GEOLOGY OF THE SPRUCE RUN MOUNTAIN AREA, GILES COUNTY, VIRGINIA

by

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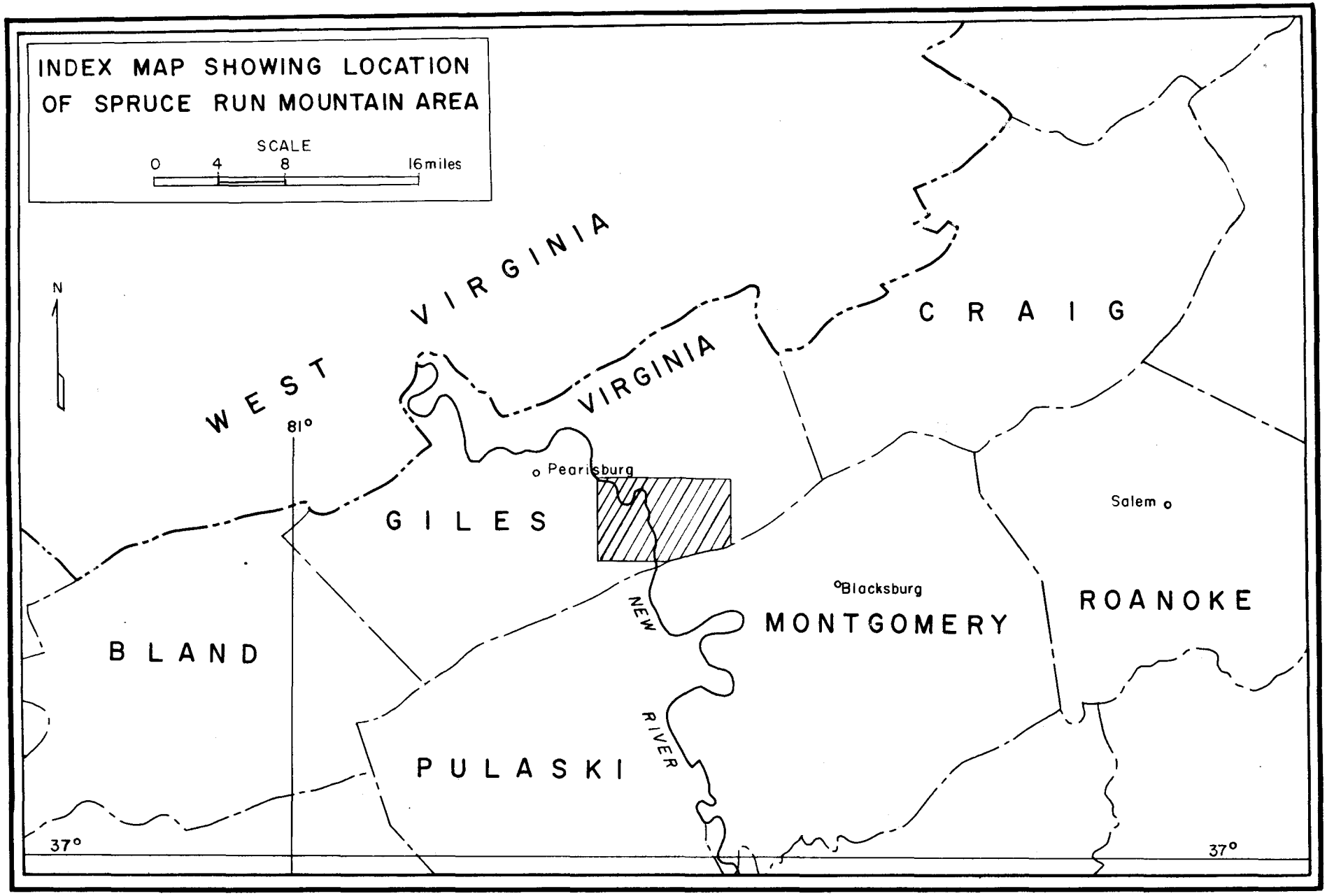
INTRODUCTION

LOCATION AND ACCESSIBILITY

The Spruce Run Mountain area of Giles County in southwestern Virginia is located in the Valley and Ridge Province. The northwestern extremity of the area is four miles from the Virginia-West Virginia border (index map, figure 1). The mapped area is nearly rectangular. It is bounded on the south by the Giles-Montgomery county line along the crest of Gap Mountain and by the latitude 37° 15'. The northern boundary is an east-west line 0.4 miles south of latitude 37° 20'. Eastern and western boundaries are respectively: longitude 80° 30' and a north-south line 1.3 miles west of longitude 80° 40'. The New River flows northwest through Giles County and cuts across the western third of the rectangular map-area. The area studied contains nearly 45 square miles.

This rectangular area is crossed from northwest to southeast by U. S. Route 460. State Route 42 extends southwest from its intersection with U. S. Route 460 near the center of the area. Nearly all lands not adjacent to these major routes may be reached by unsurfaced county roads or by private farm roads. Tracks of the Norfolk and Western Railway pass through the western third of the area on either side of the New River. The tracks follow approximately the meanders of the New River and locally, afford excellent exposures

FIGURE 1


INDEX MAP SHOWING LOCATION
OF SPRUCE RUN MOUNTAIN AREA
SCALE
0 4 8 16 miles
N
WEST VIRGINIA
VIRGINIA
CRAIG
81°
Pearisburg
GILES
Salem
Blacksburg
MONTGOMERY
ROANOKE
NEW
RIVER
BLAND
PULASKI
37°
37°

of the rocks in the Spruce Run Mountain area.

METHODS OF STUDY

Geologic mapping of the area was carried out by pace and compass field methods. Data were recorded on an enlarged portion of the United States Geological Survey 1937 edition of the 15-minute Pearisburg Quadrangle, Virginia-West Virginia.

ACKNOWLEDGMENTS

A portion of the necessary research funds was provided by Project 343 of the Virginia Engineering Experiment Station. I am grateful for this aid. I also wish to acknowledge the instruction and criticism of Professor Byron N. Cooper, Head of the Department of Geological Sciences, Virginia Polytechnic Institute. Dr. Cooper suggested the problem and spent several days in the field with me. I am also indebted to Professor Mark Fara who gave several days of field instruction. Professor W. D. Lowry read a first draft of the report and made helpful suggestions. Professor C. G. Tillman was helpful during the drafting of the geologic map.

TOPOGRAPHY, RELIEF AND DRAINAGE

Three types of topography are represented in the Spruce Run Mountain area. Lands to the north and west of Spruce Run and Buckeye Mountains are characterized by large, rounded hills separated by narrow valleys. Maximum elevations of

these rounded hills are generally between 2100 and 2300 feet. This part of the area is underlain by limestones and dolomites and has strongly developed karst topography and underground drainage. For the most part, this area is pasture and farm land with woodlands interspersed.

A second topographic type is represented by the three mountains: Buckeye Mountain, Spruce Run Mountain and Gap Mountain. The crest lines of Spruce Run and Buckeye Mountains trend N 70° E. These are long, narrow-crested, steep-sided, and thickly-forested mountains with about 800 feet of relief. Gap Mountain, located south of Spruce Run Mountain, parallels the N 70° E trend of Spruce Run and Buckeye Mountains and is topographically identical to them both. Crests on all three mountains are between 2500 and 3200 feet.

The third topographic type is represented by Spruce Run Valley which lies between Spruce Run and Gap Mountains. The topographic profile across this valley shows a broadened "v"-shaped valley with gently rolling topography (see structure sections, Plate 2). The valley is underlain by limestones and dolomites, but karst topography is not extensively developed and surface drainage predominates.

The lowest part of the area is along the New River in the vicinity of Painter School where the elevation is approximately 1600 feet. The crest of Spruce Run Mountain is 3185 feet; thus the maximum relief is 1585 feet.

The Spruce Run Mountain area is drained by the northwest flowing New River. The river is approximately 500 feet wide and meanders greatly, taking 11.7 river miles between two points 7.0 miles apart. There are only six creeks of any importance in the area, and three of these, Walker Creek, Sinking Creek, and Spruce Run, drain most of the land. The New River is a transverse stream and its tributaries, for the most part, are trellis-patterned.

STRATIGRAPHY

GENERAL FEATURES

Rocks exposed in the Spruce Run Mountain area have an aggregate thickness of 6500 feet and range in age from Middle Cambrian to Lower Devonian. All exposed rocks are sedimentary rocks recording dominantly shallow water deposition in marine environments within the Appalachian geosyncline.

In general terms, the rocks fall into four natural sequences: dolomites ranging in age from Middle Cambrian through Lower Ordovician, limestones of Middle Ordovician age, shales of Middle and Upper Ordovician age, and sandstones of Silurian and Lower Devonian age.

The general nature of the stratigraphic succession together with formation names and brief descriptions is shown in Plate 5 (columnar section).

CAMBRIAN SYSTEM

Middle Cambrian Series

Honaker dolomite

Name--The Honaker dolomite was named by Campbell (1897, p. 2) for exposures near Honaker, Russell County, Virginia. Honaker dolomite is the oldest formation exposed in the map-area, underlying the Nolichucky shale. Near Bane, outside of the map-area, the Honaker dolomite overlies the Rome Shale.

Distribution--Honaker dolomite underlies all of Rye Valley between the crests of Guinea Mountain and Rich Hill, southwest of Mountain View. Crumpled and autobrecciated Honaker dolomite is exposed discontinuously along County Road 730 in the center of Rye Valley. The Honaker dolomite crops out on the southeastern slopes of Buckeye and Spruce Run Mountains where it forms the hanging wall of the Saltville fault. Good exposure of well-bedded Honaker is present along the southeastern side of Buckeye Mountain directly across the river from Goodwins Ferry. Honaker dolomite is also well exposed along the railroad tracks south of Goodwins Ferry. The full thickness of the Honaker formation is not present in this strike belt; part is cut out by the Saltville fault. Another good exposure of Honaker dolomite is just outside the map-area along State Route 100, 0.7 miles south of Bane.

