6-1959

Geology of English Mountain and Vicinity, Cock, Jefferson and Sevier Counties, Tennessee

Robert Carl Greene
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Robert Carl Greene entitled "Geology of English Mountain and Vicinity, Cock, Jefferson and Sevier Counties, 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.

George D. Swingle, Major Professor

We have read this thesis and recommend its acceptance:

Paris B. Stockdale, C. E. McLaughlin, Otto C. Kopp

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

June 1, 1959

To the Graduate Council:

I am submitting herewith a thesis written by Robert Carl Greene entitled "Geology of English Mountain and Vicinity, Cocke, Jefferson and Sevier Counties, 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.

George D. Swingle
Major Professor

We have read this thesis and recommend its acceptance:

Paris B. Stockdale

C. E. McLaughlin

Otto C. Kopp

Accepted for the Council:

Dale Wantling
Dean of the Graduate School

THE GEOLOGY OF ENGLISH MOUNTAIN

AND VICINITY,

COCKE, JEFFERSON AND SEVIER COUNTIES,

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

Robert Carl Greene

June 1959

ACKNOWLEDGMENT

The writer is indebted to his major professor, Dr. G. D. Swingle, for many helpful suggestions on field mapping methods, as well as for criticisms of the manuscript of this thesis.

He is further indebted to Mr. Stuart Maher of the Tennessee Division of Geology for the loan of references and for stimulating discussion of the problems of the area.

He also wishes to express his gratitude to Mr. Charles T. Rhyne for permission to trespass on his property in the English Mountain area, and to numerous other property owners who were also generous with such permission.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Location and Access

English Mountain is located in middle East Tennessee near the junction of Cocke, Jefferson and Sevier counties. Its total length is 11 miles, from northeast to southwest. Newport and Chestnut Hill are the nearest towns, while Cosby and Sevierville are somewhat farther away. The small community of Carson Springs lies in a valley within the mountain. (See Figure 1.)

U. S. highway 411, connecting Sevierville and Newport, follows a major valley on the northwest side of the mountain, and secondary roads provide access to farms at its base. State highway 32 to the east connects Newport and Cosby. Two roads enter the area mapped: the Clevenger-Carson Springs road, which now extends to the top of the mountain, and the cross mountain road through Yellow Spring Gap.

The boundary for detailed mapping is the Great Smoky fault on the east, north and west. To the south, mapping ends at parallel 35-52 1/2° west of Lin Creek; east of there it was extended to the Sugar Camp Branch road.

History and Industry

The steep topography and scarcity of soil have rendered much

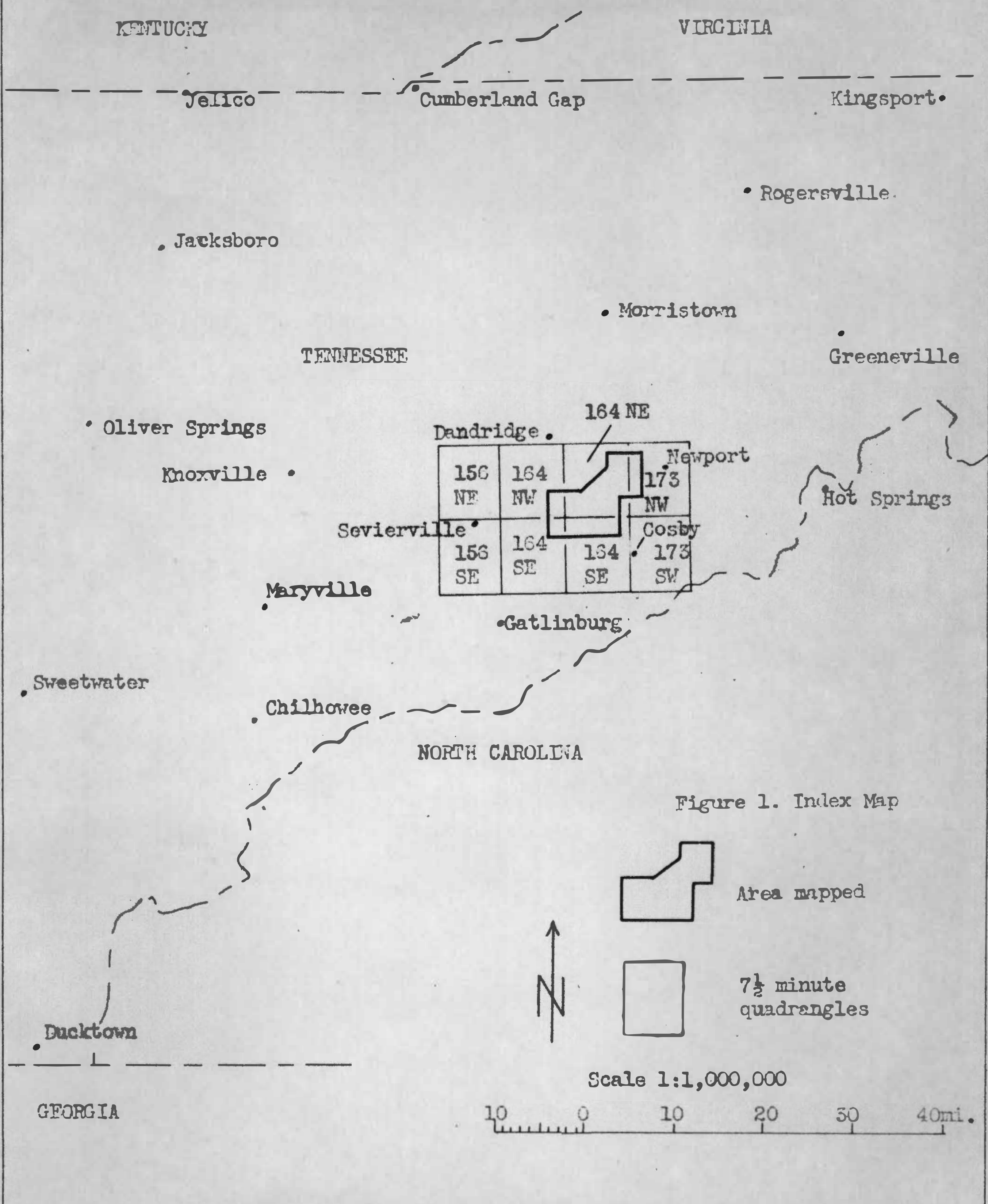

Figure 1. Index Map

of the mountain area useless for agriculture. Because of its height and position, however, the mountain has been a useful site for a fire tower. In addition, a three tower installation for radio communications with high altitude aircraft is currently being installed (June 1958). Since the turn of the century, the mountain has been gradually logged over, leaving little valuable timber remaining. Logging operations were followed in many areas by the stripping of chestnut oak for tanbark. The production of moonshine whiskey was formerly very extensive but has declined in recent years. The community of Carson Springs, the only settlement within the area, has grown from a summer resort to a deluxe Newport suburb. Here also, the Baptist Church has established a boys' summer camp (Camp Carson). Mineral industries, both past and potential, will be considered in Chapter V.

Topography

The central portion of English mountain consists of a double ridge, about five miles long. The two ridges unite at their western ends, forming an overall U shape. Here are the highest elevations of the mountain, reaching a maximum of 3,629 feet, in contrast to land as low as 1,400 feet close to the mountain's base. Between the ridges lies a high valley, flat and over 3,200 feet in the upper portion, but steep walled and declining rapidly in the lower. The valley is drained by Sinking Creek, which joins the Pigeon River above Newport.

At the northern end of the mountain, the double ridge terminates in a single east-west ridge, about four miles long, variable in height, and breached by Sinking Creek. Maximum elevation is the top of Round mountain, 2,680 feet.

West of the central portion, English mountain continues for six miles as a single ridge elongated east-west. Elevations decline westward from 3,360 feet at the Pinnacle to 2,460 feet at the most westerly summit.

Rich mountain, also mapped, lies to the south of the central portion of English mountain. It is an east-west ridge with a high point towards each end. The elevation of the eastern peak is 2,480 feet, that of the western, 2,920 feet.

Drainage

Drainage from the northwestern flank reaches the French Broad River directly through numerous creeks and branches. Drainage from the southeast flank flows to the Pigeon River via Bogard, English and other creeks. To the south, the principal drainage is into Wilhite Creek, then to the East Fork Dunn Creek and the Little Pigeon River. All drainage reaches the French Broad, and eventually the Tennessee River.

Vegetation

English mountain is largely covered with second growth and scrub hardwoods. Pines predominate only on very dry ridge crests and spurs. Rhododendron occurs generally only near semipermanent streams, but has gained a foothold on the steep slopes of the western part of the mountain.

Statement of the Problem

English mountain is interpreted by Rodgers (1953, Geologic Map of East Tennessee) as a remnant of rocks of the Chilhowee group, resting on a prong in the overthrust sheet of the Great Smoky fault. He showed the structure of the Chilhowee rocks to be synclinal in the central portion, monoclinal on the northern end, and monoclinal in the westward extension.

Objectives of the present writer were: 1) to check the major structure and detail the contacts, 2) to accurately locate the position of the Great Smoky fault, 3) to map minor structures, 4) to study the stratigraphy of the Chilhowee group. In connection with the latter: a) the rock types and separation of the Hesse-Murray-Nebo sequence, b) the lithology and subdivisions of the Cochran formation, c) the Chilhowee-Ocoee contact, and d) the base of the Cambrian system were studied specifically.

