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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF MUSKOGEE COUNTY, OKLAHOMA.

BY

GROVE B. JONES, CORNELIUS VAN DUYNÉ,
EWING SCOTT, AND H. W. HAWKER.

HUGH H. BENNETT, INSPECTOR, SOUTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1913.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1915.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 19, 1914.

SIR: The accompanying report and soil map cover the survey of Muskogee County, Oklahoma, one of the projects undertaken by the Bureau during the field season of 1913.

I recommend the publication of this report as advance sheets of Field Operations of the Bureau of Soils, 1913, as provided by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, Muskogee County sheet, Oklahoma.

SOIL SURVEY OF MUSKOGEE COUNTY, OKLAHOMA.

By GROVE B. JONES, CORNELIUS VAN DUYNE, EWING SCOTT, and
H. W. HAWKER.

DESCRIPTION OF THE AREA.

Muskogee County is situated in the eastern part of Oklahoma about midway between the northern and southern boundaries. It is irregular in shape and embraces an area of 814 square miles, or 520,960 acres. Its greatest length north and south is 38 miles and its greatest width east and west 36 miles. The county is bounded on the north by Wagoner and Cherokee Counties, on the east by Cherokee, Sequoyah, and Haskell Counties, on the south by Haskell and McIntosh Counties, and on the west by McIntosh and Okmulgee Counties.

This county includes three general physiographic divisions, one belonging to the Ozark Uplift, another to the Prairie Plains province, and the third, lying between these, comprising the bottoms and terraces of the Arkansas and Canadian Rivers.

The wooded uplands, locally known as "mountains," comprise about 7 per cent of the area of the county. With one exception—Rattlesnake Mountain—they are confined to the eastern tier of townships. These uplands do not form a continuous range, but are interrupted by the Arkansas River Valley and by areas of prairie. Rising to a height of 800 to 1,000 feet, these

mountains form a rugged escarpment with a nearly level crest which is deeply dissected by numerous small and intermittent streams.

The prairie plains, which form the greater part of the area of the county, rise generally toward the west, varying in elevation from 500 to 700 feet above sea level. The surface varies from nearly level to rolling and is broken in places by treeless ridges and rounded hills.

The terraces and overflow lands (see Pl. I, fig. 1) have their most extensive development near the junction of the Arkansas and Neosho Rivers, in the broad, high terraces south and west of Braggs, and at the junction of the Arkansas and Canadian Rivers.

The drainage of the entire county is into the Arkansas and Canadian Rivers. The smaller streams are intermittent, and during periods of extended drought water is found only in isolated pools in the larger tributaries. The Neosho and Verdigris Rivers, which empty into the Arkansas west of Fort Gibson, are not instrumental in the drainage of the county.

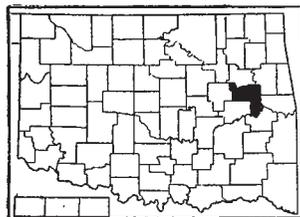


FIG. 1.—Sketch map showing location of the Muskogee County area, Oklahoma.

What is now Muskogee County was formerly a part of the lands of the Creek and Cherokee Nations. The county was organized in 1907, after Indian Territory and Oklahoma were jointly admitted to Statehood. When, as a Territory, the land was allotted to the Indians individually, that remaining was opened to settlement and the proceeds from its sale were placed in the treasury of the tribe formerly owning the land. The discovery of oil in 1894 and the subsequent development of the oil industry greatly increased the value of land, especially in the vicinity of Muskogee, where the best wells are located.

The county has a very mixed population, including Indians, whites, and negroes. The census of 1910 places the total at 52,743—a material increase over the 37,467 reported in 1907.

Muskogee, with a population of 25,278, is the county seat and the largest city in the county. It is particularly well situated with reference to markets, being 254 miles south of Kansas City, 203 miles north of Dallas, and 504 miles southwest of St. Louis. A large part of the local farm products and live stock is shipped to these points. Fort Gibson, the next largest town in the county, was established as a military post in 1824. It has a population, according to the 1910 census, of 1,344. Other towns of local importance are Haskell, Boynton, Porum, Webbers Falls, Taft, Oktaha, Braggs, and Warner. Other smaller towns and post offices are distributed throughout the county.

The school facilities are being improved. In the larger towns there are good graded schools and high schools, while rural schoolhouses are located conveniently throughout the county. The Connors State School of Agriculture, located at Warner, is doing much to improve methods of farming.

The county is supplied with an extensive system of public roads. Throughout the prairie country the roads follow section lines and are in good condition except during rainy weather. The mountain roads are rough and stony and have not yet been established along land lines.

