Oklahoma Geological Survey

Governor J. C. Walton, State Superintendent M. A. Nash,
President Strattc n D. Brooks, Commission
C. W. Shannon, Director

BULLETIN 32

Geology of the Southern Ouachita Mountains of Oklahoma

PART II

Geography and Economic Geology

By C. W. Honess, Norman, Okla.

April, 1923

WARDEN COMPANY, OKLAHOMA CITY

PINE TIMBER IN BEAVER BEND OF MOUNTAIN FORK RIVER, IN THE NW. ¼ SEC. 9, T. 6 S., R. 25 E.

OKLAHOMA GEOLOGICAL SURVEY

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PART II

GEOGRAPHY AND ECONOMIC GEOLOGY

BY
C. W. HONESS

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April, 1923

SCIENTIFIC STAFF.

C. W. Shannon	Director
C. W. Honess, author	Chief Geologist
F. M. Bullard	Field Geologist
H. E. Lillibridge	Field Geologist
M. C. Oakes	Field Geologist
A. C. Shead	Chemist
Frank Gahrtz	Draftsman
Bess U. Mills	Ass't. Draftsman

WARDEN COMPANY, OKLAHOMA CITY

GEOLOGY OF THE SOUTHERN OUACHITA MOUNTAINS OF OKLAHOMA

PART II.

GEOGRAPHY AND ECONOMIC GEOLOGY

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GEOLOGY OF THE SOUTHERN OUACHITA MOUNTAINS OF OKLAHOMA

PART II

GEOGRAPHY AND ECONOMIC GEOLOGY

INTRODUCTION

This report has for its object the fulfillment, in part, of the demand coming from the general public for information pertaining to the natural resources of the Ouachita Mountain region of Oklahoma. Hundreds of letters have been received at the offices of the Oklahoma Geological Survey during recent years, from individuals both within the State and outside the State, inquiring about the mineral resources, soils, and timber of this great region. Numerous requests have come for special investigations in various parts of the mountains to determine the importance of certain mineral deposits or to report upon agricultural tracts. This information has been freely given in so far as it has been available, and prospective buyers of property have been assisted in every way possible to learn the truth about the mineral and agricultural values of these lands. Nevertheless, as earnest as have been these appeals from the public and as desirous as have been the Survey officials to please and give reliable information concerning the Ouachita Mountain region, it has been impossible to do as much as the Survey could have wished, since up to the present time almost nothing has been written on the region.

The present report, therefore, although dealing with only a portion of the region, is designed primarily to relieve the present situation and to provide a means whereby the public may know the general geological conditions of a portion, at least, of the Ouachita Mountains, and what they have to offer in the way of natural resources.

On acount of the more purely scientific treatment of the chapters dealing with the stratigraphy, structure, and physiographic history these subjects have been combined with a brief introduction to form Part I. The chapters covering the geography and economic geology, treated less technically, and of more general and immediate use perhaps, is issued as Part II.

GEOGRAPHY

DEFINITIONS

TOPOGRAPHY, PHYSIOGRAPHY, AND GEOGRAPHY

Topography is a description, physiography an explanation of the natural physical features of a region. Usually the two subjects are discussed contemporaneously and they may incorrectly appear under either subdivision as a heading. This procedure may be convenient and in the end leave to the reader a correct and more or less vivid picture of the country dealt with, but it is not scientifically proper to use the two words interchangeably as is sometimes done in discussions of this kind. The topographer makes maps, which are graphic descriptions, showing the relief, the drainage, and the culture of the land. Some of the minor details of the topography cannot be depicted by this means, as is always the case, but by the use of photographs and a few paragraphs of descriptive writing, largely adjectives, his work is usually complete.

The physiographer is an expositor of the topography as represented by the maps and photographs. He is a philosopher who delves into the very depths of the science of geology in all its branches and related subjects of study—a student of processes, of stratigraphy, and of things in general in an effort to explain the surface features of the earth.

Closely allied to the problems of explaining the surface features of the earth are those accounting for the reasons for the culture. Why are the railroads so situated? Why are certain cities large, others small, some regions uninhabited? Why the present distribution of wealth? These are the questions asked of the geographer whose fundamental all-inclusive problem is to explain the relationship of mankind to the surface features. He too is a philosopher and must be a student not only of the history of the concrete earth, but of *Homo sapiens* and all his activities as well. The physiographer is sometimes a geographer, and vice-versa so nearly related are their respective tasks, but a topographer is not necessarily either. He is a surveyor and in some instances an artist.

LOCATION OF THE REGION

The area under consideration in this report is located in the extreme southeastern part of the State of Oklahoma, in what was formerly the Choctaw Nation of Indian Territory. The area includes nearly all of the northern half of McCurtain County, and small adjacent areas to the north and west in LeFlore and Pushmataha counties embracing in all 1,000 square miles of territory, mostly in the Lukfata quadrangle of the topographic atlas of the United States. Physiographically, the area lies in the south-central part of the Ouachita Mountains.

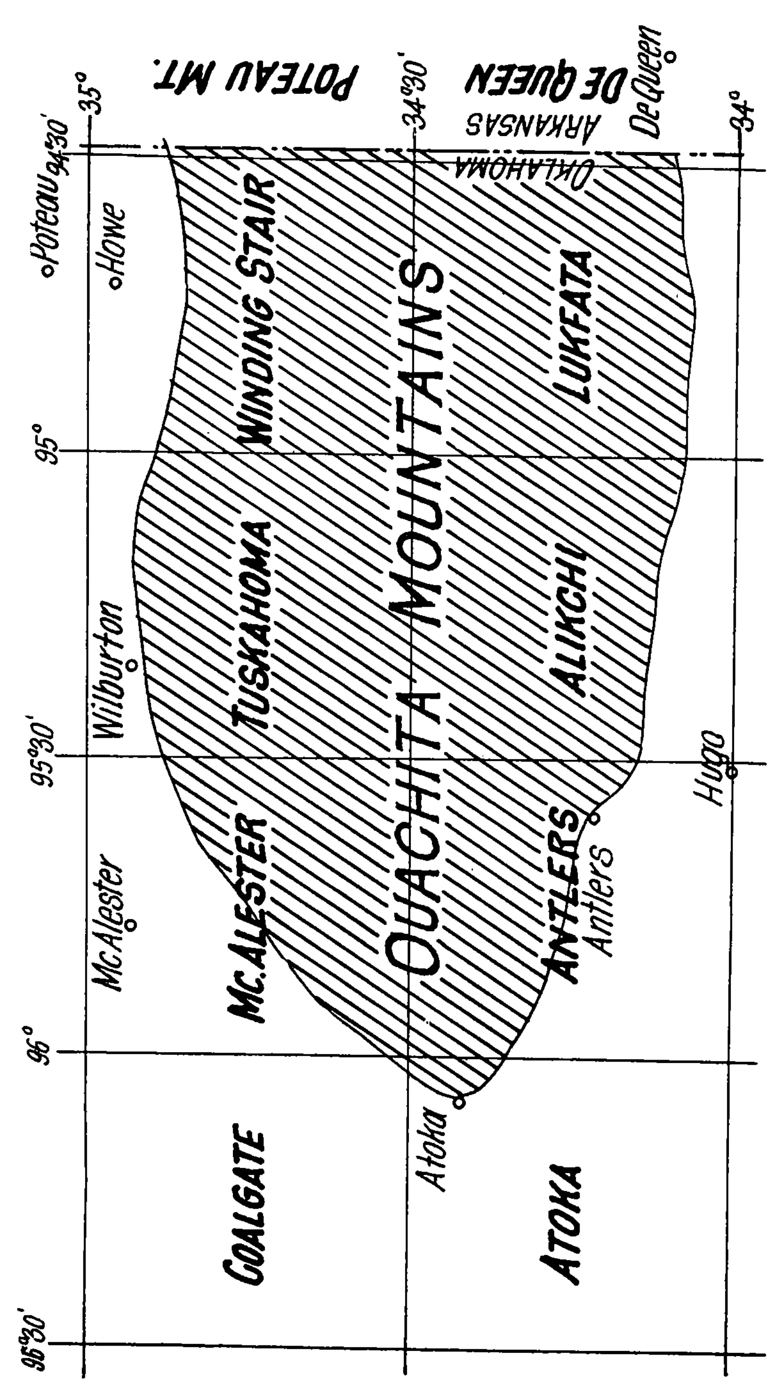


Figure 1—Table Showing Location of Topographic Atlas Sheets of the United States Geological Survey Covering the Ouachita Mountain Area in Oklahoma

For the benefit of those unfamiliar with the topographic sheets of the United States Geological Survey and their use it should be stated that these maps show three kinds, or classes of information as follows:

1. The elevation and relief of the land, i. e., they show the elevation of the land above sea level, the roughness or smoothness of the country, the size and shape of the hills and valleys, and the steepness of the slopes.

2. The surface drainage, or the location and direction of flow of all the rivers and creeks, and the position of the lakes, marshes, and other bodies of water.

3. Culture, by which is meant the roads, railroads, bridges, towns, county and section lines, and all works of man.

These maps are known as topographic atlas sheets and each sheet has a name which in each case is derived usually from the largest town or some other prominent feature within the sheet. There are ten such sheets in the Ouachita Mountain region of Oklahoma, named and located as in figure 1.

These maps are of great value in determining the location of any topographic feature, whether natural or artificial, and should be referred to by prospective buyers of farm lands, or any other lands, as the value of any piece of property may often be indicated by the contours of the topography, the proximity to roads, railroads, and towns, or by conditions of drainage.

Since the Ouachita mountain lands are sometimes misrepresented and offered for sale by certain numerous real estate agencies of a notorious character it is highly advisable that purchasers of these lands at least refer to these maps. *

The Ouachita Mountains as a whole have a length of 200 miles, extending from Atoka, Okla., to Little Rock, Ark., and have an average width of about 50 miles. The region consists of even crested mountains and high ridges bearing generally east and west the most prominent of which, in Oklahoma, are Jackfork, Winding Stair, Buffalo, Blackfork, Rich, Kiamichi, and Blue Bouncer mountains. These are separated usually by wide, flat valleys in which flow the larger streams. The flat valleys are slightly above the level of the Arkansas Valley region and the Gulf Coastal Plains region which border the mountains upon the north and south sides, respectively. The most important valleys are those of Kiamichi River, Little River, Mountain Fork River, Buffalo Creek, and Jackfork Creek. At the west end of the Ouachitas the crest of the ridges

* These topographic maps are issued by the Federal Government and may be procured from the Director, United States Geological Survey, Washington. D. C. at ten cents per sheet.

are at an elevation of about 1,000 feet above sea level, or 400 feet above the larger valleys. They rise gradually eastward and near to the Oklahoma-Arkansas line attain elevations of 2,900 feet maximum, above sea and nearly 2,000 feet above the principal valleys. In Arkansas the ridges again drop away gradually until they are only 500 feet high at the east end. South of the central axis of the range the ridges are cut across by southward flowing streams the result of which is a more rugged topography, but with less relief. The hills and ridges south of the center of the range have successively lower and lower elevations from north to south the tops of which mark the position of the southward tilted Cretaceous peneplain. Portions of the youthfully dissected southern border of this peneplain, partake of the character of low plateaus.

THE NAME "OUACHITA MOUNTAINS"

The region now generally known as the Ouachita Mountains, or Ouachitas, of southeastern Oklahoma and west-central Arkansas was originally called by Darby on page 138 of his "Emigrant's guide to the western and southwest states and territories." published in 1818, the "Masserne Mountains" and by Thomas Nuttall on pages 109 121, 146, etc. of his book, "A journal of travels into the Arkansas Territory during the year 1819," the "Massern Ranges." It was in 1888 that the mountains came to be known as the "Ouachitas" for it was then that Branner* introduced the phrase, "Ouachita Mountain System" to apply to this range of mountains, or to a part of it. Hill**, two years later followed Darby and Nuttall in speaking of these mountains and used the phrase "Ouachita System of Arkansas and Indian Territory" to include the Massern Ranges, the Arbuckle Hills, and the Wichita Mountains. Then Taff***, following Branner, first in his report on the McAlester-Lehigh Coal Field, Indian Territory, and later in all his other reports and folios used the term "Ouachitas" as essentially equivalent to Massern Ranges. Taff's works, since their publication, have formed the sources of all information concerning the Oklahoma end of these mountains and practically everyone referring to the mountains since, both in Oklahoma and in Arkansas, has used Branner's definition as accepted and modified by Taff.

In 1909 A. H. Purdue in a footnote on page 26 of his "Slates of Arkansas" says in this connection:

> The term Ouachita System was first applied in the Reports of the Geological Survey of Arkansas, 1888, vol. II, p. 10; and 1890, vol. III, p. 190 to those east-west ridges that contain the novaculites, or Arkansas whetstone

*Branner, J. C., Ann. Rept. Ark. Geol. Survey, vol. 1, 1888, p. 59.
**Hill, R. T., Geography and geology of the Black and Grand prairies: Twenty-first Ann. Rept., U. S. Geol. Survey, vol. 7, 1900, p. 37.
***Taff, J. A., Nineteenth Ann. Rept., U. S. Geol. Survey, 1897-97, Part III, p. 431.

rocks. But in later years, the term has been extended to include the important group of mountains to the north and Ouachita Range is here used [restricting the term to the novaculite ridges] in the sense of the original term "Ouachita System."

adding in the main body of his report on slates, page 26, that

"no name has yet been adopted for the aggregate of the several high mountain ridges constituting the northern part"

and proposes that these high ridges to the north be

"designated the Fourche Range, that being the name applied to one of the highest mountains of the area, as well as to another ridge of lesser importance."

Purdue's recommendations, however, have not been followed nor have Hill's. The term Ouachita Mountains or Ouachitas, as now used by everyone is essentially a substitution for the Massern Ranges of Darby and Nuttall.

Recognizing this fact and realizing that the names "Washita" and "Ouachita" are pronounced so nearly alike and are continually being confounded one with the other and both with "Wichita," the writer sent out a circular letter to some twenty-five or thirty prominent geologists throughout the country recommending the revival of the name "Massern Ranges." Special emphasis was laid upon the fact that the chief objection to the present usage is that the Ouachita Mountains of **southeastern** Oklahoma and west-central Arkansas are often confounded with the Wichita Mountains, or Wichitas, of **southwestern** Oklahoma.

A number of voluminous letters were received with arguments pro and con the change of name, and the writer here wishes to acknowledge his indebtedness and express his gratitude to those who replied so fully and energetically. He would like to include all the discussion which took place but for lack of room this will not be attempted. Without mentioning any names it may be said that the opinions were about equally divided. The writer is unmoved in his own opinion that the name should be changed back to Massern Ranges or Massern Mountains, but for lack of a substantial majority favoring this view he has followed the current usage in the present report.

In the earliest reports upon the Arkansas country the words "Ouachita" and "Washita" are used interchangeably for the river by that name and they are misspelled very often in diverse ways. From his reading the writer was led to believe that all three words, "Ouachita," "Washita" and "Wichita" originated from the same root and originally had the same meaning and reference and that doubtless two of the three words have come about from the mispronounciation and misspelling of the original—whatever it was. The word "Massern" is likewise spelled in many ways. Dr. J. B. Thoburn of the Oklahoma Historical Society in reply to correspondence concerning this question, writes as follows:

In reply to your question as to the origin, derivation, signification, and possible identity of the names Ouachita, Washita and Wichita: (1) Ouachita is the French rendering of the native name of a small tribe of Indians of the Caddoan linguistic family, appearing in various forms in the writings of Tonti (1690), Iberville (1700), Penicault (1712), La Harpe (1719) and DuPratz (1774). This tribe or band seems to have been merged with the Natchitoches (to whose people they were doubtless closely related) shortly after the French occupancy, even as the latter were subsequently absorbed by the Caddoes. Their original habitat was on the river which still bears their name, in northern Louisiana:

(2) The name Washita is directly derived from that of Ouachita and the pronunciation of the two is practically identical. For some reason which has never been explained, the French voyagers and traders who paddled up Red River from the French settlement at Natchitoches, in Louisiana, to trade with the Indians of the Upper Red River country, always referred to the tributary which enters Red River from the north at a point near the center of the southern border of Oklahoma as the "Faux Ouachita," which literally translated, means "False Washita." It was still designated as the Faux Ouachita during the early part of the last century and, with the name Anglicized, was called the False Washita thereafter until about the time of the Civil War, since which time the prefix has not been used, the river being merely called the Washita. It is to be regretted that there should be such an identity between this Oklahoma river and the stream in Arkansas and Louisiana, in the matter of name, for the Oklahoma stream certainly seems possessed of sufficient distinction to warrant a name of its own: its Caddo name, by the way, was Bahachaha;

(3) The origin of the name Wichita, as applied to an Indian tribe, a range of mountains in Oklahoma, a river in Texas and a city and a county in Kansas, is open more or less to conjecture, as the name does not seem to appear in its present form until well along toward the middle of the last century. When I first discussed this matter with Doctor Gould, something over a dozen years ago, I was inclined to accept his surmise that it was in fact a derivation of Ouachita and Washita but subsequent investigation and research led me to a different conclusion. In considering this matter it is well to bear in mind that the French and Spanish languages do not employ the use of the letter "w" and, as a consequence, the same word which would naturally be rendered with a "w" in English, might begin with "ju" in Spanish or "ou" in French. Probably no tribe of Indians in the United States has had more appelations than have the Wichita Indians, though it is quite possible that some if not most of these may have been merely those of particular subtribes or bands, for the present Wichita tribe is the remnant of a once powerful confederacy of closely related tribes and bands. Among the names by which they seem to have been known by the Spaniards of Texas and New Mexico are the following: Jumanos, Tejas, Ahijaos, Taovayases, and Taguayachi; among the French names for the same people were: Toayas (La Harpe, 1719), Taouayaches (Robin, 1802-6), Ouichita (La Harpe, 1719), Panis Noirs (Bruyere, 1742), Panis Piques (Perrin du Lac, 1805) and Les Quichaatcha, ou les courtes jambes, which is to say, "the Quichaactcha, or short legs" (De L'Isle, 1700). American names for the same people have included Towiaches, Tawehash, Pawnee Piquas, Pawnee Pictas, Tattooed Pawnees, Black Pawnees, Witchetaw and Wichita. Most of the foregoing names have been subject to so many variations that they form but a small fraction of the whole number. It is my conclusion that the origin of the present Wichita must be sought in "les Quichaatcha," of De L'Isle's map in 1700, or

in La Harpe's "Ouisita" in 1719, rather than as a derivative of Ouachita or Washita.

I know nothing of the name, Massern, though I have seen it in Nuttall's journal. Presumably, it is of French origin, as were most of the geographic names of that region, a century since.

DRAINAGE AND TOPOGRAPHY

The particular region under consideration in this report lies wholly within the area which is characterized by southward flowing streams. The main streams in order of their importance are Little River on the west, Mountain Fork River to the east, and Glover Creek in the center. These streams flow due south, directly across the strike of the rocks, and gather from either side numerous creeks and branches which, in general, have a southeasterly, or southwesterly direction. Little River, after it enters the Coastal Plains region to the south of the mountains, turns east-southeast, thence east, where it is conjoined by Glover Creek and Mountain Fork River. These waters wend their way eastward into Arkansas where they are joined by other large creeks and rivers, and there flow into Red River, thence into the Mississippi and finally to the Gulf. In the southern part of the region in question, between the main rivers are other southward flowing streams, chief among which, named in order from west to east are Cypress, Horsehead, Lukfata, Yashoo, Yanubbe, Lick, Luksuklo, and Rock, all of which find their way more or less independently into Little River to the south.

The pattern of the streams in general may be said to be a combination of the trellis type of drainage with the dendritic type, and superimposed as it is upon a general east-west folded structure, the region is further characterized by irregularly shaped hills and mountains and short, high, narrow, nearly parallel ridges. The slopes are steep, rugged, and covered with coarse float. Outcropping ledges of hard sandstone and flint appear at frequent intervals chiefly along the crests and around the ends of the mountains (in the water gaps). The ravines and gullies are sharply V-shaped, rock-ribbed, and choked with dèbris.

The hills and mountains range in elevation from 750 feet to 1,250 feet ordinarily, but some peaks are higher. Williams Mountain (sec. 6, T. 3 S., R. 26 E.) is 1,450 feet in elevation, or 650 feet above its base; He Mountain (T. 2S., R. 25 E.) rises to a height of 1,500 feet; and several unnamed heights (T. 3 S., R. 26 E.) rise 1,300 feet to 1,400 feet above sea level. The general region of these high points, (Ts. 2, 3, and 4 S., Rs. 25 and 26 E.) in the valley of Mountain Fork River is one of the roughest regions in the entire

Ouachitas. In this particular vicinity the streams are crooked and they have cut the hills into odd and irregular shapes developing cliffs and gorges. Mountain Fork River south of Hochatown (T. 5 S., R. 25 E.) has entrenched itself 450 feet below the highest ridges and peaks in that vicinity, 950 feet below the tops of the mountains north of Hochatown (T. 3 S., Rs. 24, 25, and 26 E.) and 900 feet below the high divide west of Smithville in the north (T. 1 S., Rs. 24 and 25 E.), but in this last named locality the slopes are longer and the stream development more regular, hence the country there is not so rough as farther to the southeast.

The average relief in the valley of Glover Creek in the central part of the area is about 500 feet with the high points on either divide east and west 1,000 feet and 750 feet, respectively, in elevation. None of the rougher country along Little River happens to fall within the area at present under discussion.

