THE AREAL GEOLOGY OF THE BLACKSBURG REGION

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INTRODUCTION

Location of the Area

The Blacksburg Area as herein described is that portion of Montgomery County, Virginia, which comprises the north third of the Blacksburg Quadrangle. This Quadrangle is the southwest quarter of the Christiansburg topographic sheet published by the United States Geological Survey in 1890. The region is in the heart of the Allegheny Mountains. It is bounded by latitudes N. 37° 15' and N. 37° 10' and by longitudes W. 80° 30' and W. 80° 15', an area of approximately seventy-eight square miles. The east-west dimension is 13.8 miles and the north-south dimension is 5.7 miles.

The town of Blacksburg, which is the location of the Virginia Polytechnic Institute, is within this area and is at longitude W. 80° 30' near the northern boundary of the area. The region is traversed in a north-south direction by state highway number 8 connecting the Lee Highway, U. S. 11, at Christiansburg, with Princeton, West Virginia, and main U. S. Highways to the west. A spur of the Norfolk and Western Railway connects Blacksburg with the main line at Christiansburg.

The town of Shawsville is located in the extreme southeastern corner of the area. The main line of the Norfolk and Western Railway as well as U. S. Highway 11 pass through this town. They both connect that portion of the area with Roanoke, Virginia, and the eastern seaboard, with East Radford, Virginia, the Pocahontas Coal Fields and other points west to the Mississippi Valley.

The main line of the Virginian Railway traverses the entire region from east to west, following the North Fork of the Roanoke River from Ironto to Ellett and from there westward by way of Merrimac. This railway, like the

Norfolk and Western, is a connecting link between the Atlantic Seaboard at Norfolk, and the West Virginia Coal Fields by way of Roanoke.

The Blacksburg Area is consequently readily accessible from most any direction by rail or by road, although within the area it is quite rugged and a few localities are none too easily reached.

Previous Work

The first systematic geologic work in Virginia was done by W. B. Rogers during his survey from 1835 to 1892. Because of lack of funds, the final report on this work was never published, but in 1884 a reprint of the annual reports was made and published by Major Jed Hotchkiss of Staunton, Virginia. These reports formed an octavo volume of about five hundred pages. Rogers recognized, on a lithologic basis, the major divisions of Appalachian Stratigraphy as found in Virginia. The units of his column were given numbers ranging from one to fifteen. It was a very creditable piece of work, as most of his divisions of Palezoic formations still stand in the light of recent research using fossil correlations. It is true that he produced little of detail work, but his generalizations were excellent considering the difficulties of transportation in his time as well as the lack of geologic information then available. Concerning the Blacksburg area there are several references in his report. These mention the coal in the Brush Mountain Area, and the formations present in Catawba (Paris) Mountain.

Little or no stratigraphic work was carried on in Virginia from the time of Rogers until 1897 when there appeared a section in MacFarlane's Geological Railway Guide[56] devoted to Appalachian stratigraphy. In this publication may be found a generalized "List of Geological Formations Found in Virginia and West Virginia." Reference is made in this guide to the formations found at

Shawsville and Big Tunnel, both of which are located within the area of this report.

The Christiansburg topographic sheet was published by the United States Geological Survey in 1890. Following this, several more detail surveys were made by M. R. Campbell, N. H. Darton and Arthur Keith in several areas in Virginia. The work of these men was published in United States Geological Survey Folios between 1894 and 1900.

The most extensive and detailed survey of the Blacksburg vicinity was made by M. R. Campbell, R. J. Holden and others in 1926. This survey was in connection with the Report on the Valley Coal Fields, Bulletin XXV of the Virginia Geological Survey. The object of this report was not stratigraphic in nature but dealt chiefly with the structure and the occurrence of coal. It included only the western part of the Blacksburg Area.

A survey of the Roanoke Area was made by Herbert P. Woodward prior to 1930. This work was published in 1932 as Bulletin 34 of the Virginia Geological Survey and was entitled, "Geology and Mineral Resources of the Roanoke Area, Virginia." That part of the Blacksburg Area west to longitude W. 80° 20' was included in this survey.

The advance topographic sheet of the Blacksburg Quadrangle was made during 1931 and 1932. Copies of it were received in the spring of 1933.

A generalized map of this region appeared in the Guidebook Number 3, Excursions in the United States, International Geologic Congress, Washington 1933, showing the areal Geology from Elliston to Glenlyn, Virginia. The route taken on this excursion crossed over the Blacksburg Area.

The Geology Department of the Virginia Polytechnic Institute has a copy of an early geologic map of the states of Virginia and West Virginia. It was hand made and colored in the "Engineer Office of Jed Hotchkiss, Staunton, Va. October 1881. Drawn by Huldrich Weber." The map is 8 x 16 feet and was made from the notes of W. B. Rogers' survey of Virginia, 1835 to 1842.

Two state geologic maps have been published by the Virginia Geological Survey. The first was published in 1911 by T. L. Watson; the second was published in 1928 by W. A. Nelson. The latest generalized map shows only the areal geology of the Appalachian Valley of Virginia. It was published with Bulletin Number 42, Virginia Geological Survey, 1933 by Charles Butts. All of these maps, as well as the one in Guide Book Number three of the International Geological Congress, give the general distribution of the geology described in the Blacksburg Area.

The map accompanying this report is to show the geology of this region in detail, using a scale of one inch to the mile.

Scope of the Report

Although some reconnaissance work had been previously done by the writer, the actual field work, which forms the basis of this report, was not started until August 20, 1933.

At that time approximately three weeks were spent in the field tracing the contacts of various formations as well as fault zones within the area. During the period from September to December at least three afternoons per week were devoted to field work of similar character. Disagreeable weather prevented any further efforts until April 1, 1934, when field work was resumed and continued at intervals until completion of the report June 1, 1934. A total of approximately four hundred and twenty-five hours was devoted to field work alone. This is equivalent to about fifty-three days or eight weeks at eight hours per day. The area was mapped in detail at the rate of about one and one-half square miles per working day. The writer was familiar with the geology of this region before starting the actual field work. Previous to the current year he had spent three years in undergraduate work at the Virginia Polytechnic Institute followed by four years as a graduate student and instructor in geology.

The method of working in the field was to use a System Paulin barometer to determine elevations. This instrument was set and checked at every opportunity during each field trip on United States Geological Survey bench marks. By means of the elevations thus obtained each locality on the contours of the base map could be fairly accurately identified. Land marks and culture were used as an aid in identifying these localities. Where necessary, pacing was used to measure distances and widths of formations. The actual distinction of individual formations and map units was based on lithology and type fossils. In some cases fossils were rare or absent, but when present were invaluable aids in determinations of formation boundaries. Lithology in this particular area seemed to be a comparatively safe and reliable criterion.

An attempt was made to use the Christiansburg sheet, of 1890, as a base map for the areal geology but the small scale, the errors in topography, and lack of culture, made this impractical. In the spring of 1933 copies of the advance sheet of the Blacksburg Quadrangle were obtained. This topographic map was made in 1931 and 1932 and had a contour interval of 20 feet as compared to 200 feet on the Christiansburg sheet and a scale of one mile to the inch. The later map was used exclusively.

Originally this thesis was intended to cover the geology of the entire Blacksburg Quadrangle. However, after work had been started, it was decided to discuss only the areal geology of a small portion in detail rather than a large area in a general but less accurate manner. Consequently, only the north third of the quadrangle has been included. This is the area most closely associated with Blacksburg and therefore with V. P. I., thus presenting a description of the local rocks.

The object of this discussion is primarily to offer a map showing the areal geology of this region, as well as descriptions of the stratigraphy. A chart showing stratigraphic relations of this region with other portions of the Appalachian Province, as well as tables of formation names, has been included.

The work here discussed was undertaken upon the suggestion of Dr. R. J. Holden, Head of the Department of Geology at the Virginia Polytechnic Institute.

STRATIGRAPHY

General Features

The rocks exposed in the northern third of the Blacksburg Quadrangle are entirely of sedimentary origin. The areal distribution of these rock formations is shown on the accompanying geologic map. Their thickness and character are shown by the columnar section of the correlation chart. A discussion of the characteristics of each formation is included in the detailed descriptions. Fifteen units are shown on the map.

The formations in the Blacksburg Area are all of Paleozoic age. They range from Lower Cambrian time to Lower Mississippian time inclusive. This series is not complete, as a number of formations found in other sections of Virginia are missing in this vicinity. On the other hand, several formations which are present here are not found in other parts of the state. The total sedimentary deposition represented is approximately 15,000 feet or more.

These rocks are the result of the deposition which took place in the great Appalachian trough or geosyncline during the Paleozoic. This trough was occupied by seas which advanced and retreated from time to time, and were caused probably by oscillations of the earth's crust. Evidently the seas were deeper and more extensive during the earlier periods of rock deposition, as the lower members of the section are predominately calcareous; toward the middle they are quite sandy, some even indicating beach conditions, and toward the top they become argillaceous or clastic. Continental conditions of lowland swamp are evident in the youngest formations from the occurrence of a number of beds of coal. The Appalachian geosyncline occupied the present site of the Appalachian and part of the Blue Ridge Mountains. It is thought that probably this great thickness of sediments was derived from the old land mass of the continent of Appalachia which existed to the east of the geosyncline.

The western border of such a continent would have been in the region of what is now the Piedmont section of Virginia and the other Atlantic border states.

Considerable folding and faulting has affected the rocks of the Blacksburg Area so that as a result they are not always in normal sequence. In general the individual beds dip toward the southeast. The strike is consequently more or less parallel to the direction of the major faults and folds which are in turn parallel roughly to the strike of the ridges of the Appalachian Mountains. This orientation of the strike and dip was caused by the same factors which determined the major structures of the entire geosyncline. The main factor is supposed to have been a great thrust from the southeast. In spite of this extensive disturbance, the rocks of the region show little or no alteration of a regional metamorphic nature. Practically all of the mapable units have a definite lithologic character by which they may be distinguished. Fossils are plentiful in many of the formations showing distinct faunal zones and are consequently of great aid in correlating the stratigraphic sequence in connection with the lithology. A description of each mapped unit follows.

Detailed Stratigraphy of the Blacksburg Area

Cambrian System

Rome Formation (Cr)

The Rome formation is that group of strata which normally overlies the Shady dolomite. The formation was named by C. W. Hayes[77] in 1890, and the locality from which the name was taken is near Rome, Floyd County, Georgia. In northwestern Virginia it is called the Waynesboro[10] formation. In several folios of the U. S. Geological Survey on the geology of northern Tennessee the name Watauga[78] has been applied. This name has also been used locally in southwestern Virginia.[61, 73] It is derived from the type locality along the Watauga River in northeastern Tennessee, and was first used by Arthur Keith in the Cranberry Folio. M. R. Campbell has applied the name Russell to the same formation in the Bristol[21] and Estillville[14] folios. In Montgomery and Pulaski counties in 1891, he used the term Graysonton for the local exposure of the Rome.[15]

Although the Rome is a very heterogeneous formation, it has several outstanding lithologic characteristics. Its chief distinguishing feature is the large percentage of red or purplish and green shales interbedded throughout its extent in layers varying in thickness from one to ten or more feet. Associated with the shales are beds of limestone, dolomite and often sandstone. The shales are very fine grained and of a sericitic nature. They do not weather readily and produce small falkes in the soil. Flakes of shale of this nature may be seen on the drill field of the Virginia Polytechnic Institute at Blacksburg. The limestone and dolomite beds are fairly common, with the latter being by far the more plentiful. These beds may reach a thickness of 50 feet and seem more plentiful around Blacksburg than in other Rome localities in

Virginia. The dolomite is bluish gray and weathers with rounded, water worn faces. This stone is used in the buildings at the Virginia Polytechnic Institute. It often is somewhat sandy. The sandstone, where found, is in comparatively thin beds. It is usually fine grained and is brown or green and sometimes red. In general, the Rome weathers to a yellowish brown or red, more or less argillaceous soil, somewhat sandy in some localities. The soil makes fair agricultural land and is cultivated in this vicinity.