Previous Work

The students of the Chilhowee rocks and of the faults bordering the mountain province have been numerous, but few have mentioned English mountain. Actual field work in the area has been limited, if not entirely absent.

Safford (1869, p. 29) mentioned "English's mountain" as one of the "Foothills of the Great Smoky," which foothills he designates the Chilhowee range. The rocks underlying the Chilhowee range are called by him the Chilhowee formation, a part of his lower Silurian[1] Potsdam group.

Keith included English mountain in his Mount Guyot 30 minute quadrangle (unpublished). His interpretation was surprisingly accurate but much of it has not passed the test of further work with better base maps. He mapped as Nebo quartsite much that we now understand to be the upper part of the Cochran, and similarly substituted Murray shale for Nichols shale, and Hesse quartsite for Nebo quartsite. The white quartsite on Rich mountain he interpreted as Nebo, and adjacent exposures of dolomite as Shady. The present writer places the white quartsite in the Cochran, and designates the dolomite as Knox, exposed in a reentrant of the Great Smoky fault. In Keith's favor it may be said that he included a more nearly continuous belt of Sevier shale around the mountain than did later interpreters.

Stose and Stose (1944, p. 372) include English mountain in a general map illustrating their interpretation of structure in the Unaka range. They indicate that the Ocoee series is thrust from the south against the Chilhowee rocks. Their fault, however, runs approximately from Yellow Spring Gap to the junction of the two forks of Bogard creek. The writer found this to be a line of minor lithologic changes. Additionally, they place an area of "Shady dolomite and younger rocks" along the southeast flank of the mountain. This was not confirmed by the writer.

---

[1]Cambrian of present usage.

Rodgers' map of East Tennessee (1953) includes English mountain on the Mount Guyot sheet. His work represents the first attempt since that of Keith to subdivide the Chilhowee group. His results come much closer to the true picture, although he includes a considerable area of Murray shale in the northern part of the mountain. The writer found the presence of this unit to be doubtful. In addition, Rodgers drastically reduces the thickness and extent of the Cochran formation, replacing much of it with the Sandsuck shale (a unit in the Ocoee series) in conformable sequence below the remaining Cochran. This is not in agreement with the writer's interpretation.

King, et al. (1958) include the English mountain area in their general map to illustrate the latest scheme for subdividing the Ocoee series. They again introduce a fault separating the Chilhowee rocks completely from the Ocoee series. Their fault, however, lies south of Rich and English mountains, and does not cut across either. The writer confirmed the presence of the eastern portion of this fault. King reduces the area of the Sandsuck formation considerably, yet retains more than does the present writer.

CHAPTER II

PHYSIOGRAPHY

English mountain presents an outstanding example of the structural control of topographic features. According to the subdivision of the Appalachian highlands by Fenneman (1938) the mountain falls in the Blue Ridge province and the west base forms the boundary of that province. Considering the detailed map of the area, the Great Smoky fault forms an excellent province boundary, with the footwall area lying in the Great Valley, and the thrust sheet forming a prong of the Blue Ridge province.

The main ridge former in the mountain area is the upper member of the Cochran formation. Erosion of adjacent formations has produced up to 1,100 feet of relief on this unit, forming a double ridge with outward facing escarpments. This mirrors the synclinal structure. Quartzite bodies hold up peaks of exceptional height, such as The Pinnacle and The Lookoff.

The heterogeneity of the lower member of the Cochran is reflected in the varying altitude of the land surface developed on it. On Rich mountain, an area of the quartzite member has also caused 1,100 feet of relief to develop, without the aid of other resistant formations.

Toward the western end of English mountain, the altitude of the trace of the Great Smoky Fault rises, and up to 800 feet of relief is attained on the Knox and Sevier formations. The presence of the relief is also in this case owing to the caprock effect of the Cochran sandstones.

The Ocoee shales south of the mountain underly a rough, knobby, intricately dissected area of no great relief. This is quite typical of the topography developed on broad belts of shale, particularly in the Appalachian region.

Referring again to the synclinal portion of the mountain, the Hesse-Nebo quartsite adds an additional 400 feet of elevation to the highest part of the mountain, its basin structure exactly mirrored in the gentle basin shape of its inner surface. It, too, has an outward facing escarpment slope. Between the Hesse-Nebo and the Cochran, the Nichols shale underlies a shelf area. Here the slope lessens substantially, providing the climber with an opportunity to pause for breath.

At the northern end of the mountain the resistant formations dip too steeply to allow their relief-producing effects to compound, hence altitudes are lower. The east-west strike of the Hesse-Nebo quartsite is clearly shown in an east-west ridge with a maximum relief of 900 feet. The changes of strike towards the eastern end of the mountain are also reflected in the trend of this ridge.

The non-resistant character of the Shady is reflected in the steady decline of the land surface away from the Chilhowee rocks. Physiography is believed to be important in the formation of manganese deposits in the Shady residuum. Flat or terrace-like areas close to the contact with the Chilhowee group are considered favorable. Several such areas were prospected in the English mountain area. (See Chapter V.)

The Rome shales, although present only in a relatively small area, show the knobby topography for which the Rome is well known.

CHAPTER III

STRATIGRAPHY

General

The major rock units of Eastern Tennessee were recognized as early as 1865 by Safford, further elaborated on by Keith, and described in currently acceptable form after much further work by Rodgers (1953). A summarized stratigraphic column is presented in table 1.

The formations mapped in the English mountain area are listed and briefly described in Table 2. They include a complete upper Pre-cambrian-lower Cambrian section from the Chilhowee group through the Rome formation in the hanging wall, and Sevier shale and Knox dolomite in the footwall.

Ocoee Series, Undifferentiated

Ocoee rocks were mapped by the writer between Rich mountain and the Sugar Camp Branch road. Their thickness is not possible to estimate, since neither the base nor the top of any specific unit was observed.

The rocks consist almost entirely of shales, with occasional interbeds of sandstone and conglomerate. The shales are thin-bedded, silty, and micaceous. The mica is commonly concentrated in thin, evenly spaced beds, giving the shale a finely laminated appearance.

Table 1. General Stratigraphic Column for East Tennessee

Pennsylvanian	Lower	Lee sandstone
Mississippian	Upper	Newman limestone
	Lower	Grainger, Fort Payne formations
Devonian-Mississippian		Chattanooga shale
Silurian	Lower	Clinch, Rockwood formations
Ordovician	Upper	Juniata formation
	Middle	Chickamauga group, including Sevier shale
	Lower	Knox group
Cambrian	Upper	
	Middle	Conasauga group
	Lower	Rome formation
		Shady dolomite
Precambrian		Chilhowee group
		Ocoee series
		gneiss and granite

Table 2. Stratigraphic Column for the English Mountain Area

			Formation	Thickness	Lithology
Ordovician	Middle		Sevier shale	1000', top not preserved	Shales, blue-gray and calcareous
	Lower		Knox dolomite	base not preserved	limestone and dolomite, gray-blue and thick bedded
Cambrian	Upper				
Sequence broken by faulting					
	Lower		Rome formation	1000', top not preserved	shale, varicolored and micaceous
			Shady dolomite	800'	represented only by "jasperoid" float
		CHILHOWEE GROUP	Hesse-Nebo quartzite	1000'	quartzite, fine-grained and pure white
Precambrian		CHILHOWEE GROUP	lower member	100'	quartzite, gray, with some clays
		CHILHOWEE GROUP	Nichols shale	400'	shale, greenish-gray, micaceous and silty
		CHILHOWEE GROUP	Cochran formation	2600', base not preserved	arkose, quartzite and conglomerate; yellow and red shales
			Ocoee series	indeterminate	shales, blue-grey yellow weathering laminated silty-micaceous

The fresh shale rock, seen rarely in outcrop, is blue-gray in color and non-fissile, breaking in large blocks. Cleavage is detectable at a few outcrops only, but chevron folding of an amplitude of about three feet is often developed. This is illustrated in Figure 2.

The sandstones and conglomerates occur as interbeds and lenses within the shale sequence. They are coarse, arkosic, poorly sorted and cemented, commonly forming an abrupt contact with the shale.

The Ocoee rocks weather deeply, so that nearly all outcrops, including those in roadcuts, consist of the yellow-brown softened shale which can be dug out with a pick. The sandstones, also, are soft and porous. The softened silty shales form a soil of fair quality. Thus many fairly prosperous farms are to be found in their outcrop area.

No fossils have been found in rocks of the Ocoee series anywhere. This fact plus the absence of a major unconformity between the Ocoee rocks and the lowest fossils (at the top of the Chilhowee group) has led to much controversy about the age of the series. The present writer, following custom, considers the Ocoee to be Precambrian. A discussion of the age question is presented in the section on the Chilhowee rocks.

Recently, geologists of the Great Smoky Mountains field party of the U.S.G.S. (King, 1958) have subdivided the Ocoee series into three groups: the Snowbird group, the Great Smoky group, and the Walden Creek group. The Ocoee rocks mapped by the writer are a part of the Walden Creek group as indicated on the general map by King

Figure 2. Incompetent folding in the Ocoee shales. Sugar Camp Branch road.

(1958), but are probably not a part of the Sandsuck formation as now defined. Correlation of these rocks awaits the publication of a paper by W. B. Hamilton of the U.S.G.S. on the geology of the Jones Cove and Richardson Cove quadrangles.

