6-1951

The Geology of Miller Cove, Blount County, Tennessee

Charlie Alexander Tucker
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Charlie Alexander Tucker entitled "The Geology of Miller Cove, Blount County, Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geology.

Paris B. Stockdale, Major Professor

We have read this thesis and recommend its acceptance:

H. E. Evland, Harry Klepser, F. G. Snyder

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

May 21, 1951

To the Graduate Council:

I am submitting herewith a thesis written by Charlie Alexander Tucker, Jr. entitled "The Geology of Miller Cove, Blount County, Tennessee." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geology

Paris B. Stockdale
Major Professor

We have read this thesis
and recommend its acceptance:

H. E. Eveland
Harry J. Klepser
F. G. Snyder

Accepted for the Council:

E. A. Waters
Dean of the Graduate School

THE GEOLOGY OF MILLER COVE
BLOUNT COUNTY, TENNESSEE

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

---

by

Charlie Alexander Tucker, Jr.

June 1951

ACKNOWLEDGMENT

The problem for this thesis, "The Geology of Miller Cove, Blount County, Tennessee", was brought to the writer's attention by Philip B. King, Ph.D., of the U. S. Geological Survey. Dr. King is in charge of a survey party which is studying the geology of the Great Smoky Mountains. The field work was done in the summer of 1950 while the writer was employed by the U. S. Geological Survey and the writer wishes to express his gratitude for the opportunity thus afforded.

The writer is deeply indebted to Dr. King who directed the field studies and accompanied the writer in the field on many occasions. He wishes to express his appreciation for the many helpful conferences and suggestions as the field work progressed.

The writer is also indebted to P. B. Stockdale, Ph.D., Head of the Department of Geology and Geography, University of Tennessee, for his guidance in the preparation of the manuscript.

Acknowledgment is due Robert B. Neuman, Ph.D., for his help on field problems and his valuable advice and assistance in the preparation of the manuscript.

The writer expresses his gratitude to John F. Spangler for his assistance with the photography contained herein.

C.A.T.,Jr.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Location and Size of the Area

Miller Cove is an elongated lowland lying in the northwest part of the Kinzel Springs Quadrangle, Blount County, Tennessee. The airline distance southeast of the town of Maryville is seven miles. The cove is seven miles long from northeast to southwest. Its maximum width is 1.5 miles. It is bordered on the northwest by narrow-crested Chilhowee Mountain and on the southeast by Miller Cove Mountain and Hurricane Mountain.

Topographic Conditions

Miller Cove is topographically similar to other so-called coves found in and near the Great Smoky Mountains. The elevation of the floor of the cove ranges from 930 to 1,200 feet above sea level. The point of maximum elevation is on an unnamed hill in the southwest end of the cove, whereas the lowest elevation is at the junction of Reed Creek and the Little River. Chilhowee Mountain on the northwest side of the cove rises 2,300 feet above sea level, and Miller Cove Mountain on the southeast rises 1,700 feet. The maximum elevation of the portion of Hurricane Mountain that borders the cove on the southeast is 1,500 feet.

The stream pattern in Miller Cove is trellis. There is some subsurface drainage due to the solubility of the dolomites that make up a large part of the floor of the cove. The cove is drained to the northwest by a master stream, the Little River, which emerges through a water gap in Chilhowee Mountain. The northeast end of the cove is drained by Reed Creek and the southwest end is drained by Hesse Creek, both of which are tributaries to the Little River. (See Plate I.)

Geography of the Area

The village of Walland is located approximately in the center of the cove on State Highway 73 which runs east-west across the cove. A graded gravel and black-top road runs the length of the cove and joins the State Highway at Walland. Formerly the Little River Railroad extended from Maryville through Walland to Townsend, but was discontinued about 25 years ago.

The climate of the cove is the humid subtropical type. The summers are generally long and warm while the winters are mild and short. The winter temperatures average slightly above freezing, and July and August, the hottest months, average 77 degrees. The average annual precipitation is slightly over 55 inches, with a monthly minimum of 1½ inches in October and a maximum of 9 inches which comes in June. Frost can be expected from the latter part of October to the middle of April, leaving a frost-free growing season of approximately 193 days.

Many of the people in the cove work in the aluminum plant at Alcoa about 12 miles away. Farming is the major occupation in the cove itself. Most of the farms are subsistence farms but some of the factory workers have part-time farms or garden plots. The cove lies in the corn and winter wheat belt, and winter wheat is important in farming programs of both farm types. The crops are diversified, with corn, winter wheat and tobacco being the most important, whereas oats, Irish potatoes, yams, sorghum, and cotton are of less importance. Most of the land in the floor of the cove is in use, with the greater part devoted to permanent pastures and the rest to crop land and forest. Cattle grazing is prominent.

The tourist trade at present is only a minor function of Miller Cove with only two places, the Chilhowee Inn and the Blackberry Farm, offering meals and overnight accommodations for tourists. This business should show a marked increase upon completion of the proposed highway that is to replace the present State Highway 73. This new highway will form a much better connection between Maryville and the Great Smoky Mountain National Park.

CHAPTER II

PHYSIOGRAPHY

Valley and Ridge Province

The Valley and Ridge Province extends northeast-southwest from the St. Lawrence Valley to the Gulf Coastal Plain in Alabama. Its length is 1,200 miles and its maximum width in the vicinity of Harrisburg, Pennsylvania, is 80 miles. The width is 65 miles in northern Virginia, and the extreme width in East Tennessee is 40 miles, which is approximately the average width for the southern half of the province. In Tennessee, the province is bounded on the west by the Appalachian Plateaus Province and on the east by the Blue Ridge Province.

The Valley and Ridge Province may be divided into three parts, the northern, the middle, and the southern sections. The boundary between the northern and middle sections is the Delaware River. The divide between the New River and the Tennessee River makes up the boundary between the middle and southern sections.

Fenneman (1938) describes the province as a lowland, an assemblage of valley floors surmounted by narrow, even-topped ridges. The altitude of the valley floor ranges from less than 400 feet near the large rivers in the northern states to more than 2,400 feet on divides in southern Virginia. At these localities, relief between valleys and the ridge tops is from 1,000 to 1,500 feet. The valleys and ridges are the result of differential erosion of folded strata. The ridges may be

