OKLAHOMA GEOLOGICAL SURVEY
CHAS. N. GOULD, Director

ROBERT H. DOTT

BULLETIN No. 38

GEOLOGY OF BEAVER COUNTY OKLAHOMA

By
CHAS. N. GOULD AND JOHN T. LONSDALE

FOSSIL LEAVES FROM BEAVER COUNTY
By
E. W. BERRY

AGRICULTURE OF BEAVER COUNTY
By
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By
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NORMAN
AUGUST, 1926.

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FOREWORD

THE OCCASION

During the second special session of the Ninth Legislature of the State of Oklahoma, held in 1924, an appropriation was passed for the maintenance of the Oklahoma Geological Survey, providing among other things for an agricultural and soil survey of Texas and Beaver counties. This appropriation of only $500.00 for the two counties, included both salaries and field expenses. No provision was made for printing.

It is obvious that the amount of money thus appropriated was totally inadequate to secure data for a complete agricultural soil survey report on one of the counties, much less two. After canvassing the situation thoroughly it was decided that taking everything into consideration the best use that could be made of the funds which had been appropriated for a specific purpose would be to prepare and print a geological report on the geology of both counties, with particular reference to agriculture, and publish these reports as regular bulletins of the Survey. On account of the small appropriation available it was found impossible to do little more than conduct a reconnaissance survey to determine certain salient factors and to supplement the information thus gained with other available data in the preparation of the report.

The senior author who had been appointed Director of the Oklahoma Geological Survey assumed his duties July 1, 1924. He secured the cooperation of the junior author, then assistant professor of geology in the University of Oklahoma, in preparing the report.

Trips were made to the two counties, Texas and Beaver, the general outlines of the geology were determined, and the first draft of the reports made. Later the junior author again visited the two counties checking and verifying the observations. The report on Texas County, written largely by the junior author, has already been published as Bulletin No. 37 of this Survey. This paper was written largely by the senior author, but both reports have been revised and corrected by both authors.

ACKNOWLEDGMENTS

In the preparation of the present report the authors have called to their assistance for the preparation of special chapters, two citizens of Beaver County, namely Mr. F. C. Tracy of Beaver, a member of the constitutional convention and for forty years a citizen of the county, who has written the chapter on History, and Mr. Ernest Slocum of Beaver has written the chapter on Agriculture. The sincere thanks both of the Oklahoma Geological Survey and of the people of Oklahoma are due these

authors, both busy men, for their assistance in the preparation of the report.

Other citizens of Beaver County have also assisted, notably Messrs. Robt. H. Loofbourrow, R. B. Loofbourrow, F. D. Wood, and W. B. Hanly, of Beaver, and Hon. Roy Coppock of Gate, member of the legislature, representing Beaver and Harper counties, and many others. Only the most courteous treatment and the most friendly cooperation was afforded the authors while engaged in the work of collecting and preparing data for this report.

PREVIOUS GEOLOGICAL WORK IN BEAVER COUNTY

The first geological work in Beaver County, so far as known, was accomplished in June 1903 by the senior author of this report. At that time he was in the employ of the United States Reclamation Service studying the water conditions of the Great Plains. A party including four young men then students in geology at the University of Oklahoma outfitted at Woodward and worked northwest following the Cimarron and North Canadian rivers to their sources. The men were Chas. T. Kirk, Pierce Larkin, Chester A. Reeds, and Charles A. Long. Camps were made near Gate, Beaver, and Boyd in what is now Beaver County.

As the result of this reconnaissance and of other subsequent work in the region a brief statement of the geology of Beaver County was included in a government report published in 1905.[1]

The description of old Beaver County, now including Beaver, Texas and Cimarron counties, may be found on pages 131 to 133 of that report. The map of the territory including Beaver County is Figure 1 of this report.

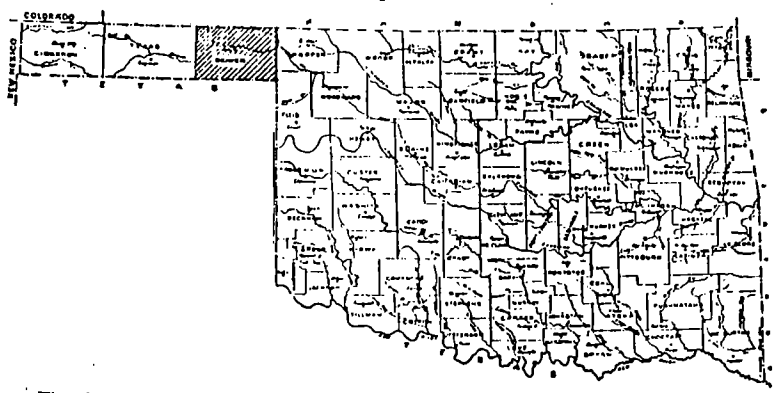


Fig. 1. Index map of Oklahoma showing the location of Beaver County.

1. Gould, Chas. N., Geology and Water Resources of Oklahoma. U. S. Geol. Survey Water-Supply Paper, No. 148, 1905.

GEOGRAPHY

LOCATION

Beaver County is the easternmost of the three counties which make up the Panhandle of Oklahoma, which lies immediately north of the Panhandle of Texas. The south border of the county is the Oklahoma-Texas line, being 35 degrees 30 minutes north latitude, and the north boundary is the line between Kansas and Oklahoma, 37 degrees north latitude. The east line is the 100th meridian, while the west line is about 3 miles east of the 101st meridian.

Beaver County is rectangular in shape. The length from east to west is about 52 miles, and the width from north to south is 34 miles. The approximate area of the county is 1,768 square miles.

LAND SURVEYS

The land in all the Panhandle country of Oklahoma is surveyed from a different principal meridian and base line than that of the remainder of the state. For the greater part of Oklahoma the Indian Meridian is used, and the Initial point, where the Indian Meridian crosses the Base line, is located near old Fort Arbuckle, 6 miles west of Davis, Murray County.

In the Panhandle counties the land was surveyed from the Cimarron Meridian which is the west line of Cimarron County, this being the line between Oklahoma and New Mexico. The Base line for the region is the south line of the Panhandle counties, so that all the land in Beaver, Texas, and Cimarron counties is numbered north from the Base line, and east from Cimarron Meridian.

This fact often leads to confusion, for it will be readily understood that unless the particular meridian is indicated, a tract of land described as being located in T. 5 N., R. 23 E., might be either on the flat plains of Beaver County, or in the rugged Winding Stair Mountains of LeFlore County.

TOWNS

Beaver County, being very largely an agricultural region with a scattered population, has no large towns. The oldest town in the county, also the largest, is Beaver City, the county seat. This town was the county seat of old Beaver County in territorial days. The population in 1920 was 920.

Forgan, for many years the terminus of the Wichita Falls Northwestern Railroad has a population of 582. Other towns

are Gate, near the eastern margin of the county with 309 people. Knowles and Turpin were recently established at a temporary terminus on the Beaver, Meade, and Englewood Railroad now being built to Hooker, Texas County.

TRANSPORTATION

The most important railroad of Beaver County is the Wichita Falls Northwestern, a branch of the Missouri, Kansas and Texas system, which runs from Wichita Falls, Texas, northwestward across the western counties of Oklahoma. This road has connections with the Santa Fe at Woodward and with the Rock Island at Elk City. From Forgan, the terminus of this railroad, a short line, the Beaver, Meade & Englewood runs to Beaver City and has recently been constructed 20 miles west from Forgan to Turpin near the west line of the county. The northwest corner of the county is served by the Rock Island railroad, at Liberal, Kansas, and Tyrone, Oklahoma, the northeast corner by the Santa Fe railroad at Englewood, Kansas, and the southern tier of townships by towns on a branch of the Santa Fe which crosses the northern part of the Panhandle of Texas.

PUBLIC ROADS

There are no better natural roads anywhere in the United States, than the roads of the High Plains. The mixture of sand and clay in the soil makes these roads hard and firm practically all year. The only exceptions to this rule are the roads in the breaks and in the Sand Hills. Roads have been opened on practically all section lines.

Several of the main thoroughfares have been put to grade, drained, otherwise improved, and marked by the State Highway Department. Oklahoma State Highway No. 11, the main route to Colorado, runs east and west through Beaver County passing through Gate, Knowles, and Forgan, to Hooker, Texas County.

TOPOGRAPHY

RELIEF

The word relief as used by geologists and physiographers means unevenness of land surfaces. A country of little relief is one in which the surface is smooth such as a plain or broad valley. A country of great relief is one with mountains, hills, and valleys. Beaver County is a good example of an area of little relief.

Beaver County may be thought of as a rectangular block with its greatest distance east and west, cut out of the High Plains. The surface which slopes gently to the east is not quite even, but is interrupted by two major stream valleys of the Cimarron and of the Beaver, which will be discussed later.

The total amount of relief, that is the difference in elevation between the bottom of the valleys and the flat upland is approximately 200 feet.

Points of elevation in the county as supplied by C. J. Turpin, vice-president and general manager of the Beaver, Meade & Englewood Railroad Company, and F. Ringer, chief engineer of the Missouri, Kansas and Texas Railroad Company, are as follows: Gate, 2,172 feet; Knowles, 2,177 feet; Forgan, 2,675 feet; Beaver, 2,500 feet; Turpin, 2,770 feet. The elevation of Liberal, Kansas, which is located immediately north of the northwest corner of Beaver County is 2,851 feet.

From these figures it will be noted that the slope of the surface is approximately 12½ feet per mile to the east.

TYPES OF TOPOGRAPHY

The topography of the county may be divided into four general types, namely, High Plains, Sand Dunes, Breaks, and Valleys. Geologists believe that at one time during a former geological age all the territory now included in Beaver County consisted of a vast sloping plain, with a comparatively smooth and even surface, untouched by drainage channels. Practically all the unevenness of surface now found in the county has been caused by the erosive action of water, and the cutting of streams, this action having given rise to the many valleys, large and small which now interrupt the structural flat surface of the plain.

HIGH PLAINS

The High Plains of the western part of the United States, of which Beaver County is a part, present a peculiar form of

topography. It is believed that the material, chiefly sand and gravel, which now composes these plains was originally derived from the Rocky Mountains during Tertiary time. This material was then carried out on the plains by streams of desert habit and deposited as a vast debris apron sloping gradually away from the mountains. Present streams are cutting into this vast sheet of sedimentary material. A number of the larger rivers such as Platte, Arkansas, and South Canadian which rise in the Rocky Mountains have cut valleys entirely across the Plains and in many cases have also cut down through the Tertiary blanket to the red rock beneath. Other streams like the Red, Beaver, North Canadian, Cimarron, Smoky Hill, and Republican do not rise in the mountains, but on the Plains and have also cut valleys across the area occupied by Tertiary deposits. Two of these latter streams, Beaver and Cimarron cross Beaver County.

It is the work of these rivers, and in a still larger degree of their numerous smaller tributaries, that has destroyed the former flat and apparently level surface of the Tertiary plain. In certain regions like the Llano Estacado of Texas and considerable parts of western Kansas and Nebraska, there are areas sometimes occupying entire central counties "unscoured by drainage, yet standing in relief." The considerable number of small streams, tributary to the larger rivers, cutting headward throughout the region, are slowly yet constantly at work dissecting this flat plain, and given time, will eventually whittle it away. The flat areas remaining throughout the plains region simply represent those areas where stream erosion has not yet been effective.

In Beaver County there remains but one considerable area of undissected upland. Some eight townships in the northwestern part of the county extending from the vicinity of Forgan west to Texas County, and from the sand hills north of Beaver Creek, to the Kansas line, may be included in the original flat upland topography.

Rothrock[1] has written very concise descriptions of the general topography of the uplands of this part of the State. The authors feel that they cannot improve on the descriptions and for that reason they are quoted here.

> "Character of Surface: This plain is often spoken of as being "flat as a floor," which in a way expresses its character, but the general flatness is broken by minor features which may be divided into three groups, (1) the broad undulations, (2) the basins, and (3) the sand dunes.

1. Rothrock, E. P., Geology of Cimarron County, Oklahoma: Oklahoma Geol. Survey Bull. 34, pp. 16-19, 1925.

> "Undulations[1]: Viewed carefully, the surface of the plain is seen to be composed for the most part of broad, low hills separated by very broad, shallow depressions, giving an impression somewhat similar to the waves and troughs of a gently heaving sea. The relief in this topography is 15 to 20 feet, but as the crests of the hills are 1 to 3 miles apart, the slopes are extremely gentle. Here and there rises a ridge-like hill a few miles long, which from a distance and from certain positions appears as a distinct topographic feature but so gentle are its slopes that it is almost imperceptible to one crossing it. One of these hills about 2 miles south of Boise City is composed for the most part of sandy loam, and another in the north half of secs. 32 and 33, T. 3 N., R. 8 E., is capped by Tertiary limestone. In a few instances, as in sec. 22, T. 3 N., R. 9 E., small gullies have developed in the hills which, though quite definite toward the head, spread out and finally merge into the general surface of the hollow into which they flow. These streams are very few, however, and the surface presents simply a series of indefinite, undrained sags and swells with no apparent definite relation to each other.
>
> "Unequal stream deposition, settling of sediments, and wind erosion are the three processes which have developed this surface. It is probable that each of them played an important part in its formation, though the exact relative importance of each is as yet a matter of conjecture.
>
> "The surface of the Great Plains was developed on the Late Tertiary formation which formed a sheet of rock waste spread on an arid land surface by streams coming from the Rocky Mountains, in late Tertiary time. As the process is described by Johnson,[2] a fairly even sheet of debris was deposited, thinning from its source to its outer limit. In such a sheet it is hardly to be expected that the surface would be a geometrical plane, for from the nature of stream deposition more material would be deposited in some places than in others. Such differences would make slight elevations and depressions in the surface which might be accentuated by later processes.
>
> "Another factor, settling of the sediments, may take place either during deposition or after it has ceased. There are some and these will be discussed under the origin of basins. Settling may be caused by a compacting of sediments, due to the settling of the particles, crowding them together so that the mass occupies less space, or it may be due to the dissolving of soluble materials in the rocks which allows the insoluble portions to settle into the cavities so formed. If more of the limestone of the Later Tertiary formation was dissolved from some places than from others, the overlying sands and clays would settle, leaving the unevenness shown on the surface.
>
> "The last factor, the wind, is operative a considerable part of the time, and its action is effective in dry times, as may be seen on any of the sand flats of the main streams, or on patches of earth from which vegetation has been removed. Even in pastures the soil is often blown away from the roots of the grass tufts so that they stand up on little mounds one to three inches high. It is possible that the action of the wind on bare spots, or on light

1. Johnson, W. D., The High Plains and their utilization: U. S. Geol. Survey, 21st Ann. Rept. pt. IV, pp. 615-621, 1899-1900.
2. Johnson, W. D., Op. cit.

sandy spots when the vegetation would not form sod might cause depressions of the sort described. It is not probable, however, that the wind alone was responsible for depressions formed by other causes. Loose material from the depressions was removed and deposited on the top and lee sides of hills which were able to hold it because of their covering of vegetation.

"Basins. Scattered over the plains are saucer-like depressions of various sizes. The smallest are circular in ground plan, one or two hundred feet across and but two or three feet deep. From this size they range to great depressions 2 miles across and 50 to 150 feet deep. The circular outline and saucer-like shape usually persist until the depressions reach a size of a quarter to a half mile across and 20 to 30 feet in depth. Larger basins, though roughly circular in outline are in most cases more irregular in shape. One basin, about 2 miles west of Boise City in T. 3 N., R. 5 E., has the form of a trough 2 miles long and but a little more than a quarter of a mile wide, and a high ridge along its east side. The bottoms of the basins are flat and are covered with a deposit of black clay which has been washed from the soil on the slopes and has settled in the temporary ponds which form after heavy rains. In a few of the basins there is water for a large part of the year. In the bottom of some of the larger basins there are two or more depressions in which water accumulates.

"There is little regularity in the distribution of these basins except that they do not occur outside the area in which the Tertiary rocks are at the surface, nor are they found in the sand dune areas. With these exceptions they are scattered over all parts of the county. The largest number are on that portion of the plains between Cimarron and Beaver rivers in the central and western parts of the county, and there is a group on the south of Beaver River in the neighborhood of Wilkins Postoffice in T. 1 N., R. 4 E. There are only a few scattered basins outside of this area south of Beaver River and only a few in the eastern part of the county in Ranges 8 and 9 East. It is not certain that this distribution has any significance, but it may throw some light on the character of the underlying rocks if the accepted theories for their origin are correct.

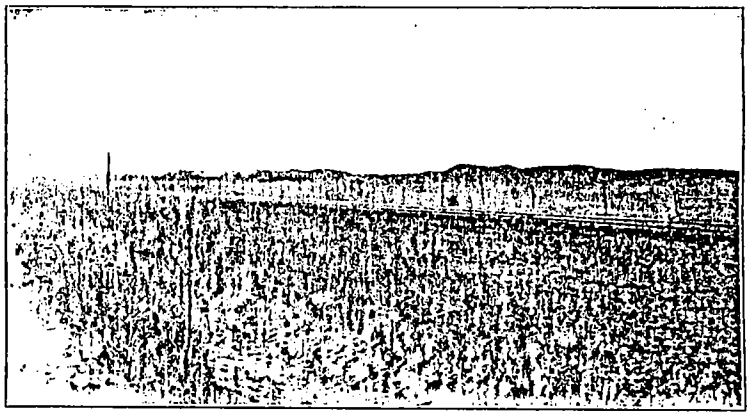
"The popular notion is that the basins were formed by the tramping and wallowing of the great herds of buffalo which once roamed these plains, and they are still called "buffalo wallows." It is possible that some of the shallower ones were formed in this way, but it would hardly be possible to account for basins a mile or two across and 80 to 150 feet deep in such a manner, nor for the elongate shape of such a depression as that 2 miles west of Boise City.