Five railroads traverse the county, four of them entering Muskogee. The St. Louis, Iron Mountain & Southern Railroad affords transportation facilities for that part of the county east of the Arkansas River. The Midland Valley, the Missouri, Kansas & Texas, the Missouri, Oklahoma & Gulf, and the St. Louis & San Francisco Railroads provide for the remainder of the county. In addition to the steam roads an interurban electric line connects Muskogee with Fort Gibson.

CLIMATE.

Muskogee County has a mean annual precipitation of about 38 inches, which as a rule is well distributed, the greater proportion occurring during the growing season. The rainfall is thus sufficient

for the successful production of a wide variety of crops. Periods of drought, ordinarily short, occur during the summer months, but are rarely of sufficient intensity or duration materially to injure the crops, though in both 1912 and 1913 yields were greatly reduced by a scarcity of moisture during July and August.

The growing season is long enough to permit the maturity of many staple crops as well as fruits and vegetables, though the variable temperature during the spring season causes damage to fruit crops in some instances.

The mean annual temperature at Muskogee is 60° F. The absolute maximum is 109° F. and the absolute minimum -14° F., a range of 123 degrees.

The average date of the last killing frost in the spring is March 30, and of the first in the fall, November 2. The latest date of killing frost recorded in the spring is May 1, and the earliest recorded in the fall, October 10.

The following table, compiled from the records of the Weather Bureau station at Muskogee, shows the normal monthly, seasonal, and annual temperature and precipitation at that place:

Normal monthly, seasonal, and annual temperature and precipitation at Muskogee.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December	40.7	75	5	1.81	1.78	0.23
January	38.8	74	-1	1.69	0.35	1.45
February	38.3	80	-14	1.44	1.11	4.15
Winter	39.3			4.94	3.24	5.83
March	52.5	92	12	3.23	2.11	1.35
April	60.0	91	28	4.07	3.67	9.15
May	67.6	95	32	6.13	3.03	12.28
Spring	60.0			13.43	8.81	22.78
June	75.4	99	48	4.17	2.51	6.84
July	78.7	108	53	3.72	2.76	2.94
August	80.9	109	52	2.79	1.48	2.36
Summer	78.3			10.68	6.75	12.14
September	73.7	107	35	3.04	0.81	2.15
October	62.3	94	29	3.52	4.69	5.08
November	51.2	82	13	2.43	2.34	6.00
Fall	62.4			8.99	7.84	13.23
Year	60.0	109	-14	38.04	26.64	53.98

AGRICULTURE.

Muskogee County is embraced within the country originally allotted to the Creek and Cherokee tribes of Indians. Later this land was allotted to these Indians individually, but they were not permitted to dispose of any part of their allotment. Subsequently these restrictions were removed and they were allowed to sell all their property except the "homestead," which consisted of 40 acres. The unallotted land was purchased by settlers, and later much of that allotted to the individual Indians changed hands.

The Indians did not practice agriculture extensively, but raised some corn and subsisted principally by hunting and fishing. The early white settlers devoted themselves almost entirely to this method of livelihood, along with cattle raising.

The prairie country was for a long time considered suitable only for stock raising, and the bottom lands of the Arkansas and Canadian Rivers were the first to be cultivated. Gradually the prairie country was settled and cultivated. The sandy lands of the mountains were the last to be developed.

Corn and cotton were the crops grown on the bottom lands, and the same crops, with oats, wheat, and wild hay, were the leading products in the prairie section. Corn and cotton are still by far the most important crops (see Pl. I, fig. 2), but the agriculture of Muskogee County has become more diversified within the last few years and the methods of farming are being improved by means of labor-saving machinery and more intensive cultivation. Alfalfa, kafir, milo, and millet are crops of comparatively recent introduction. The 1910 census reports a total of 84,535 acres in corn in 1909, with a production of 1,511,586 bushels. Cotton is reported on 28,018 acres, with a yield of 10,723 bales.

It is only within the last eight years that the growing of alfalfa has been attempted, and this crop is steadily becoming more popular. It is recognized as a valuable feed for all kinds of stock, as well as an excellent soil renovator. In the census of 1910 a total of 303 acres is reported, with a production of 912 tons of hay. Alfalfa is grown almost exclusively on the river-bottom soils. Seeding is usually done in April, though some farmers prefer to seed in the fall, claiming that a better stand is obtained and that weeds are rendered less harmful. When seeded in April the first cutting can be made in June, the second in August, and a third in October. After a three-year stand, five cuttings are frequently made, the first three yielding about 1 ton per acre at each cutting, and the other two somewhat less.

