

GEOLOGY OF THE
JOHNS CREEK MOUNTAIN-PETERS MOUNTAIN AREA
GILES COUNTY, VIRGINIA

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ABSTRACT

The Johns Creek Mountain-Peters Mountain area lies in the northwest corner of Giles County, Virginia, and contains marine sedimentary rocks that range in age from Middle Ordovician to Middle Devonian. The summit of Johns Creek Mountain is the southeastern boundary of the area and the northern slope of Peters Mountain forms the northwestern boundary. Ten different rock formations are recognized and are mapped, measured, and described in detail. The geologic structure of the area is described and includes six major synclines, five major anticlines, four faults, and several minor folds, all illustrated on the geologic map (Pl. 1). A discussion of the geomorphology and of the structural evolution is included.

INTRODUCTION

Location of Area

The Johns Creek Mountain-Peters Mountain area lies along the northeastern border of Giles County, Virginia, approximately 12 miles northeast of Pearisburg. It is bounded on the northwest by the crest of Peters Mountain (West Virginia-Virginia State Line) and on the southeast by the crest of Johns Creek Mountain. The northeastern boundary lies along the Monroe (West Virginia)-Giles-Craig county lines. The southwestern boundary lies along a line N. 50° W. passing through the communities of Mountain Lake and Interior. Kire is near the center of the area. The total area encompasses approximately 65 square miles (Pl. 2, p. 10). The area is included on the 15-minute Pearisburg and Waiteville quadrangles of the United States Geological Survey. The base map used in preparing the geologic map was redrafted from a photographic enlargement of portions of the 1:62,500 Pearisburg and Waiteville quadrangle lithographic maps of the United States Geological Survey (Pl. 1).

Purpose of Investigation

The primary purpose of this investigation was to make a detailed geologic map of the area. This investigation included: study and description of the rock formations in the area; preparation of a geologic map

and structure sections; and detailed measurements of a number of stratigraphic sections.

Accessibility of the Area

Access to the area is seriously limited to three State-maintained secondary roads and a few unimproved roads used for logging and fire control. Salt Sulphur Turnpike, County Road 613, goes from the Mountain Lake along Salt Pond Mountain to the intersection of the Stony Creek road (635) at Kire. It crosses Fork Mountain and continues to the crest of Peters Mountain (West Virginia-Virginia State Line). The Stony Creek Road, County Road 635, extends from Interior through the community of Kire and continues northeastward into Waiteville, West Virginia, and southwestward to U.S. Route 460 and New River near Ripplemead, Virginia. County Road 601 parallels Johns Creek Mountain and crosses the crest of the mountain at the Giles-Craig County Line. County Road 632 parallels Johns Creek but it is accessible only southwestward from County Road 601 for 1.1 miles. The roads northwest of Stony Creek can be traversed only by cross-country vehicles. Part of the Appalachian Trail extends from the crest of Johns Creek Mountain at the Giles-Craig County Line along Salt Pond and Big mountains to Bailey Gap and down to Interior. Approximately two-thirds of the area is inaccessible except on foot.

Geography

Relief

The area lies within the Appalachian Valley and Ridge Province. The highest point in the area is Bald Knob on Salt Pond Mountain, which has an elevation of 4,327 feet. The lowest point in the area is along Stony Creek at Interior at an elevation of 2,350 feet. The maximum relief in the area is about 2,000 feet. All the major ridges and intervening valleys trend approximately N. 60° E. The area includes six unusually high ridges: Johns Creek Mountain (3,550 feet), Salt Pond Mountain (4,327 feet), Big Mountain (4,100 feet), a high ridge variously known as Rocky-Kire-Little mountains (3,500 feet), Fork Mountain (3,600 feet), and Peters Mountain (4,085 feet). The three major valleys in the area are: Johns Creek, Little Meadows, and Kelly Flats. Two minor valleys are Epling Draft and North Fork. In the northwest corner of the area Sarton Ridge (2,750 feet) and Huckleberry Ridge (3,680 feet) are prominent.

Drainage

The New River-James River watershed divide crossing the area parallels the crests of Johns Creek Mountain and Salt Pond Mountain to the confluence of Big and Salt Pond mountains near the Giles-Craig-Monroe county lines. From that point northward the divide essentially parallels the

Giles-Monroe Virginia-West Virginia state line to the crest of Peters Mountain. Johns Creek whose headwaters are located at the confluence of Johns Creek and Salt Pond mountains drains to the northeast and joins the James River near Newcastle, Virginia. Most of the small streams that drain into the Johns Creek originate from the shale member of the Rose Hill Formation. Stony Creek and Little Stony Creek flow southwest and join New River at Norcross and Pembroke, respectively. The headwaters of Little Stony Creek which originate from the Rose Hill Formation drain the table-land between Salt Pond Mountain and Big Mountain. The stream passes through Little Meadows and then turns southwestward to cut a 1,000-foot gorge near the Cascades. Stony Creek, a major tributary of the New River, has its headwaters in the area between Big Mountain and Fork Mountain from Kire to the Virginia-West Virginia state line. Two prominent water gaps which appear to be related to minor cross structures occur in the area: one just south of Kire and the other approximately 1.5 miles north-northeast of Interior.

Acknowledgments

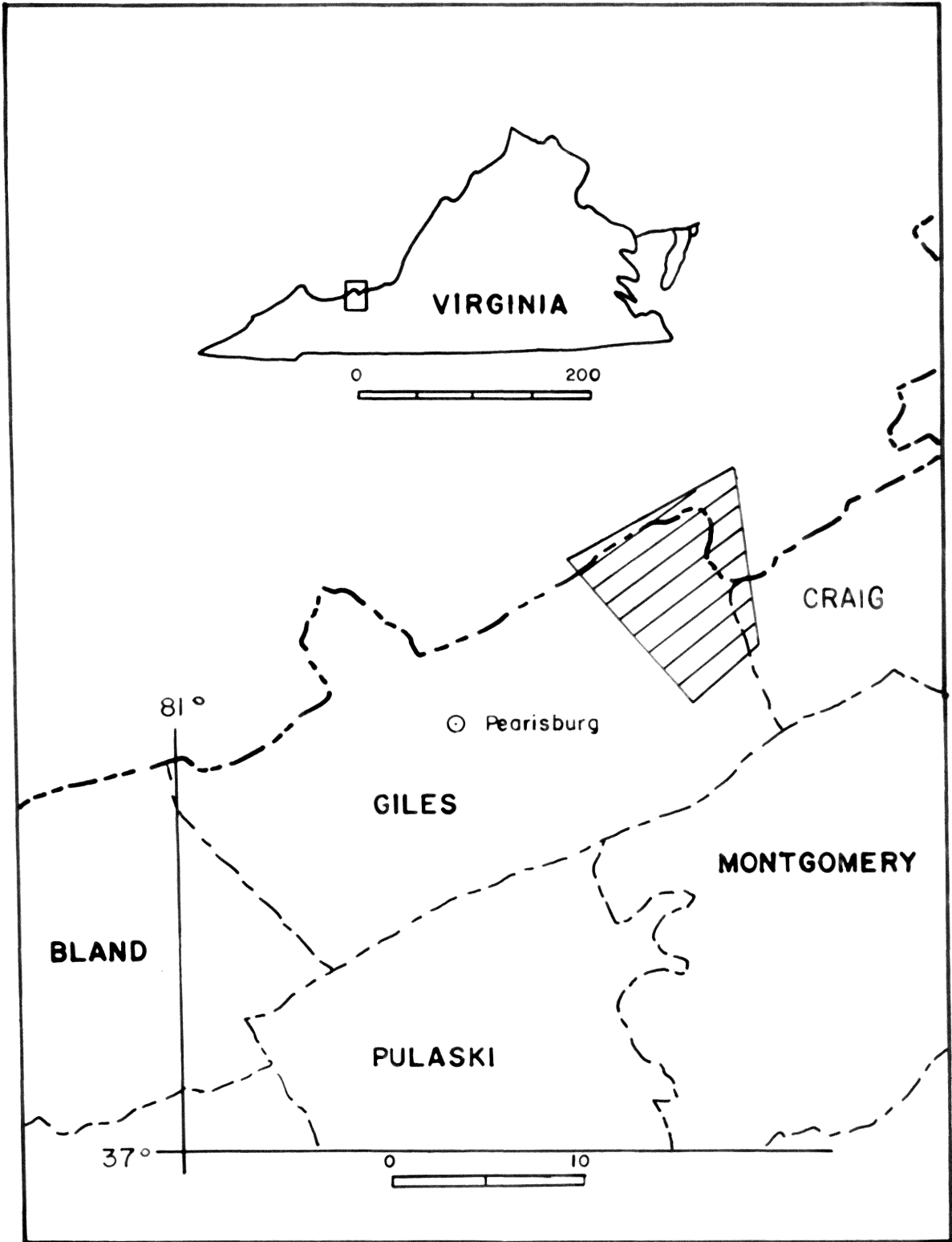
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Previous Work

The first published work concerning the geology of Giles County was that of W.B. Rogers (1841). Boyd (1881) published the first summary of the geology of Giles County in his report on the mineral resources of that area. Stevenson (1887) made a geological reconnaissance of several counties in southwestern Virginia which included a portion of Giles County. Watson (1907) mentions the iron mines and furnaces of the county. In 1909 Bassler included Giles County in his work which dealt with the stratigraphy of southwestern Virginia. Stose and Miser (1922) published descriptions of the manganese prospects in Giles County, including detailed stratigraphic descriptions of the manganese-bearing formations. Hubbard and Croncis (1924) published an outline of the geology of Giles County which included a brief summary of the physiography, stratigraphy, and economic resources. Mathews (1934) described the rock types and discussed the general struc-

ture of Giles County. In 1925 the West Virginia Geological Survey published the Monroe County map. Butts (1940) discussed the stratigraphy and structure of Giles County in his "Geology of the Appalachian Valley in Virginia". Hobbs (1953) described the structure along Johns Creek Mountain in an unpublished thesis.