Lithology--In the Spruce Run Mountain area the Honaker is entirely dolomite of which there are two chief types. The lower 600 feet of the formation is dark-gray and dark bluish-gray, fine-grained dolomite. This rock is dense, flinty, medium- to thin-bedded and weathers blocky. Along State Route 100 south of Bane, the lower zone of the formation contains four feet of light-gray, clastic dolomite with an estimated 15 per cent 0.25 mm. sand grains, chiefly black chert and quartz. The lower zone contains a few black chert nodules showing relict oolitic structure.

The upper 400 feet of the Honaker dolomite is light-gray and creamy-gray, finely-granular dolomite interbedded with minor amounts of dark-gray dolomite. The creamy-gray, granular dolomite is thick-bedded and featureless except for numerous stylolites of the cone and socket type.

The character of the Honaker dolomite is shown in the following section.

Geologic section 1--Honaker dolomite and Nolichucky shale along State Route 100, 0.2 miles south of Bane, Giles County, Virginia

	Thickness Feet
Nolichucky shale (52 feet)	
9. Shaly limestone, black, thin-bedded, fissile.	52

	Thickness Feet
Honaker dolomite (980 feet)	
8. Dolomite, dark-gray to black, medium- and fine-grained, thick-bedded.	96
7. Dolomite, interbedded dark-gray and light-gray, dense, medium-grained, thick-bedded, relict oolites.	94
6. Dolomite, creamy-gray, very fine-grained, stylolites.	24
5. Dolomite, interbedded bluish-black and creamy-gray, granular	27
4. Dolomite, light creamy-gray, medium-grained, granular	137
3. Dolomite, dark-gray and dark bluish-gray, 4-foot zone 89 feet above base contains 0.25 mm. sand grains.	100
2. Dolomite, black, fine-grained, dense, flinty, a few chert nodules showing relict oolites	497
1. Covered	5
Rome formation	

Near Bane, the upper part of the Honaker dolomite is pure and weathers creamy-white. South of the Saltville fault at Goodwins Ferry the upper part contains silt laminations

and weathers rusty-brown. An estimated 800 feet of Honaker is present at this locality.

Upper Cambrian Series

Nolichucky shale

Name--The Nolichucky shale was proposed by Keith (1897, p. 2). In the Spruce Run Mountain area the Nolichucky shale overlies the Honaker dolomite and underlies the Knox dolomite.

Distribution--On the geologic map (Plate 1), the Nolichucky shale is represented by the contact between the Honaker dolomite and the Knox dolomite. West of the New River the Nolichucky shale is a prominent topographic ridge former, capping Guinea Mountain and Rich Hill on either side of Rye Valley. Good exposure of the Nolichucky shale is along County Road 663 where Big Springs Branch cuts through Rich Hill. South of the Saltville fault the Nolichucky shale is exposed approximately 1.0 miles south of Goodwins Ferry along the Norfolk and Western Railway. The Nolichucky strike belt extends northeast through Spruce Run Valley where it is cut out by the Saltville fault. In this valley the Nolichucky is poorly exposed and has no recognizable topographic expression. The occurrence of the Nolichucky shale in Spruce Run Valley marks the most northeasterly extent of the formation.

Lithology--Unweathered Nolichucky shale is dark-gray to black, thin-bedded, argillaceous limestone. It is fine-grained, flinty-textured and breaks with subconchoidal fracture. Nolichucky shale is nearly everywhere weathered to light-gray and

light grayish-buff limestone. Weathered exposures are a sheaf of plates of shaly limestone. Soil underlain by Nolichucky shale contains abundant platelets of argillaceous limestone.

The Nolichucky shale-Honaker dolomite contact is rarely exposed in natural outcrops but in road cuts the transition from thick-bedded Honaker to thin-bedded Nolichucky is readily apparent. Likewise, the contact of the Nolichucky with the overlying Knox dolomite is easily recognized where exposed because of the change from thin-bedded Nolichucky to medium-bedded Knox dolomite.

Along Rich Hill and Guinea Mountain, in the western part of the Spruce Run Mountain area, the Nolichucky shale is 52 feet thick. South of Goodwins Ferry along the Norfolk and Western Railway, the Nolichucky is approximately 50 feet thick. A few feet of shaly limestone near Newport may represent the northeasternmost exposure of Nolichucky shale in the map-area.

CAMBRIAN AND ORDOVICIAN SYSTEMS

Upper Cambrian and Lower Ordovician Series

Knox dolomite

Name--Knox dolomite was defined by Safford (1869, p.204) for exposures in Knox County, Tennessee. The term Knox is used in this report to comprise the Beekmantown group, Chepultepec limestone and Copper Ridge dolomite of Butts (1940, p. 102 and p. 90). In belts southwest of the Spruce Run Mountain area, the Beekmantown and Copper Ridge are separated by the Chepultepec limestone. A limestone, lithologically similar to the Chepultepec limestone, is present south of the Saltville fault within the map-area, but it has not been found north of the fault.

Distribution--North of the Saltville fault the Knox dolomite forms a broad outcrop belt curving around the Bane anticline. Knox dolomite is well exposed along the Norfolk and Western Railway although the contact with the Nolichucky is not exposed on the western tracks. A few hundred feet of upper Knox dolomite forms the crest of the Clover Hollow anticline but exposure is poor. South of the Saltville fault, the Knox is present in a northeast-trending belt in Spruce Run Valley. Complete exposure exists along the eastern tracks of the Norfolk and Western Railway between overhead pole E-442-S and U. S. G. S. Bench Mark 1674.

Lithology--The majority of the Knox is medium-gray, finely-granular, thick-bedded dolomite, but there are color and texture variations from bed to bed. Besides the most common medium-gray color, there are pink, gray-green, dark-gray, brownish-gray, blue-gray, and gray-white dolomites. Beds of cross-bedded quartzose dolomite, dolomite conglomerate (edgewise-type), and argillaceous, thin-bedded dolomites are also common.

Thin quartzose dolomitic sandstones occur in the lower 1500 feet of the Knox in the Spruce Run Mountain area. All dolomitic sandstones except the lowest are of variable persistence. The lowest sandstone is a cross-bedded, brownish-orange weathering, dolomitic sandstone approximately 13 feet thick and located 50 feet above the Nolichucky shale. In Spruce Run Valley this lowest sandstone is a minor ridge former. Where exposed on the south side of the Bane anticline, the sandstone is chiefly quartz with minor amounts of white, black and red chert. Microcline with overgrowths of secondary microcline constitutes less than one per cent of the sand fraction. Average grain size is between 0.25 and 0.40 mm. and grains are round to subround. Sand constitutes 60 per cent of the rock; the remainder is light-gray and white coarsely granular dolomite. On weathering, the dolomite matrix is removed and the sandstone turns a distinctive rusty-orange.

The sandstone is commonly cross-bedded and may show both current and oscillation ripple marks.

The Knox dolomite is medium- and thick-bedded but within individual beds, there are minute laminations caused by films of silt. They stand out in relief on the weathered surface and may be crinkled, wavy or straight.

Chert is common in the Knox dolomite but abundant only in the upper 500 feet. There are four types of chert: (1) beds and nodules of black chert showing oolitic structure, (2) small, irregular nodules of white chert, (3) beds of white chert up to one foot thick, (4) concentrically banded gray chert in flattened, spherical forms ("pancake chert"). Some of the chert, particularly the white, bedded variety, preserves molds of dolomite crystals on the weathered surface.

The character of the Knox is given in the following section.

Geologic section 2--Knox dolomite along the eastern tracks of the Norfolk and Western Railway, 0.7 miles south of Goodwins Ferry

	Thickness Feet
Five Oaks limestone	
Knox dolomite (2133 feet)	
22. Dolomite, pearly-gray, finely granular,	

		Thickness Feet
	partly laminated, thick-bedded, some black oolitic chert and abundant white chert nodules	495
21.	Limestone, dark-gray and medium-gray, weathers light bluish-gray, very fine-grained, medium- and thick-bedded, stylolites.	16
20.	Dolomite, pearly-gray, chiefly finely granular, blocky weathering, 2 to 8 inch beds of white chert.	152
19.	Dolomite and chert, dolomite is gray, finely laminated, weathers rusty, chert is white and in four one-foot-thick beds	15
18.	Dolomite, pearly-gray, thick-bedded, partly laminated.	415
17.	Dolomite, dark-gray, weathers medium-gray, tan mottlings, some bedded white chert. . . .	30
16.	Dolomite, medium-gray and pearly-gray, thin- to thick-bedded, finely laminated; abundant white chert.	236
15.	Dolomitic sandstone, and dolomite, rusty weathering sandstone interbedded with dark-gray, coarse-grained dolomite	1

		Thickness Feet
14.	Dolomite, dark-gray, very finely granular, thin-bedded, weathers fissile	10
13.	Sandstone, dolomitic, white, weathers orange-brown, cross-bedded, ripple marks	1.5
12.	Dolomite, medium-gray and white weathering, thin- to medium-bedded, laminated	157
11.	Dolomite, medium-gray weathers buff, finely granular, thin-bedded	157
10.	Dolomite, light gray-buff, thick-bedded, laminations, weathers white	65
9.	Dolomite, tan, mottled medium-gray, finely granular, wavy laminations.	70
8.	Dolomite, dark-gray and medium-gray, coarsely granular, irregular seams of oolitic chert. . .	5
7.	Dolomite, light gray-white, finely granular, thick-bedded.	23
6.	Dolomite, dark-gray, interbedded with some light-gray dolomite	193
5.	Dolomite, dark-gray, coarsely granular, masses of black chert.	14
4.	Dolomite, light grayish-tan, medium-grained, laminated	39
3.	Dolomite, dark-gray, weathers buff-orange, thin-bedded	4

	Thickness Feet
2. Dolomite, light-gray and pearly-gray, weathers gray-white, pink mottled	18
1. Dolomite, medium- and pearl-gray, medium-grained, one bed of oolitic chert	17

Nolichucky shale (50 feet)

North of the Saltville fault the Knox dolomite is about 2350 feet thick where all of it is present. Thickness of the Knox dolomite is variable because of the disconformity between the Knox and the overlying Blackford formation.