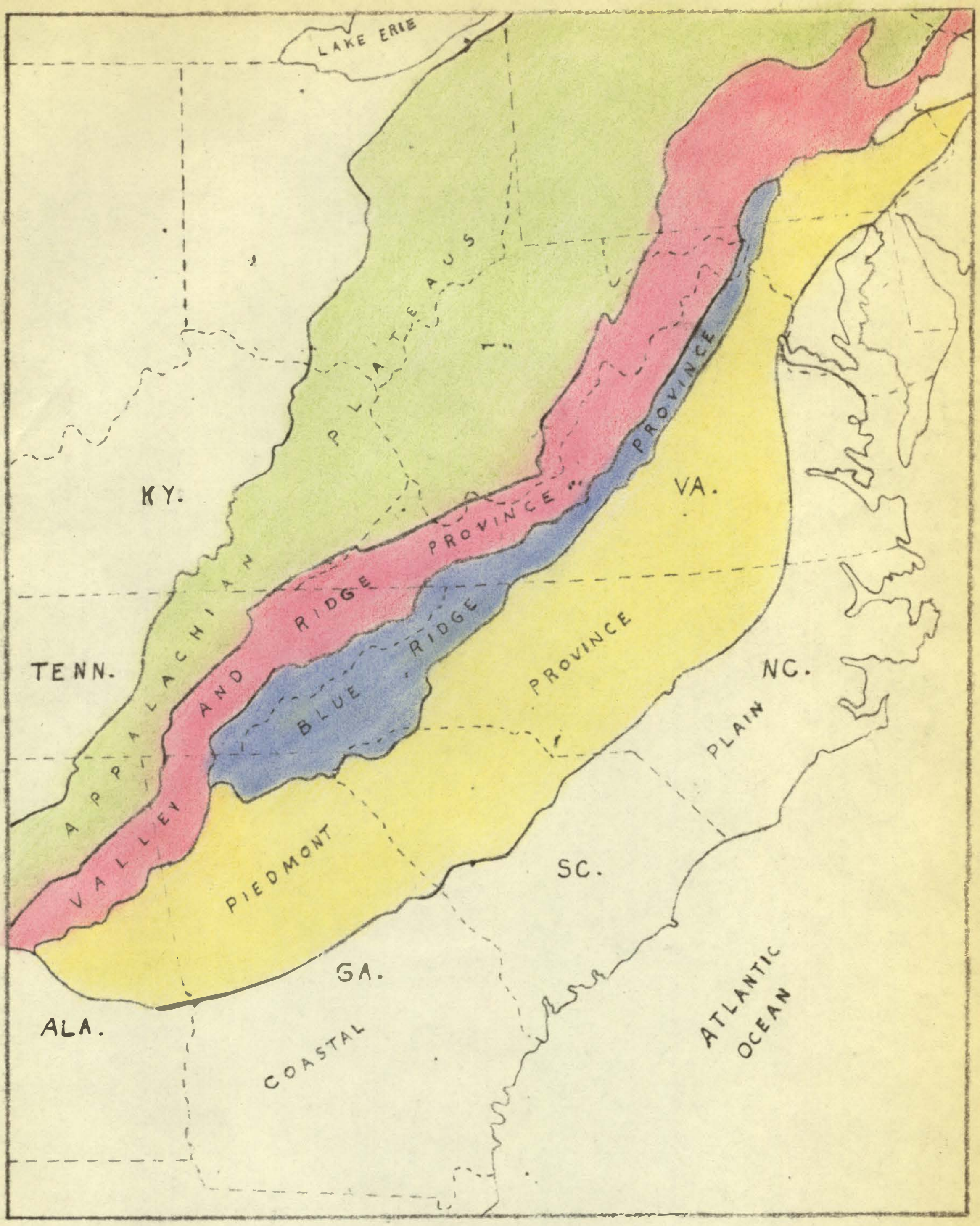


Figure 1. Physiographic regions of eastern United States

anticlinal, synclinal or monoclinal, but monoclinal ridges are predominant. The ridges in most cases are supported by resistant sandstones, while the valley floors are made up of less resistant limestones and shales.

The province has a trellis drainage pattern. The southern section is drained by the Tennessee River and its tributaries and the Coosa River. Both of these systems are fed from the southeast and receive very little water from the plateau on the northwest. The Tennessee River follows the southwest trend of the valley until it reaches Chattanooga, where it turns sharply west and flows through a deep gorge in Walden Ridge across the plateau.

Blue Ridge Province

This province is a mountainous section that lies west of the Piedmont Province and east of the Valley and Ridge Province. It extends from the Susquehanna River in Pennsylvania south to northern Georgia. The western boundary is placed at the limit of overthrusting of the older, frequently metamorphosed rocks on the younger rocks of the Valley and Ridge Province.

The Blue Ridge Province is divided into two sections which are separated by the Roanoke River. The northern section is a narrow belt about 14 miles wide. It has a linear form and is a belt of even-topped, rounded knobs averaging about 1,500 feet in elevation. The southern section is a broad expanse that increases in width and height southwestward from Roanoke Gap. It reaches a maximum of 70 miles in width. There are several peaks that reach above 6,000 feet while many more extend above 5,000 feet in elevation.

The Blue Ridge Province is formed of metamorphic rocks, some of which are pre-Cambrian in age, and of Lower Cambrian sediments. These rocks are very resistant and the structure is quite complex. In places along the western margin of the province where these older rocks have been thrust over the limestones of the adjacent province, fensters, or windows, have been formed. The overthrust block has been worn through in places and the limestones form the surface. Five such fensters are found on the northwest slope of the Great Smoky Mountains.

Miller Cove Region

In the Miller Cove region Chilhowee Mountain is the dividing line between the Blue Ridge and Valley and Ridge Provinces. Inasmuch as Chilhowee Mountain is the northwest boundary of Miller Cove, the cove lies just within the western part of the Blue Ridge Province.

There are several physiographic features connected with the cove that are noteworthy; i. e., the cove itself, a water gap in Chilhowee Mountain, some knobby hills, and some Karst topography.

The cove is a striking feature and presents quite a contrast to the surrounding area. It is an elongate lowland covering approximately 10 square miles, and is almost completely surrounded by mountains. The cove is not a fenster although it is almost completely encircled by older rocks and is somewhat similar in appearance to Cades Cove and Tuckaleechee Cove to the south which are fensters.

The water gap in Chilhowee Mountain just northwest of Walland is a very striking physiographic feature and it is also a very important economic feature. The Little River, which is the major stream draining the cove, flows through this gap into the Valley and Ridge Province. The gap also offers the only practical entrance to the cove from the northwest. The mountain on both sides of the gap reaches an elevation of approximately 2,000 feet, which is about 1,000 feet above the river in the gap. There are no other low passes or gaps present for many miles along the crest of the Chilhowee Mountain. Without this natural entrance, construction of a road into the cove would have been difficult and expensive.

In the southwest part of the cove there are several rounded knobs or hills that have a linear arrangement. These knobs extend from 150 to 200 feet above the floor of the cove and are different in many respects from the other low hills found in the cove. All of these knobs are underlain by the Rome formation and are characteristic of this formation in Miller Cove.

There are a number of medium-sized sink holes present in the part of the cove that is underlain by Shady dolomite. They are roughly circular and from 20 to 30 feet deep. Many of the sink holes have small streams that drain into them and continue underground. This is the source of water for many of the springs in the area. The sink holes along State Highway 73 at the southeast edge of the cove give a good indication of the change in lithology from resistant mountain rock to the less resistant dolomite of the cove. (See additions on Plate I.)

Figure 2. Water gap in Chilhowee Mountain looking southeast

Figure 3. Rounded hills underlain by the Rome formation

Figure 4. Sink hole in Shady dolomite

CHAPTER III

STRATIGRAPHY

Geologic Column in General

The stratigraphic section within the general area of Miller Cove ranges from Upper pre-Cambrian through Lower Cambrian. The oldest rocks exposed are argillites or argillaceous shales of the Ocoee series. The youngest rocks exposed are the variegated shales of the Rome formation.

Keith (1896), in the Knoxville folio, assigned the rocks on the floor of Miller Cove to the Knox dolomite, and to an overlying unit called "shore deposits of Knox dolomite". These "shore deposits" are described as sandy shales and thin sandstones of bright red, green, and yellow colors. In an earlier paper Keith (1892) also correlated the dolomites of Miller Cove with the Knox, and believed them to lie with great unconformity and hiatus on the Chilhowee group of Early Cambrian age. Keith did not see the resemblance between the red "shore deposits" in Miller Cove and the Rome formation which he described in the Knoxville area. If Keith had made this correlation he would have been able to discard the great unconformity that he believed existed between the Lower Cambrian rocks of Chilhowee Mountain and the Lower Cambrian rocks of the Knoxville area.