CLIMATE

The climate of the region and the southeastern portion of the State generally, compared to that of the plains regions in the central and western parts of Oklahoma, is more equable and uniform and is subject to fewer marked changes of temperature than that of the higher altitudes. The mean annual temperature for this part of Oklahoma is 62.1° and the average annual rainfall is 43 inches.

In the spring, intermittent heavy rains and daily showers swell all the creeks and rivers to capacity and overflowing, and soak the ground thoroughly, both in the mountains and in the plains. Immediately after heavy rains the rivulets and creeks are everywhere in flood and the whole country seems virtually under water. In the plains regions whole sections become quagmires, and in the mountains the rivers and creeks run with such high velocities that the farmers and other settlers are compelled to remain at home until the water subsides and the land becomes firm. Severe electrical storms accompanied by high winds are certain to approach from the south at this time of the year causing in some instances, considerable damage to the timber as when large numbers of trees are tipped out by the roots. This happens especially where the trees stand on a shaly formation in a water soaked and thin clay soil.

The atmosphere is warm and humid, and the woods are white with dogwood blossoms and bursting buds during the closing days of March when the period of growth begins. Throughout the spring and summer months the country is clothed with a luxurious growth of trees, underbrush, and grasses; in the limited agricultural districts with flourishing corn, oats, and cotton—everywhere a mat of vegetation. As the summer grows the rains become less frequent, but amply sufficient, and the heat more intense, yet bearable. The months of July and August are sultry and even in the mountains the heat is oppressive. Nevertheless, there is everywhere an abundance of shade, and there is plenty of good water in the deep holes in the creeks and in the springs.

The dry season of the year usually begins early in August and may continue throughout the months of September, October, and part of November with an occasional shower. Sometimes, however, there are protracted rains in October. September is very warm, but not an uncomfortable month ordinarily. The remainder of the fall is characterized by beautiful, dry weather, ripening seeds and grains, drying leaves and a diminishing supply of grass. Extreme drouth, however is unknown in the Ouachita Mountains. Even during the very dry summer of 1918 corn remained green until it matured and grass was plentiful throughout the summer. Thousands of cattle were shipped from the drouth stricken districts of Texas during the late summer and fall of this year into McCurtain County where they found plenty of green grass and other herbage, as well as water.

Frosty nights usually make their appearance in the early part of November and an occasional rain will intervene, but no bad weather need be expected before the first of December. Although sleet and snow are not uncommon forms of precipitation in January and February, the winter months are never severe. Periods of cold are usually short and rarely does snow remain on the ground more than one or two days. Rain is more common than snow, but neither come in great abundance in the winter.

Tornadoes and bad storms, such as the populace of the plains region of the west are familiar with, rarely visit southeastern Oklahoma. A few "twisters" have passed through McCurtain County as is plainly evidenced by the strips of fallen timber in the mountains as well as by the vivid recollections in the memory of those residing in the region. However, their frequency is not sufficient to cause uneasiness and one sees no "storm cellars" in this country. The greatest danger in most storms lies in the falling of timber which sometimes is occasioned by the slightest movement of air. A good house therefore, is abundant protection from storms at all times. Most storms come from the Gulf and the winds blow from the south the greater part of the time. A southeast wind is generally productive of rain sooner or later, but a southwest wind very seldom brings rain. A shifting of the wind from southeast to southwest during a storm invariably brings about fair weather, and a shifting of the wind from south to north is certain to bring about a change in the weather.

Owing to the sluggish character of the streams after they leave the mountains certain portions of the southern area are frequented by the *anopheles* mosquito which is the carrier of malaria. The

PLATE II.

BRUSHY PINE AND OAK WOODS IN GUM SPRING BEND OF MOUNTAIN FORK RIVER IN THE SW. ¼ SEC. 34, T. 3 S., R. 25 E.

presence of the malaria germ in these districts is the chief cause for illness in the region and is the greatest hindrance to a rapid clearing and settling up of the agricultural tracts. In the more mountainous portions of the country conditions are better and very little sickness occurs.

On the whole, therefore, the climate of the southern Ouachitas, the northern half of McCurtain County especially, is admirably suited to agriculture and to cattle and hog raising, and with the exception of certain restricted areas along the sluggish courses of streams, may be said to be one which is conducive to health. Just what areas are suitable to agriculture and which ones to grazing will be pointed out on subsequent pages.

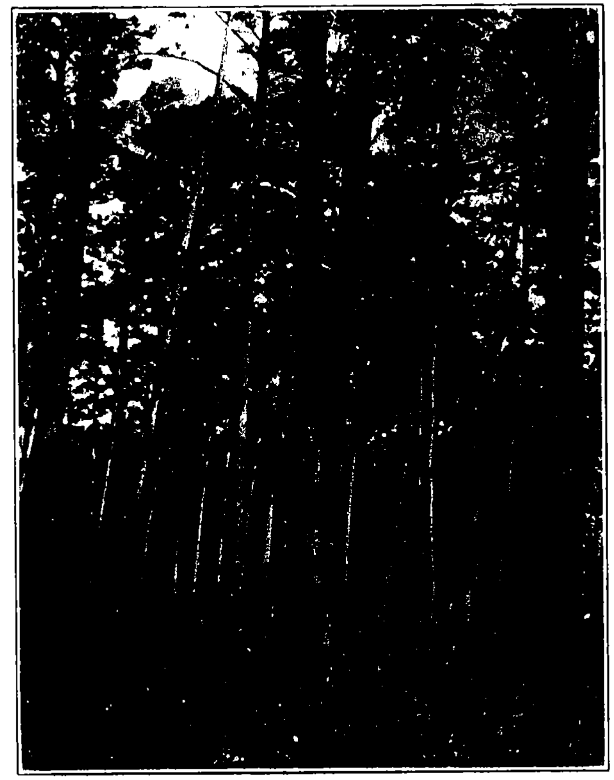
PLANT LIFE

The flora of the southern Ouachita Mountains is similar to that of all the country contiguous to the lower valley of the Mississippi River. It is rich in its great variety of species and unusual in the number and size of some of the plants. The country was originally covered with forest growth, save small, relatively insignificant strips of prairie, and much of the forest was heavy timber, but in recent years a large portion of the valuable timber has been stripped away.

The species of trees most commonly observed in the woods are the following: post oak, white oak, black oak, red oak, pin oak, peach oak, (willow oak or water oak), black jack oak, chinquapin, white hickory, pig hickory, sweet gum, sour gum or pepperidge, hackberry, yellow pine, American elm, sycamore, holly, blue beech, ironwood, redbud, and dogwood; and those of less common occurrence: walnut, shellbark hickory, red cedar, cypress, cottonwood, sugar maple, white maple, American beech, green ash, white ash, black ash, box elder, sassafras, and bois d'arc, besides a great many others of less importance. Of wild fruits there are a number of species including plums, haws, cherries, blackberries, raspberries buckberries, currant, gooseberries, grapes, muskadines, elder, persimmons, and strawberries. Of the grasses and other plants the ordinary bunch grass, blue-stem, golden-top and crop-grasses; the horsemint, daisy, saw-brier, and poison-ivy are the most common. Bear grass is present locally and a host of the rarer plants and weeds occur, a complete list and classification of which, together with all the species of trees and shrubs in these woods would make a real contribution to the science of botany. The region is highly recommended by the writer to any and all who feel inclined to take up such a task. The yellow pine occupies the rocky slopes and tops of the mountainous regions and the dissected plateau region and is found growing best and almost solely where rocks and a sandy soil prevail. The oaks and the hickories, with the exception of the pin oak and peach oak, all occupy high ground, but like the weeds of

the florist's garden they are difficult to keep out of any region. They occupy the rockiest mountain slopes, the high flint hills, and the rich river flats alike, but the black jack oak is seen to have a preference for high, rocky, sandy, and poor country; white oak, post oak, red oak, and black oak thrive best in fertile soils. Pin oak and peach oak require soggy, moist flats and grow to a great size very quickly. All species of the ash and elm, the gums and the hackberry grow

PLATE III.



HEAVILY TIMBERED SLOPE (YELLOW PINE), SEC. 13, T. 5 S., R. 23 E.

on low ground as a rule; while the sycamore, red cedar, holly, blue beech, iron wood, soft maple, and swamp dogwood are found invariably along streams. The cypress is a very specialized type of plant and refuses to grow anywhere excepting in the water of certain streams. The cypress swamps of Little River, and along the lower reaches of Cypress Creek, Glover Creek, and Mountain Fork River are its favorite haunts. It is also growing along Buffalo Creek in the northeastern part of McCurtain county. It attains a vary large size, the majority of the trees being 4 to 6 feet in diameter. Of all plants restricted in geographical distribution the white beech or American beech is the most unusual case. It is found only along Beech Creek and on the banks of Mountain Fork River at the mouth of this creek (T. 1 S., R. 26 E.). In the locality where it is found, however, it is an abundant constituent in the flora and grows to a fairly large size, some of the trees being three feet in diameter. It is found along the creek bottoms growing in the alluvial soil. The horse tail (Equisetum) is another rare plant, very common in the northern and eastern parts of the United States, but seldom seen in McCurtain county. Its habitat is a rich soil on the bank of a stream.

PLATE IV.

GENERAL APPEARANCE OF CUT-OVER COUNTRY, SEC. 10, T. 4 S., R. 20 E.

The diversity of the plant life and the variety of habitats made use of, together with the climatic conditions produce a type of country the general appearance of which is difficult to describe. There are, corresponding with the various types of soils and habitats, many kinds of horticultural gardens, whose general aspects are as different one from the other as is a bed of violets from a row of sunflowers. Each produces a type or kind of country peculiar unto itself, but after looking at each successively and repeatedly one is left with the general impression that this is indeed a "wooded, brushy, 'hairy' country."

ANIMAL LIFE

In the character of its animal life, as well as that of its plant life, the southern Ouachitas is not different from other regions in the southern Mississippi Valley. Originally the whole country was a veritable paradise for the hunter and trapper, as is indicated in the letter written in 1805 to Gen. Henry Dearborn, Secretary of War, by Dr. John Sibley, who states that "from Blue River on both sides of Red River, there were innumerable quantities of wild horses, buffalo, bears, wolves, elk, deer, foxes, sangliers or wild hogs, antelope, white hares, rabbits, etc., and on the mountains the spotted tiger, panther, and wild cat." *The region here referred to is in Bryan county but it is reasonable to assume that all of these animals found their way also into the mountains to the north. Major Bedford for instance found the buffalo in the valley of the Kiamichi in 1819 and the Leavenworth Expedition found them near the site of Eufaula in 1834** which proves their adaptation to the timbered regions, though it is scarcely possible that buffalo frequented the mountains in large numbers. Wild horses were also found in the eastern part of the State in early days and doubtless were present in the Ouachita Mountains. That the black bear, wild hog, panther, and spotted tiger had inhabited the immediate region, however is beyond question for all were hunted and killed in the mountains up to a very few years ago, and many of the mountaineers and hunters now residing in the hills can relate incidents of their capture. The beaver was also originally very common along the creeks and rivers. Common among the mammals living in the mountains at the present time are the Virginia deer, raccoon, opossum, timber wolf, fox, otter, mink, skunk, rabbits, squirrels (four species), wild cat or bob cat, wood rat, and possibly farther north may still be found the bear and cougar lion.

Of the bird life there are the turkey buzzard, bald eagle, crow, hawks, (several species), owls (three species), wild turkeys, ducks, and quail, besides large numbers of southern song birds and others such as the robin, wren, cardinal, bobolink, blue jay, mockingbird, whip-poor-will, and sparrows. Formerly wild turkeys and quail were present in large numbers in this region as well as in the plains to the west, but they have been hunted and destroyed until very few remain. Swans were originally present in great numbers below the mouth of Kiamichi River according to Dr. Sibley's letter of 1805 above mentioned. They may also have been present farther east.

*History of Oklahoma by J. B. Thoburn p. 33.

**Op. cit. p. 6.

Several dangerous snakes inhabit the mountainous parts of the country notably the diamond-backed rattlesnake which attains a length of 7 to 10 feet and a circumference of startling dimensions, others are the velvet-tail rattlesnake, the copperhead, and water-moccasin (two species); those not poisonous are the black snake, coach whip, milk snake, spreading adder, and others.

There are also some poison lizards purple in color, and some, too, which are not poisonous. Three species of turtles are found, namely, the box turtle or terrapin, the loggerhead and a soft shelled turtle, the last being very rare. The loggerhead is a "snapping turtle" and is extremely abundant in the rivers and large creeks. The species grows to be as large as the head of a barrel and the jaws may measure 6 or 7 inches across in extreme cases. (Actual measurement made by the writer.) A number of species of toads and frogs abound. Fish are numerous in all the streams, the most common being: cat fish, buffalo fish, bass (several species), red horse, pike, gar, perch, trout, sucker, and eel.

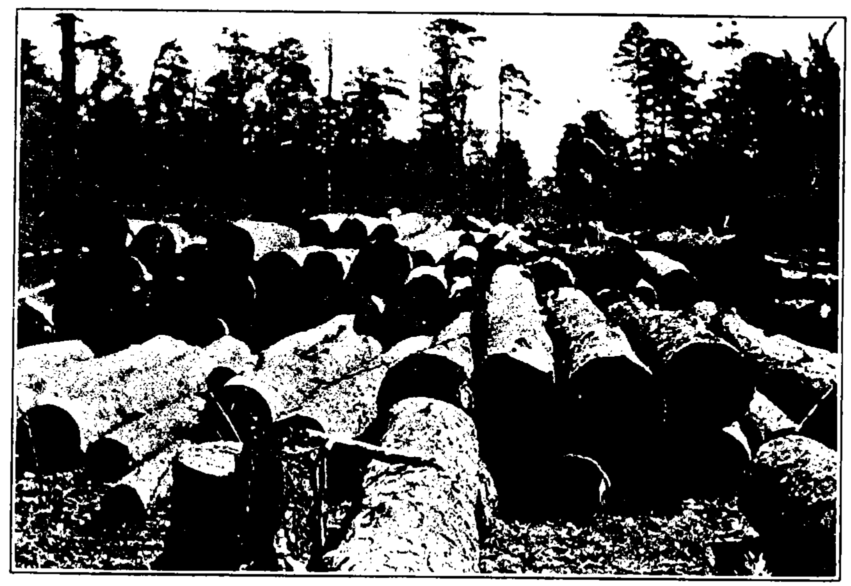
The tarantula, scorpion, and centipede are very common, each in its respective environment, also bees, wasps, and vicious hornets, and a long line of coleoptera, diptera, lepidoptera, odonata, orthoptera, hemiptera, and other orders of insects not forgetting the ticks and the chiggers (red bugs).

The Mississippi *unionidae* (fresh water mussels) live in all the large streams apparently in considerable variety. They are very numerous quantitatively and furnish a large supply of food for the hogs which "leave not a stone unturned" on the river bottoms in their search for them. Many of the hogs become very expert in this art of fishing and not only root the clams from the shoals, but go into deeper water for them, holding their breath while they go down and root, coming up for more air and again descending to further explore the bottom. The opened shells are found on the shoals literally by the thousands, where the hogs have rooted them from the mud and "cracked" them. Doubtless in former times the wild hog lived partly on the mussel, but of course chiefly on acorns, nuts, and berries. Numerous other genera of *Mollusca* chiefly Pulmonata are indigenous to the region as is also the crayfish.

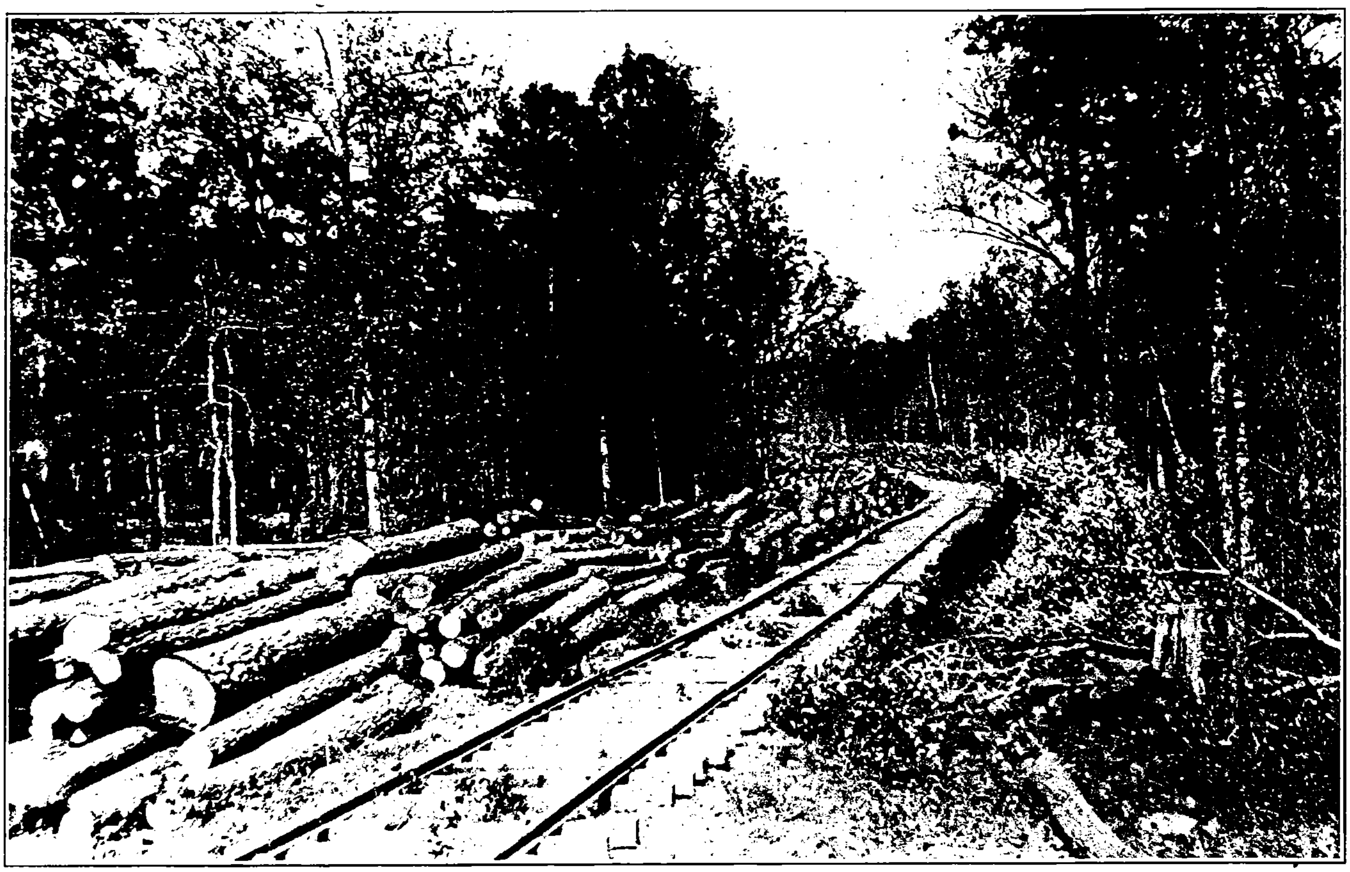
INDUSTRIES

Very naturally the chief industries have to do with the natural resources of the country, thus, formerly hunting and fishing, and later farming, cattle-grazing, hog-raising and lumbering became the essential occupations of the people. With in the memory of the most of those now residing in the south-central portion of the Ouachita Mountains the country was yet new and untouched by the

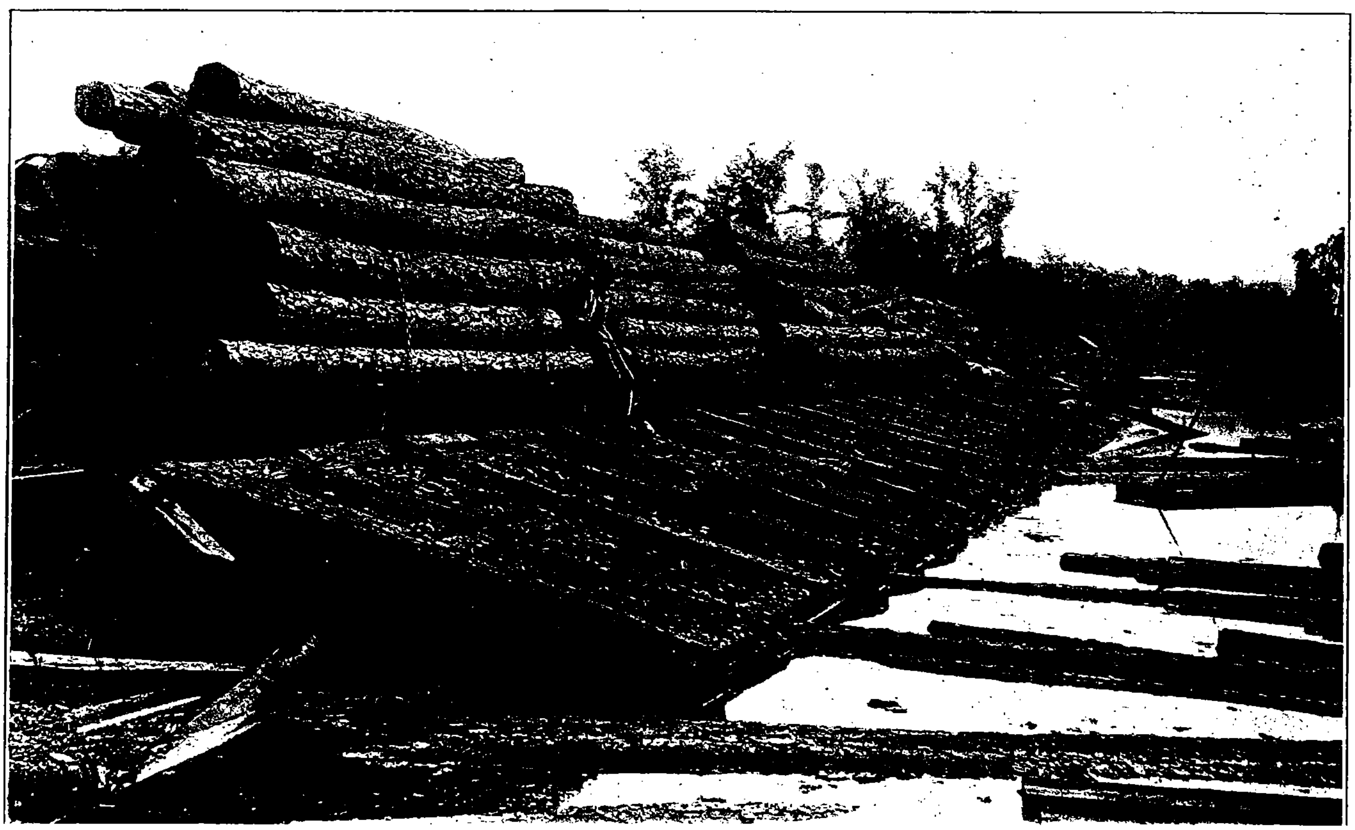
PLATE V.