**Index Map Showing Location of Johns Creek
Mtn. - Peters Mtn. Area**

STRATIGRAPHY

General Statement

The bedrock formations in the area consist of eight marine sedimentary rock formations ranging from Middle Ordovician to Early Devonian age. The thickness of the entire section is approximately 1,755 feet except in the Butt Mountain synclinerium where all the formations from the Rose Hill up to and including the Huntersville Chert seem to be notably thicker. The oldest Ordovician unit exposed in the area is the Martinsburg Shale which is composed of interbedded gray limestones and yellowish-brown weathering shales. The Juniata Formation consisting of approximately 300 feet of maroon, greenish-brown, and buff sandstones and shales is uppermost Ordovician.

The Lower and Middle Silurian are represented by the Tuscarora Sandstone and Rose Hill Formation and the "Keefer" Sandstone. The Tuscarora is approximately 140 feet thick and forms the massive ledges that make the crests of all the major mountains in the area. The overlying Rose Hill Formation makes prominent dip slopes on Salt Pond, Big, Fork, and Peters mountains and reaches the summits of Peters, Big, and Johns Creek mountains in a few localities. The Rose Hill Formation is approximately 180 feet thick. The "Keefer" Sandstone averages approximately 150 feet thick and makes prominent dip slopes on Salt Pond, Fork, and Peters mountains. The Upper Silurian is represented by

the Tonoloway Limestone which is approximately 95 feet thick at a complete exposure near Interior. On Johns Creek Mountain near Rocky Gap the "Keefer" Sandstone and the overlying Rocky Gap Sandstone (Devonian) seem to be in direct contact.

The Devonian System is represented by the Rocky Gap Sandstone which makes the lowermost row of knobs on the south slopes of Salt Pond and Fork mountains by the Huntersville Chert and by the black shale (Marcellus member) of the Millboro.

Colluvial and alluvial deposits of Quaternary age are present throughout much of the area.

Ordovician System

Martinsburg Formation

Name. - The Martinsburg Formation was named by Geiger and Keith (1891) from exposures near Martinsburg, West Virginia. The Martinsburg is considered a mapping unit rather than a distinct faunal and lithologic unit because of the fact that it is almost impossible to map the Trenton-Eden and Eden-Maysville boundaries (Cooper, 1944). The top of the Martinsburg is marked by the Orthorhynchula stevensoni zone.

Lithology. - The Martinsburg Formation (Pl. 3) consists of thin layers of interbedded olive-drab, fissile shales and argillaceous limestones. The shales are

predominantly silty and noncalcareous. The limestones are light-gray; in many the calcium carbonate has been dissolved and has left a punky, argillaceous layer in its place. The Orthorhynchula stvensoni zone consists of a reddish-brown, highly weathered siltstone overlain by an impure light-gray limestone. This zone was observed on the southeast slope of Johns Creek Mountain near Rocky Gap and near Hayes Knob on the northwest slope of Big and Peters mountains.

Distribution and thickness. - The Martinsburg Shale is poorly exposed on the southeast slope of Johns Creek Mountain and on the northwest slope of Peters Mountain. Extensive spurs and gentle slopes mark each belt of Martinsburg in contrast to the abrupt and steep slopes created by the overlying Silurian sandstones. Another belt of Martinsburg occurs along Epling Branch, but much of the formation is covered by colluvial and alluvial material and by a deep, partly residual soil cover. No complete exposure of the Martinsburg Formation occurs in the area.

Juniata Formation

Name. - The Juniata Formation was named by Darton (1896) from exposures along the Juniata River in Pennsylvania. Vanuxem (1840) and Hall (1840) included the Juniata or Red Medina as a part of the Medina Sandstone. The name Medina was not retained because later work showed that the

upper sandstone-shale member of the Medina corresponded to the Tuscarora Sandstone. The United States Geological Survey has restricted the Juniata to the beds above the Oswego Sandstone and below the Tuscarora Sandstone. The age of the Juniata Formation is considered to be Richmondian and is determined by its stratigraphic position between the Orthorhynchula stevensoni zone of the upper Martinsburg and the overlying gray orthoquartzite of the Tuscarora (Albion) Sandstone.

Lithology. - The Juniata Formation (Pl. 3) is mainly composed of interbedded maroon shales and sandstones and of several light-gray orthoquartzitic sandstones. The dark-red color of the formation is a prominent feature and makes it difficult to distinguish between the Juniata and the Rose Hill Formation (Silurian). The maroon shales are predominantly silty and contain light-green streaks and blotches of reduced iron oxide. The maroon sandstones are fine grained and generally thin bedded. Many of the sandstone layers are cross-laminated and contain excellent examples of highly inclined foreset bedding. The light-gray sandstone layers are found within the upper 100 feet of the formation and range from 1.9 feet to 4.7 feet in thickness.

The contact between the Juniata and the overlying Tuscarora Sandstone was placed at the first grayish-white quartzitic sandstone above the red beds of the Juniata.

A more detailed description of the Juniata Formation

is given in Geologic Sections 1 and 2.

Distribution and thickness. - The best exposure of the Juniata occurs on the north slopes of Johns Creek, Big, and Peters mountains. Much of the formation is preserved because of the protection against weathering and stream-action afforded by the overlying Tuscarora Sandstone. The best exposure of Juniata is along County Road 613 near Wind Rock on Potts Mountain. The Juniata Formation as exposed near Wind Rock is 375 feet thick; on the northwest slope of Peters Mountain the Juniata is 380 feet thick.

Silurian System

Tuscarora Sandstone

Name. - The term Clinch was originally proposed by Safford (1856) and included both the red and white sandstones above the Juniata Formation exposed along Clinch Mountain, Tennessee. A later revision by Darton (1896) from work in Tuscarora Mountain, Pennsylvania, introduced the name Tuscarora for the grayish-white sandstone member of the Clinch. Butts (1940) cited both authors and recommended that the term Tuscarora be discontinued because of the priority of the term Clinch; the former term to be used from central Virginia northward and the latter for southwest Virginia and Tennessee. Cooper (1961) followed Rodgers (1953) who concluded that the type section of the Clinch Sandstone

along Clinch Mountain possibly includes beds of Clinton age and is therefore not synonymous with Tuscarora.

Lithology. - The Tuscarora Sandstone (Pl. 3) consists of white to light-gray, massive, fine to coarse grained orthoquartzitic sandstones with scattered layers of quartz-pebble conglomerate in the basal portion. On the weathered exposure there are thin layers of interbedded brown to gray shale. The quartz grains are bounded together by an interstitial siliceous cement. The orthoquartzites are nearly pure but contain a little ferruginous or argillaceous material. Case hardening is prominent on these layers. The quartz-pebble conglomerate consists of ellipsoid shaped pebbles ranging from 0.16 inch to 1.5 inches in diameter. Wedging cavities are prominent on the larger pebbles. Weathered exposures of the conglomeratic layers show that the interstitial cement has been removed by solution action and consequent penetration by iron- and manganese-rich solutions have accentuated many sedimentary features such as foreset bedding and scour-and-fill structures. In many layers, particularly in the conglomeratic layers, the red iron stain has produced a pseudo bedding. The most abundant fossil that occurs in the Tuscarora is Arthropycus alleghaniensis, which is found on weathered bedding surfaces.

A more detailed description of the Tuscarora Sandstone is given in Geologic Sections 3 and 4.

Distribution and thickness. - The Tuscarora Sandstone is the most prominent formation in the area. Because of its ability to resist weathering, it dominates all the topographic highs including Johns Creek, Big, Fork, and Peters mountains. The Tuscarora on Big and Peters mountains is horizontal and the undermining of the Juniata and Martinsburg has resulted in great accumulations of sandstone blocks on the obsequent slopes. On Johns Creek Mountain and Rocky-Kire Mountain the sandstone is nearly vertical and subsequent weathering of the adjoining formations has formed cliffs from 20 to 40 feet high.

The Tuscarora Sandstone ranges in thickness from 90 feet on Big Mountain to 140 feet on Johns Creek Mountain.

Rose Hill Formation

Name. - The Rose Hill Formation was named by C.K. Swartz (1923) from exposures near Rose Hill, Cumberland County, Maryland. The formation was defined as comprising all the beds between the top of the Tuscarora Sandstone and the bottom of the Keefer Sandstone. Butts (1940) cited work done by Vanuxem (1842) and Hall (1843) that included this red sandstone as a member of the Clinton group; Ulrich (1912) proposed that the Clinton be limited to the red and white sandstones above the Tuscarora Sandstone and the Rochester Shale be excluded. In the Johns Creek Mountain-Peters Mountain area the name is

applied to all the beds occurring between the top of the Tuscarora Sandstone and below the "Keefer" Sandstone.

Lithology. - The Rose Hill Formation consists of olive-drab, reddish-brown, and dark-red shales, greenish-gray sandstones and beds of fossiliferous hematite-cemented sandstone. The multicolored shales are slightly silty and are present throughout the formation but are more abundant in the lower third of the section. Several fossiliferous layers containing ostracodes and trilobite fragments are found throughout much of the section. The argillaceous shales range in thickness from 0.1 inch to 10 inches.

Two light-gray sandstone layers are present in the upper and lower portions of the formation. The sandstone is very fine grained and difficult to detect owing to its similarity to the overlying "Keefer" Sandstone. Throughout the area it was noted that red iron stain had penetrated the light-gray sandstone layers and, therefore, the true color could be seen only on a fresh surface. Trilobite fragments were very abundant in the lower light-gray sandstone. The sandstone layers range in thickness from 10 feet to 30 feet.

