OKLAHOMA GEOLOGICAL SURVEY

GUIDE BOOK VII

Guide to Robbers Cave State Park and Camp Tom Hale

by

DEARL T. RUSSELL

1958

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CARL C. BRANSON, *Director*

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LATIMER COUNTY, OKLAHOMA

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DEARL T. RUSSELL

NORMAN
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FOREWORD

The geology and biology of Robbers Cave State Park and the surrounding area are of unusual interest. Dearl T. Russell studied and mapped northern Latimer County and submitted a thesis on his investigations for the Master of Science degree at the University of Oklahoma. As an additional contribution he prepared this guide book to help scouts at Camp Tom Hale and visitors to the state park to enjoy and understand the natural history of the area.

The Oklahoma Geological Survey plans similar guide books for other State Park areas. There has been a great increase in awareness of natural science among the youth of the State and such interest deserves to be encouraged.

CARL C. BRANSON

ACKNOWLEDGMENTS

Thanks are extended to the Parks Division of the State Planning and Resources Board of Oklahoma for information concerning the early history of the region surrounding Robbers Cave State Park.

Mr. Warren S. Green, Scout Executive of the Choctaw Area Council, Boy Scouts of America, contributed information concerning recent developments and early history of Camp Tom Hale.

Information on the date of original construction of State Highway 2 was obtained from the Oklahoma State Highway Department.

Appreciation is also extended to the Oklahoma Geological Survey for assisting in the completion of the report and to Dr. Carl C. Branson, Director of the Survey, for suggesting the report and for proofreading the manuscript.

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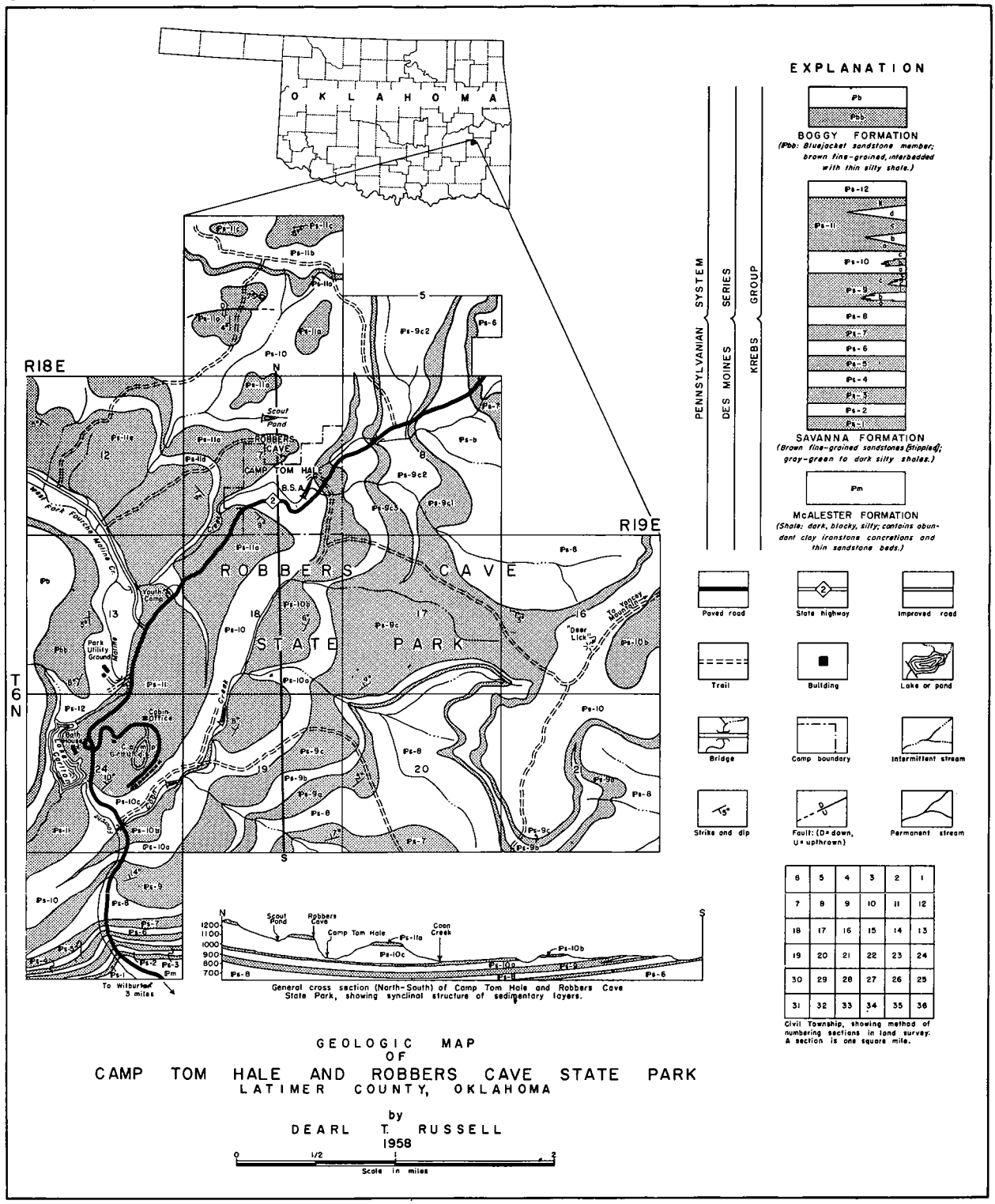
OKLAHOMA
EXPLANATION
PENNSYLVANIAN SYSTEM
DES MOINES SERIES
KREBS GROUP
BOGGY FORMATION
(Pbo: Bluejacket sandstone member; brown fine-grained, interbedded with thin silty shale.)
SAVANNA FORMATION
(Brown fine-grained sandstones (stippled); gray-green to dark silty shales.)
McALESTER FORMATION
(Shale: dark, blocky, silty; contains abundant clay ironstone concretions and thin sandstone beds.)
Paved road
State highway
Improved road
Trail
Building
Lake or pond
Bridge
Camp boundary
Intermittent stream
Strike and dip
Fault: (D= down, U= upthrown)
Permanent stream
R18E
R19E
T6N
ROBBERS CAVE STATE PARK
Scout Pond
ROBBERS CAVE
CAMP TOM HALE
Youth Camp
Park Utility Ground
Cabin Office
Bath House
Deer Lick
To Yancey Mountain
To Wilburton 3 miles
General cross section (North-South) of Camp Tom Hale and Robbers Cave State Park, showing synclinal structure of sedimentary layers.
Civil Township, showing method of numbering sections in land survey. A section is one square mile.
GEOLOGIC MAP
OF
CAMP TOM HALE AND ROBBERS CAVE STATE PARK
LATIMER COUNTY, OKLAHOMA
by
DEARL T. RUSSELL
1958
Scale in miles

THE GEOLOGY OF CAMP TOM HALE
LATIMER COUNTY, OKLAHOMA

by

Dearl T. Russell

CHAPTER I
INTRODUCTION

Purpose of this Report

Scouters who visit Camp Tom Hale each summer have an opportunity to explore abundant rock exposures and to discover many of the once deeply buried secrets contained within the rock strata which now crop out at the surface. Exploring the rocks which crop out on the surface of the earth is one of the most interesting and informative phases of geology. This method is used by "surface" geologists in their search for oil and gas pools.

On your next trip to the camp, observe the hills and valleys as you drive along State Highway 2. They were not molded overnight into their present shape. There is a reason—other than the fact that they are "just there"—for their existence.

As you view the geological features in the area, you may ask: What caused the cliffs such as the one overlooking Lake Carlton and the long high ridges such as the one lying immediately north and parallel to Coon Creek? Why are the rock strata dipping into the subsurface? What is the origin of the coal seams in the strata? How old are the rocks and where did they come from? What types of rock are found here? Are there fossils in the rocks? How were Robbers Cave, the Devil's Slide, and the Stone Corral formed? These are, perhaps, only a few of the questions which may enter your mind as you continue your investigation.

It is with the intention of answering these questions and assisting your search for geologic knowledge that this report is written.

In the report, you will also learn about the history, botany, zoology, and scenic points of interest in the region surrounding the camp.

Location of the Camp

Camp Tom Hale is in Robbers Cave State Park in northern Latimer County, Oklahoma. It lies in the southeast quarter of section 7, Township 6 North, Range 19 East. It is approximately seven miles north of Wilburton, Oklahoma. State Highway 2 affords convenient access to the camp as well as to the state park.