In the 1910 census 3,883 acres are reported in Irish potatoes, with a total yield of 198,485 bushels. During recent years considerable attention has been given the commercial production of this crop near

Webbers Falls and Fort Gibson, on the river-bottom lands. The first crop is harvested in June, the average yield being about 100 bushels per acre. A second crop is sometimes harvested in October. These potatoes are banked—placed in the ground and covered with a foot or two of soil—and shipped in the spring. They possess much better keeping qualities than the June crop and bring a higher price in the spring than in the fall. The second crop only is used for seed. Potatoes are sold to buyers who visit the region at the beginning of the potato season. The principal markets are Kansas City, St. Louis, and Chicago.

Sweet potatoes are grown to some extent, and are found profitable. The acreage each year is being increased. The Yahola very fine sandy loam and very fine sand and the Reinach very fine sandy loam are well suited to this crop. The yield is from 150 to 200 or more bushels per acre and there is always a ready market.

Peanuts do exceptionally well on the Gerald very fine sandy loam, the Shawnee very fine sandy loam, and the Yahola very fine sand and very fine sandy loam, making an excellent crop for fattening hogs. Cowpeas are beginning to be recognized as a valuable crop not only for forage but also on account of their soil-improving qualities. They are usually planted in the corn at the second cultivation.

Oats are sown for early hog pasture, the stock being turned in when the grain is headed. The total area devoted to oats is given in the 1910 census as 6,983 acres, with a yield of 186,648 bushels. Wheat is reported on 106 acres, with a production of 1,080 bushels.

On some of the sandy types the growing of peaches and apples is becoming an important industry. The fruit produced on the mountain soils is said to be of exceptionally good flavor and color and to possess better keeping qualities than that grown on lower-lying types. The value of all orchard products of the county, including small fruits and nuts, is given in the 1910 census as \$27,897.

Hog raising is becoming an important and profitable industry in some parts of the county. The raising of beef cattle is practiced extensively, and there is a tendency toward the improvement of the herds. Some well-bred horses are kept, and considerable attention is given to the production of mules. Some of the dairy farms around Muskogee are stocked with Jersey and Guernsey herds. The total value of live stock in Muskogee County is given in the 1910 census as \$2,073,301.

The census of 1910 reports a total of 320,891 acres in farms in Muskogee County, with 217,522 acres improved. During recent years there has been a steady increase in the area actually under cultivation. The average size of the farms is given as 212.1 acres. According to the same authority, one-third of the farms are operated

by the owners. The tenant system of farming is thus seen to dominate the agriculture. The terms of leasing farm lands vary greatly. Most of the land is leased on shares, the owner receiving one-third of the corn and one-fourth of the cotton, delivered at the crib or gin. Where cash rent is taken, the rates range from \$5 to \$8 an acre if planted to corn, cotton, or alfalfa; from \$6 to \$10 when planted to Irish potatoes; and from \$10 to \$12 an acre when seeded to alfalfa.

Labor is scarce. Cotton pickers receive 65 cents to \$1 per hundred pounds, and are often difficult to obtain. Frequently a large part of the cotton crop remains ungathered until late in the winter on account of the scarcity of labor.

The value of farm land ranges from \$8 to \$20 an acre for the sandy mountain soils, from \$40 to \$100 for prairie land, and from \$100 to \$125 or more for first and second bottom lands. Land in the vicinity of oil developments frequently is not on the market or is held at a high price.

The soils of Muskogee County are capable of producing larger yields of all the crops grown than are now obtained. Throughout the county there is a general need for better crop rotations, a greater diversification of crops, the growing of legumes, and deeper and more thorough tillage.

SOILS.

The soils of Muskogee County are comprised in three broad groups: (1) The Great Plains, or residual prairie soils, including the Oswego, Gerald, Spearfish, Bates, and Leslie series; (2) the Ozark Border soils, including the Hanceville and Dekalb series; and (3) the alluvial soils, including (*a*) the Osage and Yahola series of the first bottoms, or overflowed bottoms of the streams, and (*b*) the McLain, Reinach, Brewer, Shawnee, Teller, and Muskogee series of the second bottoms, or nonoverflowed stream terraces.

The Great Plains soils occupy the prairie section of the county. They are residual, mainly from the underlying Carboniferous shales and sandstones which belong largely to the Winslow formation.¹ The Leslie soils are residual from limestone, shale, and sandstone.