The prominent feature of the formation is the thin to thick bedded hematite-cemented sandstones which occur in the section. Most of the ferruginous layers are dark-red and consist of quartz grains cemented and coated by iron

oxide. Several intervals show distinct lamination of the coarse grained and fine grained layers; many of the coarse grained layers are concretionary. Green to light-brown clay galls are prominent and range in size from less than one-sixteenth of an inch to one inch in diameter. Scolithus and ostracode zones are found in the maroon sandstone layers. Two massive beds of hematite-cemented sandstone occur in the upper 70 feet of the formation but they are not persistent throughout the area. Weathering of the underlying shales causes the thin bedded sandstones to break into roughly rectangular pieces and to cover most of the formation with a flaggy colluvium. Wavellite, a white, radiating hydrous aluminum phosphate mineral of secondary origin is found on the weathered surfaces of some beds. A prominent Scolithus zone occurs at the Tuscarora-Rose Hill contact on Johns Creek and Big mountains.

A more detailed description of the Rose Hill Formation is given in Geologic Sections 5, 6, and 9.

Distribution and thickness. - The Rose Hill Formation occurs near the crest of Johns Creek, Salt Pond, Big, and Peters mountains. Along War Spur and the south slope of Fork Mountain the Rose Hill forms prominent dip slopes. The best exposure of the Rose Hill Formation is found on Johns Creek Mountain near Rocky Gap. Two other exposures occur on Big Mountain approximately 2.2 miles northeast of Wind Rock and on the northwest slope of Peters Mountain.

The Rose Hill Formation ranges in thickness from 150 feet on Johns Creek Mountain to 200 feet on Peters Mountain.

"Keefer" Sandstone

Name. - The Keefer Sandstone was first described by Stose (1912) in the Pawpaw-Hancock Folio of the United States Geological Survey and it was considered to be a member of the Rochester Formation. Swartz (1912), from work along the Keefer River, Franklin County, Pennsylvania, revised the atlas edition of the folio and placed the Keefer in the Niagaran Series. Butts (1940) concurred with Stose and Swartz in considering the Keefer Sandstone a member of the Rochester Formation. Cooper (1961) used the term "Keefer" because the beds so named in Giles County may be part of the Rose Hill and, therefore, be older than the type Keefer of Rochester age.

For this report the "Keefer" Sandstone consists of all the beds of white orthoquartzite from the top of the Rose Hill to the base of the overlying Tonoloway Limestone.

Lithology. - The "Keefer" Sandstone is a massive, light-gray to white, orthoquartzitic sandstone with thin layers of interbedded brown shale. A conglomerate layer composed of egg-shaped cobbles, which measure from 3 to 6 inches in diameter, occurs approximately 30 feet above the Rose Hill and "Keefer" contact. The orthoquartzitic sandstone is very resistant and usually is stained a light-

brown on weathered exposures. Case hardening is prominent in the lower portion of the formation. Several of the sandstone layers contain abundant Scolithus, Arthropycus alleghaniensis, and an ostracode resembling Leparditia. Fragments of trilobites were found on a few weathered surfaces of assorted shales and siltstones. Ripple-marks and cross-bedding accentuated by weathering occur on some of the beds. Some of the coarse grained sandstones show the presence of black, manganese streaks and irregular blotches and light-brown clay galls.

A more detailed description of the "Keefer" Sandstone is given in Geologic Sections 7, 8, and 9.

The "Keefer" Sandstone closely resembles the Tuscarora and can be distinguished only by stratigraphic succession.

Distribution and thickness. - The "Keefer" Sandstone is exposed extensively along the dip slopes of Salt Pond, Fork, and Peters mountains. The resistant sandstones form prominent flat-irons midway down the south slopes and extending completely across the area. The "Keefer" reaches the summit of Johns Creek Mountain near Rocky Gap. The best exposures of the "Keefer" occur along the south slope of Salt Pond Mountain and along the slopes of Big and Peters mountains.

The "Keefer" Sandstone ranges in thickness from 95 to 200 feet.

Tonoloway Limestone

Name. - The Tonoloway Limestone was named by Ulrich (1911) without stratigraphic limitations from exposures along Tonoloway Ridge, Washington County, Maryland. Stose and Swartz (1912) defined the lower contact between the Tonoloway and the Wills Creek Formation by distinguishing the less resistant argillaceous limestones of the Wills Creek from the more resistant pure limestone layers of the Tonoloway. The upper contact between the Helderberg Formation and the Tonoloway was defined by the marked difference of the massive, resistant overlying Helderberg and the laminated, less resistant beds of the Tonoloway Limestone. In the Johns Creek Mountain-Peters Mountain area the Tonoloway Limestone rests unconformably on the "Keefer" Sandstone.

Lithology. - The Tonoloway Limestone consists of interbedded gray, magnesian limestone; yellowish-brown weathering argillaceous limestone; and, gray to light-brown, very fine grained sandstone. The lower part of the formation consists of interbedded gray to orangish-brown limestone and light-brown, very fine grained sandstone that are thick bedded and unfossiliferous. The contact between the "Keefer" Sandstone and the Tonoloway Limestone is marked by a laminated bright red and tan, clayey shale and a 4-foot thick bed of shale and manganese wads. The middle portion consists of interbedded gray and tan, impure

limestones with abundant black, calcareous shale partings averaging 0.25 inch in thickness. Several fossil zones (Geologic Section 10) containing ostracodes, trilobites, and brachiopods occur within this member. The upper part of the formation is composed chiefly of fine grained, massive weathering limestone that weathers a yellowish-brown. Two beds of gray, calcareous quartzite are interbedded with the limestones. The yellowish-brown color is indicative of a greater clay content. Vugs of black or white calcite occur throughout the formation.

A more detailed description of the Tonoloway Limestone is given in Geologic Section 10.

Distribution and thickness. - The Tonoloway Limestone is best exposed on the south flank of Sarton Ridge approximately 0.1 mile northwest of Interior. The Tonoloway is poorly exposed in a narrow belt extending from the base of Huckleberry Ridge just north of Interior eastward for 1.5 miles to the water gap of the North Fork. On the south flank of Peters Mountain approximately 0.9 mile northwest of the intersection of North Fork and County Road 613 the position of the Tonoloway is marked by bright red and yellow, laminated clayey mantle. No exposures of Tonoloway were observed on Big Mountain, Salt Pond Mountain, or Johns Creek Mountain. On the summit of Johns Creek Mountain near Rocky Gap the Tonoloway Limestone is in direct contact with the "Keefer" Sandstone.

The Tonoloway is poorly exposed throughout the area; its presence is indicated by lumpy light-brown soil, which is typical, and by a shallow topographic swale and "covered interval" which is frequently found between the exposures of the "Keefer" Sandstone and the Rocky Gap Sandstone.

The Tonoloway Limestone ranges in thickness from 35 feet for the red and yellow laminated residuum to 106 feet at the complete exposure near Interior.

Devonian System

Rocky Gap Sandstone

Name. - The Rocky Gap Sandstone was named by F.H. Swartz (1929) from exposures near Rocky Gap, Bland County, Virginia. Butts (1940) used the name Becraft for this particular formation and defined the stratigraphic limits for western Virginia as the sandstone-limestone facies between the Tonoloway Limestone and the overlying Oriskany Sandstone. B.N. Cooper (1944) used the name Rocky Gap because of differences in the facies and faunal characteristics between the Virginia Rocky Gap and the type section of the Becraft in New York. Cooper (1961) suggested that the Rocky Gap Sandstone is mainly Helderbergian in age but contains fossils suggestive of lower Oriskany (Deerparkian).

Lithology. - The Rocky Gap is a massive, coarse

grained, steel-gray to brown, carbonate-cemented sandstone, predominantly conglomeratic throughout much of the formation. The Rocky Gap Sandstone where fresh is a steel-gray coarse grained sandstone cemented with calcium carbonate (Cooper, 1944). As generally observed on the outcrop, deep leaching of the carbonate cement has rendered the sandstone very friable. Much of the sandstone is stained with iron and manganese oxides and is very poorly sorted. Limonite is present along the bedding and jointing planes. Because of differential weathering of the sandstone and the limonite, the latter occurs as prominent protruding ridges on the weathered outcrop. The conglomerate layers consist of coarse grained, ferruginous sandstone with either angular fragments of a light-gray to white, coarse grained sandstone or small, grayish-blue, irregular shaped pieces of chert. On Fork Mountain both types of conglomerates are exposed on the south slope near North Fork. Bedding laminations that weather rusty-brown and grayish-white occur in the upper 25 feet of the formation. A very rich fossil zone containing corals, ostracodes, and brachiopods occurs on the southeast slope of Fork Mountain approximately 30 feet from the top of the formation. On Fork Mountain and Huckleberry Ridge excellent examples of the fossiliferous layer, the conglomerate layer which contains white sandstone fragments measuring up to 6 inches in diameter, and the laminated beds, are present. On Johns Creek Mountain,

Salt Pond Mountain, and Big Mountain the fossiliferous zone and the conglomerate beds could not be found.

Where the calcareous cement has been leached away a poorly exposed, loose sandy residuum occurs making accurate measurements of formation thickness impossible. Where iron and manganese oxide has reinforced the sand the rock is relatively resistant and measurements ranging in thickness from 65 to 85 feet were made.

A more detailed description of the Rocky Gap Sandstone is given in Geologic Section 11.

Distribution and thickness. - The Rocky Gap Sandstone is best exposed on the northwest slope of Big Mountain approximately 1.5 miles east-northeast of White Pine Lodge. The southernmost row of flatirons extending from White Pine Lodge eastward to the intersection of Little Stony Creek and County Road 613 is formed by massive cliffs of Rocky Gap Sandstone. A narrow belt of Rocky Gap Sandstone extends from Sarton Ridge near Interior northeastward for 0.7 mile to the vicinity of Kire. Numerous exposures occur along County Road 635 which parallels the southwest flank of the Waiteville syncline. The southernmost row of flatirons along the south slope of Peters and Fork mountains are formed by gently dipping Rocky Gap Sandstone. The north slope of Fork Mountain is formed by a dip slope of Rocky Gap Sandstone. Another exposure of Rocky Gap Sandstone occurs on the crest of Johns Creek Mountain near Rocky Gap.