"Johnson[1] ascribes the origin of the basins to settling of the sediments due to compacting, to solution of the lime from the underlying "mortar beds" of the Tertiary rocks, and to solution of the beds of gypsum in the underlying red beds. The shallow depressions he ascribed to the first and second causes, and the large basins to the last. He found in many instances cracks in the soil around the rim, roughly concentric with the center of the basin, some of which were formed within the memory of the inhabitants of the country. This shows that there was movement of soil and rock material toward the center of the basin. He also found that in the bottom of the large basins the red beds are very near the surface, and in one case, that of the salt well near Meade, Kansas, the settling had been due directly to solution of the underlying salt and gypsum. Generalizing from such evidence he concludes that all the basins of the Great Plains were formed in this manner. This explains their peculiarities better than other theories which have been advanced. The buffalo would be attracted to such depressions because of the water they contained and there is no doubt that trampling and wallowing tended to deepen them. It is also probable that the wind has played a part in their formation, for in some instances there is an area of sand to the east of the basin which does not appear to the west and south. As the prevailing winds in this region are southwesterly the sand appears to have been blown out of the basins and deposited along the eastern side near the rim.

"In summary it may be said in the light of present evidence it is believed that the basins are the result of settling of the sediments due to compacting, and the solution of the underlying rocks with the work of the wind and the trampling of the buffalo as contributing causes."

1. Johnson, W. D., Op. cit. pp. 703-704.

PLATE I.



SAND DUNES ON THE ROAD BETWEEN FORGAN AND BEAVER.

SAND DUNES

The sand dune type of topography in Beaver County is confined chiefly to the north slope of Beaver Creek. The dune area occupies a strip, or zone, paralleling Beaver Creek extending the entire length of the county, east and west, a distance of over 50 miles. The width of the area varies from 2 to 8 miles averaging perhaps 4 miles.

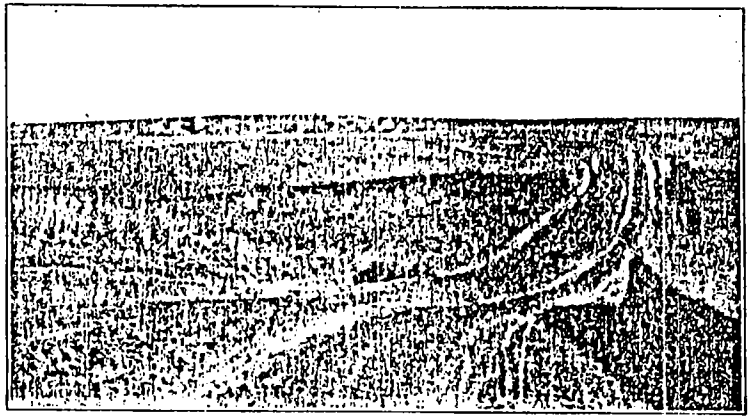
In most places these sand hills are grass-covered with tall blue stem predominating. Sage brush and yucca also occur

plentifully. There is considerable timber chiefly hackberry. In certain localities the sand hills are barren of vegetation, being composed of white or yellowish sand, which is blown by the wind. Several of these dunes are shifting northward. In size the dunes vary up to 20 or 30 feet in height. To the north they decrease in size, and finally merge with the flat upland prairie.

BREAKS

The authors of this report have described the breaks in Texas County west of Beaver.[1] Inasmuch as the same conditions occur in both counties the descriptions used in Texas County are used here.

PLATE II.



HEAD OF A "BREAK" ON KIOWA CREEK, SOUTHEASTERN BEAVER COUNTY.

"Under this term is included the rough, broken land lying between the essentially level lowland, or valley flats, and the essentially level uplands, or undissected stream divides. The term means, to employ the local usage, the place where the plain breaks into the valley.

"The breaks exist in the region because of the lack of gradual transition from plain to valley. As has already been shown, the edge of the valley is marked by steep slopes and often by an escarpment. If instead of this escarpment and steep slope a gradual slope existed, the breaks would represent a much smaller area than is now the case. In the wider valleys which are too young to have developed noticeable flats, the entire width of the valley will be rough and broken and will correspond to the definition given for breaks. In some cases where a narrow valley has several tributary gullies and ravines the whole area involved by them will be simply a succession of steep slopes and escarpments. It is such topography which throughout the High Plains region has come to be known as the breaks.

1. Gould, Chas. N., and Lonsdale, John T., The Geology of Texas County, Oklahoma: Oklahoma Geol. Survey Bull. 37, pp. 18-20, 1926.

"As stated above, the steep slopes and escarpments of the valley walls are responsible for the formation of the type of topography under discussion. These features, slope and escarpment, are due to the presence near the surface of a layer of hard, calcareous material, sometimes called caliche, and known locally as rim rock or cap rock. This material in almost all cases forms the steep escarpment of the region and because of its light color in outcrops can often be seen for miles."

VALLEYS AND DRAINAGE

It has already been stated that all the drainage of Beaver County is into two major streams, Cimarron and Beaver. Both of these streams belong to the drainage system of the Arkansas River.

Cimarron River. Cimarron River rises in Johnson Mesa, a flat-topped mountain held up by a sheet of volcanic lava, in northeastern New Mexico, and flows east through a broad canyon which it has carved among the rocks for a distance of 75 miles, entering Oklahoma in the northwest corner of Cimarron County. After flowing for nearly fifty miles in this county, the river crosses into the southeast corner of Colorado, thence into southwest Kansas, and again flows into Oklahoma at a point a short distance east of the center of the north line of Beaver County. In this county the Cimarron flows east for about 20 miles, being at no place at a greater distance than four miles south of the Kansas line, then flows into northwestern Harper County across the corner of that county, again for a short distance in Kansas before finally, for a third time, entering Oklahoma.

In Beaver County the Cimarron flows in a broad shallow valley averaging about 8 miles wide and 150 feet deep. The channel of the Cimarron is typical of that of the streams of the Plains, being sand-choked with low sandy banks. For a considerable part of the year the stream carries relatively little water but during flood time the river overflows its banks and covers the bottomlands. For months at a time, however, the channel may be almost dry with, at most, a small trickle of water running in numerous braided channels.

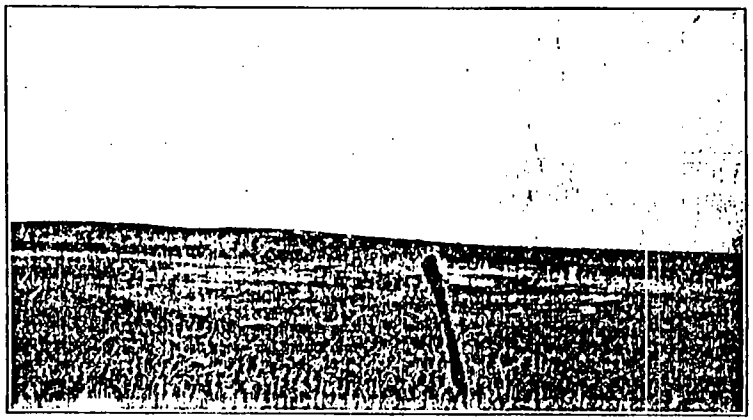
Several short tributaries of the Cimarron rise in the flat upland of central Beaver County and flow north to join the river. Horse Creek north of Gate and Taintor Creek north of Knowles are the largest of these tributaries. The divide between the headwaters of these creeks flowing north into Cimarron, and the headwaters of the creeks flowing south into Beaver Creek is traversed by the Wichita Falls, Northwestern Railroad.

Beaver Creek. Beaver Creek (sometimes called Beaver River) is formed in southwestern Cimarron County by the junction of two creeks, Ceineguilla de Burro (Spanish for Burro Lake), usually spelled Seneca, and Currumpa. The latter stream, which is the larger, rises on the east slope of Sierra Grande, a volcanic peak near Des Moines, Union County, New Mexico. From the point of junction the Beaver flows east practically the entire length of the Panhandle of Oklahoma. In Beaver County, Beaver Creek flows first northeast, thence east across the county, a distance not including minor bends and curves of about 55 miles. On leaving Beaver County, Beaver Creek flows southeast across the southwest corner of Harper County and into Woodward County where at Supply it joins Wolf Creek to form North Canadian River.

The general character of Beaver Creek is quite similar to that of the Cimarron. Both are typical Plains streams with broad, sand-filled channels and low sand banks. Beaver Creek is not so large a stream as Cimarron River. The width of the channel of Beaver from bank to bank averages perhaps 200 yards.

A number of tributary creeks empty into Beaver from the south. All these streams originate on the flat upland of the southern part of the county or across the State line in northern Lipscomb and Ochiltree counties, Texas. The largest of these streams is Kiowa Creek which crosses the southeastern corner of Beaver County and enters Harper County before uniting with Beaver Creek. Other of the more prominent streams flowing north into the Beaver are Mexico, Duck Pond, Clear, Home, Six

PLATE III.



BOTTOM LAND ALONG KIOWA CREEK, SOUTHEASTERN BEAVER COUNTY.

Mile, Dugout, Willow, Jackson, and Fulton. From the north Beaver Creek receives several tributary creeks which rise in the sand hills. The most important are Kidds, Negleys, Timber, and Sharps.

The greater number of the creeks tributary to Beaver are spring-fed and carry water for a considerable part of the year. The channels are usually sand-filled and during dry times the water sinks into the sand. These various valleys of the smaller streams average 50 to 100 feet deep below the level of the divides. The main valley of Beaver lies about 175 feet below the original plains level.

GEOLOGY

GENERAL STATEMENT

The geology of Beaver County is not complex. The formations represented in the county are few in number, and simple in arrangement. The records of the rocks do not show any great or violent upheavals, or any intense folding or faulting, such as have occurred in many parts of Oklahoma. Neither has erosion or weathering worn down the surface to the extent shown in many regions. The surface rocks of the county belong to three (possibly four) geological ages, namely Permian, possibly Cretaceous, Tertiary and Quaternary. These formations will be described in the order named.

PERMIAN ROCKS

General Statements Regarding the Permian. The greater part of western Oklahoma, along with the Panhandle of Texas and western Kansas, is occupied by a great series of red clay shales of Permian age, usually spoken of as the red beds. Sometimes these red beds are exposed on the surface and sometimes they are covered by a blanket of younger rocks. In Beaver County, as will be shown later, the red beds are exposed chiefly along Beaver Creek and certain of its southern tributaries where erosion has removed the blanket of higher (Tertiary) formations.

Taken as a whole the Permian red beds of the Great Plains region consist of a thick mass of red clay shale, interstratified with which are certain beds of sandstone, dolomite, gypsum and rock salt. The thickness of the formation varies up to 3,500 feet. In Beaver County as shown by logs of deep wells the red beds are approximately 1,500 feet thick.

Farther east in Oklahoma where the red beds have been studied quite carefully for many years and where a number of separate and distinct formations are exposed on the surface, the

following formations beginning at the top have been named and described.

Table of Oklahoma Red Beds Formations[1]

NAME	Approximate Thickness
Quartermaster formation. Red sandy clay	300 feet
Cloud Chief gypsum. Massive white gypsum interbedded with red clay shale	125 feet
Day Creek dolomite. Hard, brittle, white dolomite, sometimes in two ledges, separated by red clay shale	6 feet
Whitehorse sandstone. Massive to cross-bedded, fine red sandstone	200 feet
Dog Creek shales. Red clay shales and thin beds of dolomite	200 feet
Blaine gypsum. Massive white gypsum in ledges, separated by red clay shales	100 feet
Chickasha formation. Red clay shales with gypsum	200 feet
Duncan sandstone. Massive red or gray sandstone separated by shale beds	200 feet
Hennessey shales, red shales	400 feet
Garber sandstone, red sandstone and shales	500 feet
Wellington formation, red clays and sandstone	500 feet
Stillwater formation, red clays and sandstone	800 feet

In Beaver County only one of these Permian red beds formations, the Cloud Chief, is definitely known to be exposed on the surface. The geologic map shows the outcrops of these beds and it will be seen that the principal exposures of the red beds are along Beaver Creek and its southern tributaries. Red beds also appear along the Cimarron in the northeast corner of the county.

When the senior author in 1903 and the years following first attempted to work out the geology of this part of Oklahoma there were several points of stratigraphy and correlation which were obscure. Not everywhere are the red beds exposed. Large areas of western Oklahoma are covered by Tertiary deposits and sand hills, so that it is often impossible to connect scattered exposures with other outcrops of known age.

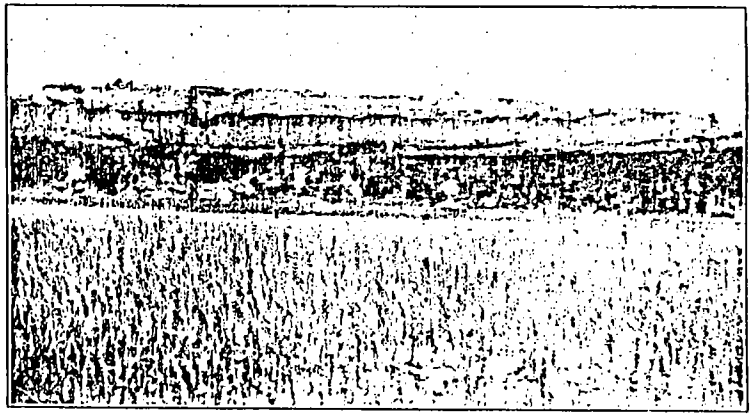
For these and other reasons the Permian rocks along the south side of Beaver Creek in Beaver County were designated as "red beds of uncertain relations," and until the present time this designation has not been changed.

Cloud Chief Formation. For reasons which need not be discussed at this time it has been found advisable to revise the classification employed in Water Supply Paper 148. A new formation, the Cloud Chief gypsum[1] has been recently intro-

1. Gould, Chas. N., A new classification of the Permian red beds of southwestern Oklahoma: Am. Asso. Pet. Geol. Bull., vol. 8, No. 3, p. 325, 1924; also Aurin, F. L., Officer, H. G., and Gould, Chas. N., Subdivision of the Enid formation: read before the meeting of the Am. Asso. Pet. Geol., March, 1926.

duced, this being the same as the "eastern area" of the "Greer" as these terms were formerly employed.

PLATE IV.



PERMIAN RED BEDS WITH GYPSUM LEDGES. SEC. 8, T. 3 N., R. 24 E., C. M.

The Cloud Chief is the higher of the two gypsum-bearing horizons of the Permian red beds. At its type locality at Cloud Chief, Washita County, Oklahoma, it consists of massive, white rock gypsum 100 feet or more thick. At most places outside the type locality, however, the Cloud Chief is made up of two or more ledges of gypsum separated by red clay shales.

From the type locality in Washita County, the Cloud Chief may be followed north across Washita, Custer, and Dewey counties, crossing the South Canadian River near Taloga. Gypsums of this formation are known to be exposed south of the North Canadian River near Richmond and Mutual in southern Woodward County. Between Woodward and Supply the Permian is covered by deposits of later age, chiefly Tertiary, but the gypsum is again exposed in the bluffs south of Beaver Creek between May and Laverne in southwestern Harper County, and from this point the formation may be traced almost continuously to connect with exposures along the south side of Beaver Creek, practically all the way across Beaver County.

In Beaver County it is to be noted that the Permian red beds are conspicuously exposed along the creeks emptying into Beaver from the south, while the north slope of Beaver Creek is covered with sand hills. This fact is in strict conformity with conditions farther east in Oklahoma. It has long been a matter of comment among geologists that the south slopes of

1. Gould, Chas. N., A new classification of the Permian red beds of southwestern Oklahoma. Bull. Am. Assn. Pet. Geol. Vol. 7, No. 3, pp. 337-339, 1924.

the greater number of larger streams in western Oklahoma were canyon-cut into the red beds, while the north slopes were covered with sand hills. Conditions in Beaver County differ from conditions farther east only in degree and not in kind. To say it differently; wherever in Beaver County the Tertiary deposits are thick, and where erosion has not been able to remove them, the exposures of Permian are consequently less conspicuous. Practically every creek emptying into Beaver from the south in Beaver County has exposures of red beds. Along some creeks there are bluffs 20 to 40 feet high with red shale and gypsum, while along other creeks only scattered exposures of red may be seen. Some of the streams containing the more conspicuous exposures of Permian are Camp, Kiowa, Duck Pond, Clear, Home, Six Mile, Dugout, Willow, Jackson, and Fulton. A typical exposure on sec. 8, T. 3 N., R. 24 E., 9 miles southeast of Beaver City and one which slightly modified might be served for almost any part of the area is given herewith. Plate IV is a photograph of this section.

Section of Red Beds, Sec. 8, T. 3 N., R. 24 E., Beaver Co. Okla.

	Feet
Gypsum	1
Shale, gypsiferous	1
Gypsum, massive	3
Shale, gypsiferous, red	3
Gypsum, massive	4
Shale, gypsiferous, red	1
Gypsum, massive	2
Shale, red, sandy	12
	27

During the past few years there has been much detailed work done in this region by geologists of various oil companies. These men have come to recognize the following generalized section for the district southeast of Beaver City.

Generalized Section of the Permian Red Beds Southeast of Beaver City, Beaver County, Oklahoma

	Feet
Tertiary rocks	0-400
Cretaceous rocks	0- 75
Permian rocks	
Loose red shales	5- 50
Shaly gypsum	2-
Red shale	4-
Gypsum	3-4
Red shale	15-20
Gypsum	3-4
Red shale	2-4
Gypsum	3-4
Red sandy shale	3-4
Massive gypsum	5-6
Red shale	2-3
Gypsum	2-4
Loose unconsolidated red shale with thin bands of gray shale	20-30

From a study of this section it will be noted that, according to the observations of the petroleum geologists who have worked in the region, the total maximum exposure of the Permian is about 140 feet, of which a maximum of 22 feet is gypsum, exposed in five ledges. One who is familiar with conditions of the red beds of western Oklahoma and Texas will scarcely fail to recognize that this alternation of red shales and thin gypsums is typical Cloud Chief stratigraphy. It is not like the stratigraphy of any other part of the red beds series in Oklahoma or Kansas and most certainly not like the Triassic of the Plains.