The Ozark Border soils are the mountain soils of the county. They occupy the slopes and the flat to undulating tops and benches of the Ozark Mountains. They are residual, the Hanceville soils chiefly from sandstone, and the Dekalb soils from sandstone and shale.

Of the alluvial soils those developed in the first bottoms consist of recently deposited alluvium. The material is composed of wash from the sandstone and shale prairie soils, influenced in places by an admixture of sediment from Permian Red Bed areas. The second-

¹ See Muskogee Folio, U. S. Geol. Survey.

bottom or terrace soils are composed of old alluvium. The material consists mainly of wash from the residual prairie soils. These soils, like those of the first bottoms, are influenced by wash from the Red Beds region, which imparts a reddish color to the material.

Forty types, including two miscellaneous classifications—Rough stony land and Rock outcrop—are recognized in Muskogee County. These soil types represent 15 series.

The following table gives the names and actual and relative extent of the soils mapped in this county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Gerald silt loam.....	162,688	31.2	Shawnee very fine sandy loam.	4,416	0.8
Gerald very fine sandy loam..	75,264	15.5	Teller sand.....	4,288	.8
Shallow phase.....	5,120		Muskogee very fine sandy loam.....	3,264	.6
Hanceville fine sandy loam...	31,104	6.0	Osage loam.....	3,008	.6
Spearfish loam.....	25,856	5.0	Leslie stony loam.....	2,944	.6
Hanceville stony loam.....	25,408	4.9	Reinach silt loam.....	1,024	.4
Bates stony loam.....	17,728	3.4	Brown phase.....	1,024	
Gerald fine sandy loam.....	16,768	3.2	Teller loamy sand.....	1,728	.3
Oswego silty clay loam.....	16,512	3.2	Spearfish stony loam.....	1,664	.3
Osage silty clay loam.....	13,568	2.6	McLain clay.....	1,472	.3
Osage silt loam.....	11,968	2.3	Brewer silty clay loam.....	1,280	.2
Osage clay.....	10,240	2.0	Yahola silt loam.....	1,024	.2
Yahola clay.....	8,960	1.9	McLain silty clay loam.....	960	.2
Dark phase.....	1,216		Oswego clay.....	832	.2
Yahola very fine sand.....	9,856	1.9	Hanceville fine sand.....	704	.1
Oswego silt loam.....	9,792	1.9	Dekalb loamy sand.....	704	.1
Hanceville very fine sandy loam.....	9,216	1.8	McLain silt loam.....	576	.1
Rough stony land.....	8,128	1.6	Spearfish fine sandy loam....	576	.1
Yahola very fine sandy loam .	6,784	1.3	McLain very fine sandy loam.	448	.1
Yahola silty clay loam.....	6,336	1.2	Rock outcrop.....	448	.1
Gerald loam.....	5,888	1.1			
Reinach very fine sandy loam.	5,440	1.0	Total.....	520,960	.....
Spearfish very fine sandy loam.....	4,736	.9			

OSWEGO SERIES.

The Oswego soils are typically dark gray or black in color. The subsoils are yellowish and are compact and impervious. The series is of residual origin and derived from interbedded sandstone and shale, which sometimes occur as a bedrock substratum at comparatively shallow depths. The topography is usually gently rolling or rolling and as a rule the soils have good surface drainage but poor subdrainage. In this county the Oswego series includes three types—the silt loam, silty clay loam, and clay.

OSWEGO SILT LOAM.

The Oswego silt loam consists of a black or dark grayish brown mellow silt loam, underlain at an average depth of about 8 inches by a brown or dark-brown silty clay loam, which in turn is underlain at about 18 to 24 inches by yellowish-brown or greenish-yellow, plastic, heavy clay. The lower part of the subsurface, or silty clay loam stratum, is sometimes mottled with ochreous yellow, while the subsoil is in some areas mottled with red, especially in the upper part. The subsoil contains varying quantities of black oxide of iron concretions and sometimes a few lime concretions.

The Oswego silt loam is a prairie type, important areas lying to the east and southeast of Taft and northwest of Muskogee. Smaller areas are found in the western part of the county. The surface varies from level to very gently sloping and undulating, and nearly all of the type has good surface drainage. Cotton, corn, grass, sorghum, milo, peanuts, and Irish potatoes are crops that can be grown. The type is associated with the Oswego silty clay loam and is used for about the same crops. The yields are believed to average somewhat better than on the silty clay loam, for the reason that this soil is easier to maintain in a condition of tilth most favorable to the conservation of moisture.

The type has about the same value as the Oswego silty clay loam.

OSWEGO SILTY CLAY LOAM.