The Rocky Gap Sandstone ranges in thickness from 70 feet on the south slope of Salt Pond and Peters mountains to at least 130 feet in the Butt Mountain synclinorium.

Huntersville Chert

Name. - The Huntersville Chert was named by Price (1929) from exposures near Huntersville, Pocahontas County, West Virginia. Previously, the formation was referred to as the Oriskany; later, it was found to contain the same fauna as Butts' "Onondaga" chert which is known to be post-Oriskany. B.N. Cooper (1961) considered the formation as including the lower part of the Onondaga and the complete underlying Schoharie Sandstone of West Virginia. Cooper (1961) stated that both the Onondaga and Schoharie Sandstone were represented by the Huntersville Chert.

The Huntersville Chert formed the upper zone of Campbell's (1894) Giles Formation; the Rocky Gap Sandstone and the Tonoloway Limestone constituted the middle and lower zones respectively. The grouping of these "poorly exposed strata" into a convenient mapping unit was more than justified, particularly in the Johns Creek Mountain-Peters Mountain area.

Lithology. - The Huntersville Chert consists of milky-gray to bluish-gray, chert and silty, glauconitic shales. The chert is extremely hard and is characteristically broken into small, irregularly shaped blocks that

have been coated with manganese or iron oxides. Some of the reddish-brown chert is essentially jasper. The glauconitic shale is bright green and contains nodules of brown, silty, phosphatic material that appears amorphous on X-ray patterns. The green shale layer is approximately 4 inches thick and is well exposed along County Road 613 approximately 0.3 mile northeast of Kire.

A more detailed description of the Huntersville Chert is given in Geologic Section 12.

Distribution and thickness. - The best exposure of Huntersville Chert occurs along the south flank of Fork Mountain approximately 0.3 mile northeast of Kire. No good exposures of Huntersville Chert were found in the area; the presence of the formation was based on the occurrence of scattered chert float and the yellowish-brown color of the soil mantle. Partial exposures of the formation occur in the stream bed of the North Fork between Fork and Peters mountains and on the south flank of Big Mountain near White Pine Lodge. Extensive chert float occurs along the gently dipping spurs surrounding Johns Creek and Little Meadows.

The Huntersville Chert is approximately 65 feet thick on Fork Mountain.

Millboro Shale

Name. - The Millboro Shale was named by Butts (1940)

from exposures at Millboro Springs, Bath County, Virginia. Darton (1892) included the Millboro facies as a part of the Romney Shale which represented all the beds from the Oriskany Sandstone to the Brallier Shale (upper Middle Devonian). Butts (1940) limited the Millboro Shale so as to include only the Marcellus and Naples shales of the original Romney.

The Marcellus Shale was named by Hall (1839) from exposures near Marcellus, New York. G.A. Cooper (1942) stated that the "Marcellus" member of the Millboro in Virginia might possibly represent not only the type Marcellus in New York but also the Hamilton Formation or Butts' "restricted" Romney. Cooper (1944) mentioned that the term "Marcellus" was used for the black shales of typical Marcellus character, which might possibly be a black shale facies of the Hamilton.

Lithology. - The "Marcellus" Shale consists of black, silty, fissile shale that splits into very thin chips and weathers buff to light-gray. The "Marcellus" is cut by numerous small faults and is intricately folded in the area. Several small concretions occur in the lower portion of the formation which is exposed along County Road 632. Several calcareous layers from 3 to 9 inches thick are exposed in the creek bed behind White Pine Lodge. An inarticulate brachiopod occurs in many of the shale layers.

Distribution and thickness. - The incomplete

exposures and intricate folding of the "Marcellus" prevent an accurate measurement of its thickness. Its presence can be detected by the abundance of the black shale chips throughout the brown soil cover. The "Marcellus" Shale is exposed in the trough of the Johns Creek syncline along County Road 632 and in the trough of the Butt Mountain synclinerium near Little Meadows.

The "Marcellus" Shale is approximately 200 feet thick.

Quaternary System

Unconsolidated Deposits

The unconsolidated deposits of the Johns Creek Mountain-Peters Mountain area include talus of both residual and transported material, boulder streams or "rock glaciers", "let-down erratics", alluvial fans (representing material that has been moved in more recent times), and residuum. The colluvium and alluvium were grouped together and mapped as a unit chiefly because of their value as a possible source of percolating ground water. Only the deposits that were of sufficient areal extent and thickness so as to prevent accurate delineation and determination of the underlying residual soil or bedrock were mapped. Nearly all the gullies and stream beds are choked with some alluvial and colluvial material.

Three major concentrations of colluvial and alluvial

material occur within the area. One belt extends along Stony Creek from Interior eastward approximately 4.5 miles to the vicinity of Kire. In Kelly Flats and extending up the north slope of Big Mountain to an elevation above 3,000 feet, subrounded to subangular boulders and cobbles of Tuscarora and "Keefer" sandstone occur within the deep soil. Many smaller cobbles and pebbles of Rose Hill are mixed with the larger blocks. A small prospect pit approximately 0.2 mile west of Hayes Knob at an elevation of 3,100 feet reveals a colluvial and alluvial cover to a depth of 11 feet. The second large deposit of unconsolidated material occurs within Epling Draft approximately a mile southeast of Kire. The valley floor is composed of shale of the Martinsburg Formation. The deep cover contains boulder- and cobble-sized blocks of Tuscarora, Rose Hill, and "Keefer" sandstone. The majority of the larger boulders and cobbles of Tuscarora and "Keefer" sandstone are subangular to angular; most of the smaller cobbles and pebbles are predominantly ferruginous sandstone from the Rose Hill Formation. Several larger alluvial fans, which extend along the obsequent slope from the crest of Big Mountain down to the valley floor, are composed of large irregular blocks of Tuscarora Sandstone. "Let-down erratics" (Landes, 1959) of Tuscarora Sandstone measuring 7x7x12 feet occur within the fans and as single isolated blocks along County Road

613, which traverses the valley. Several of the large blocks of Tuscarora occur 1.4 miles downslope from the parent outcrop. Other examples of "let-down erratics" are found (1) on the south slope of Johns Creek Mountain, (2) along Johns Creek, and (3) on the north slope of Peters Mountain. An excellent example of "let-down erratics" can be seen at the north end of Mountain Lake. The third major concentration of unconsolidated material occurs near the head of Johns Creek, near the confluence of Johns Creek and Salt Pond mountains. A few of the perennial streams that feed Johns Creek originate within the unconsolidated material. The area is mostly composed of float from the Tuscarora and "Keefer" sandstones with minor amounts of the Rose Hill Formation. The blocks range from 0.6 to over 3.0 feet in diameter and are angular to subangular in shape. The colluvial and alluvial cover along Salt Pond and Johns Creek mountains extends from the valley floor to an elevation of approximately 3,000 feet.

Boulder streams choke the floors of many of the narrow valleys and ravines such as North Fork, War Spur, and Saltpeter branches. The boulder streams consist mainly of blocks of Tuscarora and "Keefer" sandstones because of their greater hardness and resistance to weathering. Most of the talus and boulder stream deposits are produced primarily through the effects of frost action

and undermining by weathering of less resistant underlying bedrock. Evidence of these processes can best be seen along the crests of Peters, Big, and Johns Creek mountains.

Structure

General Statement

The Johns Creek Mountain-Peters Mountain area is located on a major thrust block bounded on the northwest by the St. Clair fault and on the southeast by the Saltville fault. The geologic structures of the rocks exposed in the area are typical of those throughout the folded Appalachian Valley. The most prominent features within the area are the many asymmetrical folds that are slightly overturned to the northwest (Pl. 1). Most of the major folds extend for several miles past the boundaries of the area (Pl. 4); for example, Butt Mountain synclinorium is part of a major down-fold that extends for over 170 miles (Cooper, 1961). The intricately folded strata displayed around Little Mountain show characteristics that persist for some distance in the Appalachian Valley. The period of deformation of the rocks in the Appalachian region occurred within the Paleozoic era.

Major Folds

Johns Creek Syncline

The Johns Creek syncline, one of the major folds in the area, is a relatively asymmetrical syncline which opens abruptly northeastward down the valley of Johns Creek (Pl. 1). The fold is slightly asymmetrical with an axial trace striking N. 50° E. and dipping approximately 8° to 14° to the southeast. The trough of the fold consists of Millboro

Shale which is exposed along County Road 632. The northwest nose of the syncline is made by the confluence of Johns Creek and Salt Pond mountains but is extensively obscured by unconsolidated material. Beds on the southeast flank dip 40° to 50° to the northwest and gradually increase along strike to a maximum of 80° just south of Rocky Gap. Along the northwest limb of the fold the beds dip 24° to 40° southeast; both flanks are sharply defined by prominent dip slopes of "Keefer" Sandstone and Rose Hill Formation and by numerous perennial streams. Nearly all the formations from the Tonoloway Limestone down to and including much of the Millboro Shale are covered by colluvial and alluvial material.

Butt Mountain Synclinerium

General Statement. - Salt Pond and Big mountains outline a relatively asymmetrical structure underlain by complexly folded Silurian and Devonian formations (Pl. 1). As shown along County Road 613 crossing from Mountain Lake to Wind Rock, the general structure is synclinal. The structure which extends southeastward across the New River Valley is part of a major downfold more than 170 miles long (Cooper, 1961).

Butt Mountain syncline. - The most conspicuous structure between Salt Pond and Big mountains is a syncline

which is marked topographically by the many extensive ridges that surround Little Meadows and Little Stony Creek. The axial plane is nearly vertical and is roughly paralleled by Little Stony Creek (Pl. 1). The northwest flank is marked by prominent dip slopes of "Keefer" Sandstone and Rose Hill Formation and dip 10° to 45° southeast. The beds on the southeast flank dip 25° to 45° to the northwest. The trough consists of Millboro Shale that shows extreme fracturing and shearing. All the formations are notably thicker in the trough of the fold (Cooper, 1961). For example, the Rocky Gap Sandstone which is normally 75 feet thickens to at least 130 feet.