Geologically speaking, the camp is located in the McAlester Basin. It is underlain by layers of sedimentary strata many thousands of feet thick (see figure 1). That part of the McAlester Basin underlying the camp and park is at the northwestern edge of the Ouachita Mountains in the sandstone hills region of eastern Oklahoma.

Robbers Cave State Park

The park covers 13 square miles of the rugged Sans Bois Mountains, and completely surrounds the property boundaries of Camp Tom Hale. It is named after Robbers Cave in section 7, Township 6 North, Range 19 East.

Deer and many other smaller animals are numerous in the wildlife preserve in the park. And, they are not the only beings attracted to the rustic beauty of the area! Every year the park is visited by numerous vacationers, youth campers, and Boy Scout troops. Cabins for vacationers are picturesquely located on a high, pine-covered sandstone ridge overlooking Lake Carlton and vicinity. Lake Carlton is a 52 acre lake whose waters are held by a concrete dam in the valley of Fourche Maline Creek (see figure 2). The lake is provided with excellent swimming, fishing, and boating facilities. The park also has community buildings, youth camps, free camp sites, and several play areas.

Population

The region surrounding the camp is thinly populated. This is because the region is hilly and rough with no large fields for farming and with few good roads leading into the remote parts. Wilburton, the largest town in the vicinity of Camp Tom Hale, has a population of approximately 2,000. Red Oak, a mining community with a population of 568, is located ten miles east of Wilburton on Federal Highway 270.

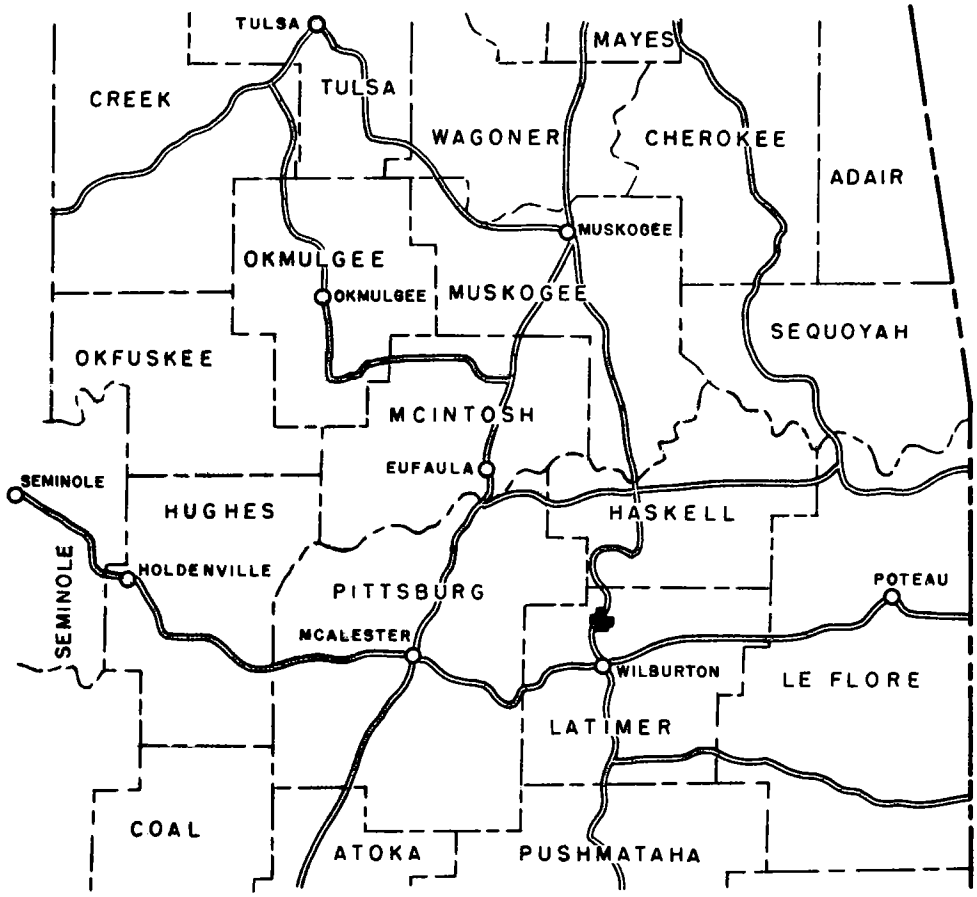

FIGURE 1. Map showing location of Robbers Cave State Park.

Climate

The presence of moist gulf air and the influence of hilly wooded topography cause the occurrence of more frequent rain showers in the eastern part of Oklahoma than in the western part. In late spring eastern Oklahoma and the adjoining states receive more rainfall than any other part of the country east of the Rocky Mountains. The annual average rainfall is 40 inches. In general, the annual range in temperature is marked: the mean for midsummer being about 45 degrees higher than for midwinter. The temperature maximum is 110 degrees Fahrenheit, and the minimum is minus 6 degrees Fahrenheit.

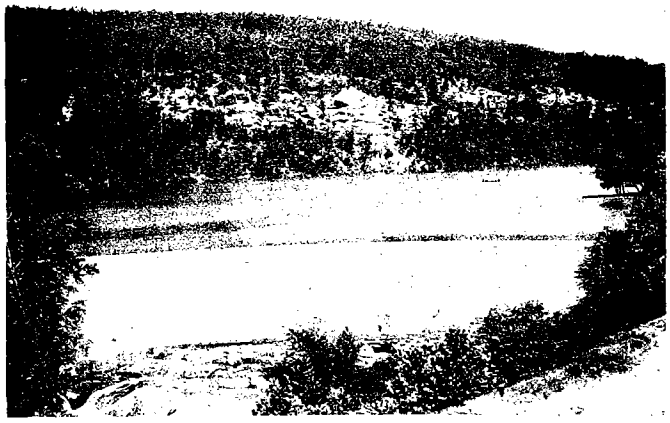

FIGURE 2. Lake Carlton.

CHAPTER II

HISTORY

The first white men to enter the wilderness region surrounding the present camp site were French traders and trappers. They travelled along the Arkansas and Poteau Rivers. Their influence on the region is reflected in such names as Poteau River, Sans Bois Mountains, Cavanal Mountain, and Fourche Maline Creek. This region had long been the hunting ground of Indians who were the forefathers of the warlike Osages. In 1719 Bernard de La Harpe, a French explorer, reported finding villages of these Indians approximately 60 miles north of Camp Tom Hale.

For many years prior to the removal of the Choctaw Indian Tribe from Mississippi to this region in 1830, hunters of that tribe became familiar with the region on their yearly trips west for buffalo meat. The word, "Owa-chita", was the name the Indians called this annual hunting trip. This word, in modified form, became the name of the Ouachita Mountains as we know them today. Influenced by reports of their hunters, the Choctaw tribe chose the southeastern corner of the Indian Territory in which to settle after agreeing to leave Mississippi.

The Missouri-Kansas and Texas Railroad was extended southward through the Choctaw country in 1872. The Choctaw Coal and Railway Company built westward in 1887 through the site of Wilburton to the McAlester coal region. The town of Wilburton, which is now the county seat of Latimer County, was named for a railroad man, Will Burton.

During the Civil War, when deserters from both the Union and Confederate forces used it, Robbers Cave began to be associated with outlaw legends. *The authenticity of such legends is not proven, but it is interesting to relate them.** During the period following the Civil War, gangs of robbers made it a rendezvous between raids on stores, stagecoaches, agency payrolls, and law-abiding farmers. Along Fourche Maline Creek, and only a stone's throw from the present camp site, lay a path which came to be known as "Robbers Trail". With it were associated the names of the Younger brothers, Jesse and Frank James, and the notorious woman bandit, Belle Starr. Her home in Youngers Bend of the Canadian River was about 35 miles northwest of the cave. Her original name was Myra Belle Shirley.

Legendary stories include the incident of a posse led by a United States marshal beseiging a band of outlaws in Robbers Cave for two days, killing one, and capturing the others after they were "smoked out."

Stories of hidden treasure are also associated with the cave. It is reported that the last exploration in search of the treasure was carried out in 1931 by three men from Texas. They, of course, brought along the traditional map showing the location of the treasure. The rumor that they had found the treasure and had hastened to get away with it spread among the local people when the explorers suddenly departed.