The soil of the Oswego silty clay loam is a black, moderately friable silty clay loam. This is underlain at about 8 to 12 inches by a dark-brown to brown rather compact heavy silty clay loam, which usually extends to a depth of about 18 to 24 inches, the lower part frequently being mottled with yellow. The subsoil is a dark yellowish brown or yellow, heavy plastic clay frequently having a greenish tinge and mottled with yellow, and in places with red. The subsoil usually contains small iron concretions, these being abundant in some places, especially where the drainage is not well established. Lime concretions also occur in the subsoil of some areas. Occasionally the heavy yellowish subsoil clay is encountered immediately beneath the black silty clay surface soil, sometimes within 10 or 12 inches of the surface. The line of separation between the soil and subsoil is nearly always sharp. The shales giving rise to this soil generally lie in a nearly horizontal position. They have been weathered in most cases to a depth of somewhat over 3 feet, and frequently to a depth of 8 to 10 feet, and possibly more.

The Oswego silty clay loam is a prairie type. Its surface configuration varies from flat to gently sloping and undulating. The more nearly level areas are usually lower than the sloping and undulating

areas. Some of these are rather poorly drained and carry sufficient alkali in places to have a harmful effect upon crops. This phase of the Oswego silty clay loam is known as "flat black prairie." The remainder of the type occupies long, gentle slopes and very slight ridges, and together with the corresponding phase of the other Oswego soils, is called "black ridge prairie."

Important areas of the Oswego silty clay loam are situated at Haskell, at and to the northwest of Council Hill, and near Crekola.

This is considered a good type of prairie land, well suited to the production of cotton, corn, grass, sorghum, and milo. With deep plowing and favorable rainfall, yields of about 1 bale of cotton, 60 to 75 bushels of oats, and about 50 bushels of corn per acre are obtained. In dry seasons, however, the yields fall considerably below these figures. When there is an abundance of rainfall cotton matures slowly, and the crop is sometimes damaged by frost. When the crop shows such a tendency, applications of 300 to 400 pounds per acre of acid phosphate are beneficial, materially hastening maturity.

Strong teams and implements are necessary for the proper breaking of this land. The type is valued at about \$20 an acre.

OSWEGO CLAY.

Typically, the Oswego clay consists of a black plastic clay, very dense and heavy below a depth of 1 inch. The lower part of the soil profile usually has a slightly lighter color, being very dark brown or dark gray, faintly mottled with yellow. In dry weather the soil hardens and cracks to a considerable depth; when wet it is very sticky and plastic.

Only one important area of the Oswego clay is mapped. This occurs about $2\frac{1}{2}$ miles northwest of Council Hill and embraces about one square mile. A few small areas occur in the northeast corner of the county.

This type is largely used for hay and pasturage, and owing to the difficulty experienced in cultivating it this is probably its best use.

GERALD SERIES.

The Gerald soils differ from the Oswego in having a lighter color. The surface soils are gray or grayish brown to light brown. The subsoils consist of light brown or yellowish-brown silty clay loam, which grades into a dingy-brown or snuff-colored, plastic, heavy clay, deeper subsoil, frequently mottled with gray. A substratum of sandstone often occurs at about 36 to 48 inches. Iron concretions are of common occurrence in the soil and subsoil. The topography varies from flat to strongly rolling, but the surface is not badly dissected or broken. Surface drainage is good in rolling areas, but

underdrainage is poor on account of the imperviousness of the heavy clay subsoil. The flat areas comprise poorly drained, late soils. The Gerald series is typically developed through a broad section of the northern Ozark Plateau region. In mode of formation and character of parent material these soils are similar to those of the Oswego series. A large part of the Gerald soils occur as prairie.

In Muskogee County four types are recognized—the Gerald fine sandy loam, very fine sandy loam, loam, and silt loam. Together they cover more than half the area of the county.

GERALD FINE SANDY LOAM.

The Gerald fine sandy loam in its typical development consists of a dark grayish brown fine sandy loam, underlain at about 6 inches by yellowish-brown, friable fine sandy loam, which in turn passes at a depth of about 16 to 20 inches into a yellow clay containing considerable sand and mottled in places with red. The parent sandstone is ordinarily reached at about 24 to 36 inches. In some places the rock is much nearer the surface, displacing the clay subsoil. Low mounds are of frequent occurrence.

This soil occupies moderate slopes and low ridges in the prairie. The most important areas are those in the vicinity of Crekola and Mission, about 2½-miles north of Warner, south and southwest of Keefeton, and south and east of Summit.