Lone Pine Peak anticline. - In the vicinity of Lone Pine Peak there is a relatively broad anticline capped by Rocky Gap Sandstone (Pl. 1). The fold persists northward from County Road 613 along War Spur Trail and plunges beneath the surface near the Giles-Craig county line (Pl. 4). The "Keefer" Sandstone exposed on the northwest flank dips 10° to 15° northwest and forms the southeast limb of the Butt Mountain syncline. The north nose of the fold is exposed near Lone Pine Peak.

Wind Rock syncline. - The southeast flank of Potts Mountain is made by a narrow, tight syncline of "Keefer" Sandstone (Pl. 1). The axial plane of the doubly-plunging fold essentially parallels the crest of Potts Mountain. The

southwest flank of the fold is cut by the Big Mountain fault (Pl. 4). Beds on the southeast flank dip 40° to 60° southeast. The northeast nose of the fold is expressed topographically by the broad flats formed by "Keefer" Sandstone near the north nose of the Lone Pine Peak anticline.

Bane-Mountain Lake Anticline

On the southeast flank near Mountain Lake is an asymmetrical anticline that opens to the southwest where it joins the Clover Hollow anticline to form one large fold. The northeast nose is marked topographically in the elbow of Doe Mountain and Salt Pond Mountain (Pl. 1). The axial plane dips 8° to 13° to the southeast and essentially parallels Doe Creek. Erosion of the fold has exposed the core of Martinsburg Formation along County Road 613 near the Mountain Lake hotel. A shallow reversal of plunge to the northeast has exposed the Tuscarora Sandstone in Saltpeter Branch.

Epling Draft Anticline

A sharp southwest plunging anticline in the rocks immediately south of Rocky and Kire mountains causes the Martinsburg Formation to be exposed along Epling Branch (Pl. 1). The misidentification of the Martinsburg as

Devonian black shale caused the West Virginia Geological Survey to label the structure the Ray syncline (Reger, 1925). The axial trace of the fold essentially parallels Spring Branch and dips approximately 10° to 12° southeast. The southeast flank consists of the Martinsburg Formation and is drag-folded so that a portion of the Juniata Formation is repeated on the northwest slope of Potts Mountain. The northwest limb of the anticline is steeply overturned to the southeast, from the western border of the area, northeastward to the vicinity of Hayes Knob (Pl. 4). The same anticlinal structure persists northeastward beyond the eastern border of the area.

Little Mountain Syncline

The crest of Little Mountain is made by a northeast-plunging syncline of Rose Hill Formation (Pl. 1). The trough of the relatively shallow fold consists of "Keefer" Sandstone. The axial plane essentially parallels the crest of the mountain and dips approximately 5° to 10° northeast (Pl. 4). The southwest part of the syncline is a tight fold with near vertical dips on either flank.

Back Valley Anticline

Strata along the northwest slope of Little and Kire mountains are folded into a northeast plunging anticline

that extends past Waiteville, West Virginia (Pl. 4). The axis of the asymmetrical fold converges with the slightly overturned northwest limb of the Epling Draft anticline near Hayes Knob (Pl. 1). The beds on the southeast flank dip 25° to 30° to the southeast and form the normal limb of the Little Mountain syncline. The Rose Hill Formation on the northwest slope of Little Mountain dips 30° to 40° northwest and gradually increases to a maximum of 80° in the southwest corner of the area. The anticline has been eroded in the gorge of Epling Branch where the Rose Hill Formation reflects the symmetrical arch along County Road 613.

Waiteville Syncline

Just north of Stony Creek the Millboro Shale is folded in a narrow asymmetrical syncline whose axial trace essentially parallels County Road 635. Along the southeast flank the dip is 25° to 40° northwest, but on the other flank the dip is only 15° to 30° to the southeast. Only the southwest nose of the fold is shown on Plate 1, but it extends northeastward past Paint Bank, Monroe County, West Virginia (Pl. 4). The White Rock Mountain fault dies out in the southwest nose of the fold in the vicinity of Interior. The fold is constricted locally by minor reversal of plunge near the Virginia-West Virginia state line and near the C.A. Lucas farm just northeast of Interior.

Fork Ridge Syncline

Just southeast of Sarton Ridge, the Huntersville Chert is folded into a narrow syncline which pitches southwest and dies out near White Rock Mountain (Eckroade, 1962, personal communication). Beds on the southeast flank dip 30° to 40° to the northwest and form the slightly overturned northwest limb of the Epling Draft anticline (Pl. 4). The folded northwest limb forms the normal southeast limb of the Waiteville syncline (Pl. 1). Near Interior the fold is obscured by colluvial and alluvial material.

Fork Mountain Anticline

The Fork Mountain anticline is a prominent asymmetrical fold in the northern part of the area and extends northeastward beyond the area for approximately 9 miles to the vicinity of Waiteville, Monroe County, West Virginia (Pl. 4). The axial plane trends approximately N. 60° E. and roughly parallels the crest of Huckleberry Ridge and Fork Mountain (Pl. 1). Beds on the northwest flank dip 20° to 30° northwest, and the "Keefer" Sandstone and Huntersville Chert are repeated by shallow flexures. The southeast flank of the anticline is broken by the Huckleberry Ridge fault which extends northeastward across the crest of the fold and dies out on the northwest flank in the vicinity of Johnson Flats. The arch is well shown along County Road 613 near Links

Cabin. The fold plunges to the southwest and, as with North Fork syncline, passes beneath the surface near the confluence of Huckleberry Ridge and Peters Mountain. The fold has been breached by North Fork forming a water gap that exposes inliers of Tuscarora Sandstone.

North Fork Syncline

Immediately north of Fork Mountain and extending northeastward from the confluence of Huckleberry Ridge and Peters Mountain to Waiteville, Monroe County, West Virginia, is a northeast plunging asymmetrical syncline (Pl. 1). The fold axis trends approximately N. 70° E. and roughly parallels North Fork (Pl. 4). The trough consists of Huntersville Chert that forms the extensive flatirons near the confluence of Dixon Branch and North Fork. The southeast flank of the syncline with several minor flexures is the northwest limb of the Fork Mountain anticline which is marked by a prominent dip slope of "Keefer" Sandstone dipping 20° to 40° southeast. In the vicinity of Johnson Flats the fold is narrowed locally by an anticlinal saddle; northeast of the State line the syncline broadens.

Minor Folds

Rocky Gap Syncline

Atop Johns Creek Mountain just northwest of Rocky Gap, the Devonian beds are folded into a sharp syncline which

plunges to the northeast. The trough consists of Rocky Gap Sandstone; the fold continues past the northwest boundary of the area and into Craig County, Virginia (Pl. 4). The northwest limb of the fold is broken by the Rocky Gap fault (Hobbs, 1953) and the "Keefer" Sandstone has been thrust upon overturned southeast dipping Juniata Formation (Pl. 1). The southeast flank of the fold is broken by a minor fault that dies out in the Rose Hill Formation near the southwest nose of the syncline. The structure is best shown along County Road 601 in the vicinity of the Giles-Craig County line.

Structures Atop Peters Mountain

Atop Peters Mountain, extending from the point where County Road 613 intersects the crest northeastward past the West Virginia State line, lies a narrow synclinal basin (Pl. 4). The axis of the structure is indicated by the narrow strip of "Keefer" Sandstone that strikes parallel to the crest of the mountain (Pl. 1). Both flanks are marked by outcrop slopes of Rose Hill and Tuscarora Sandstone dipping approximately 20° . The syncline is relatively symmetrical and plunges to the northeast.

Faults

Big Mountain Fault

The Big Mountain fault was named for the break which

occurs along the overturned southeast limb of the Epling Draft anticline resulting in a repeated section along the upper northwest slope of Big Mountain (Pl. 1). The dip of the fault plane in the vicinity of Bailey Gap is estimated at 50° to the southeast. In the southwest part of the area the fault is marked by the contact of the Juniata Formation and the "Keefer" Sandstone resulting in a 400 foot stratigraphic displacement. The displacement decreases to the northeast and the fault dies out in the Lone Pine Peak anticline (Pl. 4).

White Rock Mountain Fault

The White Rock Mountain fault was named (Eckroade, 1962, personal communication) for the break which occurs on the southwest nose of Sarten Ridge near Interior (Pl. 1). The fault plane is steeply inclined to the southeast. The fault originates near Kerns approximately 12 miles southwest of Interior and dies out in the southwest nose of the Waiteville syncline (Pl. 4).

Huckleberry Ridge Fault

The Huckleberry Ridge fault extends northeast along the base of Huckleberry Ridge and Fork Mountain and dies out in the vicinity of Johnson Flats on the northwest slope of Fork Mountain (Pl. 1). The fault plane is highly inclined

or vertical and the stratigraphic displacement decreases in a northeast direction. Bekroade (1962, personal communication) mapped the fault trace southwestward across the crest of Peters Mountain near Dickinson Gap (Pl. 4).

Rocky Gap Fault

The Rocky Gap fault (Hobbs, 1953) was named for the break that occurs along the crest of Johns Creek Mountain near the Giles-Craig county line (Pl. 1). The main fault plane is highly inclined or vertical and dies out southwestward along the crest of Johns Creek Mountain (Pl. 4). The fault plane bifurcates near the northeast boundary of the area.

Geomorphology

Previously, the topography of the Appalachian Valley and Ridge province was thought to be the result of successive uplifts separated by long periods of crustal stability with erosion sculpturing the relief and altitude of the region. The resulting erosion surfaces, termed peneplains (Davis, 1899), were the basis for the interpretation of the present day topographic features. The historical development and fundamental ideas of the school of "Peneplanation" are discussed in detail by Cooper (1944, p. 205-213).