The possibility that another and somewhat similar dolomite formation existed below the Knox had not been considered by Keith. Safford (1869) did not recognize or describe any dolomite formation below the Knox, but placed his "Knox sandstone" (Rome) in direct succession on his Chilhowee sandstone. Later Keith, in the Cranberry folio (1903), discovered a lower dolomite formation and named it "Shady limestone". This discovery has been regarded as the only major contribution that has been made to the East Tennessee Paleozoic section since Safford's original work.

In more recent times, Stose and Stose (1944) pointed out the fact that the dolomites lying on the Chilhowee group in Miller Cove were not Knox, but were the Shady formation. They also showed that Keith's "shore deposits" were equivalent to the Rome formation of the Knoxville area.

The exact location of the base of the Cambrian is another problem within the stratigraphic section of this general area. Various authors have placed the base of the Cambrian at different horizons in the Ocoee series and Chilhowee group. Howell and others (1944) of the Cambrian Subcommittee (Committee on Stratigraphy of the National Research Council) and several other authors place the base of the Cambrian at the lowest horizon containing Lower Cambrian fossils. Some geologists think this is a very restricted and arbitrary boundary. King (1949) in a more recent paper places the base of the Cambrian in the southern Appalachians at the base of the Chilhowee group. He believes that this group forms the lowest unit of the Lower Cambrian series. Several reasons are given as the basis for this decision. One is that although the highest part of the Chilhowee group is fossiliferous and the remainder unfossiliferous, it is a closely knit sequence of deposits laid down in conformable succession, with none of its parts greatly differing in age from the other parts. He also believes there

SYSTEM	SERIES	MILLER COVE AREA	DESCRIPTION
Cambrian	Lower	Rome formation	Red, green and yellow shale, some silty shale
		Shady formation	Blue-gray and white dolomite, some shaly dolomite
		Chilhowee Group: Helenmode	Green siltstone and dolomitic sandstone
		Chilhowee Group: Hesse	Massive white sandstone
		Chilhowee Group: Murray	Grayish-blue sandy shale
		Chilhowee Group: Nebo	Thinly-bedded, massive white sandstone
		Chilhowee Group: Nichols	Grayish-blue sandy shale
		Chilhowee Group: Cochran	Coarse conglomerate, quartz and feldspar pebbles
Pre-Cambrian	Upper	Ocoee Series	Grayish-blue graywacke, much siltstone, some limestone, shale and conglomerate

Figure 5. General stratigraphic section of the Miller Cove area

is a change in sedimentation between the Chilhowee group and underlying formations. Thus the most recent work done on this problem in this area places the base of the Cambrian at the base of the Chilhowee group.

This is a major problem and although it involves some of the rocks in the Miller Cove area, this report makes no effort to treat it. A generalized stratigraphic section of the area is presented on page 13.

Pre-Cambrian System

The oldest rocks bordering Miller Cove are argillites and shales of the Ocoee series of late pre-Cambrian age. They occur on the southeast side of the cove. (See Plate II.)

Ocoee Series

The Ocoee series was named by Safford (1856) from the Ocoee River, Polk County, Tennessee. Rocks of the series are exposed in eastern Tennessee, western North Carolina, and northern Georgia, extending from the French Broad River in eastern Tennessee southwest along the Tennessee-North Carolina border to the vicinity of Ellijay in northwestern Georgia. They form the bulk of the Great Smoky Mountains and other high ranges on the Tennessee-North Carolina border.

Ocoee rocks are exposed on the southeast side of Miller Cove and form the bordering Miller Cove Mountain and Hurricane Mountain. The Miller Cove fault, a thrust fault, separates the Ocoee series from the Shady dolomite and Rome formation. The Ocoee rocks exposed adjacent to this fault are light gray and greenish gray argillites with a

Figure 6. Shaly outcrop of the Ocoee series

distinct sericitic sheen. A few thin beds of calcareous sandstone were seen, and at one locality a red, silicious shale, harder and more brittle than similar colored shale of the Rome formation, was noted.

The Ocoee series is made up of slightly metamorphosed sedimentary rocks, mainly of clastic origin, except for a few thin beds of limestone. The rock types are fine-grained to coarse-grained graywackes, sandstone, conglomerates, and shale. Some limestone beds are found in the upper part of the series. The color of the Ocoee rocks is gray, bluish gray, or very dark gray. Graded bedding is characteristic of the graywackes. No fossils have been reported in the Ocoee series.

In the most recent work on the Ocoee series, King (1949) has divided the rocks into four units as follow: (1) the basal unit, as yet unnamed, which is made up of coarse clastic deposits; (2) the Great Smoky conglomerate, which is also made up of coarse clastic deposits; (3) the succeeding unit, which includes the Nantahala slate and Pigeon siltstone, made up mostly of dark gray or black siltstone and slate with some interbedded graywacke; and (4) the Sandsuck shale, which makes up the uppermost unit and consists of argillaceous shale with interbedded layers of limestone and conglomerate.

There has been some doubt as to the thickness of the Ocoee series. In the Knoxville and Nantahala Quadrangles, Keith (1895, 1907) reported a thickness of 7,500 feet to more than 10,000 feet. King (1949) believes these to be underestimates and thinks the thickness may exceed 20,000 feet.

Cambrian System

Three formations of Early Cambrian age represent the youngest group of rocks in Miller Cove. In ascending order they are: (1) the Helenmode member of the Hesse sandstone; (2) the Shady dolomite and (3) the Rome formation. The floor of the cove is underlain primarily by dolomite and shaly dolomite of the Shady formation. Three small areas, one southwest and two northeast of the Little River, are underlain by red, brown and yellow shales of the Rome formation. The Helenmode member of the Hesse sandstone crops out along the base of the Chilhowee Mountain on the northwest side of the cove.

Hesse Sandstone

The Hesse sandstone was named by Keith in 1895 for outcrops along Hesse Creek, Blount County, Tennessee. In Miller Cove only the upper part of the Hesse formation was mapped. This part has been designated the Helenmode member by King and others (1944) for exposures at the Helenmode pyrite mine in Carter County, Tennessee. This member is exposed along the lower part of Chilhowee Mountain on the northwest side of Miller Cove at an elevation between 1,100 and 1,400 feet. Swingle (1949) studied this part of Chilhowee Mountain in detail and defined the limits of the Helenmode member in all but the southwesternmost part of the area. The member is overlain conformably by the Shady dolomite. It strikes approximately North 40° East and dips on an average of 35° to the southeast. In Miller Cove it is approximately 200 feet thick and consists mainly of a thin-bedded, shaly sandstone. Some of the sandstone has a yellowish color, but most of it is white or gray. There is also some massive sandstone present. Near the top of this member Swingle (1949) found a coarse-grained sandstone that contains rounded quartz pebbles. Where weathered, it leaves a residium that contains coarse quartz grains that resemble fish-eggs. The only fossils found in Miller Cove were Scolithus tubes confined to the Hesse sandstone.