The same red beds which occur in Beaver County, containing the same gypsum ledges, may be traced practically uninterruptedly into southeastern Texas County, where along Palo Duro Creek a mile or two east of Range post office there are exposures of red clays with interbedded gypsum more than 50 feet thick. It is the present belief of the senior author that the red beds exposed along Beaver Creek near Redpoint and on Tepee Creek western Texas County, as well as those along the Cimarron River northeast of Boise City, Cimarron County, are also of Permian age and not of Triassic age.[1]

The geological history of the Permian of this part of the Great Plains is not yet thoroughly understood. Enough is known, however, that the following generalized statement may safely be made.

Permian deposition represents a long period of time during which sediments were laid down chiefly in shallow seas. The climate was doubtless arid. The land oscillated, sometimes being above the water, sometimes being submerged. Inland seas were formed, which afterward dried up, as shown by the vast deposits of gypsum and salt. At times the land stood out of the water, and desert conditions must have obtained, as witness the sand dune cross-bedding in the Whitehorse sandstone. Occasionally marine, or at least brackish-water, conditions were present as shown by the ammonite and pelecypod fossils associated with the Blaine gypsum.

The source of the materials making up the red beds has not yet been definitely located. There are those who look to the Arbuckle and Wichita Mountains for this material. Others would seek its source in the now buried Amarillo Mountains,

1. Gould, Chas. N. and Lonsdale, John T., Geology of Texas County, Oklahoma, Okla. Geol. Survey Bull. No. 37, pp. 25-26, 1926.

or granite ridge of the Texas Panhandle; while still other geologists look to the Ancestral Rockies of eastern Colorado and New Mexico for the source of these formations. Possibly when all data have been secured and the final word has been written, it will be found that all three of these sources have been drawn on for the material which now constitutes the Permian red beds of western Oklahoma.

CRETACEOUS ROCKS

After the close of the Permian period that part of North America now represented by Beaver County was raised above the level of the sea, and so far as we now definitely know has never again been totally submerged. During the next two geological periods the Triassic and the Jurassic, this part of the country stood out of the water and the agents of denudation, rain, wind, frost, and heat, beat upon these Permian rocks and great masses of them were carried away. Valleys were worn down, hills were left standing, and the topography of the region probably took on a rough and broken appearance.

During the next geological period the Lower Cretaceous (or Comanchean) there was a lowering of the surface over a considerable part of the Great Plains area, and the sea swept north over parts of Texas and southern Oklahoma till it lapped against the south flanks of the Arbuckle and Ouachita Mountains. At this time the western half of what is now the State of Kansas was under water. At one time this sea transgressed over a considerable part of what now is western Oklahoma, as is shown by deposits of shell rock found scattered over the prairies in this region. These rocks, which are chiefly limestone, made up largely of fossil oyster shells, may be found along a north and south line about one county wide chiefly in Washita, Custer, Dewey, Woodward, and Harper counties, connecting with a large area of Comanche-Cretaceous rocks typically exposed at Belvidere, Kansas. Fred M. Bullard, R. L. Clifton, and others who have studied the fossils in the scattered "shell rock" in western Oklahoma find that they represent the Washita stage of the Comanche-Cretaceous of Texas.

Rocks of the same age containing similar fossils occur in Cimarron County, Oklahoma.[1] The formation in which they are contained in this county is known as the Purgatoire formation and consists largely of sandstone and shale. The fossils found in the Purgatoire of Cimarron County are the same as those from the Washita stage of Texas and southern Oklahoma, from the scattered "shell rock" of west-central Oklahoma, and from

1. Rothrock, E. P., Geology of Cimarron County, Oklahoma. Okla. Geol. Survey Bull. 34, pp. 37-49, 1926.

the Comanche-Cretaceous beds of the Belvidere region of southern Kansas.

Oyster shells of Comanche-Cretaceous age have been found in several places in Beaver County. It has been thought that beds of "shell rock" like those in counties farther east in the State occurred in the county, and on the map prepared by the senior author, published in Water-Supply Paper No. 148, U. S. Geological Survey, 1905, two localities were given in Beaver County where these "shell beds" were supposed to occur. One of these localities was along Clear Creek near the center of T. 3 N., R. 24 E., and the other along Duck Pond Creek in the southeast corner of T. 3 N., R. 25 E., and the northeast corner of T. 4 N., 25 E. The present recollection of the senior author is that he did not personally see these exposures but that the localities were described to him by others who had found fossil shells at these places.

So far as we have been able to learn no one since that time has reported the presence of "shell rock" in Beaver County. The following excerpt from the notes of the junior author, under date of June 4, 1925, discusses this point.

> "Although diligent search was made, no evidence of the Cretaceous oyster beds mapped in Gould's Water-Supply paper was found, none of the inhabitants of the region in which the shells were supposed to be found knew of them, and no exposures were found after traversing the area."

Throughout all this region scattered fragments of shells and blocks of sandstone containing shell impressions are found near the base of the Tertiary rocks, to be described later. In Texas County, near Redpoint, the authors found blocks of sandstone weighing sometimes as much as 100 pounds, containing Cretaceous fossils. These blocks were evidently of Purgatoire age, having been carried from the northwest during Tertiary time and deposited on the eroded surface of the Permian red beds.

For the present it must remain an open question whether or not beds of "shell rock" of Cretaceous age are actually present in Beaver County. To state it differently, it is not today known whether the transgression of the Cretaceous sea extended this far west. We know that this sea did occupy territory east, north and west of the county and there need be no surprise if further investigations show the presence of the typical "oyster shell bed" limestone in Beaver County.

LATE TERTIARY ROCKS

The most wide-spread surface exposure in Beaver County consists of a blanket of rocks chiefly sands and clays, of Ter-

tiary age, lying unconformably upon the underlying Permian red beds.

This formation or series of formations, is perhaps the most wide spread of any single surface formation in the United States. It extends from the Dakotas to southern Texas and from the base of the Rocky Mountains east to central Nebraska, Kansas, and Oklahoma, and occupies parts of North Dakota, South Dakota, Montana, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Texas, and New Mexico.

Although the formation is so extensive, being exposed in ten states, and although a number of geologists have studied the rocks in each of these states, there remains much to be learned about them. The character of the beds renders them difficult to work, and because of their wide areal extent in so many states, it so happens that no one state cares to spend money in working out the details of the problem. Since the beds show very little, or perhaps no surface structure there is no incentive for petroleum geologists to spend time on them. They contain few products of economic value. Fossils, though known to be present, are usually very rare, and for that reason the paleontologist has passed them by. So it need not be considered strange that the problems connected with the Tertiary deposits of the Plains are little nearer solution today than they were a quarter century ago.

In 1906, the senior author of this report published a report entitled "The Geology and Water Resources of the Eastern Portion of the Panhandle of Texas,"[1] in which was set forth the general descriptions of the Tertiary. Inasmuch as Lipscomb and Ochiltree counties, Texas, described in that report, join Beaver County on the south, a description of the Tertiary formations in the Texas counties will serve equally well for Beaver County, Oklahoma, and further because of the fact that the government report has long been out of print and can usually be consulted only in the larger libraries, it has been thought wise to reprint here part of the description from that paper.

LITERATURE

Note: For extended discussions of the Tertiary rocks of various parts of the Great Plains the reader is referred to the following publications:

Cummins, W. F., Notes on the geology of northwest Texas: Fourth Ann. Rept. Texas Geol. Survey, 1893, pp. 190-203.

Dumble, E. T., Cenozoic deposits of Texas: Jour. Geol. vol. 2, No. 6, pp. 549-563, 1894.

Hay, Robert, Water resources of a portion of the Great Plains: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1895, pp. 569 et seq.

Haworth, E., Physical properties of the Tertiary: Univ. Geol. Survey, Kansas, vol. 2, 1897, pp. 247-284. Underground waters of southwestern Kansas, Water-Supply and Irrigation Paper U. S. Geol. Survey No. 6, 1897.

Darton, N. H., Report on the geology and water resources of Nebraska west of 103d Mer.: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 4, 1899, pp. 719-785. Also in Prof. Paper No. 17, U. S. Geol. Survey, 1903.

Darton, N. H., Rept. on the geology of the central Great Plains: Prof. Paper, U. S. Geol. Survey No. 32, 1905.

Johnson, Willard D., The High Plains and their utilization: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 4, 1901, pp. 601-741. Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 4, 1902, pp. 631-669.

1. Chas. N. Gould, U. S. Geol. Survey, Water-Supply Paper No. 154, 1906.

STRATIGRAPHY

"General Statement. After the deposition of the Permian and Triassic red beds in the Panhandle region the area was elevated and for a long period of time the land was extensively eroded. Farther south and west extensive deposits of Cretaceous rocks rest on the red beds, but in the part of the Panhandle under discussion Cretaceous formations are absent.

"Resting uncomfortably upon the eroded surface of the red beds throughout the region described in this paper are extensive deposits of the Cenozoic age—Tertiary or Quaternary—which make up the rocks of the High Plains. These formations, which consist largely of loosely consolidated clays, sands, and conglomerates, typically white, but varying locally into gray, buff, brown, or other colors, constitute the 'Tertiary grit' and the 'Tertiary marl' or 'mortar beds' of the Kansas geologists. In Nebraska, Mr. Darton subdivides the beds of approximately this age into the Arikaree and the Ogalalla. In the Panhandle of Texas Professor Cummins has distinguished four horizons, basing his classification upon the evidence afforded by vertebrate fossils obtained in the different beds and identified by Professor Cope.[1]

"The following table sets forth the names of the members as used by Professor Cummins, the geologic age, and the number of species Professor Cope found in each:

Vertebrate Fossils Distinguishing Four Horizons in the Panhandle of Texas

Period	Epoch	Formation	No. of Species
Quaternary	Pleistocene	Tule (*Equus* beds)	10
Tertiary	Pliocene	Blanco	16
	Transition	Goodnight	8
	Miocene	Loup Fork	17

1. Fourth Ann. Rept. Texas Geol. Survey, pt. 8, 1893, pp. 18-86.

"**Loup Fork Formation.** The term 'Loup Fork' has long been used to include a series of rocks, usually considered late Pliocene in age, which are extensively exposed on the Great Plains, particularly in Colorado, Nebraska, Kansas, Oklahoma, Texas, and New Mexico. The rocks consist largely of sands, clays, and conglomerates, the latter made chiefly of smooth water-worn pebbles presumably derived from the Rocky Mountains. The thickness of the deposits varies, but the maximum is several hundred feet. The Loup Fork beds constitute the lowest Tertiary formation known to exist in the Panhandle. According to Professor Cummins[1] these beds do not extend farther south along the eastern edge of the Llano Estacado than the Prairie Dog Fork of Red River. On Mulberry Creek, 12 miles west of Clarendon, where Cummins and Cope obtained the fossils identified by the latter, the Loup Fork beds are 30 feet thick and 'composed of alternating beds of bluish and almost pure white sand.' [2]

"**Goodnight Formation.** This division, named by Professor Cummins from the town in Armstrong County, Texas, consists of calcareous and arenaceous clays, sands, and heavy conglomerates. Lithologically, it is practically impossible to differentiate these beds from those of the Loup Fork or Blanco, and it is only by means of fossils contained in them that the beds are known to be of different age. Professor Cope[3] identified eight vertebrates from these beds and assigned them to an age intermediate between the Loup Fork and the Blanco.

"Professor Cummins states that the Goodnight beds have extensive development south of Mulberry Creek. The maximum thickness as given by him is approximately 150 feet.[2]

"Dall,[4] on the authority of Dumble, has called these beds Palo Duro. He classes them as transitional between the Miocene and Pliocene, and says: 'These beds, identified in western Texas by Scott as transitional, also had the absurd name of Goodnight applied to them.'

"Certainly no one who has ever been in that portion of the Panhandle would consider the name of Goodnight as absurd, for it is the name of one of the largest of the old-time cattle ranches, as well as of a good-sized town, the seat of a flourishing college.

1. Cummins, W. F., Notes on the geology of northwest Texas: Fourth Ann. Rept. Texas Geol. Survey, 1893, p. 304.
2. Cummins, Op. cit. pp. 201-202.
3. Cope, E. D., Vertebrate fauna of the Loup Fork beds: Fourth Ann. Rept. Texas Geol. Survey, pt. 8, 1893, p. 46.
4. Dall, Wm. H., Table of North American Tertiary horizon, etc.: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1898, p. 338.

"**Blanco Formation.** Professor Cummins gave the name Blanco to those Tertiary rocks which rest uncomfortably upon the dockum conglomerate at the type locality of the latter, i.e., at Dockum, Dickens County, Texas. Vertebrate fossils from that region have been identified by Professor Cope,[1] who states that 'the horizon is more strictly and nearly Pliocene than any of the lacustrine terranes hitherto found in the interior of the continent.' The rocks consist of alternating layers of sand, clay, and diatomaceous earth, approximately 160 feet in thickness.

"**Tule Formation.** These beds, described by Professor Cummins[2] and by Professor Cope, were assigned by the latter to the *Equus* bed horizon of the early Pleistocene, on account of vertebrates from Tule Canyon in Swiser County. In general, the statement made by Professor Cope that '*Equus* beds form the superficial formation of the country at various points on the Staked Plains and about its eastern escarpment' [2] may be considered as accurate. However, the *Equus* beds are by no means confined to the top of the Llano Estacado, but occur in other localities as well, notably north of Canadian River. These rocks consist of coarse sand, clay, and gravel of variable thickness.

"**Age of Beds.** It is the experience of the writer, after ten seasons spent in studying these deposits in Kansas, Oklahoma, Texas, and New Mexico, that it is practically impossible to separate either the Tertiary or Pleistocene deposits of the plains into mappable formations. From the bottom of the Loup Fork to the top of the *Equus* beds the general character of the rocks changes so constantly and with such extreme irregularity that they can not for the most part be differentiated in the field. Sections made at about twelve points in eastern Colorado, western Kansas, western Oklahoma, and in the Panhandle of Texas show such a marked similarity of structure that without the evidence of fossils it is impossible to determine whether the rocks belong to the Miocene, the Pliocene, or the *Equus* beds. Even Professor Hay, who studied these rocks in Kansas and applied to them the descriptive terms 'Mortar beds,' 'Tertiary grit,' 'Tertiary marl,' etc., did not succeed in differentiating them into definite horizons. If it were possible to distinguish formations stratigraphically, the matter of classification would be greatly simplified, but in the light of present knowledge, it seems not only inexpedient but even impossible to differeniate them structurally. In view of these facts, therefore, the general term Tertiary will be used to include the Loup Fork, the Goodnight, the Blanco, and in most cases also the Tule or *Equus* beds. The *Equus* beds are

1. Cope, E. D., Vertebrate fauna of the Blanco beds: Fourth Ann. Rept. Texas Geol. Survey, 1893, p. 47.
2. Cummins, Op. cit. pp. 199-200.

classed with Tertiary chiefly, as stated above, because these beds can not be distinguished in the field, nor indeed, by any other means than that of vertebrate fossils, which are present only in scattered localities.

ORIGIN OF THE TERTIARY DEPOSITS

"With regard to the origin of the Tertiary deposits of the Great Plains two general theories have been advanced. The earlier geologists who studied these rocks considered them lacustrine in origin; Professor Marsh,[1] for instance, described a great Pliocene lake covering practically the entire Great Plains area, in which deposits 1,500 feet thick were laid down. Professor Cummins,[2] in speaking of the Goodnight beds, says: 'They seem to have been deposited in a lake much more extensive to the south than the Loup Fork, which latter seems to have had its southern termination here at Mulberry Canyon.' Professor Cope has already been quoted regarding 'Lacustrine terranes.' Professor Hay[3] accepted the lake theory, although he did not account for the formation of these supposed bodies of water. Later investigations, however, have led to the opinion that it is to fluviatile rather than to lacustrine agencies that we must look for the origin of the Tertiary deposits.

"Professor Haworth,[4] in discussing the Kansas Tertiary, observes: 'The relative positions of the sand, the gravel, and the clay of the Tertiary over the whole of Kansas * * * correspond much better to river deposits than to lake deposits. The irregularity of formation succession, the limited lateral extent of the beds of gravel, sand, and clay, and the frequent steepness of the cross-bedding planes, all correspond to river deposits. * * * The materials themselves have many indications of river deposits and a very few of lake deposits."

"Mr. Johnson,[5] in his report on 'The High Plains and Their Utilization,' expresses the opinion that 'The structure, an uneven network of gravel courses and elongated beds of sand penetrating a mass of silt and sand-streaked clay, is the normal product of desert-stream work under constant desert conditions. The coarse material is not regarded as the product of necessarily strong-running streams and the fine material of sluggish streams, in alternating epochs of humid and dry climate or of high and low inclination of slope, but as the simultaneous product of branching streams of the desert habit, here running in a channel and there spreading thinly.'

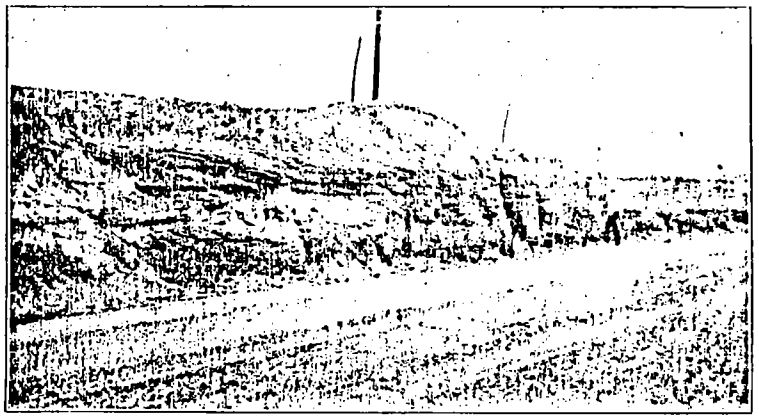
1. Marsh, O. C., Amer. Jour. Sci., vol. 9, Jan. 1875, p. 52.
2. Cummins, W. F., Notes on the geology of northwest Texas: Fourth Ann. Rept. Texas Geol. Survey, 1893, p. 201.
3. Hay, Robert, Water resources of a portion of the Great Plains: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1895, p. 571.
4. Haworth, E., Physical properties of the Tertiary: Univ. Geol. Survey Kansas, vol. 2, 1897, p. 233.
5. Johnson, W. D., The High Plains and their utilization: U. S. Geol. Survey, Twenty-first Ann. Rept., pt. 4, p. 655, 1901.