Much of the evidence favoring peneplains was based on the existence of even-crested ridges that characterize the Appalachian region. Correlation of peneplains was done by comparing the general altitudes of these ridges and then classifying the particular ridges in one of the 3 to 5 recognized erosion cycles. Cooper (1944, p. 213-215) stated that the ridge crests have been lowered but that they are still being lowered at different rates by the work of erosional agencies now active. Considering that even-crested ridges do not demonstrate the existence of former peneplains, the problem of correlating remnants of a particular peneplain is impossible.

The highest areas in the Johns Creek Mountain-Peters Mountain area are Salt Pond Mountain (altitude 4,300 to 3,600 feet), Big Mountain (3,900 to 4,100 feet) and Peters Mountain (3,810 to 4,085 feet), and are made by essentially

horizontal Silurian sandstones. The highest prominences are formed by either very gently dipping (7° to 15° southeast) or broad arches of Tuscarora Sandstone. Johns Creek Mountain, with an altitude of 3,200 to 3,500 feet, is lower because of the steeper dip (55° to 85° northwest) of the Tuscarora Sandstone, part of which has been faulted and overturned by the Rocky Gap fault (Pl. 1). On Big Mountain the Silurian sandstones dip very gently to the southeast but they are somewhat thinner (Geologic Sections 3 and 4) than the outcrops on Salt Pond and Peters mountains. Salt Pond Mountain has retained its altitude because of a broad anticlinal arch of Silurian sandstone. The lower altitude of Rocky and Kire mountains is the consequence of very steeply dipping (60° to 75° northwest) Tuscarora Sandstone; the rate of lowering of a ridge, especially of steeply dipping rocks, is accelerated because of the smaller surface area that can be attacked by weathering. Fork Mountain (3,500 to 3,800 feet), structurally a broad anticline capped by Silurian sandstones, is somewhat lower because the crest has been faulted by the Huckleberry Ridge fault. In the northwest portion of the area the higher elevation of Peters Mountain is due to a narrow synclinal basin flanked by Silurian sandstones. Sarton Ridge (2,750 feet) is formed by gently dipping "Keefer" Sandstone.

The general altitudes of the areas below the sandstone

ridges denote the nonresistant character of the Ordovician and Devonian rocks. Johns Creek Valley, Little Meadows, and Kelly Flats (Stony Creek) are formed by the Devonian Millboro Black Shale. The Huntersville Chert that is exposed in North Fork shows some degree of resistance to weathering by the many small flatirons that occur along the flanks of the creek. The first row of prominent flatirons that surround each of the depressions is formed by Devonian Rocky Gap Sandstone; due to the poor competency and the unsorted calcium carbonate cemented character of the formation it is less resistant to weathering. The second row of flatirons and the many steep cliffs that occur above the Rocky Gap are formed by the "Keefer" Sandstone; the flatirons are usually accented by the erosion and removal of the Tonoloway Limestone so that a prominent topographic swale occurs at the heel of the ridge.

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GEOLOGIC SECTIONS

Geologic Section 1. - Juniata Formation exposed on Johns
Creek Mountain along County Road 601 near Rocky Gap,
Craig County, Virginia

	Thickness Feet
Tuscarora Sandstone	
Juniata Formation (330 feet)	
15. Sandstone, greenish-gray, fine grained, thick bedded; interbedded with maroon silty shales; cross laminated.....	35
14. Shale, maroon, silty; interbedded with brown to light-gray shales; ripple marks.....	32
13. Sandstone, buff, fine grained; interbedded with red shale; scour- and-fill.....	15
12. Shale, maroon, silty; interbedded with cross-bedded, thin bedded maroon sandstone weathering light- red.....	10
11. Sandstone, maroon, fine grained, thin bedded, laminated.....	39
10. Covered, probably maroon sandstone...	17

	Thickness Feet
9. Sandstone, maroon to greenish-gray, fine grained, thin to thick bedded.....	14
8. Sandstone, maroon, fine grained, laminated; interbedded with maroon sandy shales.....	19
7. Sandstone, maroon, fine grained; weathering rusty-brown.....	9
6. Covered, probably maroon siltstone...	21
5. Sandstone, brown, fine grained, laminated.....	2
4. Covered, probably maroon siltstone...	27
3. Siltstone, maroon, thick bedded.....	8
2. Siltstone, maroon, weathering buff.....	26
1. Covered, probably maroon siltstone...	30

Martinsburg Formation (Orthorhynchula zone)

Geologic Section 2. - Juniata Formation exposed along
County Road 613 just below the crest of Big
Mountain, Giles County, Virginia

	Thickness Feet
Tuscarora Sandstone	
Juniata Formation (314 feet)	
27. Covered interval.....	4
26. Sandstone, light-green on fresh surface, very fine grained; weathers yellowish-green and massive, green clay galls; inter- bedded with thin bedded maroon siltstone averaging 0.25 foot.....	6
25. Sandstone, light-green on fresh surface; interbedded with thin bedded maroon sandstone showing prominent purple blotches on fresh surface.....	4
24. Siltstone, maroon with green blotches, shaly.....	2
23. Sandstone, light-green on fresh surface, very fine grained; green clay galls; black manganese stain.....	5
22. Siltstone, maroon, shaly; inter- bedded with light-green laminated	

	Thickness Feet
sandstone containing <u>Scolithus</u>	2
21. Siltstone, maroon with green blotches, thin bedded; inter- bedded with light-green cross- bedded sandstone averaging 1.6 feet thick.....	20
20. Siltstone, maroon with green blotches, thick bedded; inter- bedded with light-green cross- bedded sandstone averaging 0.6 foot thick.....	21
19. Sandstone, maroon, very fine grained; prominent maroon shale chips; interbedded with maroon shaly siltstone.....	5
18. Sandstone, light-green, very coarse grained, cross-bedded; punky weathering, larger grains sub- rounded to rounded, contains <u>Scolithus</u> ; interbedded with thin bedded maroon siltstone.....	10
17. Sandstone, light-green, friable, thick bedded; interbedded with maroon siltstone and maroon very fine grained sandstone.....	40

	Thickness Feet
16. Sandstone, maroon, very fine grained; interbedded with maroon shaly siltstone.....	25
15. Sandstone, maroon, thick bedded; interbedded with maroon siltstone and light-green friable sand- stone.....	13
14. Sandstone, maroon, very fine grained, cross-bedded.....	4
13. Siltstone, maroon, thin bedded; interbedded with maroon very fine grained sandstone.....	6
12. Sandstone, maroon, very fine grained, cross-bedded.....	3
11. Siltstone, maroon, highly fractured; interbedded with maroon thin bedded sandstone.....	35
10. Sandstone, maroon, thick bedded; interbedded with maroon shaly siltstone.....	12
9. Covered.....	9
8. Siltstone, maroon, shaly; inter- bedded with maroon thin bedded sandstone.....	6

	Thickness Feet
7. Partly covered with scattered out- crops of maroon fine grained sandstone.....	11
6. Siltstone, maroon, thin bedded; interbedded with maroon thin bedded sandstone.....	22
5. Partly covered with scattered out- crops of maroon fine grained sandstone.....	8
4. Sandstone, maroon, thick bedded; interbedded with maroon thin bedded siltstone.....	18
3. Partly covered.....	16
2. Siltstone, maroon, thick bedded; highly fractured.....	12
1. Sandstone, maroon, thin bedded; interbedded with maroon cobbly siltstone.....	24
Martinsburg Shale (<u>Orthorhynchula</u> zone)	

Geologic Section 3. - Tuscarora Sandstone exposed along
Fire Trail that parallels Big Mountain approximately
1.0 mile southwest of Giles-Craig-Monroe county
line

	Thickness Feet
Rose Hill Formation	
Tuscarora Sandstone (74 feet)	
10. Sandstone, white, very fine grained; weathers slabby.....	20
9. Sandstone, grayish-white, fine grained; weathers buff, clay galls on fresh surface, rough weathered surface.....	15
8. Covered.....	2
7. Sandstone, white, fine grained; weathers slabby.....	3
6. Covered.....	4
5. Sandstone, white, fine grained; thick bedded; black manganese stain.....	14
4. Covered.....	2
3. Sandstone, white, fine grained, thin bedded.....	3
2. Covered.....	2
1. Sandstone, white, coarse grained, thick bedded; interbedded with	

Thickness
Feet

subrounded to rounded quartz pebble
conglomerate with wedging cavities
on larger pebbles; black manganese
stain.....