This type is rather excessively drained, except where the bedrock lies about 2 feet below the surface. Most of it is used for the production of hay and pasturage. With adequate rainfall fair yields of hay are produced.

GERALD VERY FINE SANDY LOAM.

The typical soil of the Gerald very fine sandy loam is a grayish-brown to dark grayish brown, friable very fine sandy loam. This is underlain at an average depth of about 6 to 8 inches by a lighter brown or yellowish-brown, compact to friable very fine sandy loam, which in turn is underlain generally between 24 to 30 inches by yellowish-brown or yellow, tough, plastic heavy clay. Although there is usually an abrupt change from the very fine sandy loam of the subsurface layer to the heavy clay of the subsoil, there is in some areas a gradational layer of silty clay loam. In a few areas the upper part of the subsoil is slightly mottled with red. As in the case of the silt loam, the immediate surface soil dries out to a decidedly grayish color, but when moist the surface material ranges from grayish brown to dark brown. Some iron concretions are occasionally encountered in the subsoil.

The material of this type is derived from arenaceous shales interstratified with shaly and moderately thick-bedded, fine-grained,

yellowish sandstone. Weathering has taken place throughout the greater part of the type, to a depth of over 3 feet, and only in a few areas, especially on the crests of ridges and upper slopes, is the parent rock encountered at depths of less than 3 feet. A few fragments of the rock are intermingled with the soil material.

The Gerald very fine sandy loam is extensively developed throughout the prairie section of Muskogee County. It occupies gently sloping, undulating, and gently rolling areas. Mounds are of frequent occurrence over a large part of the type. These are generally larger, a little higher, and more numerous than on the Gerald silt loam. In some places they give the surface a billowy appearance and interfere somewhat with cultivation. In these mounds the soil is usually somewhat lighter in texture than elsewhere, while clay is not usually reached within 3 feet of the surface. A greater part of this type is well suited to cultivation. Lighter teams and tools can be used than on the silt loam.

This type has good surface drainage and underdrainage. Where plowed to the proper depth and cultivated frequently it conserves moisture well. With the ordinary uniform depth of plowing, however, the subsurface frequently becomes compact, assuming a hardpan-like structure which favors the loss of moisture by evaporation. In order to prevent this in soils of this kind it has been found advisable to break the ground to a depth of at least 10 inches, and it is generally better to subsoil below this, particularly in those fields having a compact subsurface layer. The injury to crops resulting from dry weather is materially diminished by deep plowing and subsoiling, with frequent shallow cultivation, and by plowing under organic matter. Owing to its thorough drainage, the soil warms up earlier than the Gerald silt loam, and crops generally mature earlier than on that type.

The Gerald very fine sandy loam is well suited to the production of cotton, corn, cowpeas, sorghum, kafir, milo, and oats. With the same treatment it produces somewhat lower yields than the Gerald silt loam.

Other crops which do well on this soil are sweet and Irish potatoes, peanuts, watermelons, and a number of vegetables.

Gerald very fine sandy loam, shallow phase.—The characteristic location of the shallow phase of the Gerald very fine sandy loam is on the narrower ridges and upper slopes. The phase typically consists of a brown to dark-brown, friable very fine sandy loam, underlain at about 8 to 18 inches by light-brown or yellowish-brown, friable very fine sandy loam. Bedrock is encountered between 15 and 36 inches. Usually the lower part of the soil material is mottled with ochreous yellow. Sometimes a thin layer of silty clay loam

occurs directly over the bedrock. Fragments of the rock are commonly disseminated throughout the soil material.

The parent rocks are similar to those giving rise to the typical Gerald very fine sandy loam.

This phase is of moderate extent. It occurs in association with the typical soil and other members of the Gerald series. It is excessively drained, and is less productive than the main type. It is used mainly for pasturage and forage crops.

The results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Gerald very fine sandy loam are given in the following table:

Mechanical analyses of Gerald very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450305.....	Soil.....	0.2	0.9	2.6	16.9	34.8	35.7	8.8
450306.....	Subsoil.....	.2	.4	2.1	14.6	34.6	29.5	18.4
450307.....	Lower subsoil...	.2	.4	.9	5.7	15.1	43.9	33.8

GERALD LOAM.

The Gerald loam consists of a brown heavy fine sandy loam to light loam, underlain at about 6 inches by a yellowish-brown, friable heavy fine sandy loam or loam, which rests, usually between 15 and 20 inches, on bedrock. In some places there is a thin layer of yellowish clay immediately above the bedrock. Small fragments of the parent arenaceous shale and sandstone are disseminated throughout the soil mass.