Shady Dolomite

The Shady dolomite was named by Keith (1903) for its exposures in Shady Valley, Johnson County, Tennessee. It is widely distributed in northeastern Tennessee and southeastern Virginia. In northeastern Tennessee it is well exposed and has been mapped recently by King and others (1944) and by Rodgers (1948).

The Shady dolomite is the oldest carbonate formation in the Paleozoic section in the Appalachians. Typically the formation consists of blue-gray and white dolomite with a little interbedded limestone and a few thin beds of shale. Several well-marked lithologic units may be distinguished in the typical section, and they have been recognized as members of the formation by several authors (Currier, 1936; Butts, 1940; and King and others, 1944).

In Miller Cove the Shady dolomite forms most of the floor of the cove. Throughout the length of the cove it conformably overlies the Helenmode member of the Hesse sandstone, and is in turn conformably overlain by the Rome formation where present. It strikes approximately North 60° East and dips on an average of 35° to the southeast.

Several rock types may be distinguished in the Shady formation in Miller Cove but the only persistent and distinctive units are characterized by either shaliness or massiveness of the dolomite. Five mappable subdivisions of the Shady dolomite have been distinguished by the writer. Essentially the formation is blue-gray, fine-grained dolomite in laminated beds from 6 inches to 4 feet thick, with two shaly zones. The basal portion of the formation (lower dolomite member) is at least 225 feet thick, although poorly exposed. It is characteristically lighter colored, some with a pinkish tint, and is more thickly bedded than the overlying portion. The white, sugary dolomite that occurs in the lower dolomite member does not recur higher. This unit is succeeded by very light gray to blue-gray dolomite that is perceptibly finer grained than the basal unit. This unit (middle dolomite member) measured 37.7 feet thick at the Wolf Creek section.

Shaly dolomite and dolomitic shale about 50 feet thick forms a mappable and readily distinguished unit in the sequence (lower shale member). It is characterized by light blue-gray shaly dolomite in beds 4 to 10 inches thick, and brownish dolomitic shale that is marked by thin, dark laminae.

The best exposed unit of the Shady dolomite in the cove is the upper dolomite member, about 175 feet thick. It is medium gray, fine-grained, cherty dolomite, in beds 1 to 2 feet thick.

The most readily distinguishable portion of the Shady sequence is its uppermost shaly member. In the Wolf Creek section this member measured about 100 feet thick, where it is characterized by shaly dolomite with interbedded thin dolomite layers. A green shale bed at

Figure 7. Medium-bedded, blue-gray outcrop of Shady dolomite

Figure 8. Thin-bedded laminated outcrop of Shady dolomite

the base of the unit is unique in the entire Shady sequence, and its identification at many places in the cove has proved a reliable datum.

The dark gray, non-calcareous siltstone that was observed at the top of the Wolf Creek section may represent the base of the Rome formation. It is included with the Shady formation, however, because it lacks the fissility that characterizes the rocks of the Rome formation. It is a thin unit, exposed only in this section.

The best section of the Shady dolomite in Miller Cove is exposed along Wolf Creek in the southwestern part of the cove (see Plate I.) This section extends from the highest known outcrop of Shady dolomite, which is within a few feet of the Rome-Shady contact, to the Helenmode member of the Hesse sandstone at the base of the Shady dolomite. The lower part of the section, including the Helenmode-Shady contact, is covered, hence the total thickness of the Shady is only approximate.

<u>Section on Wolf Creek.</u> The following is a detailed description of the section referred to above:

	Thickness	Total Unit Thickness
Rome formation	Not measured	
Shady dolomite		
Upper shale member		
Siltstone-dark gray, non-calcareous, in 3" beds	1' 8"	
Covered	5' 11"	
Dolomite-medium gray, very finely crystalline, in 1" to 3" beds. Some layers undulating	9' 1"	

(Cont.)

	Thickness	Total Unit Thickness
Shale-dark gray, platy fissle, thickly laminated, only slightly calcareous. One 2" bed of dolomite in middle	2' 11"	
Dolomite-medium gray, in 1" to 4" beds with thin veins of white dolomite	6' 8"	
Covered	19' 4"	
Dolomite-medium to dark gray, finely crystalline, thin-bedded, with some covered intervals. Beds ¼" to 3" thick. Weathered surface appears somewhat argillaceous	32' 5"	
Dolomite-medium gray, shaly, in ¼" beds	7' 1"	
Dolomite-medium to dark bluish-gray, finely crystalline. Beds 6" to 1' thick	7' 1"	
Shale-greenish drab, argillaceous, non-calcareous	8' 7"	100' 9"

Upper dolomite member

	Thickness	Total Unit Thickness
Dolomite-medium gray, finely crystalline, with beds 1" to 2" thick. Large lenses and spherical nodules of light gray chalcedonic chert in top 2'	38' 2"	
Dolomite-mostly covered, a few scattered light gray outcrops	55' 6"	
Covered	45' 6"	
Dolomite-medium to dark bluish-gray, finely crystalline, in 1" to 2" beds. Some irregular nodules of chalcedonic chert	8'	

(Cont.)

	Thickness	Total Unit Thickness
Covered	27' 4"	174' 6"
Lower shale member		
Dolomitic shale-light blue-gray and brownish less dolomitic and more argillaceous shale marked by thin dark laminae. Beds are several inches thick	10'	
Covered	28' 4"	
Dolomite-thin-bedded, shaly, blue when fresh, brown when weathered. Faint light and dark laminae	9' 8"	48'
Middle dolomite member		
Dolomite-very light gray, medium crystalline, sugary	7'	
Dolomite-dark blue-gray	3'	
Covered	6' 6"	
Dolomite-very light gray, fine-grained	6'	
Dolomite-mostly covered, scattered light blue-gray outcrops	15'	37' 6"
Lower dolomite member		
Dolomite-medium blue-gray, finely crystalline, massive. Beds 2' to 4' thick	13' 6"	
Mostly covered, some gray dolomite at the bottom	7' 4"	

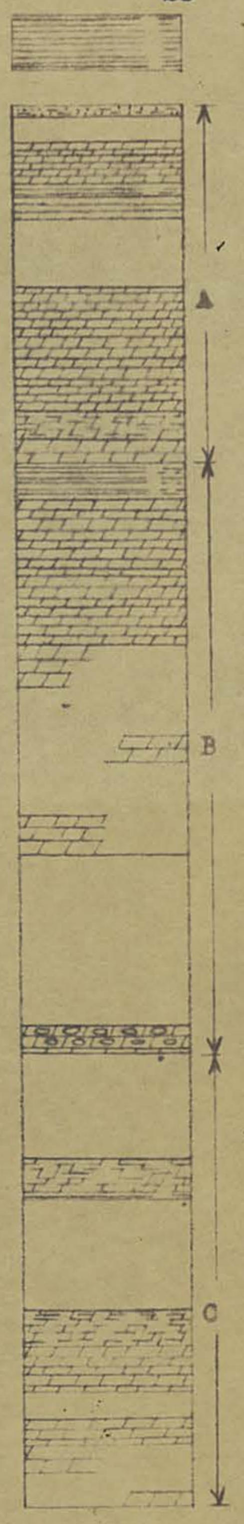
(Cont.)