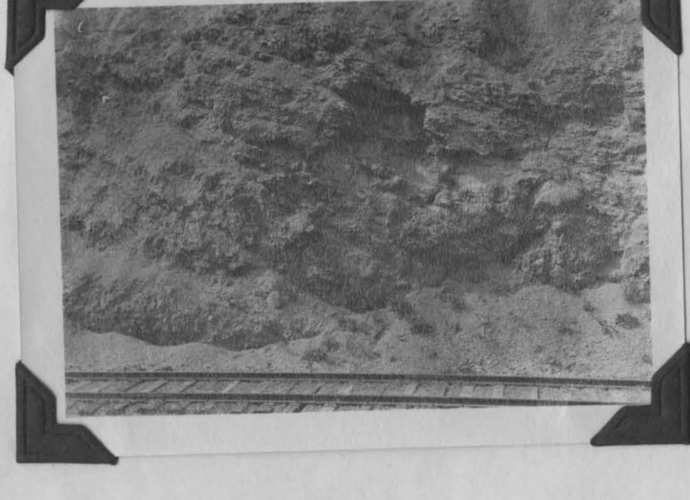
The thickness of the Rome in the Blacksburg area is estimated to be about one thousand feet. Accurate measurements are practically impossible, as the entire mass is closely folded and cut by a number of faults. It is also cut off by two major faults, the Salem overthrust and the Pulaski overthrust. Woodward[75] reports a thickness of 900 feet in the Roanoke Area. Butts[10] gives a maximum thickness for the state of 2,000 feet, and an accurately measured section of 1,100 feet just south of Brookside Inn, Russel County. The latter measurement does not include the entire thickness, however, as the lower part has been cut off by a fault.

Good exposures of typical Rome are none too numerous in the Blacksburg Area. The formation is included in the region between the southern extremity of the area here mapped and the Pulaski fault along the southern base of Brush Mountain. This expanse of Rome is interrupted towards the south central part by the Price Mountain fenester which it completely surrounds. To the west it extends beyond the limits of the map, and to the east it is terminated by a local fault which might be termed the Blacksburg fault as it runs north and south through that town. The Copper Ridge dolomite is thrust over the Rome by the Blacksburg Fault. This fault passes through Yellow Sulfur Springs and joins the Salem Fault to the south. To the northeast of Blacksburg it joins the Pulaski Fault. Flakes and soil colorations from the red, yellow and green shales so typical of the Rome may be seen on the surface and in road cuts over most of the area. The best exposures of the red shales may be seen along the railroad at Vickers, on highway No. 8 just south of the V. P. I. airport and along gullies in fields off the road leading northeast from the residence of J. H. Woolwine on the road to Prices Forks. At several localities along the Salem Fault reddish and greenish shales are in evidence. These are similar to the Rome as described, but no evidence to prove that they are of this formation has been found. Butts and Stose in the Guide Books of the International Geologic Congress[36] of 1933 show a small area of Rome located near Den Creek on the south side of the Salem Fault and another in the Pedlar Hills south of Ironto. No reference is made to these exposures in the written descriptions. Woodward[75] has also noted these shales but denies that they are of the Rome formation. He places them in the Elbrook on the basis of mineral composition. The writer is inclined to agree with Woodward, as green shales have been noticed in the Elbrook at several localities, particularly where faulting has taken place. (See discussion of Elbrook.)

It may be that not all of the area here described as Rome is of that formation. Along Toms Creek at the foot of Brush Mountain and on the south side of the Pulaski Fault there is a belt of dolomite which resembles that usually associated with the Rome shales. It likewise resembles the upper beds of the Shady dolomite which in other areas of the Appalachian Valley, underlies the Rome. There are red shales south of this belt but there seem to be none directly associated with it. As there are no fossils present and as the dolomites of the two formations are very similar, no conclusions can be drawn. The belt is, however, in the correct stratigraphic position to be

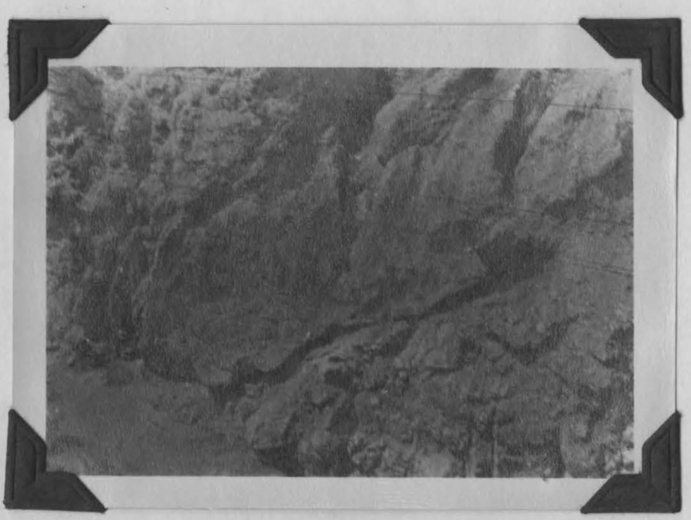
1. Dolomite (Shady?) Rome formation near
Toms Creek south of Pulaski Fault.

2. Soil erosion in Rome soil near Toms Creek.



3. Rome formation near Vickers.

4. Blacksburg Fault
on Virginian Ry.
near Yellow Sulfur Springs
— upper half



5. Blacksburg Fault
on Virginian near Yellow
Sulphur Springs
— upper half

considered as a possible upper member of the Shady dolomite.

The determination of the Rome in the Blacksburg region is based entirely on lithology, as no fossils have been found in the formation. The conclusion is comparatively safe though, as the lithology of the Rome is rather definite throughout its length from Alabama to Pennsylvania, and the local formation though differing in quantities of component materials is in general the same as that of regions definitely identified. In the Roanoke area the age of the Rome is placed at Lower Cambrian. This is based on the discovery of Olenellus thompsoni by R. J. Holden in that vicinity. The presence of Ptycoparia kingi in some exposures in the Appalachian region causes some geologists to place it in the Middle Cambrian. The concensus of opinion seems to be that the Rome is Lower Cambrian throughout most of its thickness and possible Middle Cambrian towards the top. In this report the general opinion will be followed and the Rome is placed in the Lower Cambrian. In normal sequence the Rome formation is succeeded by the Elbrook dolomite. The Elbrook is present in this vicinity and is next described.

Elbrook Dolomite (Ce)

The name of the Elbrook formation is derived from the town of that name on the Western Maryland Railroad in southern Pennsylvania. The name was applied by G. W. Stose[79] in 1906. The Elbrook dolomite in Virginia, as in Pennsylvania, succeeds the Rome formation and is overlain by the Conococheague limestone or Copper Ridge Dolomite. It corresponds to the Conosauga formation of the southern Appalachians and is equivalent to the combined Honaker dolomite and Nolichucky shale of southwestern Virginia.

The Elbrook formation is mainly a dolomite. It varies, however, considerably in both composition and structure. The lower part is composed of thin shaly beds which grade upward into more massive, purer dolomite with thin beds of gray limestone. The color of the formation as a whole is gray to bluish gray. In some local occurrences as in Pedlar Hills the Elbrook contains some beds of red shale and limestone. There seems to be some question as to whether these red rocks are Elbrook or Rome. Woodward says they are Elbrook and bases his conclusion on the mineralogic composition.[75] Butts and Stose in the Guidebook No. 3, Route Map No. 19, International Geologic Congress, 1933, show Rome occurring in the vicinity here referred to. The writer has seen these red beds as well as numerous green beds in the Elbrook. These colored strata seem to be in normal relation to the other beds. The writer has also noticed that often where the beds of the Elbrook are faulted or brecciated that the materials so disturbed seemed to be colored green. It seems highly probable that since the Elbrook is in part equivalent to the Nolichucky shale, which contains green and red beds, that these beds here bear the same relation. In this report all of these beds will be considered as a part of the Elbrook. Until fossil evidence disproves this probability, the writer will consider them of that formation and not the Rome. The Elbrook dolomite is fairly soluble as shown by numerous sinks and caverns along its strike. A good example of such a cavern may be seen at the head of Falls Hollow south of the Virginian station at Fagg. The formation weathers rather readily but because of the argillaceous character of many of its beds produces a moderately rough topography. It forms a rich clay soil often mixed with reddish shale flakes showing the shaly nature of the original dolomite which does not give the shaly appearance until weathered. This soil is yellow to red, containing little or no chert and where the topography is not too hilly produces comparatively rich agricultural land. The Elbrook soil is not as brown as that of the Rome formation.

The total thickness of the Elbrook dolomite is not included in the Blacksburg area described here but is included in the Blacksburg quadrangle. This total thickness is estimated to be about twelve hundred feet. Woodward reports 1000 to 1600 feet in the Roanoke Area[75]; Butts gives a thickness of 1800 feet near Wytheville.[10] As in the case of the Rome, no sections are exposed in this region and the formation is extensively folded and faulted.

The only exposure of the Elbrook dolomite in the Blacksburg area is along the south side of the Salem fault where it has been thrust over the formations west of Fort Lewis Mountain. It therefore covers the extreme southeastern portion of the area mapped except for the small region where the Conococheague limestone is in the trough of a syncline near Shawsville. The faulted edge of the Elbrook may be seen along the south side of the North Fork of the Roanoke River in the Pedlar Hills. The southern boundary is the southern edge of the map. The northern boundary is the Salem Fault. This produces a wedge-shaped exposure on the map, with a point of the wedge at the intersection of Mill Creek and the southern edge of the map.

The identification of the Elbrook dolomite in this region was based entirely on lithology, as no fossils have been observed. Butts has reported finding the trilobite "Crepicephalus" on Widner Branch, thirteen miles east of Abingdon, Washington County, Virginia. Crepicephalus is a typical Nolichucky fossil which definitely correlates the Elbrook with that formation. On this basis it is placed in the Middle and Upper Cambrian; probably more of the latter. Normally, the Elbrook is overlaid by the Copper Ridge dolomite or the Conococheague limestone.

6. Scarp of overthrust Elbrook formation, Salem Fault, along road to Montgomery.

7. Elbrook Limestone on road along Den Creek.

Upper Cambrian U. S. G. S., Ozarkian System (Ulrich)

In 1911 E. O. Ulrich[65] proposed that two new systems be introduced into the Paleozoic Era. The names proposed by him were Ozarkian and Canadian. The Ozarkian system was to take the place of the Upper Cambrian of earlier authors and the Canadian was to be used for the lowermost division of the Ordovician. This plan has not as yet been adopted by geologists in general or by the United States Geological Survey but has been used in the most recent publications of the Virginia Geological Survey. The writer as yet can see no justification for the use of these systems in discussing the Blacksburg area but will, because of their adoption by the State S urvey, refer to them and show their relation to the older classification. The formations affected by this new arrangement are those included in what was formerly the upper division of the Shenandoah limestone and are equivalent to the Knox dolomite of earlier writers. The Knox dolomite was considered to be of Cambro-Ordovician age. Later studies have shown that it may be further subdivided, and in the Blacksburg region there is evidence of two of these divisions, although the line separating them is not easily recognized. The lower division would correspond to the Copper Ridge dolomite and its Conococheague Limestone equivalent. This is, as elsewhere, placed in the Ozarkian or Upper Cambrian. The upper division of this great mass of dolomite would be of Beekmantown age, probably Nittany, and is placed in the Canadian or Lower Ordovician. Faunal evidence justifies such a division of the Knox dolomite. Two formations then will be described. The first will be the Copper Ridge and Conococheague facies of the Upper Cambrian (Ozarkian) and the Nittany of the Beekmantown group of the Lower Ordovician (Canadian).

Copper Ridge Dolomite(Ccr)

With the introduction of the two systems just referred to, by E. O. Ulrich in 1911, a number of formation names were also used for the first time. Included among these was the name Copper Ridge dolomite.[65] This name is derived from the type locality for the formation in northeastern Tennessee.