A AND B. PINE LOGS ASSEMBLED ALONG A NEWLY CONSTRUCTED RAILWAY SPUR OF THE PINE BELT LUMBER COMPANY'S SYSTEM, SEC. 10, T. 4 S., R. 20 E.
Note the condition of the cut over area in A. The background in B shows standing timber on the right and partially cut timber to the left.



TEMPORARY TRAMWAY, SEC. 10, T. 4 S., R. 20 E., CONSTRUCTED FOR THE PURPOSE OF HAULING OUT THE PINE LOGS.



hand of man. Indeed one can scarcely approach the region even now without becoming aware of its newness. Certain very rough and remote portions in fact are in the same condition now as when Columbus discovered America—unmarred and rarely seen by mankind. Until very recently, within the present decade, hunting and fishing were important occupations of a great many of the inhabitants residing in these mountains. The Oklahoma Game Laws passed in 1912 and later have made it unlawful to kill wild turkey and deer which are still present, but in rapidly decreasing numbers.

Certain small tracts of land both on the hills and in the bottoms along the creeks have been under cultivation for a long time, many being farmed for a time, then abandoned. At present about half of the available farming lands are occupied. The region, however, can never become an important agricultural country, since, as will be shown later (p. 60) there are only about 81 square miles of arable land in the region, the remainder being rocky, rough, and mountainous country unsuited to that purpose.

Cattle grazing and hog raising are the uses to which these mountainous lands are best adapted. In general, but with a few exceptions, grass grows abundantly throughout the spring and summer months, on all the hillsides and valley flats. With the Red River plains near at hand to the south capable of producing corn and hay for the winter months, and with an abundance of pasture and excellent water in the mountains there is no reason why this region should not become an important center for the raising of cattle and hogs. This is at present the chief industry, but the losses sustained by some of the ranchmen in recent years have been heavy while attempting to carry the cattle and other animals entirely through the winter without feed. This is very unwise on the part of those few who undertake to do this, financially speaking, and brings a vast amount of suffering to the poor dumb brutes, not at all deserving of it. The writer is glad to note, on the other hand, that in numerous places whole sections, half sections, and even whole townships are leased and fenced and the cattle thus enclosed are being well guarded and taken care of much to the comfort of the animals and financial gain to the owners.

Lumbering has also been an important industry since about the year 1910. Prior to that time there were no means of transportation. At present there are two large permanent mills in operation, one at Broken Bow, the other at Bismark (Wright since the war) south of the mountains and also a number of small portable mills in the mountains to the northeast. The large mills each have a capacity of about 150,000 feet of lumber per 20 hour day, and are supplied with pine logs from the mountains by means of steel tramways constructed from the main line of the railroad back into the hills. The timber cut and hauled out, the steel is then taken up and laid elsewhere. The portable saw-mills are supplied by team and wagon and the rough lumber hauled to the railroad by auto-truck, or in some instances with teams. It is customary to cut all pine trees large enough to make a 2x4. The oak is used for ties and the red cedar (present only locally) for fence posts. The hickory and much of the oak is left standing.

TRANSPORTATION

RAILROADS

The first railroad to enter old Indian Territory was the Missouri, Kansas, and Texas Railway which was built from the Kansas border across the Cherokee, Creek, and Choctaw Nations to Texas in 1870-72. This road connected Vinita and the present sites of Wagoner, Eufaula, McAlester, Atoka, and Durant with the Gulf but did not come within 50 miles of the region dealt within this report at its nearest point. In 1886 the St. Louis-San Francisco Railway was constructed from Fort Smith, Ark., to Paris, Tex., through Antlers and Hugo which opened up country within 10 miles of the present area at its nearest approach. It was not until the greatest period of activity of railroad building, 1900-1904, however, that a railroad entered McCurtain county. The St. Louis-San Francisco road was then built from Ardmore in Carter county, Okla. east through Marshall, Bryan, Choctaw, and McCurtain counties to Ashdown south of DeQueen, Arkansas. This road parallels Red River and has been a means of opening up the southern plains region of the country, but Little River cut off all approach to the Ouachita Mountains from this line.

The Choctaw Lumber Company in recent years has constructed, piece by piece, a privately owned road (the Texas, Oklahoma, and Eastern) from Valliant Okla., on the St. Louis and San Francisco Railway east to DeQueen Ark., on the Kansas City Southern Railway. This has only just recently (1921) been completed. It passes along the southern border of the Ouachitas, thus putting the mountains, finally within fairly easy reach by rail, but as yet no railroad enters the south-central part of this region, and all this time it has been and still is difficult of access.

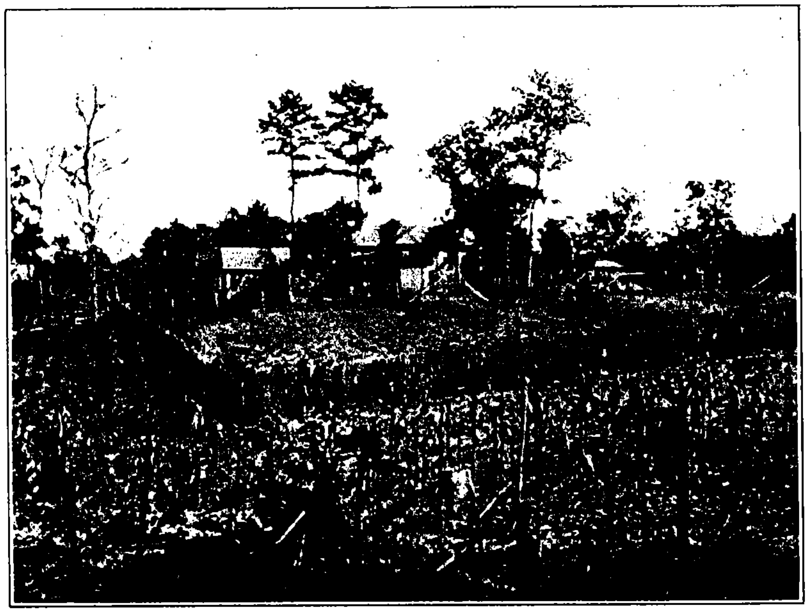
ROADS

There are but few wagon roads in the mountains, none that can be called good roads. There are no bridges across any of the streams, hence these roads cannot be traveled at all times. Automobiles can be driven without much difficulty from Broken Bow to

Hochatown, or from Bismark to Bethel, thence east by way of "The Narrows" to Smithville, Watson, and out to Cove, Ark., or from Smithville via Beechton to Hatfield, Ark., when the rivers are low. It is possible to drive a car from Bethel to Sherwood, then east-southeast to Mountain Fork River or from Bismark Front east to Glover Creek, but at no time can cars be put across either stream at these places.

An auto-road (Williams Highway) is at the present time being constructed from Broken Bow to Bethel and was completed well toward half way, in the fall of 1921, when last traveled by the

PLATE VIII.



HOUSE, FARM, AND GARDEN, IN THE CENTER SEC. 22, T. 1 N., R. 27 E.

writer. An auto road is also being constructed from Bismark to Bethel and Ida to be finished in 1921. Some of the roads pass through very pretty, mountainous country clad in forests of virgin pine and oak. It is being considered by the Government to set aside a portion of this wooded mountain country in the vicinity of Linson Creek east of Mountain Fork River as a park and game preserve. In the opinion of the writer it would be far better to expend the money available for the park on the roads that the whole country might become accessible to visitors, for without much money expended on the roads the park will prove of no avail. If

the road from Bog Springs, Ark., to the mouth of Linson Creek were graded some very pretty mountainous country would become accessible to the tourist. The Williams Highway above mentioned will open up some attractive country and it is hoped that people will take advantage of it before the lumber men denude the hills of all their verdure.

POPULATION

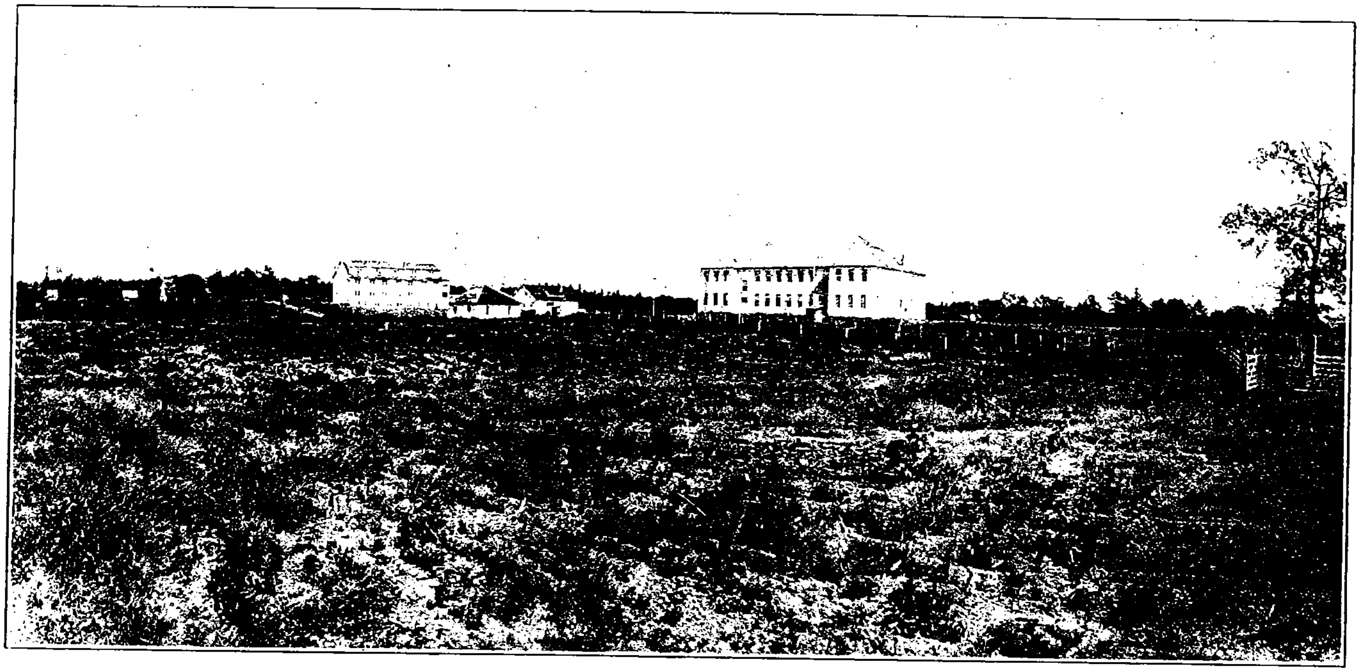
The early settlers and hunters of the region were southerners

PLATE IX.

SCHOOLHOUSE, IN THE SW. COR. SEC. 34, T. 1 N., R. 27 E.

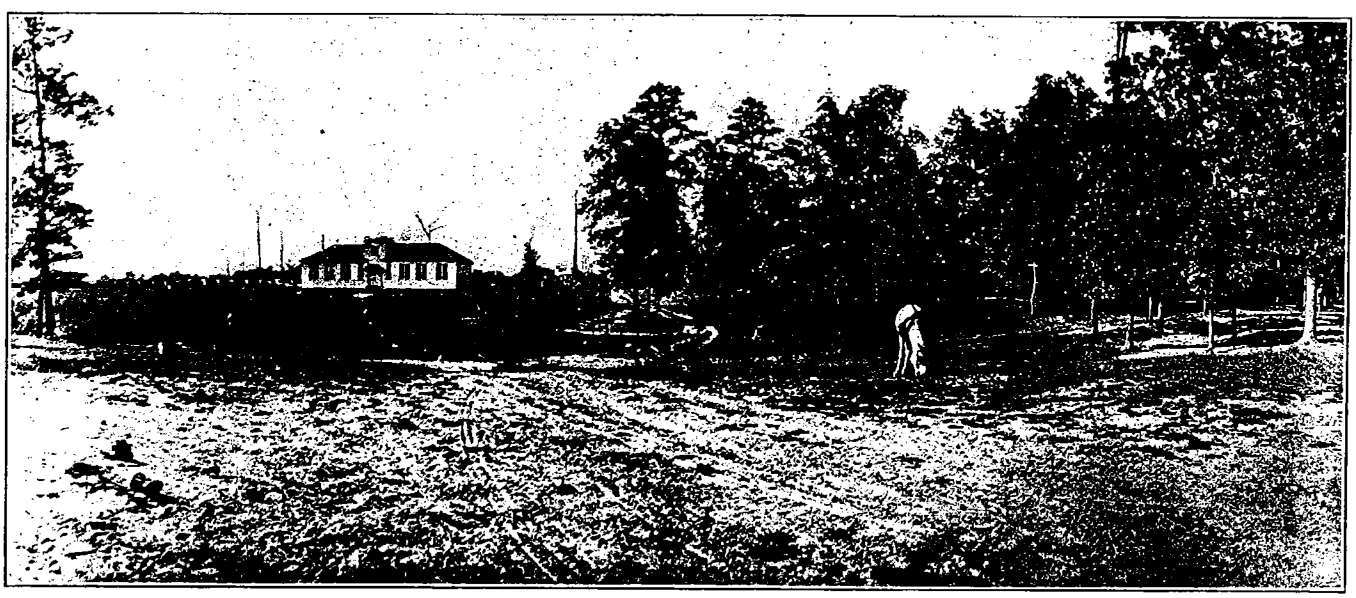
who came for the most part from Tennessee, Kentucky, Alabama, and Georgia. When Arkansas Territory was opened, agriculturalists and fruit growers from the same general regions occupied much of that country and in recent years many have come from Arkansas to Oklahoma to mingle with those originally from Georgia, Alabama, and Tennessee. The movement of the Choctaws into the

PLATE X.



PUBLIC SCHOOL BUILDINGS AT SMITHVILLE, SEC. 13, T. 1 S., R. 25 E.

PLATE XI.



PUBLIC SCHOOL AT IDA, IN THE SE. ¼ SEC. 7, T. 2 S., R. 23 E. VIEW LOOKING NORTH.

Arkansas River country began about 1800 and by 1825 they were well established in the Ouachita Mountains. Their descendants form a considerable percentage of the present population, but they live for the most part in settlements by themselves, as at Nunihchito, or as single families in very remote recesses of the woods. A few cattlemen have lately come from Texas and there are a few foreigners, Germans, farming some of the creek bottoms. The lumber business has brought people from the north, and there are considerable numbers of negroes about the large lumber yards and mills along the southeastern edge of the mountains, but none of the people connected with the lumber business, negroes or whites, have permanent residences in the mountainous regions.

The population is very scant all told. Most of the region is uninhabited and uninhabitable. In 1917 there was not a single soul living in some townships. In all parts of the region it was then an easy matter to pick out 10 square miles, or 25 square miles where no one lived. The entire population of the region 5 years ago did not exceed 1,000 people. Now (1922) the population is somewhat larger. The people live chiefly in the small agricultural settlements of Hochatown, Smithville, Watson, Beech, Sherwood, Bethel, Nunihchito, Glover, Ringold, Sobol, and Corinne, each of which has its combination store and postoffice, blacksmith shop, and grist mill. The larger trading points, Broken Bow, Idabel, Bismark, and other towns are all located outside the area to the south to which those living in the mountains come occasionally for supplies and goods of various kinds. In some quarters it is necessary for the ranchers, farmers, and others to keep stocked with the necessities of life, six months ahead, lest high waters in the rivers prevent them from going to town for a long period.

Among the mountaineers like all other people everywhere, are some easy going, shiftless ne'erdowells; others are saving, hard-working, and energetic; some good, some bad. While working in the region the writer has met with friends in all parts and has always found somebody ready and willing to lend a hand whenever needed, often without compensation. Strangers entering the country, if they mind their own business will have no trouble with anyone anywhere.

Needless to say the schools are poor and not as well attended as they should be. Some children never go to school, but become instead, experts in the 'possum hunt, good riders, good cattlemen, good woodsmen and fill a place in the world which one not born and raised into can scarcely hope to fill. They serve a purpose, have a business, and live about as happily apparently after all as anyone with much schooling.

ECONOMIC GEOLOGY

LEAD, ZINC, AND COPPER PROSPECTS

JOHNSON'S COPPER PROSPECT

North of Eagletown, in the SW. ¼, sec. 16, T. 5 S., R. 27 E.; in the spring of 1917 Meade Johnson discovered and began digging on a small vein of quartz containing chalcopyrite, pyrite, galena, and sphalerite. At the time of the writer's visit to the place in June, 1917, a hole about 5 feet square and 20 feet deep had been dug and preparations were being made for installing hoisting machinery and sinking a shaft. A few specimens were collected and the facts of the geology noted at this time, but how deep the shaft has been driven since that day, and what the finds in depth have been are not known. The present description is taken from the facts as observed and specimens collected in 1917.

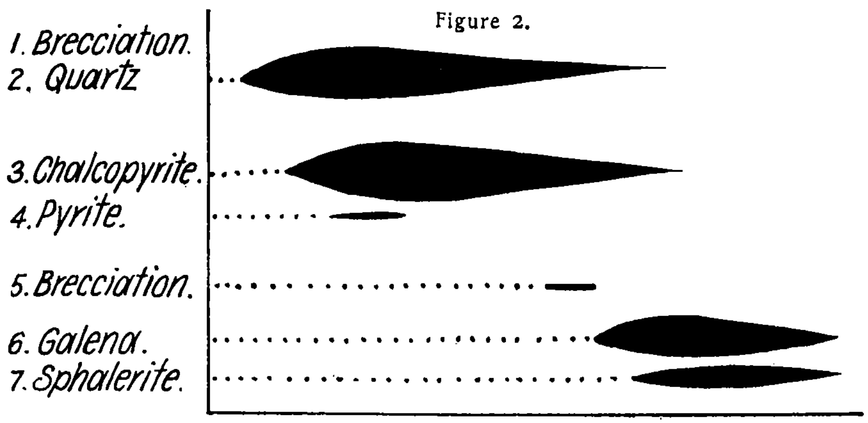
The country rock throughout the general region of the prospect is hard, gray, quartzitic sandstone, and hard, black slate or shale of the Stanley shale (Pennsylvanian) formation striking east-west and dipping 75°N. In the shaft the rock is a shattered blue-gray, quartzitic sandstone containing a number of small veins of milky quartz, and vugs of crystalline quartz. The sulphides occur sparingly and are associated with the shattered sandstone and quartz veins in a zone about a foot wide, the strike and dip of which is roughly parallel with the strike and dip of the bedding of the sandstones as near as could be determined. The vein could not be followed for more than a few feet either side the shaft. Chalcopyrite is the most abundant of the sulphides and it is intimately associated with the quartz gangue. The less common lead and zinc sulphides occur in very small amounts and there is a tendency for them to be more or less separated from the chalcopyrite and to occur in bunches up to a few inches across. There is scarcely any pyrite present, but what little there is seems to be intimately associated with the chalcopyrite. Six ounces of silver per ton are reported to be present upon analysis of some of the ore, but this figure has not been verified by the Oklahoma Geological Survey. The chalcopyrite has altered somewhat at the surface yielding malachite and limonite.

In the fresh materials a thin coating of milky quartz usually encrusts the fragments of the brecciated sandstone indicating that the initial deposition was quartz. Chalcopyrite followed soon afterward and, contemporaneously with quartz, filled most of the cavities, yet leaving tiny vugs filled with crystals of quartz and chalcopyrite with occasionally a small speck of pyrite showing. The chalcopyrite is slickensided through faulting and the galena frequently is seen in small fissures in the chalcopyrite so that it is evident that some movement took place subsequent to the deposition of the chalcopyrite and that galena filled fissures formed at this time It is not thought that all of the galena was precipitated after the second movement, however since there are intimate intergrowths of galena and chalcopyrite, the former predominating, in some places. Where sphalerite occurs it contains small inclusions of chalcopyrite and galena, indicating the rather late introduction of the sphalerite.