	Thickness	Total Unit Thickness
Dolomitic shale-buff, platy	3' 2"	
Covered	83' 10"	
Dolomite-medium blue-grey	3'	
Covered	39'	
Dolomite-white, sugary	24'	
Covered	22'	
Dolomite-white, sugary	29' 6"	225' 4"
Covered from here to outcrops of Hesse sandstone		
Total approximate thickness of the formation		586' 1"

Whereas the thickness of the Shady dolomite in Miller Cove measures approximately 580 feet, Rodgers (1948) found it to be only approximately 450 feet thick in Bumpass Cove, Unicoi and Washington Counties, Tennessee. Greater thicknesses have been measured in other sections. The thickness was measured as 1,150 feet in Stony Creek Valley in northeastern Tennessee by King and others (1944) and Ferguson (1951) gives 1,000 feet as its approximate thickness in the Del Rio area. Butts (1940) gives the thickness as 1,800 feet in southwestern Virginia. No fossils were seen in the Shady dolomite in Miller Cove and none have been reported in northeastern Tennessee. Fossils of early Cambrian age have been found in the Shady dolomite in Virginia (Butts, 1940; Cooper, 1951) and in the Cartersville district of Georgia (Kesler, 1950).

The Shady dolomite is very susceptible to weathering, especially by solution. In some areas, therefore, it is covered by thick residual

UNIT A	Upper shale member	100'	9"
UNIT B	Upper dolomite member	174'	6"
UNIT C	Lower shale member Middle dolomite member	85'	6"
UNIT D	Middle dolomite member Lower shale member		
UNIT E	Lower dolomite member	225'	4"
Total thickness of Shady dolomite		586'	1"
UNIT F	Includes Hesse quartzite and some Shady dolomite	659'	



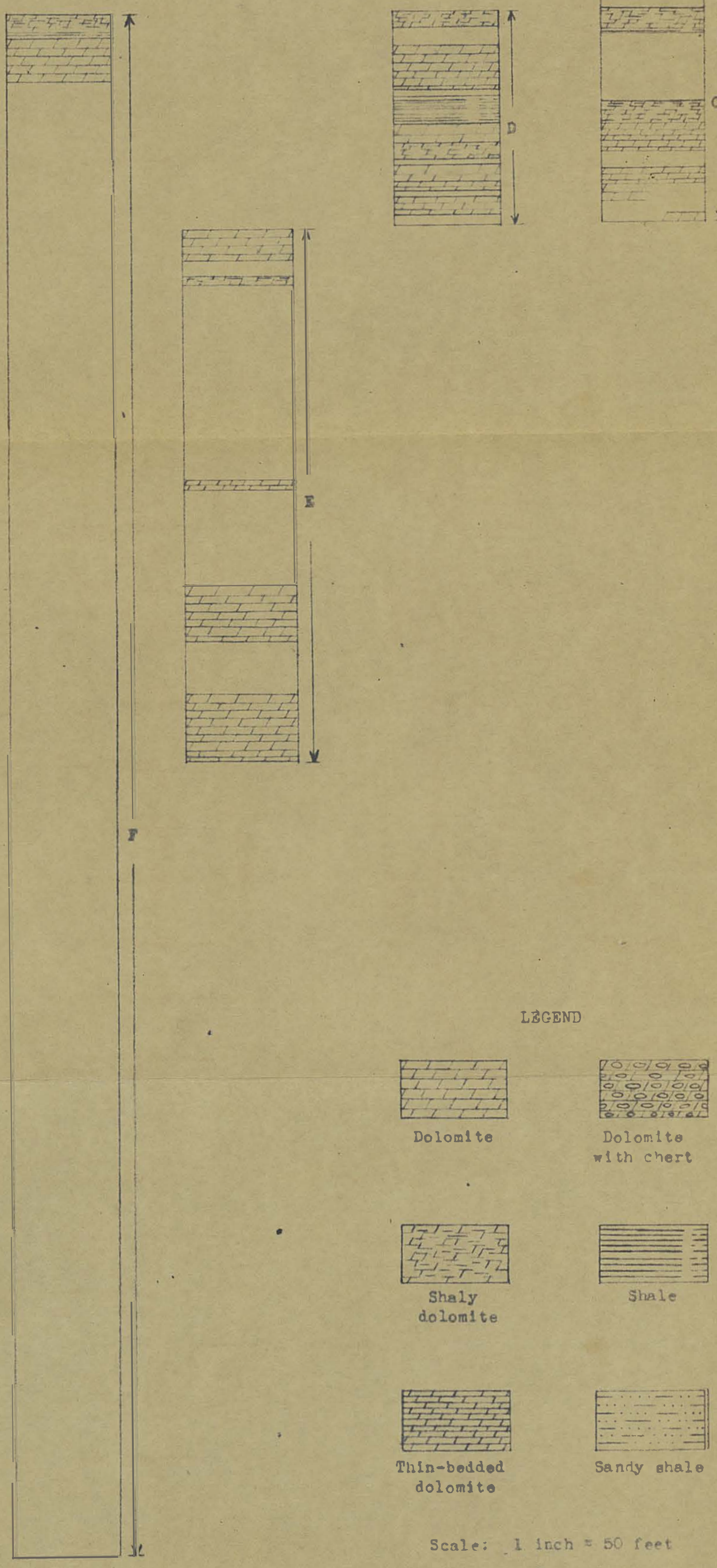


Figure 9. Measured section of Shady dolomite on Wolf Creek

clay which is yellow to brown in color, usually tough and waxy, and without structure. During weathering the soluble dolomite and calcite are removed and the clay is left with other insoluble material such as quartz dolocasts, chert, and jasperoid.

A chert-like form of silica, called jasperoid, is widely distributed in northeastern Tennessee, mostly in the belts of outcrop of the Shady dolomite. In Miller Cove jasperoid is not too abundant and occurs only as small masses in residual clay. It is predominantly yellowish brown, but red, white, and gray varieties are also present. It is typically yellowish brown and flinty, but its character varies widely. In Miller Cove most of the jasperoid has a stockwork structure, but some appears to have no particular structure or shape.

The origin of jasperoid is not definitely known. Kesler (1939) has concluded that the jasperoid in the Cartersville area, Georgia, is of hydrothermal origin, having replaced the dolomite along faults and fractures. Because of its widespread occurrence in residual clay, and its absence in extensive areas of the underlying bedrock, some authors (King and others, 1944) believe the jasperoid was formed by silicification of dolomite during weathering. King (1944) also believes the greatest amount of silification took place in strongly deformed and fractured areas, when the dolomite would be more exposed to weathering. Most authors suggest (King and others, 1944, and Rodgers, 1949) that the jasperoid formed under climatic and weathering conditions that do not prevail today.

Figure 10. Greenish drab, shaly outcrop of the Shady dolomite with jasperoid in the foreground

Figure 11. Massive white Shady dolomite in abandoned quarry

<u>Rome Formation</u>

The Rome formation was named by C. W. Hayes (1891) for the variegated shales and beds of a heterogeneous nature which underlie extensive areas in the Coosa Valley near Rome, Georgia. The name "Watauga shale" was later proposed for the same unit by Keith (1903) for outcrops along the Watauga River in northeastern Tennessee and was extensively used in reports on Tennessee until about 1944. The term "Rome formation" has priority and has been substituted for the term "Watauga shale" which has been abandoned (Wilmarth, 1938).

The Rome formation and its equivalents are exposed in a belt stretching from northern Alabama into eastern Pennsylvania. Northward from the type area in Georgia the formation crops out in several belts across the entire width of the Valley and Ridge Province. In eastern belts its lower part occurs with the Hesse and Shady formations in a manner similar to the Miller Cove occurrence.