The Chilhowee Group

General

The name "Chilhowee group" has been applied with varying consistency to a sequence of clastic rocks of lower Cambrian and possible Precambrian age that outcrops discontinuously from the Susquehanna river in Pennsylvania to the terminus of the Appalachians in Alabama. They are usually found capping the Blue Ridge or its western foodhills. The rocks of this segment were probably physically continuous at the time of deposition. Rocks of similar lithology and possibly equivalent age recur sporadically from eastern Pennsylvania to Gaspé. Physical continuity between the two segments, and within the northern segment, is doubtful.

The Chilhowee rocks consist of sandstone, conglomerate, and shale, and their metamorphosed equivalents. The sandstones are dominantly orthoquartzite and arkose, and the shales micaceous and silty varieties. The conglomerates are lenses and interbeds in the sandstones, and rarely contain pebbles larger than one inch.

Many excellent descriptions of Chilhowee sections have appeared in the literature, as well as regional summaries of the rock types and lateral variations. Among the sections described at specific localities, those at South Mountain, Pennsylvania (Stose, 1953), Harpers Ferry, Virginia-West Virginia (Nicklesen, 1956), and Doe River gorge, Northeastern Tennessee (King, 1944) may be cited. A description of the section on Chilhowee mountain (middle East Tennessee) by Swingle and Ferguson will be included in future publications of the U.S.G.S. Regional summary descriptions have been provided for Virginia by Butts (1946), for Tennessee by Rodgers (1953) and King (1949), and for Alabama by Butts (1926). Other descriptions available include those in folios by Keith for Tennessee, Butts for Alabama, and Stose for Pennsylvania and Maryland.

Correlation

The thickness, lithology, and correlation of the various formations of the Chilhowee sequence has been summarized by Rodgers (1956). He includes in addition to the main outcrop belt, supposedly equivalent clastic units as far north as New Jersey, and highly metamorphosed sequences east of the Blue Ridge, also believed equivalent. The correlations are summarised in Table 3.

Rodgers bases his correlation entirely on the thickness and lithology of the rock units and visualizes the Chilhowee group as a three-fold sequence, characterized by quartzite in the upper unit, shale in the middle unit, and conglomerate in the lower unit. The section on English mountain displays this same sequence.

Age of the Chilhowee group

The age assignment of the Chilhowee group, as well as the under-

Table 3. Correlations of the Chilhowee Group and Equivalent Rocks, According to Rodgers, 1956

Location	Penna.-New Jersey border	WNW of Philadelphia, Penna.
Overlying rocks	Kittatiny ls.	Vintage dol., Conestoga ls.
Chilhowee equivalents	Hardystown fm. 0-300'	Antietam qtzt. 450'
		Harpers phyllite 1000'
		Chickies qtzt. 1000'
Underlying rocks	gneiss, schist & marble	gneiss, schist & marble

Location	York Co., Penna.	Baltimore Co., Md.
Overlying rocks	Vintage dol., Conestoga ls.	
Chilhowee equivalents	Antietam qtzt. 200'	Peach Bottom slate 1000'
	Harpers qtzt. 1000'	Cardiff cong. 100'
	Chickies qtzt. 800'	Glenarm group
Underlying rocks	Catoctin volcanics	Wissahickon fm.

Location	W. of Fredrick, Md.	Elkton, Va.
Overlying rocks	Tomstown dolomite	Tomstown dolomite
Chilhowee equivalents	Antietam sandstone 800'	Antietam qtzt. 800'
	Harpers shale 2000'	Harpers shale 900'
	Weaverton sandstone 1000'	Weaverton qtzt. 1600'
Underlying rocks	Loudon fm.	Loudon fm.

Table 3, continued

Location	NE of Lynchburg, Va.	SE of Johnson City, Tenn.
Overlying rocks	Evington group (upper)	Shady dolomite
Chilhowee equivalents	Candler phyllite 8000'	Erwin qtzt. 1400'
		Hampton shale 1400'
		Unicoi fm. 5000'
Underlying rocks	Lynchburg gneiss	Mt. Rodgers volcanics

Location	50 mi. E. of Knoxville, Tenn.(French Broad river)	Great Smoky Mountains,Tenn. (spec. Chilhowee Mtn.)
Overlying rocks	Shady dolomite	Shady dolomite
Chilhowee equivalents	Erwin qtzt. 2000'	Hesse qtzt. 400', Murray shale 500', Nebo qtzt. 250'
	Hampton shale 2000'	Nichols shale 700'
	Unicoi fm. 5000'	Cochran cong. 1000'
Underlying rocks	Ocoee series	Sandsuck shale (part of Ocoee series)

Location	Murphy belt, N. Ga.
Overlying rocks	Murphy marble
Chilhowee equivalents	Brasstown fm. 1500'
	Tusquitee qtzt. 200'
	Nantahla slate 1800'
Underlying rocks	Great Smoky group

lying unfossiliferous clastic and volcanic rocks, has long been a subject of controversy. Ages of the Chilhowee rocks as suggested by various writers are summarized in Table 4.

The evolution of thought on the base of the Cambrian system in the Appalachians is interesting to follow. Fossils representing the lower Cambrian Olenellus fauna were described from the topmost beds of the Hesse quartzite by Walcott (1890, p. 570), and these have since been confirmed (King, 1958, p. 964). In addition, Keith (1895) reported fossils from the Murray shale at two localities on Chilhowee mountain. However, one locality was misplaced stratigraphically, and the other has failed to yield more fossils and is now considered doubtful.

The earlier workers (Safford, Keith, Ulrich and Barrell) sought merely for a major unconformity below the lowest fossils and placed the Cambrian-Precambrian boundary there. Thus not only the Chilhowee but the thousands of feet of Ocoee sediments were placed in the lower Cambrian.

Snyder (1947) took the opposite viewpoint, arguing that the base of the Cambrian system should be placed directly below the lowest fossils. He believed that fine marine silts (apparently he was referring to the Nichols, Hampton and equivalent shales) which appeared to have been formed in environments favorable for marine life must be assigned to the Precambrian if unfossiliferous. He considered the acquisition of the shell forming habit by marine organisms to have taken place in a short time and during a period of continuous deposition of sediment.

Table 4. Age of the Chilhowee Group, According to Various Writers

Writer	Year	Formation	Age
Safford	1869	Chilhowee formation	Lower Silurian (Cambrian of present usage)
Keith	1895	Chilhowee group	Lower Cambrian
Ulrich	1911	Chilhowee group	Lower Cambrian
Barrell	1925	Chilhowee group	Lower Cambrian
Snyder	1947	Hesse quartzite Murray shale, upper	Lower Cambrian
		Murray shale, lower Nebo quartzite Nichols shale Cochran formation	Precambrian
King	1947	Chilhowee group	Lower Cambrian
Rodgers	1953	Chilhowee group	Lower Cambrian
Rodgers	1956	Hesse quartzite	Lower Cambrian
		Murray shale Nebo quartzite Nichols shale Cochran formation	Lower Cambrian (?)
King	1958	Hellermode member	Lower Cambrian
		rest of Chilhowee group	Precambrian (?)
Greene	1959	Hesse-Nebo quartzite	Cambrian and Precambrian (?)
		Nichols shale Cochran formation	Precambrian

This event, he believed, marked the beginning of Cambrian time.

Following the introduction of the concepts of the eugeosyncline and miogeosyncline, King, in an elaborate discussion (1949) proposed placing the base of the Cambrian at the base of the Chilhowee group. He believed that this horizon represented a major tectonic change, terminating eugeosynclinal and introducing miogeosynclinal deposition in East Tennessee. This interpretation was adopted by Rodgers in his 1953 work.

Later on, however, Rodgers (1956) withdrew his concurrence and considered the Chilhowee group as of doubtful Cambrian age below the lowest fossils in the Murray. He further designates the Ocoee series, Mt. Rodgers group, and other controversial rocks below the Chilhowee as "Cambrian or Precambrian," reserving unquestioned Precambrian for gneisses and granites radioactively dated at more than 550 million years.

The workers in the Great Smoky mountains field party (1946-1955) failed to confirm the presence of fossils in the Murray shale. This result has caused King to withdraw his previous interpretation, so that he now (1958) considers the Chilhowee group below the Helenmode member (upper part of the Hesse quartzite) to be Precambrian (?).

The present writer believes that the base of the Cambrian, like any other systemic boundary, must be based chiefly on paleontologic evidence. The beginning of the Cambrian period is considered by many to be that time when certain marine animals acquired the ability to form shells. The writer can see no reason why this biologic phenomenon should be considered to be contemporaneous with certain tectonic events such as the filling of a eugeosyncline or the production of an unconformity. Therefore, the writer is most inclined to agree with Snyder in assigning the Nichols shale, equivalent and lower units to the Precambrian.

In the upper Chilhowee rocks, the presence of the Murray shale in the "southern sequence" from Chilhowee mountain south-west introduces further complications. If the Murray is indeed unfossiliferous and represents an environment suitable for marine life, then it, the Nebo quartzite, and the lower part of the Erwin quartzite must all, similarly, be assigned to the Precambrian. However, because of the possibility of fossils in the Murray, the writer must consider the Hesse, Murray, Nebo and Erwin as Cambrian and Precambrian(?).

<u>The Cochran Formation</u>

<u>General</u>. Rocks of the Cochran formation occur on both flanks of the English Mountain syncline, on the westward extension and southward over Rich mountain to the contact with the Ocoee shales. The writer has divided the Cochran formation into four members. These are an upper member, a red shale member, a quartzite member, and a lower member.

The Cochran has yielded no fossils, either on English mountain or elsewhere.

<u>Lower Member and Quartzite Member</u>. The lower and quartzite members include all the rocks lying stratigraphically below the red

shale member. These occur south and west of the English mountain syncline.