In the following diagram (Figure 2) worked out from thin sections and polished surfaces of the specimens the relative position of the individual mineral plats indicates the order (from left to right) in which the various minerals were deposited, their length represents duration of deposition while the vertical dimensions show the relative amounts of the respective minerals present in the sulphide bearing rock.

The vugs or cavities containing crystals of quartz and chalcopyrite were not filled with galena and sphalerite, it is believed, because the lead and zinc solutions happened to be traversing other channels when the precipitation took place.

Figure 2.



PARAGENESIS Johnson's Mine.

Up to the time of its examination this prospect had not yielded all told more than a few hundred pounds of the sulphides.

BUFFALO MINES

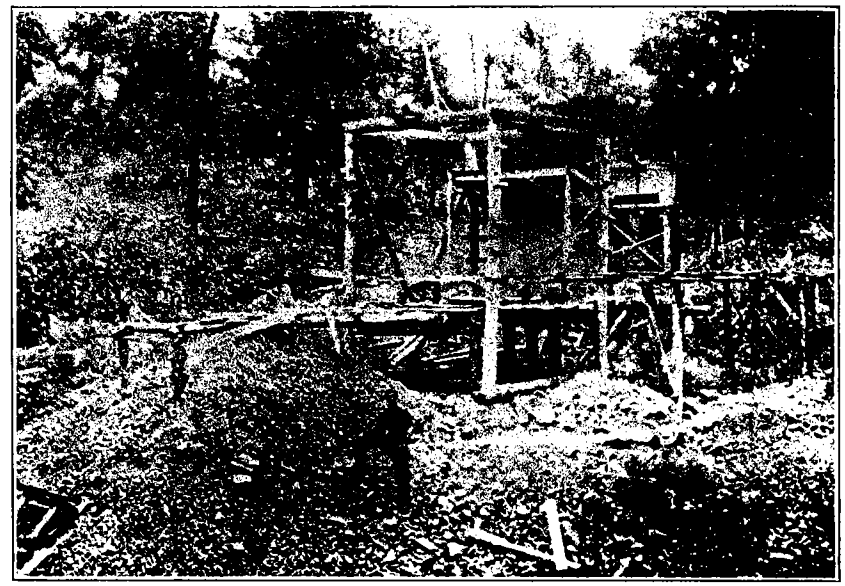
At a point about four miles south of Watson (600 paces south and 350 paces east of the NW. cor., sec. 14, T. 2 S., R. 26 E.) two shafts have been sunk upon a fractured zone of black siliceous shale and hard blue quartzite of the Stanley shale formation, locally containing lead and zinc sulphides. The two shafts are located in the southeast corner of an old and abandoned field on the north side of a small creek which enters Buffalo Creek 60 paces to the south. Owing to their proximity to Buffalo Creek the workings are known as the Buffalo Mines.

It is stated by cattle men in the vicinity that Spanish settlers first worked the deposits from an open pit 25 feet deep and that later (about 1907) this old pit was deepened by machinery to a depth of 80 feet and finally abandoned.

Forty feet to the east of the older and deeper shaft is a second one 60 to 70 feet deep opened at a somewhat later date, (the exact time not known) and abandoned in 1915.

It is reported that considerable ore has been taken from these two shafts, but there was no ore in sight at the mines and both shafts were full of water when visited by the writer in 1917. No one seems to have any knowledge of the character or extent of the underground workings, the richness of the ore or width of the vein or brecciated zone. A large amount of rock has been taken from the shafts and is now piled upon the mine dumps. This material is largely dark gray quartzite and dark siliceous shale, portions of which are brecciated and the fragments cemented with silica, calcite, and the sulphides. Several specimens of the brecciated materials containing sulphides were picked up. In most cases these are firmly cemented with finely crystalline quartz in such manner that they are virtually quartzites. In all cases observed the original fragments are completely surrounded by a thin veneer of very fine quartz, but in

PLATE XII.

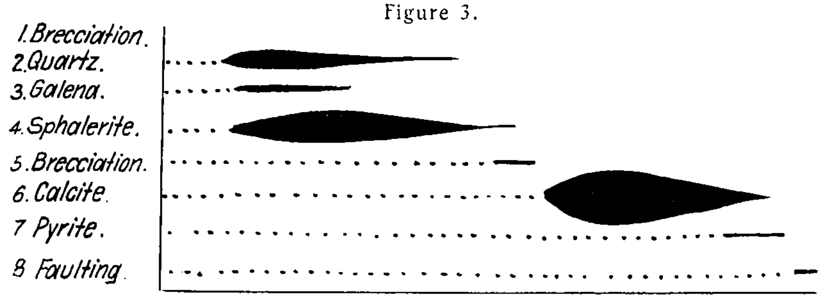


ALL THAT REMAINS OF THE BUFFALO MINES, IN THE NW. ¼ SEC. 14, T. 2 S., R. 27 E. (SEPTEMBER, 1917).

some instances sphalerite and galena are associated with the quartz in increasing quantities away from the original fragments of the breccia, indicating the order of precipitation to be (1) quartz and (2) galena and sphalerite. The fragments of original rock are not replaced by the sulphides. Veins of carbonate are very common. These in all cases intersect the original silicified breccia and the sulphides, and are clearly of later date. They themselves carry neither galena nor sphalerite, but crystals of pyrite may be seen associated with the calcite in some specimens where they sit on calcite and are apparently later in origin than most of the calcite.

One specimen (No. 421) is a massive fine grained, dark grey quartzite carrying disseminated sphalerite, galena, and pyrite and thin veins of calcite. The rock has been slickensided and there are polished surfaces developed on the pyrite, sphalerite, and calcite showing that there has unquestionably been some movement subsequent to the mineralization. Sphalerite estimated to amount to 15 per cent of the rock is the most abundant sulphide. In thin section the rock is seen to be finely brecciated and the fragments saturated and cemented with silica. The sphalerite, occurring in large and small, ragged, irregular grains and fine specks, is intimately interwoven with the quartz and apparently is contemporaneous with it in origin. The calcite occurring in veins is of later date. The pyrite and galena do not happen to show in the thin section.

Figure 3.



PARAGENESIS Buffalo Mines.

There appears therefore, in sum, to have been three periods of brecciation; the first followed by an introduction of quartz, galena, and sphalerite; the second by calcite and pyrite; the third is known only from slickensided surfaces developed on all the other minerals, In the diagram below (Figure 3) the relative position of the individual mineral plats indicates the order (from left to right) of the deposition of the minerals, their length represents the duration of the deposition while the vertical dimensions of the individual plats indicate the estimated relative amounts of the respective minerals present in the sulphide bearing rock.

EADES MINE

About 2 miles southwest of Watson in the SE. ¼ of the NW. ¼, sec. 33, T. 1 S., R. 26 E., a shaft has been sunk to a depth of about 40 feet in some dark slates and shales and interbedded blue quartzites of the Stanley formation. The rocks are badly shattered, probably through faulting, and contain sphalerite, barite, dolomite, quartz, and a slight amount of pyrite all of which occur as vein materials in the shattered country rock. At the time of examination of the mine (Nov., 1917) about 3 tons of sphalerite had been taken from the shaft and placed in an ore bin, and about a half ton of barite had been piled to one side, but operations had ceased, and it was not possible to examine the rock below ground.

Several specimens of the country rock and vein materials were collected from the dump some of which are coarsely brecciated, dark, fine-grained sandstones cemented with finely crystalline quartz. The filling of the crevices is complete when the fissures do not exceed 3 mm. In excess of that width the fissures are not filled and their hollow centers bristle with the projecting points of tiny quartz and calcite crystals. Specimen 456-A is a massive, greenish-gray fine-grained, quartzitic sandstone cut by quartz and calcite veins. Where the veins are thick, calcite occurs with the quartz, but if less than 3 mm. broad only quartz is found. Resting on quartz in a vug on one side of the specimen are several cubes and octahedra of pyrite.

From the materials collected it is clear that quartz was the first mineral to be precipitated on the broken fragments of country rock and that calcite followed later together with a little pyrite, but for want of better specimens it is not known what position the sphalerite and barite take in the order of precipitation.

OTHER LEAD, ZINC, AND COPPER PROSPECTS

Specimens containing galena, sphalerite, chalcopyrite, pyrite, quartz, and calcite were collected by Malcolm Oakes from a point about 2 miles south of Watson on Little Dry Creek (exact locality not known). A partial analysis of the ore from this place, made by A. C. Shead, Chemist, Oklahoma Geological Survey, shows 2 ounces of silver per ton of selected galena.

Lead and zinc minerals are reported to have been procured also from the Gipson-Goen Ranch located about 2 miles west of Watson, in the NW. ¼, sec. 28 T. 1 S., R. 26 E., on the Stanley shale formation.

A small pocket of galena, sphalerite, and chalcopyrite associated with calcite and quartz was found in the creek bed in the SE. ¼, SE. ¼, sec. 14 T. 5 S., R. 23 E., near Lost Springs. The minerals are vein materials in the Collier shale occupying a zone two or three feet wide striking northeast, but the mineralization seems to be very local and the vein could not be followed out of the creek bottom.

A few sphalerite crystals were noted in the Collier limestone 100 paces south of the E. ¼ cor., sec. 12, T. 5 S., R. 23 E. These were very small and very sparsely distributed through the limestone.

There are a number of prospects and small mines just over the border in the State of Arkansas. One of the largest of these is the Bela Mine, located approximately in sec. 12, T. 7 S., R. 3 W., Arkansas. The principal minerals here are chalcopyrite, and sphalerite with minor amounts of galena and pyrite in a quartz gangue. The order of precipitation appears from the specimens (Nos. 3032 to 3041 inclusive) to have been: (1) quartz, (2) chalcopyrite, (3) sphalerite and galena, and (4) pyrite. The country rock is Stanley brecciated sandstones and shales.

South of Gillham, Ark., (exact locality not determined) there is an antimony mine from which enough stibnite was mined in 1915 and 1916 to temporarily supply a small smelter at Gillham. Operations below ground were carried on in these years only with great difficulty because of the great quantities of water which constantly flowed into the workings The writer did not enter the mine nor attempt to follow the vein at the surface.

CONCLUSIONS

A study of the various occurrences of lead, zinc, and copper minerals in the region reveals the facts: (1) that all are vein materials associated with fault breccias, and (2) that the order of precipitation of the metals is: first, copper, and second, lead and zinc. In search for minerals of this character, therefore prospectors would do well to confine their labors to a search for, and the following out, of the fault zones or crush zones. The faults should, in general strike in an east-west direction, and the mineralization in most cases should not extend more than a few feet in width.

It should be expected also that where lead and zinc alone occur at the surface, some copper might be found at lower levels, but where copper occurs at the surface little lead and zinc should be expected in depth. These conclusions are based partly on the facts as gathered from the specimens in hand and in part from the general run of copper-lead-zinc mines which as a rule carry increasingly more copper and less lead and zinc as lower levels are reached, and vice versa in the opposite direction. This is true, however, only when all three metals are deposited by a single process, perhaps in a single brief period. Just why lead and zinc are carried longer in solution and farther out toward the surface is a long and complicated subject and altogether out of place here.

If lead and zinc represent a later and separate impregnation coming at a much later period than the chalcopyrite, as seems to have been the case in some veins or zones, then the lead and zinc sulphides might be found well down, the abundance of the lead and zinc depending upon the extent of the brecciation caused by the second diastrophic movement, for it seems, judging from the specimens collected that the lead and zinc when associated with chalcopyrite occur most often as veins in the latter and could get there only by entering fissures caused by fracturing subsequent to the deposition of the copper pyrite.

It is pertinent as ask at this time, Why are the quartz veins and the quartz-orthoclase veins practically free from any and all metallic sulphides? Reference is here made to the heavy masses of quartz in the Collier-Crystal Mountain-Womble series in the center of the Choctaw anticlinorium and the smaller, but nevertheless, important quartz veins in the Stanley, especially on the east flank of the Choctaw anticlinorium. In one or two places a little pyrite was found in them, but that is all. This is not an easy question and the answer is not immediately forthcoming. The sulphide veins usually carry not more than 50 per cent of quartz and other gangue minerals. The large quartz veins are practically all quartz. The former are prominently brecciated, the latter are tension joints, free from brecciated country rock and are of the type known as gash veins in most cases at least. The writer is of the opinion, therefore, that the gash veins are relatively shallow, and that the brecciated fault zones are deep and are the channels through which deep seated magmatic waters circulated in finding their way to the surface. The writer does not wish to infer that the quartz of the gash veins is not also magmatic. It is considered hydrothermal quartz and is thought to come from alkaline silicate water migrating to the surface through granitic rocks. The quartz must have been precipitated from the hot alkaline solutions by the carbon in the richly graphitic and carbonaceous slates and shales of the Collier, Womble, and Stanley especially. It is thought that the sulphides came from still deeper sources than the sheer quartz pegmatites and, also, were precipitated from thermal solutions. Nothing is known of the relative ages of the two types of veins.

With regard to the actual work of mining and marketing the lead, zinc, and copper, emphasis should be laid on these points in particular: (1) that the ore is in no place abundant so far as the discoveries to date prove, and that apparently the cost of extraction is more than the ore is worth; (2) that the gangue is largely quartzite and milky quartz necessitating expensive treatment in order to concentrate the values; and (3) there are no means of transportation at all adequate to carrying on mining operations within 10 miles of the nearest prospect.

Such a report is discouraging, but should not blast all hopes of future development. Much of the country is covered with mantle rock, and certainly on that account there is much in the way of mineral matter yet to be discovered in this region. Whether there are any really large deposits of chalcopyrite, sphalerite, and galena is not known, but there probably are not, for the occurrence must of necessity be of the fissure vein or brecciated zone type of deposit. There are no replacement deposits of copper, lead, or zinc in the general region.

There is not enough silver in the copper-lead-zinc ore to cause any excitement in that direction and gold appears only in traces.

MANGANESE DEPOSITS

The manganese deposits in the region occur chiefly as pockets and veins of psilomelane in the lower division of the Arkansas novaculite. Locally there are deposits of wad (an impure hydrous oxide of manganese) in the stream debris and there is a very wide spread distribution of disseminated rhodocrosite (manganese carbonate) in the upper division of the novaculite formation, but only the pockets and veins in the lower division have any potential economic value. Below are described some of the more important prospects known to the writer.

PINE MOUNTAIN MANGANESE PROSPECT

In the center of the SW. ¼, sec. 15, T. 3 S., R. 26 E., some prospecting has been done in the manganese bearing novaculite. At this location the novaculite forms a ridge known as Pine Mountain, which strikes across country in a general east-west direction. The novaculite outcroppings at the diggings, strike N. 75° W. and dip 58° N. It is a white, fine-grained material when fresh, and is not translucent and flinty, but stony in appearance as a general rule. It occurs in massive beds from 2 feet to 6 feet in thickness, and weathers by jointing into angular and irregular shaped blocks and fragments which form a thin rocky soil on the top and flanks of the mountain. The weathered rock is stained pink or yellow with iron oxide, and the clay occuring with the chert in seams and partings is quite red with it.

The manganese ore is chiefly botryoidal and stalactitic psilomelane which occurs in cracks and in pockets in the white novaculite as a vein material and as a cement to a novaculite breccia. The veins range in thickness from a fraction of an inch to several inches, but in all cases the veins are not continuous for more than a few feet. The zone of enrichment however, is more constant and appears to be a crush-zone, possibly a fault zone, some 6 feet

wide. The origin of the deposit seems to have been enrichment by outward moving ground waters.

It is estimated that about 20 per cent of the material, quantitatively, is ore of high grade. The rock in all cases is thrown to one side and separated from the ore so that it is not difficult to form an estimate. Locally there is as much as 40 per cent of ore in the zone of precipitation. Consequently the deposit may be of some value. It only remains to be proved whether there is length and depth sufficient to justify mining.

Outcroppings of the manganese ore appear along the summit of the ridges for 300 paces or more. The impregnated zone dips with the bedding of the rock 58° N. Both foot wall and hanging wall are of the white novaculite. As many as eight openings have been made on the zone of enrichment and in each case the ore has been separated and piled to one side, several tons in all. The character of the deposit is the same throughout and the ore mineral is very abundant locally at the surface.

In one prospect pit the south side or foot wall of the enriched zone is a pink clay probably the weathered product of the Missouri Mountain slate. The zone of enrichment at this point is extended in width to 15 feet or more. A three inch vein of ore lies adjacent to, and on top of the clay.

The larger and better exposures occur in the center of the zone where the oar seems most abundant. Sheets of it encrust the boulders and blocks of novaculite. Pockets are filled with botryoiral masses some of which resemble geodes 6 inches to 12 inches in diameter. Thin films have been deposited on all the hard novaculite blocks and numerous dendritic forms have resulted from this deposition. Veins and stringers are extended in all directions. These are invariably made up of two parts a growth from either side of the fissure.

Considerable red clay occurs in and about the ores which has undoubtedly been washed into the cracks from the shales and clays occurring locally to the south after the deposition of the ore had been completed. This material will probably be found wanting at greater depths. None of the pits are more than 6 feet deep and only surface material and surface conditions are known.

The whole extent of the manganese deposit east-west is about 300 paces or approximately 750 feet and the width from 6 to 15 feet. Providing there is depth to the deposit there might be considable ore at this place, but whether it could profitably be mined or not is a question, for there are no transportation facilities and the nearest railroad is 20 miles distant. There are no more than a few car loads of ore in sight, and if the deposit has no depth, and no other deposits near can be found it is scarcely possible that the deposits can be profitably mined out.

Following is a series of analyses of the manganese ores from the Pine Mountain prospect pits made by the K. C. Testing Laboratory, Kansas City, Mo. The analyses were sent voluntarily, by the courtesy of the Kansas City people.

Analyses of Manganese from Pine Mountain

	I.	II.	III.	IV.
Gold	0.00	0.00	0.00	0.00
Silver	.06 Oz./Ton	.030 Oz./Ton	0.00	.05 Oz./Ton
Silica	15.90	10.73	56.25	63,21
Manganese	39.50	46.71	9.83	7.05
Iron	6.83	5.04	7.73	3.14
Phosphorus	.19	.14	.24	.08

I and II, picked samples; III and IV grab samples.

A partial analysis made by A. C. Shead, chemist for the Oklahoma Geological Survey, of material collected by Meade Johnson presumably from Pine Mountain is as follows:

Analysis of Manganese from Pine Mountain

Moisture, (H_2O at 120°C.)	4.97
Silica (SiO_2)	2.10
Phosphorus (P)	.057
Iron (Fe)	4.63
Alumina (Al_2O_3)	2.24
Manganese (Mn)	49.2
Carbonate ($CaCO_3$)	5.08

HOCHATOWN MANGANESE PROSPECTS

About one and one-half miles northeast of Hochatown in the SW. ¼, sec. 14, T. 4 S., R. 25 E., there is another deposit of manganese, chiefly stalatitic and botrioidal psilomelane in the lower portion of the Arkansas novaculite. The outcroppings are on the top of the mountain north of the "Hollar" at the thin west end of an eastward plunging, northward dipping, overturned synclinal fold. Beneath this thin lip of novaculite lies the Missouri Mountain slate, which crops out on the flanks of the mountain on either side and which is partially covered with float from the manganese-bearing novaculite which caps the top.

Two pits have been dug in the mountain side, one in the novaculite where manganese was locally abundant, another beginning in novaculite float and penetrating into the Missouri Mountain slate. Both are 10 to 15 feet deep and 5 or 6 feet square. Considerable ore has been thrown out of the first, but only the novaculite float proved productive in the second. Manganese is scattered about over the surface of the ground quite widely, but the psilomelane in place seems to be limited to a narrow horizon interbedded in the novaculite formation. The ore could not be traced continuously and appears to be in small irregular lenses or pockets.

Manganese is reported to have been found about a mile or so to the south and east, along the strike of the manganese bearing horizon, at the foot of the mountain and in the valley floor, but this particular place could not be found. Other lenticles might well be expected along the strike of those occurring in sec. 14.

There are several tons of manganese ore of excellent quality in sight on the top of the mountain, but it seems that the total amount available in this particular region is bound to be small and very diffcult to locate or to remove from the mountains, after it is once mined.

OTHER DEPOSITS OF MANGANESE

Minor amounts of manganese were noted in crushed and faulted zones in the novaculite on the Cross Mountains at the N. ¼ cor., sec. 1, T. 3 S., R. 26 E., and westward; also at a point 200 paces north of the W. ¼ cor., sec. 9, T. 4 S., R. 26 E.; and again 75 paces north of the center of sec. 26, T. 3 S., R. 24 E.

One sees occasionally small amounts of a soft earthy manganese (wad) of secondary origin. One place where such materal was noted was in the alluvial soils of West Fork of Rock Creek at the S. ¼ cor., sec. 20, T. 4 S., R. 26 E.

Doubtless many other localities where manganese occurs could, with systematic search, be found. No special effort on the part of the writer was made to locate them. It is his personal opinion that in no case does manganese occur in this region in quantities sufficient to pay for the trouble and cost of extraction judging from the occurrences above described.