This type, together with other shallow soils of the same series, is sometimes locally known as "shale land." It is a prairie soil, occupying slopes and low ridges. It is used mainly for pasture and for the production of hay and kafir. Crops are inclined to suffer during dry periods more than on the deeper soils.

GERALD SILT LOAM.

The typical soil of the Gerald silt loam is a dark-brown or dark grayish brown mellow silt loam, underlain at an average depth of about 6 inches by a brown to yellowish-brown, compact or moderately friable silt loam which extends to depths ranging from about 18 to 30 inches. The subsoil characteristically is a yellowish-brown to yellow, tough, plastic heavy clay, sometimes faintly mottled with ochreous yellow. Black iron concretions and sometimes lime concretions occur in the subsoil of some areas. In a few places the subsoil is faintly mottled with gray or red. The line of separation between the soil and subsoil is practically always distinct. The upper few inches of



FIG. 1.—TERRACE IN FOREGROUND AND BOTTOM LAND IN MIDDLE DISTANCE.

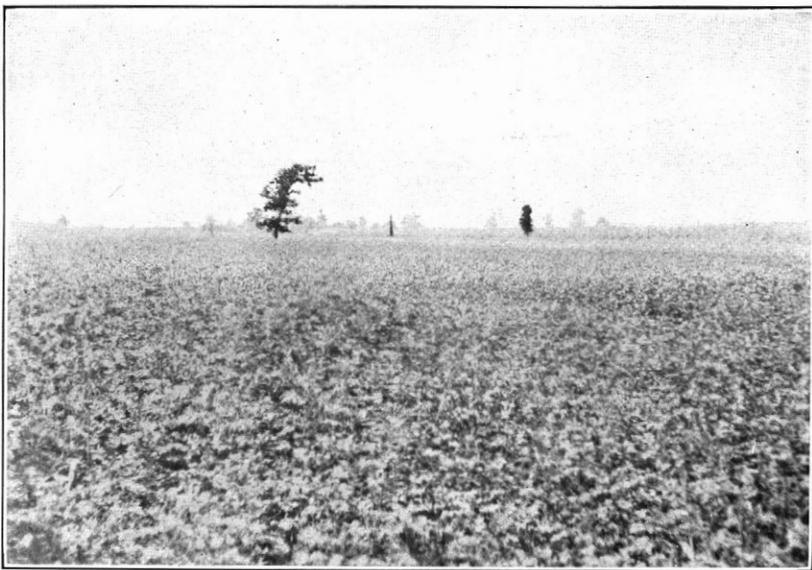


FIG. 2.—COTTON ON WELL-DRAINED TERRACE SOIL.

the subsoil sometimes consists of a moderately friable silty clay loam, and in such areas the change from soil to subsoil is rather more gradual.

On drying out thoroughly the immediate surface generally has a decided grayish cast, while the subsurface material in those fields which have not been plowed deeply so as to conserve moisture has a very compact structure, favoring an upward movement of soil moisture by capillarity and a rapid loss of the moisture through surface evaporation.

Rocks, mainly of the Winslow formation, give rise to this soil. Weathering has taken place to depths ranging from about 4 to 8 or 10 feet, though in occasional small areas the parent rock is encountered in the lower part of the 3-foot section, and a few small fragments are disseminated through the soil mass. The underlying rocks lie in a nearly horizontal position.

The surface of the Gerald silt loam varies from level, as along Ash Creek just south of Haskell, to gently sloping and moderately rolling. In places round hummocks or mounds about 2 feet high and 10 to 15 feet in diameter occur at irregular intervals. The surface drainage is good, except in flat and slightly depressed areas, where water sometimes stands on the surface. The soil absorbs water rapidly, and where deep plowing and subsequent shallow cultivation are practiced it conserves moisture sufficiently to meet the ordinary requirements of crops, except during long periods of dry weather. In the occasional flat areas which do not have proper surface drainage alkali occurs in harmful quantities.

The Gerald silt loam is extensively developed in the prairie section of the county, and all of it is available for cultivation. The crops to which it is best suited are cotton, corn, sorghum, milo, grass, and oats (see Pl. II, fig. 1). With good seasons cotton yields 1 bale or more, corn from 35 to 60 bushels, and oats from 40 to 75 bushels per acre. Droughts frequently reduce these yields considerably. Wheat is grown in a small way, and yields about 20 bushels per acre. Cow-peas fruit well and make a good growth of vine when the rainfall is sufficient. Peanuts do very well and Irish potatoes fairly well. Land of this type is valued at about \$40 an acre.

SPEARFISH SERIES.