*One "old timer" at Wilburton informed me (almost vehemently) that there was no truth to the outlaw legends associated with Robbers Cave.

The establishment of Camp Tom Hale in 1926 through the efforts of Carlton Weaver, a member of the legislature from Wilburton, preceded the development of Robbers Cave State Park. The lake in section 24, Township 6 North, Range 18 East was named CARLTON in his honor. Lake Carlton covers approximately 52 acres. During the early years of its development, the camp was in a complete wilderness with nothing known by the public about the cave. No roads led conveniently to its location. Campers in those early times were obliged to hike as much as ten miles over rough logging trails in order to get to the present camp site. The construction of State Highway 2 in 1931 and 1932 enabled campers to reach the camp by automobile.

The property that is now Camp Tom Hale was purchased in the name of the Choctaw Area Council, B.S.A., about 1932. The camp now contains a caretaker's home, eight rock buildings, one frame building, campsites for approximately eight troops at a time, a council ring, and archery and rifle areas. In addition, the camp has a convenient pool which was constructed in 1956 for swimming and boating programs. Swimming by scouts was done for many years in Fourche Maline Creek both below and above the Lake Carlton Dam.

The Civilian Conservation Corps did much of the development work in the area; particularly the construction of the Scout pond dam, Lake Carlton Dam, the bathhouse and other buildings in the park, and several improved trails over the surrounding mountains. The buildings on the camp site were provided by the citizens of the communities served by the Choctaw Area Council and by service and veterans' organizations.

Robbers Cave State Park was taken over in 1935 by the State Parks Division of the Game and Fish Department, which became a division of the Oklahoma Planning and Resources Board in 1937. All development in the park was under the supervision of the National Park Service.

CHAPTER III

BOTANY

Many plants, including those of a heavily timbered forest, flourish in the camp area and in the surrounding region. The upland areas are characterized by a predominance of southern yellow pine, red and white oaks, blackjack oaks, hickories, elms, and hackberries. In the parts of the valleys that have not been cleared are thick growths of hickories, wild plums, cottonwoods, shrubs, grasses, and vines. In the warm season an abundance of wild flowers graces the area with their beauty.

The opportunity to earn a merit badge in botany is everywhere present in this region. With this goal in mind, the PLANT KINGDOM will be briefly discussed, and some of the more common plants which grow in the area will be identified by their scientific names.

Paleontology, the science of ancient animal and plant fossils, is an important phase of geology. Paleobotany is the branch of paleontology which deals with fossil plants exclusively. Knowledge of paleobotany would be useful to Camp Tom Hale scouters, because there are many fossil plants in the strata which crop out in the surrounding region. Fossil plants found in the strata will be discussed in the chapter on geologic history.

The PLANT KINGDOM is divided into four PHYLA. The word, PHYLA, is derived from the Greek word "phylon", meaning "race". The singular of phyla is "phylum". The scheme of classification is as follows:

Phylum 1. THALLOPHYTA: simplest forms—bacteria, fungi, algae, sea weeds.

Phylum 2. BRYOPHYTA: simple land plants—mosses and liverworts.

Phylum 3. PTERIDOPHYTA: ferns, club mosses, and horsetails.

Phylum 4. SPERMATOPHYTA: flowering plants. Includes GYMNOSPERMS (naked seeds) and ANGIOSPERMS (covered seeds).

Plants which grow in the area are listed by their common names followed by the generic and specific names in parentheses. All of the plants listed below are in the Phylum SPERMATOPHYTA.

The more common trees in the park are southern yellow pine *(Pinus echinata)*, red cedar *(Juniperus virginianum)*, black walnut *(Juglans nigra)*, scaly bark hickory *(Carya ovata)*, white hickory *(Carya tomentosa)*, king nut hickory *(Carya laciniosa)*, red oak *(Quercus rubra)*, chinquipin oak *(Quercus muehlenbergii)*, white oak *(Quercus alba)*, blackjack oak *(Quercus marilandica)*, post oak *(Quercus stellata)*, river birch *(Betula nigra)*, English hawthorn *(Crataegus monogyna)*, American elm *(Ulmus americana)*, winged elm *(Ulmus alata)*, slippery elm *(Ulmus rubra)*, sugar maple *(Acer saccharum)*, hackberry *(Celtis)*, black locust *(Robinia pseudoacacia)*, sycamore *(Platanus occidentalis)*, wild cherry *(Prunus serotina)*, red mulberry *(Morus rubra)*, red bud *(Cercis canadensis)*, dogwood *(Cornus florida)*, chickasaw plum *(Prunus augustifolia)*, and deciduous holly *(Ilex decidua)*.

For more detailed information on trees, you are referred to the article: "Forest Trees in Oklahoma —How to Know Them". This is a pocket manual prepared by George R. Phillips, Frank J. Gibbs, and Wilbur R. Mattoon. It is edition number 6, and was revised and edited by the Division of Forestry, Oklahoma Planning and Resources Board, State Capitol, Oklahoma City, Oklahoma.

Among the shrubs found in the park are black haw *(Viburnum prunifolium)*, button bush *(Cephalanthus)*, wild rose *(Rosa)*, summer huckleberry *(Gaylussacia)*, blackberry *(Rubus)*, elderberry *(Sambucus canadensis)*, plum *(Prunus)*, and spice bush *(Lindera benzoin)*.

Characteristic vines are honeysuckle *(Lonicera)*, wild grapes *(Vitis)*, virginia creeper *(Parthenocissus)*, and poison ivy *(Rhus)*.

Wild flowers which grow in the area are anemone *(Anemone)*, phlox *(Phlox)*, blue violet *(Viola cucullata)*, dogtooth violet *(Erythronium)*, arum *(Arisaema)*, horsemint *(Mentha longifolia)*, cardinal flower *(Lobelia cardinalis)*, verbena *(Verbena)*, spiderwort *(Tradescantia)*, spring beauty *(Claytonia)*, goldenrod *(Solidago)*, and aster or frost flower *(Aster)*.

CHAPTER IV

ZOOLOGY

Some bear *(Ursus americanus)*, cougar *(Felis concolor)*, and beaver *(Castor canadensis)*, were present in this region in early times, but were soon exterminated when settlement by the white man began.

White tail deer *(Odocoileus virginianus)* were once plentiful over the entire region, but their numbers were being rapidly depleted before state game laws gave them protection from hunters. Today they are quite numerous in the game preserve of 8,400 acres which surrounds Robbers Cave and Camp Tom Hale. Alert scouts may detect signs of their presence. although deer are elusive and difficult to stalk for purposes of observation in their natural habitat. At one place in the park approximately 2¼ miles southeast of camp, the writer personally observed a "deer lick". It consists, actually, of a small heap of fine rock particles which were brought to the surface from the depths of a well drilled many years ago in a search for oil. The site of this old well is in section 16, Township 6 North, Range 19 East. It lies immediately north of a trail and approximately ¼ mile northeast of the intersection of two trails in the southern part of section 16. The rock particles from this well contain a small amount of salt, and deer are attracted to the locality by their need for salt as food. Consequently, it is locally referred to as a deer lick, because deer lick the ground where the salt-bearing particles lie. In the same locality there are scars on the bark of several small trees where bucks have sharpened their antlers by rubbing them against the trees. Several spots bare of grass mark the places on the ground where bucks have pawed the ground during the mating seasons.

Smaller fur bearing animals in the region are coyotes *(Canis latrans)*, wolves *(Canis lupus)*, red fox *(Vulpes fulva)*, otter *(Lutra canadensis)*, mink *(Mustela vison)*, muskrats *(Ondatra zibethicus)*, skunks *(Mephitis mephitis)*, raccoons *(Procyon lotor)*, opossums *(Didelphis marsupialis)*, squirrels *(Citellus)*, wildcats *(Lynx rufus)*, and cotton tail rabbits *(Sylvilagus)*.

Reptiles are numerous. Rattlesnakes *(Crotalus)* are present and are to be respected. Among the varieties of rattlesnakes in the area are those known by the local names of "coon tail" and "velvet tail" rattlers. On the basis of personal experience by the writer, these appeared to be the most vicious species of reptiles in the area. Copperheads *(Agkistrodon mokasen)*, and water moccasins *(Agkistrodon piscivorus)*, bull snakes *(Pituophis sayi sayi)*, and turtles *(Pseudemys)* are also present.