In March 1912, Hewett examined a number of the manganese deposits in Ts. 2, 3, and 4 S., Rs. 24 and 25 E. He says in part:*

Two classes of deposits have been found in the region—first, and more important, deposits in which psilomelane cements and locally more or less replaces fractured chert and sandstone; second, deposits in which wad (impure hydrous oxide of manganese) occurs as small round nodules in stream allu-

*Hewett, D. F., Manganese and Manganiferous ores: U. S. Geol. Survey, Mineral Resources, 1912, Pt. 1, p. 218, 1913.

vium. The deposits of the second class are confined to superficial material and are not important. Six deposits of the first class were examined. The deposits consist of a number of pockets of highly irregular shape and variable size lying in belts that range in width from 12 to 35 feet and in length from 200 to 900 feet. Though many pockets contain lumps of solid ore weighing as much as several hundred pounds, the minable portion of the deposits would only locally yield material containing more than 15 per cent manganese minerals. In order to prepare a marketable product the ore would have to be crushed and concentrated in jigs or tables. The deposits are essentially similar in superficial aspect—that is, in extent and grade of material—to those which occur in Polk, Montgomery, Pike, and Garland counties, Ark., and which have been described by Penrose. (Penrose, R. A. F., Manganese; Ark. Geol. Survey, Vol. 1, 1891, pp. 340-371).

A more recent description of the manganese deposits of west central Arkansas is that by Miser** in which he describes fully all the known manganese mines and prospects in the Ouachita region of Arkansas.
His conclusions are the same as those of Penrose, and in as much as the origin and character of the ores and the general geology of the region in which they occur is the same for the Arkansas deposits as for the Oklahoma deposits Miser's conclusions should apply as well to the deposits of Oklahoma. Under the heading Economic Possibilities (p. 84) of his report Miser says:

The possibilities of manganese mining in west-central Arkansas are ably discussed by Penrose*, from whom the following is quoted:

'The aggregate amount of manganese in the region is undoubtedly large, but it is distributed over an extensive area, and in almost all places it is hoplessly scattered through the rock in small nests and seams. If these nests and seams were in sufficient quantities, the rock might be crushed and the ore concentrated by washing, but the pockets containing them are too small to permit the expense of machinery. It is a popular idea that the ore will increase in quantity at a depth, but there is absolutely no reason to expect this, as such deposits are just as likely and sometimes even more likely to become poorer at a depth than they are to improve.

'From the nature of the deposit it is to be expected that the ore at a depth is, at the very best, no more plentiful than in the surface outcrops of the so-called "lodes"—that is, that it exists as a series of pockets separated by greater or less distance of barren rock. With very few exceptions the pockets of ore seen on the surface can not be worked at a profit, and in the rare cases, where a small profit might be made, the amount would not be enough to pay for sinking through the barren rock that separates the pockets from each other. The intervening thickness of barren rock is much greater than the depth of any one pocket.'

*Penrose, R. A. F., Jr., Manganese—its uses, ores, and deposits: Arkansas Geol. Survey Ann. Rept. for 1890, vol. 1, p. 306, 1891.
**Miser, H. D., Manganese Deposits of the Caddo Gap and DeQueen Quadrangles, Arkansas; U. S. Geol. Survey, Bull. 660-C, 1917.

The quantity of manganese ore that can be mined at a profit from any one deposit is therefore small, which means that under normal conditions manganese mining will never become one of the chief industries in this region.

Ores from a number of manganese deposits, as shown by the chemical analyses—contain a sufficiently high percentage of manganese (40 per cent or more) and a sufficient small percentage of silica (8 per cent or less) for the manufacture of ferromanganese, but most of the ores of which analyses are available exceed the phosphorus limit (0.20 per cent) for this purpose. The prices paid for medium-grade ores used in the metallurgic industries are relatively stable and generally range between $8.00 and $13.00 a ton* being governed by the content of manganese, phosphorus, and silica. The price has however, steadily increased since the outbreak of the war in Europe. Manganese ores sold in 1915 for $14.40 to $22.05 a ton** and in 1916 the maximum price was $32.50***. This increase in price has accordingly increased the possibility of the economical recovery of the manganese ores of the area herein described, but some deposits that might be worked at a profit will not pay to work after the price of ore again becomes normal, which will probably be within a year after the conclusion of peace.

The wad and other low-grade oxides could be used for giving brick a chocolate color. The pyrolusite, manganite, and psilomelane could be used to produce the spots of some varieties of speckled bricks and mixed with red-burning clay for brown bricks, and with buff-burning clay for grey bricks.

Some of the purer psilomelane and especially the manganite pyrolusite could be used in chemical industries, in the manufacture of electric batteries, and for other purposes. Psilomelane is hard, however, and is less easily treated than manganite and pyrolusite. Ores required in the manufacture of dry batteries should contain less than 1 per cent of iron, less than 0.05 per cent copper, nickel, and cobalt, and at least 80 per cent of manganese peroxide**** which is the form of the larger part of the manganese in pyrolusite, manganite, and psilomelane. The price of ores suited for the above mentioned purposes fluctuate greatly, ranging from $20.00 to $100.00 a ton.*****

The average price during 1922 for low grade (10 to 35 per cent manganese) ores was $3.50 per ton; and for high grade ores (35 per cent manganese or more) about $34.00 per ton, which figures are somewhat lower than the corresponding figures for 1921.******

*Harder, E. C., Manganese ores of Russia, India, Brazil, and Chile: Am. Inst. Min. Eng. Bull. 113, pp. 763-764, May, 1916.
**Hewett, D. F., U. S. Geol. Survey, Mineral Resources, 1915, pt. 1, p. 39, 1916.
***Hewett, D. F., U. S. Geol. Survey Press Bulletin 306, Jan., 1917.
****Hewett, D. F., U. S. Geol. Survey, Mineral Resources, 1915, pt. 1, p. 32, 1916.
*****Harder, E. C., op. cit. p. 763.
******Calculations made from the report of Jenison, H. A. C., Manganese; Review Number and Year Book, Engineering and Mining Journal-Press, Jan. 20, 1923.

OIL AND GAS

The sediments of the Ouachita Mountain region in southeastern Oklahoma have always been regarded as too sharply folded, faulted, and otherwise disturbed to yield petroleum in commercial quantities. This has been the opinion up to the present time of practically all geologists, competent to judge of the situation and in so far as the southern portion of the region is concerned the writer has, with but one possible exception, been forced to the same conclusion. In general terms the southern Ouachita Mountain region, as has been shown in the chapter dealing with the structure (Part I) has been under tremendous lateral pressure, which has thrown the rocks into a vast series of overturned or recumbent folds, so that any oil or gas which might have been present in the sands should have long ago escaped through the many fissures developed during the periods of uplift. Yet while this is in general the case there is one locality nine miles in length by one to two miles in breadth, east of Smithville and south of Beachtown (north central portion of T. 1 S., R. 26 E. and extending into T. 1 S., R. 27 E.) where the strata have apparently escaped some of the deformation common to the region as a whole, and whose strata lie almost flat or only slightly arched over this particular strip. (See map Plate I.)

It is with much hesitancy that the writer recommends this anticline as prospective oil and gas territory because of its association with more pronounced folds and thrust faults, particularly to the south, nevertheless, the local structure is a simple, gentle fold and for that reason he does not see fit to class these lands with the remainder of the Ouchitas in this regard, and is unwilling to state that oil or gas in commercial quantities will never be found in this locality. The structure may conveniently be called the Smithville anticline, naming it from the village of Smithville near its western termination. This is the only acreage in the southern portion of the Ouachita Mountains proper that the writer feels he can at all recommend and it should be distinctly understood that even the Smithville anticline is not first class prospective territory, on account of its relationship to positively non-productive acreage.

A map has been drawn (Plate XIII) showing the principal folds of the Paleozoic area, mapped in detail by the writer, together with a portion of Arkansas mapped largely by Purdue and Miser*. It is evident from the trend of the structure lines here shown and from what other information is at hand in the Paleozoic area that oil should not be expected in the Paleozoic rocks beneath the Trinity sand for a long distance south of the mountains. There is no doubt that the Cambro-Ordovician and Siluro-Devonian strata of the Choctaw anticlinorium extend southwest beneath the capping Trinity and should be encountered by borings along Red River in Ts. 7 and 8 S., Rs. 20, 21, and 22 E. at depths ranging from 500 to 600 feet allowing for a dip south of 40 feet per mile, in the Comanchean deposits. These ancient Paleozoics are sharply folded, faulted, and metamorphosed where they are exposed in the mountains and since the thrust which caused the folding had a southerly source it is reasonable to assume that the buried structure farther south is just as much complicated, if not more so, as in the mountains themselves to the north. Obviously then no oil or gas should be expected in the Cambro-Ordovician and Siluro-Devonian rocks now buried beneath the Trinity sand and later sediments in the area as outlined west of Idabel, (extending from sec. 36, T. 7 S., R. 19 E., northeast to sec. 36 T. 5S., R. 21 E., thence east to sec. 3, T. 6 S., R. 25 E., and southwest to sec. 30 T. 8 S., R. 23 E.) How far into Texas this structure may be expected to extend cannot be very accurately calculated or estimated.

*Miser, H. D., and Purdue, A. H., Asphalt Deposits and Oil Conditions in Southwestern Arkansas: U. S. Geol. Survey Bull. 691 Part II, Plate XXXIII, 1918.

The Stanley shale area on the east flank of the Choctaw anticlinorium (Ts. 4 and 5 S., Rs. 26 and 27 E.) is one of complicated folding and some faulting. At least, as far east as the Oklahoma-Arkansas state line the structure is too sharp to retain oil or gas, and no doubt conditions are bad for oil accumulation several miles farther east into Arkansas, in this latitude. Following the trend of the Choctaw anticlinorium, it is obvious that the same type of structure which is found here should prevail southwestward, in the Stanley now buried beneath the Trinity sand and later Comanchean deposits and if this is so no oil or gas should be expected from the buried Paleozoics for some distance east of Idabel (the strip of country extending from sec. 3, T. 6 S., R. 27 E., Oklahoma, southwest to sec. 30, T. 9 S., R. 24 E. and west 12 miles to the other unproductive area). Farther east, however, embracing about 300 square miles of country in the extreme southeastern part of McCurtain county there is a possibility, so it seems, that some oil might be found entrapped in the buried Stanley, and the farther to the southeast the better the chances providing the drilling be done on anticlinal structure. This conclusion is arrived at solely from the fact that throughout secs. 33 and 34 of T. 5 S., R. 27 E., Oklahoma the sandstones dip to the southeast 25° to 35° whereas, everywhere north or west of this locality they dip north or northeast and the folds are overturned. There is in this change of dip of the rock to the southeast an indication that the normal type of fold, not the isoclinal or recumbent types, will prevail at all points farther east or southeast. If this be the case there is a possibility that petroleum may have collected in some of the arches. On the other hand, it would not occur in the isoclinal or recumbent folds.

On the west flank of the Choctaw anticlinorium the Stanley shale area is as complexly folded as on the east side. For the same reasons that that strata should be much crumpled, below the Comanchean series to the east, so they should be crumpled below the Comanchean deposits on the west. Hence oil and gas should not be looked for in the buried Stanley between Hugo and Valliant (in the area bounded on the west by a line drawn from sec. 24, T. 7 S., R. 17 E.., northeast to sec. 6, T. 5 S., R. 21 E. and on the east by a line joining sec. 36 T. 7 S., R. 19 E., with sec. 31 T. 5 S., R. 22 E.) Westward of this area lie the southwestward plunging Hugo Syncline and the sharply folded southwestward plunging Corinne anticline neither of which should be expected to produce petroleum or natural gas. How far to the southwest the Hugo syncline and Corinne anticline may be regarded as having an influence on the accumulation of oil and gas is not known, but to the writer it seems **useless to drill into the Paleozoics anywhere in the eastern half of Choctaw County, or anywhere in the southern half of McCurtain County, Oklahoma, excepting an area of about 300 square miles in the extreme southern part of McCurtain County.**

Of course it is inconceivable that oil should occur in the Bethel syncline, Boktukola syncline, Lynn Mountain syncline or in the intervening faulted structures, farther north.

The question now arises as to the possible production of oil from the Comanchean sediments, overlying the Paleozoics in the southern half of McCurtain County and in eastern Choctaw County. Although not within the scope of the present report it seems desirable to mention at least what influence the folding of the Paleozoics has had on the accumulation of oil in these overlying sands, clays, and thin limestones . Oil was found presumably in the Trinity sand at Madill in Marshall County, Okla., and with this fact as a basis for argument some presume that oil may be found farther east in the same sand. Asphaltite occurs at the top of the Trinity on the banks of Little River, north of Idabel and in the same horizon at Valliant. Miser and Purdue* have mapped several deposits near Lebanon, Murpheesboro, and Pike, in Arkansas. The asphaltite is evidence that some oil did at one time occur in the Comanchean sediments, but whether any now occurs or not is impossible to say. It seems, however, that since the folding in the mountains took place prior to the deposition of the Trinity sand and later Comanchean sediments, that what oil was in the Paleozoics must have made its escape at that time, or before the period of encroachment of the Comanchean sea—at any rate the great bulk of the oil must have been lost about that time. This being the case the Paleozoics could not possibly "leak" oil into the overlying Trinity, for the old rocks have little or none to lose, having already lost it. What asphaltite occurs

*Op. cit.

in the Trinity sand in this general region must, therefore, be indigenous material, or if derived from the underlying Paleozoics it should be very limited in amount, and in no case indicate the presence of large pools of oil in the neighborhood. Since the Comanchean sediments are comparatively shallow and loosely consolidated materials estimated to have an average thickness along Red River of from 500 to 1,200 feet only, the writer is of the opinion that very little oil indeed will be found in the Comanchean sediments excepting in the 300 square miles or so of country in the extreme southeastern part of McCurtain County where it is thought that Paleozoic oil might be entrapped and could possibly yield some of its lighter hydrocarbons to younger strata.

Concerning the origin of the asphaltite and the possibility of encountering oil and gas in west central Arkansas and southeastern Oklahoma, Miser and Purdue write as follows:*

The Trinity formation contains petroleum and asphalt at many places in northern Texas and southeastern Oklahoma. The asphalt in these two states and in Arkansas, as in other regions, is doubtless a residue of crude petroleum, whose lighter and more volatile parts have escaped by evaporation, The petroleum yielding the asphalt in Arkansas is believed by the writers to have been derived from the Carboniferous rocks underlying the Trinity formation, near the base of which the asphalt is found. In support of this belief is the fact that there are small amounts of asphalt in the sandstone of the Atoka formation, of Carboniferous age, which crops out in two narrow belts with a north of east trend in Pike County ,a few miles north of Pike and Murfreesboro. Asphalt is also found in Carboniferous and older rocks near Mena, Ark., and in southeastern Oklahoma. The Carboniferous rocks pass beneath the Trinity formation, and the beds are tilted in such a manner that their edges project against the base of the Trinity. Any oil in the Carboniferous beds would, in the course of time, work its way upward into the Trinity. It could not go higher than the lower limestone of the Trinity, because of the impervious character of this limestone and the associated clays. As the Trinity has a gentle dip to the south, the oil would be conveyed up the dip to the surface. There is, however, no direct proof that some or all of the petroleum did not originate in the basal part of the Trinity formation, which contains some fossilliferous limestone.

On the assumption that the petroleum yielding the asphalt herein described originated either in the Trinity or in the underlying rocks, the petroleum has probably migrated northward. There is, however a possibility that it came upward from the Paleozoic strata immediately subjacent to the areas containing the asphalt deposits. The Cretaceous rocks in southwestern Arkansas have a southward dip of about 100 feet to the mile, and although they have been slightly warped, no pronounced anticlines or synclines occur

*Miser, H. D. and Purdue, A. H., Asphalt Deposits and Oil Conditions in Southwestern Arkansas; U. S. Geol. Survey Bull. 691 Pt. II, pp. 280-281.

in Pike, Howard, and Sevier counties. Thus, if petroleum occurs in the region south of the asphalt deposits, its accumulation into quantities of possible commercial importance would probably be controlled by terrace structure, lenticlular character of sands, or irregularities in the Cretaceous floor. Harris* says: "Hopes may be entertained of finding oil and gas so entrapped [by change in character of sediments] in wells sunk in various places near the Eocene-Cretaceous contact from Arakadelphia [Ark.] to and beyond San Antonio."

The peridotite masses near Murfeesboro may have lifted the Trinity so as to produce structure favorable for the accumulation of oil about them, just as volcanic necks or plugs have done in Mexico and probably in Texas, but such phenomena have not been observed around the peridotite masses.

There is no possibility that either oil in commercial quantities or gas in large pools will be found in the Ouachita Mountain region of west-central Arkansas or in most of this region in Oklahoma. The Carboniferous and older rocks have been so highly tilted and so much fractured and metamorphosed that if oil or gas were ever present in them the gas and much of the oil would have made their escape to the surface and the remainder of the oil would have been distilled to asphalt.

In connection with the statement of Miser and Purdue it is of interest to note that no asphaltite or oil seepages were found anywhere in the Paleozoic rocks of McCurtain County, nor in the region adjacent to the north, east, or west so far as the writer has extended his field studies. The nearest asphalt deposit in Paleozoic rocks in Oklahoma is at Page in LeFore County in sec. 24, T. 3 N., R. 26 E.**

BUILDING MATERIALS

From a commercial point of view there are no rocks in the region which can be used for building, masonry, or construction work of any kind calling for durable stone. The great bulk of the materials are metamorphosed shales and interbedded hard sandstones and cherts all of which are badly jointed and tilted at such high angles that quarrying practically is impossible. Some of the sandstones in the Stanley and portions of the Jackfork have locally been made use of in chimneys and foundations for houses. At Lamberson, on Winding Stairs Mountain (sec. 29, T. 4 N., R. 22 E., Le-Flore County, Oklahoma) the St. Louis and San Francisco Railway opened a quarry in the Jackfork sandstone for the purpose of obtaining stone for bridges abutments and ballast for the railroad,*** but

*Harris, G. D., Oil and gas in Louisiana, with a brief summary of their occurrence in adjacent States: U. S. Geol. Survey Bull. 429, p. 27, 1910.

**Taff, J. A., Grahamite Deposits of Southeastern Oklahoma; Bull. U. S. Geol. Survey, No. 380, Pt. I, 1909, p. 294-295.

***Along the route of the Kansas City Southern Railway, where it crosses the Ouachita Mountains, the ballast and all the rock used for bridge abutments and culverts is chert and limestone, and was obtained outside of the region entirely.

these purposes served, it was abandoned. The rocks in the quarry dip 60° a fact which made it very difficult no doubt to get the rock out. The devitrified tuff bed near the base of the Stanley is very resistant, extremely tough and hard, and should an occasion arise for its use as a building stone it could be used, but it cannot be quarried in a commercial way because of the narrow outcrop and steep dip of the bed wherever found.

There is an abundance of good road material everywhere. All of the slates and shales make excellent surfaces; the sandstones, novaculites, and cherts can be reduced to small blocks and used for filling and grading and road making in general. Within the region in question, good roads are everywhere possible by removing the stumps and grading. Shales have been used in road construction very extensively in the coal regions of southeastern Oklahoma, notably around Lehigh, Coalgate, and Hartshorne, demonstrating their adaptability to this purpose very decisively. There are great quantities of shale throughout the whole of the region dealt with in this report and some of the best roads in the region now are the natural shale roads.

The sandstones and cherts have been made use of in constructing road beds in the mountains north of Broken Bow and between Bismark and Bethel. These have been surfaced in general with sandy soils which prevail over much of the region, graded, and good roads are the result.

Along the southern border of the mountains in certain localities there are great quantities of gravel which may readily be made available for road building. These materials occur in the lower portion of the Trinity sand in situ and in the creek bottoms whither they have been washed in recent times. There are no gravel deposits of value in the mountains proper.

LIMESTONES

The only limestones in the region are the Collier thin-bedded limestones aggregating a total thickness of about 25 to 30 feet and outcropping mainly in the valley of Lukfata Creek. These are relatively pure, black limestones in places, but in certain horizons locally they become siliceous. Their limited extent and thickness and their local siliceous content as well as their location are factors any one of which would discourage their development. It seems therefore that they will never be used commercially in the lime or cement industries. As a road metal they would serve as well as any of the sandstones in the region.

SLATE

It is possible that commercial slate, roofing slate, etc., locally could be produced from the Missouri Mountain slate formation, providing the trouble were taken to find it, build roads and do the necessary stripping. The preliminary drilling and prospecting, however, it is believed would be more expensive than the formation justifies. The production of slate from this formation has been attempted in several places in Arkansas* and one judges, from reading of this report, that most of the attempts have resulted in failures. It is reported** that "scattered deposits of slate have been more or less developed in Arizona, Arkansas—(other states included), and a little work was done on some of them in 1915, but no sales of slate were reported." In the 1916 volume of Mineral resources, p. 65 Loughlin says "Deposits of slate in Arizona, Arkansas, Colorado, Georgia, and Tennessee remained inactive."

If roofing slate of good grade cannot be found in Arkansas it is very reasonable to suppose that it does not exist in Oklahoma. The writer has no location to recommend for prospective work along this line, in the Ouachitas of Oklahoma.

ABRASIVES

The Arkansas novaculite of Arkansas has long been known as an excellent stone for the manufacture of oil stones, scythe stones, and hones. These articles have been made from it from the time of its discovery in 1818***, to the present time and the state of Arkansas has led in the production of these stones in the United States for many years.**** In the Ouachitas of Oklahoma the Arkansas novaculite presents the same opportunities as those now enjoyed by the state of Arkansas in this regard. There is an abundance of excellent rock for the manufacture of oil stones throughout the whole general region of outcrop of the novaculite formation much of which is easily accessible. Concerning the properties, occurrences, manufacture and use of this remarkable rock Phalen***** writes as follows:

OILSTONES OF ARKANSAS

There are two kinds of whetstones or oilstones quarried in Arkansas. They come from the vicinity of Hot Springs, Garland county and are known as Arkansas stone and Ouachita****** stone. In the trade two grades of each of these are recognized, namely, the hard and the soft varieties. Each stone has its own uses and is adapted to particular tools.