ORDOVICIAN SYSTEM

Middle Ordovician Series

Blackford formation

Name--The term Blackford was first used by Butts (1940, p. 126-127) for a facies of a limestone he identified as Murfreesboro, but the name was later raised to formation rank by Cooper and Prouty (1943, p. 862-863). In the Spruce Run Mountain area the Blackford formation disconformably overlies the Knox dolomite and underlies the Elway limestone.

Distribution--The general distribution of the Blackford formation is shown on the geologic map (Plate 1). North of the Saltville fault the formation is well exposed along the eastern tracks of the Norfolk and Western 0.5 mile south of Eggleston, along Sinking Creek 0.7 mile southwest of the junction of U. S. Route 460 and Mountain Lake road, and along U.S. Route 460 0.6 mile southeast of Hoges Store. South of the Saltville fault the Blackford is exposed along the eastern tracks of the Norfolk and Western and in Spruce Run Valley approximately 3.0 miles southwest of Newport.

Lithology--The Blackford formation in the Spruce Run Mountain area is composed of two lithologic zones: dolomite with chert sharpstone conglomerate and shaly limestone.

The lowermost zone within the Blackford formation is medium-grained dolomite, chiefly gray but locally pink, gray-green and red. The dolomite weathers tan-gray or buff and

shows a peculiar rounded-but-blocky outcrop that is diagnostic of basal Blackford formation. Locally, the base of the unit is marked by one or more feet of chert and dolomite conglomerate. In the map-area this cobble-sized conglomerate is found only at the base of the formation although stratigraphically higher beds of dolomite may contain chert sharpstone conglomerates. The chert pebbles are black, gray, or white and stand out in relief on the weathered surface.

Overlying the dolomite zone of the Blackford formation is the shaly limestone zone. The zone is composed exclusively of dark dove-gray, thin-bedded, fine-grained limestone that weathers light blue-gray. This zone commonly exhibits fracture cleavage. The shaly limestone zone of the Blackford formation is rarely exposed, even in road cuts.

The Blackford formation reaches maximum development in exposures along the eastern tracks of the Norfolk and Western Railway south of Eggleston. There, the Blackford formation is 200 feet thick and consists of 110 feet of clastic dolomite and chert conglomerate and 90 feet of shaly limestone. On Mountain Lake road near the junction with U. S. Route 460, the Blackford formation is poorly exposed with a maximum possible thickness of 150 feet of which only the lower 35 feet is dolomite. South of the Saltville fault, along the Norfolk and Western railway, the Blackford formation is absent; but along strike to the northeast, in Spruce Run Valley at the divide

between Spruce Run and Greenbrier Branch, the formation is approximately 100 feet thick with a lower zone of chert conglomerate and dolomite that is about 40 feet thick.

Variation in thickness of the Blackford formation and of its lithologic zones is thought to be due to deposition upon an irregular surface (Cooper, 1948, p. 282).

Elway limestone

Name--The Elway limestone was named by Cooper (1945, p. 42) to denote beds separated from the Lincolnshire limestone by the Five Oaks limestone.

Distribution--The general distribution of the Elway limestone is shown on the geologic map (Plate 1). Excellent exposures occur along Mountain Lake road in the vicinity of the bridge over Sinking Creek and along the eastern tracks of the Norfolk and Western south of Eggleston.

Lithology--The Elway is characteristically dark-gray to black, very fine-grained, impure limestone. Silicified Dinorthis holdeni are very abundant in the Elway limestone. Chert is common and where unweathered is black with resinous luster and conchoidal fracture. Though nodules of black chert aligned parallel to bedding surfaces are the most common form of Elway chert, the limestone also contains unique beds of pure chert that are traceable over an entire exposure. This blocky-weathering, bedded chert serves to distinguish the Elway limestone from others that are dark and contain black

chert. Upon weathering, the Elway chert forms a residual deposit which is a minor ridge-former.

In the mapped area the Elway contains several very fine-grained, dark dove-gray calcilutites. The most important of these is near the top of the formation and is separated from the overlying Five Oaks limestone by a few feet of cherty limestone.

For mapping purposes, the lower boundary of the Elway was drawn at the lowermost bedded chert, and the upper boundary was placed at the base of the non-cherty, Five Oaks limestone.

The Elway limestone ranges in thickness from 80 to 130 feet within the Spruce Run Mountain area.

Five Oaks limestone

Name--The Five Oaks limestone was named by Cooper and Prouty (1943, p. 863) for exposures in a quarry near Five Oaks, Tazewell County, Virginia. In the Spruce Run Mountain area the Five Oaks limestone overlies the Elway limestone and underlies the Lincolnshire limestone.

Distribution--North of the Saltville fault, good exposures of the Five Oaks may be seen on the road extending north from Zion Church, along the north side of Sinking Creek in the vicinity of Maybrook, and on the Mountain Lake road south of the bridge over Sinking Creek. Generally, the Five Oaks is deeply

weathered and rarely exposed. In pasture land the formation is commonly represented by a continuous grassy interval without apparent outcrop.

Lithology--The Five Oaks limestone is one of the most distinctive limestones in the Spruce Run Mountain area. It is dark dove-gray calcilutite. The limestone is thick-bedded, weathers chalky-white, breaks with a conchoidal fracture and rings when struck sharply with a hammer. Numerous small blebs of clear calcite are common and diagnostic. Stylolites are well developed in the formation.

Throughout the mapped area the Five Oaks ranges in thickness from 20 to 50 feet. On the Mountain Lake road, it is 35 feet thick, at the New River it is 55 feet thick and contains a chert interbed, and on the road north from Zion Church it is approximately 50 feet thick. South of the Saltville fault, along the Norfolk and Western Railway, 61 feet of Five Oaks limestone overlies the Knox dolomite.

Lincolnshire limestone

Name--The Lincolnshire limestone was named by Cooper and Prouty (1943, p. 863). In the Spruce Run Mountain area it overlies the Five Oaks limestone and underlies the Rockdell limestone.

Distribution--The general distribution of the Lincolnshire limestone is shown on the geologic map (Plate 1). Good exposures of the formation are rare, but there is complete exposure

along the eastern tracks of the Norfolk and Western both north and south of the Saltville fault.

Lithology--The Lincolnshire is essentially a single lithologic zone of dark-gray, medium bedded, medium- to coarse-grained, argillaceous limestone. Black, nodular chert is abundant. Scattered blebs of calcite and coarse detrital grains break along cleavage plains, giving the rock a "spangled" appearance in strong sunlight. The rock weathers bluish-gray and has a rough surface caused by weathered-out crinoid stems and other organic fragments. Weathered Lincolnshire beds are nodular because of the varying response to weathering processes of wavy, irregular and anastomosing seams of shaly limestone. Lincolnshire cert is similar to that of the Elway and upper Rockdell except that little blocky or bedded chert is present in the Lincolnshire. Much of the Lincolnshire emits a fetid odor when broken or pulverized.

In the mapped area the Lincolnshire is a well-defined formation. Its lower boundary is marked by the distinctive Five Oaks lithology and its upper boundary is marked by the brownish-gray, chert-free limestone of the basal Rockdell.

The Lincolnshire limestone is 125 feet thick north of the Saltville fault and 110 feet thick south of the Saltville fault.

Rockdell limestone

Name--The Rockdell limestone was named by Cooper (1945,

p. 137) for use in areas where the equivalent Ward Cove and Peery limestones cannot be differentiated.

Distribution--The distribution of the Rockdell limestone is shown on the geologic map (Plate 1). Good exposures of the formation may be seen along Mountain Lake road south of the bridge over Sinking Creek and in a field north of State Route 42, 1.1 miles west of the junction with U. S. Route 460.

Lithology--North of the Saltville thrust where the Rockdell is recognized, the formation consists of two distinct limestones: a light-gray, coarse-grained calcarenite and a dark-gray, cherty limestone. The coarse-grained portion, from 25 to 50 feet thick, is brownish-gray, coarsely-crystalline calcarenite that weathers medium-gray. Weathered surfaces of the limestone are rough with abundant organic fragments, chiefly crinoids, in relief. The limestone is thick-bedded, contains stylolite seams, and emits a fetid odor when pulverized.

The overlying unit ranges from gray to black to bluish-black and is fine- to medium-grained. It generally contains small nodules of black chert. The formation is medium- to thin-bedded and nodular, weathering bluish-gray.

There is similarity between the upper Rockdell and the overlying Benbolt limestone. During mapping, the uppermost cherty limestone was considered the upper limit of the Rockdell limestone.

The formation shows a marked range in thickness. In cuts

along the eastern tracks of the Norfolk and Western south of Eggleston, the formation is 220 feet thick, whereas near the junction of Mountain Lake road and U. S. Route 460, it is only 125 feet thick. South of the Saltville fault, Rockdell limestone is not recognized.

Benbolt limestone

Name--The Benbolt limestone was named by Cooper and Prouty (1943, p. 861-868). In the Spruce Run Mountain area, the Benbolt overlies the cherty part of the Rockdell limestone and underlies the Gratton limestone.

Distribution--The general distribution of the Benbolt is shown by the geologic map (Plate 1). Excellent exposures of Benbolt limestone are at Haven Hoge farm near Boyd Chapel, on Mountain Lake road near the junction with U. S. Route 460 and on Straley farm on State Route 42, 4.0 miles southwest of Eggleston. In addition, Benbolt limestone is well exposed south of the Saltville fault along the eastern tracks of the Norfolk and Western Railway.

Lithology--The Benbolt limestone is typically dark, nodular limestone similar to the Elway and Lincolnshire but lacking chert. Benbolt limestone is dark-gray to bluish-black, impure, argillaceous and crumbly weathering. The rock varies greatly in grain size from coarsely granular calcarenite to calcilutite. Thick-bedded, light-colored calcarenites are common near the

top of the formation. Typical Benbolt limestone weathers to a rough gray surface that is tan-streaked and upon which fossil sponges, bryozoans and cephalopods etch out in relief.

At the junction of U. S. Route 460 and Mountain Lake road, the upper 70 feet of the Benbolt is light-gray and light brownish-gray, very coarse-grained limestone. This zone extends westward along strike on both sides of the Clover Hollow anticline for a distance of two miles. The most western exposure of this lithology is on the Haven Hoge farm near Boyd Chapel. At this locality the calcarenite is interbedded with typical dark-gray Benbolt limestone. A similar zone is present on the Straley farm approximately four miles southwest of Eggleston. There, the Benbolt is a mixture of coarse organic calcarenite and dove-gray calcilutite.