The lower member is the most heterogeneous part of the Cochran formation. It consists of sandstone, conglomerate, and shale. Lenses and interbeds of fine, clean quartzite occur, and where large enough to be mappable have been designated as the Quartzite member.

The sandstones are arkoses and quartzites, poorly sorted and poorly rounded. The grain sizes vary from fine sand through coarse sand to fine conglomerate. Where a considerable proportion of pebbles are present the bed is designated a conglomerate; all gradations are present. The cement is generally silica and the finer quartzites are well cemented. The coarser rocks are, however, poorly cemented and crumble easily after moderate weathering.

The Quartzite member is differentiated on Rich mountain and on English between Stinnett and Yellow Spring gaps. The rock type of this member is a white, fine-grained, cleanly washed, well cemented, vitreous quartzite. It contains but few heavy minerals. Almost no bedding is visible and few strike and dips may be obtained. In addition, the rock is often sheared and recrystallized, obliterating any primary structures. Outcrops of this rock type were also observed within the area mapped as the lower member.

The quartzite on Rich mountain was mistaken for Nebo by Keith (unpublished data). The lithology is indeed similar, but the massive character, the lack of the Scolithus tubes, and the lack of the Nichols shale beneath make this interpretation unacceptable.

Other quartzites in the lower member of the Cochran are coarser and more poorly sorted. These are generally white and clean but may contain 1/2 percent heavy minerals. Quartzite of this type is well exposed along the Yellow Spring Gap road (partly in the Red shale member). Here iron-bearing solutions have stained the rock in interesting patterns. Some exposures exhibit a crisscross pattern related to fractures, others concentric banding or liesegang. (Figures 3 and 4)

The arkoses of the lower member are medium to coarse grained and poorly sorted. Feldspar content usually does not exceed 25 percent. The feldspar grains are usually smaller than those of the surrounding quartz, and may be distinguished by their white to pink color, good cleavage, and weathered nature. The arkoses, too, are usually recrystallized. Close examination reveals that the quartz grains are often large, angular, and interlocking, resembling those in an igneous rock. This form must have been produced by secondary overgrowth of silica on the original grains. A thin section would probably reveal the original grain boundaries in "ghost" outline. This phenomenon may account for the disparity in grain size between quartz and feldspar. The arkoses contain few heavy minerals.

Shales of the lower member of the Cochran are yellow-brown to greenish (weathered outcrops), micaceous and silty. They are interbedded with sandstones and conglomerates, possibly becoming more prominent lower in the section.

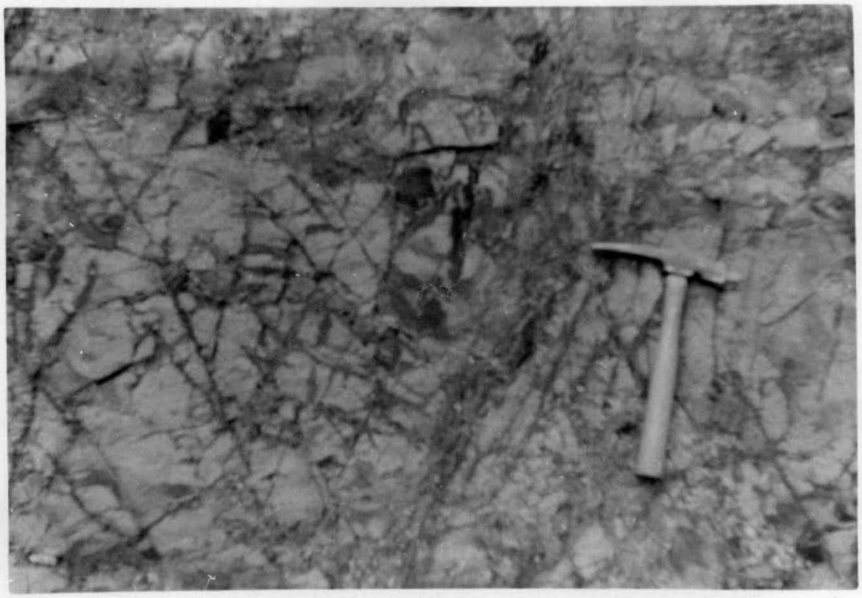

Figure 3. Criss-cross iron staining in coarse quartzites of the Cochran formation. Yellow Spring Gap road.

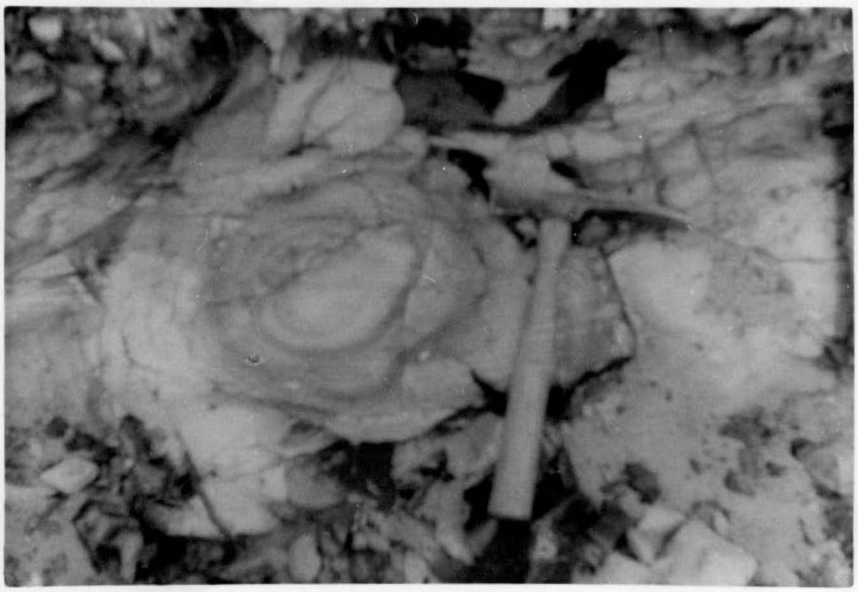

Figure 4. Concentric iron staining in coarse quartzites of the Cochran formation. Yellow Spring Gap road.

Interpretation. The presence of shales below the ridge-forming portion of the Cochran led Rodgers (1953) and Hamilton (personal communication, 1958) to map some of the Lower member of the Cochran as Sandsuck shale (top unit of the Ocoee series). The writer believes, however, that the Red shale member forms a significant key bed at a definite stratigraphic position, and, since it is lacking outside of the single band mapped, all rocks to the south and west must be stratigraphically lower. Therefore, these rocks must be all Cochran or all Sandsuck, unless a new contact not adjacent the Red shale member was recognized.

This is in conflict with interpretations by Rodgers and Hamilton, who introduce Sandsuck below the Red shale exposures, then reintroduce Cochran on Rich mountain and the western part of English mountain, where no red shale is exposed.

Reliable strike and dip information in the Lower member of the Cochran is difficult to obtain; that shown on the accompanying map must be considered as doubtful. Therefore, structural complications not detected by the writer may occur southwest of the well-defined English Mountain syncline.

The writer believes that the presence of the irregularly distributed quartzite and shale units within the Lower member of the Cochran must be ascribed to changes in facies.

Red Shale Member. The Red shale member has been mapped in a single continuous belt from the Great Smoky fault near Yellow Spring gap to the same fault on the opposite side of the mountain. It is approximately 300 feet thick.

The rock types of the lower member persist into the Red shale member. In addition maroon shales and arkoses are characteristic of the Red shale member. The red shales are silty, micaceous and finely laminated. They usually appear at abrupt contacts with sandstone (see Figure 5) but may interbed marginally with light green shales of similar composition.

Red arkoses also appear in the Red shale member. These are similar to previously described arkoses, but contain red coloring matter between sand grains. The redness of this material as well as that in the shales is due no doubt to the presence of iron oxides in the ferric state, while iron in the adjacent green shales is in the ferrous state.

A lens of blue quartz grains was observed at a single locality in the Red shale member on the Yellow Spring Gap road. This material formed a poorly cemented, crumbly, coarse sandstone.

Weathering phenomena in the Red shale member may be observed in the excellent road cut exposures. The iron staining has been mentioned above. The permeability of the coarse sandstone allows easy penetration by ground water, causing removal of cement and consequent softening of the rock. Thus an abundance of detrital sand is washed from the road cut exposures.

Upper Member. The Upper member of the Cochran formation is found in a continuous horseshoe-shaped belt of outcrop from the Pinnacle northeastward, giving definition to the mountain and the

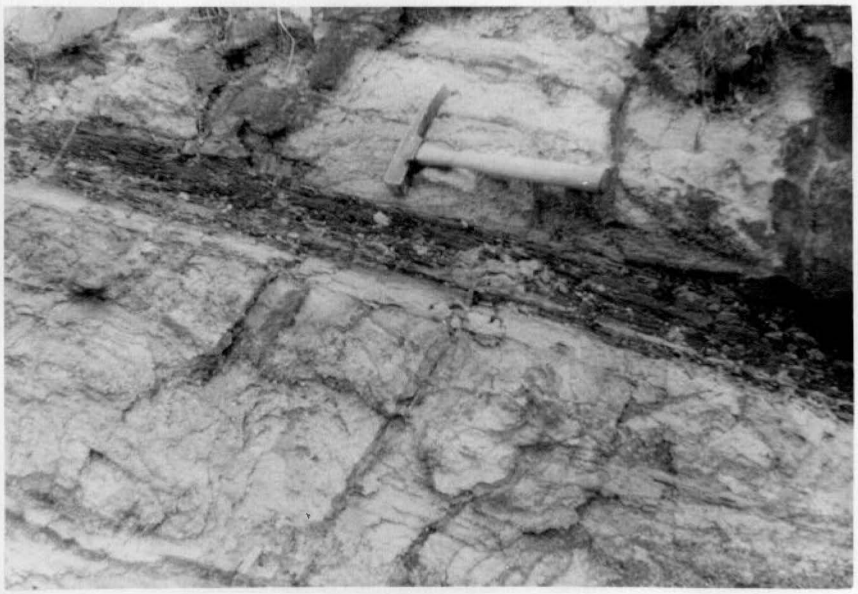

Figure 5. Bed of red, silty shale in Red shale member of the Cochran formation. Sandstone and conglomerate above and below. Yellow Spring Gap road.

syncline. Its thickness may vary considerably; where the base is preserved it is about 1,300 feet. The predominant rock type of the upper member is arkosic sandstone, fine to coarse, poorly sorted, with few heavy minerals. Lenses of conglomerate are rare.