9

Juniata Formation

Geologic Section 4. - Tuscarora Sandstone exposed along
Fire Trail that parallels Big Mountain approximately
0.1 mile southwest of Giles-Craig-Monroe county
line

	Thickness Feet
Rose Hill Formation	
Tuscarora Sandstone (94 feet)	
13. Sandstone, white, very fine grained; weathers slabby.....	7
12. Covered.....	4
11. Sandstone, white, fine grained; weathers buff; black manganese stain.....	10
10. Covered.....	10
9. Sandstone, white, fine grained; weathers slabby; interbedded with subrounded to subangular quartz pebble conglomerate weathering friable.....	9
8. Sandstone, buff, fine grained, slabby.....	6
7. Sandstone, white, very fine grained..	5
6. Sandstone, white, fine grained, thick bedded, friable; interbedded with quartz pebble conglomerate.....	15

	Thickness Feet
5. Sandstone, buff, very fine grained...	4
4. Sandstone, white, fine grained, contains <u>Scolithus</u> ; interbedded with thin lenses of quartz pebble conglomerate.....	12
3. Sandstone, white, fine grained, slabby.....	6
2. Covered.....	2
1. Sandstone, white, coarse grained, thick bedded; interbedded with quartz pebble conglomerate.....	5

Juniata Formation

Geologic Section 5. - Rose Hill Formation exposed along
north slope of Little Mountain, Monroe County,
West Virginia

	Thickness Feet
"Keefer" Sandstone	
Rose Hill Formation (165 feet)	
9. Covered.....	10
8. Sandstone, maroon, very fine grained, hematite cement; weathers flaggy...	15
7. Sandstone, maroon, coarse grained, cross-bedded; weathers reddish- brown; thin bedded; interbedded with angular to subangular hematite-cemented quartz-granule conglomerate measuring from 2.0 to 6.0 inches thick.....	19
6. Sandstone, reddish-brown, coarse grained, thin bedded; weathers flaggy.....	15
5. Shale, reddish-brown, clayey; weathers yellowish-brown to buff...	2
4. Sandstone; interbedded with hematite- cemented quartz-granule conglom- erate; similar to unit 7.....	27
3. Sandstone, maroon, very fine grained;	

	Thickness Feet
weathers yellowish-brown to brownish-red, shaly.....	9
2. Sandstone, maroon, fine grained, friable.....	7
1. Covered.....	40
Tuscarora Sandstone	

Geologic Section 6. - Rose Hill Formation exposed along
County Road 601 on Johns Creek Mountain near Rocky
Gap, Giles County, Virginia

	Thickness Feet
"Keefer" Sandstone	
Rose Hill Formation (168 feet)	
14. Shale, buff, silty; interbedded with thin bedded maroon hematitic shale.....	1
13. Sandstone, maroon, very fine grained, thick bedded.....	5
12. Sandstone, maroon, very fine grained, hematite-cemented; interbedded with buff shale weathering rusty- brown.....	20
11. Sandstone, maroon, fine grained, hematite-cemented; interbedded with buff shale.....	2
10. Sandstone, maroon, fine grained, thin to medium bedded; interbedded with olive-drab silty shale.....	8
9. Partly covered with olive-drab and buff shale chips.....	16
8. Sandstone, maroon, fine grained, hematite-cemented; numerous clay	

	Thickness Feet
galls.....	6
7. Shale, green to buff, silty; weathers rusty-brown; interbedded with maroon and light-green fine grained sandstone weathering reddish- brown.....	41
6. Sandstone, maroon, fine grained; weathers buff to light-brown; laminated with reddish-brown silty shale.....	12
5. Shale, green to buff, silty; inter- bedded with very thin bedded maroon sandstone.....	20
4. Sandstone, maroon, very fine grained; weathers rusty-brown.....	9
3. Shales, red and green, silty; weathers buff.....	8
2. Shale, buff, silty; interbedded with maroon shaly hematite-cemented sandstone weathering flaggy.....	3
1. Siltstone, light-gray, thick bedded; weathers red and green, mottled....	17

Tuscarora Sandstone

Geologic Section 7. - "Keefer" Sandstone exposed along
State Road 635 about 1 mile northeast of Goldbond,
Giles County, Virginia

	Thickness Feet
Rocky Gap Sandstone	
"Keefer" Sandstone (151 feet)	
17. Sandstone, light-brown, very fine to fine grained; weathers reddish- brown to greenish-brown; inter- bedded with coarse grained friable sandstone; prominent iron and manganese stain; jointed.....	10
16. Orthoquartzite, brownish-red to purple, very fine grained; weathers light-brown; jointed.....	2
15. Shale, yellowish-brown, silty.....	3
14. Sandstone, greenish-white, fine grained; friable, iron stained.....	2
13. Shale, yellowish-brown, silty.....	2
12. Sandstone, maroon, very fine to fine grained; weathers light-brown; jointed.....	3
11. Orthoquartzite, similar to unit 16...	5
10. Sandstone, maroon, fine grained, upper 0.6 foot friable.....	12

	Thickness Feet
9. Orthoquartzite, light-brown, very fine grained; weathers reddish-gray; black manganese stain; middle 2 feet very friable.....	18
8. Covered.....	12
7. Sandstone, similar to unit 14; jointed.....	15
6. Conglomeratic sandstone, reddish-brown, fine grained; weathers light-brown; rounded to subrounded light-brown very fine grained orthoquartzitic pebbles measuring .45 to .15 inch; mud galls and shale chips scattered throughout interval.....	2
5. Orthoquartzite, similar to unit 9, with manganese pods and prominent case-hardening.....	14
4. Sandstone, light-brown, very fine grained; weathers reddish-brown; current marks on weathered surface, spheroidal weathering.....	6
3. Sandstone, light-brown, very fine to fine grained; weathers gray to	

	Thickness Feet
reddish-brown to yellowish-brown; fossiliferous (ostracodes); man- ganese pods.....	24
2. Orthoquartzite, similar to unit 9....	17
1. Covered.....	12

Rose Hill Formation

Geologic Section 8. - "Keefer" Sandstone exposed along
the summit of Little Mountain approximately 1.5
miles east of Kire, Monroe County, West Virginia

	Thickness	
	Feet	Inches
Not exposed, probably Tonoloway Limestone		
"Keefer" Sandstone (125 feet)		
14.	Covered.....	45 0
13.	Partly covered with scattered out- crops of milky-white, very fine grained orthoquartzite.....	6 0
12.	Sandstone, grayish-white to tan on fresh surface, coarse grained; thin bedded; black manganese stain.....	4 0
11.	Partly covered with scattered out- crops of tan to buff, fine grained thin bedded sandstone.....	8 0
10.	Orthoquartzite, milky-white, very fine grained; laminated with reddish-brown coarse grained sand- stone weathering grayish-white.....	2 0
9.	Orthoquartzite, milky-white, very fine grained, hard; weathers massive.....	18 0
8.	Sandstone, greenish-brown, fine grained; weathers yellowish-brown;	

	Thickness	
	Feet	Inches
friable.....	3	0
7. Orthoquartzite, milky-white, very fine grained; contains <u>Scolithus</u> ; thin bedded; weathers massive.....	10	0
6. Sandstone, grayish-white, fine grained; grades into subrounded quartz pebble conglomerate.....	6	0
5. Sandstone, greenish-brown, fine grained; laminated with reddish- brown coarse grained friable sand- stone weathering grayish-white; near base a rounded to subrounded quartz pebble conglomerate.....	2	0
4. Shale, gray, silty, noncalcareous....	0	6
3. Orthoquartzite, milky-white, very fine grained, hard; weathers massive; black manganese stain.....	3	0
2. Sandstone, similar to unit 8.....	1	0
1. Orthoquartzite, similar to unit 3....	10	0

Rose Hill Formation

Geologic Section 9. - "Keefer" Sandstone and Rose Hill Formation exposed along County Road 613 from Link's Cabin southeast for approximately 0.7 mile, Giles County, Virginia

	Thickness Feet
Rocky Gap Sandstone	
Tonoloway Limestone	
64. Bright red and yellow laminated soil.....	6
"Keefer" Sandstone (220 feet)	
63. Sandstone, bluish-gray, very fine grained, thin bedded; brownish-orange laminae weathering gray; brown specks on fresh surface; contains <u>Leperditia</u> and <u>Tenaculites</u> ; beds highly weathered.....	3
62. Partly covered; scattered outcrops of highly weathered bluish-gray sandstone similar to unit 63; red and yellow soil.....	11
61. Breccia, manganese-cemented, angular fragments composed of bluish-gray highly weathered sandstones; contains <u>Leperditia</u>	1

	Thickness Feet
60. Sandstone, reddish-brown, fine grained; weathers tan; manganese pods and streaks measuring 0.25 to 3.0 inches.....	5
59. Bright red and yellow soil.....	15
58. Sandstone, similar to unit 63 except brownish-orange specks on fresh surface and weathers massive; contains <u>Arthrophyous</u>	10
57. Bright red and yellow soil.....	9
56. Sandstone, white, coarse grained; weathers light-brown, friable, massive; interbedded with white fine grained sandstone; current marks prominent on weathered surface.....	10
55. Sandstone, white, coarse grained, friable; black and red stain; large quadrilateral radial cavities measuring 2 inches in diameter.....	3
54. Sandstone, laminated, red and yellow, very fine grained, shaly; weathers mottled red and brownish-yellow....	3
53. Orthoquartzite, grayish-white, very fine grained, hard; prominent red	

	Thickness Feet
stain.....	2
52. Sandstone, white, fine grained, black and red stain, friable.....	2
51. Orthoquartzite, similar to unit 53...	4
50. Sandstone, similar to unit 54.....	6
49. Covered.....	9
48. Sandstone, white, fine to coarse grained; red and black stain; interbedded with red shaly sand- stone weathering friable; clay galls.....	6
47. Sandstone, red, very fine grained, shaly; weathers bright red.....	3
46. Sandstone, white, fine grained, friable.....	6
45. Covered.....	2
44. Sandstone, white, fine grained, friable; contains <u>Scolithus</u>	2
43. Covered.....	4
42. Sandstone, white, fine to coarse grained; red stain; friable.....	5
41. Sandstone, white, fine to coarse grained; red specks on fresh surface; contains <u>Arthropods</u>	6

	Thickness Feet
40. Sandstone, red to yellowish-brown, fine grained, friable; black manganese stain and pods.....	9
39. Covered.....	4
38. Orthoquartzite, grayish-white, very fine grained, hard.....	4
37. Covered.....	3
36. Orthoquartzite, similar to unit 38..	4
35. Sandstone, white, fine grained; red stain.....	3
34. Sandstone, white, fine grained, friable; contains <u>Scolithus</u> ; weathers grayish-white.....	2
33. Covered.....	4
32. Sandstone, red and yellow, very fine grained; shaly; laminated.....	2
31. Sandstone, white, fine grained, friable; weathers light-brown.....	1
30. Sandstone, red, shaly.....	4
29. Orthoquartzite, grayish-white, very fine grained; prominent red stain.....	2
28. Sandstone, white, fine to coarse grained, friable; brownish-red	