The Copper Ridge is a thick bedded gray to blue dolomite. There are a number of distinguishing features by which it may be recognized in the field, but care must be taken as there are other formations above and below the Copper Ridge which are quite similar to it and might be mistaken for it. The outstanding feature of the Copper Ridge and probably its most easily recognized characteristic is the presence of quartz sandstone beds scattered through its thickness. These sandstones are somewhat calcareous and are not so easily recognized on fresh surfaces by casual observation. The Copper Ridge is always marked by a moderately rough topography due to the formation of the ridges by the more resistant sandstones. On the tops of these ridges the rusty brown sandstones are found as residual material from the weathering of the formation. This feature of the formation may be seen in the series of hills lying immediately to the east of Blacksburg. The Cohee Country Club is located on one of their summits. The sandstones are particularly diagnostic of the Copper Ridge as they are not found in the Elbrook below or in the Beekmantown formations above. Associated locally with some of the sandy horizons are beds of reddish shales and dolomites. These may be seen along a road about one and one-half miles east of Blacksburg. Residual cherts are produced throughout the thickness of the Copper Ridge. They are supposed to be the result of replacement of the limestone on weathering as they are not found to any great extent in fresh exposures of the formation. The cherts are white to gray in color and are quite dense and blocky. Some horizons of the Copper Ridge seem to produce more chert than others. Where this is true they are a hindrance to agriculture as they must be removed from the land to be cultivated. Piles of these cherts may be seen on any farm located on this formation. The Copper Ridge cherts may at times be confused with those of the overlying Nittany. However, the presence of Lecanospira in the Nittany cherts is sufficient to place them with that formation, and an association of sandstone beds is considered sufficient proof of the Copper Ridge. The Nittany cherts are if anything, lighter in color than those of the Copper Ridge. Wherever exposed surfaces of the Copper Ridge formation are found, the beds show thin crinkled, sandy laminae which project from the edges of the thick strata. These dark colored laminations one-eighth to one-half an inch in thickness are characteristic, although not conclusive, as similar sandy laminations have been noticed in the Nittany dolomite. Sinks are fairly common in the upper part of the Copper Ridge, indicating a fair degree of solubility of some of the beds. Geodes, veins and cavities containing quartz crystals are also found locally in some of the upper beds in this vicinity. Quartz crystals have been found in the overlying soil at a number of localities east of Blacksburg.

The thickness of the Copper Ridge, as estimated from measurements along the road from Blacksburg to Luster's Gate, is not over 1800 feet but may be closer to 1500 feet. Covered areas and folding prevent accurate measurements. Butts[10] gives the thickness for Virginia as 1200 to 1400 while Woodward[75] gives a thickness of 1600 feet.

The Copper Ridge in the Blacksburg area is located in a belt varying from three-quarters of a mile at its southern extremity to two miles at the northern boundary. The belt runs roughly north and south with its western boundary passing through Blacksburg and Yellow Sulfur Springs. The eastern boundary divides the great mass of dolomite between the Blacksburg fault and the North Fork of the Roanoke River into two nearly equal parts. The western boundary is the Blacksburg fault which places the Copper Ridge in contact with the much older Rome. Exposures are readily seen at most points within this area as outcrops are fairly plentiful.

The Copper Ridge dolomite has been considered unfossiliferous in this region although Croptozoon are reported from the Roanoke area.[75] In the pink shale associated with a sandstone about one and a half miles east of Blacksburg, several trilobite pygidium and glabella were found by C. E. Sears and the writer. These seem to be a species of Sauki or possibly Tellerina, but have not been definitely identified. If this is true, the Upper Cambrian age for the Copper Ridge is correct.

The Copper Ridge dolomite is underlaid normally by the Elbrook dolomite and overlaid by the Chepultepec limestone. In this vicinity the Elbrook has been cut out by the Blacksburg fault and the Chepultepec has not been identified, although more careful study may reveal its presence. The Beekmantown succeeds the Copper Ridge without any apparent break, although if the Chepultepec limestone is absent, there must have been a period of erosion between these two massive dolomite formations.

Conococheague Limestone (Cc)

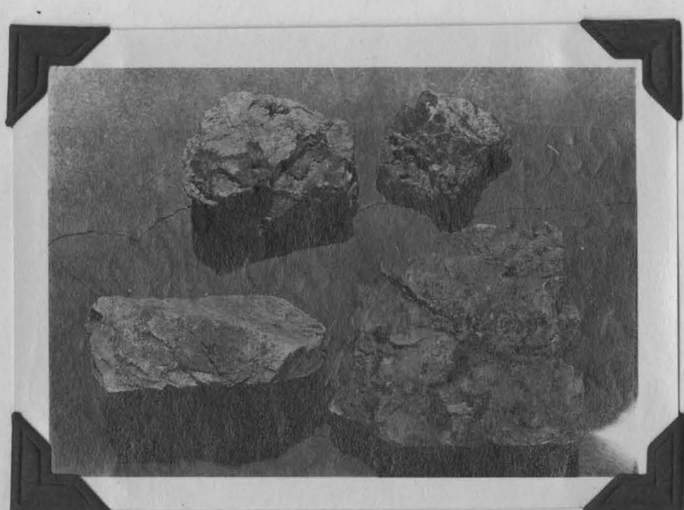
The Conococheague limestone was named by G. W. Stose[80] and the term was first used in his description of the Chambersburg-Mercersburg area in 1909. The Conococheague is found only along the southeastern border of the Valley and Ridge Province in Virginia.

The description previously given for the Copper Ridge dolomite might be applied to the Conococheague limestone. Their characteristics are alike and the only distinction is made in that the Conococheague is predominately a limestone with associated dolomite whereas the Copper Ridge is chiefly a dolomite. They both bear the same stratigraphic relation in that both are underlaid by the Elbrook dolomite and overlaid by the Beekmantown formations. Most geologists consider the two to be different facies of the same formation. This is substantiated according to Butts[10] by the fact that the two facies meet each other and are continuous around Tinker Mountain near Roanoke. The thickness of the Conocheague may be slightly less than that of the Copper Ridge.

The Conococheague limestone is found in the area mapped only in a small zone to the northwest of Shawsville where it occupies the trough of a syncline pitching to the southwest. This structure causes the Conococheague to disappear to the north of Shawsville but to widen to the southwest where it passes out of the area mapped. The exposure is roughly two miles long and a half to three-quarters of a mile in width.

8. Quarry in Copper Ridge dolomite between Blacksburg and Ellett. Stone is crushed and used in highway construction at V. P. I.

9. Crinkled argillaceous Laminations. Copper Ridge Dolomite.



10. Two types of Copper Ridge Cherts. Lower, large blocky type, and upper, small, dark rounded forms showing Iron stain.

Ordovician System

Lower Ordovician U. S. G. S.,Canadian of Ulrich

This division in Virginia includes the elements of the Beekmantown and are included under that head for mapping purposes. The subdivisions of this group are:

Dolomite equivalent to the Bellefonte of Pennsylvania

The Nittany dolomite

Stonhenge limestone member

Only the Nittany has been recognized in the immediate locality so that the mass of dolomite between the Copper Ridge and the Stones River group is considered of that equivalent, and is so indicated on the accompanying map.

Nittany Dolomite (Ob)

The name of the Nittany is taken from the Nittany Valley of central Pennsylvania and was named by E. O. Ulrich[65] in 1911. It is an equivalent member of the Beekmantown group of New York named by J. M. Clarke and Charles Schuchert[81] in 1899.

The Nittany dolomite is a massively bedded gray to blue formation not unlike the underlying Copper Ridge in general appearance. The dolomite beds are fairly dense and contain very fine crinkled laminations in some cases. Beds of fossiliferous light gray limestone are found about the middle of the formation. They have been quarried and burned for lime near Ellett. These beds of limestone are readily recognized by their well rounded weathered surfaces, the presence of a species of Lecanospira, a bryzoan and their light gray color. They effervesce readily with dilute hydrochloric acid. The outstanding and most definite characteristic of the Nittany is the huge amount of chert which it produces when weathered. The Nittany chert looks somewhat like that produced by the Copper Ridge but is readily distinguished by its lighter color, being usually white but often iron stained, its frequent cauliflower appearance and its rounded, rather than blocky form. These cherts are readily broken and are iron stained on fractured surfaces and are fossiliferous, which is not true of the Copper Ridge cherts. The zones which are productive of considerable chert do not weather as readily as the rest of the formation and as a result produce rows of hills or ridges along the strike. The high ridges just west of the North Fork of the Roanoke River are topographic expression of these resistant beds. High Knob near Ellett is a very good example. The Nittany because of its irregular topography and great amount of chert is not particularly well adapted to agriculture but is utilized for this purpose despite its inhospitable character. The plowed fields and cultivated areas are marked by piles of chert which have been removed from the soil. In spite of this the soil is often thickly speckled by the white cherts which may be seen from a considerable distance. Unlike the Copper Ridge the Nittany shows the chert in the dolomite beds as well as in the soils. The formation produces a red clay soil.

The thickness of the Nittany in the Blacksburg area has been calculated to be about eight hundred and fifty feet or less. It reaches the maximum thickness at its northern limit in the area but is probably less due to faulting at the southern extremity near the Salem Fault. Butts[10] gives the following thickness for the Nittany in Virginia: 1000 feet northwest of Bristol, 500 feet east of Bristol and 500 to 800 feet near Staunton.

The Nittany is well exposed in the Blacksburg area. It is found in a belt running north and south roughly parallel to the west of the North Fork of the Roanoke River. Its outcrop is about one mile wide toward the north but is not over a quarter of a mile at its southern end. The formation may be seen

11. Nittany dolomite, Virginian Railway cut near Ellett.

12. Abandoned Lime Kiln in Nittany beds near Ellett. Note cherty waste material in foreground.

13. Beekmantown float rock. Note large quantity of white chert.

14. Typical Nittany cherts showing coiled gastropod impressions (Lecanospira).

on the road to Luster's Gate, and along the Virginian Railroad west and southwest of Ellett.

A gastropod of the genus Lecanospira is found in the Nittany both in the dolomite and more often in the cherts. The cherts containing impressions of this fossil mark a diagnostic horizon known from Pennsylvania to Alabama. It is very valuable for correlation purposes.

A decided erosion break apparently separates the Beekmantown dolomites from the Stones River Group which follows in normal sequence. The lithology and fauna both indicate an unconformity.

Stones River Group (Osr). The Stones River group was first named by J. M. Safford in 1851 in a discussion in the American Journal of Science, 2nd. series, vol. xii, 1851, of the Silurian Basin of Middle Tennessee, with notices of the strata surrounding it. The typical Stones River is composed of these units, the Murfreesboro limestone, the Mosheim limestone and the Lenoir limestone respectively. These units have not been differentiated definitely in the Blacksburg area. The Lenoir is known to be present. The Murfreesboro is apparently missing and the Mosheim is thought by the writer to be present. Since these formations are relatively thin, quite variable in areal extent, and because of the uncertainty of the presence of the individual members, the group is mapped as a unit.

The Mosheim, named by E. O. Ulrich in 1911 from that locality in Greene County, Tennessee, is a pure, bluish gray limestone distinguished by the typical texture of vaughnite. This feature is not conclusive, as there are certain strata of the Beekmantown limestones as well as other thin beds of the Stones River Group which show this structure. The vaughnite texture is one which is produced by the forming of crystals of calcite in what was formerly single tubed Tetradium fossils in a dense, compact limestone. Sometimes this condition gives a glassy appearance to the rock. The Mosheim limestone breaks with a conchoidial fracture.

In the Blacksburg area the Mosheim is probably represented only by a thin strip locally present. Its maximum thickness would not be more than fifty feet as measured in a cut along the Virginian Railway just west of Ellett. The Mosheim is not present in the Stones River Group along the road near Luster's gate. Talus of Mosheim has been found near the southern limit of the Stones River unit as mapped.

It is believed that the Mosheim limestone is present in variable thickness between a point about one mile and a half north of Ellett and the southern limit of the area mapped.

The Murfreesboro limestone as previously mentioned, has not been recognized here, so the Mosheim is separated from the Nittany by a definite unconformity. The Lenoir conformably overlies the Mosheim.

In the "Elementary Geology of Tennessee, pp. 108, 123, 130-131, 137, in 1876, J. M. Safford and J. B. Killebrew first used the name Lenoir. It was named from Lenoir City, London County, Tennessee.