Quartzite is less abundant than in the lower member. Bodies of this rock type occur with increasing frequency toward the top of the section, however, and cap such prominent summits as The Pinnacle and The Lookoff. The quartzites are similar to the coarser varieties of the lower member, i.e., poorly sorted, poorly cemented, and containing few heavy minerals. They, too, show recrystallization and secondary overgrowths.

Shales are rare in the upper member. The writer found only two occurrences, one a lens of an unusual olive-brown color which occurred at an altitude of 2,500 feet directly northwest of the Pinnacle. The other was red shale, perhaps a remnant of the Red shale member. It occurs along the minor creek directly northwest of Finchum cemetery.

The lack of shale in the hanging wall rocks has led the writer to reject the occurrence of Sandsuck shale on the flanks of the mountain, as reported by Rodgers (1953) and King (1958).

Primary Structures in the Cochran Formation. The Cochran sandstones are notable for their cross-bedding. This may be observed in roadcut exposures along the Yellow Spring Gap road and in cliffs and stream beds elsewhere on English Mountain. Various types of cross-bedding are illustrated in figures 6 and 7. Notable features are the

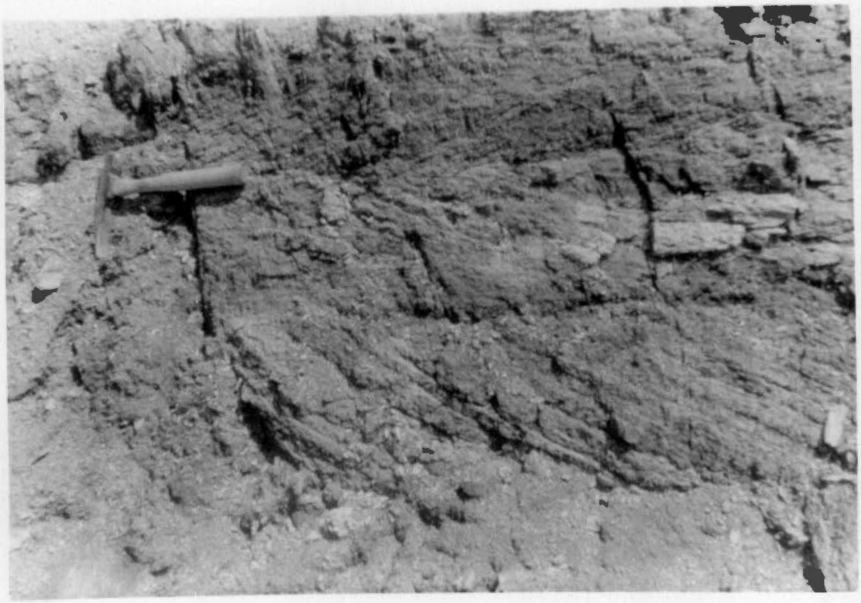

Figure 6. Cross-bedding of herringbone-deltaic type. Note even cross-beds deposited by currents from approximately opposite directions. In Red shale member of the Cochran formation, Yellow Spring Gap road. Hammer handle parallel to principal bedding.

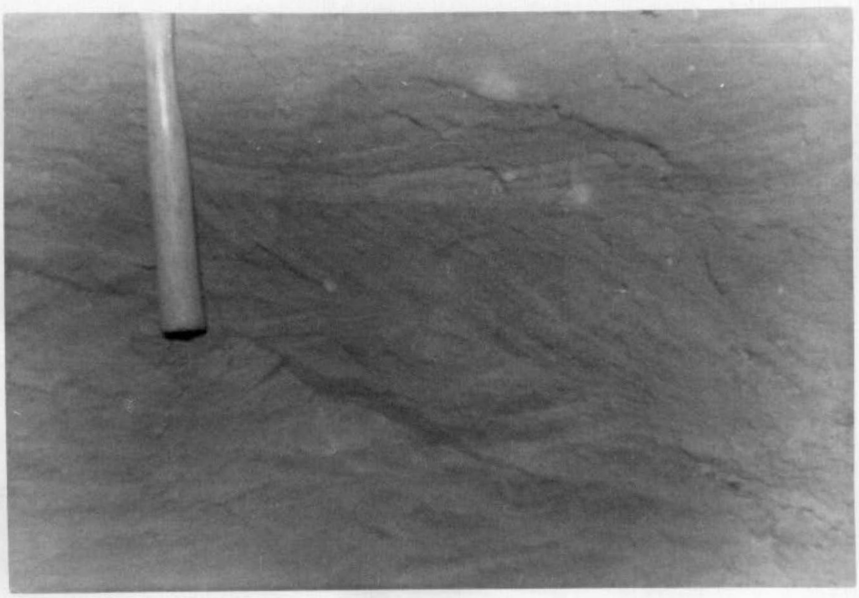

Figure 7. Cross-bedding of torrential type, showing shifting current directions. Red shale member of the Cochran formation, at Yellow Spring Gap.

irregularity of cross-bedding and the changing direction of inclination in the foreset beds, suggesting deposition by shifting currents.

Small "mud ball" pellets were observed in the sandstones at one locality. These pellets were composed of greenish-micaceous-silty material probably containing glauconite, and occurred along a single bedding plane in an outcrop composed mainly of arkoses.

No Scolithus tubes were observed in the Cochran formation.

Nichols Shale

The Nichols shale occurs as a semi-circular band within the English Mountain syncline, and continues as a wide belt of outcrop northward past Carson Springs. A narrow belt reaches the Great Smoky fault near the eastern end of the mountain.

The Nichols is poorly exposed. Although outcrops of the upper member of the Cochran are numerous, exposures usually cease when the contact with the Nichols is reached. The best exposures of the Nichols are found on the mountain road between Carson Springs and the fire tower, and on steep cliffs and in the bed of Sinking Creek directly above Carson Springs.

Where the top and base are preserved, the Nichols is about 400 feet thick. Calculations of thickness based on outcrop width and amount of dip indicate a variable thickness, but care must be exercised in measuring the thickness of such incompetent materials sandwiched between competent units.

The Nichols where observed consisted of uniform silty and micaceous shale and mudrock. Like many such rocks, it is blue-grey when fresh but usually found in weathered outcrops. The weathered Nichols is olive-green to brown, lacking the yellow color of the Ocoee shales.

Mica is sometimes concentrated in thin bands, giving the rock a laminated appearance. These are generally less even than those in the Ocoee shales, so that the rock often breaks into slabs with irregular curved surfaces.

Siltstone and fine sandstone with argillaceous cements occur occasionally in thin beds. No Scolithus tubes were observed in these beds, although they have been reported from the Hampton formation (Rodgers, 1953, p. 39).

The Nichols shale forms a thin soil that is full of chips. However, such a soil often has little opportunity to develop, being covered by float and talus from the sandstones which outcrop upslope.

The Nichols has yielded no fossils, other than the controversial Scolithus.

Hesse-Nebo Quartzite

The Hesse-Nebo quartzite is present in an elliptical area in the center of the English Mountain syncline, and in an east-west outcrop belt at the north end of the mountain. In the syncline a lower member was distinctive, and could be differentiated. The Hesse and Nebo are here treated as one formation. The writer found but one doubtful occurrence of the Murray shale, which is supposed to separate the two quartzites.

The thickness of the Hesse-Nebo is about 800 feet in the northern belt, where top and base are preserved. In the syncline about 500 feet are preserved; however, the lower member is greatly thickened near Sinking Creek, probably because of structural complications.

The characteristic lithology of the Hesse-Nebo is quartzite. This is fine-grained, well-sorted, and moderately well-rounded. It is usually composed solely of quartz grains plus silica cement but some beds contain about one-half percent heavy minerals. The fresh rock is very hard and breaks with difficulty, forming splinters with a vitreous luster. Bedding is massive and often indistinct. Other primary structures include wavy bedding surfaces suggesting ripple marks and pit-like marks suggesting rainprints. Cross bedding of an even, deltaic type was observed at two or three localities.

Scolithus tubes are abundant in these quartzites. At many large outcrops they permeate all the rock in view. The tubes themselves consist of rod-like structures, very straight and perpendicular to the bedding. They are about one-fourth inch in diameter and spaced one to two inches apart. They are made visible by the presence of slight concentrations of coloring matter at their edges, or by even alignment of sand grains within. If they are truly of organic origin, the animal would have had to resist the vigorous wave and current action necessary to sort and wash the sands, while such hard parts as it may have possessed were not preserved. It is possible that the tube linings dissolved during consolidation of the sandstone.