In the streams and lakes are bass *(Micropterus)*, crappie *(Pomoxis)*, bluegill *(Lepornis machrochirus)*, channel catfish *(Ictalurus punctatus)*, gars *(Lepidosteus)*, bull frogs *(Rana catesbeiona)*, and varieties of perch, suckers, and mudcats.

Some of the birds found in the park are quails of the bob white variety *(Colinus virginianus)*, blue-jays *(Cyanocitta cristata)*, loggerhead shrikes *(Lanius ludovicianus)*, crows *(Corvus brachyrhynchos)*, cardinals *(Richmondena cardinalis)*, bluebirds *(Sialia sialis)*, doves, woodpeckers, hawks, owls, wrens, orioles, robins, mocking birds, and blackbirds. Wild turkey are absent from this region. Some migratory wild fowl, ducks, and geese, fly through in the Spring and Fall. A few herons spend the summers here.

If you are familiar with the Linnaean system of classification of the ANIMAL KINGDOM, you will have noticed that all of the animals named are included in the phylum CHORDATA. This phylum includes the higher forms of animal life, those which have a backbone. Animals with backbones, or spinal columns, are called "vertebrates", while the lower forms of life in the other phyla are without backbones and are called "invertebrates".

Paleozoology is the branch of paleontology which deals with fossil animals, both vertebrate and invertebrate. Ancient fossils of invertebrate animals serve as a guide to the identification of some geologic formations. That is, some formations contain certain invertebrate fossils which are not found in other strata. Thus, the paleontologist is able to identify the geologic formation from the fossils contained within its strata.

FIGURE 3. Large slumped sandstone blocks near Robbers Cave.

CHAPTER V

TOPOGRAPHY AND STRUCTURAL GEOLOGY

Topography

The term, topography, refers to the shape of the earth's surface. High rugged escarpments, or bluffs, and enormous detached blocks of sandstone characterize the topography of Camp Tom Hale and the Sans Bois Mountains (see figure 3). The force of gravity has gradually pulled huge blocks downhill from the position of their original outcrop. Natural features such as Robbers Cave, Devil's Slide, and Stone Corral are formed by these slump blocks (see figure 4). In some cases the gradual downhill movement caused the sandstone layers to separate along smooth bedding planes. The steep crevice called Devil's Slide, for example, is caused by gravitational separation along a bedding plane of a sandstone.

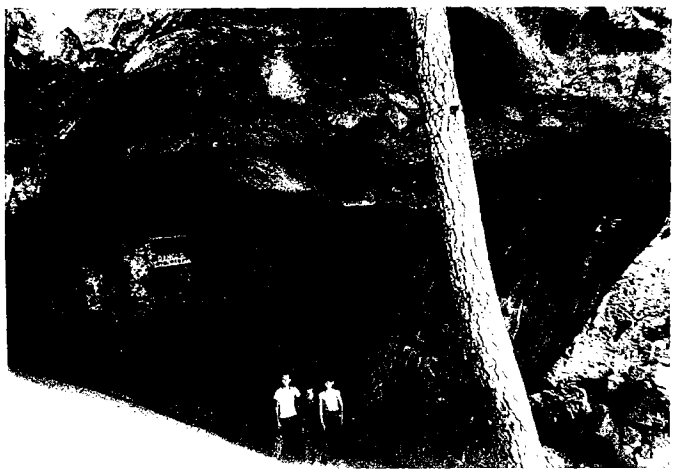

FIGURE 4. Robbers Cave.

The high sandstone ridges are separated by valleys which have been cut into the soft shale layers by streams. Thus, the topography of the area is caused by selective erosion of the rock strata. That is, the soft rocks are worn down while the hard rocks are left standing as hills and ridges. The height of topographic features is related to the dip, hardness, and thickness of the supporting strata. The thicker and more resistant layers form the larger hills and ridges, and the shales form the valleys. The long ridges are called "hogbacks" or "cuestas" by geologists. They are specialized names for outcrops of rock strata. In cross section it is seen that the difference between a hogback and a cuesta is caused by the amount of dip of the supporting strata (see figure 5). The rugged sandstone ridge overlooking Lake Carlton and underlying the park tourist cabins is a cuesta. The thick sandstone which forms this cuesta dips to the northwest under Lake Carlton. The sturdy foundation of the concrete dam of Lake Carlton is on this same sandstone.

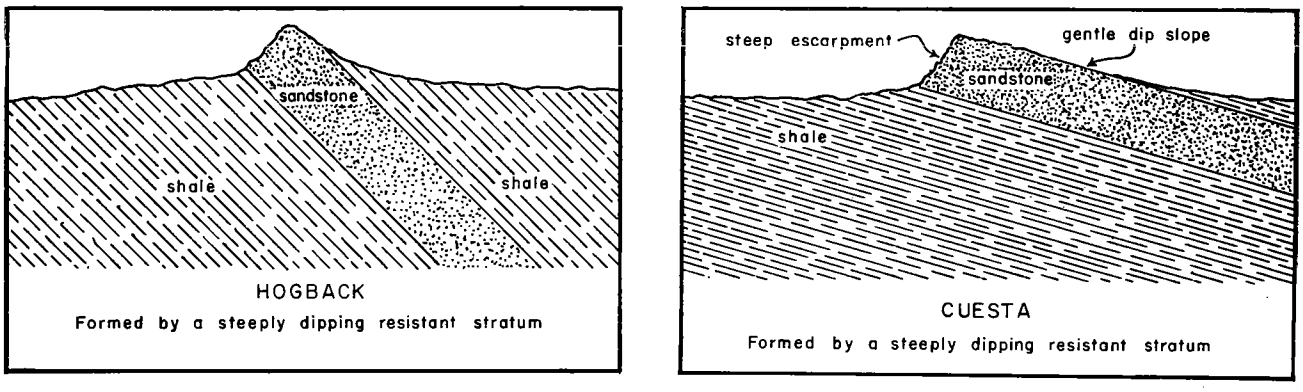

FIGURE 5. Diagram of a hogback and of a cuesta.