The Lenoir is a light gray to black limestone. Some beds are compact, some are crystalline. The formation is highly fossiliferous. The strata are massive, and usually well rounded solution surface outcrops are plentiful. Often on these weathered surfaces black cherts stand out in relief, showing that some of the beds are impure and of a siliceous nature. The areal extent of the formation is usually well marked by the presence of numerous large sinks along the strike. Caves are common features. The Lenoir produces a fertile red clay soil which is excellent for agricultural purposes where not covered by cherts from the Nittany. It is interesting to note that in this vicinity

15. Outcrop of Stones River limestone near Ellett. (Note cedars).

16. Sink holes in Stones River Limestone between Luster's Gate and Ellett.

wherever the Stones River limestones are present that cedar trees are exceedingly numerous.

The thickness of the Lenoir is variable. On the road west of Luster's Gate it is about seventy-five to one hundred feet. At Ellett it is close to two hundred feet.

The Stones River group is found in the Blacksburg area in a narrow belt extending north and south across the entire region. It forms the west side of the North Fork of the Roanoke River Valley which it roughly parallels. The road from Luster's Gate to Cambria runs along the east boundary of the Stones River to Ellett. From Ellett to the southern limit of the area it runs within the boundaries of the limestone.

A large per cent of the fossils in the Lenoir have been identified, but often they are so crowded that definite identifications are impossible. Numerous gastropods, brachiopods, cephlapods and bryzoa may be recognized. Large coiled gastrapods are recognized as Maclurea magma and a species of Orthoceros is also common. Trilobites are known but are not so common.

Blount Group. This group is composed of the Holston limestone, Whitesburg limestone, Athens shale and Ottosee limestone. Only the Whitesburg limestone and the Athens shale are present in this region. The Holston limestone is found in the Roanoke area, and so far as is known the Ottosee is confined to southwestern Virginia.

Whitesburg Limestone--This member of the Blount Group is usually, because of its meager thickness, mapped with the Athens shale. This custom has been followed here, and the Whitesburg forms the basal member of the Athens as mapped.

The Whitesburg was named by E. O. Ulrich, from Whitesburg, Tennessee. It was defined by him in marble deposits of East Tennessee, Tennessee Department of Education, Div. Geol., Bull. 28, p. 34, 1924.

The formation is a highly fossiliferous gray limestone usually of a coarsely crystalline texture. It weathers with well rounded surfaces which are white or rusty colored, producing a bright brownish red clay soil. The limestone is rather pure. An interesting point in connection with the Whitesburg is that the angular fragments which have been cemented together and the fragmentary nature of the fossils together indicate that it is a beach deposit.

The thickness in this region is about ten feet which forms a narrow strip paralleling the Stones River formations with which it is in unconformable contact. Its areal distribution is similar to that group.

The pygidium and head shields of the trilobite genera Agnostus have been found near Luster's Gate. These usually appear as rounded colorations on the freshly fractured surface of the limestone. Fragments of the trilobite, Isotelus gigas are also plentiful.

Athens Shale (Oa)--The Athens shale was named by C. W. Hayes in 1894. He first used this term in the U. S. Geological Survey Atlas, Kingston Folio, number 4, page 2. The name was taken from the type locality, Athens, Tennessee. This name has been used for most descriptions of the formation, although in the vicinity of Lexington, Virginia, the terms Lexington and Liberty Hall[11] have been used.

In the Blacksburg area the Athens shale is chiefly a black, fissile, limy shale which is easily distinguished in its lower part. The beds are usually several inches thick and give the appearance of a thin bedded limestone. On weathering, the lime content of the beds is removed, producing thin, splintery shale flakes in the derived soil. The formation is black in its lower part but gradually becomes a light blue upward and finally is gray and sandy toward the top. The more resistant sandy beds produce a series of low knobs along the east side of the North Fork of the Roanoke River. At the very top of the Athens is found a light gray, medium grained sandstone. This is filled with small cavities about one-eighth of an inch in diameter. It seems to be quite resistant to weathering, and along with the overlying Moccasin produces the lower part of a series of shoulders along the west slope of Paris Mountain. Some have considered this sandstone to be equivalent to the Tellico sandstone of Tennessee, but there is as yet no evidence to substantiate this supposition. Here this sandstone is considered as the top of the Athens. The lower part of the Athens weathers to a brown, fertile soil covered with black shale splinters. The upper part weathers to a sandy yellowish soil showing yellow shale flakes. Where accessible the Athens is cultivated for agricultural purposes, although it seems best suited for grazing.

Its thickness is here estimated to be about fifteen hundred feet. No actaul measurements could be made because of lack of outcrops. It is probably not as thick as this, as the dip of the strata is variable. The thickness was determined graphically.

The Athens shale is found in a belt which includes the valley of the North Fork of the Roanoke River, and extending about one-third way up the west slope of Paris Mountain. Mill Branch Valley is composed mostly of Athens shale. The formation extends from the Salem Fault as its southern boundary to the limit of of the map on the north. About one-half a mile north of Yellow Sulfur Springs there is a small outcrop of Athens shale along the Blacksburg Fault. This is an interesting occurrence, as it is completely out of place stratigraphically. It is bounded on the east and west by the Rome and Copper Ridge respectively, both of which are much older than the Athens. Identification of this outcrop was made on the basis of its graptolite fauna.

The Athens contains numerous fossils, particularly in the lower black shale belt. The fauna is mostly graptolites although some brachiopods and trilobites are known. By means of the graptolites the Athens has been correlated with the Normanskill shale of New York and the Glen Kiln shale of Scotland.

The following graptolites have been found in the Athens shale about one-half mile south of Luster's Gate:

Climacograptus bicornis (Hall)

Cenograptus gracilus (Hall)

Dicranograptus Nicholsoni, var. parvangulas (Gurley)

Glossograptus (Quadumucronatus (Hall)

Dicellograptus divoricatus, var. bicurvatus (Hall)

Nemograptus sp.

Mastegograptus multiromosus

Climacograptus oligotheca

Lasiograptus mucronatus (Hall)

The following trilobites have also been found near the same locality:

Triarthis becki (Eaton)

Trinucleus sp.

It is only in the southeastern belt of the Appalachian Valley that the Athens is to be found. It is absent northwest of the Salem Fault and northwest of Clinch Mountain. Ordinarily the formation is overlaid by the Moccasin with

17. Athens Shale on road near Luster's Gate.

18. Hills of Athens in foreground with shoulders formed by the Moccasin formation in background.

19. View across North Fork of Roanoke River Valley showing hills of Athens and Moccasin (background) topped by Martinsburg shale.

20. Low Hills of Athens in foreground with Paris Mountain in background. Latter is capped by the Clinch sandstone.

an unconformity between which is occupied in Northern Virginia by the Ottosee limestone. The Moccasin succeeds the Athens in this vicinity.

Black River Group. The Black River Group includes the Lowville limestone, Moccasin limestone and the Chambersburg limestone. The Moccasin only is present in the Blacksburg area.

Moccasin Formation (Om)--The formation derives its name from Moccasin Ridge, Scott County, Virginia. It was first named in the Estilleville Folio, page 2, in 1894, by M. R. Campbell.[14]

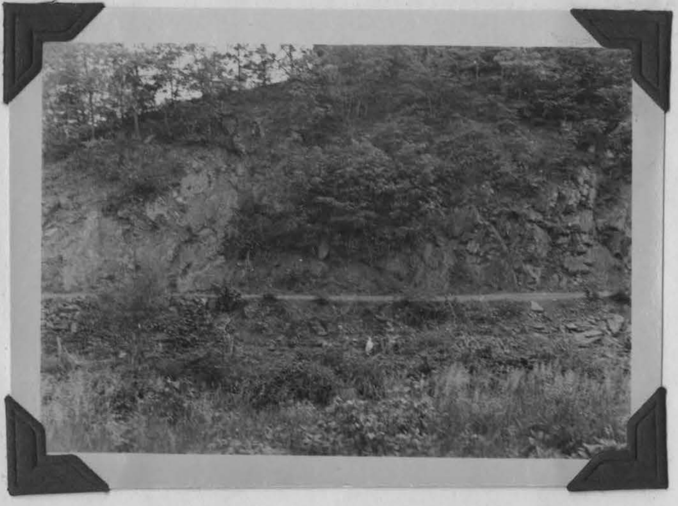
The Moccasin is usually called the Moccasin limestone. This name is hardly applicable in the Blacksburg area as here the Moccasin is not limestone, nor do any limestones seem to be directly associated with it. The term Moccasin formation is therefore used in this discussion. Its character in this region seems to be different from other known localities in the state. Here it is a gray, moderately thick bedded sandstone in the lower part. Toward the middle it is a deep red, medium bedded sandstone with interbedded thin yellow shales. The upper part is represented by thick bedded gray sandstone with interbedded thin red sandstones and shales. Outcrops of the strata are not common but may be seen along the road east of Ellett. There a complete section of the Moccasin may be observed. The formation may be identified by the knobby spurs which it produces along the west slope of Paris Mountain and the North slope of High Top Mountain. Along its outcrop the Moccasin produces a deep red soil easily recognized by its coarse gravelly character. Due to the fact that it grades into a gray sandstone above and below, its margins are fairly well recognized, although the reddish color produced by the weathering of the overlying Martinsburg shales is sometimes confusing at the contact of the two formations.

The thickness of the Moccasin formation in this vicinity is fairly constant. As measured along the road east of Ellett, the thickness was found to be about six hundred and fifty feet. This is more than is found in most localities. A minimum thickness here is probably about four hundred feet. Variations of dip produce variations in the width of the outcrop. Butts reports 1000 feet of Moccasin in Tazewell County and 200 feet north of Salem, Virginia.

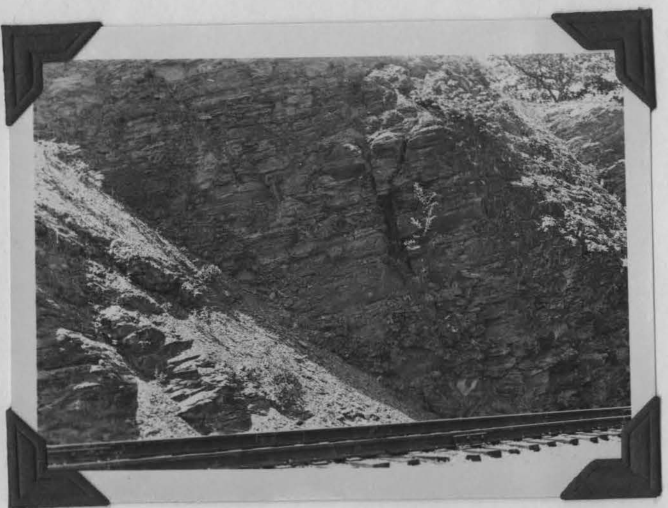
The Moccasin is found in a narrow belt half-way up the west slope of Paris and the north slope of High Top Mountains. It leaves the east end of High Top Mountain striking southwestward across the North Fork of the Roanoke and then swings south a quarter of a mile east of Ellett. The formation ends abruptly in the hills east of Den Creek and north of the Salem Fault. Two small faulted outliers of the Moccasin are found on the crest of two hills between Den and Mill creeks.

No fossils have been found in the Moccasin of this vicinity. None are likely to be found as red formations are not productive as a rule of fossils. The known fossils in the limestone facies of the Moccasin in other localities are not likely to be present in the sandy materials in this vicinity which is probably an off-shore phase. The Moccasin is considered to be of Lowville age because of its stratigraphic position and because of the presence in limy phases of the fossil Tetradium Cellulosum. It is succeeded by the Trenton division of the Martinsburg shale. This indicates an unconformity, as the Chambersburg limestone is missing.

Martinsburg Shale (Omb). The Martinsburg shale was named by N. H. Darton in 1892, from its exposure in the vicinity of Martinsburg, West Virginia. It



21. Contact of Martinsburg (light colored to left) with Moccasin (dark colored to right) near mouth of Den Creek.



22. Martinsburg Shale along Virginian Railway near Fagg.

23. Anticlinal fold in Martinsburg on Den Creek.

has been erroneously called Sevier shale in U. S. G. S. folios of Tennessee and Virginia, which is older than the typical Martinsburg.