"The only point at issue among these writers seems to be whether the cause of the deposition of the material by the streams is to be sought in climatic changes which produce alternate periods of aridity and humidity, or in deformation movements of the earth's crust by which the eastern part of the Great Plains was elevated and the gradient of the streams lessened. With regard to this matter the writer does not express an opinion. The subject has been discussed by Johnson,[1] to whose article the reader is referred.

GENERAL CHARACTER OF THE TERTIARY DEPOSITS.

It has been stated already that the greater part of the rocks consists of clays, sandstones, and conglomerates with clays predominating. In color the clays are normally white, so white that when exposed they are frequently spoken of as "gyp" cliffs or "chalk" cliffs, although they contain neither gypsum nor chalk. However, the color of the clays is not invariably white, it often grades into the various other light tints. In structure the clay is usually so soft that it may be crushed with the fingers, but on the other hand the more calcareous members are frequently indurated and make a fair quality of limestone. Occasionally beds are found full of white calcareous lumps or concretions, which give to the rock a mottled appearance. The lime often cements the clay together in the form of elongated concretions,

PLATE V.



TERTIARY SANDSTONE AND MORTAR BEDS. NOTE MASSIVE BEDS IN CROSS-BEDDED FORMATIONS.

1. Idem., chap. 2, pp. 612-656.

which, on weathering, have a resemblance to stalactites, and form what one author calls 'pipy' concretions.[1]

"Sand beds and ledges of conglomerate also constitute a considerable part of the Tertiary and Quaternary. The sand is usually in smooth, rounded, white or yellowish grains and the material is of quartz. The conglomerate is made up typically of smooth water-worn pebbles, usually composed of quartz, granite, prophry, and other igneous rocks, varying in size from sand grains to boulders as large as a peck measure. These pebbles most commonly occur in beds or layers sometimes as much as 25 feet thick, but often they are intermingled with fine sand and sometimes sprinkled through the clay members.

"In a number of localities the gravel beds at the immediate base of the Tertiary contain considerable numbers of water-worn *Gryphea* shells of lower Cretaceous age. It has been stated that at the present time there are no Cretaceous rocks exposed between the red beds and the Tertiary deposits in this part of the Panhandle, but that extensive Cretaceous deposits are found along the southern and western edges of the Llano Estacado. Whether these shells were derived from the lower Cretaceous rocks in place, or were transported by streams from beds farther west, it is impossible to determine, but in the light of available data the latter supposition seems probable.

"The relative proportion of the different rocks enumerated above varies with the locality, but it is probable that three-

PLATE VI.

MASSIVE SANDSTONE IN CROSS-BEDDED MATERIAL. FIFTEEN MILES SOUTH OF BEAVER.

1. Darton, Nelson H., Report on the geology and water resources of Nebaska west of 103d Mer.: Prof. Paper No. 17, U. S. Geol. Survey, 1903, p. 25.

fourths of the Tertiary and Pleistocene materials exposed along the eastern edge of the Staked Plains is some form of clay, silt, or marl, the other one-fourth being sand or conglomerate. Farther north, in Kansas and Nebraska, the proportion of coarser material is relatively larger, often being more than one-half.

"In all places on the plains, so far as known, these materials are arranged in a heterogeneous manner—the clays, sand, pebbles, silt, conglomerate, and other forms of rock occurring indiscriminately and without similarity of position. In one place a section of a hill shows nothing but clay and silt; half a mile away beds of sandstone and gravel occur; and still farther away the section reveals little besides sand and conglomerate."

The most recent work on the Tertiary of the region is contained in two reports of this Survey.[1]

In the Cimarron County report Professor Rothrock[2] goes into considerable detail in discussing the composition of the clays, conglomerates, sands and cements which make up the Tertiary. To his very excellent description the reader is referred.

In the Texas County report Professor Lonsdale[3] has described quite fully that phase of the Tertiary consisting of clay, usually more or less hardened, formerly spoken of as "chalk," "gyp" or "indurated clay," but to which the name "caliche" is now generally applied. The reader is referred to Professor Lonsdale's description.

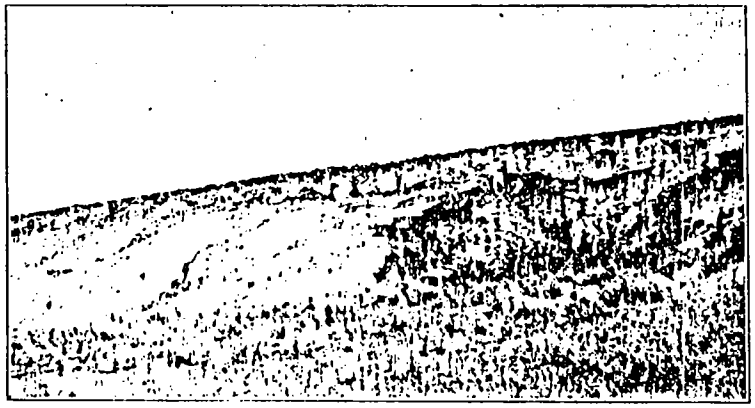
In Beaver County the greater part of the uplands except those occupied by sand hills consist of Late Tertiary rocks. On the flat Plains in the northwestern part of the county these rocks are not usually exposed on the surface, being buried beneath a mantle of soil.

The best exposures of Tertiary may be seen in the breaks along the heads of the small creeks which take their rise in the flat plains. This is especially true of the streams of northeastern Beaver County that flow north into the Cimarron, as well as in the case of the creeks and their small tributary draws in the southern half of the county. Hundreds of exposures of 20 to sometimes as much as 50 feet, may be seen on the various streams throughout the county.

As one studies these exposures and attempts to compare them he is struck with the irregularity or heterogeneity of the Late Tertiary as a whole, and is willing to agree with Rothrock[4]

1. Rothrock, E. P., Geology of Cimarron County, Oklahoma, Okla. Geol. Survey Bull. 34, pp. 57-73, 1925. Gould, Chas. N., and Lonsdale, John T., Geology of Texas County, Oklahoma, Oklahoma Geol. Survey, Bull. 37, pp. 26-33, 1926.
2. Op. cit. pp. 58-67.
3. Op. cit. pp. 29-33.
4. Op. cit. p. 58.

PLATE VII.



TERTIARY LIMESTONE. SEC. 3, T. 3 N., R. 25 E., C. M.

who sums it up by saying, "This formation consists of a heterogeneous mixture of clays, sands, and gravels." There is no continuity of deposition. Many exposures consist entirely of clay and its indurated phase caliche. Other exposures exhibit fine sand and clay or fine sand and coarse sand, in some places cemented, but often loose. In many exposures the material is a conglomerate, the pebbles consisting of water-worn igneous material such as quartz and granite. Water-worn oyster shells are sometimes found in the conglomerate. The beds of sand and conglomerate when traced far enough are usually found to be

PLATE VIII.

TERTIARY LIMESTONE. SEC. 3, T. 3 N., R. 25 E., C. M.

lenticular. Often they are notably cross-bedded, but sometimes lie comparatively even. Plate VI shows very clearly the cross bedded lenticular character of this formation.

A ledge of soft white limestone, known locally as chalk rock occurs in the Tertiary in various localities in eastern Beaver County. It has long been used for building purposes, chiefly in the construction of farm houses in the region south of Beaver Creek. Reference to the map in pocket, will show the location of several exposures of this rock in the county and Plates VII and VIII illustrate their occurrence. This lodge has been described in manuscript under the name Laverne formation by Mr. V. V. Waite, but the description has not been published. The following excerpts from Mr. Waite's manuscript on file in the office of the Oklahoma Geological Survey are given:

> "The limestone of this formation varies from a pure white to a buff-colored cherty limestone that has a concoidal fracture. This member is prolific with fossils. Mollusca occur in abundance. Bones and teeth are very often found. A great many leaves of many varieties are found in the buff-colored limestone. Among those found are poplar, sycamore, cottonwood, elm, and others not yet determined. The leaves and fruit resemble those of the present day.
>
> "The age of the formation cannot at this time be definitely assigned. The fossil evidence will in all probability give the age of this formation. At present it can be said that the formation is at least Tertiary. This is evidenced by the recent aspect of the fauna and flora. The identification of mastadon bones, tusks and teeth will no doubt give the exact age.
>
> "It has been suggested by A. A. Snickoff and I. M. Goubkin, Russian geologists with the Russian Embassy, that the age is probably Pliocene. In a conversation with Dr. J. A. Udden, he suggests the probability of Tertiary (Eocene) age. Dr. J. W. Beede suggests the possibility of either Tertiary or Pleistocene.
>
> "Dr. J. A. Udden suggests that the limestone formation is probably a caliche formation. That is, a precipitation of lime from the water caused by the evaporation exceeding the inflow. It is the opinion of the writer that the formation represents a series of small lakes, perhaps similar to the present lakes in northern Indiana. This suggestion is tentatively made for the reason that the formation is scattered and has a variation in lithologic character even though the outcrops are only a short distance apart. The fauna too indicates small separate bodies of water. For instance, at one locality clam shells are found in abundance and not in others. In one locality the fossils were much larger than in others. At another place a great number of leaves were found. A two inch seam of peat was found at still another.
>
> "These facts would indicate small bodies of water either isolated or connected in which the conditions in one place were different in another and thus the cause for variety of fossils both in size and species."

QUATERNARY ROCKS

The youngest geological formations in Beaver County consist of sand hills and alluvium, or valley wash. Both formations are now in process of being laid down in the region.

FOSSIL LEAVES FROM BEAVER COUNTY, OKLAHOMA

So far as the authors are aware no one has described either the molluscs, or the vertebrates (bones and teeth) from Laverne formations. This is a fertile field for future investigation. A collection of fossil leaves (Plates IX and X) from this region has been described by Prof. E. W. Berry[1] of Johns Hopkins. Professor Berry's description, slightly modified, follows:

"The following short paper is based upon materials collected by Prof. E. C. Case, of the University of Michigan, and presented by him through the writer to the United States National Museum. These collections were incidental in the exploration of the red beds of Oklahoma in search for Permian vertebrates, under the auspices of the Carnegie Institution. They were made from an outcrop of chalk-like clay on the south side of Beaver Creek, near the since abandoned post office of Alpine, about 10 miles east of Beaver City. The matrix is a light-colored fluffy clay which appears to be largely a volcanic ash. No vertebrates were found associated with the plants except a few undeterminable fishbones. A small undetermined crustacean was also found in the clay.

"Darton[2] in 1899 divided the Loup Fork of the central Great Plains into the Arikaree and the Ogallala formations, regarding the former as Miocene and the latter as possibly Pliocene in age. Various local subordinate divisions have been recognized by the field geologists in Kansas and Nebraska. Materials corresponding in a general way to those of the Ogallala formation of Kansas and Nebraska are widespread in western Oklahoma. These are clays, sands, and gravels of exceedingly variable character and proportions. They probably once covered the entire "panhandle" but are now preserved chiefly on the uplands where the argillaceous cliffs of these materials are locally known as "mortar beds" or "chalk." The thickness varies from place to place and ranges in Beaver County from thin remnants to upwards of 300 feet. These deposits are, in the latter region, usually underlain by the red beds of the Permian, although locally traces of the Lower Cretaceous may be intercalated.

"According to our present knowledge of the genesis of the continental Tertiary deposits it can not be expected that similarity of lithologic composition has any definite bearing upon correlation, and it must be understood that the conclusions of the present paper refer only to the fossiliferous outcrop which is discussed.

"The florule collected from this outcrop represents but six determinable species, of which four are new, and three additional forms that are generically but not specifically recognizable. It includes two grass or sedge-like plants which are fragmentary and of no botanical value beyond indicating the presence of such plants in this region at that time. Willow leaves are present, but not specifically determinable. The most abundant forms are the *Platanus* (Sycamore) and the *Sapindus* (Soapberry). The *Gymnocladus* (Kentucky coffee bean), *Rhamnus* (Buckthorn), *Bumelia* (Southern Buckthorn), and *Diospyros* (Persimmon) are all represented by a scanty amount of material, but as the collection is a small one the individual abundance of the different species is probably without significance.

"All of the forms appear to have been alluvial species of river bottoms, and most of them have their genera still represented in the valleys of the principal streams that enter eastern Oklahoma from the Coastal Plain of the Gulf States. This statement is true of *Platanus*, *Gymnocladus*, *Sapindus*, *Rhamnus*, *Bumelia* and *Diospyros*. All these genera are normal constituents of the rich alluvial deciduous forests of the southeastern United States, and the presence of fossil representatives in western United States, and the presence of fossil representatives in western Oklahoma shows that climatic conditions in that region were more mesophytic toward the close of the Miocene than they are at the present time, with the stream valleys covered with a mixed deciduous forest, which may also have covered more or less of the interstream areas.

"Regarding the age indicated by this florule, it may be said that the *Cyperactites* (sedges), *Caulinites* and *Salix* (Willow) are without significance. Only one of the nine forms—namely, *Rhamnus lesquereuxi* —is limited to a single outside horizon, and this species occurs in the later Miocene of Florissant, Colorado. *Platanus aceroides* and *Diospyros brachysepala* are recorded throughout the Tertiary in both this country and Europe, and while both are probably composite species, it is impossible to segregate them in the present state of knowledge. Both are, however, typically Miocene forms, the *Platanus* being found in the John Day Basin on the west coast and in the Calvert Miocene of the Atlantic coast, and indistinguishable leaves of the *Diospyros* occur at Florissant, Colorado. Moreover, the new species of *Sapindus* approaches closely to *Sapindus lanceolatus* Lesquereux, another Florissant species. From this it would seem that the Oklahoma plants were of somewhat similar age to those of Florissant, the different physical conditions combined with the much less effective methods of preservation accounting for the sparseness of the flora recognized from Oklahoma. I believe that this is substantially true, and I am inclined to regard the Oklahoma outcrop as of upper Miocene age, although there is no conclusive evidence in this region during the early Pliocene, there being no considerable American Pliocene floras, except that of the Gulf coast with which to make comparisons."

1. Berry, E. W., Fossil Plants from the Late Tertiary of Oklahoma, Proceedings U. S. National Museum, vol. 54, pp. 627-636, 1918.
2. Darton, N. H., U. S. Geological Survey 19th Ann. Rept., pt. 4, p. 734, 1899; Professional Paper 32, p. 175, 1905.

It will be understood that soft rocks such as those described are subject to rapid erosion. The cementing material of the sands and conglomerates is largely calcium carbonate which is easily dissolved by water. As the rains continue to fall on these beds of sand and conglomerate, the cement is dissolved and the individual sand grains and pebbles are loosened and washed into the streams.

This material is the chief source of the sand which fills the channels of the various rivers on the plains and of the sand hills on the divides. All of the larger streams in Beaver County such as Cimarron, Beaver, Kiowa, Duck Pond, and Clear, as well as the smaller creeks and draws, have channels filled with sand derived from sand and gravel beds of the Tertiary.

PLATE IX.

FOSSIL LEAVES FROM BEAVER COUNTY.

Fig. 1. **Bumelia oklahomensis, new species.**
2. **Gymnocladus easei, new species.**
3. **Platanus neeroides Goeppert.**

Photograph through courtesy of United States National Museum.

PLATE IX.