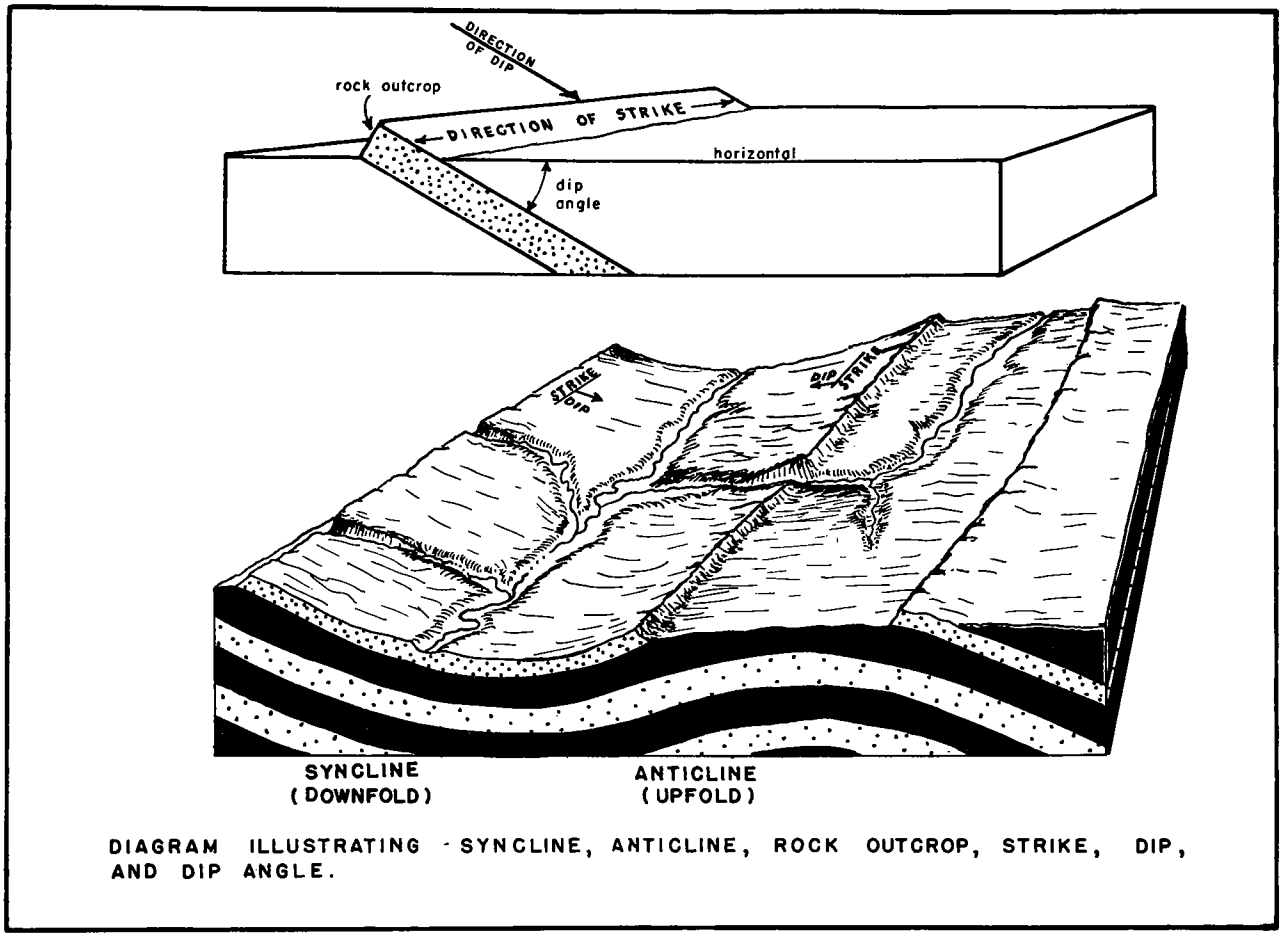

FIGURE 6. Block diagram of structural features.

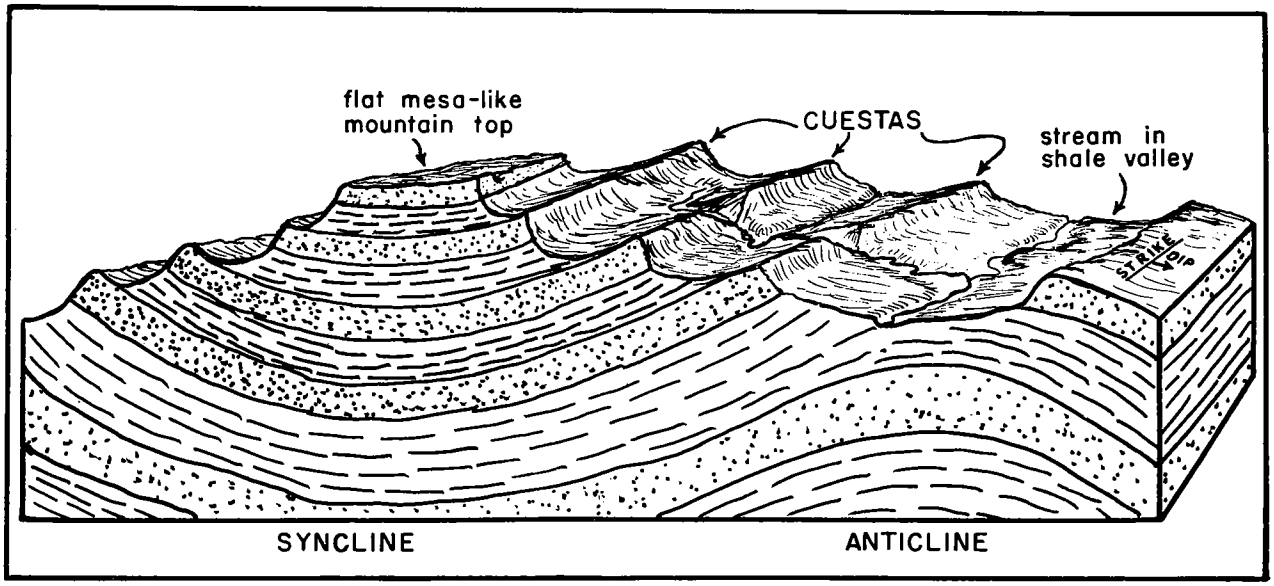

FIGURE 7. Diagram showing synclinal mountain and anticlinal valley.

Dip and Strike

A rock stratum which crops out on the surface at one place may lie at a considerable depth beneath the surface at another locality, depending on the angle of dip into the subsurface. Rock strata in the camp area and the surrounding region are inclined in this manner. The amount of inclination is called "dip" More precisely, dip may be defined as the angle between the inclined bedding plane of a rock stratum and a horizontal plane (see figure 6). The "strike" of a rock stratum is its directional trend measured on a horizontal surface. Strike is further defined as the direction of a line formed by the intersection of the bedding plane of an inclined rock stratum with a horizontal plane (see figure 6).

Structure

Correct measurements of dip and strike are important to the geologist in making a geologic map of an area. After he has plotted the location of all the rock outcrops (hogbacks and cuestas) on his map, he studies their dip and strike in order to determine the "structure" of the area. STRUCTURAL GEOLOGY involves the study of types of folds of strata and the forces which caused them to be deformed. Strata in this region were originally deposited in essentially horizontal layers. They were later warped into various types of folds by orogeny. This will be explained in the chapter on geologic history. Upfolded strata are called "anticlines" and downfolded strata are called "synclines" (see figure 6).

Topographic features give the geologist an idea of the geologic structure. The structure underlying Robbers Cave State Park is synclinal (see cross section on geologic map). You may prove this for yourself. As you drive northward along State Highway 2 from the south boundary of the park toward Lake Carlton, notice that the strata dip generally to the north. After passing Lake Carlton and proceeding toward Camp Tom Hale, you will see that the strata dip generally to the south. The direction of dip has reversed itself! *You have crossed a large syncline!* (see figure 12). You have observed, then, that rock strata dip toward the axis (center) of a syncline. Had you crossed an anticline, the relationship would have been the opposite, because the strata dip away from the axis of an anticline (see figure 6).

As a general rule the topography of the McAlester Basin is an inverse reflection of the underlying structure of the strata. That is to say that the *upland* areas (mountains) of the surface are underlain by *downfolds* (synclines) of strata in the subsurface, and the *lower* areas (valleys) of the surface are underlain by *upfolds* (anticlines) of strata in the subsurface (see figure 7).

CHAPTER VI

GEOLOGIC HISTORY

Age of the Rocks

A person's life is indeed short when compared to the long span of time that has been required by geologic processes to sculpture the surface of the earth into its present form. The age of the earth has been estimated at 3 to 3½ billion years. A more recent estimate places the age at 4½ billion years.* The oldest known rock in the world is reported to be 2½ billion (2,500,000,000) years old.

The strata which crop out on the surface around Camp Tom Hale were formed during the early part of the Pennsylvanian Period. The camp buildings are located on a thick shale which is shown on the geologic map as "Psv-10". This shale is a part of the Savanna formation. The Savanna formation, in turn, is a part of the Desmoinesian Series of the Pennsylvanian System of rock layers (see geologic time scale, page ____). The rocks here are estimated to be 230 million years old. Consider the time that would be required to count to 230 million at the rate of 200 counts per minute. If you counted continuously at that rapid rate for 24 hours a day, it would require 798 days, or a little over two years and two months! By understanding the time that would be required simply to count to 230 million, you may gain some appreciation of the length of geologic time involved in the forming of the rocks around Camp Tom Hale.