North of the Saltville fault, the Benbolt ranges in thickness from 250 feet at the Straley farm to 175 feet on Mountain Lake road near the junction with U. S. Route 460. South of the Saltville fault the stratigraphic position of the Benbolt limestone is occupied by the Chatham Hill limestone.

Chatham Hill limestone

Name--The Chatham Hill limestone was named by B.N.Cooper and G. A. Cooper (in Cooper, G. A., 1956, p. 53) for exposures on the northwestern slopes of Walker Mountain near Virginia Highway 16. It is 450 feet thick at the type locality and includes part of the Ward Cove, Peery and Benbolt formations of

Tazewell County. In the Spruce Run Mountain area the Chatham Hill limestone is present south of the Saltville fault. It underlies the Wassum limestone and overlies the Lincolnshire limestone.

Distribution--The Chatham Hill limestone forms a northeast trending strike belt along the northwestern slopes of Gap Mountain in Spruce Run Valley. The only good exposure in this area is in cuts along the Norfolk and Western Railway approximately 1.0 mile south of Goodwins Ferry.

Lithology--The Chatham Hill limestone ranges from black to bluish-black to dark-gray and is medium- to coarse-grained, weathering to a uniform light-gray. The limestone is impure, carbonaceous and emits a fetid odor when pulverized. The rock is thin-bedded and nodular with numerous irregular shale partings. In natural outcrop, the limestone forms a rubble of irregularly shaped nodules. The character of the Chatham Hill limestone is shown in the following section.

Geologic section 3--Middle Ordovician limestones along the Norfolk and Western Railway north of McCoy, Giles County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (48 feet)	
20. Limestone, dark-gray, weathers light-gray,	

		Thickness Feet
	medium- to thin-bedded, medium- to fine-grained, scattered calcarenit lenses	9.4
19.	Limestone, dove- to dark-gray, weathers light-gray, thin-bedded, dense	39.0
Wassum limestone (26 feet)		
18.	Calcarenite, gray, medium-grained, thin-bedded, some fine-grained dove-gray limestone.	24.9
17.	Calcarenite, gray, coarse-grained.	1.0
Chatham Hill limestone (450 feet)		
16.	Limestone, black, weathers buff-gray, fine-grained, thin-bedded and crumbly, highly fossiliferous.	95.0
15.	Limestone, dark bluish-gray, weathers light blue-gray, fine-grained, thin-bedded, argillaceous.	140.2
14.	Covered.	14.8
13.	Limestone, gray-black, weathers dark-gray, medium-grained, shaly, less than one per cent chert.	16.4
12.	Limestone, gray-black, weathers light-gray, coarse-grained	11.9
11.	Limestone, gray-black, weathers light-gray, fine-grained, abundant bedded chert.	50.9

		Thickness Feet
10.	Limestone, black, weathers gray, medium-grained, 3 per cent chert.	81.4
9.	Covered.	39.5
Lincolnshire limestone (100 feet)		
8.	Limestone, black weathers gray; bedded black chert is 20 per cent of the rock	13.3
7.	Limestone, black, weathers medium-gray, chiefly fine-grained, small calcarenite lenses of fossil debris, some nodular black chert	44.2
6.	Limestone, black, weathers medium-gray, mixture of fine- and coarse-grained, thick-bedded, irregular shaly partings	22.2
5.	Calcarenite, brownish-gray; grains average 1.5 mm.; abundant fossil debris.	1.1
4.	Covered.	19.9
Five Oaks limestone (61 feet)		
3.	Calcilutite, dove-gray, weathers gray, stylolites, hematite pseudomorphs after pyrite nodules.	23.1
2.	Calcilutite, dove-gray, weathers buff-gray, thin-bedded and shaly, poorly exposed.	30.8
1.	Calcilutite, light-gray, weathers gray-white, thick-bedded	7.4
Knox dolomite		

The Chatham Hill is 450 thick south of Goodwins Ferry (Geologic section 3, above). The thickness cannot be determined elsewhere in Spruce Run Valley because of insufficient exposure.

Gratton limestone

Name--The Gratton limestone was named by Cooper and Prouty (1943, p. 872-873) from exposures at Gratton, Tazewell County, Virginia. In the Spruce Run Mountain area, the Gratton occurs only north of the Saltville fault. It overlies the Benbolt limestone and underlies the Witten limestone.

Distribution--The distribution of the Gratton limestone is shown on the geologic map (Plate 1). Gratton limestone is well exposed near the intersection of U. S. Route 460 and Mountain Lake road, along the Norfolk and Western Railway near Eggleston and at the Straley farm 4.0 miles southwest of Eggleston.

Lithology--The Gratton is a finely-granular, medium-gray limestone with brownish-overtones. In the map-area its most diagnostic characteristic is cross-bedding 4 to 6 inches thick. The limestone is dense and brittle, weathering to rounded forms showing cross-bedding as wavy laminations.

No overall directional pattern is apparent in the cross bedding of the Gratton limestone, but in an exposure of Gratton in fault contact with the Moccasin formation along U. S.

Route 460 near the junction with Mountain Lake road, B. N. Cooper pointed out a recumbent fold with significant crestal thickening that suggests soft-sediment slumping. If the interpretation is correct, the sense of the slumping would be to the southeast.

North of the Saltville fault and east of the New River, the Gratton limestone is from 20 to 35 feet thick. In the vicinity of the Straley farm, the Gratton is approximately 60 feet thick. Accurate measurement at this locality is difficult because the Witten, Gratton and Benbolt formations tend to lose their lithologic identity. The Gratton is absent south of the Saltville fault and its stratigraphic position is occupied by the Wassum limestone.

Wassum limestone

Name--The Wassum limestone was named by B. N. Cooper and G. A. Cooper (1956, p. 97) for exposures west of Marion, Smyth County, Virginia. It overlies the Chatham Hill limestone and underlies the Bays formation. In the Spruce Run Mountain area the Wassum overlies the Chatham Hill limestone and underlies the Witten limestone.

Distribution--The Wassum limestone is present south of the Saltville fault in Spruce Run Valley. The only complete exposure of Wassum limestone is along the Norfolk and Western Railway approximately 1 mile south of Goodwins Ferry.

Lithology--The Wassum limestone is largely brownish-gray, medium- to coarse-grained calcarenite. Calcarenite is 50 to 80 per cent of the rock and is confined to small lenses, irregular masses and thin beds separated by calcilutite. The mixture of differing textures is the most distinctive aspect of the formation. In natural outcrop the Wassum interval is deeply weathered and the formation crops out in only a few places.

The Wassum is 26 feet thick along the Norfolk and Western Railway south of Goodwins Ferry. Its thickness, extent, and character are not known north of this exposure.

Witten limestone

Name--The Witten limestone was named by Cooper and Prouty (1943, p. 872-873) for exposures near Witten Mill in Tazewell County, Virginia. In the Spruce Run Mountain area, the Witten overlies the Gratton limestone and underlies the Moccasin formation.

Distribution--The geologic map (Plate 1) shows the general distribution of the Witten limestone. Like the Gratton, the Witten crops out extensively in the map-area because it directly underlies the ridge forming Moccasin formation. Among the many good exposures are those at Haven Hoge farm near Boyd Chapel, along U. S. Route 460 near the junction with Mountain Lake road and along the eastern tracks of the Norfolk and Western Railway south of Goodwins Ferry.

Lithology--The Witten limestone is a mixture of distinctive lithologies. Typically, as in the strike belt north of the Saltville fault and east of the New River, it is a mixture of the six persistent zones shown in the following section.

Geologic section 4--Witten and Gratton limestones near junction U.S. Route 460 and Mountain Lake road, Giles County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (100 feet)	
6. Limestone, cream-gray with red specks	3
5. Limestone, dark-gray, fine-grained, dense, flinty-textured	2
4. Limestone, gray- to light-gray, medium- to coarse-grained, some edgewise conglomerate.	16
3. Limestone, dark-gray, fine-grained, dense, tan weathering bands of magnesian limestone	35
2. Limestone, black weathering light-gray, nodular, poorly exposed	46
Gratton limestone (27 feet)	
1. Limestone, dove and brownish-dove-gray, weathers light-gray, fine-grained at base grading up to calcilutite, uniform thin-bedding	27
Benbolt limestone	

The most persistent and distinctive lithology is the upper three feet of cream-gray, red-specked limestone. It has been noted in every outcrop of the upper part of the Witten examined by the writer.

The character of the Witten changes west of the New River and at the Straley farm 4.0 miles southwest of Eggleston, it is light-gray, aphanitic limestone with numerous bryozoa, corals and sponges. The formation is 260 feet thick at this locality. South of the Saltville fault, along the eastern tracks of the Norfolk and Western, the Witten limestone is light- to dark-gray, thin-bedded and very fine-grained with many small lenses of calcarenite. The formation is 75 feet thick at this locality.

Moccasin formation

Name--The Moccasin formation was named by Campbell (1894, p. 2) for exposures along Moccasin Creek, Scott County, Virginia. In the Spruce Run Mountain area the Moccasin overlies the Witten limestone and underlies the Eggleston formation.

Distribution--The Moccasin formation is mapped as a single unit and its distribution is shown on the geologic map (Plate 1). The best exposures are along the eastern tracks of the Norfolk and Western Railway south of Goodwins Ferry, along State Route 42 near Trigg, along County Route 705 near Maybrook and along U. S. Route 460 near the junction with Mountain Lake road.

Lithology--In the Spruce Run Mountain area, as in the Burkes Garden Quadrangle, the Moccasin formation has a persistent three-fold development (Cooper, 1944, p. 93). The three units are mottled red calcilutite, red calcareous mudstone and olive-weathering sandstone.

The basal unit is 5 to 40 feet thick and consists of mottled red, gray, apple-green and tan calcilutite. These beds, referred to as Moccasin marble by Mathews (1934, p. 2), are composed of brittle, flinty-textured rock that breaks with a subconchoidal fracture. The unit is uniformly thin-bedded with beds separated by partings of mud-cracked red shale.