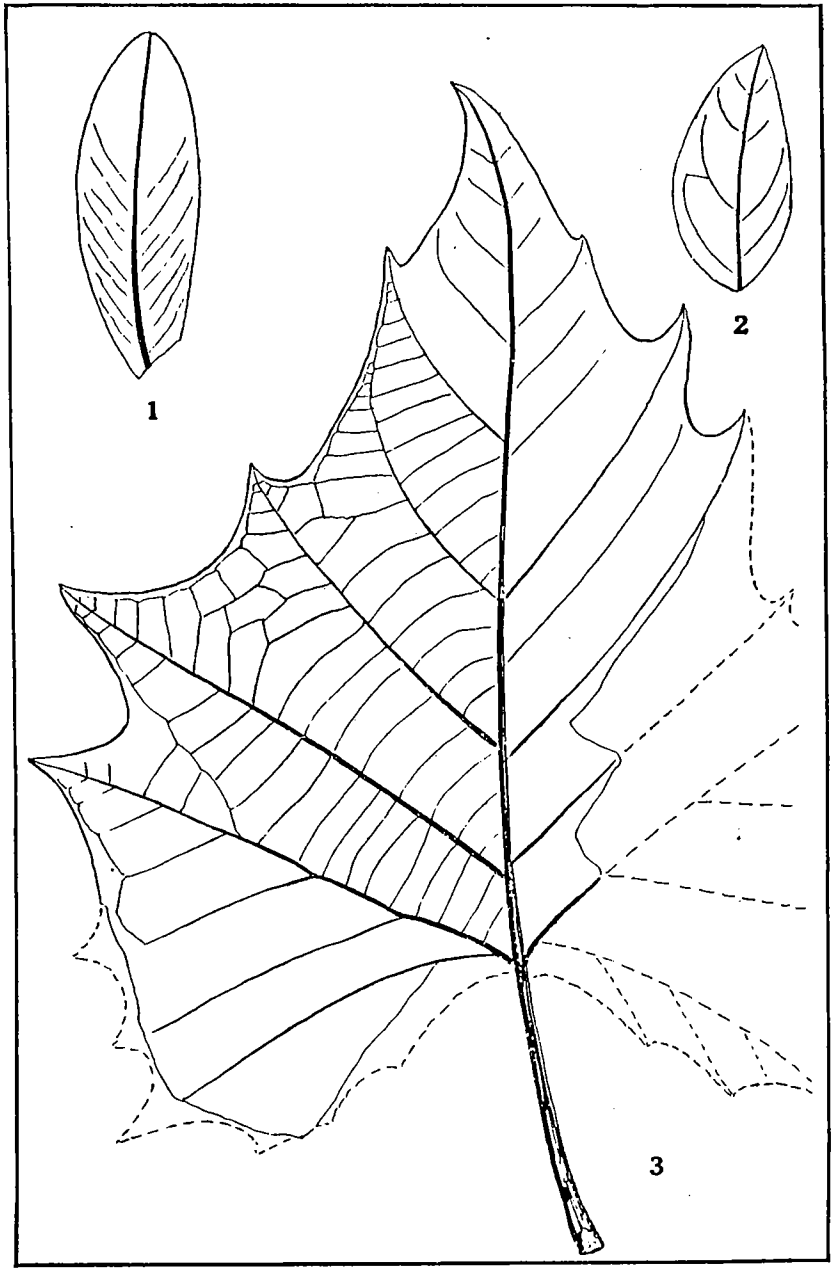


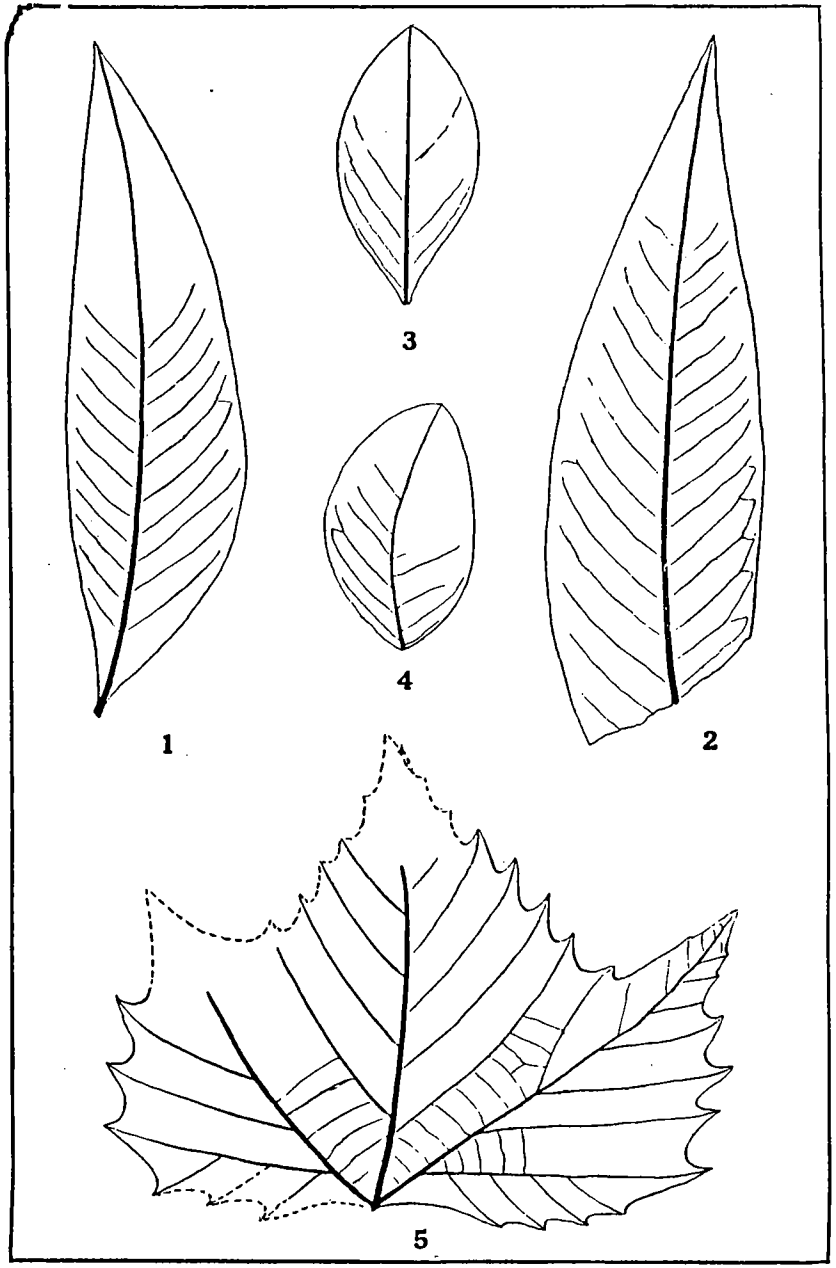
PLATE X.

FOSSIL LEAVES FROM BEAVER COUNTY.

Figs. 1, 2. **Sapinus oklahomensis, new species.**
3. **Diospyros brachysepala Al. Braun.**
4. **Rhamnus lesquereuxi, new species.**
5. **Platanus aceroides Goeppert.**

Photograph through courtesy of United States National Museum.

PLATE X.



SAND HILLS

The principal region of sand hills in Beaver County is a strip of country 3 to 6 miles wide lying north of Beaver Creek. This phenomena of sand hills north of the streams, however, is not confined to this county nor to this stream. Throughout Oklahoma, and to a lesser degree throughout other states of the plains sand hills occur along the north bank of the various east-flowing rivers. This is true of the Salt Fork, the Cimarron, the North Canadian of which Beaver is one head tributary, and the South Canadian.

The strip of sand hills of which those of Beaver County form almost the western extension, extends east on the north side of Beaver and North Canadian River, across Harper, Woodward, Major, Blaine, Canadian, and Oklahoma counties, a distance of 175 miles. In Harper and Woodward counties the width of this sand hill strip is often 6 to 10 miles, but on passing farther east the amount of sand gradually decreases and the width of the belt is less. The easternmost patch of sand of this character of any considerable size on the North Canadian is in western Oklahoma County.

The origin of these sand hills is not thoroughly understood. The popular explanation is that the sand composing the sand hills has been derived from the streams to the south, being carried out of the stream bed by prevailing south winds.

There can be no doubt that wind is a very powerful agent, and that throughout a period of years vast amounts of sand might be transported for considerable distances. To this all will agree.

However, another factor must be considered. On many of the sand hills some of them, several miles from the streams, masses of loose water-worn pebbles are found. These do not differ from the pebbles which make up the conglomerate in the Tertiary deposits. So common are these pebbles throughout several states that the general name "Tertiary pebbles" is usually applied to them by geologists. They are found not only in regions where deposits of Tertiary now cover the ground, but also in regions far to the east. The ordinary interpretation of the presence of these pebbles in the red beds area of central Oklahoma is that they represent the last vanishing remnant of the now eroded Tertiary beds which once covered the area, but which have been removed by erosion leaving behind only the more insoluble siliceous pebbles.

For these reasons many geologists believe that the sand hills in Beaver County, and similar regions represent the partly-eroded and worked-over Tertiary. They believe that the lime has been dissolved out and removed by the action of water. The sand grains and pebbles remain behind. The strong winds shift the sand but cannot move the pebbles which tend to accumulate first on top of sand hills. As these hills are worn down by the action of water and wind, the pebbles roll down the sides of the hills and accumulate on the lower slopes.

What has preceded refers only to sand hills on the slopes and the upland at some distance from the streams. In the region there are sand hills in which the wind is not only the modifying factor and the shaping factor, but the originating factor as well. These are the sand hills found along the river bottom both north and south of the stream, but chiefly to the north. One who on a windy summer day has watched the sand carried from the stream channel by the wind and deposited as sand hills on the bottom land cannot doubt the efficacy of wind as a factor in making sand hills. These channel-originated, wind-carried sand hills sometimes merge with those of the other type previously discussed so that it is often impossible to differentiate between them.

ALLUVIUM

Deposits of sand, gravel, and mud, formed wherever the flow is checked in a stream, is known as alluvium. The terms bottom land, valley wash, or flood plain material are also used to describe the same thing. The character of the alluvial material naturally depends on the character of the formations which make up the region drained by the streams. In a limestone or shale region the alluvium along the river bottoms will probably be a heavy clay, very fertile but usually difficult to cultivate. In a region like Beaver County where the rocks consist very largely of sand, the alluvium will be sandy also.

The greatest amount of alluvium in Beaver County occurs along the valleys of Cimarron and Beaver creeks. These valleys average from one mile to two miles wide and the greater part of this is covered with alluvium. In many places wind-blown sand has covered the water-carried flood plain material so that practically the entire width of the bottom is covered with sand. Alluvium is also found along the smaller creeks tributary to the major streams but in such cases the bottom land occupies a smaller area than it does on the larger streams.

WATER RESOURCES

SPRINGS

Beaver County is in general well watered. That is, water occurs naturally either in springs or streams; or artificially in wells.

In the chapter on Physiography, the stream system of the county, the chief major streams, and the system of secondary streams tributary to them have been discussed. The greater number of those minor streams are spring fed, the springs issue usually from beds of sand and gravel, often at the contact between the sand and an underlying clay bed.

Springs of this character are more common in the southern part of the county in the area occupied by red beds where the springs usually issue from under beds of Tertiary or Quaternary sands and gravels, which overlie the clays of Permian red beds. Such streams as Kiowa, Camp, Duck Pond, Clear, Willow, and Jackson and their smaller tributaries are fed in part at least by these Tertiary springs.

In the sand hills north of Beaver Creek the streams, all of which flow south into Beaver spring, are abundant. The surface of this region is covered with sand dunes which lie on a floor of either Permian red beds, or of late Tertiary clays and shales. The springs are largely contact springs, usually between the sands above and clays, either red beds or Tertiary below. In many places among the sand hills are so-called seep springs occupying shales, or low flat area between the dunes where water seeps up from the flat surface and sometimes forms small lakes. The water from these seep springs often does not find its way into any creek but remains in enclosed basins until it evaporates.

WELLS

On the high level upland particularly in the northwestern part of the county there are no springs, but usually water may be secured in wells. This water is often spoken of as "sheet water" from the fact that it usually occurs at regular levels or "sheets" throughout the region. "Sheet water" has been so often described in other reports that it is not necessary to rewrite its description. The following quotation from a report prepared by the senior author 20 years ago describing conditions in the Panhandle of Texas which joins Beaver County on the south will set forth our knowledge of the subject.[1]

> "In order to understand underground-water conditions, it is necessary to know the geologic structure of the rocks from which the water is obtained. In the Panhandle of Texas, as has been stated, by far the greater part of the water comes from Tertiary rocks, and for that reason a brief discussion of the origin and structure of these rocks will be given here.
>
> "The Tertiary rocks found in the Panhandle consist of deposits in most places several hundred feet thick, made up chiefly of alternating, more or less lenticular, or cross-bedded layers of clay, sand and gravel, the latter being composed mainly of smooth, rounded, water-worn pebbles. There seems little doubt that the original material of these deposits was derived largely from the Rocky Mountains. Streams which flowed away from the mountains carried material out on the plain and left deposits in some places of sand, in others of clay, and still others of gravel or pebbles, which in turn were covered by other deposits, here and there the same, but more commonly of other material. This process, which continued for a long period, resulted in the accumulation of several hundred feet of alternating beds of irregularly stratified rock. Being laid down under such conditions the Tertiary series as a whole is necessarily composed largely of beds irregularly lens-shaped in cross section and in most cases not continuous over large areas. In some localities the greater part of the thickness may consist of fine materials, while in others sandstone and gravels may predominate; but in general the beds of fine and coarse material are mixed in a heterogeneous manner.
>
> "The terms 'sheet water' or 'underflow' are often used in the States of the Great Plains to indicate any fairly constant supply of water at a more or less uniform depth. The general impression seems to be that at some depth beneath the surface there is a continuous 'sheet' or 'lake' of water which if tapped by a well will yield a fairly constant supply. In some places two or even three such 'sheets' are supposed to exist, and the expressions 'first sheet' and 'second sheet' or 'first water' and 'second water' are common. Another prevalent notion is that the water in these 'sheets' is constantly flowing streamlike beneath the surface, an idea disclosed by the common expression that the 'underflow is to the east.'
>
> "While it is true that these popular ideas are widespread and in general are based on common observations, there is, however, in them much that is erroneous and not based on a correct conception of the conditions found in the nature and relations of the water-bearing strata. Rounded grains of sand and gravel such as make up the lenticular beds which constitute the majority of the Tertiary rocks do not lie closely enough together to fill all the space, but have very small interstices between them. These pores or spaces are minute reservoirs for the water, which in its passage through such materials either vertically or laterally seeps from one of these minute reservoirs to the next, and thus very slowly flows along underground. This movement is popularly called 'underflow,' but it is not nearly so rapid as is commonly supposed. A number of experiments have been made on the rate of the flow of underground waters, and it has been found that even along stream valleys, where the material is coarse, the pores large, the gradient relatively steep, and all conditions favorable for a rapid flow (as, for instance, along Arkansas River in western Kansas), the rate of underflow does not average more than 10 feet a day.[1] On the High Plains, such as constitute the region under discussion, where the gradient is low, much of the material fine, and the pores relatively small, and where the lenticular beds dip in many places at different angles in different directions, it is doubtful if on an average the water moves more than 10 feet a year."

1. Gould, Chas. N., The Geology and Water Resources of the Western Portion of the Panhandle of Texas, U. S. Geol. Survey, Water Supply Paper No. 191, pp. 37-40, 1907.

According to the theory just advanced dry ground is ground in which the pores between the rock particles contain

no water, while wet or saturated ground is that in which the pores are filled. Since water always tends to sink to the lowest levels, there is in most regions a certain but variable thickness of beds filled with water in what is technically known as the "zone of saturation." The upper surface of this zone of saturation is called the "water table" or "water plane," and this is in many places identical with what is meant by the popular phrase "sheet water," so common on the Great Plains. Since water moves slowly underground, this water table becomes approximately similar in contour to the surface of the ground, being high on the divides and low near the streams, where the water may escape in springs.

As originally deposited the lenticular beds which constitute the greater part of the Tertiary deposits must have had an irregular outline and surface, especially where they were laid down in swamps or lakelets. Where the material is clay or very fine sand the interstices between the particles are very minute and practically impervious to water. Fine deposits such as those just described are in numerous instances overlain by sand and gravel which was originally laid down in basins or channels, and these in turn by other fine-grained deposits in varying succession, so that the alternation of water-bearing and impervious beds is in many places, very irregular. If deposits of this nature are penetrated by a well, the first sand encountered will furnish water, the quantity depending on the size of the water-bearing deposit, the coarseness of its grain, the height of its edges, etc., in the next coarse sand bed a second water stratum will be found, and soon, until finally the main water table is penetrated. This may be considered a probable explanation of the "first and second" water, or "first and second sheet" so often spoken of on the Great Plains. It also possibly accounts for the conditions found in many parts of the region where records obtained from a relatively small area show well depths varying up to a hundred feet.

In general the average depth of the wells in any particular locality may be considered the approximate depth of the water table at that place. As will be understood from what has been stated, the water table, or the level at which the top of the ground water stands, varies constantly from place to place, from year to year, and even from day to day. It is supplied chiefly from rainfalls and is lowered whenever the water is removed—as, for instance, by springs, artesian wells, or heavy pumping. Ordinarily the water table is at a considerable distance below the surface, but here and there it reaches the surface level, as in springs, swamps, or marshes.

1. Slichter, C. S., The motions of underground waters: Water-Supply and Irr. Paper No. 67, U. S. Geol. Survey, 1902, pp. 41-43.

On the High Plains the water table is located at the upper point of saturation of the pervious beds. Well records from widely separated localities show that this water level for the High Plains as a whole averages from 20 to 250 feet beneath the surface. So far as known, this level in each locality is fairly constant, the amount of water taken away by springs and wells being approximately equaled by the amount added each year by precipitation.

STREAMS

This subject has been treated under another heading. See pages 15 and 16.

ECONOMIC RESOURCES

GYPSUM

Gypsum, or hydrous calcium sulphate, occurs in central Beaver County as ledges in the Permian red beds. On page 20 is given the section of a hill containing four ledges of gypsum, the thickest of these being 6 feet. Sections made at other places would show a different number of ledges.

Gypsum is extensively used for a number of purposes; chiefly in the manufacture of plaster of Paris, dental plaster, pottery molds, plaster relief work, in Portland cement, paint, and alabastine, for various adulterants, for fertilizer, and for several other purposes. Its chief uses however, are for wall plaster and for plaster wall boards. Perhaps 90 per cent of the gypsum used is for the two latter products. Gypsum plaster has practically driven lime plaster out of the trade, and gypsum wall board for interior work is rapidly taking the place of other material.

The gypsum in Beaver County is suitable for all of these uses. The principal difficulties which prevent the present utilization of this material are the lack of cheap fuel and transportation. Gypsum is a bulky product requiring much fuel for its manufacture. Since its greatest use is in the building trades the distance to large centers of population which constitute the market is of great importance. Plants for its manufacture should be established if possible on railway lines leading directly to markets. If a supply of fuel, such as natural gas, should be developed in Beaver County the gypsum industry might become of considerable importance.

SAND AND GRAVEL

Sand suitable for building purposes is abundant in all parts of Beaver County, except on the flat upland in a few of the

northwestern townships. It has already been shown that the Tertiary deposits which cover the greater part of the county are composed to a considerable extent of loose sandstone and conglomerate. As these materials are uncovered by erosion, and the cementing materials are dissolved by the action of water the sand grains and pebbles are released forming sand and gravel.

Beds of building sand occur in many places on the hillsides, and all the channels of streams both large and small, are filled almost completely with sand. There is an abundance for all local use, and if occasion should demand, to ship to other sections.