The Rome formation underlies three areas in Miller Cove. The most extensive outcrop area lies in the southwest end of the cove and forms a strip about one-half mile wide and three miles long between Miller Cove Church and the flat in the southwest end of the cove. In this strip it forms a line of rounded or knobby hills. A much smaller outcrop of Rome shale is found in the northeast end of the cove in the vicinity of Watertown. A very small outcrop of Rome shale is exposed approximately a quarter of a mile north of Walland. It lies at the base of Chilhowee Mountain only a few hundred yards northeast of the water gap. This small slice occurs along a tear fault, and was carried to its present position by this fault. The Rome formation is the

Figure 12. Variegated outcrop of the Rome formation

Figure 13. Thin-bedded, variegated outcrop of the Rome formation

highest formation exposed in Miller Cove and it conformably overlies the Shady dolomite.

As exposed in Miller Cove, a large part of the Rome formation is red or maroon shale, part of which is silty. Some yellow argillaceous shale is also present. Maroon to brown, fine-grained, thin-bedded sandstone beds are probably the youngest rocks in the cove. These were found in places where the Rome is in contact with the Ocoee formation. The distinctive feature of the formation is the red color of both shales and sandstone. The shale of the Rome formation in Miller Cove weathers into small chips.

The presence of the Rome formation can be determined from the maroon soil that it forms. Fresh or even weathered rock is seldom exposed so that a measured section of that part of the formation preserved in the cove cannot be made. The best locality to observe the lowest part of the formation is about 2 miles southwest of Walland where the rocks are mostly red clay shale and silty yellow shale. The higher beds are best exposed on the rounded hills in the southwest end of the cove where they are predominantly sandy.

The thickness of the Rome formation cannot ordinarily be determined because of complex structure. In Miller Cove the total thickness is unknown because its top is nowhere exposed. However, for the general vicinity of Knoxville, the thickness has been estimated to be approximately 1,000 to 1,200 feet. No fossils were seen in the Rome formation in Miller Cove, but in other areas it is known to contain a variety of fossils of Early and Middle Cambrian age (Butts, 1940).

CHAPTER IV

GEOLOGIC STRUCTURE

General Features

The rocks of eastern Tennessee were strongly folded and faulted by movements during the Appalachian Revolution in late Paleozoic time. These movements produced elongate folds that were broken by thrust faults in many places. The northeast-trending outcrop belts which are characteristic of the Valley and Ridge Province reflect the trend of the structures. Strata in this province commonly have very complex structural relationships. The outstanding tectonic features of the southern sections of the Valley and Ridge Province and the Blue Ridge Province are large low-angle overthrust faults that displace strata northwestward. (See Plate II.)

During or shortly after thrusting, the large overthrust sheets become broadly folded. In some places erosion has cut through the complete thickness of the overthrust strata, reexposing the underlying rock amidst an enclosure of the overthrust, older beds. The term "window" (from the German word "fenster") has been applied to these areas. Several of these "windows" are present along the northwestern border of the Blue Ridge Province in northeastern Tennessee. Best known are Tuckaleechee Cove and Cades Cove only a few miles to the southeast of Miller Cove, and King (King and others, 1944) described several in northeast Tennessee.

The Great Smoky overthrust which carried Ocoee and Chilhowee rocks over younger Paleozoic rocks is perhaps the largest of the Appalachian overthrusts. It has moved a minimum distance northwestward of six miles. Chilhowee Mountain, which forms the northwest border of Miller Cove, and Miller Cove are parts of this thrust block.

Along the southeast border of the cove, Ocoee rocks have been faulted against the Rome formation and the Shady dolomite by a similar thrust fault of less displacement within the main overthrust sheet. (See Plate II.) This fault, named the Miller Cove fault, strikes about North 35° East, and dips 40° southeast (Neuman, 1951).

The trace of the Miller Cove fault is covered by the flood plains of Hesse and Reed Creeks throughout most of the length of the cove. At a few places the fault cuts across low hills within the cove, or at the foot of the ridges on the southeast. The actual fault plane is not visible at any point, but contrasting rock types permit its location within a few feet where it is not buried beneath alluvium.

The topographic lineament described by Hesse and Reed Creeks is thus only an approximation of the trace of this fault, and the topographic expression of the fault outside of the flood plain is subtle or non-existent. South of Miller Cove Church, and where Tennessee Highway 73 crosses it, the fault plane emerges in saddles, but in the hills southeast of Wolf Creek there is no manifestation of the fault in the topography.

Special Features

The rocks of Miller Cove are folded into a moderately gentle trough or syncline. The clastic formations on the northwest flank dip southeastward on an average of 40° and form Chilhowee Mountain. The southeast flank of the syncline is overridden by the Miller Cove thrust fault which brings Ocoee rocks into contact with the younger rocks of the cove floor. (See Plate II.) Therefore, only a small portion of the syncline is preserved. Northwest dipping Shady beds occur west of the Little River. These beds swing around to the west and then southeast to define the trough of the syncline south of Miller Cove Church. Here the synclinal axis plunges about 10° southwest.

A small area underlain by the upper shale member of the Shady is preserved near the top of the knoll west of the Little River about .5 mile south southwest of Walland, and a larger area underlain by this member lies east of the Little River surrounding the area underlain by the Rome formation at Watertown.

Thus the southwest plunge of the syncline southwest of the Little River becomes horizontal and then plunges gently to the northeast. Within the area of Rome outcrop at Watertown it again becomes horizontal and emerges at the Mountain View Church with a southwestern plunge. At a few points between the Little River and Huskey Branch northwest dips of the southeast limb of the syncline are preserved.

The syncline as a whole is not very asymmetrical. Dips on the southeast limb range from 10° to 85° northwest, although only one reading reached the steepest value. The average dip is from 25° to 35°

northwest, whereas the average southeast dips of the northwest flank are 25°.

There is a northwest-trending tear fault in the southwest end of the cove on the side of Chilhowee Mountain just north of the junction of Hurricane Creek and Hesse Creek. This fault displaces the Helenmode member of the Hesse formation on the southwest and cuts off the Shady dolomite. Complicated faulting and structural conditions occur on the Chilhowee Mountain west of this fault. Another tear fault, mapped by George Swingle in 1949, passes through the Little River Water Gap at Walland. A small slice of the Rome formation was carried along this fault and is now in contact with rocks of the Chilhowee group. No trace of this fault was found east of Walland because of the cover in the flat near Reed Creek.

Several other faults, including high angle thrust faults as well as normal faults, are present in the northeast end of the cove near the base of Chilhowee Mountain. These faults were mapped earlier by George Swingle (1949).

Minor Features

Some minor warping and fracturing of the rocks in the Miller Cove area occurred simultaneously with the main overthrusting. However, the present attitude of the majority of these rocks is mainly due to movement subsequent to the main overthrust.

Most of the minor structural features are localized and are too small to be plotted accurately on a map. Many joints or fractures are present in rocks of the Shady dolomite, but they do not make a definite pattern.

CHAPTER V

GEOLOGIC HISTORY

General

The geologic history of large areas such as the Valley and Ridge Province and the Blue Ridge Province can be deduced from the evidence shown by the lithology, stratigraphy, structure, and paleontology of the rock strata. The history of one small area such as Miller Cove cannot be determined by information gained in the limited area alone, but by combining information obtained from both local and regional studies the history can more completely and accurately be determined.