Overlying the marble beds are 43 to 120 feet of dark-red calcareous mudstone. Beds of this unit are complexly folded and faulted with well-developed cleavage. This deformation has obscured but not obliterated the depositional texture, fabric, bedding and structure. Fresh specimens of mudstone show a faint sheen on cleavage planes. Undeformed mudstone is exposed 1.7 miles east of Hoges Store and there the rock is coarser grained, less calcareous and lighter red than in the deformed exposures along the northwest slopes of Spruce Run Mountain. Both exposures of deformed and undeformed red mudstone contain numerous thin-bedded, blue weathering gastropod-bearing limestones as well as buff weathering siltstones. The mudstone unit is a ridge former, particularly where deformed. The appearance of weathered and unweathered mudstone is not significantly different.

The third zone, from 19 to 58 feet thick, consists of interbedded conglomerate, red shale, and gray calcareous sandstone. North of the Saltville fault, there is a persistent four-fold arrangement of lithologies. Lowermost is 2 to 8 feet of calcareous conglomeratic quartzose sandstone. The rock is cross-bedded throughout, and the lower 18 inches is usually a single conglomeratic graded-bed composed of milky quartz with minor amounts of gray, red and black chert cemented by calcite and quartz overgrowths. In thin section, several of the milky quartz grains contain "vermiform chlorite" as described by Rowland (1939, p. 451).

Above the conglomeratic sandstone in the third zone of the Moccasin formation is 3 to 10 feet of cuneiform-jointed red shale containing waxy-yellow metabentonites. Overlying the red shale is 5 to 18 feet of gray, fine-grained calcareous sandstone that weathers olive. The sandstone is medium-bedded and contains isolated grains of clear quartz up to 1 mm. in diameter. The calcareous sandstone unit grades into the uppermost unit of the zone composed of interbedded red mudstone, olive fine-grained sandstone and greenish-gray limestone. This unit, as a whole, is thin-bedded and cuneiform-jointed.

Thickness of the Moccasin formation and its divisions is shown on Plate 3 (Lithologic units of the Moccasin formation, Spruce Run Mountain area, Giles County, Virginia) and in the measured sections (Appendix).

Eggleston formation

Name--The Eggleston formation was named by Mathews (1934, p. 11) for exposures along County Road 605 across the river from Eggleston, Giles County, Virginia. When Mathews defined the formation, the best section of the Eggleston was exposed near Narrows in western Giles County. As the name Narrows was already in use, Mathews specified the Eggleston exposures as the type locality and the Narrows exposures as the type section. However, a section superior to the Narrows section was exposed by blasting during August, 1959 along County Road 605 across the river from Eggleston. The writer recommends that this section be designated both type locality and type section.

Distribution--North of the Saltville fault, the Eggleston formation extends along the northwest slope of Spruce Run and Buckeye Mountains. Good exposures are along U. S. Route 460 0.4 mile south of the junction with Mountain Lake road, on State Route 42 near Trigg and at the type locality on County Road 605 across the river from Eggleston. South of the Saltville fault, the formation forms a northeast-trending strike belt along the northwest slope of Gap Mountain. In this strike belt the Eggleston formation is well exposed along the eastern tracks of the Norfolk and Western 800 yards south of U. S. G. S. Bench Mark 1674.

Lithology--The Eggleston formation is chiefly gray and olive calcareous shales and shaly limestones that weather buff or light grayish-green. Calcareous shale, dark-gray in fresh exposure, is almost everywhere weathered to light-olive. Weathering may extend several inches into relatively fresh exposures. Thin-bedded limestone, which makes up a small portion of the formation, is brown, gray-green or olive and very finely crystalline. Buff siltstone beds and fine-grained sandstones are common but seldom more than one inch thick.

The characteristic feature of the Eggleston is siltstone and silicified limestone that displays rhombic or cuneiform-jointing. In some exposures, metabentonites are present near the base of a cuneiform-jointed unit. A number of cuneiform-jointed beds are present in the type section.

Geologic section 5--Eggleston formation along County Road 605, 75 feet above the eastern tracks of the Norfolk and Western near Eggleston, Giles County, Virginia

	Thickness Feet
Martinsburg formation	
8. Limestone and shale, 4- to 6-inch beds regularly interbedded, shale is black, limestone is dark-gray, calcarenitic, generally in graded-beds	

		Thickness Feet
Eggleston formation (106 feet)		
7.	Shale, gray-green, weathers buff, thin-bedded, upper contact is sharp.	18.0
6.	Shale, olive, weathers buff, large scale cuneiform-jointed.	29.0
5.	Shale, olive, weathers buff, pencil cleavage with superimposed rhombic-jointing.	3.5
4.	Limestone, dark-gray, argillaceous, cuneiform-jointed	1.0
3.	Shale, calcareous, black, weathers olive, thin-bedded with a few 1-inch limestone beds	22.5
2.	Shale and sandstone, thin beds of buff, fine-grained sandstone interbedded with olive shales, well developed cuneiform-jointing	5.0
1.	Limestone, argillaceous, gray-olive, weathers light-olive or buff, thin-bedded.	27.0
Moccasin formation		

Cuneiform joint blocks maintain their form in soil derived from the Eggleston formation and differentiate it from "Martinsburg type" soil.

The contact of the Eggleston formation with the overlying Martinsburg formation is sharply defined by the appearance of dark-gray, coarse-grained limestone with abundant

brachiopods. However, the contact of the Eggleston with the underlying Moccasin formation is gradational. During mapping, the contact was drawn at the last red mudstone underlying Eggleston lithology. For most sections, this includes several feet of Eggleston lithology within the Moccasin formation.

The Eggleston formation is 106 feet thick at the type locality near Eggleston. The section near Trigg appears to be thicker but structural complication precludes measurement. South of the Saltville fault the Eggleston is approximately 30 feet thick.

Middle and Upper Ordovician Series

Martinsburg formation

Name--The Martinsburg formation was named by Geiger and Keith (1891, p. 156-163) for exposures near Martinsburg, West Virginia. In the Spruce Run Mountain area the Martinsburg overlies the Eggleston formation and underlies the Juniata formation.

Distribution--The Martinsburg formation forms two broad, subparallel strike belts, one on the northwest side of Spruce Run Mountain continuing on Buckeye Mountain and a second on the Northwest slope of Gap Mountain. Overturned and faulted Martinsburg beds are present on the southeastern slopes of both Buckeye and Spruce Run Mountains, but they are rarely exposed. The Martinsburg formation is not completely exposed anywhere in the map-area but several hundred feet of basal Martinsburg are exposed along County Road 605 across the river from Eggleston, and a few tens of feet of uppermost Martinsburg are exposed on the southwestern end of Buckeye Mountain.

Lithology--Where exposed across the river from Eggleston, the Martinsburg formation consists of regularly interbedded 4- to 6-inch beds of dark-gray, coarse-grained limestone and black, pyritiferous shale. The thin-bedded limestone is chiefly coarse organic calcarenite and commonly shows graded-bedding. Lower contacts of calcarenite beds are clear and sharp whereas upper contacts are gradational. The shale beds are uniformly black

and may show fracture cleavage.

Where exposed on Buckeye Mountain, the upper Martinsburg consists of brown, thin-bedded sandstone and siltstone. A persistent fossil horizon, the Orthorhynchula zone, caps the mountain at this locality.

Although the Martinsburg formation rarely crops out, it is one of the most easily recognized units in the map-area because of its distinctive soil. Martinsburg soil is yellow-brown, well granulated, clayey and contains numerous platelets of shale.

The Martinsburg formation has responded to deforming forces as an incompetent unit and good exposures commonly show close folding, usually of the chevron-type. For this reason, only approximate thicknesses may be determined. The Martinsburg formation is estimated to be 1200 feet thick both north and south of the Saltville fault.

Juniata formation

Name--Darton named the Juniata formation for exposures along the Juniata River in Pennsylvania (Darton, 1896, p. 2). In the Spruce Run Mountain area the Juniata formation overlies the Martinsburg formation and underlies the Clinch sandstone.

Distribution--The distribution of the Juniata formation is shown on the geologic map (Plate 1). Good exposure of the formation in the map-area is unknown. A few outcrops are

present at the western end of Spruce Run Mountain and approximately 100 feet of Juniata cap the highest point on the south end of Buckeye Mountain.

Lithology--The Juniata formation is chiefly thin-bedded, finely-laminated red siltstone and fine sandstone. Beds of brown siltstone and several feet of pinkish-gray sandstone appear near the Juniata-Clinch contact at the southern end of Spruce Run Mountain but are not present on Buckeye Mountain.

The writer was unable to find a complete section of Juniata to measure within the map-area. At the narrows of the New River near Narrows, Virginia, the Juniata formation is 175 feet thick (Butts, 1940, p. 228). Krinitzsky (1947, p. 109), working at the southern end of Spruce Run Mountain, suggests a thickness of 89 feet. Krinitzsky's measurement may have been made on the overturned limb of a tight syncline and if so, is inaccurate because of minor faulting. More than 100 feet of Juniata formation is present on the southern end of Buckeye Mountain, but an undetermined amount has been eroded from the top of the formation. The Juniata formation is probably between 100 and 175 feet thick in the Spruce Run Mountain area.

SILURIAN SYSTEM

Lower Silurian Series

Clinch sandstone

Name--The Clinch sandstone was named by Safford (1856, p. 157). In the Spruce Run Mountain area, it overlies the Juniata formation and underlies the Rose Hill formation.

Distribution--The Clinch sandstone crops out in cliffs 10 to 50 feet high near the crest of the three mountains in the map-area. The base of the formation is usually obscured by large blocks that have fallen from the cliffs but complete sections are present along the New River on Spruce Run, Buckeye and Gap Mountains.

Lithology--The Clinch is entirely quartzose sandstone and conglomeratic quartzose sandstone. On fresh surfaces it is white, light-gray or light-buff and weathers light-tan. For the most part, the Clinch is medium- to thick-bedded and, with the exception of a conglomeratic zone 9 feet above the base, it is medium- to coarse-grained. Cross-bedding, ripple marks and Scolithus structures are common. Because it is nearly pure quartz, the Clinch is one of the most resistant formations in the southern Appalachians.