**Holmes, Arthur,* 1956. "How Old is the Earth?", Edinburgh Geol. Soc., Trans., vol. 16, pt. 3, p. 313-333.

PLATE II

GEOLOGIC TIME TABLE

ERA	PERIOD (SYSTEM)	EPOCH (SERIES)	DURATION (in years)	SUCCESSION OF LIFE — PLANTS	SUCCESSION OF LIFE — ANIMALS
CENOZOIC	QUATERNARY	RECENT	2 MILLION	age of modern seed plants	age of mammals: age of man
		PLEISTOCENE			
	TERTIARY	PLIOCENE	53 MILLION		mammals increase, reptiles decrease, birds abundant, horse developed
		MIOCENE			
		OLIGOCENE			
		EOCENE			
		PALEOCENE			
MESOZOIC	CRETACEOUS	GULFIAN	55 MILLION	deciduous trees develop; ferns, cycads abundant.	age of reptiles: dinosaurs abundant, pterosaurs abundant, birds increase, mosasaurs appeared
		COMANCHEAN			
	JURASSIC	MALM	28 MILLION	age of ancient seed plants; age of cycads: ferns, conifers abundant; scale trees extinct.	dinosaurs (walking type), pterosaurs (flying), ichthyosaurs & plesiosaurs (swimming) abundant; few mammals; first bird (Archeopteryx)
		DOGGER			
		LIAS			
	TRIASSIC	KEUPER	23 MILLION	ferns, conifers, rushes abundant.	first dinosaurs; first mammal appeared
		MUSCHELKALK			
		BUNTER			
PALEOZOIC	PERMIAN	OCHOAN	33 MILLION	true conifers develop; scale trees, Calamites, & rushes abundant.	age of amphibians: amphibians abundant, fin-backed reptiles developed.
		GUADALUPEAN			
		LEONARDIAN			
		WOLFCAMPIAN			
	PENNSYLVANIAN	VIRGILIAN	37 MILLION	age of spore bearing plants: swamps filled with scale trees, Calamites, ferns, & Cordaites (forerunner of modern pine tree).	cockroaches, large insects, & large sprawling amphibians abundant.
		MISSOURIAN			
		DESMOINESIAN			
		ATOKAN			land snails appeared; first reptiles appeared.
		MORROWAN			
		SPRINGERAN			
	MISSISSIPPIAN	CHESTERIAN	37 MILLION	scale trees, Calamites, & ferns abundant.	fishes, amphibians, & crinoids abundant.
		MERAMECIAN			
		OSAGEAN			
		KINDERHOOKIAN			
	DEVONIAN	BRADFORDIAN	37 MILLION	scale trees develop; sea ferns abundant.	fishes extremely abundant.
		CHAUTAUQUAN			
		SENECAN			
		ERIAN			amphibians appear.
		ULSTERIAN			
		ORISKANIAN			
		HELDERBERGIAN			
	SILURIAN	CAYUGAN	22 MILLION	age of sea weeds: a few land plants develop.	all animal life is in the ocean: eurypterids (sea scorpions) abundant. air-breathing animals appear. fishes appear.
		NIAGARAN			
		ALEXANDRIAN			
	ORDOVICIAN	CINCINNATIAN	79 MILLION	all plant life in ocean: algae	graptolites extremely abundant.
		MOHAWKIAN			
		CHAZYAN			
		CANADIAN			corals appeared.
	CAMBRIAN	CROIXIAN	69 MILLION		trilobites abundant.
		ALBERTIAN			
		WAUCOBIAN			
PROTEROZOIC	KEWEENAWAN		(The estimated age of the Earth is 4 1/2 billion years.) 1,335 MILLION	Fossils rare. Life consisted of simple one-celled animals and low-order plants.	
	HURONIAN				
ARCHEOZOIC	TIMISKAMING				
	KEEWATIN		beginning		

Type of Rocks

All of the rocks in the region surrounding the camp are *sedimentary*. Because sedimentary rocks are deposited in layers, one on top of the other, they are often referred to as *strata*. A single sedimentary layer is called a *stratum*. Sedimentary rocks are further divided into two types: *clastic* and *non-clastic*. Almost all of the rocks in the camp area are clastic sedimentary rocks. They are composed of particles derived from older or pre-existing rocks. The older rocks were broken up into smaller pieces (disintegrated) by processes of weathering such as alternate freezing and thawing, prying action of plant roots, and chemical action. The disintegrated particles were then carried away (eroded) by agents of transportation (wind and water) to lower areas where they were deposited and finally compacted into rock strata.

The different kinds of clastic sedimentary rocks in the area are as follows:

SANDSTONE. This rock is composed of sand grains (quartz) cemented together by iron oxide. The colors range from light gray to brown depending upon the cementing material and impurities contained.

SILTSTONE. Similar to sandstone except that the individual sand grains are smaller and are mixed with more impurities such as mud and clay. The colors range from light gray to brown.

SHALE. A shale is composed of muds and clays which have been compacted into thinly stratified beds. A shale may include minor amounts of sand grains. Clay ironstone concretions are abundant in many of the shales of this region. The color of the shales ranges from gray to green to black.

Coal is another type of sedimentary rock present in the area. It is carbonaceous matter derived from the partial decomposition of plant life. The prevailing view among geologists is that coal was formed in place in large fresh water swamps. Plant remains accumulated under swampy waters and were partially preserved in the stagnant environment. Burial by more sediments caused the organic plant remains to be subjected to pressure and a consequent rise in temperature. This overburden caused the eventual transformation of the organic plant remains into soft or bituminous coal. The coal beds which crop out in the park are thin, impure, and far apart. Those mined from the strip pits near Wilburton are high grade bituminous coals.

Limestone, a non-clastic sedimentary rock, was found at only one locality in the park area. It crops out in a roadcut on the east side of State Highway 2 in the southeast quarter of section 24, Township 6 North, Range 18 East. At this place it is thin, sandy, and yellowish-brown. It contains the fossil shells of numerous invertebrate animals. It is underlain by a coal seam 2 inches thick.

Limestone is formed by chemical action in water. It is carried in solution (dissolved) by water to a basin of deposition and there precipitated (deposited) as a solid rock stratum. Deposits which coat the inside of water pipes in your home, and sometimes even stop the flow of water, are chemically precipitated from your drinking water in much the same way that limestone is deposited in the ocean.

Source of the Rocks

During the early part of the Pennsylvanian period, 230 million years ago, the region now known as the McAlester Basin gradually began to sink. The region to the south slowly began to rise to form the Ouachita Mountains. The sedimentary rocks in the camp area were probably derived mainly from disintegrated rocks of the Ouachita Mountains.

As the movement of the earth's crustal rocks gradually continued through millions of years, the elevated surface rocks of the Ouachita Mountains were at the same time being disintegrated by weathering, carried to the sinking McAlester Basin by the waters of many streams, and deposited there in horizontal layers of strata. As more and more layers accumulated in the basin, the sediments were gradually compacted into solid rock layers.

Movements of the earth's crustal rocks were not sudden. They would not have been noticeable if you had stood in the same spot and watched for a hundred, or even a thousand years. Nevertheless, the rocks of the earth's crust moved. The cause of the movement of the crustal rocks is not exactly known. Recent examples of movement of crustal rocks in different parts of the world are seen in the form of earthquakes, volcanic eruptions, and the appearance or disappearance of islands in the Pacific Ocean. Thus, we see that even today the earth's surface is not a permanent shape that will remain unchanged through all eternity.

By the end of Pennsylvanian time the sedimentary rocks in different parts of the McAlester Basin had accumulated to a thickness ranging from 21,000 to 23,000 feet. Some time after the strata were deposited in horizontal layers, a force slowly folded and tilted the strata away from the horizontal. Geologists refer to this force as the OROGENY. An orogeny is a mountain-making movement of the earth's crustal rocks. The exact time of the orogeny is unknown, but many geologists believe it reached its greatest proportions near the end of the Pennsylvanian Period. It is the Appalachian Orogeny which caused the strata in the region surrounding the camp to be dipping into the subsurface as they are today.

As the strata were being warped and folded by this great force, the processes of weathering and erosion were ever at work to destroy the uplifted rocks. The same processes are still today gradually wearing down the hills in the area and carrying them away, particle by particle, in the waters of Fourche Maline and other streams. Particles of rocks on the highest hills surrounding Camp Tom Hale will someday be swept down the hillside by wind or rain into Fourche Maline Creek to begin their journey to a new resting place. Many of the particles will probably be deposited in the ooze on the bottom of Lake Carlton, while others may be carried over the spillway and eventually be deposited as far away as the Gulf of Mexico.