*Purdue, A. H., the Slates of Arkansas, Ark. Geol. Survey, 1909.

**Loughlin, G. F., Slate: U. S. G. S., Mineral Resources of the United States, 1915 Part II, Non-metals p. 24.

***Griswold, L. S. Novaculite of Arkansas, Ark. Geol. Survey, Rept. 1890, Vol. III, p. 83.

****Phalan, W. C., Abrasive Materials, U. S. Geol. Survey, Mineral Resources of the United States Part II, Non-metals, p. 841.

*****Phalan, W. C., Abrasives, pp. 842-845 of the U. S. G. S., Mineral Resources of the United States, Part II, Non-metals, 1911.

******Spelled also "Washita." The latter form is used almost exclusively in the trade.

ARKANSAS STONE

Properties:—The Arkansas stone is a true novaculite; that is, it is homogeneous, gritty, has a finely granular structure, and a siliceous composition. It is translucent on the edges and has a pronounced conchoidal fracture. The following is an average of several analyses made of the Arkansas stones:

Average Analysis of Arkansas Novaculite

Silica (SiO_2)	99.50
Alumina (Al_2O_3)	.20
Iron (ferric oxide) (Fe_2O_3)	.10
Lime (CaO)	.10
Magnesia (MgO)	.05
Potash (K_2O)	.10
Soda (Na_2O)	.15
Loss on ignition (water)	10
	100.30

The most striking point brought out in this analysis which is a fair average for this stone, is the very constant and high percentage of silica—which, it may be added, is present in a very stable, that is, insoluble form. The microscopic examination of thin sections of the Arkansas stone gives results which agree with the conclusions drawn from the chemical analyses. Nothing but silica can be seen. The silica is present in minute irregular grains closely crowded together to form a dense ground mass. The grains are very uniform in size and average less than 0.01 milimeter in diameter. As the silica of the novaculite is neither crystalline, amorphous, nor chalcedonic, it must be classed with cryptocrystalline minerals—those too fine to show distinctive characters.

The arrangement of the silica in the thin sections is a matter of interest. The ground mass is composed of densely crowded grains of silica, but here and there are little cavities with rhombic outlines indicating the former presence of calcite now dissolved away. The cavities average about 0.05 millimeter in diameter. Occasionally these cavities are filled with secondary silica forming a larger grain than usual. These larger grains have some influence on the abrasive qualities of the Arkansas stone but the cavities probably have more.

The Arkansas stone when fresh has a white color with a slightly bluish watery tint. Oil soon gives it a green tinge. Often it is tinged brownish or reddish by diffused oxide of iron. The bluish tint and translucent properties give it a striking resemblance to chalcedony, but it does not contain any of the latter mineral.

The Arkansas novaculite can not be scratched by a knife point. Quartz will scratch it, however, and likewise it will scratch quartz; hence its hardness may be considered that of this mineral. It is not tough like flint but it is brittle and easily chipped with a hammer, though its fracture is quite as irregular as that of flint. It drills at the rate of about a foot in two hours with a 1¼ inch drill with two men striking. Ouachita stone drills about three times as fast.

Experiments on the absorption of water by this stone and the Ouachita stone indicate that both are very dense and practically the same so far as effectiveness of abrasion depending upon porosity is concerned. The actual space in the Arkansas stone is about 0.0017 of the total bulk. This is very small, but it seems to give the stone considerable advantage as a whet stone over the perfectly dense stones.

Occurrence:—The novaculite usually occurs in massive strata, usually presenting plane surfaces and having only thin layers of shale interbedded. The common thickness of the novaculite formation is 500 or 600 feet, which includes generally some flinty shales and soft shales or sandstones. The novaculite, however, is the prominent portion of the formation and occurs in massive beds from a few inches to 12 or 15 feet in thickness. The massive beds are so closely associated that there often appears to be no parting between them, but stratification lines are indicated in quarries by thin seams of clay.

The region in which the stone is found has been subjected to pressure and the strata are commonly found in a position nearer vertical than horizontal. The quarries are therefore narrow, slanting, open cuts conforming to the bedding. The brittle novaculite, as a result of the pressure, has in many places been crushed into fragements and in other places has developed natural cleavages or joint planes called by the quarrymen "splitting seams." Two or three may be found at almost any place, and as many as six have been observed in a single quarry. In addition to the local hard or tougher spots and cracks presenting difficulties to prospectors, fine quartz veins intersect the rock in all directions and in great numbers. Some of them are so thin that they can not be distinguished with the naked eye. Since they do not always appear at the surface, they are frequently not found until the stone has been sawed, in such cases occasioning considerable loss. On account of the occurrence of these small quartz veins, manufacturers prefer blocks of medium rather than large size. Finally, small cavities known as "sand holes" may be present.

Manufacture and uses:—The workable stone is obtained usually in rather small pieces. The blocks of stone are trimmed at the quarries. In the case of the hard Arkansas stone, anything weighing over 5 pounds is shipped. In the case of the soft Arkansas stone, anything weighing more than 15 pounds is shipped. The blocks are sent to various abrasive factories in different parts of the country, and are there sawed and rubbed into forms in which they are used. The stones are used in a variety of ways by engravers, carvers, dentists, jewelers, especially manufacturing jewelers and watchmakers, cutlers, manufacturers of fine edge tools in general, machinists and woodworkers, manufacturers of fine machinery and metal work—in short, by all artisans who use small pointed or fine edged tools. Various forms of the stone are turned out depending upon the use to which they are to be put; dentists have

certain shapes applicable in their work; carvers and jewelers need other forms. The stone is well suited for small files and points, but small articles made from it must be used with care on account of its brittleness. Wheels also have been made from this stone.

OUACHITA (WASHITA) STONE

Properties:—The Ouachita stone resembles the Arkansas stone in all its physical characters, but it is less dense and more porous, its porosity excluding it from the class of true novaculites. As a result of its porosity it lacks the waxy luster of novaculite and has the dead appearance of unglazed chinaware. Instead of the fine conchoidal fracture of the Arkansas stone it has a subconchoidal fracture.

It has the same chemical composition as the Arkansas stone and its percentage of soluble silica is less than that of quartz crystals, which is 4 per cent, and is therefore less than that of the Arkansas stone, which is 5 per cent. Its remarkable abrasive qualities depend upon the existence of many cavities in a dense ground mass. As in the Arkansas stone, these cavities have a rhombohedral form, but they are more important in the Ouachita stone as here they are larger and much more numerous. The silica is more compact about the cavities than elsewhere, as a result of which their sides present fine cutting edges to a tool rubbed on the stone. These edges must accomplish the cutting, for the Ouachita stone differs from the Arkansas stone in no other way that could account for its much greater abrasive powers. The cavities of the Arkansas stone amount to 0.25 per cent of the total bulk; in the densest of the Ouachita stone the pores constitute about 5 per cent.

The Ouachita stone resembles the Arkansas stone in its mode of occurrence. There is nothing in the structure of the two stones to render impossible the graduation from one into the other in the same bed but such transition is rarely observed. The defects that are met with in the Arkansas stone are also common in the Ouachita stone. Like the Arkansas stone it may be intersected by joint planes, which divide it into fragments too small for use. However, the Ouachita stone is freerer from defects than the Arkansas stone, and some masses weighing several tons are quarried. The hard spots in the Ouachita stone are not flinty in appearance but appear to be simply dense portions of the stone, which in use are liable to glaze. They may be the result of a mineral cement binding the grains more firmly in those particular places, or they may be due to the smaller number of cavities in that particular part of the stone. Quartz veins are not so numerous in the Ouachita stone as in the Arkansas stone. "Sand holes" are, however, more numerous and attain a larger size than in the Arkansas stone. Freezing does not have the injurious effect on the Ouachita stone that it does on the Arkansas stone, for the former is porous enough to allow some expansion. Long drying is injurious, for it seems to cause loss of easy fracture and to make the stone tougher and harder. For this reason it seems inadvisable to keep the stone a long time before shipping to the factory or to hold it at the factory a long time before sawing. It saws more readily when fresh from the quarry. A defect in the stone from some quarries is due to the uneven distribution of the rhombic cavities. The change occurs in the stratification planes and shows that the amount of calcite deposited in the original stone varied at different times. As a result, the stone is composed of bands of different densities which appear in the finished product as areas of unequal hardness. Ouachita stone has been found in much larger quantities than Arkansas stone, a fortunate circumstance, for the demand for the former is much greater than for the latter. As already stated, Ouachita stone is shipped in much larger blocks than Arkansas stone, blocks of 40 to 50 pounds being about as small as manufacturers care to buy, for the small blocks produce more waste. From this minimum the blocks of Ouachita stone vary in weight up to 1,500 pounds and even more.

Manufacture:—The same machinery and methods are used in the manufacture of Ouachita stone as in that of Arkansas stone. The former is, however handled in larger quantities, hence a regular system of sawing can be employed. The first cuts are 2 inches apart; the 2-inch slabs are cut into 8-inch lengths, and these into whetstones 1⅛ inches in thickness. The great mass of the stone is manufactured in this shape, all of the other forms of the stone requiring special adjustment of the saws. After sorting, the stones go to the rub wheel. Here the Arkansas stones get their final finish, but not so with the Ouachita stones. The water absorbed in the sawing and rubbing processes gives the latter a bluish or greenish color, which is considered objectionable, so the stones are dried, when they assume a pure white hue. After drying, the stone may be rubbed with pumic, the process being called cleaning. This restores the white color which may have become obscured from dirt filling the pores during the sawing and rubbing processes. The chief use of Ouachita stones is for whetstones for the coarser tools. The Arkansas stones are generally used to finish tools which have undergone a preliminary sharpening with a coarser stone.

BURRSTONES AND MILLSTONES

There is no doubt whatever, but that many of the fine grained quartzites and quartzitic sandstones of the Stanley and Jackfork formations would make excellent millstones and burrstones. So far as known to the writer these formations have never been considered of any value in this connection. The demand for millstones is not large, but it is possible that sometime there may be a wider field of application of this type of abrasive and it is well to call attention to this possible source of raw material.

QUARTZ

Silica, the oxide of silicon (SiO_2), or quartz in the clear, crystalline, and milky varieties is extremely abundant as a pure mineral in veins of large size over a wide area in the region. It occurs also as the chief constituent in the coarse soils in many sections of the country. It could readily be obtained in large quantities from the veins or by washing from the soils.

All of the important veins have been located on the map (Plate I Part I). The reader's attention should be called especially to those to the southwest of Hochatown (secs. 29, 30, 31, and 32 of T. 4 S., R. 25 E., secs. 23, 24, 25, 26, 35, and 36 of T. 4 S., R. 24 E. and secs. 1 and 2 of T. 5 S., R. 24 E.) but there are large quantities of the quartz at all places where it has been mapped.

Of the uses of quartz, Katz* says:

Silica (quartz) as discussed, in this chapter is used for many purposes, principally in the manufacture of pottery, paints, and scouring soaps, as a wood filler, as a polisher, and in metallurgical and chemical processes. In the pottery industry, where it is generally called flint, silica is used in the body of the ware to diminish shrinkage and is also used in glazes. Silica for use in pottery should contain less than 0.5 per cent of iron-bearing minerals. Manufacturers of paint use considerable quantities of very finely ground silica, which forms as much as one-third of the total pigment to some paints. For this purpose finely ground crystalline material is superior to fine sand in its natural state because of the angularity of the grains, which makes them adhere more firmly to the article painted and after wear affords a good surface for repainting. The same angularity makes artificially comminuted crystalline quartz superior to natural sand for use in wood fillers. For soap and polishing powders ground material is preferred to natural sand on account of its whiteness and angularity. For all these purposes large quantities of pure quartz sand and sandstone are finely ground and yield a product fully equal to that obtained by grinding massive crystalline quartz.

Quartz crushed and graded to various sizes is used in making sandpaper and sand belts, as a scouring agent, for "frosting" glass with sand-blast apparatus, and for other purposes. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and as a flux in copper smelting. Ground quartz is also used in filters and in tooth powder and by dentists as a detergent.

Sand and crystalline quartz have been used in making silicon and alloys of silicon with iron, copper, and other metals in the electric furnace. Quartz may be fused in the electric furnace to make chemical apparatus, such as tubes, crucibles, and dishes.

A railroad could easily be constructed from the larger quartz veins, southwest of Hochatown, to the town of Broken Bow, 10 miles due south where connections could be made with the Texas, Oklahoma, and Eastern Railroad. There has already been constructed over this route a graded automobile road so that the materials are quite accessible for exploitation if there is any demand.

DIAMONDS

It is a well known fact that diamonds have been recovered for a good many years from the basic igneous intrusives near Murphres-

*Katz, Frank J.; Silica; U. S. Geological Survey, Mineral Resources of the United States, Part II, Non-metals, p. 55, 1915.

boro Pike county, Arkansas. Two diamond-bearing pipes have been found in that region and a wide search has been made for others, but so far without success. It is entirely possible that diamond-bearing peridotites may occur in Oklahoma as well as in Arkansas and a thorough search might lead to important discoveries.

AGRICULTURAL LANDS

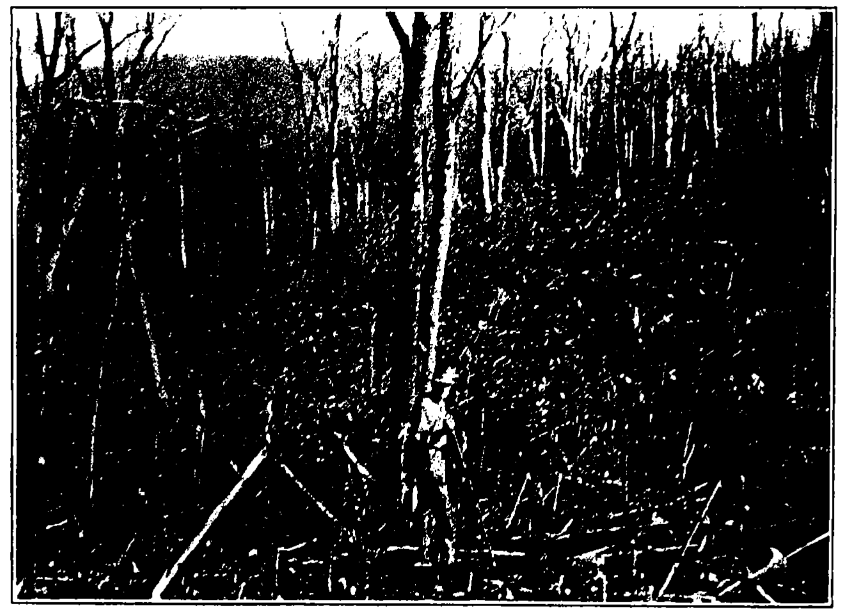
The area under consideration in this report lies wholly within the Choctaw Nation of what was a few years ago known as Indian Territory. As late as 1911 the entire region as well as large tracts on the north and west belonged solely to the Government of the United States and to the Choctaw Indians. In recent years the Government has sold from time to time at public auction large tracts of such lands as belonged to the Government until now all the unallotted lands (lands not owned by the Choctaws) have been disposed of. The purchasers have been men in all walks of life located in all parts of the country, many of whom knew nothing of the character of the lands they have acquired. Literally hundreds of letters of inquiry concerning the 'soils and mineral resources'' of these lands have come to my notice in the past two or three years. Under the circumstances it seems highly desirable to state briefly what the agricultural possibilities are in that part of the Choctaw Nation which falls within the scope of the present report.

It may readily be guessed that in a country where the prevailing rocks are hard sandstones, slates, cherts, and novaculite, where the topography is mountainous and the structure complexly folded, that very few soils of agricultural value would occur. There are some gravelly, sandy areas on the divides between the larger streams and in a few places alluvial flats have formed along the margins of the streams. These may be designated as agricultural lands of one kind and another, good and poor, the total acreage of which amounts to about 81 square miles in the whole 900 square miles of Paleozoic rocks or 9 per cent. The map (Plate XIV) shows a three-fold classification of all the lands in the area of Paleozoic sediments:

1. Unalloted agricultural lands (originally Government lands) classified by the Department of Interior.*
2. Agricultural lands now under cultivation (practically all originally allotted Indian lands) mapped by C. W. Honess.
3. Grazing and timber lands, unsuited to agriculture (originally Government lands) mapped in part by the Department of the Interior** and in part by C. W. Honess.

*Map of the Timber Lands, Choctaw Nation. Prepared in the Office of the Commissioner to the Five Civilized Tribes, Muskogee, Okla., June, 1913.
**Idem.

SANDY UPLANDS FOUNDED ON THE STANLEY SHALE FORMATION, IN THE NE. ¼ SEC. 19, T. 1 S., R. 27 E.
Corn and cotton are planted among the girdled postoak trees.



CORN AND ORCHARD ARE PLANTED ON TOP OF LYNN MOUNTAIN AMONG THE GIRDLED OAKS IN THE RICH, BROWN, SANDY LOAM WHICH WEATHERS FROM THE JACKFORK SANDSTONE.
Location in the NE. ¼ Sec. 4, T. 1 N., R. 26 E. Elevation 2,200 feet.

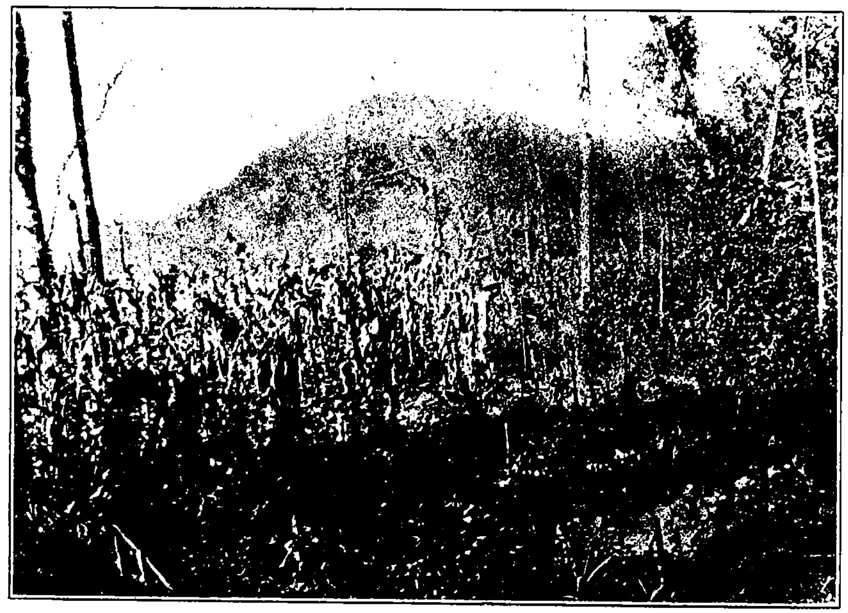
Since the lands which were allotted to the Indians are now practically all cleared and under cultivation in so far as they are suited to that purpose, the Government mapped agriculture lands together with the cleared and cultivated lands as mapped by C. W. Honess constitute all the agricultural lands there are in the region of Paleozoic rocks. The remainder may be said to be grazing and timber lands, characterized in general, as mountainous country with steep, rocky, talus-covered slopes and projecting ledges of sandstones and cherts unsuited to agriculture. (See also letter by Hon. Gabe E. Parker, Superinendent for the Five Civilized Tribes, Muskogee, Okla., (Page 70.)

The soils on the hills are residual and have been derived largely from sandstones and shales. These are loose, sandy loams, in places several feet in depth but ordinarily they are less than one or two feet thick and are very apt to be more or less rocky. Sharp angular fragments of milky vein quartz, the weathered product of quartz veins, is a prominent constituent of the soils which overlie the Collier and Womble formations; sandstone gravel up to 2 inches, but ordinarily under 1 inch may form a considerable proportion of the soils anywhere on high ground. The gravel is the partially decayed residuum of the one time more extensively distributed Trinity formation. A thin veneer of the finer sandy portions of the Trinity is sometimes preserved also, and may be thick enough to be recognized as a mappable outlier. The Trinity sand is very productive when first cleared and any admixtures of this material with the soils derived from the Paleozoic formations always increases their value tremendously.

The alluvial soils are water-transported and are less sandy than the residual ones. Locally, as along Lukfata Creek these may be heavy, soggy, black clays, in other places clay loams. There is every gradation between the transported alluvial soils in the creek bottoms and the residual sandy loams of the uplands as one goes from low ground to high ground.

In some of the glades the soils are partially transported and partially residual clay loams. The glades are flat valleys lying between hills of sandstone, and owe their origin usually to a belt of slate or shale which comes to the surface between two masses of sandstone. The structure may be what it will, in any case the slate makes a very poor subsoil and because of its imperviousness to water the overlying soil, ordinarily thin on the glades, soon dries out after a rain and will not sustain plant life through long periods of drought. No farmer familiar with the conditions attempts to farm a glade. In their wild state they are usually grass covered, in places supporting a sparse growth of hawthorn, wild plum, persimmon and other small trees or shrubs, but never large trees. The grassy glades are ordinarily fenced and used as hay-fields.