The Martinsburg is a thick mass of shale, limestone and sandstone found on the slopes of mountains capped by the Silurian sandstones. It is divisible in this region into three parts on the basis of both fossils and lithology, although the latter grades from one division to the next gradually so that a sharp line cannot be drawn.

The lower part of the Martinsburg, constituting about three-fourths of the total mass, is considered to be of Trenton age and is designated the Trenton limestone. It is composed of thin, greenish blue, limy shale beds with interbedded thin layers of fairly pure and fossiliferous limestone. This division becomes more shaly toward the top. The Trenton weathers to a distinctive reddish soil covered with small flakes of resistant shale which are usually bright yellow and red. The colors are probably produced by the oxidation of the iron contained in the formation on weathering as the original shale shows no such coloration, although it is frequently stained with manganese. The lower part of the Trenton seems to be rather barren of fossils but certain beds in the middle and upper portions contain distinctive fossils. Those that have been identified on the west slope of Paris Mountain in an outcrop along the Virginian Railway near the mouth of Den Creek are:

Prasapora simulatrix (Ulrich)

Zygospira recurvirostris (Hall)

Plectambonites sericeus (Sowerby)

Dalmanella testudinaria (Dalman)

Rafinesquina alternata (Emmons)

Herbertella sp.

Orthoceras sp.

Crinoids stems

Cryptolithus tesselatus (Green)

Calymene sp.

The several hundred feet of shale succeeding the Trenton is considered the Eden division of the Martinsburg. They consist principally of thin, yellow, manganese-stained shales which become more sandy toward the top. Scattered through the shale are beds of limestone,and at the very top is found a gray sandstone which forms pronounced ledges where it outcrops along the slopes made up of the Martinsburg. The Eden division weathers somewhat like the Trenton except that the soil is yellowish brown and is more sandy without the extensive covering of shale flakes. These soils wash easily as is testified by the numerous gullies which denote its presence. Plants do not seem to be as hearty where they develop on Eden soils as on other sections of the Martinsburg, so it is apparently not of great agricultural value. Typical fossils of the Eden division that have been identified on the west slope of Paris Mountain are:

Rafinesquina alternata (Emmons)

Dalmanella testudinaria (Dalman)

Plectambonites sericeus (Sowerby)

Zygospira recurvirostris (Hall)

The upper hundred feet or more of the Martinsburg are recognized as being of Maysville age. This division is composed mostly of hackley brown to red sandstone with some more massive beds of gray sandstone. This series of sandstones must be quite a bit more resistant to erosion than is generally supposed. The orthodox attitude is to say that the Martinsburg is on the slopes of mountains of the Valley and Ridge province because it is controlled by the more resistant Clinch sandstone beds. In the Blacksburg area the upper Martinsburg beds are found on the crests of some of the highest peaks with the Silurian sandstones well down on the slopes. This is true in the case of Paris Mountain, High Top Mountain, Mill Knob and certain of the high knobs between Mill and Den creeks. It is true, the Clinch in this area is quite thin and faulted, which may account for this condition. The Maysville division is recognized by the way it weathers into small, blocky, red fragments and by the occurrence of the Orthoryncula faunal zone in a narrow series of beds near its very top. The following fossils are found in this zone:

Orthorhyncula linneyi (James)

Byssonychia radiata (Hall)

Modiolopsis modiolaris (Conrad)

Lingula nicklesi (Bassler)

This zone is distinctive as it is found consistently from Pennsylvania to Alabama.

The total thickness of the Martinsburg in the Blacksburg area is estimated to be about fifteen hundred feet, although it may be less. No sections are exposed and the beds are faulted locally to a great extent. H. P. Woodward reports 1000 to 1400 feet in the Roanoke area.[75] Charles Butts[10] gives a thickness of 3000 feet in the Massanutten syncline and 1500 feet in southwestern Virginia.

The Martinsburg is found in this vicinity on the upper western slope of the northern end of Paris Mountain. It is on the crest and upper west slope of the southern end of Paris Mountain. The crest and north slope of High Top Mountain are composed of Martinsburg. It is found along the North Fork of the Roanoke River from Fagg westward to Mill Creek. The crest of Mill Knob is composed of Martinsburg as are the Hills to the north of the Salem Fault from Fagg to Mill Creek.

There is an unconformity between the Martinsburg and the overlying Silurian sandstones, as the Oswego sandstone and Sequatchi formation are both absent in this region.

Silurian System

Clinch Sandstone and Clinton Formation (Scc)

In 1856, in a geological reconnaissance of the State of Tennessee, J. M. Safford first used the name Clinch Mountain sandstone. The term was taken from Clinch Mountain in Tennessee. In his Geology of Tennessee in 1869, Safford shortened the term to Clinch sandstone, including in it the underlying red sandstones, where present, and now called the Juniata formation. In the U. S. G. S. Atlas, London folio (No. 25) 1896, Keith restricted the Clinch to its present usage.

The Clinch sandstone is a very persistent horizon marker throughout the Appalachian Valley where it is responsible, where the strata are tilted, for some of the highest ridges of that physiographic province. The Clinch is an easy formation to recognize both because of its lithologic characteristics and its topography. It is a very massive, hard and dense sandstone of a quartzite character. The thick beds are composed of rounded quartz grains varying in size from half an inch to fine grained sand. From its texture it might be considered a conglomerate, especially in the lower part. The formation is very resistant to weathering and is broken by a hammer with difficulty. The hammer usually rebounds from its surface, leaving no impression. The sandstone ranges in color from white through gray to pink. It is prevailingly grayish white. The Clinch sandstone weathers to a sandy soil and produces a heavy talus which litters the slopes of mountains on which it is,and formations lower down. A definite ledge of outcrop may be seen wherever the sandstone is present. In the vicinity of Fagg the Clinch is broken by numerous minor faults which produce slickensides on practically all of the talus in that vicinity.

On Paris Mountain the Clinch is comparatively thin, varying from ten to thirty feet in thickness. In northern Virginia where this formation is known as the Tuscarora its thickness reaches more than 900 feet, but elsewhere in Virginia it is seldom more than 100 feet.

In the area here described the Clinch is found along the crest of the northern portion of Paris Mountain. East of Slate Lick Run it drops well down the east slope of Paris Mountain. Faulting is probably responsible for this. The Clinch follows most of the south slope of High Top Mountain. From the western end of High Top Mountain it strikes southeast, passing through Fagg, and then follows the north slope of Mill Knob. It finally swings in a high arc to the south and west, ending abruptly at the Salem Fault.

A typical fossil, Arthrophycus harlani, is reported to have been found in the Clinch sandstone on Paris Mountain.

Clinton Sandstone

The Clinch is discomformably overlaid by the Clinton formation next described. It is correlated with the Medina of New York.

The name Clinton was used by Vanuxem, in the Geology of New York in 1842. This is one of a number of the first New York Survey terms that have been adopted for corresponding formations in Virginia. In Tennessee it is called the Rockwood formation.

In this vicinity the Clinton is divided into two members. The lower member first described is known as the Cacapon while the upper member is called Keefer.

The Cacapon division of the Clinton is composed of soft red, moderately thick bedded sandstones and interbedded thin red shales. It is about one hundred feet in thickness. The only place where outcrops are known to be exposed is at Fagg where the North Fork of the Roanoke River has cut across the resistant Silurian Sandstones, exposing them along the highway and Virginian Railway. In other places the member is covered with soil and a dense growth of brush.

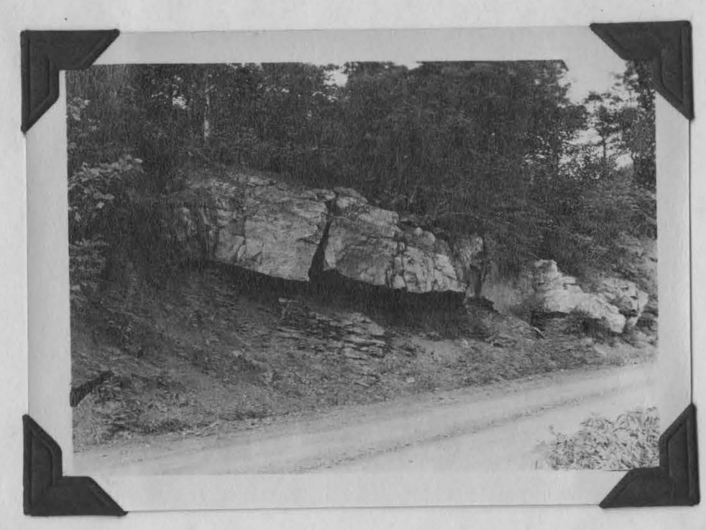
The Keefer member of the Clinton consists of variable, interbedded white and reddish sandstones with buff shales. The white sandstones are fine grained, friable and nearly pure quartz. They are in moderately thick beds. The red sandstones are similar to the others except that they are deeply stained from a high content of iron oxides. The white Keefer sandstone may often be recognized by the sparkling character of some of the grains exposed on a fresh fracture. A sandy soil is produced by the Keefer which is true of all of the Silurian formations. This character is of value in field mapping as it helps to separate these formations from the overlying Helderberg. Outcrops of the Keefer are rare and the soil is usually covered by a dense growth of brush, making observations difficult. Talus of the Keefer is fairly plentiful. In this region the Keefer is possibly three hundred feet thick.

The total thickness of the Silurian sandstones on Paris Mountain is estimated to be about four-hundred and fifty feet. Of this amount around four hundred feet is Clinton.

The Clinton formation is found in a belt parallel to the Clinch and occupying about two-thirds of the way up east slope of Paris Mountain, the south slope of High Top Mountain and the north slope of Mill Knob.

No fossils have been found in the Clinton formation in the Blacksburg area.

The Silurian formations are disconformably overlaid by formations of Helderberg in this region.



24. Contact of Clinch above with underlying Martinsburg. (Maysville division.) Note fault near center of picture.

25. Clinch sandstone at summit of Paris Mountain.

Caca
26. Clinch overlaid by Clinton (cocapon) formation near Fagg.

<u>Devonian System</u>

Lower Devonian (Helderberg Group (Dh))

The term Helderberg was introduced by W. W. Mather of the New York survey in the 4th Annual Report in 1840.

This group in Virginia includes the following members:

Becraft

New Scotland

Coeymans

Keyser

In the Blacksburg area the group is poorly exposed and consequently its limits on the map may not be as accurately marked as could be desired. The entire mass is covered with soil, talus from formations on higher slopes, and a dense overgrowth of brush. A few outcrops are occasionally found along the lower east slope of Paris Mountain. These indicate that the lower part consists of an irregular gray and very cherty limestone. Just which member of the group this might be is uncertain as no fossils have been found for identification. It produces a sandy clay soil containing many small angular fragments of a bluish chert. Overlying the limestone is a very coarse, gray to brown and very friable sandstone. On weathered outcrops the sand grains separate readily when struck with a hammer, causing the rock to pour from the impact like salt. A reddish sandy soil is produced by this member.

The total thickness of the group is not more than seventy-five feet and may be less. The sandstone member is estimated to be about twenty-five feet thick.

The Helderberg group as here described occurs in an irregular belt along the east base of Paris Mountain. In the vicinity of Fagg it occurs well up on the slope of Paris and High Top mountains and Mill Knob. As the the dip of the beds is nearly the same as the slope of Paris Mountain, the belt of Helderberg is considerably wider than might be expected.

No fossils were found in the formations.

The Helderberg is overlaid by the Black Shales corresponding roughly to the Romney of other sections. A few thin beds of Onondaga are possibly present between the Helderberg and the Black Shales.

In his description of the Geology of the Roanoke area,[75] H. P. Woodward discusses an exposed section of the Helderberg along the Salem-Newcastle road. He describes fifty feet of limestone and twenty-five feet of sandstone. According to him, the formations contain fossils, indicating Becraft age. This is in accordance with the ideas of Butts[10] and Ulrich.[70] However, the sandstone described is similar in every respect to typical Oriskany sandstone found in other localities. In fact, some geologists consider this to be the Oriskany. It seems highly probable to the writer that such may be the case. The finding of the fossil Spirifer arenosus would help clear up the present controversy, and would place these beds as Oriskany.