On Spruce Run and Buckeye Mountains, the Clinch sandstone is 120 feet thick. South of the Saltville fault, on Gap Mountain, the formation is 60 to 95 feet thick.

Middle Silurian Series

Rose Hill formation

Name--The Rose Hill formation was named by C. K. Swartz (1923, p. 27-28). In the Spruce Run Mountain area, it overlies the Clinch sandstone and underlies the Keefer sandstone.

Distribution--The Rose Hill formation forms the crests of Spruce Run and Buckeye Mountains, but only the resistant sandstones are exposed. Complete exposure of the formation is in cuts where the Norfolk and Western Railway crosses the Giles-Montgomery county line.

Lithology--The Rose Hill formation is chiefly shales and mudstones. The rocks range in color through maroon, red, brown, gray, green, and buff and are thin-bedded and soft. Intercalated with the shales and mudstones are thin, gray and maroon hematitic sandstones. Two of these sandstones attain significant thickness: the lowest is 7-feet thick and 66 feet above the base of the formation; the highest is 5- to 7-feet thick and 90 feet above the base of the formation. Both are medium-grained quartzose sandstones uniformly maroon colored. Quartz grains constitute 70 per cent of the rock; the remainder is hematite and clay. The sandstones are thin-bedded, flaggy, structureless and break with subconchoidal fracture. This rock, which caps the crest of Spruce Run Mountain, is the most resistant to weathering of all the lithologies in the map-area. Slabby, angular, hematitic sandstone float litters

the slopes of Spruce Run and Buckeye Mountains.

The Rose Hill formation ranges in thickness from 240 to 270 feet.

Keefer sandstone

Name--The Keefer sandstone was defined by Butts (1918, p. 536) although the name was used earlier by Ulrich (1911, p. 522). In the Spruce Run Mountain area the Keefer sandstone overlies the Rose Hill formation and underlies the Rocky Gap sandstone.

Distribution--Keefer sandstone forms a narrow strike belt on the southeastern side of Spruce Run Mountain. It also crops out southeast of the crest of Gap Mountain in Montgomery County. Good outcrops of Keefer are in forest land on Spruce Run Mountain, a few hundred yards northwest of the first farm house on County Road 606.

Lithology--The Keefer sandstone is light-gray, pure quartzose sandstone. It is fine- to medium-grained, medium- to thick-bedded and weathers pale buff-yellow or white. Large scale cross-bedding and Scolithus structures are common features. Keefer sandstone closely resembles Clinch sandstone but is generally finer grained and lacks the conglomeratic sandstones found in the Clinch.

The formation is estimated to be 150 feet thick in the Spruce Run Mountain area.

DEVONIAN SYSTEM

Lower Devonian Series

Rocky Gap sandstone

Name--The Rocky Gap sandstone was named by Swartz (1929, p. 80) for exposures at Rocky Gap, Bland County, Virginia. In the Spruce Run Mountain area, the sandstone probably overlies the Keefer sandstone as the intervening Tonoloway limestone appears to be absent. Rocky Gap sandstone is the youngest formation in the map-area.

Distribution--The Rocky Gap sandstone crops out south of the crest of Spruce Run Mountain in forest land a few hundred yards northwest of the first farmhouse on County Road 606. These are the only exposures seen by the writer.

Lithology--No completely unweathered Rocky Gap sandstone was found during the study of the Spruce Run Mountain area. According to Cooper (1944, p. 127) unweathered Rocky Gap is steel-gray sandstone with calcium carbonate cement. In the map-area the formation is typically buff colored, brown weathering, medium- and coarse-grained sandstone. Most is friable. Ripple marks, fine laminations and minute cross-bedding are common features of the thin-bedded sandstone. Weathered surfaces are commonly stained pink or red and crusted with iron and manganese oxides. Several scattered outcrops of the Rocky Gap sandstone are composed of extremely well sorted sandstone in which the grains are approximately 0.5 mm. in diameter, well

rounded, highly spherical with frosted surfaces.

Although Rocky Gap sandstone crops out in few places, it may be recognized by the light red-brown sandy soil which it forms.

The formation is estimated to be 65 feet thick.

STRUCTURAL GEOLOGY

GENERAL FEATURES

The Spruce Run Mountain area is within the Appalachian Valley and Ridge Province, a northeast trending belt of folded Paleozoic sedimentary rocks. North of Roanoke, Virginia, the folded Appalachians are characterized by large, open folds whereas south of Roanoke, the folds are tighter and commonly broken by thrust faults. The Spruce Run Mountain area is in the folded and faulted region of the Appalachians. There are three major folds and one major fault in the map-area.

Portions of the Spruce Run Mountain area were mapped by Hobbs (1953) and Shanholz (1955).

FOLDS

Spruce Run Mountain syncline

The tightest major fold in the map-area is the Spruce Run Mountain syncline. The Spruce Run Mountain syncline extends most of the length of the map-area, and its trough parallels the crest of Spruce Run and Buckeye Mountains.

The geometry of the Spruce Run Mountain syncline is poorly known because the northwestern and southeastern limbs are complicated by close folding and reverse faulting. Probably the southeastern limb is overturned beneath the Saltville fault. Evidence for this is (1) crumpled, overturned Martinsburg shale, Moccasin mudstone and Middle Ordovician limestones

in fault slices associated with the Saltville fault, (2) dip of cleavage in various Ordovician formations. If cleavage in the Middle Ordovician limestones, Moccasin formation, Eggleston formation and Marthsburg formation parallels the axial surface of the major syncline, the axial surface dips approximately 50° southeast. This dip strongly suggests that the southeastern limb of the fold is overturned.

The Spruce Run Mountain syncline is a doubly plunging syncline, plunging southwest on Spruce Run Mountain and northeast on Buckeye Mountain. The structural low of the syncline is at the northeast end of Buckeye Mountain.

Bane anticline

An anticlinal fold in the northwestern part of the map-area is called the Bane anticline for exposures of the structural crest near Bane on State Route 100. Rome formation is the oldest unit exposed in the fold, but Rome exposures do not extend into the Spruce Run Mountain area. The general nature of the anticline may be seen from scattered outcrops along County Road 622. The best topographic expression of the fold is in the vicinity of Rye Valley where prominent ridges are formed of Nolichucky shale.

In the vicinity of Rye Valley the axial trace of the fold trends N 55° E from the western margin of the area to Mountain View. The axis roughly parallels County Road 623.

Between Mountain View and Hoges Store, the axial trace curves north and leaves the map-area in the vicinity of Doe Creek.

The fold plunges approximately 15° northeast. The extent of Knox dolomite along the axial trace is greatly increased by gentle cross folding and probably by minor faulting. Shaly dolomites of the Honaker are commonly crumpled and autobrecciated along the axial trace in Rye Valley.

Clover Hollow anticline

The Clover Hollow anticline is located in the northeastern part of the map-area. The southwestern end of the fold near Zion Church and approximately 5 miles of the axial trace are shown on the geologic map (Plate 1). County Roads 604 and 685 cross at right angles to the axis and provide an excellent view of the fold.

The Clover Hollow anticline trends approximately N 60° E. Dips on the limbs range from 20° to 35° and are slightly steeper on the northwest flank. The anticline is slightly asymmetric with an axial surface dipping southeast at a steep angle.

Isoclinal folds northwest of Spruce Run Mountain

On the northwest slope of Spruce Run Mountain, between Zion Church and the junction of Mountain Lake road with U. S. Route 460, is an area of tight, northeast trending isoclinal folds that involve the Benbolt, Gratton, Witten, Moccasin and

Eggleston formations (Plate 2, sections A-A', B-B'). This closely folded area is approximately 5 miles long and three-quarters of a mile wide.

Most simply, the belt is a syncline overturned on the southeastern limb. The syncline is bordered on the northwest by the Clover Hollow anticline and on the southeast by an isoclinal anticline. The northwestern limb of this anticline forms the southeastern limb of the isoclinal syncline. The complete anticlinal fold is present southwest of the junction of U. S. Route 460 and State Route 730, but to the northeast along strike, the southeastern limb is thrust over the northwestern limb, obscuring the anticline and partly covering the syncline.

The structure, as outlined above and as shown on the structure cross sections (Plate 2, sections A-A', B-B'), is not readily apparent in the field. Minor folds, faults and cleavage obscure the general structure. An example of these complexities is shown in Plate 4, a detailed structure cross section of the Moccasin formation along U. S. Route 460 near the junction with Mountain Lake road. Exposures near County Road 705 at Maybrook are another example of this intense, small scale folding and faulting. Small scale folds in the Moccasin and Eggleston formations usually show cleavage approximately parallel to the axial surface of the fold. Such cleavage is probably the result of flowage and shear folding in incompetent beds.

Folding in this isoclinal belt is of the similar type. Small folds show significant thickening and extension in the crestal portions. Crestal thickening probably occurs in the large isoclinal folds.

FAULTS

Saltville thrust

The Saltville thrust, one of the major thrust faults of the southern Appalachians, crosses the Spruce Run Mountain area. This thrust extends from northern Georgia to Craig County, Virginia. In the Spruce Run Mountain area, the Saltville thrust intervenes between the Spruce Run Mountain syncline on the northwest and the southeast dipping formations of Gap Mountain on the southeast.

In the map-area the fault trends approximately N 60° E and parallels the crests of Spruce Run and Buckeye Mountains. At Goodwins Ferry the Saltville thrust dips roughly 50° southeast and separates Martinsburg shale or overturned Middle Ordovician limestone on the northwest from Honaker dolomite on the southeast. The stratigraphic separation is from 4000 to 5000 feet.

Northeast of Goodwins Ferry the Honaker dolomite is in fault contact with formations ranging in age from Early Ordovician to Early Devonian. This is caused by minor reverse faulting within the footwall block.