As with sand, so with gravel. This material is eroded from Tertiary conglomerates which outcrop in many parts of Beaver County. Beds of gravel, suitable for building purposes, and road construction are common, and are more than ample for local use.

CLAY AND SHALE

There are two kinds of clay and shale in Beaver County; that derived from the red beds and that derived from Tertiary rocks. The former is probably the more valuable.

Red beds clays occur chiefly in the southern part of the county along streams flowing north into Beaver Creek. This clay is deep brick-red in color, the color being caused by the presence of iron oxide. The clay is suitable for the manufacture of brick, building tile, sewer pipe and for most other purposes where the red color is not objectionable. Similar clays have been used for many years in other parts of western Oklahoma. The amount of material is, for practical purposes, inexhaustible.

Clay of Tertiary age is found in many parts of the country. As a usual thing this clay contains too great a percentage of lime to be used for brick. However, it is altogether possible that a careful search would reveal the presence of Tertiary clay suitable for brick manufacture.

The chief obstacles to the profitable manufacture of clay products in Beaver County are lack of fuel and transportation. The greater part of the brick made in western Oklahoma has been burned with coal which for the most part comes from the McAlester region of eastern Oklahoma. It is not profitable to haul coal any great distance if suitable clay can be found nearer the coal fields. If natural gas is ever found in commercial quantities in this region it might give a great impetus to the manufacture of clay products.

However, the matter of transportation must always be taken into account. The authors do not know of any red clay in this county located on a railroad. Even if railroads were present, on account of the sparsely settled region near at hand the long haul to market would make it questionable whether or not the manufacture of clay products on a large scale would be profitable.

BUILDING STONE

Beaver County has sufficient building stone for local use. This stone is of two kinds, namely sandstone from the red beds, and limestone from the Tertiary.

The red beds which are exposed in many places in the southern part of Beaver County consist largely of red clay shales. Here as elsewhere, however, these beds contain ledges of red sandstone. Sometimes this sandstone is soft and unsuited for building purposes, but in many places, ledges may be found which are hard enough to be used.

In an early day this stone was extensively used for foundations and for farm houses throughout the region. Business blocks in Beaver have been constructed of this red sandstone.

It has already been shown on page 33 that a ledge of soft white limestone, known locally as chalk rock, of Tertiary age, has long been used for building purposes, chiefly in the construction of farm houses in the southern part of the county. Reference to the map, in pocket, will show the location of several exposures of this rock in Beaver County and Plates VII and VIII illustrate their occurrence.

VOLCANIC ASH

Volcanic ash occurs in a number of places throughout Oklahoma, and some of the most extensive deposits known in the State are in northeastern Beaver County and in northwestern Harper County, just east of the Beaver County line.

A report of this survey[1] by Frank Buttram describes quite fully the subject of volcanic ash. Regarding the physical and chemical properties of volcanic ash, Mr. Buttram says:

> "The leading physical properties of volcanic dust are its color and the angular character of the flakes of glass of which it is largely composed. In appearance it closely resembles chalk and also gypsite, a form of weathered gypsum. The deposits of volcanic dust are usually more or less adulterated with other substances and therefore no two beds have exactly the same tint, as the color varies considerably. The colors are usually of light gray, but some are bluish gray, others are dark gray, and still

1. Buttram, Frank, Volcanic ash in Oklahoma. Okla. Geol. Survey Bull. No. 13, 1914.

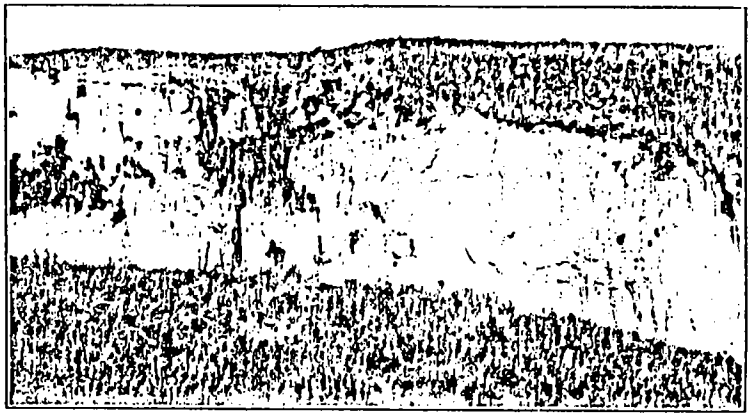
others which contain some oxidized iron have a slightly reddish color. The individual flakes are usually too small to be seen by the unaided eye, but when examined under a microscope they are found to have a glimmering, glistening, and more or less vitreous appearance and are seen to consist of numerous angular, almost transparent, and usually non-crystalline flakes and shreads of glass, which frequently contain irregular cavities and tubes. Artificial volcanic dust may be almost precisely duplicated by grinding ordinary glass.

"Volcanic dust does not vary greatly in physical and chemical properties, deposits in widely distributed areas showing a marked similarity. It has a specific gravity of about 2.5. This specific gravity readily distinguishes it from diatomaceous earth, which is much lighter. These two substances closely resemble one another in other respects. Dry diatomaceous earth will float for a while on water until it becomes "water logged," while on the other hand volcanic dust will sink immediately."

The economic value of volcanic ash is also discussed by Buttram as follows:[1]

"Volcanic dust, although only recently considered as a commercial commodity, has varied and extensive uses. It is at present used largely for abrasive purposes in the form of polishing powders, scouring soaps, etc., but, because of its pumaceous condition, it is used in the manufacture of dynamite, and as a holder of nitroglycerine; and also because of lightness and porosity it is a good non-conductor of heat, and for this reason is being used as packing material for safes, steam pipes, and boilers and as fire-proof building material. According to authoritative reports it is said that it may be used with satisfactory results as a substitute for sand in paint where the surface coated is exposed to the weather. In Germany its field of usefulness is still more

PLATE XI.



VOLCANIC ASH EXPOSURE NORTHWEST OF GATE, OKLAHOMA.

1. Op. cit. pp. 32-33.

extensive. It is there used as an absorbent for liquid manures in preparation of artificial fertilizers, and in the manufacture of water glass, of various pigments of analine and alizarine colors of paper, sealing wax, fireworks, gutta percha, and many other articles.

"It is a well known fact that volcanic dust is an excellent fertilizer. Wherever this dust has spread over an area with an average rainfall there is a very abundant and prolific vegetation. Along certain parts of the Rocky Mountain plains and over scattered areas of the Great Basin the country in places is literally covered with volcanic dust, and wherever this volcanic soil is subject to irrigation no better or more fertile soil can be found. The very beauty of Java, the "garden spot of the world," is due to the rich, fertile soil formed largely from volcanic dust and other eruptive matter that have fallen over the island at different periods in former volcanic eruptions."

Buttram's description of deposits of volcanic ash in Beaver County north of Gate follows:

"Another prominent dust deposit occurs near the center of the northwest quarter of sec. 10, T. 5 N., R. 28 W. and only about 1½ miles southwest of the first deposit described. The deposit at this place is about 10 feet thick. It outcrops on the surface but the top 3 feet contain some pebbles of impure limestone, quartzites, and thin seams of sands and other impurities common to the Pleistocene formations. The pebbles vary considerably in size, most of them being the size of small marbles, but one pebble or boulder 1 foot in diameter was seen. The bottom 7 feet of the deposit is almost free from impurities. It rests on a sandstone of very irregular grain, but, like the other deposit to the east, the contact line is very sharp.

"The volcanic dust in this deposit occurs in a ridge that runs north from the small canyon to the south. The dust is exposed only over a territory about 120 feet wide east and west, extending back along the ridge for a distance of about 450 feet. Farther to the north there is no surface indication of its presence, but there is no evidence that it does not occur immediately under the surface.

"About 300 feet southeast of the above deposit is another small bluff in which volcanic dust occurs. At this point the dust is very irregular in thickness. On the west end it is about 4 feet thick, but within the first 20 feet to the eastward it thins down and has a thickness of only one foot. From this point to the eastward, in a distance of 60 feet, it attains a maximum thickness of 7 feet. Apparently the dust extends only a short distance back in the ridge.

"Another deposit of dust outcrops up the canyon about 1,200 feet due east of the deposit just described. It is exposed for a distance of about 150 feet and is apparently about 10 feet thick. At the outcrop the deposit is covered with about 6 to 8 feet of surface soil, but within 225 feet it extends under an embankment.

"There were a few additional deposits of volcanic dust noticed in the general vicinity of Gate, but they were too small to merit further notice."

The chemical composition of the volcanic dust occurring in the deposits described above is shown by the following analysis:[1]

Analysis of Volcanic Dust at Gate, Oklahoma

SiO	72.18
Fe_2O_3, Al_2O_3	13.5
CaO	.54
SO_3	.597
Organic matter	5.05
Ma_2, K_2O, and MgO not determined	
	91.827

"About 4 miles west of the area discussed above, in the east-central part of the N. W. ¼ sec. 1, T. 5 N., R. 27 W., occurs a 12 foot deposit of material which resembles volcanic dust. Its principal constituents are CaO, 35.55 per cent; Fe_2O_3 and Al_2O_3, 23.49 per cent; and SiO_2, 10.68 per cent. This material when studied under the microscope shows numerous diatoms and Dr. Van Vleet, head of the Department of Botany in the University of Oklahoma, believes that practically all of the silica in this material is accounted for by the silica in the diatoms. The presence of these diatoms indicates that this calcareous diamtomaceous earth was deposited under water.

"Owing to the angular nature of the hardness of its component particules, diatomaceous earth has valuable abrasive properties and in most cases may be used as a substitute for volcanic dust. The deposit above is the only deposit of diatomaceous earth that is known to exist in the State of Oklahoma. It does not at present have any commercial value, however, because in the first place it contains too many impurities, and in the second place it is not accessible to railroad transportation.

"At first the writer was inclined to believe that this deposit occurs on an old extinct volcanic cone, because the out-cropping strata dip about 15° in every direction from a central excavation tion which has the appearance of an old crater. The diameter of the central depression is about 750 feet but there is no evidence of any former volcanic activity. Inasmuch as the strata lie unconformably on one another, and have never been affected by volcanic matter the dome structure is due to a slight local uprising of the surface formations, while the excavation is due to surface erosion."

In 1920 Mr. A. C. Shead, then chemist of the Survey, visited the general regions described by Buttram and gave a further description of a deposit which Buttram probably did not see. The following quotation is from an unpublished manuscript report made by Shead on file in the office of the Oklahoma Geological Survey:

"The Pemberton mine was apparently not listed in Bulletin No. 13 as it locates all deposits as northeast of Gate, Oklahoma, whereas this Pemberton prospect is northwest of Gate, Oklahoma,

1. Analysis made by F. L. Aurin, Chemist for the Oklahoma Geological Survey.

five and one half (5½) miles as shown by the speedometer and is in the N. ½ of the NW¼ of sec. 8, T. 5 N., R. 28 W. of the Cimarron Meridian in Beaver County as accurately as could be determined. It occurs in the gullies which are 30 feet deep and which are very noticeable, both on the map and the landscape. On the southwest rim of the gullies stands an old, but well preserved sod house that might serve as a landmark.

"An intermittent stream runs through the deposit and has cut deeply into the volcanic ash but not through it and has deposited gravel in its bed on top of the ash. Cliffs of almost pure white material averaging twenty feet in height form the banks of the canyon on both sides. The straight line distance through the canyon from limit to limit of the deposit is 115 steps or 345 feet, thus giving a working face of marketable material, exclusive of a slight overburden of about 6,900 square feet as a minimum. The width of the deposit is at least 50 feet before the top goes under an overlying marl bed (about 10 feet thick) which contains small but well preserved shells. These show that the overlying formation is very recent. This marl could be very easily mistaken for volcanic ash by a hasty examination but the presence of shells and a reaction for carbon dioxide shows very simply and readily the difference.

"The roads from this location to town have a fairly steep grade in some places, and in one spot at least is very sandy where a wide shallow creek crosses so that while the distance (5½ miles) is shorter to town than the Haynes place the roads are much worse and would probably tax vehicles much more severely.

"Records show that about nine car loads have been taken out of this deposit and the writer was told that the ash cost about $150.00 per car f. o. b. Gate, Oklahoma, the shipping point, utilizing teams. Farmers were hired in slack times to haul the material.

"The dust in both deposits is almost pure white, nearly impalpable and very free from foreign material."

Shead gives the following analysis of the material from the Pemberton mine:

Analysis of Volcanic Dust from Pemberton Mine

Silica, SiO_2	72.96
Alumina, Al_2O_3	12.91
Ferric oxide, Fe_2O_3, oxide of iron	.60
Ferrous oxide, FeO, oxide of iron	.90
Magnesia, MgO, oxide of magnesium	Trace
Calcium oxide, CaO, "Quick lime"	.73
Sodium oxide, Na_2O	3.96
Potassium oxide, K_2O	4.40
Water below 110° C., H_2O	.41
Water above 110° C., H_2O plus	4.33
Magnous oxide MnO	.04
Titanium dioxide, TiO_2	.14
	100.38

It will be noted from a study of a township map that the three deposits listed are in the same general region and in practically a straight line. The Pemberton deposit described by Shead lies about midway between the two deposits described by Buttram[1] and about 2 miles distant from each.

OIL AND GAS

During the past few years there has been a considerable amount of prospecting for oil and gas in Beaver and other counties of the Oklahoma Panhandle. Three wells have been drilled to a considerable depth. The first one, known usually as the Gate well, located near the eastern line of the county on sec. 33, T. 5 N., R. 28 E. of the Cimarron Meridian, was the first deep well drilled in this part of Oklahoma. The log of the Gate well follows:

Log of Gate Well, Sec. 33, T. 5 N., R. 28 E., Cimarron Meridian

Formation	Top	Bottom	Formation	Top	Bottom
Soil	0	5	Blue slate	905	910
Sand clay	5	25	Red rock	910	970
Red rock	25	40	Lime	970	978
Water sand	40	48	Red rock	978	985
Red rock	48	83	Sandy lime	985	1000
Water sand	83	90	Red rock	1000	1005
Red rock	90	170	Lime	1005	1015
Water sand	170	178	Red rock	1015	1045
Red rock	178	265	Salt	1015	1048
Sandy lime	265	268	Sandy lime	1048	1065
Red rock	268	275	Red rock	1065	1067
Sand	275	300	Sandy lime	1067	1080
Red rock	300	350	Red rock	1080	1085
Sandy lime	350	353	Sandy lime	1085	1100
Red rock	353	362	Red rock	1100	1123
Lime and gyp	362	395	Red lime	1123	1130
White lime	395	412	Red rock	1130	1140
Blue shale	412	420	Sandy lime	1140	1155
Brown shale	420	450	Red rock	1155	1160
Sandy lime	450	467	Salt	1160	1166
Salt	467	567	Gray lime	1166	1177
Red rock	567	572	Red rock	1177	1187
Salt	572	585	Blue lime	1187	1203
Red rock	585	620	Red rock	1203	1215
Salt	620	630	Lime	1215	1240
Red rock	630	670	Red rock	1240	1250
Salt	670	720	Salt	1250	1288
Red rock	720	740	Red rock	1288	1290
Sand	740	743	Salt	1290	1395
Red rock	743	840	Blue slate	1395	1405
Sand	840	842	Salt	1405	1430
Red rock	842	860	Red rock	1430	1510
Sandy lime	860	865	Blue slate	1510	1528
Red rock	865	890	Red rock	1528	1548
Sand	890	892	Blue slate	1548	1563
Red rock	892	905	Red rock	1563	1575

1. Idem. p. 35.

Formation	Top	Bottom	Formation	Top	Bottom
Brown slate	1575	1600	Slate	2190	2205
Red rock	1600	1625	Lime	2205	2245
Brown slate	1625	1650	Slate	2245	2248
Red rock	1650	1725	Lime	2248	2365
Blue slate	1725	1765	Sandy lime	2365	2370
Lime	1765	1770	Salt	2370	2395
Blue slate	1770	1775	Lime	2395	2505
Lime	1775	1780	Lime	2505	2665
Blue slate	1780	1795	Gray slate	2665	2667
Lime	1795	1820	Sandy lime	2667	2750
Blue slate	1820	1823	Water sand	2750	2765
Lime	1823	1840	Slate	2765	2770
Blue slate	1840	1855	Water sand	2770	2775
Lime	1855	1895	Red slate	2775	2780
Slate	1895	1900	Sandy lime	2780	2832
Lime	1900	1905	Slate	2832	2837
Slate	1905	1915	Lime	2837	2862
Lime	1915	1918	Asphalt	2862	2893
Slate	1918	1943	Brown sand	2893	2903
Lime	1943	1958	White lime	2903	2908
Salt	1958	1975	Lime and sand	2908	2918
Lime	1975	1990	Gray lime	2918	2940
Salt	1990	1997	Black lime	2940	3005
Slate	1997	2015	Gray lime	3005	3014
Salt	2015	2020	Blue shale	3014	3020
Lime	2020	2035	Lime, gray	3020	3030
Salt	2035	2040	Brown sand	3030	3040
Sandy lime	2040	2050	Lime and much sand	3040	3049
Salt	2050	2063	Pink lime	3049	3060
Limey salt	2063	2087	Gray shale	3060	3065
Lime	2087	2092	Coarse sand	3065	3068
Lime and slate	2092	2102	Brown shale	3068	3073
Lime	2102	2107	Gray lime	3073	3079
Salt	2107	2165	Black lime	3079	3099
Lime	2165	2170	Gray lime	3099	
Salt	2170	2190			

Another well located near the center of Beaver County in sec. 17, T. 3 N., R. 23 E., about ten miles southwest of Beaver City, known as the Skear or Carson well was drilled in 1924-1925, and reached a depth of 3,005 feet. The log of the well follows:

Log of Skear Well, Sec. 17, T. 3 N., R. 23 E., Cimarron Meridian

Formation	Top	Bottom	Formation	Top	Bottom
Soil	0	10	Sand (dry)	712	720
Red beds	10	250	Red beds	720	840
Sand and water	250	265	Red beds and salt, mixed	840	860
Red beds	265	300	Brown shale	860	1140
Sand and water	300	310	Soft red beds	1140	1500
Red beds	310	400	Hard gray lime	1500	1540
Quick sand	400	425	Red beds	1540	1600
Red beds	425	600	Brown shale	1600	1810
Salt	600	640	Soft cavy red beds	1810	2000
Red beds and blue shale	640	692	Brown shale	2000	2018
Blue shale	692	712	Hard blue shale	2018	2030

Formation	Top	Bottom
Hard white lime	2030	2040
Lime and blue shale, mixed	2040	2072
Sandy lime, good showing oil	2072	2075
Hard blue shale	2075	2102
Hard gray lime	2102	2105
Blue shale	2105	2120
Brown shale	2120	2123
Blue shale	2123	2250
Black shale, soft	2250	2262
Light blue shale	2262	2272
Hard sandy lime	2272	2287
Black shale, soft	2287	2295
Hard sandy lime, gray	2295	2300
Sand (dry, gray)	2300	2312
Black shale, mixed with soft white formation	2312	2318
Blue shale	2318	2340
Dark shale (fine)	2340	2370
Blue shale mixed with soft white formation	2370	2385
Mixture of lime, salt and sand	2385	2410
Soft blue shale	2410	2427
Coarse dark blue shale and soft white formation	2427	2450
White lime, not very hard	2450	2465
Black shale	2465	2475
Hard lime and blue slate mixed	2475	2522
Hard white lime	2522	2810
Sandy brown lime	2810	2915
Sand and water, about 600 feet water in hole	2915	2985
Brown sandy lime	2985	3005

A third deep well known as the Empire well completed in September 1923, is located in the southwest corner of Beaver County in sec. 6, T. 1 N., R. 20 E. of Cimarron Meridian. The log follows:

Log of Empire Well, Sec. 6, T. 1 N., R. 20 E., Cimarron Meridian

Formation	Top	Bottom
Soft red surface	0	19
Soft red mud	19	79
Hard red shell	79	82
Soft red sand 1 bbl. water per hr.	82	85
Soft red mud	85	125
Hard white lime	125	140
Soft red mud	140	180
Soft red sandy shale 15 bbls. water at 185′	180	195
Soft red mud	195	255
Soft red sandy shale	255	270
Soft red mud	270	331
Soft red quick sand	331	336
Soft red mud	336	367
Soft red quick sand	367	374
Soft red mud	374	395
Hard red shell	395	402
Soft red sand	402	406
Soft red mud	406	409
Soft red sand, ½ HFW	409	416
Soft red mud-hole cave	416	430
Soft sandy red rock	430	436
Soft red mud	436	447
Soft red mud	447	502
Soft red shell gyp	502	506
Soft red mud	506	512
Hard white rock gyp	512	530
Hard red shell	530	540
Hard white gyp	540	550
Soft red mud	550	580
Hard red shell	580	588
Soft red mud	588	653
Hard white shell	653	670
Soft red rock Boulders at 685′	670	685
Hard red shell	685	690
Soft red rock	690	785
Soft red mud	785	820
Hard red shell	820	825
Soft red mud	825	885
Soft red salt	885	895
Soft red mud	895	1040
Hard red sand	1040	1065
Soft red mud	1065	1165
Soft red shale	1165	1175
Soft red mud	1175	1275
Hard sandy shell	1275	1290
Soft red mud	1290	1340
Soft red sandy mud	1340	1360
Soft red sandy shale	1360	1450
Soft red mud	1450	1480
Soft gray lime mud	1480	1490
Hard gray lime	1490	1535
Soft red mud	1535	1595
Hard gray shell	1595	1610
Soft red mud	1610	1620
Hard white salt-caving	1620	1695

Formation	Top	Bottom
Soft red mud	1695	2040
Soft red shale	2040	2085
Hard white lime	2085	2090
Soft gray shale	2090	2115
Soft red mud	2115	2145
Hard gray shell	2145	2148
Soft gray slate	2148	2175
Soft blue slate	2175	2200
Hard white lime slate	2200	2320
Hard white lime	2320	2350
Hard white salt	2350	2355
Hard white lime	2355	2385
Soft blue slate-lime	2385	2530
Hard white lime	2530	2850
Hard white sandy lime	2850	2855
Hard white lime	2855	2860
Hard brown sand	2860	2905
Soft brown sandy lime	2905	2940
Hard white lime	2940	2975
Soft white sand	2975	2980
Hard white sandy lime	2980	3012
Hard white lime	3012	3037
Soft blue slate	3037	3040
Hard white lime	3040	3050
Soft white sandy lime	3050	3060
Hard white sand	3060	3083
Hard white lime	3083	3107
Soft blue slate	3107	3110
Hard white lime	3110	3119
Soft white sand	3119	3129
Soft blue slate	3129	3132
Soft white sand	3132	3140
Hard white sandy lime	3140	3147
Hard white lime	3147	3150
Hard white sandy lime	3150	3205
Hard black lime	3205	3215
Hard gray lime	3215	3290
Hard red mud	3290	3295
Hard white sandy lime	3295	3385
Soft white sand	3385	3392
Hard white lime	3392	3415
Hard black lime	3415	3423
Hard white sandy lime	3423	3475
Hard gray lime	3475	3537

By comparison of these wells it will be found that, allowing for discrepancies of drillers records, which is always a factor to be considered in the interpretation of any well log, the red beds were passed through at a depth of about 2,000 feet and that below this point the drill penetrated limestone and shale with beds of salt.

The general conditions connected with the occurrence of oil and gas in any particular region are so well known that they need only be mentioned here. Suffice it to say that at least four factors are necessary; first, a source of supply, second, a reservoir rock, third a cap rock, and fourth, some form of structure which will tend to segregate or separate the oil and gas.

The drilling in Beaver County shows that the same general stratigraphic conditions occur there as are known to occur in the Amarillo country in the Panhandle of Texas some sixty miles to the southwest, as well as at Texhoma, Oklahoma, Liberal, Kansas, and in Clark County, Kansas, at all of which places oil or gas have been found in commercial quantities. The Amarillo wells are located on well-defined structures, which were determined on the surface before the drilling was done. So far as the authors know the wells at Texhoma and Liberal were not located on determinable surface structure. There is a question regarding the structure in Clark County, Kansas.

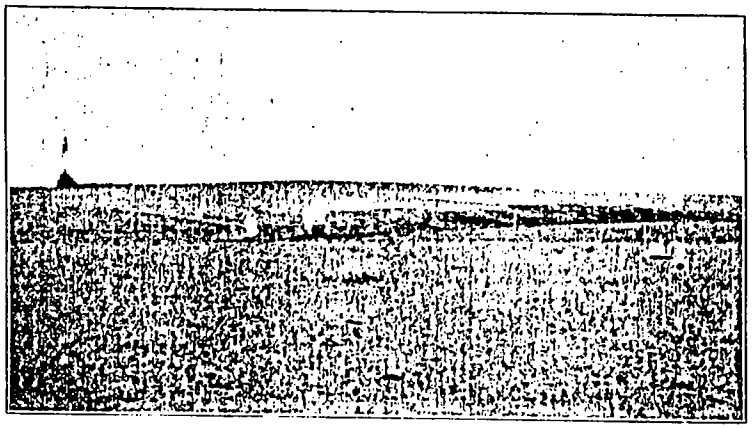
The most common oil bearing structures are anticlines, domes, and faults. When there are sufficient surface exposures geologists are sometimes able to determine these structures.

Drilling on a surface structure sometimes reveals the presence of oil, sometimes it does not.

In Beaver County any oil that would occur would probably be found somewhere below the base of the red beds in the same formation which produces oil and gas in the Amarillo region, at Texhoma, Liberal, and in Clark County, Kansas.

As has been stated under Geology the red beds are exposed in the southern part of Beaver County along the various streams which flow north into Beaver Creek. In these regions the authors did not find any surface anticlines, domes, or other favorable oil structures. The attention was called to certain places where other geologists had located oil structures, but the authors were forced to consider the apparent dips of the rocks at these places as examples of either cross-bedding or slumping rather than well defined anticlines or domes.

PLATE XII.



DRILLING FOR OIL SOUTHWEST OF BEAVER.
To the extreme right red beds are dipping away from the derrick location. (This is the structure).

It has already been stated that much of the northern part of the county that part lying north of Beaver Creek, is covered by a blanket of Tertiary deposits and sand hills. So far as we are aware no dependable surface structures have been found in the Tertiary rocks of Oklahoma, or any other states of the Plains. This will mean that any structures in the red beds which underlie the Tertiary will be concealed and covered, and cannot be observed from the surface. This does not mean that oil and gas may not occur in commercial quantities in Beaver County. In point of fact the results of drilling throughout this

general part of the plains, including Kansas, Oklahoma, and the Texas Panhandle during the past few years render it rather likely that these substances will be found in the county. It is, however, our opinion, that the discovery of oil and gas will be made either by accident, by the location of subsurface structures by core drilling, or by some other method, rather than by the results of the determination on the surface of dependable oil structures.

GENERAL CONCLUSIONS

The present consensus of opinion among geologists now working in the Panhandle of Oklahoma and adjacent parts of Kansas and Texas is to the effect that the northwestern part of the Anadarko Basin extends into the northern part of the Panhandle of Texas. The Anadarko Basin is a great structural trough or syncline lying north of the Wichita Mountains recently recognized in the Permian of southwestern Oklahoma. It is known to extend from a point in southwestern Garvin County a few miles west of the Arbuckle Mountains northwest for an unknown distance. Toward the axis of this basin the rocks dip from both directions. The axis of the Basin crosses Stephens, Grady, Caddo, Washita and Roger Mills counties, Oklahoma. The northwestern limits of the basin have so far not been determined but a study of logs of deep wells in the High Plains of southwestern Kansas, western Oklahoma, and the Panhandle of Texas indicates that it may be carried across southern Hemphill, central Roberts, northern Hutchinson, and probably northern Moore counties in the Panhandle of Texas. It may even be found to reach Dallam County, Texas, and southwestern Cimarron County, Oklahoma.

Beaver and Texas counties Oklahoma lie along what is now believed to be the northern rim of this basin. For the reasons stated many geologists now believe that a structural high occurs in these counties. This will account for the fact that geologists now consider these counties as likely places in which to prospect for oil.

As this report is being written and going through the press there is considerable activity in Beaver and adjoining counties looking toward the discovery of oil. It is our judgment that there need be no surprise if fields of commercial importance are found to occur in this region.

AGRICULTURE IN BEAVER COUNTY OKLAHOMA

By

ERNEST SLOCUM

GENERAL DESCRIPTION

Beaver County is located in the Panhandle of Oklahoma, being the eastern county of the three counties that compose it. It contains 1,768 square miles, being 52 miles long and 34 miles wide. The Beaver River runs through the entire county, lengthwise, and the Cimarron cuts across the northeast corner, but neither of them have many tributaries in the county. Along these streams the land is broken and is used principally for grazing purposes, however much of the rolling land is farmed.

The total area of the county in acres is 1,160,320 of which 875,311 is in farms; and of the latter figure, 422,017 is cultivated, the remainder being in pasture. Seventy-seven per cent of the farmers own their farms. The average size of the farms in the county is 346 acres.

CLIMATE

The altitude is approximately 2,600 feet above sea level. The temperature varies and has a tendency to run to extremes at times, due to the semi-arid condition and high altitude. These extremes range from 108°F in the summer months to as low as 16°F below zero in the winter. However, these temperatures are unusual and are usually of short duration; the winters generally being mild, and the summer nights, particularly cool and pleasant.

The average rainfall for the past five years is 19.09 inches; however 23.00 inches is the average over a greater period of time. May and June are the wet months, the winters being dry except for an occasional fall of snow.

TRANSPORTATION

The county has two railroads, the Missouri, Kansas & Texas, running through the county east and west, north of the Beaver River to Forgan, and the Beaver, Meade and Englewood connecting Beaver City to the M. K. & T., at Forgan.

Numerous graded highways as well as state roads traverse the county in all directions.

WATER SUPPLY

For domestic purposes the windmill is commonly used to pump the sheet water which is of excellent quality. The wells average about 125 feet in depth and furnish plenty of water.

SOILS

The soil is of two classes; the "north flat," that is the country north of the Beaver River, is of a more or less sandy loam, which is dark and rich; the "south flat," the country south of the river, is a very tight soil, resembling gumbo or hard pan, but there is a mixture of sand throughout which improves its quality. Both of these flats have many shallow lake beds on their surface, which sometimes contain water the year around. Some of them contain as much as a square mile of land and when drained make excellent farm land. The rough and broken land along the streams is composed of various kinds of soil, while along both rivers are seen sand dunes composed of a loose yellow and white sand which is worthless for cultivation.

CROPS

Small grains, wheat, rye, oats, and barley are extensively grown throughout the county and upon both flats the wheat very often yields 30 bushels to the acre, while the oats and barley commonly run around 50 bushels to the acre. The average yield per acre covering a period of five years is seventeen and two-fifths bushels for wheat, 25 bushels for barley and 12 to 20 bushels for rye and oats, these latter two not being grown so extensively.

Many of the wheat farmers own their own combine with which they harvest the small grain grown at an average cost of six cents per bushel. The average for each farmer is around 450 acres. The tractor is used quite extensively in the preparation of the wheat ground immediately after the harvest, as well as during the harvest to pull the combines.

Grain sorghums are grown abundantly for all feeding purposes. Kaffir, milo maize, sudan grass, and the many varieties of cane are planted, while along the river bottoms alfalfa and sweet clover thrive, as does wild grass of an excellent quality which is used as a forage for live stock throughout the winter months. About 75 per cent of the above grain crops are shipped out of the county not being needed for consumption locally. Some corn is grown, but the yield is never large. Broom corn is grown quite successfully, and all varieties are used, the dwarf being the most prevalent. The average yield of this crop is one ton to four acres.

Cotton is being grown but the yield is light on account of

the short season, and it probably never will become a staple crop. Garden truck and fruit are found in abundance in the sub-irrigated lands but on the flats these crops must be irrigated in order to produce a sufficient yield for the average family. Apples, cherries, grapes, and some peaches compose the main varieties of fruit grown.

LIVESTOCK

The dairy cow is playing an important part in the developing of agriculture in the county. The overhead expense is met on most farms by the product of the cow and the hen. As yet there are few dairy herds established, but what few there are are preeminently successful.

The beef breeds of cattle throughout the entire county are mostly all pure bred, and due to the ideal conditions of the county for producing healthy livestock are far above the average. The Hereford is the most prevalent breed on the larger ranches while on the farms, the Shorthorn and other breeds are seen.

Hogs are coming more and more into prominence in this county, the Poland China and Duroc being the favorites. Poultry in almost all of the leading breeds are to be found on the farms and many carloads of eggs and chickens are shipped out each year going to the larger markets.

During the last three years, due to the low prices, livestock breeders have sold most of their stock, keeping only enough on hand for breeding purposes. Present time prices are on the incline and considerable activity is being noted among the breeders.

METHODS OF FARMING

Due to the practice of dry farming the semi-arid conditions of the county is gradually giving way to increased yields of crops. This dry farming method consists of the conservation of moisture by the making of a mulch of the top soil promptly after each rain, thus storing the moisture in the sub-soil. Care is taken to keep down the weeds, and the mulch is never made too fine, because of the winds that might blow the soil about damaging the growing crop. When deep plowing is practiced which is seldom, the sub-surface packer is immediately used.

When the eastern and northern methods of farming are abandoned in favor of the necessary methods of cultivation in vogue in a semi-arid country, splendid crops are produced. These methods having for the most part been adopted, today Beaver County ranks well up in the list of successful agriculture counties of Oklahoma.

HISTORY OF BEAVER COUNTY OKLAHOMA

By
F. C. TRACY

FOREWORD

Beaver County prior to statehood, embraced that portion of the Territory of Oklahoma, lying between the 36 degrees 30 minutes and 37th degrees of latitude, and the 100th and 103rd degrees of longitude. Its area was nearly six thousand square miles, over three and one-half million acres.

In 1907 the Constitutional Convention divided Beaver County into three counties of nearly equal area. The eastern one-third retained its original name of Beaver County. The central one-third was given the name of "Texas" County, in honor of the state of which Beaver County was once a part. The western one-third was given the name of "Cimarron" County in honor of the non-existant "Cimarron Territory," the name of the Provisional Government under which No Man's Land, later Beaver County, knocked at the doors of Congress, seeking "admission to the United States" and extension of federal laws over its domain. The agitation raised in Congress over the status of No Man's Land, and opening its lands to settlement, was a material factor in bringing about the opening of the public lands in the Indian Territory and creation of the Territory of Oklahoma.

In assembling this history of Beaver County, necessarily recitals of events prior to 1907, relate to the original Beaver County.

EARLY HISTORY

The territory now embraced in Beaver County has been owned and disowned, claimed and disclaimed, has been an orphan among nations—a No Man's Land—and finally reached a haven of rest as an appurtenance to the state of Oklahoma. The handle to the pan. A nuisance to map makers, who usually detach it from the northwest corner of the map where it properly belongs, and place it on the lower left corner as an addendum. Yet, whether appurtenance, addendum or handle, it is a handle often needed by the pan statistically, in obtaining first place for some product of the farm or ranch.

Its lands have been under the sovereignty of two monarchies, three republics and two states. Its boundaries were cre-

ated as a result of diplomacy, of war, of slavery, and in part, just happened.

In 1803, its sovereignty passed from France to the United States in the Louisiana Purchase. Only to be disclaimed and given to Spain in 1819 through the Florida treaty in compromise over the more valuable territory along the Gulf coast. By this treaty the boundary lines between the United States and Spanish territory, were in part, designated as the 100th degree of longitude, the eastern boundary of Beaver County.