Clean, silica-cemented quartzites of the Hesse-Nebo type are among the most resistant rock types possible. Thus the rocks of this formation respond but slowly to the attack of weathering agents. Near rectangular blocks break off from steep faced exposures; the loci of breaks is determined by jointing or by the Scolithus tubes. These blocks persist with little decomposition until they come to rest on a horizontal surface, where penetration of water finally removes cement and the rock crumbles. A weathering crust of brown oxides is commonly found about one-eighth inch below the surface on decomposed blocks.

A thin soil of sand and humus forms over gentler slopes on this formation.

The writer found no fossils besides Scolithus in the Hesse-Nebo. The topmost beds of the Hesse have yielded fossils elsewhere, however. (See "Age of the Chilhowee group," p. 22.)

Lower Member of Nebo Quartzite. The lower member of the Nebo was differentiated in the English mountain syncline. In the northern belt of outcrop it was not distinctive enough to merit separate mapping. The lower member is probably about 200 feet thick. The apparently greater thickness near Sinking creek is probably due to structural repetition.

The lower member of the Nebo is darker and more thinly bedded than the main portion of the Hesse-Nebo. This color difference is owing to both change to smoky quartz as the dominant constituent and to the presence of argillaceous cementing material. Thus the lower member may be considered to represent a Nichols-Nebo transition.

Murray Shale

A narrow zone of shale within the Hesse-Nebo was observed at two points on Grindstone Mountain and has been indicated as the Murray shale on the map. Shale in this horizon was not found elsewhere in the English Mountain area. This fact is surprising because either the Murray shale or a middle shale member of the Erwin quartzite has been reported from the other Chilhowee sequences both to the northeast and to the southwest.

The shale is about 100 feet thick, yellow-brown (weathered outcrops), silty and micaceous.

Fossils were reported from the Murray by Keith (1895) but they have since been discredited (King, 1958).

Shady Dolomite

The Shady dolomite, in conformable sequence beneath the Rome formation and above the Chilhowee group, is present in a small area near the northern end of English Mountain. It is nowhere exposed, its presence being indicated by residuum composed of a red and brown vuggy chert known as jasperoid.

By extrapolation from dips on adjacent formations, the Shady is apparently about 800 feet thick.

For completeness, the following description of the lithology of the Shady is quoted from Rodgers (1953):

> Some of the dolomite is white and pure, some blue-gray and slightly silty. Limestone is present locally in the lower third; detrital material is confined to a few sandy layers at the base...

The Shady weathers deeply to a yellow clay soil, in this area often mixed with sandstone float from the mountain. The diagnostic jasperoid type of chert is sporadic in occurrence, being found in greatest abundance on flat hilltops. This environment is also favorable for the accumulation of lumps and nodules containing manganese minerals. (See Chapter V) An unusual pinnacle of jasperoid, fifteen feet in height, occurs on the top of a semi-detached knob underlain by Shady and lying directly west of Inman cemetery.

No fossils have been found in the Shady dolomite in Tennessee, but collections from both Virginia and Georgia have established its age as early Cambrian.

Rome Formation

The Rome is the topmost formation preserved in the hanging wall block of the Great Smoky fault in the English Mountain area. It occurs on the tip of the prong of the Great Smoky thrust sheet on which English Mountain sits. Its thickness is indeterminate, but may exceed 1,000 feet. The top is not preserved. The Rome of this area is less well exposed than in many belts in the Great Valley of Virginia and Tennessee, where it forms comby ridges with frequent water gaps. Where observed in the writer's thesis area, it consisted entirely of shales, silty and micaceous, and colored in varying shades of maroon, green, yellow, and purple. Sandstone, limestone and dolomite were lacking. The Rome shales are infrequently exposed in the artificial cuts of lumber roads, but residual chips on the steeper slopes indicate its presence.

Fossils of the Olenellus fauna have been reported from several localities in the Rome, establishing its age as early Cambrian.

Knox Dolomite

The Knox dolomite occurs directly beneath the Great Smoky fault in two areas where the Sevier shale is absent. One is on the northeast end of the mountain, from Sinking creek to Inman cemetery, the other in a curious reentrant area on the slopes of Rich mountain. Additionally, wide outcrop belts of the Knox form anticlinal valleys on both sides of the English mountain syncline. The one to the northwest has been named the Fair Garden anticline and described by J. G. Bumgarner (1956, unpublished master's thesis, The University of Tennessee). Bumgarner reported a complete section of the upper Knox, which he divided into the Newala, Longview, and Chepultepec formations. No detailed work has been done on the anticline southeast of the mountain, nor on the other outcrops of Knox nearby.

The Knox observed by the writer on the flanks of the mountain belonged to the Newala, or uppermost Knox formation, as it occurs directly beneath Sevier shale. The Knox on the northeast end is of more complex structure and obscure stratigraphic position.

The Knox along the flanks of the mountain consists of massively-bedded limestone and dolomite. The limestone, which is perhaps more abundant, is very fine grained and bluish in color. The dolomite is light to dark gray, and fine grained. Both types of rock weather to deep orange-yellow clays and leave nodules of chert.

Much of the Knox adjacent the northeast end of the mountain was deformed to a cataclastic layered or sheet-like structure, apparently owing to the movement of the thrust sheet over it.

Fossils from the Fair Garden and other areas have shown the Knox from the Newella to the Chepultepec to be early Ordovician.

Sevier Shale

The Sevier shale occurs directly beneath the Great Smoky fault in nearly continuous fashion around the mountain.

Its thickness has been reported in varying amounts from 2,500 feet to 7,000 feet. Less than 1,000 feet is preserved in this area between the top of the Knox group and the Great Smoky fault.

The Sevier shale observed by the writer consists of blue-gray shales, commonly calcareous but rarely silty. Limestone interbeds are common, often containing seams of white calcite. In good exposures there is a suggestion of fracture cleavage.

The shale weathers to a yellow-brown and forms a thin soil full of chips. Outcrops are frequent on the crests of spurs and in steep valley heads.

The Sevier shale is unfossiliferous, but has been classed as Middle Ordovician because of lateral continuity with fossiliferous formations of the Chickamauga group.

CHAPTER IV

STRUCTURE

The Great Smoky Fault

The Great Smoky fault was recognized by workers as early as Safford, who realized that despite their superficially conformable appearance, the rocks of the mountain belt were thrust over those of the Great Valley. Keith is said to have at first mistaken the Chilhowee and Ocoee rocks for units overlying the Middle Ordovician but most if not all of his published work recognizes the presence of the fault.

The most recent regional map (Rodgers, 1953) shows the Great Smoky fault as a continuous feature from near Cosby to the Georgia line, a distance of about 150 miles. To the northeast, other thrust faults take up the displacement. In Georgia and Alabama, the fault continues, under the same and other names.

The Great Smoky fault is a thrust fault of mature development. As it formed, the hanging wall segment moved northwestward[1] and the contact with the footwall became nearly horizontal. Subsequently, the thrust sheet and its footwall were affected by further deformation, both folding and faulting. (See Figure 8.)

---

[1]The writer will present evidence that the movement was northward in the English Mountain Area.