The fault surface is rarely exposed, but at the northeastern end of Buckeye Mountain, in cuts along the Norfolk and Western Railway, a clay gouge several inches thick separates Martinsburg shale from Honaker dolomite. Across the

river, at Goodwins Ferry, the fault surface is exposed near the mouth of New River Cave. There the fault zone is six inches thick and composed of brown travertine. Elsewhere, at scattered localities on the southeast slope of Spruce Run and Buckeye Mountains, the fault trace underlies an orange, clayey soil containing black nodules of manganese oxide.

The rocks south of the Saltville thrust dip steeply to the southeast. As the Saltville thrust is traced northeast along strike, it dies out in an anticline near Newcastle, Craig County (Butts, 1934). In the Spruce Run Mountain area the southeast dipping beds south of the Saltville thrust probably represent the southeastern limb of this anticline faulted over the concealed northwestern limb.

GEOMORPHOLOGY

GENERAL FEATURES

The Spruce Run Mountain area is located in the Valley and Ridge Physiographic Province, an area characterized by long, narrow ridges separated by parallel valleys. Subsequent streams, arranged in trellis pattern, flow through the valleys. Ridges and valleys generally parallel strike and topography correlates closely with the structure and litholog of the bedrock.

In the Spruce Run Mountain area the land south and east of a line through Hoges Store, Zion Church and Green Valley is typical valley and ridge topography. North and west of the line is an area characterized by rolling topography and dendritic drainage. This part of the map-area is underlain by gently dipping carbonate rocks.

TOPOGRAPHIC EXPRESSION OF STRUCTURE

Syncline

The crests of Spruce Run and Buckeye Mountain coincide approximately with the trough of the Spruce Run Mountain syncline. Silurian sandstones are the ridge forming rocks.

Anticlines

The shapes of the Bane anticline and the Clover Hollow anticline are reflected in the topography. In the case of the Bane anticline, resistant beds of Nolichucky shale form

a horseshoe-shaped ridge surrounding Rye Valley. This ridge, (Rich Hill and Guinea Mountain) accurately reflects the shape of the anticline within the map-area. On the Clover Hollow anticline the chert-bearing Elway limestone forms rounded, dome-shaped hills arranged around the exposed core of Knox dolomite.

Saltville fault

No characteristic topography is generally associated with the Saltville fault. Locally however, on the southeastern slopes of Spruce Run and Buckeye Mountains, the trace of the fault coincides with a nearly horizontal break in slope 10 to 50 feet wide. This break in slope is not a continuous feature and cannot be recognized on aerial photographs or topographic maps.

RESISTANCE OF LITHOLOGIES

Hematitic sandstones of the Rose Hill formation form the highest elevations on Spruce Run Mountain and are the most resistant rocks in the map-area. Clinch sandstone is nearly equal to the Rose Hill sandstones in resistance to weathering, forming bold cliffs beneath the crests of Spruce Run and Buckeye Mountains. While the Rose Hill and Clinch formations are more resistant than other formations in the map-area, other formations form recognizable topographic prominences. The Eggleston and Moccasin formations form a

series of low, rounded hills that parallel the mountains. Likewise, the Nolichucky shale and sandstone low in the Knox form low ridges, particularly around the Bane anticline. Locally, very cherty horizons such as the Elway limestone and upper Knox dolomite weather to a lag deposit of chert which forms low, dome-shaped hills.

DRAINAGE

The Spruce Run Mountain area is drained by the New River, a northwest flowing, transverse stream that is part of the Ohio River watershed. Within the map-area, the New River is an entrenched, meandering stream.

The four major tributary streams in the map-area (Doe Creek, Sinking Creek, Walker Creek and Spruce Run) provide most of the surface drainage. Permanent and temporary streams, which head in the mountain heights, are common but usually sink after flowing across the Moccasin formation. Much drainage is underground.

In Spruce Run and Sinking Creek Valleys, the streams are subsequent and arranged in a trellis pattern. Northwest of Zion Church, in an area of gently dipping carbonate rocks, the streams are consequent and arranged in dendritic patterns.

DEGRADATION PROCESSES

Chemical weathering, resulting in soil formation, is the fundamental degradational process affecting the Spruce Run

Mountain area. Residual soils of Cambrian and Lower Ordovician dolomites are gray-brown or orange-brown clay-loams. Middle Ordovician limestones form brown clay-loams, and as a rule, the purer the limestone, the more clayey the soil. Moccasin, Eggleston and Martinsburg shales form yellow-brown, very clayey soils containing chips of the source rock. Silurian and Devonian sandstones form red, brown, gray, and yellow sandy soils deficient in clay.

Excluding stream erosion, the second most important degradational process in the Spruce Run Mountain area is downslope movement of colluvium. The colluvium is derived from the ridge-forming sandstones. Colluvium chokes small valleys and caps spurs extending from the mountains. The greatest dimension of transported blocks ranges from a few inches to six feet or more and size decreases with increasing distance from the source. As the lobate "stream" of colluvium creeps down the slope, larger blocks disintegrate to sand and eventually a soil profile forms on the surface of the mass. Blocks of sandstone that have been transported in this manner are usually crusted with small, water-clear quartz crystals.

GEOLOGIC HISTORY

SEDIMENTATION

The oldest formation exposed in the Spruce Run Mountain area is the Honaker dolomite of Middle Cambrian age. Within the map-area the Honaker dolomite, the overlying Nolichucky formation and the still younger Knox dolomite are a sequence of similar lithologies representing similar conditions of deposition during Middle Cambrian, Late Cambrian and Early Ordovician time. The rocks formed during this long interval of time were originally limestones, deposited in a shallow sea in which currents swept the depositional sites, reworking and transporting sediment. After deposition, alteration to dolomite obliterated original textures but left depositional fabrics intact.

At the close of Early Ordovician time, the area was exposed (at least partly), and the Lower-Middle Ordovician time resulted in erosion of an unknown thickness of Knox dolomite in some areas and, locally, deposition of the dolomite and chert conglomerates of the lower part of the Blackford formation.

Resubmergence of the area in Middle Ordovician time brought a return of calcium carbonate deposition but this time, without dolomitization. Limestone formation persisted during much of the early Middle Ordovician and is represented by the upper part of the Blackford and all of the Elway, Five

Oaks, Lincolnshire, Rockdell, Benbolt, Gratton, and Witten formations.

The complex lithofacies of the Middle Ordovician limestones suggest deposition in normally saline waters with some local relief on the bottom. Traditionally, shallow water deposition is suggested by the abundant calcarenites, edgewise conglomerates and cross-bedding of many Middle Ordovician limestones while deeper or restricted environments are suggested by the carbonaceous, fetid, pyritiferous, and silicified portions of the Elway, Lincolnshire, Rockdell, and Chatham Hill limestones. Unfortunately, this traditional interpretation of lithologies is based on incomplete knowledge of the many processes of limestone deposition. Probably, a complex of microenvironments existed within the widespread conditions of limestone formation that occurred during much of Middle Ordovician time.

There is a notable thickness difference between the Middle Ordovician limestones north of the Saltville fault (about 1200 feet) and those south of the Saltville fault (about 600 feet). The thickness difference might be the result of relief on the Lower-Middle Ordovician disconformity, but some workers have suggested that the difference was caused by differential subsidence (Cooper, 1960) or by gentle folding during sedimentation (Lowry, 1956, p. 645).

In the Spruce Run Mountain area, deposition of the red

Moccasin mudstone began in the Trenton part of Middle Ordovician time. The advent of mudstone marks the end of pure limestone formation in the map-area. Succeeding deposits were dominantly detrital and broadly viewed, were increasingly coarse-grained.

The Moccasin mudstone was deposited in a shallow, probably intertidal, marine environment. Abundant polygonal mud cracks suggest that the depositional site was frequently exposed to the atmosphere. At other times, fluctuation of the detrital source permitted depostion of thin limestone beds.

The upper Moccasin formation contains several calcareous conglomeratic sandstones interbedded with metabentonites and bentonitic shales. Similar bentonites and sandstones are included in the overlying Eggleston formation. The bentonites probably resulted from the alteration of volcanic ash under marine conditions. Devitrification of the volcanic ash may have caused silicification of the Eggleston formation.

During Late Ordovician, the Martinsburg formation was deposited above the Eggleston formation. The dark-gray, carbonaceous, pyritiferous shale was probably deposited in an euxenic environment.

The Martinsburg formation was succeeded by the Juniata formation. This red, fine-grained and finely-laminated sandstone may have been deposited in very shallow, near-shore conditions.

The Juniata is succeeded by approximately 350 feet of Silurian and Devonian sandstones and shale. There are three major sandstones (Clinch, Keefer, and Rocky Gap) all of which are cross-bedded and ripple-marked. The sandstones were deposited in a marine, near-shore environment. Beds of upper Silurian and Early Lower Devonian age are absent in the map-area. Possibly the Silurian sandstones and shales reflect distant diatrophism which later caused non-deposition during Late Silurian and part of Lower Devonian time.

DEFORMATION

On the basis of local evidence, it is impossible to date the deformation of the Spruce Run Mountain area because beds younger than Lower Devonian are absent. The faulting is certainly post-Lower Devonian because Rocky Gap is the youngest formation in the footwall of the Saltville fault. At Berton, within the map-area, Recent (?) alluvial deposits cover the trace of the Saltville fault.

Neither can the date of folding be fixed. Rocky Gap sandstone is the youngest formation folded in the Spruce Run Mountain syncline. Cooper (1960, p. 8) has presented evidence that suggests folding commenced early in the Paleozoic Era.

This study uncovered no evidence bearing on the chronology of post-Paleozoic events or on the physiographic history of the Spruce Run Mountain area.