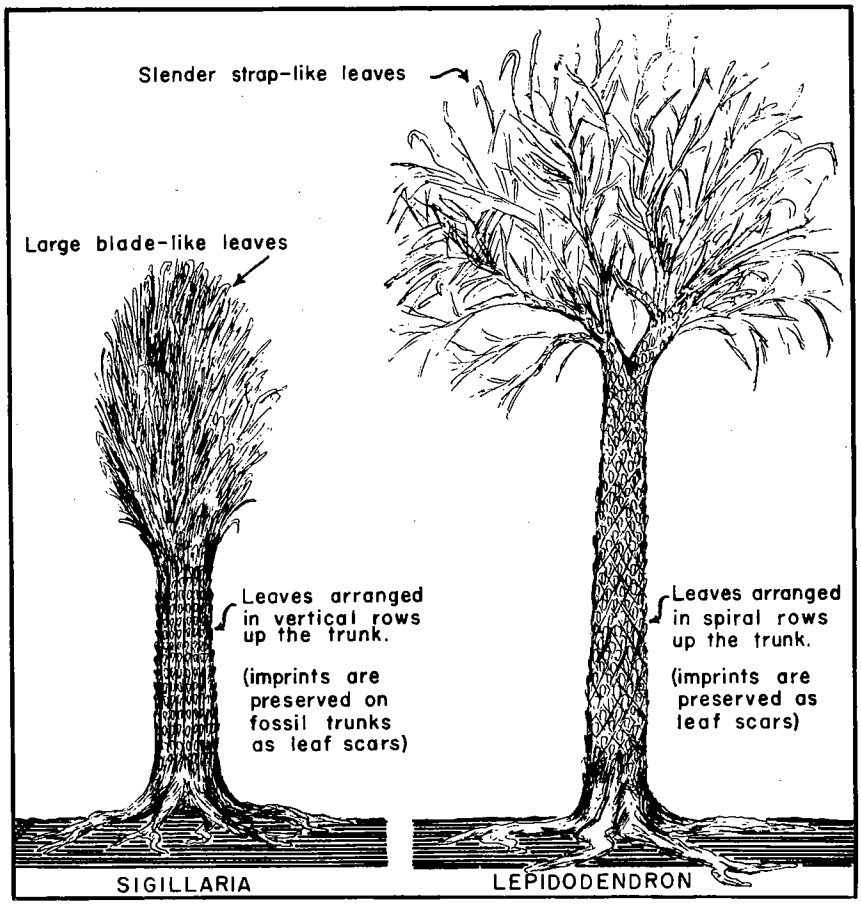

FIGURE 8. SCALE TREES. Sandstone casts of the trunks are abundant in the park area.

Fossils in the Rocks

The fossil remains of many ancient plants are present in the strata which crop out in the region surrounding Camp Tom Hale. Fossil remains of animals are absent except in the thin limestone that crops out near Highway 2. Fossil tree underground stems, stumps, and trunks are plentiful. Sandstone has replaced the original woody material. Imprints of plant leaves are also present in many of the shales, but they are difficult to find. Coal beds in this region nearly always contain the remains of leaves, stems, and spores of many plants.

FIGURE 9. Fossil stump of a scale tree, on State Highway 2.

The most common fossils found in the region are SCALE TREES, STIGMARIA, and CALAMITES (see figures 8, 9, 10 & 11). Two genera of scale trees are most common. They are LEPIDODENDRON and SIGILLARIA (see figure 8). A stump of a scale tree was found exposed in a new roadcut of State Highway 2. The roadcut is excavated in the thick sandstone layer which forms the cuesta underlying the park tourist cabins. It is just north of Coon Creek and overlooks Lake Carlton dam. This sandstone stump and its attached roots is in a dark, shaly part of the thick sandstone layer (see figure 9). Stigmaria are the fossil underground stems of scale trees. They resemble cacti at first glance (see figure 11). They have even been mistaken for the fossil remains of ancient snakes by those not familiar with paleobotany. Numerous stigmaria may be found in creek beds where they have come to rest after having been eroded out of the strata. Calamites are numerous. They are a rush-like plant with vertical grooves up the trunk.

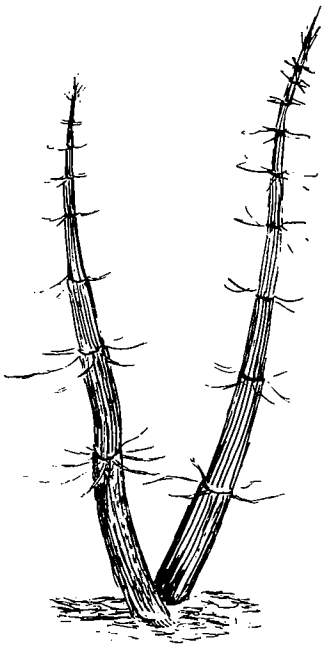

FIGURE 10. CALAMITES. Vertical grooves in the bark characterize this Pennsylvanian rush. Sand casts of this plant are numerous in the park area.

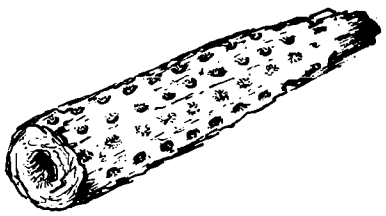

FIGURE 11. STIGMARIA. Fossil underground stem of a scale tree. Pits are where rootlets were attached. These plants are common in the camp area and have been mistaken for fossil cacti or even fossil snakes.

The study of fossil plants found in the strata enables paleobotanists better to understand the earth's history. From the fossils are gained ideas as to the type of life that existed during the time the strata enclosing the fossils were being deposited. For example, the plant fossils found in the region surrounding the camp represent plants that lived in an environment similar to plants that grow today in warm humid climates. (It is logical to assume that the climate that prevailed during the growth of the fossil plants was also warm and humid.) In this way paleobotanists and paleozoologists turn back the "pages of geologic history."

Summary of Geologic History

The geologist, in his quest for knowledge of the earth's past history, pieces together bits of evidence he has discovered in the outcrops of ancient rocks. Let's put the bits of evidence together so they will tell a story: the story of how the rocks in the region surrounding Camp Tom Hale came to be.

During early Pennsylvanian time the McAlester Basin began to sink and at the same time be filled with thick layers of clastic sedimentary strata. Deposition of the sediments occurred in shallow bodies of water or as terrestrial deposits. The landscapes were barely above sea level. Plant remains lead us to believe that the landscapes were covered by abundant vegetation which flourished in a warm and humid climate. There were many marshy areas whose stagnant waters preserved the organic plant remains which now appear as coal seams in the strata.

As more and more sediments were deposited in the basin, it continued to subside. Eventually the strata accumulated to a great thickness. The strata which are now exposed at the surface around Camp Tom Hale were many hundreds of feet beneath the surface at one time.

In late Permian time the APPALACHIAN OROGENY "flexed" its "mountain-making muscles" and caused the strata in the McAlester Basin to be folded into large anticlines and synclines. The eroding power of streams over the basin was then increased, and they began the unceasing task of wearing down the surface. After millions of years of erosion, the once deeply buried rock strata were exposed at the surface as the topographic features which exist today around Camp Tom Hale.

CHAPTER VII

SCENIC GEOLOGY

After visiting the points of interest in the park, you may want to explore some of the surrounding region. Here is a challenge to those scouts wishing to earn a merit badge in hiking! There is much scenic geology in the more isolated region east of the park that cannot be observed from the window of a car. You will have to walk! Large hogbacks and cuestas form many high cliffs. Several high vantage points afford a panoramic view of distant mountain tops of the Sans Bois Mountain Range. The nearby green of the thick forest seems to grade into a dull hue of purple on the slopes of distant mountains.

Yancey Mountain is approximately six miles east of Camp Tom Hale. It may be easily reached by following the trail which begins directly across old Highway 2 from the camp entrance. This trail passes by the "deer lick" mentioned in the chapter on zoology. On reaching the top of Yancey Mountain, you will find a rather flat mesa-like area as shown in figure 6. It is an example of a synclinal mountain.

If you have a strong pair of hiking legs and a desire for adventure, hike approximately one mile down the south side of Yancey Mountain until you reach Cunneo Tubby Creek. Follow the general direction of its flow to the southwest, and you will be hiking along a part of the route used by horsemen many years ago to cross the Sans Bois Mountains. After descending Yancey Mountain and following the creek for approximately 1½ miles, you will find a place where it widens to form a natural swimming pool called "round pond". It is located in the extreme eastern part of section 23, Township 6 North, Range 19 East at the intersection of a small tributary stream with Cunneo Tubby Creek.

Cunneo Tubby Creek has carved its way downward through many layers of rock to make a canyon whose walls in some places reach an impressive height. By following the creek to where it flows out along the flat shale valley near the settlement of Center Point (one mile north of Wilburton), you will have, indeed, observed some of the more rugged geology of the sandstone hills region of eastern Oklahoma.

The region to the west of Robbers Cave State Park is also geologically interesting. Large cuestas crop out around a synclinal mountain in the shape of a canoe (see figure 12). The "bow" of the "canoe" extends into the park to Lake Carlton. By standing at the highest point at the east end of the central part of the mountain and looking east, you will enjoy a striking view. The high vantage point is marked by an "X" on figure 12. The circular outcrop of a cuesta forms a wide arc which is clearly visible from this vantage point. The rock strata which form the cuestas around the mountain dip back under your position. Visualize yourself in a canoe. The bow is the circular outcrop to the east. The floor of the canoe extends from the bow and sides under your feet. In the same way, you may visualize the geologic formations as extending from their surface outcrop into the subsurface under the point on which you stand.