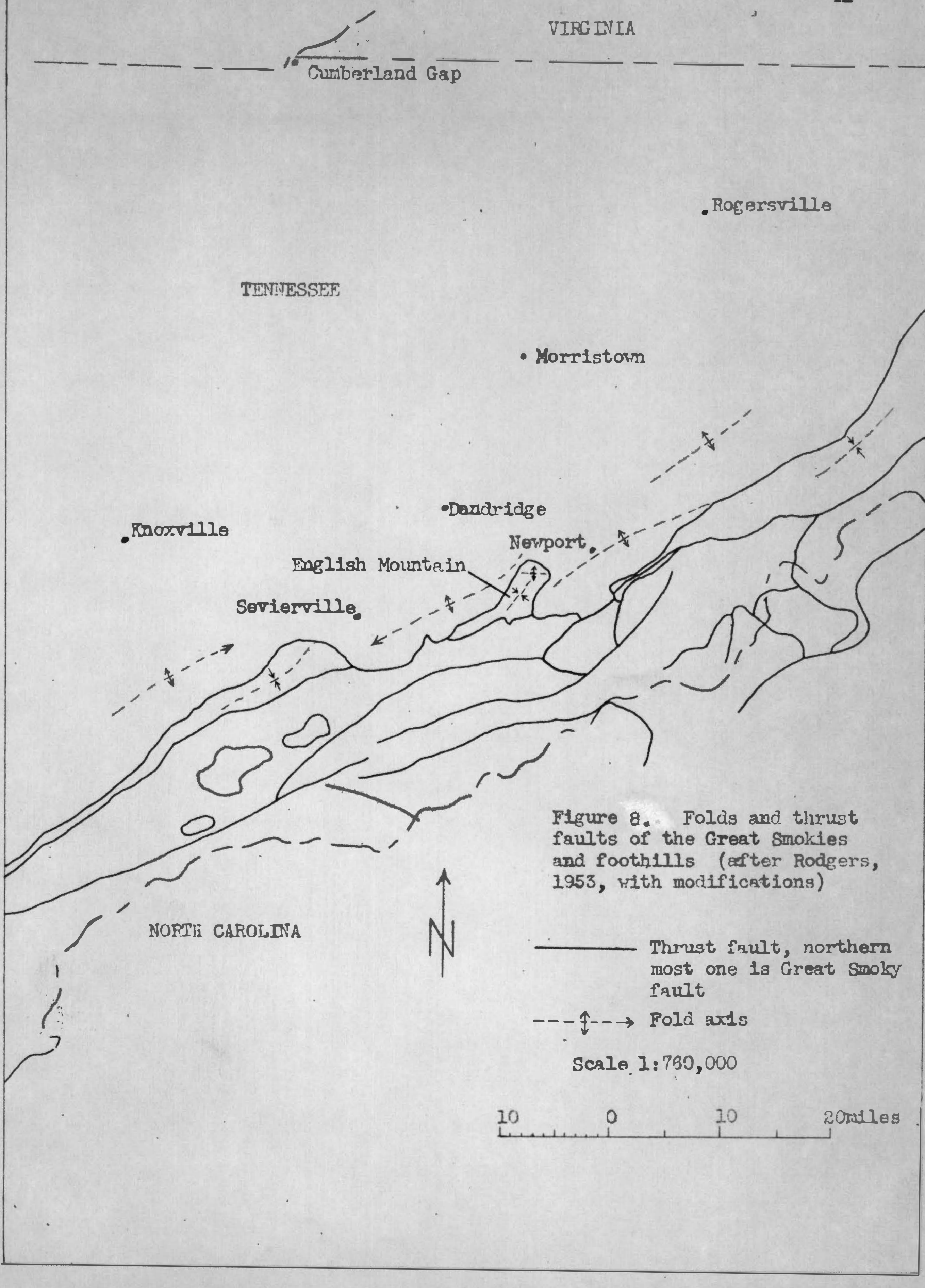

Figure 8. Folds and thrust faults of the Great Smokies and foothills (after Rodgers, 1953, with modifications)

The Fault and Footwall Structure in the English Mountain Area

The writer mapped the position of the Great Smoky fault for approximately twenty miles along its trace. Nowhere were hanging- and footwalls exposed in a single outcrop, but locally abundant residual materials made exact location of the fault possible.

Everywhere around the mountain, Sevier shale was present immediately below the fault trace, except between Sinking Creek and Inman Cemetery and the re-entrant area on Rich Mountain. This evidence suggests that the Sevier shale persists between the Knox and the thrust sheet almost everywhere beneath the mountain. The Sevier might easily have been a "lubricating horizon" that provided for the easy advance of the thrust slice. Post-fault folding has probably thickened the shale near the axis of the syncline. Little disturbance was observed in the Sevier shale, however, even close to the fault. The Knox dolomite, where in contact with the fault at the north end of the mountain, has been severely deformed. Outcrops east of Edgemont Cemetery exhibit a cataclastic layered structure probably owing to horizontal shearing stress during the advance of the fault slice.

A small segment of a similar appearing rock occurs west of Sinking Creek, directly west of the smaller remnant of Rome formation. Although this may be Shady dolomite, lithologic similarity to the footwall rocks on the east lead the writer to interpret the segment as Knox.

The writer made no effort to detail the Knox-Sevier contact. This, however, has been done by Bumgarner (1956, unpublished master's thesis, The University of Tennessee) for the northwest side of the mountain. The contact was found by Bumgarner to be conformable, and a large faulted anticline of the Knox formation was discovered.

Reconnaissance east of the mountain demonstrated the presence of a wide area underlain by the Knox dolomite. This lies conformably below the Sevier shale, which outcrops on the lower slope of the mountain. Dips on the Knox and Sevier suggest an anticline similar to the Fair Garden structure.

Knox and Sevier form a jumbled pattern north of the mountain. This was shown by Rodgers to be an intricately faulted area, but it has not been mapped in detail.

The English Mountain Syncline

The structure of the central portion of the mountain was correctly interpreted by Rodgers (1953) and the writer has made little change. (See Section C, Plate I.) A slightly asymmetric, doubly plunging syncline occurs here. The Hesse-Nebo quartzite is the youngest formation present, probably in nearly full thickness at the center of the structural basin. The lower member of the Nebo outlines the basin; this is followed by the Nichols shale and the upper member of the Cochran, both of which continue to the northeast.

The southeast limb of the syncline is the steeper. This is in accordance with the general plan of Appalachian structure. The observed dips, plus the lack of any younger rocks in the center, show the syncline to be a gentle, open, fold. The axis strikes about N 40° E, paralleling the axes of the anticlines on either side. Also, the elevation of the trace of the Great Smoky fault decreases considerably at the northern end of the mountain. This evidence indicates that the folding was post-Great Smoky thrusting, and that hanging and footwall rocks were folded together during this period of folding.

The Carson Springs Anticline

North of the doubly plunging syncline, an unusual structure occurs. The synclinal axis intersects the axis of an overturned anticline. The latter axis is approximately horizontal, and strikes east-west, hence the intersection angle is about 50 degrees.

At this axis the Nichols shale and the Cochran formation are at the surface, a tongue of the latter extending from the west side of the mountain across Sinking Creek. The band of Nichols shale narrows down, but an arm of it reaches the Great Smoky fault on the east side. To the west, it is faulted out.

North of the anticlinal axis, the dip breaks off steeply. Only the smallest remnants of this structure are preserved in the thin toe of the thrust sheet.

The Hesse-Nebo quartzite dips at steep angles. It is frequently vertical to overturned. On the eastern end of the outcrop belt a southward swing in the strike brings about some overturned dips. The strike changes again, however, and the beds are righted.

The Shady was not found in outcrops, but locally abundant residuals demonstrate its presence. These indicate the presence of a pair of curious slivers of Shady at the east end of the mountain.

The Rome formation is present in a few outcrops with measurable dip east of Sinking Creek. These dips show the most of the Rome to be overturned, i.e., dipping under the Shady. However, it is probable that incompetent folding and faulting pervade the Rome of this area.

The lack of parallelism of the Carson Springs anticline with any other structure, either in hanging or footwalls, is a noteworthy feature. Since this is the case, a special explanation of its presence is required. The writer believes that this anticline is a drag fold, and indicates a northward movement on the Great Smoky thrust. The folding which produced the English Mountain syncline and the anticlines paralleling it was a later event.

Structure South of the English Mountain Syncline

The structure south of the English Mountain syncline is enigmatic. Because of the massive sheared and recrystallized character of the lower Cochran sandstones, few reliable dips were obtained south of the Yellow Spring Gap road.

The accompanying geologic map indicates footwall rocks at a surprisingly high altitude (over 2,200 feet) and a curious pattern of re-entrants on the west end of Rich Mountain. To account for this it is necessary to postulate a considerable upwarp of the Great Smoky

east?

fault plane under Rich Mountain. (See Section D.) This is evidently a local dome on the anticlinal axis southeast of the English Mountain syncline.

The contact with rocks of the Ocoee series south of Rich Mountain presents yet another problem. The various interpretations of this contact were reviewed in an earlier chapter. The general map by King (1958) indicates a fault contact, presumably with the Ocoee rocks thrust from the south against those of the Chilhowee group. The writer confirmed the existence of a definite change in lithology at this place, and found persistent southerly dips in the Ocoee series. A conformable contact between the Ocoee and a younger group is therefore unlikely. On the basis of these observations, the writer is inclined to agree with King's interpretation.

Minor Structures

Folds and Faults

Folds of a small enough size to be seen in a single outcrop were observed at several localities. One such is located near a dry wash, directly below the Lookoff. Here a small anticline in rocks of the Cochran formation shows a temporary reversal of the dip; the rocks appear to have bent with surprising plasticity.

Incompetent chevron folds were observed at several localities in the Ocoee shales. (See Figure 2.) Bedding and lamination in the shale make these folds prominent.

A high angle reverse fault was seen in outcrop along the North Fork Bogard Creek below Fain Cove. This may have had a displacement of several tens of feet; its effect was not observed elsewhere.

Faulting in the Red Shale member of the Cochran was observed below Yellow Springs Gap. Displacements were on the order of a few feet only.

Cleavage

Fracture cleavage was observed in several outcrops of the Ocoee and Sevier shales. In the Ocoee, the cleavage corresponds in orientation to the axial planes of small folds. No consistent orientation was observed in the little deformed Sevier shale.

Jointing

Jointing is fairly well developed in ridge-crest outcrops of the Chilhowee sandstone units, causing the rocks to break into angular blocks. A limited number of observations of the strike of jointing were made by the writer. These suggested dominant joint directions at approximately due north and north 45 degrees east.

CHAPTER V

ECONOMIC GEOLOGY

History

Both manganese and iron ores have been produced in the English Mountain area.

The manganese ore was the typical residual lumps and nodules of psilomelane, pyrolusite and wad which are associated with the Shady dolomite throughout East Tennessee. Two prospects and one mine in the small area of Shady at the North end of the mountain are described by Reichert (1942, p. 143-145). The writer located and examined these. In all cases the prospect trenches were thoroughly overgrown. By careful search, a few nodules of manganese minerals were found at each prospect. These were abundant only at the Newport mine, a larger trench located just west of Sinking Creek. From here some production was obtained. There has been no manganese mining or prospecting activity reported from the English Mountain area since 1918.

A small prospect pit with considerable high-grade limonite lying about was discovered by the writer in the quartzite member of the Cochran formation on the top of Rich Mountain. This was apparently a residual accumulation, formed by downward percolating waters on a topographic high. Many iron and manganese deposits throughout East Tennessee appear to have formed in a similar manner. (See Reichert, 1942, and King, 1944.)

Conversations with persons living on the Sugar Camp Branch Road revealed that about 1900 a limited amount of limonite had been taken down the mountain by sled and smelted locally. It was used in the manufacture of kettles and primitive implements.