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APPENDIX

Geologic section 6 - Moccasin Formation along U.S.460 approximately one-quarter mile east of junction with Mountain Lake road, Giles County, Virginia

	Thickness Feet
Eggleston formation	
8. Siltstone, buff-olive, cuneiform weathering . . .	2.0
Moccasin formation (133.2 feet)	
7. Mudstone and sandstone; mudstone is dusky-red; sandstone is gray, weathering buff-olive; a few thin beds of greenish limestone	24.6
6. Sandstone, probably gray, weathers olive-buff calcareous, thin-bedded	7.6
5. Shale, dusky-red, cuneiform-jointed	3.0
4. Sandstone, quartzose, gray, weathers buff, calcareous, cross-bedded, conglomeratic at base grading upward to fine-grained.	5.6
3. Mudstone, red with thin pink and red calcilutites, mud cracks	29.0
2. Mudstone, red, calcareous	48.0
1. Limestone, mottled red, green, and gray; lower part is shaly	15.4
Witten limestone	

Geologic section 7 - Moccasin Formation near County Road 705, Maybrook, Giles County, Virginia

		Thickness Feet
Martinsburg formation		
Moccasin formation (193.9 feet)		
18.	Siltstone and shale, red, calcareous, thin-bedded.	8.0
17.	Sandstone, olive, weathers buff, fine-grained . .	2.0
16.	Siltstone, red.	4.0
15.	Sandstone, buff weathering, fine-grained.	1.0
14.	Shale, olive-green, weathers buff-gray.	3.8
13.	Limestone, gray-green, impure	3.0
12.	Mudstone, red	4.8
11.	Sandstone, olive, weathers buff, medium- to fine-grained, thin-bedded.	1.9
10.	Mudstone, red	3.8
9.	Sandstone, olive, weathers buff, fine-grained . .	2.5
8.	Mudstone, red, shaly.	3.5
7.	Sandstone, olive, weathers buff, silty and fine-grained	5.0
6.	Shale, red, fissile	10.5
5.	Sandstone, olive, weathers buff, silty, punky weathering.	3.8

		Thickness Feet
4.	Sandstone, gray, chiefly coarse-grained, quartz in calcite matrix	0.5
3.	Mudstone, red, calcareous, 4- to 6-inch calcilutite beds that weather pink or gray	119.0
2.	Limestone, dark-red, weathers pinkish-gray, "birdseye textured", thin- to medium-bedded	8.0
1.	Limestone, pinkish-gray, irregular silt zones one-quarter inch thick.	8.8

Witten limestone

Geologic section 8 - Sandstones in the Moccasin Formation along County Road 605 one-half mile north of Goodwins Ferry, Giles County, Virginia

Eggleston formation

Moccasin formation (total thickness unknown)

14.	Limestone, green, thin- and medium-bedded, some red mudstone.	22.7
13.	Metabentonite, waxy-yellow-green.	0.2
12.	Limestone, blue-green, some red mudstone and olive weathering sandstone.	13.0
11.	Sandstone, tan, punky-weathering, fine-grained, thick-bedded.	5.5
10.	Metabentonite, waxy-yellow-green.	0.2
9.	Sandstone, olive weathering, fine-grained	3.7

		Thickness Feet
8.	Sandstone, light-gray-green, medium- to coarse-grained, scattered granules	0.8
7.	Sandstone, olive, fine-grained, silty	2.3
6.	Conglomeratic sandstone, white, quartzose, calcite matrix, crude graded-bedding	1.5
5.	Mudstone, red, calcite blebs	7.4
4.	Calcilutite, gray-green	1.2
3.	Mudstone, red	4.5
2.	Limestone, mottled green, gray and red, finely-granular	3.8
1.	Mudstone, red 1- to 3-inch limestone layers, mud cracks	10.1

Geologic section 9 - Moccasin Formation along the Norfolk and Western Railway north of McCoy, Virginia

Martinsburg formation

Moccasin formation (67.2 feet)

14.	Siltstone and shale, red and olive, thin-bedded	1.0
13.	Sandstone, gray, weathers buff-olive, fine-grained, calcareous	0.3
12.	Siltstone and shale, red and olive, thin-bedded	3.8
11.	Sandstone, gray, weathers buff-olive, fine-grained, calcareous	0.8
10.	Siltstone and shale, red and olive, thin-bedded	2.1

		Thickness Feet
9.	Sandstone, gray, weathers buff-olive, fine-grained, calcareous	1.0
8.	Siltstone and shale, red and olive, thin-bedded	3.0
7.	Sandstone, gray, weathers buff-olive, fine-grained, calcareous	0.7
6.	Siltstone and shale, red and olive, thin-bedded	5.5
5.	Sandstone, gray, weathers buff-olive, fine-grained, calcareous	0.5
4.	Siltstone, red and olive, thin-bedded	0.3
3.	Covered	17.0
2.	Mudstone, dark-red, calcareous, some calcite blebs, shows cleavage	26.0
1.	Limestone, cream-brown, gray and red, fine-grained, thin-bedded.	5.2

Witten limestone

Geologic section 10 - Moccasin Formation on Chapman Hoge Farm near Hoges Store, Virginia

Martinsburg formation

Moccasin formation (169.0 feet)

10.	**Siltstone, olive, weathers buff, thin-bedded, calcareous at top, poorly exposed**	23.7
9.	**Sandstone, gray, weathers buff, medium-grained, calcite matrix, scattered black chert granules (less than one per cent).**	2.0

		Thickness Feet
8.	Covered, scattered outcrop shows calcareous mudstone, red, thin- to medium-bedded	51.8
7.	Calcilutite, gray-black, weathers dark blue-gray, abundant gastropods, bryozoa.	0.5
6.	Limestone, cream-brown, weathers buff, shaly, mud cracks, resistant unit.	1.0
5.	Mudstone, olive, weathers buff.	5.2
4.	Mudstone, red, thin dove-gray and pink calcilutite beds, abundant oscillation and interference ripple marks, mud cracks, crests of ripples trend N 76° E	19.8
3.	Mudstone, olive, weathers buff, thin-bedded, interference ripple marks, resistant unit.	1.0
2.	Mudstone, red, crumbly, poorly exposed.	46.5
1.	Calcilutite, red, brown and green mottled, weathers gray, thin-bedded, poorly exposed.	17.5

Witten limestone

Geologic Section 11 - <u>Moccasin Formation on County Road 730 near Trigg, Virginia</u>

Eggleston formation

Moccasin formation (226.7 feet)

17.	Siltstone, olive, cuneiform	1.5
16.	Siltstone, purple, buff weathering, thick-bedded and blocky.	15.2

		Thickness Feet
15.	Siltstone, reddish-purple and waxy-yellow-green, cuneiform weathering, grades into overlying massive unit.	1.0
14.	Mudstone, red, limy with thin, dove limestone and purplish-dove, fine-grained, flinty limestone	8.3
13.	Sandstone, purplish-gray, fine-grained, medium-bedded, blocky, small calcite vugs.	6.9
12.	Sandstone, gray, weathers buff, calcareous, medium-bedded, blocky, medium-grained with scattered coarse grains, quartzose.	4.1
11.	Sandstone, olive-green, fine-grained, thick-bedded weathering blocky, buff weathering	13.2
10.	Siltstone, purple with waxy-yellow-green interbed 2 inches thick located 8 inches above base, cuneiform weathering, grades to overlying sandstone	3.4
9.	Sandstone, light gray-green, calcareous medium-grained with numerous coarse grains, quartzose, some red chert grains	4.3
8.	Mudstone, limy, red, thick-bedded	9.4
7.	Shear zone, possible reverse fault.	0.1
6.	Mudstone, red, limy, pink calcilutites weathering gray, two to four inches thick.	41.2

		Thickness Feet
5.	Limestone, mottled pink, creamy-brown and pale-green, thick-bedded	2.8
4.	Mudstone, dusky-red, limy, thick-bedded	16.6
3.	Limestone, dark blue-gray weathers buff-gray and blue-gray, in part shaly and in part dense, poorly exposed.	5.5
2.	Mudstone, limy, dusky-red, medium- and thick-bedded, few distinct limestone beds	54.0
1.	Limestone, mottled red, green and cream-brown, medium-bedded, mud cracks, argillaceous	39.2

Witten limestone

ABSTRACT

The Spruce Run Mountain area embraces about 45 square miles in the south-central portion of Giles County. It lies wholly within the Appalachian Valley and Ridge Province.

The rocks exposed in the Spruce Run Mountain area range in age from Middle Cambrian to Lower Devonian. All the rocks are sedimentary rocks deposited in a marine environment and have an aggregate thickness of approximately 6500 feet. An important disconformity separates rocks of Lower Ordovician age from those of Middle Ordovician age.

The Saltville thrust, a southeast dipping thrust fault, crosses the Spruce Run Mountain area trending northeast. The thrust separates Middle Cambrian dolomite from Ordovician formations on the southeast flank of the Spruce Run Mountain syncline. The Spruce Run Mountain syncline is a northeast trending overturned syncline with a southeast dipping axial surface. The Clover Hollow anticline and the Bane anticline border the northwest flank of the Spruce Run Mountain syncline.

The geomorphology and geologic history of the area are briefly discussed.

PLATE 5

OVENSHINE 1961

AGE		FORMATION	DESCRIPTION
DEV.	Lower	Rocky Gap	Brown weathering medium-grained sandstone
SILURIAN	MIDDLE	Keefer	White weathering sandstone
		Rose Hill	Variegated shale and hematitic sandstone
	Lower	Clinch	Gray-white sandstone, conglomeratic
ORDOVICIAN	UPPER	Juniata	Laminated red sandstone
		Martinsburg	Dark-gray calcareous shale
		Eggleston	Olive sandstone, shale and silicified limestone
	MIDDLE	Moccasin	Red calcareous mudstone, conglomeratic sandstone at top
		Witten	Medium-gray thin-bedded limestone
		Gratton	Cross-bedded gray limestone
		Benbolt	Dark-gray impure nodular limestone, calcarenite at top
		Rockdell	Gray calcarenite and nodular cherty limestone
		Lincolnshire	Dark-gray cherty limestone
		Five Oaks	Dove-gray calcilutite
		Elway	Dark-gray limestone, black bedded chert
		Blackford	Gray medium-grained dolomite and impure limestone, locally conglomeratic at base
	LOWER	Knox	Gray medium-grained dolomite, laminated, several quartzose sandstones
CAMBRIAN	UPPER	Nolichucky	Gray calcareous shale
	MIDDLE	Honaker	Light gray granular dolomite

SCALE
1200 feet
1000
800
600
400
200
0

GENERALIZED STRATIGRAPHIC SUCCESSION, SPRUCE RUN MOUNTAIN AREA, GILES COUNTY, VA.