The Appalachian Geosyncline, one of the dominant tectonic features during late pre-Cambrian and Paleozoic times, played an important part in the history of this general area. Until recently the rocks of the Valley and Ridge Province were believed to represent sediments deposited in the geosyncline. The folded and faulted character of the rocks has been attributed to movements during the Appalachian Revolution which occurred during late Paleozoic time. King (1950), however, in summarizing the data obtained by more recent workers, points out the possibility that the sediments of the Valley and Ridge Province were deposited in only a part of the Appalachian Geosyncline and do not represent the entire width of the geosyncline.

Supposedly there was a high land mass of pre-Cambrian crystalline rocks bordering the Appalachian Geosyncline on the southeast.

This land mass, called Appalachia, was believed to be the source area for the sediments deposited in the geosyncline. The concept of Appalachia has been used for many years in historical geology. Many of the metamorphic and igneous rocks of the Piedmont Province are supposed to be remnants of Appalachia that were thrust westward during the Appalachian Revolution in late Paleozoic time. In the light of more recent work it is now doubtful if Appalachia ever existed as described by earlier geologists (King, 1950).

It has been suggested by King (1950) that the sediments deposited in the area of the Valley and Ridge Province were derived from fold ridges that arose in the inner zone of the Appalachian Geosyncline during successive orogenic periods of Paleozoic time. These ridges were probably composed of materials from the inner zones of the geosyncline that were deformed and metamorphosed mainly in Paleozoic time, and not of basement rocks. It is therefore possible that the metamorphic and igneous rocks of the Piedmont Province do not represent the existence of Appalachia, but were the central part of the Appalachian Geosyncline.

Pre-Cambrian History

The oldest rocks exposed in Miller Cove are part of the Ocoee series which is now believed to be of late pre-Cambrian age (King, 1949). Due to the character of these rocks King (1949) believes that they were deposited under conditions of crustal instability, probably in a rapidly subsiding trough bordered by lands of high relief, a eugeosyncline. Thus it is believed that the Ocoee rocks represent the initial deposit in the original Appalachian Geosyncline. The axis of this instable zone was probably in the vicinity of the western portion of the Piedmont Province.

It is stated by King (1949) that after deposition of the Ocoee rocks there was some tilting of the beds and erosion and truncation of the tilted beds. Thus it is possible that an unconformity separates the rocks of the Ocoee series from rocks of the overlying Chilhowee group which are Early Cambrian in age.

Cambrian History

The Helenmode member of the Hesse sandstone, which is Early Cambrian in age, is the oldest Cambrian formation exposed in Miller Cove. These rocks form the upper part of the Chilhowee group, which is from 2,500 to 7,500 feet thick, and are made up of fine to coarse clastic sediments. King (1949) believes the Chilhowee group was the initial deposit of the Appalachian miogeosyncline, and was thus laid down under different conditions and during a separate cycle of sedimentation than the Ocoee series. The miogeosyncline existed west of the older Ocoee eugeosyncline and persisted through the Paleozoic.

The oldest fossils in Miller Cove appear in Upper Chilhowee rocks. They are worm tubes of the <u>Scolithus</u> type and are found in the Helenmode member of the Hesse sandstone.

Succeeding formations of Lower Cambrian age, beginning with the

Shady dolomite and the following Rome formation, were deposited upon the Chilhowee group. The carbonate deposits of the Shady dolomite following the clastic deposits of the Chilhowee group indicate that the source area to the east had been eroded to a low level. The Shady dolomite was probably deposited in a warm, shallow water environment. The Rome formation which overlies the Shady dolomite is composed of siltstones, shales, and sandstones with interbedded limestones and dolomites. In other areas, the presence of primary structural features, i.e., mud cracks, oscillation ripple marks, and rain drop impressions in the Rome formation, indicate its deposition in a quiet, shallow sea. It is also probable that some of the clastic material in the Rome formation was derived from a source area to the west.

Post-Cambrian History

Deposition continued in the Appalachian Geosyncline building up great thicknesses of sedimentary material. Then were periods of diastrophic activity that developed time boundary markers between some formations.

The Appalachian Revolution which culminated in Late Paleozoic time deformed the sediments in the Valley and Ridge Province through the Early Permian: therefore, the Appalachian Revolution must have started before Early Permian. The Taconic Disturbance which began in Middle Ordovician may have been the beginning of the Appalachian Revolution. Due to movements during the Appalachian Revolution the rocks of the Valley and Ridge Province were compressed into a series of rather sharp folds with many faults.

Since the end of the Paleozoic the interior of eastern North America has been relatively high and the history of the area is concerned mainly with erosion and uplifts.

CHAPTER VI

MINERAL RESOURCES

General

The mineral resources of Miller Cove are limited to crushed stone, iron ore, and ground water. Ground water is the most valuable of the three and the only one utilized at the present. According to an old legend there is a lead deposit in the cove, but no trace of this deposit was found.

Crushed Stone

The two quarries in Miller Cove, now abandoned, were developed in the more massive members of the Shady dolomite. The crushed stone produced by these operations was used primarily as road metal. Some of the stone was crushed very fine and used locally as fertilizer. The road surfacing material now used on the roads in the cove is brought in from other areas.

Iron Ore

There has never been any economic production of iron ore in Miller Cove. There has been some prospecting. Many of the old prospect pits can still be found. Most of these pits are located at the base of Chilhowee Mountain in the southwest end of the cove. All of the pits found were in residium of the Shady dolomite. Small quantities of limonite are found in the residium of parts of the Shady dolomite.

Ground Water

Ground water is the most valuable single mineral resource of Miller Cove. All of the inhabitants of the area are dependent upon wells and free flowing springs for their water supply.

Most of the ground water is obtained from solution channels and joints in rocks of the Shady dolomite. Several small streams in the cove drain into sink holes in the dolomite. Many of these streams, after flowing short distances underground, reappear at the surface as springs.

The Ground Water Division of the United States Geological Survey for the past few years has been engaged in a program to determine the ground water conditions in East Tennessee. Upon publication of its report, a more accurate evaluation of the ground water condition of Miller Cove may be made.

BIBLIOGRAPHY

BIBLIOGRAPHY

Barrell, Joseph. "The Nature and Environment of Lower Cambrian Sediments of the Southern Appalachians," American Journal of Science, 5th series, Vol. 9, 1925.

Butts, Charles. "Geology of the Appalachian Valley in Virginia," Virginia Geological Survey, Bulletin 52, 1941.

_______. "Geology of Alabama: The Paleozoic Rocks," Alabama Geological Survey, Special Report No. 14, 1926.

Cooper, G. A. "New Brachiopods from the Lower Cambrian of Virginia," Journal of the Washington Academy of Science, Vol. 41, 1951.

Currier, Louis Wade. "Structural Relations of Southern Appalachian Zinc Deposits," Economic Geology, Vol. 30, No. 3, May 1935.

Dunbar, C. O. Historical Geology. New York: J. Wiley, 1949.

Fenneman, N. M. Physiography of the Eastern United States. First Edition. New York: McGraw-Hill Book Company, Inc., 1938.

Ferguson, H. W., and Jewell, W. B. "Geology and Barite Deposits of the Del Rio District, Cocke County, Tennessee," Tennessee Department of Conservation, Division of Geology, Bulletin 57, 1951.