Possibilities

The scarcity of manganese minerals in float or dug material near the prospected areas indicates little possibility for the presence of ore grade deposits. The writer also discovered two mineralized localities in the upper part of the Hesse-Nebo quartzite. However, these also did not appear to be of commercial significance.

Several tons of limonite might be removed by mule back from the prospect on Rich Mountain, but the quantity is insignificant on a commercial scale.

The only other material of possible economic value is the quartzite of the Hesse-Nebo formation. An excellent quarry site may be found on either side of Sinking Creek where it passes through Grindstone Mountain. It is unlikely that land could be obtained, however, owing to residential development in the area.

BIBLIOGRAPHY

BIBLIOGRAPHY

— Barrell, J., 1925, The nature and environment of the Lower Cambrian sediments of the southern Appalachians: Amer. Jour. Sci., v. 9, p. 1-30.

Bloomer, R. O., and Werner, H. J., 1955, Geology of the Blue Ridge region in central Virginia: Geol. Soc. of Amer., Bull., v. 66, p. 579-606.

Bucher, W. H., 1933, The deformation of the earth's crust, Princeton U. press, Princeton, N. J., 518 p.

Butts, C., 1910, Geology of the Birmingham Quadrangle, Alabama, USGS Geol. atlas, Folio 175, 24 p.

________ 1926, The paleozoic rocks of Alabama: Ala. Geol. Sur. Spec. Rpt. 14, p. 41-230.

________ 1940, Geology of the Montevallo & Columbiana Quadrangles, Alabama; USGS Geol. Atlas, Folio 226, 20 p.

— ________ 1940 , Geology of the Appalachian Valley in Virginia: Va. Geol. Sur. Bull. 52, pt. 1, 568 p.

Bumgarner, J. G., The stratigraphy and structure of the Knox dolomite in the Fair Garden area, Sevier and Jefferson counties, Tennessee, unpublished masters thesis, The University of Tennessee.

Crickmay, G. W., 1936, Status of the Taladega series in southern Appalachian stratigraphy: Geol. Soc. Amer., Bull. 47, p. 1371-1392.

________ 1952, Geology of the crystalline rocks of Georgia: Ga. Geol. Sur., Bull. 58.

Dapples, E. C., Krumbein, W. C., and Sloss, L. L., 1948, Tectonic control of lithologic associations: Amer. Assoc. Petrol. Geol., Bull. 32, p. 1924-1947.

Fenneman, N. M., 1938, Physiography of Eastern United States, McGraw-Hill, New York, 691 p.

Ferguson, H. W., and Jewel, W. B., 1951, Geology and barite deposits of the Del rio district, Cocke Co., Tenn.: Tenn. Div. Geol., Bull. 57, 235 p.

Hayes, C. W., 1891, The overthrust faults of the southern Appalachians: Geol. Soc. Amer., Bull., v. 2, 141-152.

Howell, et al., 1944, Correlation of the Cambrian formations of North America: Geol. Soc. Amer., Bull., v. 55, p. 993-1003.

Kay, M., 1951, North American geosynclines: Geol. Soc. Amer, Mem., v. 48, 143 p.

Keith, A., 1895, Geology of the Knoxville Quadrangle: USGS Geol. Atlas, Folio 16.

________ 1896, Geology of the Loudon Quadrangle: USGS Geol. Atlas, Folio 25.

________ 1903, Geology of the Cranberry quadrangle: USGS Geol. Atlas, Folio 90.

________ 1904, Geology of the Ashville quadrangle; USGS Geol. Atlas, Folio 116.

________ 1905, Geology of the Greensville quadrangle: USGS Geol. Atlas, Folio 118.

________ 1907, Geology of the Nantahala quadrangle, USGS Geol. Atlas, Folio 143.

________ 1907, Geology of the Roan Mountain quadrangle: USGS Geol. Atlas, Folio 151.

________ Geologic Map of the Mount Guyot quadrangle, compiled from unpublished data by P. B. King.

________ 1927, The Great Smoky overthrust (abs.): Geol. Soc. Amer., Bull., v. 38, p. 154-155.

King, P. B., et al., 1944, Geology and manganese deposits of north-eastern Tennessee: Tenn. Div. Geol. Bull., v. 52, 283 p.

________ 1949, The base of the Cambrian in the southern Appalachians: Amer. Journ. Sci., v. 247, p. 513-530, 635-671.

________ 1950, Tectonic framework of southeastern United States: Amer. Assoc. Pet. Geol., Bull., v. 34, p. 635-671.

________ Summary of observations in the Walden Creek, Wear Cove and Thunderhead quadrangles, compiled from field notes by H. W. Fergusson and C. D. Swingle (unpublished).

________ and Hadley, J. B., Neuman, R. B., and Hamilton, W., 1958, Stratigraphy of the Ocoee series, Great Smoky Mountains, Tennessee and North Carolina: Geol. Soc. Amer., Bull., v. 69, p. 947-966.

Krumbein, W. C., and Sloss, L. L., 1951, Stratigraphy and sedimentation, Freeman & Co., San Francisco, 497 pp.

Neuman, R. B., 1951, The Great Smoky Fault: Amer. Jour. Sci., v. 249, p. 740-754.

Nickelsen, R. P., 1956, Geology of the Blue Ridge near Harpers Ferry, West Virginia, Geol.Soc.Amer.,Bull., v. 67, p. 239-270.

Oriel, S. S., 1950, Geology and mineral resources of the Hot Springs window, Madison Co., North Carolina, N. C. Dept. Consv. & Dlpmnt. Bull. 60.

Pettijohn, R. J., 1943, Archean sedimentation; Geol. Soc. Amer., Bull., v. 54, pp. 925-972.

Reichert, S. O., 1942, Manganese Resources of East Tennessee: Tenn. Div. Geol., Bull., v. 50, 204 p.

Rodgers, J., 1953, Geologic map of east Tennessee with explanatory text: Tenn. Div. Geol., Bull., 58, 168 p.

________ 1956, The clastic sequence basal to the Cambrian system in the Central and Southern Appalachians, 20th Inter. Geol. Cong., Mexico.

Safford, J. M., 1869, Geology of Tennessee, Nashville, 550 p.

Snyder, F. G., 1947, The problem of the Lipalian interval: Jour. Geol., v. 55, p. 146-152.

Stose, G. W., et al., 1919, Manganese deposits of the west foot of the Blue Ridge; Virginia Geol. Soc., Bull., 17.

________ and Bascomb, F., 1929, Description of the Fairfield and Gettysburg quadrangles, Pennsylvania: USGS Geol. Atlas, Folio 225, 22 p.

________ and Jonas, A. I., 1933, Geology and mineral resources of the Middletown quadrangle, Pennsylvania: USGS Bull. 840, 86 p.

________ 1939, Geology and mineral resources of York Co., Pennsylvania: Pa. Geol. Sur., 4th Ser., Bull. C-67.

________ 1944, Geology of the Hanover-York district, Pennsylvania: USGS Prof. Paper 204, 86 p.

________, and Stose, A. J., 1944, The Chilhowee group and Ocoee series of the Southern Appalachians: Amer. Jour. Sci., v. 242, p. 367-390, 401-416.

________, and Stose, A. J., 1949, The Ocoee series of the Southern Appalachians; Geol. Soc. Amer., Bull., v. 60, p. 267-320.

________, 1953, Geology of the Carlisle quadrangle, Pennsylvania; USGS quad # 58.

Ulrich, E. O., 1911, Revision of the paleozoic systems, Geol. Soc. Amer., Bull., v. 22, p. 281-680.

________, 1890, The fauna of the Lower Cambrian, or <u>Olenellus</u> zone: U. S. Geol. Survey 10th Ann. Rept., pt. 1, p. 509-760.

Walcott, C. D., 1892, Notes on the Cambrian rocks of Virginia and the Southern Appalachians: Amer. Jour. Sci., v. 44, p. 52-57.

________, 1892, Notes on the Cambrian rocks of Pennsylvania and Maryland, from the Susquehanna to the Potomac: Amer. Jour. Sci., v. 44, p. 469-482.

PLATE I
GEOLOGIC MAP AND SECTIONS
OF
ENGLISH MOUNTAIN, TENNESSEE
BY
ROBERT C. GREENE
1959
EXPLANATION
Ordovician
Osv Sevier shale
OЄk Knox group
Sequence broken by faulting
Cambrian
Єr Rome formation
Єs Shady dolomite
pЄ-Єhe-nb Hesse-Nebo quartzite
pЄnbl pЄnbl - lower member
pЄmu Murray shale
pЄni Nichols shale
Precambrian
pЄchu Cochran formation
pЄchu - upper member
pЄchr pЄchr - red shale member
pЄchl pЄchl - lower member
pЄchq pЄchq - quartzite member
CHILHOWEE GROUP
pЄoc Ocoee series - undifferentiated
Contact, dashed where approximate
Transitional contact, between members of the Cochran formation
Fault, dashed where approximate
A A' Location of section
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Horizontal beds
Axes of small folds
arrow indicates plunge direction
Prospect, mine or mineral occurrence
Scale 1:24000
1 ½ 0 1 mile
Contour interval 40 feet south of latitude 35°52' 30'' and east of longitude 83°22' 30'', elsewhere 20 feet
HORIZONTAL AND VERTICAL SCALE 1" = 2000'
2.54 cm = 6.096 cm
1:24 000 why don't you say so.
ENGLISH MOUNTAIN
GREAT SMOKY FAULT