In 1824, through the successful revolution and independence of the Republic of Mexico, its sovereignty passed to Mexico, as a portion of the Mexican state of Texas. Twelve years later, Texas won her independence from Mexico, and its sovereignty passed to the Republic of Texas.

In December 1844, following several years of controversy in Congress, Texas was admitted to the United States, subject however, to several restrictions and conditions, of which two may be noted as having had an influence on the future boundaries of Beaver County. Namely, "The adjustment of all questons as to its (Texas) boundaries, as to other governments, shall be reserved to the United States," and, "That with the consent of Texas, four states or territories may be created from its territory" but that "in any state or territory which shall be formed out of its territory lying north of parallel 36 degrees 30 minutes slavery shall be forever prohibited."

Texas agreed to these restrictions and was admitted to the Union in March 1845, as a slave state, its domain extending to the Arkansas River far north of the Missouri Compromise of 1820. Its eastern boundary was the 100th Meridian, its western boundary a matter of dispute with Mexico.

The admission of Texas over the protest of Mexico, and controversy over its western boundary, lead to the war with Mexico and the subsequent acquisition by the United States of the Mexican states of California and New Mexico. The dispute between Texas and Mexico over its western boundary, became a dispute between the United States and Texas.

In September 1850 an agreement over this boundary was made through the passage of an act by Congress proposing to the State of Texas, "the establishment of its northern and western boundaries" relinquishment to the United States of all territory exterior thereto, and establishing a territorial government for New Mexico. For a consideration of ten million dollars Texas agreed, among other things, that its northern boundary should be parallel 36 degrees 30 minutes north latitude, (the Missouri Compromise line) and its western boundary, in part,

the 103rd meridian of longitude, relinquishing to the United States all territory exterior thereto.

The Territory of New Mexico was created in part from territory thus relinquished, having for its eastern boundary, the 103rd meridian, for its northern, the 37th parallel of latitude. Two boundaries for Beaver County were created by these measures, its southern and western.

Four years later, in 1854, Congress created the Territory of Kansas, with its southern boundary the 37th parallel of latitude, its western, the 102nd meridian. In 1861 the Territory of Colorado was created, with its eastern boundary the 102nd meridian, its southern the 37th parallel. The creation of these two territories with southern boundaries completed isolation from territorial government of the strip of government domain lying between the parallels of latitude 36 degrees 30 minutes and 37 degrees, and of longitude 100 degrees to 103 degrees. A narrow strip 34½ miles wide by 166 miles long, which in later years became known locally as the "Strip."

For many years this strip was unoccupied and forgotten. In the early eighties the Kansas counties adjoining on the north had become well settled. On the south, the Texas Panhandle had become the home of vast cattle ranches. Within the borders a few cattle men had established ranches along the streams. The "Strip" was believed to be Indian Territory lands, a portion of the Cherokee Outlet.

FIRST SETTLEMENT

In 1885, title to the "Strip" as a portion of the Cherokee Outlet was decided adversely to the Cherokee Nation. It was government public domain. Its survey was incomplete and it was not open for settlement, but as public domain it was subject to "Squatters rights" and as such, homeseekers could enter and squat upon the lands. This, many did in the fall of 1885.

In the early spring of 1886, a tidal wave of homeseekers entered the "Strip." Two postoffices were established. One at Gate City on its eastern border, the other at Beaver City, thirty miles westward. These offices were designated by the Postoffice Department as being in "Neutral Strip of Indian Territory." (N. S. I. T.) As a matter of fact it was never any portion of the Indian Territory. Shortly thereafter it was officially designated merely as "Public Land Strip."

The first school building constructed in the "Strip" was one at Beaver City in September 1886, with Mary Hunter teaching a subscription school therein.

The first church (Presbyterian) was erected in Beaver City in June 1887, with Rev. Robt. M. Overstreet as pastor. Inci-

PLATE XIII.

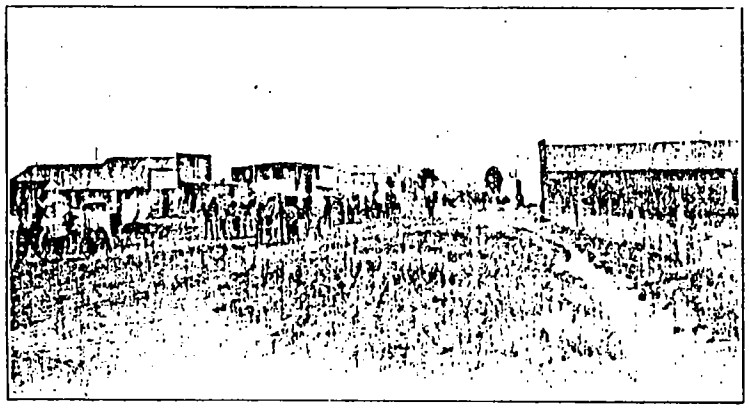
FIRST NORMAL SCHOOL CLASS, BEAVER CITY, 1890.

dentally it is claimed this church is the oldest one in Oklahoma. It is well preserved and has been continuously occupied by its members.

The first newspaper in the "Strip" was the "Territorial Advocate," first published by Brown and Payne at Beaver City in July 1887, and is the oldest newspaper in the State. Its name was later changed to "Beaver Herald" and is now the "Herald-Democrat."

The first and only townsite surveyed and platted in the "Strip" was that of Beaver City, in March 1886. An attempt

PLATE XIV.



BEAVER CITY IN 1896.

by townsite boomers from Wichita, Kansas, to perfect or obtain title to this townsite brought about the first information as to the actual status of the "Strip."

NO MAN'S LAND

To quote from an early statement of the status of the "Strip," "It was unorganized public domain, beyond the pale of any state or territory. Simply the property of Uncle Sam, a waste bit of pasture that he overlooked when laying out the rest of his farm in patches for cultivation.

"That it should have been overlooked in the course of legislation is not very surprising, but that it should be a part of the United States and yet beyond the reach of the United States courts and court officers is a matter needing explanation.

"The jurisdiction of each United States court sitting in the States and Territories around No Man's Land is definitely fixed by the bill creating the judicial district in which the court sits. No court can take cognizance of any crime committed beyond its jurisdiction. Because No Man's Land was not within the limits of any of the surrounding States or Territories, it was naturally enough overlooked in defining the judicial district.

"The sixth amendment to the Constitution of the United States provides that "In all criminal prosecutions the accused shall enjoy the right to a speedy and public trial by an impartial jury of the state and district wherein the crime shall have been committed, which district shall have been previously ascertained by law."

In what court, therefore, could a person committing a crime in No Man's Land be tried? He must be tried within the "district wherein the crime was committed, which district shall have been previously determined by law." No Man's Land was never within any district. A subsequent inclusion in some district would effect no remedy, for, at the time the crime was committed it was not committed within the district, and, another provision of the Constitution is brief but to the point, "No ex post facto law shall be passed."

"God made the west for those who knew
No fear, and He found many of them."

Knowledge that No Man's Land was beyond the pale of law or courts did not deter emigration to any perceptible extent. Surely Congress would remedy this condition without delay.

A conservative estimate of the population in 1887 would be between twelve and fifteen thousand. Settlement had extended for nearly one hundred miles from its eastern boundary.

Postoffices and small trading centers had been established at Gate City, Meridian, Blue Grass, Logan, Lockwood, Benton, and Alpine all east of Beaver City, and at Rothwell, Boyd, Paluduro, Hardesty, and Optima to the west from Beaver City. Another settlement had been made in the extreme west end around Mineral City.

Due to the fact that No Man's Land was beyond the law, it gained an unearned and unenviable reputation of being a lawless land, occupied principally by outlaws, thieves and murderers. For the past thirty years every news story purporting to be a history of the early days in No Man's Land has been largely a sensational account of the few homicides committed at Beaver City, with a little historical setting for proper background.

As a matter of history, No Man's Land was occupied by a sturdy, law abiding, homeloving class of people, principally from Kansas, Missouri, and Illinois. The usual source of disorder and crime, came from a floating element making some of the towns their temporary abode, and the few homicides to be noted came from this class through quarrels among themselves, or by vigilante action when such action became necessary.

Aside from the "Hay Meadow Massacre" of Kansas by Kansans in the county seat war between Huguton and Woodsdale, which occurred just over the No Man's Line the record of twelve thousand people in a newly settled portion of the west, in a land without law or courts, will show less than twenty homicides during the five year period of settlement. Five of these occurred at Beaver City, four at or near Gate City. The settlement of any other equal area of the west, under jurisdiction of law and courts will usually show an equal number.

As a substitute for courts, vigilance committees were organized around most community centers. Any actual homesteader could become a member. Though they seldom functioned, their existence was a deterrent to crime. When necessary they acted promptly and effectively. Probably one-third of the homicides noted were "executions" by vigilance committees, either by hanging or gunshot.

TERRITORY OF CIMARRON

During February and March 1887, organization of the "Provisional Territory of Cimarron" was effected at Beaver City. Viewed from the present day, it was a crude affair in itself but it was the medium through which a representative was sent to Washington, presenting credentials as a "delegate to Congress from Cimarron Territory" and a memorial to Congress asking "Admission to the United States," protection of federal laws and courts, and opening the lands to homestead entry.

Congress refused formal recognition to this delegate from "Cimarron Territory," though as a lobbiest or personal representative from No Man's Land this delegate appeared before Congressional committees giving first hand information concerning needed legislation.

The opening of public lands in the Indian Territory (Oklahoma) was prominently before Congress at this time, and legislation for No Man's Land became merged and involved with this issue—the age old conflict between those pioneers of the west, the cattleman and the homesteader.

PLATE XV.

R. K. PERRY OUTFIT IN 1895.

As a result, No Man's Land narrowly escaped going into the hands of the cattleman. An act, presumably as a temporary remedy for conditions in No Man's Land was maneuvered through both houses of Congress in the confusion of its closing days, attaching No Man's Land to Kansas for judicial purposes, directing a completion of its survey but carrying no appropriation for this purpose. Under its provisions, instead of its lands being opened to homestead settlement, they would have been subject to conversion into private hands through the medium of land script, with title passing in extensive blocks to land speculators and cattle interests. President Cleveland vetoed this act.

In 1889 Oklahoma was opened to settlement, with no provision made for opening No Man's Land. Its settlers, grown weary of squatting on lands awaiting the doubtful outcome of congressional legislation, abandoned their homes and flocked to the Oklahoma opening. From a population of over twelve thou-

sand in 1887, its population declined to less than three thousand in 1889.

In creating the Territory of Oklahoma in 1890, No Man's Land was included under the name of "Seventh County" with Beaver as its county seat. Seventh County was changed to Beaver County by popular vote at the first election under territorial government.

With its entry into Oklahoma Territory, the lands of Beaver County were opened to homestead entry. Squatters were given preference right to entry on their claims and a credit of two years residence thereon. It was made a separate land district, with a land office to be located in the district. Political townsite boomers were nearly successful in locating this land office at Buffalo, a non-existant town on the sparsely settled prairies but the storm of protest arising from this contemplated action caused the location to be changed to Beaver City.

Though the lands in Beaver County were open for free homestead entry, the opening of the Cheyenne, Kiowa, and other Indian reservations and the Cherokee Outlet, held the tide of emigration to central Oklahoma. From 1890 to 1903 the population of Beaver County never reached five thousand.

The first material emigration to Beaver County since 1886, came in 1903. The Rock Island railroad had constructed its road diagonally across the center of the county, and settlement spread both east and west from its stations. Overflow from the Cherokee outlet was also entering from the eastern border. By 1906 the population had increased from less than five thousand to more than forty thousand.

BEAVER COUNTY DIVIDED

In 1907 the western two-thirds of the county was segregated by the Constitutional Convention, and became Texas and Cimarron counties. By this division Beaver County lost its railroad mileage, and nearly two-thirds of its population.

In 1912 the Wichita Falls and Northwestern Railroad, a subsidiary of the M. K. & T. and now merged with the parent road, constructed its railroad partially through the county, making its terminal at a point six miles north of Beaver City.

Like most railroad construction in the west, with one unavoidable exception, for one hundred and fifty miles its survey avoided every established town near its route. Its promotors laid out their own townsites near established towns whose residents must necessarily purchase lots, move their buildings to the railroad and start anew.

BEAVER CITY BUILDS A RAILROAD

The Beaver River runs eastward across Beaver County. On its north are a range of sand hills two to four miles wide. Numerous streams and the greater portion of the acreage and population is south of the river. In avoiding the town of Beaver the railroad overlooked this material fact. Its terminal was located at Forgan north of the river and sand hills, while its principal tonnage must come from south of the river, and Beaver City with the gateway through which this tonnage must pass.

Unable to induce the railroad to build to Beaver, and aware of its advantageous position, its residents were determined Beaver would establish a precedent and be one town that the railroad would not move. If the road would not build to Beaver, then Beaver would build its own railroad. In this resolution the town had the moral and active support of a large farming community, who donated both labor and money toward its construction.

Thus came into existence the Beaver, Meade and Englewood railroad, whose mileage within the county this year will exceed that of the M. K. & T. The first construction began in the fall of 1913 when farm work was slack, and a few farmers offered to commence work on a grade if townspeople would provide board for themselves and feed for their teams. As word spread that farmers were going to build the grade, others joined the work. Within a week twenty were working, in another week fifty, and thereafter never less than a hundred, until the six miles of grade were completed.

These farmers were paid a unique and munificient wage. They were donating work, asking only expense money. A traveling kitchen followed the grade, providing meals for 25 cents. Hay and grain were supplied at wholesale, and a team ordinarily ate 75 cents worth per day. Thus expense was agreed to be 75 cents per team, 75 cents per man, and "10 cents for tobacco." Those who did not smoke were jokingly accused of hoarding their wages to buy diamonds.

With a completed grade, an appeal was made to the M. K. & T. Railroad to take the grade and right of way as a gift and complete the road, and the offer was declined. Funds were then raised to buy ten thousand ties and three miles of rails, and business at Beaver was suspended while its residents turned out and laid these ties and rails. Liniment and court plaster were in demand for many days thereafter.

Again the grade and three miles of track were offered to the M. K. & T. if they would build the remainder, and again the offer was declined. Assistance then came from an unexpected source. That which farmers had commenced, another farmer completed.

Jacob Achenbach, wealthy wheat farmer of Hardtner, Kansas, had been in a similar position to Beaver. Owning several thousand acres, he had been compelled to haul his wheat twenty miles to a railroad. He solicited the Santa Fe to build an extension to his vicinity, and was told to "go build a railroad himself." With the assistance of Mr. I. B. Blackstock of Springfield, Illinois, an old time friend and equally extensive farm owner at Hardtner, they constructed twenty miles of railroad to Kiowa, Kansas, then leased it to a rival of the Santa Fe, the Missouri Pacific.

Messrs. Achenbach and Blackstock were solicited to complete the B. M. & E. and upon investigation of its possibilities, accepted the offer declined by the M. K. & T. and the railroad to Beaver became a reality.

The Beaver, Meade and Englewood railroad is owned by these two men. It is an independent railroad having general offices at Oklahoma City, and has proved a financial success. It is the only railroad in Oklahoma free from indebtedness. In 1924 twenty additional miles were constructed westward across Beaver County, and it now has material arriving for a twenty mile farther extension to a connection with the Rock Island at Hooker, Texas County, to be completed in 1926.

PRESENT CONDITIONS

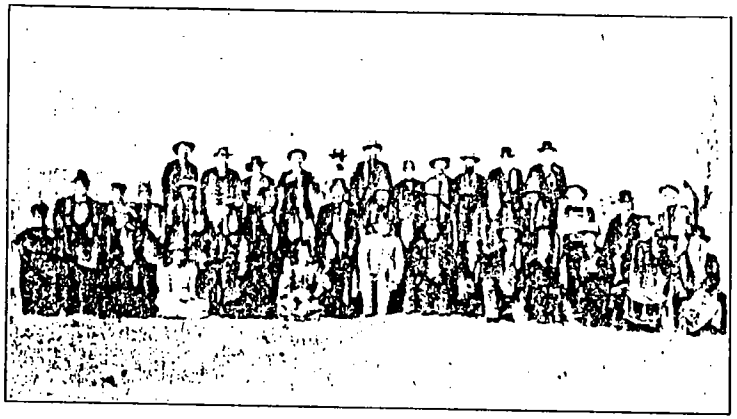
Beaver County of today is one of the progressive counties of the State, with an interstate reputation as the home of registered cattle, hogs and poultry. The best maintained dirt highways in the State are found in Beaver, Texas, and Cimarron counties. Beaver has a population of fifteen thousand, primarily a farming community. Its court house of concrete was built without a bond issue, and its sinking fund exceeds its bonded indebtedness. A stock pavillion and county fair buildings are constructed at Beaver, providing ample space for exhibit and sale of registered stock, and for holding the annual free county fair.

The sod dugouts of No Man's Land have been replaced with commodious farm homes and modern conveniences. Many have individual water and lighting systems installed. The covered wagons of former days are now automobiles, and the weekly newspaper is now a radio. The country school districts are to a large extent replaced with Union and Consolidated schools with motor transportation for pupils.

Gate, Knowles, and Forgan are substantial towns along the M. K. & T. railroad each having several churches, good grade schools and accredited high schools. Forgan has a municipal water and light plant.

Since the days of No Man's Land, Beaver has always been the metropolis and seat of government. Its first church building in Oklahoma now has company in the Christian, Methodist and Baptist edifices. Instead of its sod school house of '86 there is now a modern brick grade building and a $40,000.00 high school building erected in 1926. Its former sod business houses have been replaced by several blocks of substantial brick buildings. Its former open wells and oaken buckets have been supplanted with a model municipal light, water and ice plant, having duplicate engines, dynamos and pumps, which provide revenue for a municipal swimming pool as well as all other municipal expenses without taxation.

PLATE XVI.



G. A. R. REUNION IN 1895.

This is the transposition from No Man's Land to Beaver County.