P.28 Hayes (1891)

Howell, B. F. "Correlation of the Cambrian Formations of North America," Bulletin of the Geologic Society of America, 55: 993-1003, 1944.

Keith, Arthur. U.S.G.S. Atlas, Cranberry Folio. No. 90, 1903.

_______. U.S.G.S. Atlas, Knoxville Folio. No. 16, 1895.

_______. "Geology of Chilhowee Mountain in Tennessee," Bulletin of the Philosophical Society of Washington, 1892.

King, P. B. "The Tectonic Framework of the Southeastern United States," American Association of Petroleum Geologists, Vol. 34, No. 4, 1950.

_______. "The Base of the Cambrian in the Southern Appalachians," American Journal of Science, Vol. 247, 1949.

_______, and others. "Geology and Manganese Deposits of Northeastern Tennessee," Tennessee Department of Conservation, Division of Geology, Bulletin 52, 1944.

Moore, R. C. Historical Geology. First Edition. New York: McGraw-Hill Book Company, Inc., 1933.

Neuman, Robert B. "The Great Smoky Fault," American Journal of Science, Manuscript in press.

Resser, Charles E. "Cambrian System (Restricted) of the Southern Appalachians," Geological Society of America, Special Paper 15, 1938.

Rodgers, John. "Geology and Mineral Deposits of Bumpass Cove, Unicoi and Washington Counties, Tennessee," Tennessee Department of Conservation, Division of Geology, Bulletin 54, 1948.

Safford, James M. Geology of Tennessee. Nashville: G. C. Torbett & Co., 1856.

Snyder, F. G. "The Problem of the Lipalian Interval," Journal of Geology, Vol. 55, No. 3, Part 1, 1947.

Stephan, L. LeMar. "Geographic Aspects of Miller Cove," Economic Geography, Vol. 17, April 1941.

Stose, G. W. "Source Beds of Manganese Ore in the Appalachian Valley," Economic Geology, Vol. 37, No. 3, 1942.

________, and Stose, A. J. "The Chilhowee Group and the Ocoee Series of the Southern Appalachians," American Journal of Science, Vol. 242, 1944.

Swingle, George D. Master's Thesis, University of Tennessee, 1949.

Wheeler, Harry E. "Base of the Cambrian System," Journal of Geology, Vol. 55, No. 3, Part 1, May 1947.

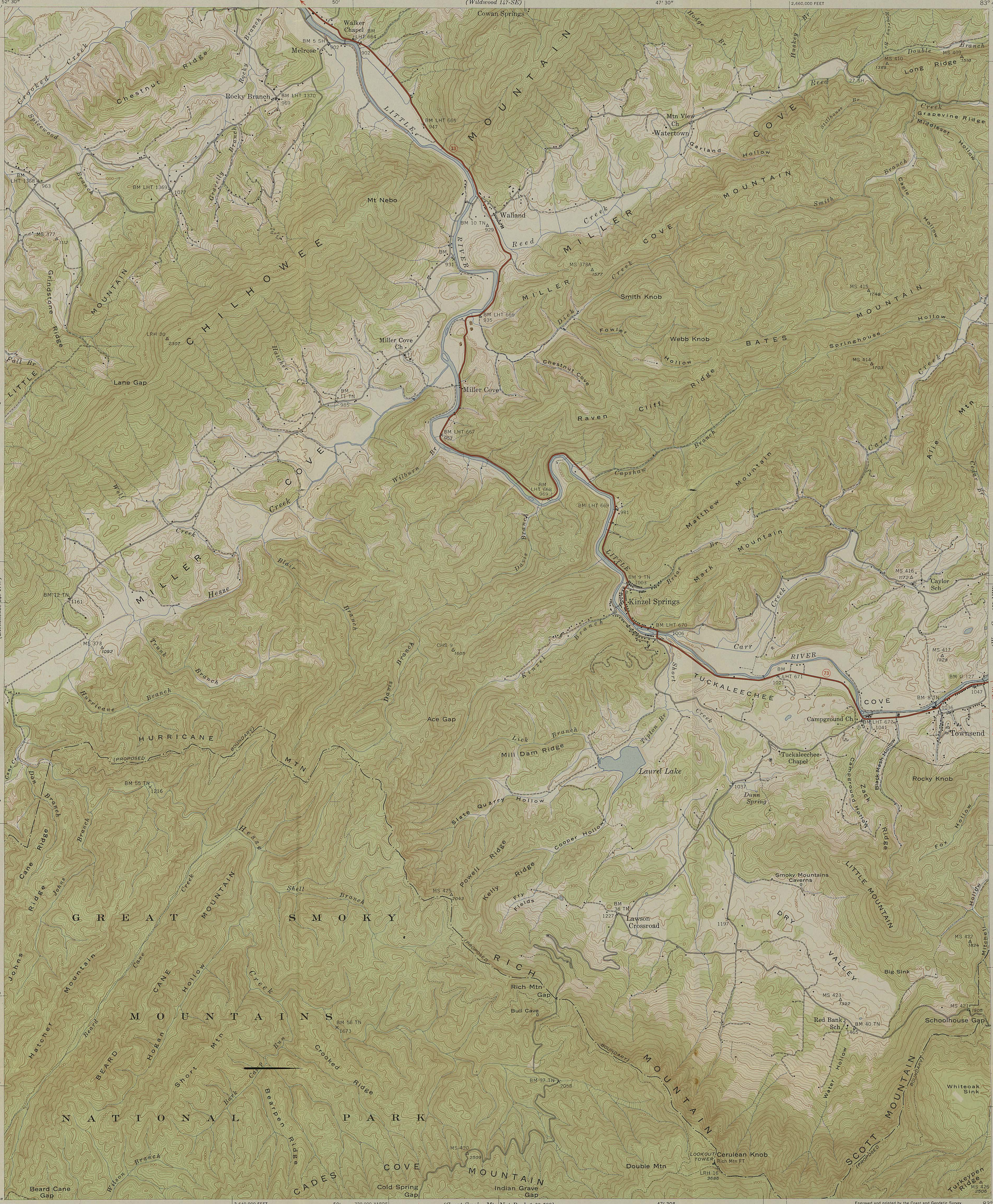
Wilmarth, M. Grace. "Lexicon of Geologic Names of the United States," U.S.G.S. Bulletin 896, 1938.

APPENDICES

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS DIVISION

TENNESSEE
(BLOUNT COUNTY)
KINZEL SPRINGS QUADRANGLE
148-NE



Control by USC&GS, USGS, and TVA
Topography by Geological Survey from aerial photographs by stereophotogrammetric methods
Field examination by Tennessee Valley Authority - 1940

Maps distributed by the Geological Survey

APPROXIMATE MEAN DECLINATION, 1941

Scale $\frac{1}{24000}$

Contour interval 20 feet
Datum is mean sea level

Engraved and printed by the Coast and Geodetic Survey

Polyconic projection. 1927 North American datum
10,000 foot grid based on Tennessee rectangular coordinate system
5,000 yard grid based on Zone system B

ROUTES USUALLY TRAVELED
HARD, IMPERVIOUS SURFACES
OTHER SURFACE IMPROVEMENTS
U. S. ROUTE
STATE ROUTE

KINZEL SPRINGS, TENN.
148-NE
Edition of 1941

N3537.5-W8345/7.5