	Thickness Feet
specks on fresh surface.....	10
27. Covered.....	10
26. Orthoquartzite, mottled red and black, very fine grained; weathers mottled red and tan and yellowish- brown; large "rolls" measuring 4 to 7 inches in diameter on weathered surface; clay galls; contains <u>Scolithus</u>	6
25. Orthoquartzite, grayish-white, very fine grained, hard; prominent red stain; large conical-shaped hollow- centered "tubes" measuring 0.25 to 1.5 inches in diameter making prominent pits on weathered surface.....	4
24. Sandstone, light-brown, fine grained; weathers yellowish-brown.....	6
23. Sandstone, white, fine to coarse grained; red stain, friable; several conglomerate lenses com- posed of rounded to subrounded clear quartz pebbles.....	7
22. Sandstone, tan, fine grained, hard...	2

Thickness
Feet

21. Sandstone, light-brown, coarse
grained; thin bedded; weathers
massive..... 2

Rose Hill Formation (130 feet)

20. Sandstone, maroon, hematite-cemented,
fine grained grading into very fine
grained and coarse grained; sub-
rounded to subangular hematite-
coated quartz pebbles measuring
0.03 to 0.05 inch in diameter;
light-brown clay galls weathering
yellowish-brown to yellowish-green;
weathers to irregular-shaped slabby
blocks..... 20

19. Sandstone, brown, very fine grained;
weathers reddish-brown..... 3

18. Sandstone, maroon, similar to unit
20..... 6

17. Sandstone, maroon, hematite-cemented,
fine grained; clay galls; streaks
of brown very fine grained dense
sandstone measuring 0.5 inch
thick..... 4

16. Sandstone, maroon, hematite-cemented;

	Thickness Feet
clay galls; dense black very fine grained sandstone on fresh sur- face.....	7
15. Sandstone, similar to unit 20.....	10
14. Shale, olive-drab, silty; weathers brownish-yellow; tan clayey lenses in thicker shale layers; shale weathers to yellowish-brown clay...	25
13. Sandstone, maroon, hematite-cemented, very fine grained; clay galls.....	2
12. Shale, olive-drab, silty; weathers brownish-yellow; contains <u>Scolithus</u>	11
11. Shale, tan, sandy; greenish-gray clay laminae; interbedded with maroon fossiliferous (ostracodes) sand- stone; interval predominantly shale.....	10
10. Shale, olive-drab, sandy.....	8
9. Sandstone, maroon, hematite-cemented, fine grained; fossiliferous (ostracodes).....	2
8. Sandstone, brown, fine grained; thin bedded.....	1

	Thickness Feet
7. Sandstone, maroon, hematite-cemented, fine to coarse grained; clay galls; weathers flaggy.....	10
6. Covered.....	25
5. Shale, olive-drab, silty; greenish- gray clay laminae.....	4
4. Shale, greenish-gray, clayey.....	5
3. Sandstone, similar to unit 7.....	4
2. Covered.....	10
1. Sandstone, maroon, hematite-cemented, very fine grained; clay galls; weathers flaggy; interval partly covered.....	15

Tuscarora Sandstone

Geologic Section 10. - Tonoloway Limestone exposed along
Stony Creek 0.1 mile north of Interior, Giles County,
Virginia

	Thickness	
	Feet	Inches
Rocky Gap Sandstone		
Tonoloway Limestone (106 feet)		
31. Limestone, gray, fine grained, medium bedded, laminated; weathers orangish-brown.....	5	6
30. Limestone, brown with black blotches, fine grained.....	2	2
29. Limestone, dark-gray, fine grained, laminated, shaly.....	1	1
28. Limestone, brown, fine grained, laminated.....	2	3
27. Limestone, brownish-gray, fine grained, thin bedded; reddish cast on weathered surface.....	4	0
26. Shale, gray, silty, calcareous.....	0	2
25. Quartzite, gray, thick bedded.....	3	7
24. Shale, gray, silty, calcareous.....	0	6
23. Quartzite, gray, slabby.....	0	7
22. Limestone, gray, silty; weathers orangish-brown and shaly.....	1	10
21. Limestone, dark-gray, fine grained,		

		Thickness	
		Feet	Inches
	thin bedded, ostracodes, cobbly....	1	4
20.	Limestone, black, fine grained, thin bedded, weathers cobbly and shaly.....	1	0
19.	Limestone, dark-gray, fine grained, thin bedded.....	2	2
18.	Limestone, dark-gray, fine grained, thick bedded, contains brachiopods and algal structures.....	3	5
17.	Limestone, gray, very fine grained, weathers yellowish-brown; interbedded with brown laminated shale and light-gray coarse grained limestone; fossiliferous (ostracodes, brachiopods, and algal structures); carbonaceous (?); white dust on weathered surface....	10	0
16.	Limestone, bluish-gray, coarse grained, laminated with thin bedded calcareous shale; interbedded with light-gray fine grained limestone.....	3	0
15.	Limestone, light to dark-gray, very fine grained; pitted weathered		

		Thickness	
		Feet	Inches
	surface, pyrite and quartz grains on fresh surface.....	5	0
14.	Limestone, gray, coarse grained, orange blotches, cobbly.....	4	6
13.	Covered.....	7	6
12.	Limestone, gray, coarse grained, fossiliferous (ostracodes and brachiopods).....	0	9
11.	Limestone, light-gray, coarse grained, weathers orangish-brown, white blotches.....	4	6
10.	Covered.....	5	0
9.	Sandstone, light-brown, very fine grained, weathers tan; jointed; manganese case hardening.....	2	0
8.	Partly covered; yellowish-brown soil.....	6	0
7.	Sandstone, similar to unit 9.....	10	6
6.	Limestone, bluish-gray, very fine to coarse grained; weathers light- brown and cobbly; fossiliferous (ostracodes and brachiopods); gray calcareous shale layers; prominent reddish-brown soil.....	4	6

	Thickness	
	Feet	Inches
5. Covered.....	3	0
4. Limestone, similar to unit 6.....	2	8
3. Shale, laminated tan and brown, manganese wads measuring 2 to 5 inches in thickness; prominent brown soil.....	3	4
2. Shale, laminated bright red and tan, clayey, greenish-gray clay inter- calations; prominent red soil.....	2	10
"Keefer" Sandstone		
1. Sandstone, light-brown, very fine grained, medium bedded, weathers brown; small bright red and brown specks on fresh surface; jointed and red and black stain; ripple marks and <u>Arthropycus</u>	10	6

Geologic Section 11. - Rocky Gap Sandstone exposed near
Little Stony Creek approximately 1.5 miles east of
White Pine Lodge, Giles County, Virginia

Thickness
Feet

Huntersville Chert

Rocky Gap Sandstone (130 feet)

9. Partly covered with scattered
outcrops of sandstone, coarse
grained; steel-gray to mottled on
fresh surface with conglomerate
layers containing rounded to sub-
rounded quartz pebbles measuring
0.25 inch in diameter..... 10
8. Sandstone, similar to unit 9 except
massive weathering..... 27
7. Sandstone, coarse grained; orangish-
brown to dark-gray on fresh sur-
face, friable; interbedded with
fine to medium grained light-tan
to reddish-gray weathering friable
sandstone..... 11
6. Sandstone, coarse grained; orangish-
brown to dark-gray on fresh sur-
face, friable; iron and manganese
peds measuring from 0.5 to 0.75

Thickness
Feet

	inch in diameter; center of pod weathered to a yellowish-brown friable sand.....	18
5.	Sandstone, fine to medium grained; light-tan to gray on fresh surface; reddish-gray on weathered surface; friable.....	7
4.	Sandstone, fine to medium grained; steel-gray to mottled on fresh surface; ferruginous calcite- cemented limonitic ridges on fractured surfaces; weathers white.....	7
3.	Sandstone, coarse grained; orangish- brown to dark-gray on fresh surface; friable.....	10
2.	Sandstone, similar to unit 9.....	25
1.	Sandstone, similar to unit 4.....	15

"Kefer" Sandstone

Geologic Section 12. - Huntersville Chert exposed along
County Road 613 approximately 0.3 mile north of
Kire, Giles County, Virginia

	Thickness Feet
Not exposed, probably black shale of Marcellus age.....	6
Huntersville Chert (64 feet)	
18. Siltstone, bright-red, angular chert fragments; manganese seams measuring 2 inches thick; dark- brown limonite on fracture surfaces.....	3
17. Covered.....	3
16. Siltstone, green, non-fissile; weathers reddish-brown; large nodules of brown noncrystalline material measuring 4 inches in diameter.....	1
15. Chert, light-brown, slightly limy, highly weathered and pitted.....	2
14. Sandstone, brown, very fine grained, shaly; weathers friable.....	1
13. Covered.....	4
12. Chert, bluish-gray to grayish-white; highly weathered and pitted; black	

Thickness
Feet

	manganese and red iron stain; pockets measuring 0.17 to 2.0 inches of angular manganese- cemented chert fragments; jointed (N. 58° E.; S. 85° and N. 28° W.; S. 15°).....	9
11.	Covered.....	3
10.	Chert, bluish-gray to grayish-white, similar to unit 12.....	9
9.	Sandstone, mottled light-brown and brownish-red, very fine grained; weathers clayey.....	2
8.	Covered.....	3
7.	Chert, similar to unit 12.....	11
6.	Covered.....	3
5.	Sandstone, mottled light-brown and yellowish-brown, fine grained; weathers tan, friable; limonite on fracture surfaces; manganese and iron seams.....	3
4.	Chert, white, weathers massive; black manganese and red iron stain prominent; highly weathered and pitted; silicified <u>Spiriferids</u>	5

	Thickness Feet
3. Covered.....	2
Rocky Gap Sandstone	
2. Sandstone, mottled brown and yellowish-brown, very fine grained, friable; manganese-cemented chert breccia in upper 2 feet.....	4
1. Sandstone, mottled tan and reddish- brown, fine to coarse grained, friable; subrounded quartz pebble conglomerate lenses in upper 4 feet; contains <u>Spiriferids</u>	8

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