A. A CORN FIELD IN THE VALLEY OF BUFFALO CREEK, IN THE SE. ¼, SEC. 7, T. 2 S., R. 26 E.



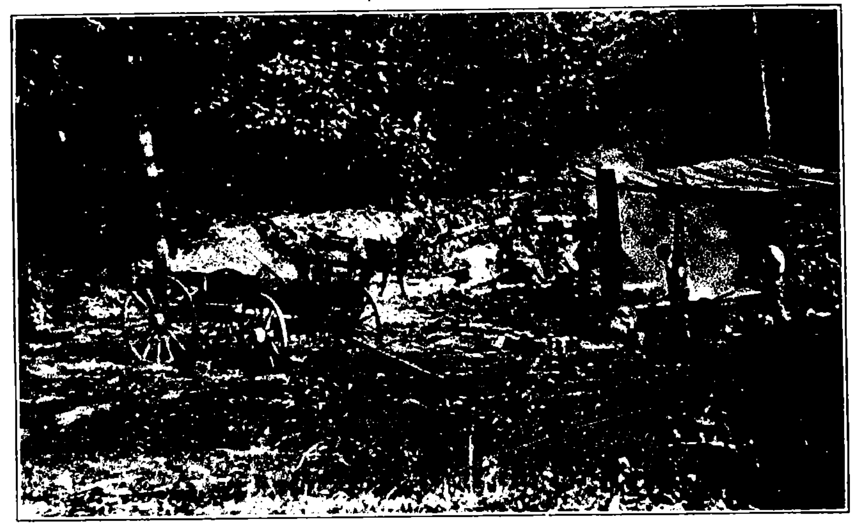
B. A CORN FIELD IN ROCK CREEK BOTTOM, IN THE SE. ¼ SEC. 16, T. 2 S., R. 27 E. JONAH MOUNTAIN IN THE BACKGROUND.

PLATE XVII.

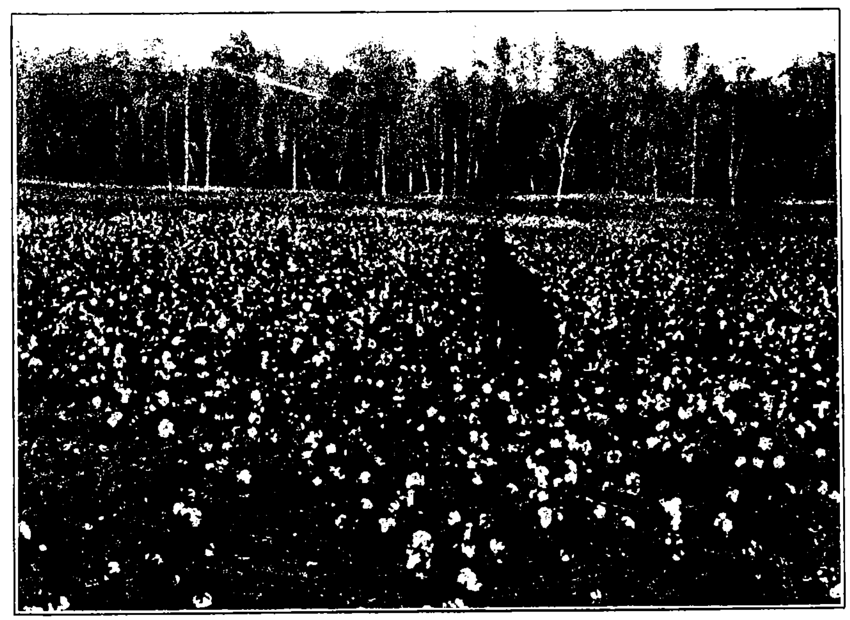
GIRDLED PINE TIMBER NEAR SHERWOOD, IN THE SE. ¼, SEC. 33, T. 2 S., R. 24 E.
The soils are sandy uplands resulting from the weathering of the Stanley shales and sandstones, with an admixture of Trinity sand and gravel, and are adapted to raising cotton and corn.

It has been the experience of farmers in the region that the "ridge land" or upland does not wear well, and indeed it should not be expected to do so, for as soon as it is cleared and plowed it at once becomes subject to washing and gullying and its initial vitality soon lags. In the vicinity of Nuihchito and around Sherwood some of the older fields have become so thin and worn that they are of

PLATE XVIII.



A. MAKING SORGHUM NEAR CORINNE, SEC. 16, T. 5 S., R. 21 E



B. COTTON ON A SANDY UPLAND, SEC. 16, T. 1 S., R. 27 E.

little use. There are small abandoned fields, again growing up to brush, all through the mountains. There is also much good upland especially near Sherwood, around Smithville, and west of Little River at Burwell Springs, and when taken care of and something given back to it occasionally, it is made to yield good returns.

The "bottom lands" or alluvial soils suffer most from wet plowing and lack of cultivation. They are abundantly productive especially along Mountain Fork River, Little River, and Glover Creek and reveal no indications of wearing out. Overflow by the rivers does some damage at times by drowning the crops or washing them out, but their equivalent is returned in new silt.

The chief and practically only crops raised in the mountains among the hills are cotton, corn, and a few garden vegetables. Here and there a patch of peanuts, cow peas, or a field of sorghum cane is grown.

The belt of Comanchean deposits south of the mountains is an area of almost flat-lying sands, clays and thin limestones, and is practically all agricultural land valuable chiefly for raising cotton and corn.

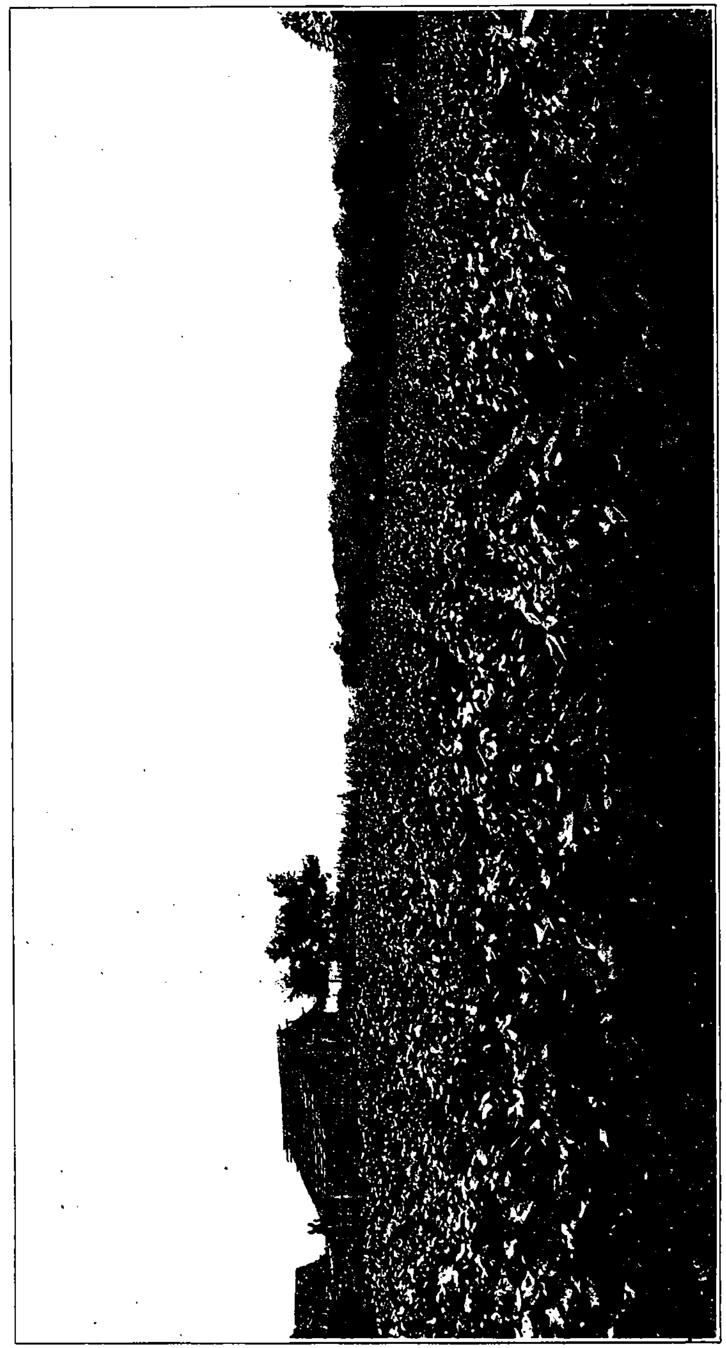
TIMBER

With the exception of here and there a small tract of prairie (glades) or brush-covered flats, the whole countryside was originally well timbered and much of the country still remains clad in its virgin forest. On the mountain sides grow the yellow pine, post oak, red and black oaks, and white hickory; in the fertile valleys and alluvial flats the large white oaks, the gums, hackberry, and soft maple, and along the streams the birch, sycamore, cypress, and red cedar. Locally there is some sassafras, walnut, linden or basswood, and cherry, as on Lynn Mountain and Walnut Mountain in T. 1 N., R. 26 E. Along Beech Creek and in the vicinity of Beech,* T. 1 S., R. 26 E., there are a few large American beech trees—one of the few locations where the American beech is found in Oklahoma.

The timber is of considerable value where the country is not too rough, and for a number of years large lumber companies have busied themselves with its destruction. To date about 375 square miles or 37½ per cent of the 1,000 square miles dealt with in this report have been denuded of their timber values. The cut-over area, with the exception of here and there a quarter section, includes T. 4 S., Rs. 19, 20, 21, 22 E.; T. 5 S.; Rs. 21; 22; 23; and 24 E.; the southern portions of T. 5 S., Rs. 25, 26, and 27 E., T. 4 S.; R. 27 E., most of T. 1 S., Rs. 25, 26, and 27 E.; T. 1 N.; R. 27 E. and the northern parts of T. 2 S., Rs. 26 and 27 E. In addition there have also been cleared, certain small agricultural tracts, chiefly in

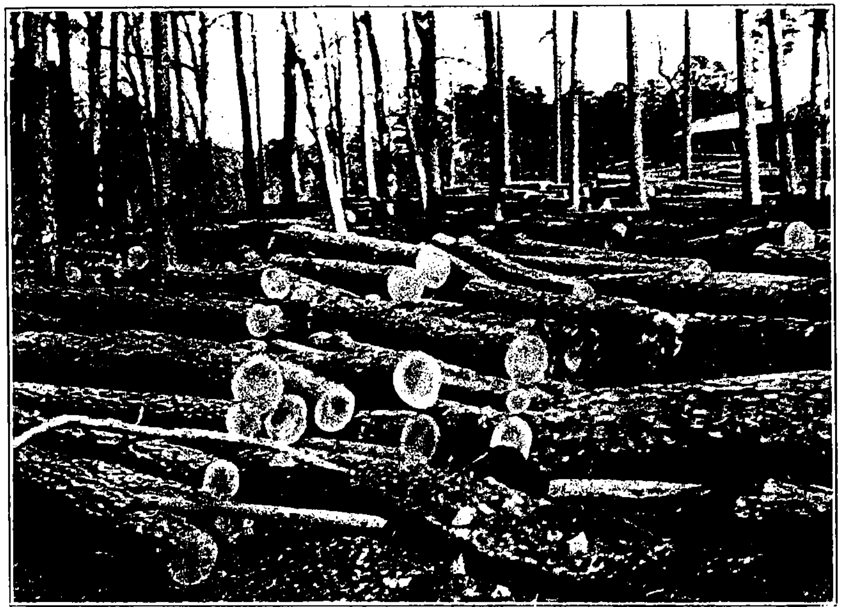
*Spelled "Beach" on the Lukfata Quadrangle of the U. S. G. S. Topographic Atlas of the United States and "Beachton" in the Postoffice guide.

PLATE XIX

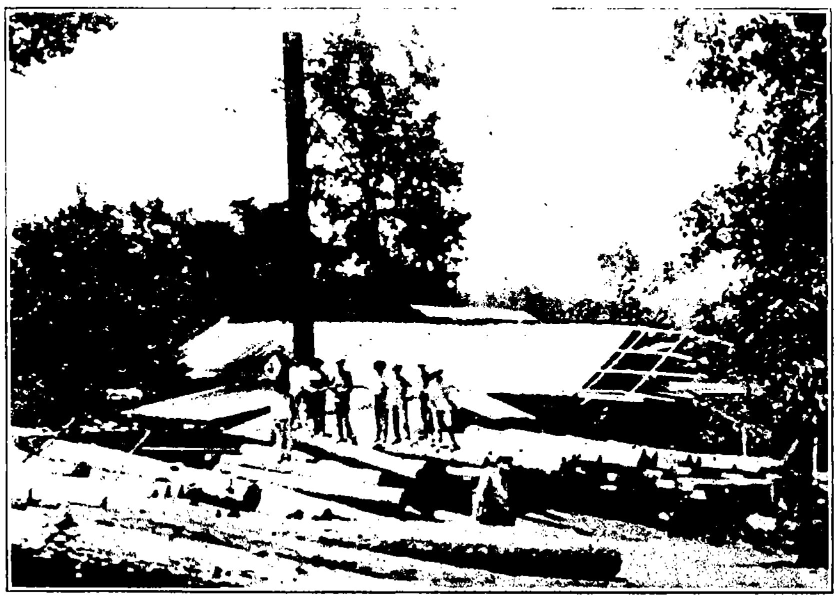


A FIELD OF COTTON AT BETHEL, IN THE SE. ¼ SEC. 24, T. 2 S., R. 23E.

PLATE XX.

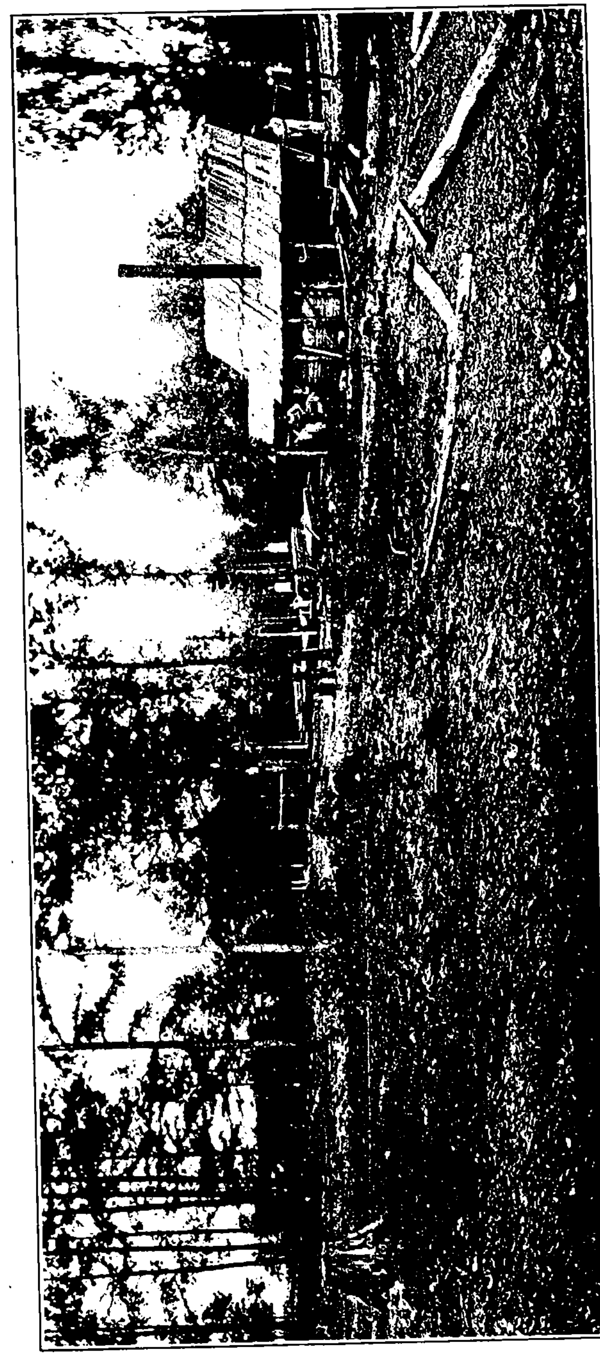


A. PINE LOGS ASSEMBLED AT A TEMPORARY SAWMILL ON BEECH CREEK, SEC. 32, T. 1 N., R. 26 E.
The rough lumber will be transported by auto truck 20 miles to a planer located at Hatfield, Arkansas.



ROTH'S SAWMILL, A SMALL PRIVATE ENTERPRISE, SEC. 30, T. 4 S., R. 27 E.

PLATE XXI.



PICKENS' SAWMILL AT PICKENS, IN THE NW. COR. SEC. 17, T. 2 S., R. 22 E.

the vicinity of Sherwood, Bethel, Hochatown, and other small settlements. The remainder of the country, embracing about 500 square miles, as well as large areas to the north and west, some of which is extremely rough and mountainous, is covered with the original timber. The pine has been estimated by the Government* for all unalloted tracts. These estimates range from nothing to more than 1,000 M feet per section with a general average of perhaps 500,000 feet per section. The oaks and other deciduous trees are not of large size ordinarily and no estimate has been made of the number of feet of lumber in these. The chief use of the oaks is for railroad ties and barrel staves.

In reply to inquiries concerning the date of sale and prices received for the unalloted agricultural lands and unalloted timber lands, and some other matters pertaining to McCurtain county, Okla. the Hon. Gabe E. Parker, Superintendent for the Five Civilized Tribes, Muskogee, Oklahoma writes under date of Feb. 28, 1919, as follows:

Referring to your letter of January 25, 1919, you are advised there have been sold in McCurtain County to date 75,620.58 acres of unallotted lands and 340,000 acres of unallotted timber lands. All of the unallotted lands have been sold, and all of the unallotted timber lands in McCurtain County have been sold except 235.21 acres. All of the other land located in this County has heretofore been allotted to citizens and freedmen of the Choctaw and Chickasaw Nations. The average price obtained for the unallotted lands is $5.75 per acre and for the timber land $6.13 per acre. The unallotted land was sold mostly in 1911, 1912, and 1913, while the timber land was sold in 1914, 1916, 1917, and 1918. It is very probable that the unallotted would have brought better prices had the sale been held later.

This office has no maps showing the entire acreage in McCurtain County, for the reason that when the unallotted lands were sold it only took in that part of the County between the south boundary of Township 4 South and the Red River, and a map was only prepared for that part of the County; the timber lands took in that section of McCurtain County from the south boundary of Township 4 South to the Base Line, and a map thereof was only prepared for that portion of the county. When the unallotted lands were sold the land was not classified as agricultural and grazing, except that all lands with the minimum price of $8.00 or more per acre were considered as agricultural. That portion of McCurtain County lying a few miles north of the St. Louis and San Francisco Railroad running from Hugo to Hope, Arkansas, to the Red River is generally considered agricultural land, but there is a considerable portion thereof, espectially that part lying adjacent to the Arkansas Line which is heavily timbered with pine timber. The balance of the country is generally rough and hilly covered more or less with pine and hard wood timber with

*Map of the Timber Lands of the Choctaw Nation, prepared in the office of the Commissioner of the Five Civilized Tribes, Muskogee, Okla., June, 1913.

PLATE XXII.

PINE TIMBER IN BEAVER BEND OF MOUNTAIN FORK RIVER, IN THE NW. ¼, SEC. 9, T. 5 S., R. 25 E. (SEPTEMBER, 1919).

some land on the slopes of the hills and mountains and along the valleys and on top of the hills that is probably suitable for agricultural purposes. A large proportion, however, of this area will undoubtedly be good for grazing purposes when the timber is removed.

WATER AND WATER POWER

Being in a humid region with 43 inches of rainfall per year, there is in this area, an abundance of good, soft water for all purposes. There are a number of good springs, some of them sulphur springs in all parts of the mountains. The larger creeks and rivers flow all the year round, and those which do not, have, along their channels, deep holes which furnish good water throughout the dry periods. Only in the valley of Lukfata Creek is the water liable to be hard (limy) for in this locality only, are there found any limestones. Elsewhere the water, both from the springs and from the flowing creeks is soft and potable, and of excellent quality for all purposes. The largest sulphur springs are at Watson in the SW. ¼, sec. 26, T. 1 S., R. 26 E., at Alikchi in the NE. ¼, sec. 35, T. 4 S., R. 21 E.; at Nunihchito, 300 paces south of the W. ¼ cor., sec. 36, T. 1 S., R. 25 E., and at Kullakasoma in the center of the SE. ¼, sec. 21, T. 3 S., R. 22 E.

Of the larger and more important sources of water throughout the year should be mentioned the following: Mountain Fork River, Little River, Glover Creek, Eagle Fork, Buffalo Creek, Hudson Creek, Linson Creek, Otter Creek, the three Rock creeks, Beech Creek, Rough Creek, Robinson Fork, Bull Creek, and Cypress Creek. The most of these are fed by springs and may be found flowing throughout the year. There are a number of small, unnamed creeks in the valley of Mountain Fork which are also fed by springs and which flow continually; the remainder of the streams including Boktukola Creek, Cow Creek, Luksuklo Creek, Lick Creek, Yanubbe Creek, Yashoo Creek, Wolf Creek, Cedar Creek, Carter Creek, Turkey Creek, and others of good size all cease to flow during periods of drought and some of them may dry up completely, especially those meandering about on the Stanley shale and Jackfork sandstone formations.

Some of the larger streams, if they could be harnessed, would furnish a source of water power. Mountain Fork River with its numerous rapids and low falls offers the best possibilities. A dam constructed across the river in sec. 3, T. 5 S., R. 25 E. to a height of 100 feet would cause a lake to be formed about 12 square miles in extent. This would be 50 to 100 feet deep over most of the area. The elevation at the foot of the dam would be 450 feet above sea, consequently the water, after being used by the force of its fall to develop electricity, might be conducted away to be used for drinking purposes, if it were needed, in the cities to the south.