Woodward[75] reports collecting the following fossils from the exposed section previously mentioned:

Spirifer Concinnus (Hall)

Eatonia peculiaris (Conrad)

Leptaena rhomboidalis (Wilckens)

Uncinulus vellicatus (Hall)

Strophonella leavenworthana (Hall)

Meristella lata (Hall)

27. Boulder and bed rock of sandstone in Helderberg group.

Onondaga Formation(?)

Above the Helderberg just described, in the Blacksburg area is found a zone producing white cherts in the overlying soil. The beds producing these cherts have not been seen. The belt of this material is comparatively narrow and the beds are probably not over a few feet in thickness. This is the correct stratigraphic position for the Onondaga beds if any are present, and consequently this zone is here considered as probably of that age. Woodward[75] reports a similar occurrence in Catawba Mountain. The line separating the Helderberg from the Black Shale on the accompanying may would serve to indicate the position of the Onondaga. In the recent publication of the Guide Books to the U. S. for the International Geologic Congress of 1934 the map of this area in Guide Book No. 3 shows the entire zone here mapped Helderberg as Onondaga.[36] It seems to the writer that this is hardly a correct representation.

Black Shale (Dbs)

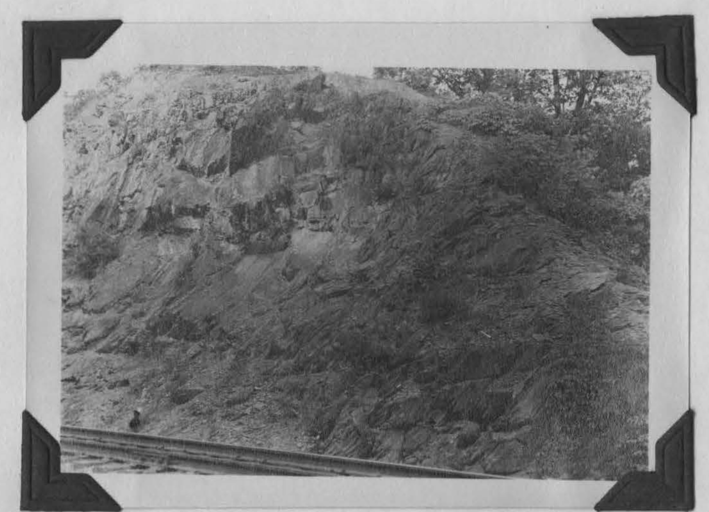
The term Black Shale is applied in the region to the stratigraphic equivalent of the Romney shale of other localities. The typical Romney contains the Onondaga which here is represented as previously described. It is on this arbitrary distinction that Butts[10] has applied the term Black Shale instead of Romney. Because the Virginia Geological Survey has adopted this usage, until a better name may be applied, it will be used in this report, although the writer can see no serious objections to calling it the Romney.

The Black Shale is, as its name indicates, a mass of thin bedded black shale. The black color seems to be due to the presence of carbonaceous matter. In fact, stems and leaves of unidentified plants have been found in the vicinity east of Fagg. The shales are of a fissile nature and are fairly free of sandy materials. The outcrops of this formation are usually stained a yellow to red from the iron content. The soil produced is rather poor and covered with resistant flakes of shale of various shades of bleached white to black. Valleys composed of the Romney or Black Shale are noted for the poor quality of their soils. Upward the black shaly material becomes slightly more sandy and lighter in color, grading imperceptibly into the olive green shales of the Brallier above. This change is so gradual that no sharp line can be drawn between the two great shale masses. The topography of the Romney is moderately irregular.

The typical Romney is composed of beds of Onondaga, Hamilton, Marcellus, Genesee and Portage (Naples) ages respectively. The Black Shale here described seems to contain a fauna indicating the presence of a thin representative of the Hamilton with the principal part of the formation made up of Marcellus and Portage equivalents.

It is impossible to obtain an accurate measurement of the Black Shale in this vicinity as it is extensively folded and faulted and there are no sections exposed. It is estimated to be about five hundred to seven hundred and fifty feet thick. This estimate is in agreement with that given by Butts[10] but is slightly more than Woodward's estimate for the Roanoke area.[75]

The Black Shale is found in this region extending from the east base of Paris Mountain to Flatwoods Branch. The west exposure limit of the formation follows along the foot of Paris Mountain parallel to the North Fork of the Roanoke River to a point north of Fagg. The southern border of the shale follows the north base of Mill Knob until it reaches the Salem Fault. This Fault forms the southern boundary to a point southeast of Ironto. The eastern boundary extends in a curved line parallel to the contour of Paris Mountain



28. Black Shale exposed in railway cut at Ironto.

from Flatwoods Branch to Ironto. Scattered faulted outliers of the Black Shale may be seen in the vicinity of Fagg and along the south slope of High Top Mountain north of Fagg.

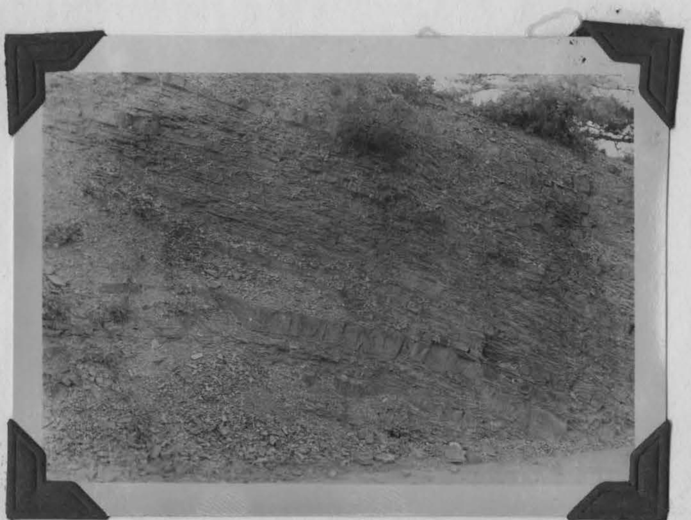
Numerous fossils may be found in the Black Shale but few have been identified. Fragments of plant impressions are common. Trilobite glabellae, probably Phacops, were found by C. E. Sears on a recent field trip with the writer. Associated with these were Pelecypods and brachopods. Near Fagg, Mr. Sears discovered Tentaculites sp. which suggests Hamilton age for the lower black shales.

The Black Shale is probably disconformable with the Helderberg group and seems to grade conformably into the Brallier above.

Brallier Shale (Db)

One of the newest names to be introduced into Virginia stratigraphic nomenclature is that of the Brallier shale. The term was first used by Charles Butts in the Geologic section of Blair and Huntingdon counties, central Pennsylvania, published in the American Journal of Science, 4th series, volume 46, p. 523, in 1918. The Brallier is of Portage age and is equivalent to the lower half of the Kimberling shale of the United States Geological Survey Folios.

The Brallier is composed of a thick mass of shales and sandstones with the former predominating. The shales begin in an unrecognizable zone above the Black Shale where the latter grade from their characteristic black color to a deep olive green color. The lowest beds of the Brallier are quite similar in general appearance to the upper Black Shale. As the formation increases in thickness upwards the shales become more yellow and there is a gradual increase in interbedded sandstones. The sandstones are a greenish gray color and are micaceous. They range in thickness from one inch to one foot.



29. Brallier Shale on road near Flatwoods Branch.

The shales throughout are thin, fissile and usually crinkled. The formation occupies valleys between the mountains formed by the Silurian sandstones on the one hand and mountains formed by the overlying Chemung formation and Price sandstone on the other. It seems to be a rather incompetent formation, for wherever outcrops are found, close folding is in evidence. The Brallier soils are thin and sandy, particularly in the upper part. Where the shale has weathered, it assumes a yellow color.

The thickness of the Brallier, like that of other shale formations in the Appalachian regions, is not easily measured because of the excessive amount of minor folding within the formation. In this vicinity the thickness of the Brallier is arbitrarily placed between 2000 and 3000 feet. It is probably closer to 2000 feet thick. Butts[10] reports 3000 to 4000 feet of Brallier in Bland and Pulaski counties.

In the area mapped here, the Brallier is found only in a fairly regular belt about one and one-half miles wide between Flatwoods Branch and Bradshaw Creek to the north and between Ironton and the eastern edge of the mapped area in the south. The belt is roughly parallel to the trend of Paris mountain.

Fossils are exceedingly scarce in the Brallier. The only ones observed in the Blacksburg area were a number of small pelecypods Buchiola retrostriata (von Buch) in the lower Brallier near the upper limit of the Black Shale.

The Brallier grades without any evidence of disconformity into the Chemung above.

Chemung Formation

The Chemung formation was first named by James Hall of the New York Geological Survey. The term appeared in the third annual report of the Survey in 1839. It is the upper part of the Kimberling shale of M. R. Campbell.

This formation is quite similar to the Brallier formation. It is a thick mass of shales and sandstones with the latter becoming more predominant toward the top. The division between the Brallier and the Chemung cannot be definitely placed, but the appearance of Chemung fossils is sufficient to mark the line between the two formations. The Chemung contains typical fossils, the Brallier contains only a few forms at most. The shales of the Chemung formation are thin bedded and of a yellowish green color. The sandstones are of about the same color as the shales and are if anything coarser than the sandstones of the underlying Brallier. These sandstones are in greater proportion to the shale in the Chemung than in the Brallier. They vary from a few inches to a foot or two in thickness and are of a flaggy nature. The increase in amount of sandstone toward the top of the Chemung causes it to be a strong ridge maker. It is found on the top of Brush Mountain and along the greater part of Fort Lewis Mountain. The soil of the Chemung is sandy throughout its thickness and is not particularly fertile. In spite of this it is often cultivated, although it is usually well covered with thick brush.

Within the boundaries of the Blacksburg area there are no complete sections of the Chemung, although the exposures here described are part of sections which extend into adjoining areas. The thickness cannot be measured because of lack of outcrops, but it is estimated that the Chemung has a total thickness in this vicinity of about 2000 feet. It is probably somewhat less.

In the region here described there are two localities where the Chemung may be found. Both are small areal exposures which continue off the mapped area, showing their greatest distribution beyond these limits. The best exposure of the formation is along the crest of Brush Mountain and one-third

30. Chemung formation along Bradshaw Creek.

of the way down its south slope. The second best exposure is along Bradshaw Creek to where this stream empties into the North Fork of the Roanoke River. The discovery of Chemung fossils by Dr. R. J. Holden in the yellow shales to the east of Highway 8 south of Blacksburg places a narrow strip of sandstone and shale in that formation. The strip extends about two or three miles along the southeastern border of the Price Mountain fenester.

Fossils typical of the Chemung formation are crinoid stems (sp.) and the brachiopod, Spirifer disjunctus (Sowerby). These are found plentifully on Brush Mountain and along Bradshaw Creek.

The Chemung is overlaid by the Price sandstone of Mississippian age. Catskill beds may be present in this region but have not been identified as such. The Chemung resembles the Price so closely that the two are separated only by the presence of the distinctive Ingles conglomerate.

Mississippian System

Price Formation (Mpr)

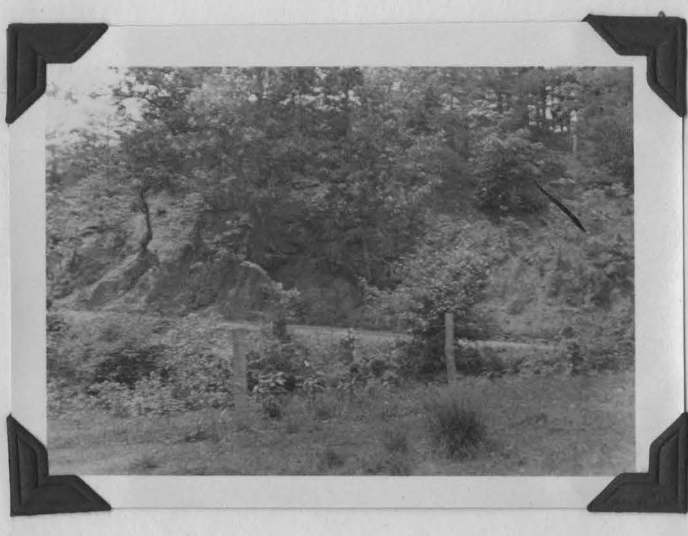
This formation is of particular interest to those who are familiar with Montgomery County, Virginia. The type locality for the Price and the place from which its name was taken is Price Mountain about three miles southwest of Blacksburg. The Price was first called the Montgomery Grits[56] by W. B. Rogers in 1831-1835. This probably referred only to the Ingles conglomerate member. In 1896 M. R. Campbell[18] named the formation the Price sandstone from Price Mountain, and later, in 1925 called it the Price formation.[23] At the base of the Price formation is a member known as the Ingles conglomerate. This name was also applied by M. R. Campbell. The term was taken from Ingles Mountain in Montgomery County. The Price formation is known as the Pocono sandstone in the north.

