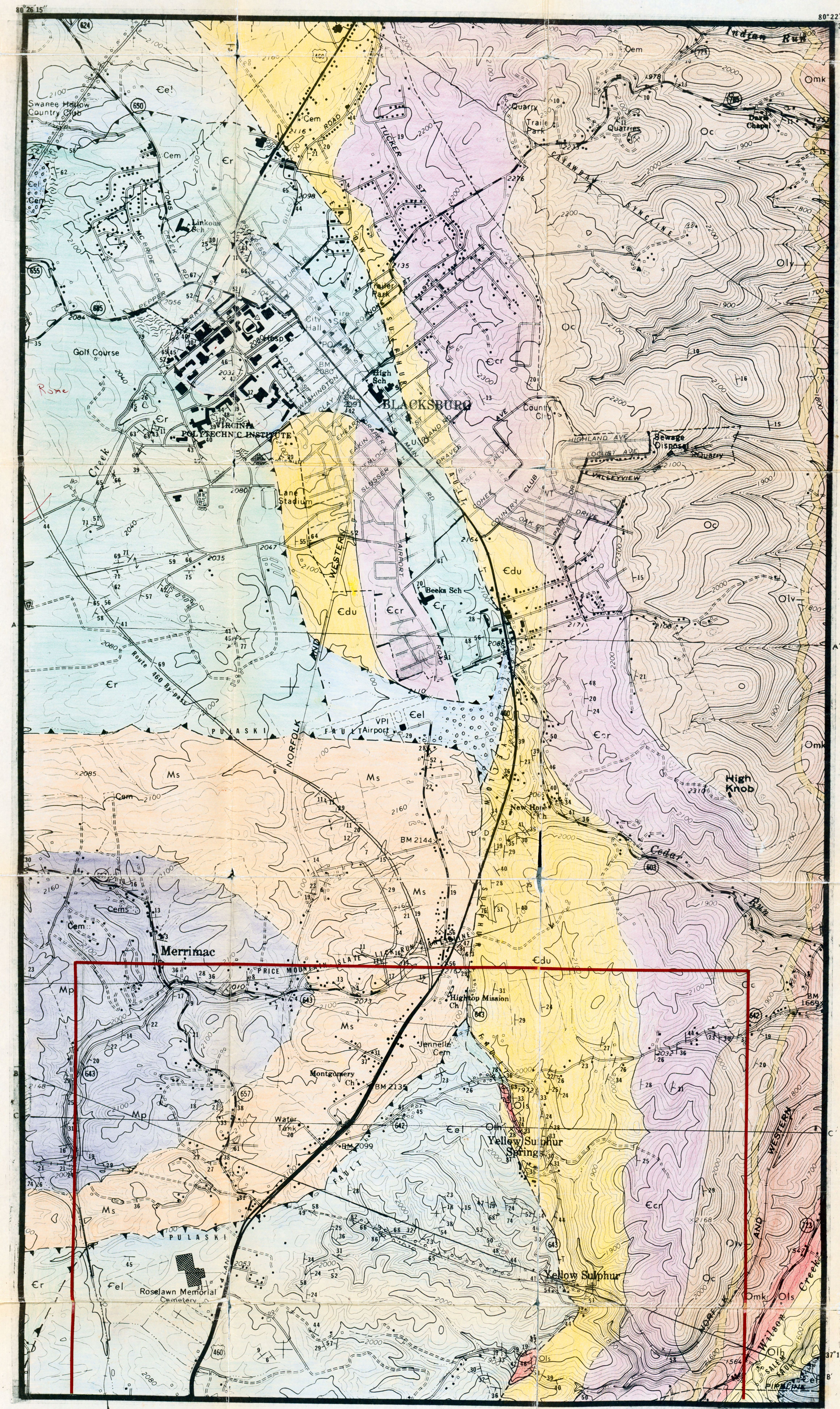
All fault structures within the area have formed during post-late Mississippian time. The apparent sequence of faulting is: (1) the westward thrusting of the Catawba syncline over the Price Mountain anticline; (2) the emplacement of the Pulaski thrust sheet; and (3) reverse movement along the eastward dipping Yellow Sulphur fault, which raised the Catawba syncline about 3000 feet relative to the Price Mountain anticline. Subsequent erosion has exposed Mississippian rocks in Price Mountain window of the Pulaski thrust and Cambrain rocks through the Blacksburg window of the Pulaski thrust sheet. Erosion has also revealed that near the base of the Pulaski thrust sheet are brecciated with the Elbrook, being typically a crush conglomerate, and the Rome being a phyllite breccia.

George Stephen Ritter

Geology of the Blacksburg area, Montgomery County, Virginia.

PLATE 1

GEOLOGIC MAP AND SECTIONS OF THE BLACKSBURG AREA, VIRGINIA



Geology by G.S. Ritter, 1967-69

SCALE 1:12,000

CONTOUR INTERVAL: 20 FEET

EXPLANATION

MISSISSIPPIAN

- Ms — Stroubles Formation
- Mp — Price Formation

ORDOVICIAN

- Olh — Liberty Hall Formation
- Ols — Middle Ordovician Limestones

DISCONFORMITY

- Omk — Mascot-Kingsport Formations
- Olv — Longview Formation
- Oc — Chepultepec Formation

CAMBRIAN

- €cr — Copper Ridge Formation
- €el (BRECCIA) — Elbrook Formation
- €du — Dolomites of Uncertain Age
- €r (BRECCIA) — Rome Formation

Strike and dip of beds

Overturned beds

Vertical beds

Contacts

Thrust fault-teeth on upper plate

Reverse fault-T on upthrown block

Contacts and faults dashed where approximate or inferred

Anticlines

Synclines

x—Derby's Localities