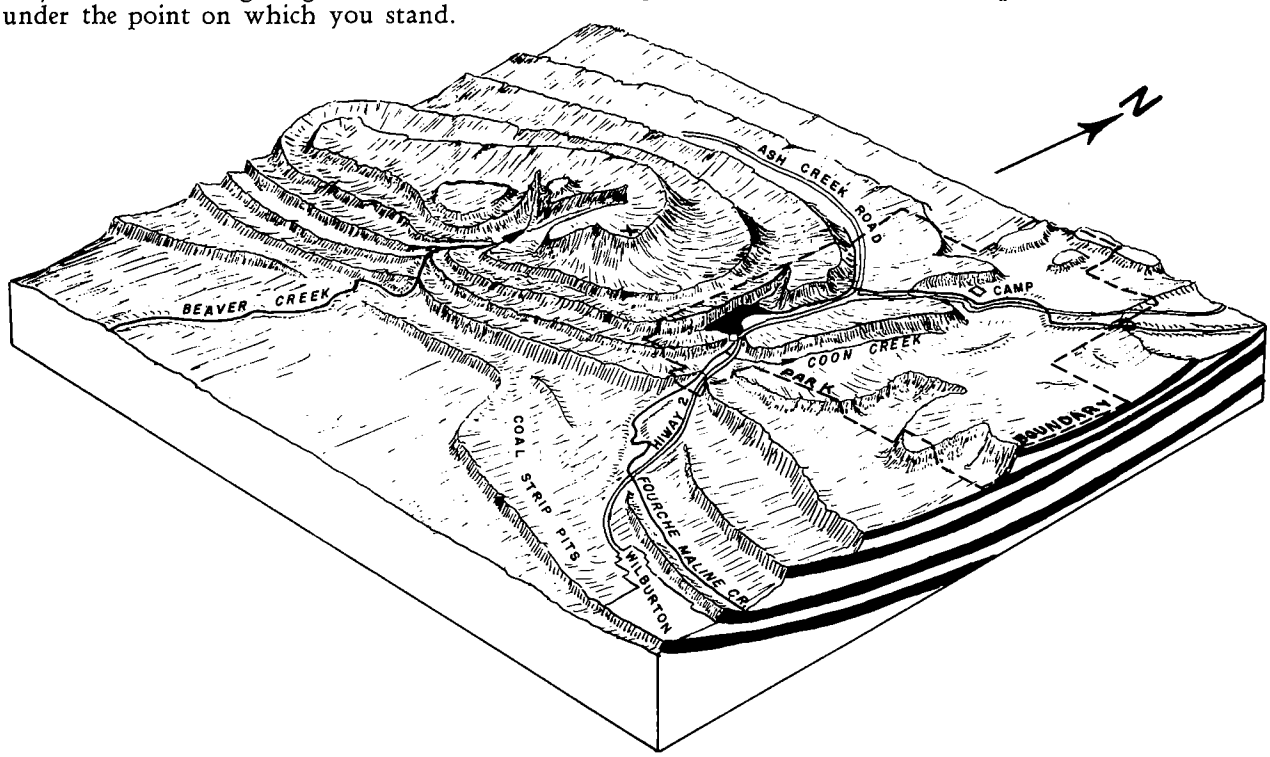

FIGURE 12. Aerial view of the canoe-shaped synclinal mountain west of Robbers Cave State Park. The bow of the canoe extends into the park. Dashed line is park boundary.

Descend the south slope of the mountain and follow Beaver Creek southwestward. The creek has cut through steeply dipping strata on the south side of the synclinal mountain. Observe closely the shales where they are exposed in the creek bed, and you will see several thin seams of coal. Continue to the small settlement of Patterson, then eastward to State Highway 2, and then northward to camp.

On completing the hikes through the region surrounding Camp Tom Hale, you will have been thoroughly introduced to field geology. Perhaps you will have noticed many of the features that are included on the geologic map of the park. At any rate, it is hoped that you will have gained a better understanding of geology and the earth on which we live.

The basic geologic principles herein presented will apply wherever you may travel. You will be able to better appreciate the scenic splendor of mountainous regions, because you will know the origin and relationship of topographic features to geologic history. As you drive through a mountain pass along any highway which follows close by a river, you will know that the river carved the rock walls in the same way that Cunneo Tubby Creek carved its canyon in the San Bois Mountains.

You may travel any direction from Camp Tom Hale—west to the Rocky Mountains, northwest to the Black Hills of South Dakota, north to the Ozark Mountains, east to the Appalachian Mountains, southwest to the Arbuckle Mountains—and you will see geologic features similar to those around the camp. Though they were formed during different times in geologic history, they were all formed by uplift and later eroded into their present appearance.

Everywhere you venture in the great out-of-doors, you are in close contact with geology.

GLOSSARY

ANTICLINE. An upfold of strata, the center of which is the "axis". The strata dip away from the axis like the roof of a house.

BEDDING PLANE. A characteristic of sedimentary rocks. They are planes along which the individual beds may separate.

CLASTIC. A sedimentary rock composed of particles of disintegrated older rocks which were mechanically transported to their place of deposition.

CUESTA. A ridge with one slope long and gentle and the other slope steep. Cuesta is a Spanish word meaning the flank or slope of a hill. Cuestas are caused by dipping formations.

DIP. The angle at which a rock stratum is inclined from the horizontal. Dip is always at right angles (90°) to strike.

DISTURBANCES. (see geologic time)

EPOCH. (see geologic time)

ERA. (see geologic time)

EROSION. Wearing away of the earth's surface by water, wind, ice (glaciers), and wave action.

FLOOD PLAIN. A relatively flat area close to a stream. It is made of sediment carried over the stream banks during time of flood.

FORMATION. The fundamental stratigraphic unit used for geologic mapping. It may include several layers. One layer of a formation is a *member*.

FOSSIL. The remains or traces of animals or plants which have been preserved by natural causes in the earth's crustal rocks. The term does not include organisms which have been buried during historic time.

GEOLOGIC TIME. Duration of the earth. Divided into ERAS, PERIODS, and EPOCHS.

ERA. Greatest of all stratigraphic "breaks". Caused by crustal movements so strong they are called REVOLUTIONS.

PERIOD. Eras are divided into periods of time by relatively great crustal movements called DISTURBANCES. Rocks formed during a period constitute a SYSTEM.

EPOCH. Subdivision of a period by local breaks of lesser intensity. Rocks formed during an epoch constitute a SERIES.

GROUP. Two or more formations with the same characteristics.

HOGBACK. Similar to a cuesta in that it is caused by dipping formations. Its slopes are roughly equal.

MARINE. Of or belonging to the sea.

MEMBER. (see formation)

NON-CLASTIC. A sedimentary rock type whose deposition was caused by chemical action.

ORGANIC DEPOSITS. Deposits formed from the remains of living matter such as plants and animals.

OROGENY. Movements of the earth's crust (folding and faulting) which cause the forming of mountains.

PALEOBOTANY. The study of plants of past geological ages through the investigation of fossils.

PALEONTOLOGY. The science which treats of fossil remains, both animal and vegetable.

PALEOZOOLOGY. The science of fossil animals. Its two divisions are vertebrate and invertebrate paleontology.

PERIOD. (see geologic time)

REVOLUTION. (see geologic time)

SERIES. (see geologic time)

SLUMP. The downward slipping of a mass of rock or unconsolidated material of any size.

STRATUM. A single sedimentary bed or layer. Plural is STRATA.

STRIKE. The direction or bearing of the outcrop of an inclined bed on a level surface.

STRUCTURAL GEOLOGY. Study of the structural features of the rocks (folds, faults, thickness), their geographic distribution, and the causes of deformation of the rocks.

SYNCLINE. A fold in rock layers in which the strata dip inward from both sides toward the axis. A downfold. The opposite of anticline.

SYSTEM. The rocks accumulated during a period.

TERRESTRIAL. Consisting of or pertaining to land in distinction from water. An example of terrestrial deposits are flood plains of streams and rivers. These clastic sediments are deposited by flood waters.

TOPOGRAPHY. The physical features of a region. The shape of the surface.

WEATHERING. The group of processes, such as the chemical action of water and air and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.