In this region the Price formation is made up of a thick mass of greenish yellow shales and sandstones quite similar to the Chemung. In fact, the only way the Price can be distinctly separated from the Chemung is by the presence of the Ingles conglomerate at the base of the former. This conglomerate is very distinctive. It is ten to twenty feet thick and is composed of a fine grained, gray, sandy matrix in which there are scattered, indiscriminately, rounded,white,quartz pebbles varying from one-fourth of an inch to possibly an inch and a half in diameter. The member is hard and resistant and is often found on the crest of mountains composed of the Price formation. This conglomerate may be seen where State Highway 8 crosses the top of Brush Mountain. The old name, "Millstone Grits," is very appropriate, as in this region, on Brush Mountain, the bed has been quarried for use as millstones. The major portion of the Price formation is made up of yellowish green, flaggy sandstone with thin interbedded yellowish shales. Both are often stained with iron and manganese oxides. About one thousand feet above the base of the Price are found several workable coal seams in association with shale beds.[23] The coal is semi-anthracite. It is mined in Price Mountain at Merrimac, and at a number of localities near the foot of Brush Mountain. It is interesting to note that wherever the overlying Maccrady shales have been pinched out by the Pulaski Fault the coal beds are missing. The presence of the coal indicates a change from marine beach conditions when the Ingles was deposited to continental conditions above. Throughout the thickness of the Price there are a number of scattered beds of red sandstones and shales. These may be seen on the south slope of Brush Mountain.

The Price formation is thicker in this region than in other localities. Sections measured through the gap at the western end of Brush Mountain show a thickness of between 1500 and 1700 feet. Campbell and Holden give a thickness of 1700 feet.[23] Butts gives a thickness of 1200 feet in Scott County, and 500 feet in Rockingham County.[10]

The Price formation is found in the Blacksburg area in the vicinities of Brush and Price mountains. It extends from the base of Brush Mountain two-thirds the way up its south slope. Southwest of Blacksburg the Price is found composing the entire central portion of the Price Mountain fenester as well as scattered strips along the edge of the fenester and beyond the Maccrady.

Fossils in the sandstones and shales of the Price formation are not common, but in the coal beds numerous plant remains have been observed.



31. Maccrady Shale along Pulaski Fault
near Toms Creek.

32. Ingles Conglomerate on Brush Mountain.

33. Price formation, N. & W. Railway cut near Merrimac.

34. Coal mine opening on Brush Mountain.

35. Waste shale. Coal mine in Price formation on Brush Mountain.

These plants are typical forms of the Mississippian. (Lepidodendron sp. and Sigillaria sp.)

Overlying the Price formation without evident unconformity is the Maccrady shale.

Maccrady Shale (Mmc)

The youngest and last formation to be described in this discussion of the areal geology of the Blacksburg area is the Maccrady shale. It was given the name Maccrady by G. W. Stose in his "Geology of the salt and gypsum deposits of southwestern Virginia," in 1913, Virginia Geological Survey Bulletin, number 8. M. R. Campbell[18] gave the same formation in the immediate vicinity the name of Pulaski shale because of its excellent exposure near the town of that name. The term Pulaski was preoccupied, and so has been abandoned for this formation.

The Pulaski shale is very distinctive in character and may serve as a key horizon. It is composed of a deep red, sandy shale or mud rock with associated thick red sandstones. It is found at the foot of mountains composed of Price sandstones. The Maccrady produces a very irregular topography of sharp knolls and steep valleys. The derived soils of this formation are sandy, gravelly and red. "Some geologists have maintained that the Maccrady shale is not inherently red, but that it turns red on weathering. This opinion seems to be based on the supposition that the present red color is due to the oxidation of carbonate of iron and that the original color of the shale was bluish and not red as it is now. It is quite possible that some of the red color of the shale is due to oxidation of iron carbonate, but recent drill cases have shown that the shale holds its red color to a depth of at least 1000 feet, and consequently we must conclude that the clayey and sandy material when it was deposited was of a deep red color."[23] The red color may have been caused by arid or semi-arid conditions at the time of deposition.

The Maccrady varies considerably in thickness as it is in every exposure, in this vicinity, in contact with the Pulaski Fault. The "Valley" limestones have in every case been thrust over the Maccrady. This has resulted in its being much shattered and completely pinched out in some cases. The thickness is here estimated to be between 0 and 500 feet. In its original condition, before the faulting took place, it was probably much thicker.

The Maccrady may be looked upon as a "buffer" between the limestone of the overthrust portion of the Pulaski Fault and the Price sandstones. This causes it to be present in a narrow strip between the base of Brush Mountain and Toms Creek and in a strip around the foot of Price Mountain. The latter belt is crossed at the top of the hill south of the V. P. I. Airport on the road between Blacksburg and Christiansburg. There the red color is very marked.

No fossils have been found in this formation by the writer.

The Maccrady succeeds the Price formation conformably and is cut off at its upper limits by the Pulaski Fault. In the region around Saltville, Virginia, it is overlaid by limestone of Warsaw age.

Summary of Stratigraphy for the Blacksburg Region

	Thickness in feet
Mississippian System	
Osage series	
Maccrady shale----------------------------------	0-700
Price formation---------------------------------	1700'
Devonian System	
Chemung formation-------------------------------	2000
Brallier shale----------------------------------	2500
Black shale-------------------------------------	500-750
Onondaga--	5-10
Helderberg formations---------------------------	50-75
Silurian System	
Clinton formation-------------------------------	400
Keefer sandstone	
Cacapon sandstone	
Clinch sandstone--------------------------------	10-30'
Ordovician System	
Martinsburg shale-------------------------------	1500
Maysville division	
Eden division	
Trenton division	
Black River Group	
Moccasin formation------------------------------	400-650
Blount Group	
Athens shale------------------------------------	1500
Whitesburg limestone	

Stones River Group

Lenoir) Mosheim) limestones--------------------------	50-250

Canadian of Ulrich

Beekmantown (Nittany) dolomite--------------	500-850

Cambrian System

Ozarkian of Ulrich

Copper Ridge dolomite--Conococheague limestone-	1800
Elbrook dolomite-------------------------------------	1200
Rome (Watauga) formation----------------------------	1000

APPENDIX

A. Paleozoic Stratigraphy of Virginia

(Those underlined are units mapped in Blacksburg area)

	Thickness in feet
Paleozoic Rocks	
Pennsylvanian system	
Pottsville Group	
Harlan sandstone-------------------	800
Wise formation---------------------	2000-2300
Gladeville sandstone---------------	50-100
Norton formation-------------------	1300-1500
Lee formation----------------------	800-1800
Mississippian system	
Chester Group	
Bluestone formation----------------	400-800
Princeton sandstone----------------	30-50
Pennington formation-Hinton formation	200-2200
Stony Gap sandstone member----	35-85
Newman formation	
Bluefield shale-Cove Creek limestone-Glen-----------	300-1000
Dean limestone	
Greenbrier L. S.	
Fido sandstone-----------	50
Gasper limestone---------	150-1000
Ste. Genevieve limestone-	80-1300

Meramec Group	
St. Louis------------------------------------	10-300
Limestone of Warsaw age----------------------	100-600
Osage Group	
Fort Payne Chert----------------------------	15
Maccrady Shale (Pulaski Shale)---------------	50-500
Price formation-Pocono sandstone-------------	300-1700
Devonian system	
Upper Series	
Kimberling formation-Grainger (old terms including)	
Catskill formation---------------------------	1000-2800
Chemung formation----------------------------	0-2000
Brallier (Upper Portage) - (Jennings)- (By Stone Gap) corresponding to Hatch and Gardeau of N. Y.---------	200-4000
Middle Series	
Romney shale---------------------------------	500-1000
Black Shale - Chattanooga	
Portage (Naples)	
Genesee	
Hamilton	
Marcellus	
Onondaga-------------------------------------	50-100
Lower Series	
Giles of Tazewell Folio	
Oriskany-(Ridgeley)-(Monterey) sandstone	0-150

Helderberg limestone (Handcock) (Niagara) (Salina) (Lewistown)---------------------	100-400
Becraft formation------------------------	0-50
New Scotland limestone------------------	15-250
Healing Springs sandstone-----------	20-50
Coeyman's limestone---------------------	20-40
Keyser formation------------------------	0-200
Clifton Forge sandstone-------------	0-100
Silurian system	
Cayuga Group	
Tonoloway limestone-------------------------------	25-300
Wills Creek sandstone-----------------------------	5-50
Bloomsburg formation------------------------------	200
McKenzie formation--------------------------------	175
Niagaran Group	
Clinton - Rockwood formation of Rochester age------	100-500
Keefer sandstone------------------------------	50-200
"Cacapon sandstone"---------------------------	50-300
Alexandrian Group	
Massanutten sandstone	
Clinch sandstone--Tuscarora quartzite---------	50-200
(Brassfield of Ky. also Medina of Richmond age.)	
Juniata--Sequatchie--Bays formation-----------	300-700
(Lorrain)--(Queenston shale at Niagara of Richmond age.)	
Ordovician system	
Upper Ordovician or Cincinnatian	

Oswego sandstone--(McMillan of Ohio)---------- 200-500

Martinsburg (Series found to be of older)----- 1500-3000

Reedsville-------350-600

Maysville

Eden--same as Utica?

Trenton----------200-500

Middle Ordovician (Mohawkian)

Middle Ordivician of Ulrich

Black River Group

Chambersburg------------------------------ 200-400

Lowville limestone--Moccasin limestone---- (Birdseye of Ohio) 500-1000

Lower Ordovician of Ulrich

Chazy age

Blount Group

Ottosee limestone------------------- 300-400

Athens shale--called Lexington by H. D. Campbell, which was found to be preoccupied, so called Liberty Hall in Staunton Folio---------- 600-5000

Whitesburg limestone[1]--------------- 0-75

Holston limestone--also called Murat by H. D. Campbell in Staunton Folio. Corresponds to Lebanon and Glade of Tennessee and Tyrone of Powell Valley?--------- 0-300

Stones River Group of Lower and Middle Chazy age

Lenoir limestone--corresponds to Ridley of Tennessee and Maclurea of Georgia and Alabama--------- 25-100

Mosheim limestone----------------	5-100
Murfreesboro limestone-----------	0-250

Lower Ordovician--Canadian of Ulrich

Beekmantown dolomite--(Knox)[2.]

Bellefonte dolomite N. E. of Staunton[3.] only------------------------------	100-1500
Nittany Dolomite---------------------	500-1000
Stonehenge limestone-----------------	50-100

Cambrian system

Upper Cambrian (Saratogan)--Ozarkian of Ulrich

Chepultepec limestone----------------------	25-500
Conococheague limestone N. E. of Roanoke, Copper Ridge--S. W. of Roanoke corresponds to Jonesboro of Tennessee-------------	1200-2000

Middle Cambrian (Acadian)

Upper Cambrian of Ulrich includes Nolichucky shale and Mayville limestone

Elbrook dolomite[4.]-------------------------	1200-2000

Nolichucky shale (100-500)

Honaker dolomite (1000)

Maryville limestone

Rogersville shale

Rutledge limestone

Lower Cambrian (Georgian)

Rome (Watauga) formation S. W. of Roanoke--Waynesboro N. E. of Roanoke--Russell of Bristol Folio--Graysonton of M. R. Campbell (1894) and Buena Vista of H. D. Campbell------------------------	2000

Tomstown N. E. of Roanoke--Shady dolomite S. W. of Roanoke--Sherwood of North Carolina by Campbell----------------------------------	1000-1800
Basal Quartzites or Chilhowie Group	
Antietam quartzite--N. E. of Roanoke-- Erwin quartzite, S. W. of Roanoke-------	800-1200
Harpers shale, N. E. of Roanoke-- Hampton shale, S. W. of Roanoke---------	2000
Unicoi formation S. W. of Roanoke-------	2000
Weverton quartzite, N. E. of Roanoke	
Loudon formation, "do"	

Pre-Cambrian system

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1. Whitesburg limestone composes the upper limit of the Chickamauga limestone group, named by Hayes in Tenn. 1890, of which the Murfreesboro limestone is the basal member. The Shenandoah limestone, named by Darton, includes all of the formations from the Basal quartzites of Lower Cambrian through the Whitesburg limestone of Middle Ordovician. In Pennsylvania the Shenandoah is known as Lancaster, Kittatinny, or York, and includes all formations from the basal quartzites through the Chambersburg. In general, it is known as the "Valley" limestone.