PLATE XXIII.

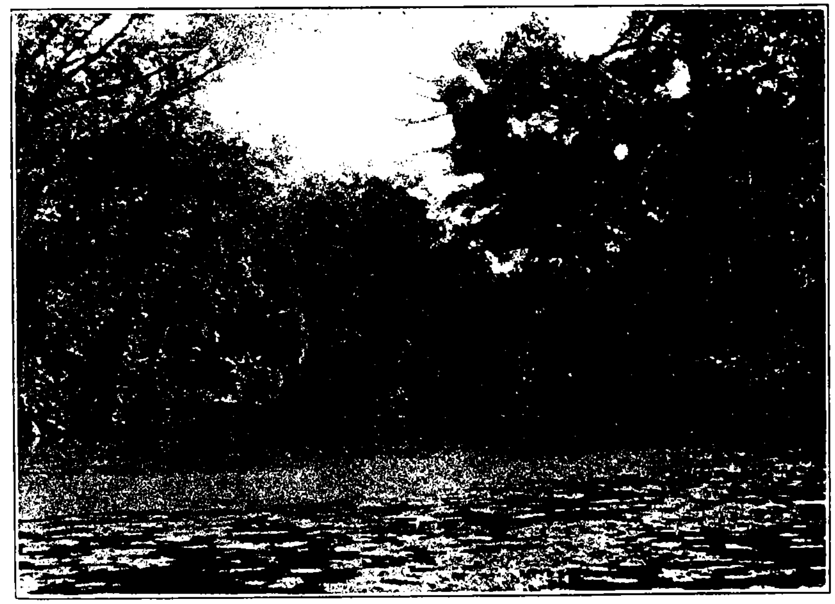
A VIEW LOOKING NORTH UP MOUNTAIN FORK RIVER FROM THE FORD, IN THE SW. ¼ SEC. 33, T. 4 S. R. 25 E.

PLATE XXIV.

CYPRESS TREES ON THE BANKS OF MOUNTAIN FORK RIVER, SEC. 33, T. 4 S., R. 25 E.

The greatest difficulty of such a project would be in the control of such a large stream as Mountain Fork which has a steep gradient and often rises suddenly 10 feet and occasionally 20 feet. It is to be doubted very much whether a dam 100 feet high across such a river would hold a 20-foot rise. There are times when even more water than that suddenly appears in the river. Depths of 10 feet to 20 feet occur every summer. This mountain stream during times of flood carries a great deal of silt and some logs also, and it is to be considered that the lake formed by such a dam as that mentioned would rapidly fill up with these materials.

PLATE XXV.



A VIEW LOOKING EAST UP BUFFALO CREEK, IN THE NW. ¼, SEC. 15, T. 2 S., R. 26 E.

The creek is deeply entrenched in the Stanley shale and has relatively few shallows or rapids, affording abundant water for cattle throughout the year.

There are no other good dam-sites on Mountain Fork River nor any suitable ones for high dams on any of the other streams in this region, but dams 20 feet to 40 feet could be placed at a number of points. A 40-foot dam it is thought might be constructed across Glover Creek in sec. 32, T. 4 S., R. 23 E. Streams smaller than Mountain Fork and Glover however, do not have a sufficient flow during periods of drought to turn machinery and their valleys are in no case large enough to impound water in quantities sufficient to bridge the dry months.

SUMMARY

It has been shown in the preceding pages that the region under consideration is in the main a rough, rocky, mountainous country, clad in a heavy growth of brush and timber and of value chiefly for lumbering and cattle grazing purposes. The rainfall (43 inches per year) is sufficient to insure good crops of cotton, corn, and vegetables of all kinds where the lands are suited to that purpose and there is good, soft, drinking water in all parts of the mountains so that living conditions generally are good and the climate healthful. The agricultural lands however, aggregate only about 9 per cent of the entire area. Although the population is sparse, and the roads and schools poor, the coming of the automobile has in recent years made the country more accessible, families are moving in, and both roads and schools are being built.

The mineral resources in the region are quite varied, including lead, zinc, copper, and manganese in small amounts, and certain non-metallics such as abrasives quartz, and road building materials. Of the metals (lead, zinc, copper, and manganese) none have been produced in economic quantities up to the present time, but it would be unwise to say that none of these ever will be produced in certain restricted areas. The lead, zinc, and copper minerals are found in fault rifts or narrow brecciated zones which in the main strike east-west and have considerable depth; the manganese occurs chiefly in pockets in definite horizons in the Arkansas novaculite. No gold has been found in the quartz veins to date, but this is on argument that the search for it should be discontinued. Diamonds might also be expected, but so far none have been found in Oklahoma.

There are almost unlimited supplies of Arkansas novaculite used in making whetstones, hones, etc. and of quartz, used in making pottery, paints, sand paper and other products. The gravel in the Trinity sand formation is in many localities of excellent quality for roads and some of the pebbles could be used in tube mills

Concerning oil and gas there is a possibility of production it is thought in two localities, namely: (1) in the Smithville anticline in the extreme northeastern corner of McCurtain County, and (2) southeast of Idabel in the extreme southeastern portion of this county. Elsewhere in the area conditions do not favor an accumulation of oil and gas.

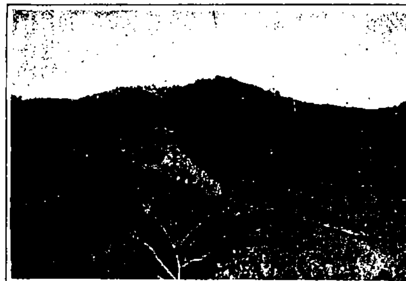
PLATES SHOWING GEOGRAPHIC FEATURES, NATURAL RESOURCES, AND INDUSTRIES IN THE OUACHITA MOUNTAIN REGION

PLATE XXVI

1. VIEW LOOKING NORTHWEST TOWARD A BIGFORK CHERT HILL, ONE MILE DISTANT, FROM THE HOGBACK IN THE NE. COR., SEC. 34, T. 3 S., R. 25 E.
2. BRUSH AND TIMBER IN MOUNTAIN FORK RIVER VALLEY, LOOKING SOUTH FROM THE HOGBACK, IN THE NE. COR., SEC. 34, T. 3S., R. 25E.
3. LITTLE RIVER AT LOW WATER, SEC. 25, T. 5 S., R. 21 E.
4. CYPRESS KNEES, MOUNTAIN FORK RIVER, SEC. 7, T. 6S., R. 26E.
5. BRUSH ALONG MOUNTAIN FORK RIVER NEAR HOCHATOWN.
6. AT THE CROSSING NEAR EAGLE TOWN: A ONE-FOOT RISE IN MOUNTAIN FORK RIVER.
7. A BIGFORK CHERT HILL, SEC. 9, T. 4 S., R. 25 E.
8. EXFOLIATION OF HARD SANDSTONES OF THE STANLEY SHALE FORMATION.

Photograph Nos. 1, 2, 5, 7, and 8, by Rolfe Engleman.

Nos. 3, 4, and 6 by E. S. Perry.


1


2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4


5


6


7


8

PLATE XXVII

1 AND 3. CYPRESS TREES ALONG MOUNTAIN FORK RIVER

2 AND 7. CHARACTERISTIC VIEWS OF THE PINE TIMBER OF McCURTAIN COUNTY.

4. THIN OPEN OAK WOODS CHARACTERISTIC OF CERTAIN SLOPES AND HILLS.

5. TRAMWAY NORTHEAST OF BROKEN BOW; PINE LOGS READY FOR LOADING.

6. PERSIMMON TREES, ONE MILE SOUTH OF CORINNE.

8. A WITNESS TREE OR BEARING TREE. "S. 25, T. 5 S., R. 22 E., B. T."; LUNCH TIME.

Photograps 1, 5, 6, and 8 by E. S. Perry. Nos. 2, 3, 4, and 7 by Rolfe Engleman.

PLATE XXVII.

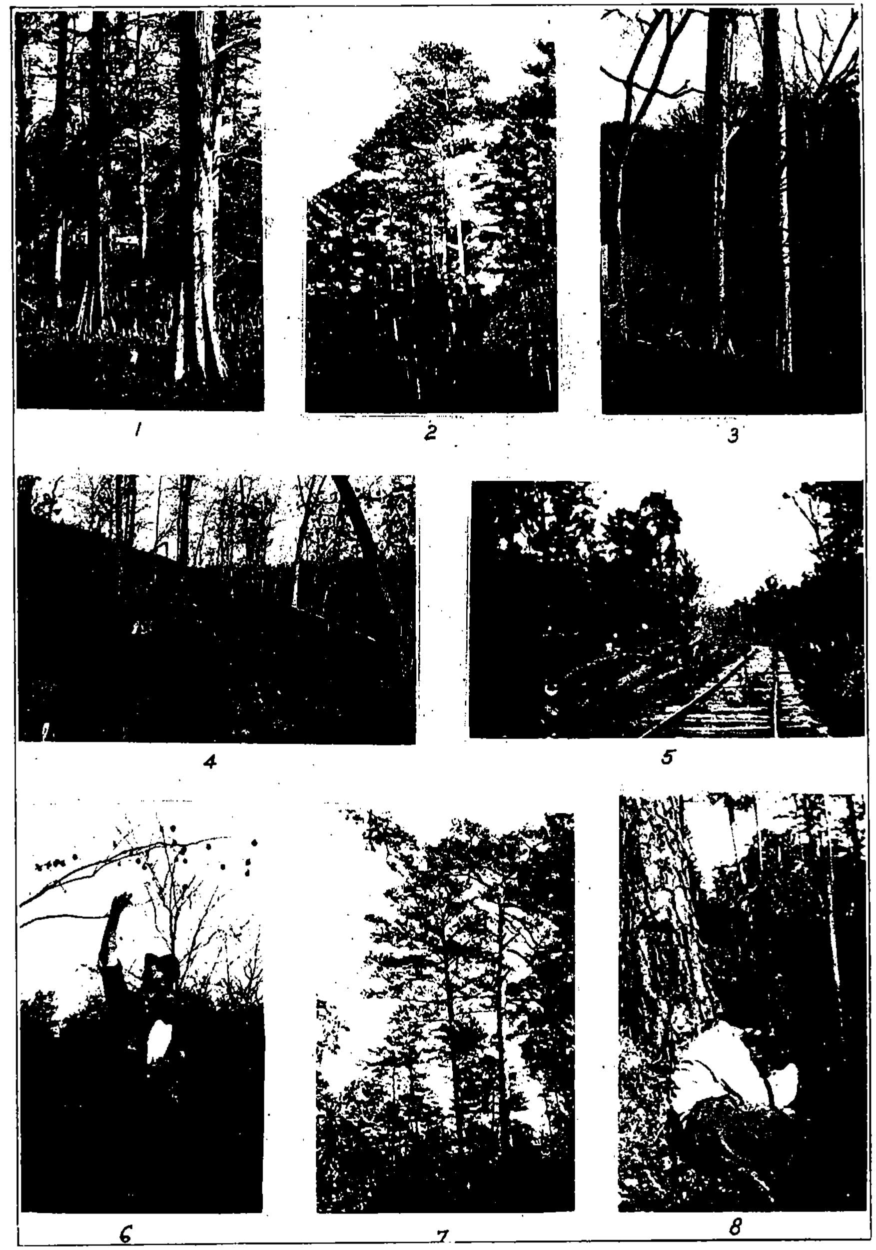


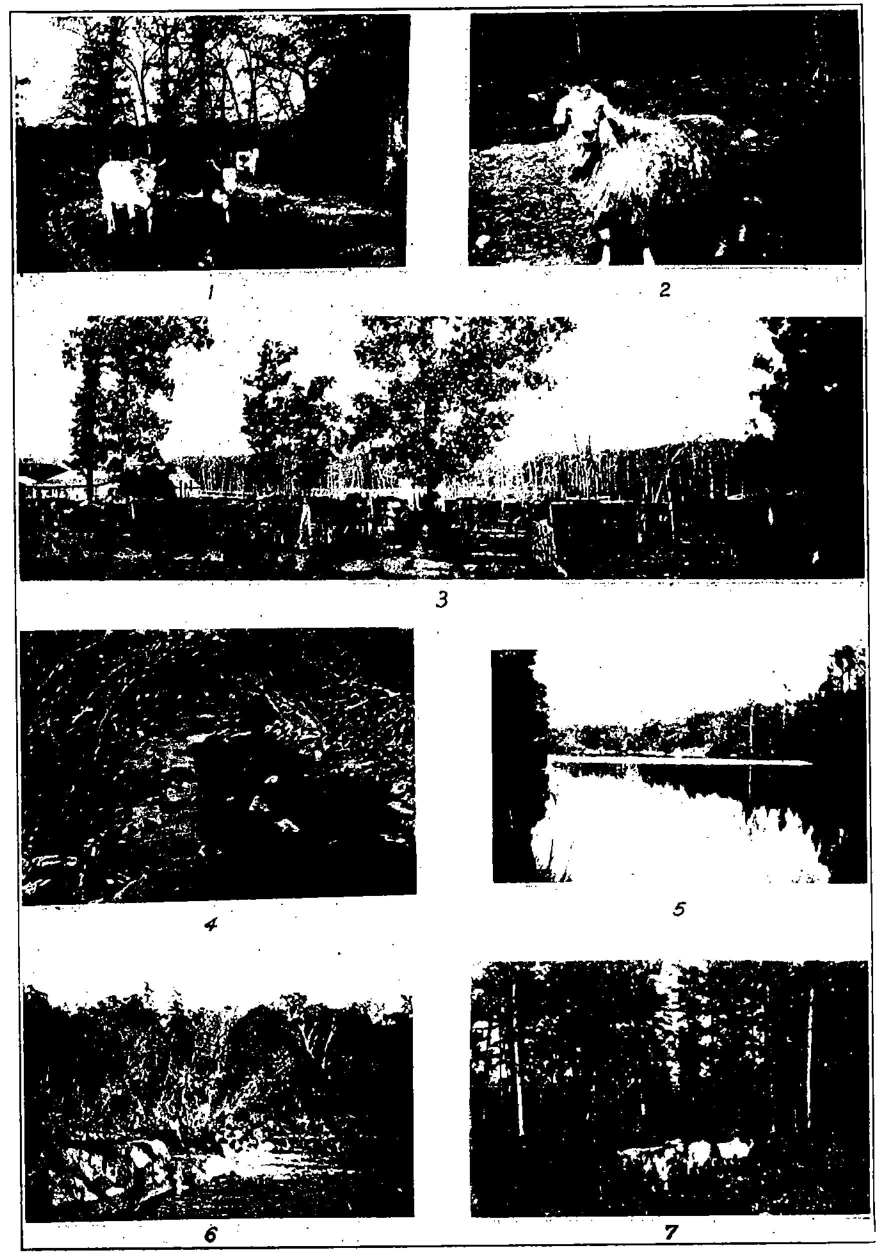
PLATE XXVIII

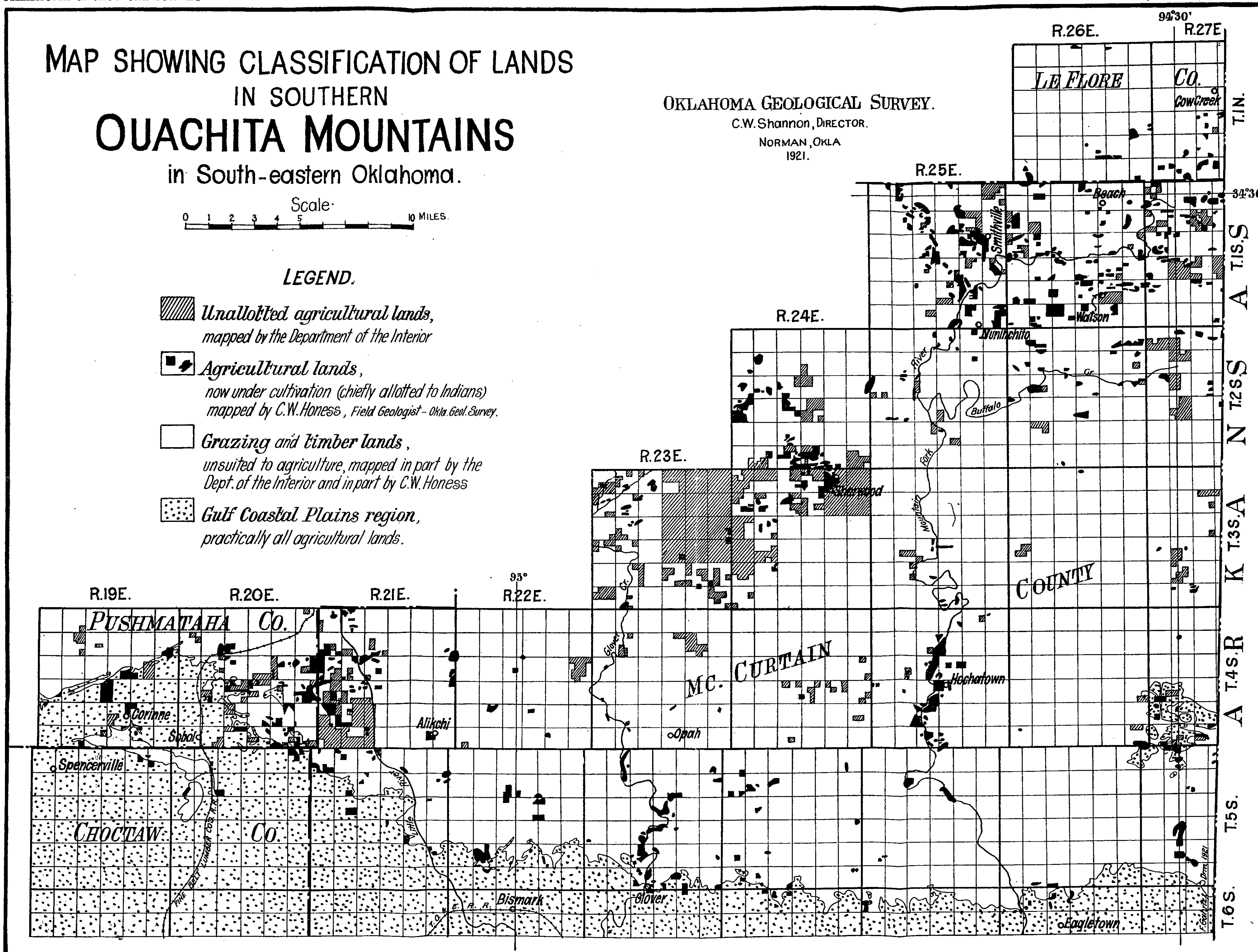
1. TEXAS STEERS, EAST OF SOBOL, 1916.
2. THE WHITE GOAT IS VERY MUCH AT HOME IN THE OUACHITA MOUNTAINS.
3. STEERS ROUNDED UP READY FOR SHIPPING, FELKNER RANCH NORTH OF BISMARK, IN THE NW. ¼, SEC. 14, T. 5S., R. 22 E.

Note also girdled post-oak timber in background—a field cleared for cultivation.

4. LINSON CREEK, SEC. 11, T. 3 S., R. 25 E., LOOKING NORTHEAST UP STREAM. NOTE BEAUTIFUL CLEAR WATER.
5. DEEP HOLE OF WATER IN MOUNTAIN FORK RIVER, SEC. 6, T. 6 S., R. 26 E.
6. LOW FALLS ON MOUNTAIN FORK RIVER FORMED BY HARD SANDSTONE OF THE STANLEY SHALE FORMATION, SEC. 31, T. 5S., R. 26E.; OKLAHOMA VIEW LOOKING EAST. NOTE AN ABUNDANCE OF EXCELLENT WATER.
7. A BUNCH OF GOATS ON LITLE RIVER, 1916.

Photographs Nos. 1, 2, 5, 6, and 7, by E. S. Perry. No. 3 by C. W. Honess. No. 4, by Rolfe Engleman




MAP SHOWING CLASSIFICATION OF LANDS
IN SOUTHERN
OUACHITA MOUNTAINS
in South-eastern Oklahoma.
Scale
0 1 2 3 4 5 10 MILES.
LEGEND.
Unallotted agricultural lands,
mapped by the Department of the Interior
Agricultural lands,
now under cultivation (chiefly allotted to Indians)
mapped by C.W. Honess, Field Geologist - Okla. Geol. Survey.
Grazing and timber lands,
unsuited to agriculture, mapped in part by the
Dept. of the Interior and in part by C.W. Honess
Gulf Coastal Plains region,
practically all agricultural lands.
OKLAHOMA GEOLOGICAL SURVEY.
C.W. Shannon, Director.
Norman, Okla
1921.
R.19E.
R.20E.
R.21E.
95°
R.22E.
R.23E.
R.24E.
R.25E.
R.26E.
94°30'
R.27E.
34°30'
T.1N.
T.1S.
T.2S.
T.3S.
T.4S.
T.5S.
T.6S.
ARKANSAS
LE FLORE Co.
PUSHMATAHA Co.
MC. CURTAIN COUNTY
CHOCTAW Co.
Cow Creek
Beach
Smithville
Watson
Bethel
Buffalo
Cr.
River
Mountain Fork
Sherwood
Glover
Hochatown
Alikchi
Opah
Corinne
Sobol
Spencerville
Little River
Bismark
Eagletown