2. The term Knox as applied to geologic formations has had a varied usage. Safford in 1869 first used the term in Alabama where the Knox group included the Knox dolomite, the Knox shale and the Knox sandstone. The Knox dolomite would be apparently equivalent to the combined Beekmantown and Copper Ridge formations; the Knox shale would be equivalent to the Elbrook formation; the Knox sandstone would be equivalent to the Rome (Watauga). Later usage has applied only the term Knox dolomite. It is the equivalent of the combined Beekmantown and Copper Ridge and is so applied in S. W. Virginia by Keith and M. R. Campbell.

3. Bellefonte dolomite is the uppermost formation of the Natural Bridge limestone of H. D. Campbell, which has the Honaker dolomite (Rutledge) equivalent as its basal member.

4. The Elbrook is equivalent apparently to Nolichucky shale and Maryville limestone in the Briceville quadrangle which in turn is equivalent to the Conasauga. The Elbrook is therefore the equivalent of the Conosauga, the Coosa, the Montevallo, the Flatwoods, the Choccolocco and the Knox shale.

B. Explanation of Stratigraphic Nomenclature to Accompany Correlation Chart

In the first stratigraphic work done in the state by the W. B. Rogers Survey, 1835 to 1842, formations were designated by number. Geologic period names were not known at that time, and so number I was taken as the lowest and oldest formation overlying the metamorphic rocks of the Piedmont Region. Successively higher numbers were given to successively younger formations. Formation number XI included what is now known as the Greenbrier or Mississippian limestone. The crystalline rocks below this series are what is now known as pre-Cambrian.

Geological work under State auspices was suspended until 1906. Meanwhile period names and formation names had been applied in New York and Pennsylvania, and the sections as designated there became standard for the Appalachian region.

Various geologists of northeastern states did occasional work in Virginia, and in their reports extended New York and Pennsylvania names to Virginia formations.

The Virginias, a magazine published by Jed Hotchkiss, 1880-1885, contained writings of various geologists, and they used formation names and other terms current in northeastern states at that time. In 1884, a reprint of the reports of the Rogers Survey was edited and published by Jed Hotchkiss. This contained a reprint of a portion of McFarlane's Railway Guide in which W. B. Rogers distributed his formations through periods as then known.

In the 80's, a considerable portion of Virginia was mapped topographically by the National Geological Survey. Shortly thereafter various folios containing geologic maps with structure and columnar sections and discussions of stratigraphy were published by the United States Geological Survey. A list of these is as follows:

Harpers Ferry Folio (No. 10), Arthur Keith, 1894

Estillville Folio (No. 12), by M. R. Campbell, 1894

Staunton Folio (No. 14), by N. H. Darton, 1894

Pocahontas Folio (No. 26) by M. R. Campbell, 1896

Franklin Folio (No. 32), by N. H. Darton, 1896

Tazewell Folio (No. 44) by M. R. Campbell, 1898

Bristol Folio (No. 59) by M. R. Campbell, 1899

Monterey Folio (No. 61) by N. H. Darton, 1898

In these folios local names were given formations, and these were correlated with the Rogers numbers and with New York, Pennsylvania and Tennessee names.

In 1906, a large volume entitled Mineral Resources of Virginia was published at the Virginia Polytechnic Institute by T. L. Watson and others. It gave incidental attention to stratigraphy.

In that same year a second geological survey was established as cooperative work between the Virginia Polytechnic Institute and the Virginia Department of Agriculture. Under these auspices three reports were issued which gave emphasis to economic considerations with only incidental thought to the stratigraphy. This survey was established on a firm basis by an act of legislature and has been maintained to the present time. About forty-five individual publications have been issued by this new survey, including two geologic maps of the State, and one map of the Valley region. While most of these reports were of an economic nature, most of them discussed stratigraphy. Some were largely concerned with stratigraphy. In these reports there has been a continual subdivision of the major formational units and also an attempt to bring about correlations of these units with those of adjoining regions.

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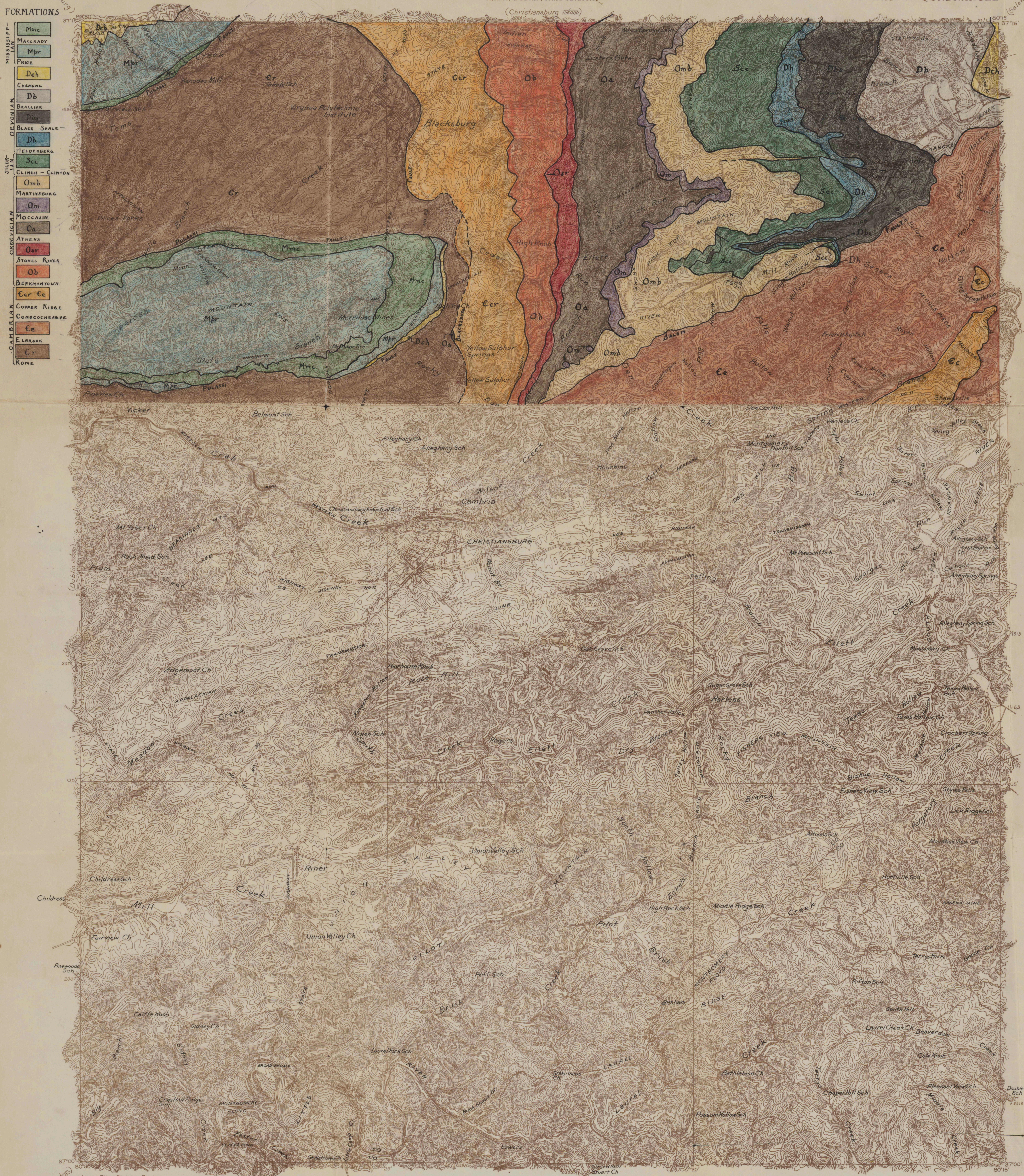
DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

STATE OF VIRGINIA
CONSERVATION AND DEVELOPMENT COMMISSION
VIRGINIA GEOLOGICAL SURVEY
ARTHUR C. BEVAN, STATE GEOLOGIST

Advance sheet. Subject to correction.

VIRGINIA
BLACKSBURG QUADRANGLE



Albert Pike, Division Engineer
Topography by G.E.Sisson, H.A.Bean, H.R.Kilmer, J.O.Kilmartin, C.W.Buckey and H.G.Warren
Control by U. S. Geological Survey and U. S. Coast and Geodetic Survey
Culture and drainage in part compiled from aerial photographs taken by Air Corps, U. S. Army
Surveyed in 1931 and 1932

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1932

Scale $\frac{1}{48,000}$

Contour interval 20 feet
Datum is mean sea level

Polyconic projection. North American datum

BLACKSBURG, VA.

COLUMNAR SECTION OF VIRGINIA
CHARLES BUTTS, VA. GEOL. SURV., BULL. NO 42
1933
SCALE: 1" = 2000'
SECTION SHOWING FORMATIONS OF BLACKSBURG QUADRANGLE, NORTH OF N. LATITUDE - 37° 10'
H.H. WAESCHE — 1934
SCALE - 1" = 1000'
VICINITY OF ABINGTON AND MARION, VIRGINIA S. OF CLINCH MOUNTAIN
VICINITY OF ABINGTON AND MARION, VIRGINIA N. OF CLINCH MOUNTAIN
BIRMINGHAM DISTRICT OF ALABAMA
HUNTINGTON AND BLAIR COUNTIES, PENNSYLVANIA
SECTION SHOWING STRATIGRAPHIC SEQUENCE IN ALABAMA, VIRGINIA, AND PENNSYLVANIA WITH CORRELATIONS AFTER CHARLES BUTTS, VARIATIONS IN APPALACHIAN STRATIGRAPHY, JOUR. OF WASH. ACAD. SCI., VOL. 18, NO. 13, PAGE 360, 1928.
- SCALE - 1" = 1000' -
BRISTOL FOLIO M.R. CAMPBELL 1899
TAZEWELL FOLIO M.R. CAMPBELL 1897
POCAHONTAS FOLIO M.R. CAMPBELL 1896
MONTEREY FOLIO N.H. DARTON 1899
HARPERS FERRY FOLIO, ARTHUR KEITH — 1894
TABLE OF FORMATION NAMES AFTER U.S.G.S. GEOLOGIC ATLAS — FOLIOS, NOS. 59, 44, 26, 61, AND 10 RESPECTIVELY.
GENERAL GROUPS
SUB-DIVISIONS IN VIRGINIA AND WEST VIRGINIA
NAMES ADOPTED BY H.D. AND W.B. ROGERS FOR THE PALEOZOIC FORMATIONS OF PENNSYLVANIA AND VIRGINIA AND USED IN THE FINAL REPORT OF THE GEOLOGY OF PENNSYLVANIA. - 1858 -
LIST OF THE GEOLOGICAL FORMATIONS FOUND IN VIRGINIA AND WEST VIRGINIA. MACFARLANE'S GEOLOGICAL RAILWAY GUIDE OF 1879 (CORRECTED TO 1883 BY PROF. W.B. ROGERS)
CORRELATION CHART OF THE BLACKSBURG AREA SHOWING COLUMNAR SECTIONS AND NAMES USED IN VARIOUS LOCALITIES AND FOR VARIOUS PERIODS SINCE — 1835
COMPILED BY — H.H. Waesche
DRAWN BY —