The soils of the Spearfish series are chocolate brown to red, and sometimes carry a sufficient quantity of organic matter to impart a dark-brown color to the immediate surface. The subsoils are reddish brown to red. Fragments of gypsum usually occur in both soil and subsoil. A stratum of gypsum or gypsum-bearing rocks often occurs at shallow depths. The Spearfish soils are of residual origin, and are

derived from gypsum-bearing shales and sandstones. The topography is level or gently rolling to rough. These soils are usually shallow, and their irrigation is difficult. In Muskogee County four members of the Spearfish series are encountered—the stony loam, fine sandy loam, very fine sandy loam, and loam.

SPEARFISH STONY LOAM.

The Spearfish stony loam is a brown or reddish-brown loam or very fine sandy loam, underlain by reddish-brown or red heavier material, mottled in places with ochreous yellow. Usually bedrock is encountered at a depth of about 10 to 15 inches, and small and large fragments of flaggy sandstone occur on the surface and throughout the soil mass. The type is so stony that it can be cultivated only with difficulty.

The Spearfish stony loam typically occupies the smooth plateaus, or small mesas in the vicinity of Crekola. On the escarpment of some of these there is a strip of yellowish, plastic stony clay. The type is treeless, and is used only for pastures.

SPEARFISH FINE SANDY LOAM.

The Spearfish fine sandy loam is a brown to reddish-brown loamy fine sand to light fine sandy loam which becomes heavier in texture and more compact in structure with increase in depth. At about 15 to 20 inches a buff or reddish-yellow, compact, friable light sandy clay, or fine sandy clay loam, which becomes redder in the lower portion, is encountered.

The topography is undulating, and the drainage is excellent. The type appears to be the prairie equivalent of the Hanceville fine sandy loam. Areas of this soil occur about $2\frac{1}{2}$ miles east of Muskogee and 2 miles southeast of Porum.

This is a good soil for cotton, corn, cowpeas, oats, sweet potatoes, Irish potatoes, sorghum, watermelons, peanuts, and peaches.

SPEARFISH VERY FINE SANDY LOAM.

The soil of the Spearfish very fine sandy loam is a brownish or reddish-brown loamy very fine sand to light very fine sandy loam, underlain at about 10 to 15 inches by reddish-yellow to reddish-brown, compact, friable very fine sandy loam, which becomes heavier and redder with increase in depth. The subsoil, beginning at about 2 feet, is a yellowish-red to red, friable very fine sandy clay.

This soil is derived from yellowish or reddish fine-grained sandstone, and it characteristically occurs on the crests of ridges. The drainage is thoroughly established, and yet sufficient moisture is conserved under ordinary seasonal conditions to supply the needs of crops.

The Spearfish very fine sandy loam is a warm-natured, early soil, very well suited to corn, cotton, oats, peaches, cowpeas, sorghum, kafir, sweet potatoes, Irish potatoes, watermelons, and a number of vegetables. With the same treatment, the yields are a little better than those obtained on the Spearfish fine sandy loam. Some apples of fair quality grow on this type.

SPEARFISH LOAM.

The Spearfish loam is a reddish-brown or chocolate-brown, mellow silty loam, underlain at about 12 to 14 inches by a red, moderately friable clay, which becomes sandier in texture and more friable in structure, and usually has a more yellowish-red color, with increase in depth. Bedrock is encountered at depths of about 24 to 40 inches. In places fragments of sandstone are scattered over the surface and disseminated throughout the soil mass. This type is sometimes known as "red shot land."

The soil has good surface drainage and underdrainage, and warms up early in the spring. Crops reach maturity early on this soil.

The type occurs on slight elevations of low ridges throughout the prairie section of the county. The larger areas are encountered in the western part of the county.

This is a good agricultural soil and the greater part of it is under cultivation. It is easy to cultivate, and with proper management holds sufficient moisture for the ordinary needs of crops. The type is well suited to cotton, corn, oats, kafir, sorghum, watermelons, sweet potatoes, Irish potatoes, and cowpeas. It is used chiefly for cotton, corn, oats, and kafir. A number of vegetables can be successfully grown. Peaches do well.

BATES SERIES.

The soils of the Bates series are typically dark gray, and the subsoils yellowish and mottled red or yellowish or buff in the upper part and mottled with yellow and red in the deeper section. The series is residual in origin, and is derived from sandstone and shale rocks. These soils are distinguished from those of the associated Oswego series by their more pervious subsoils and from the Boone series by the darker color of the surface soils. They are usually well drained and have a level to undulating topography. Only one member of the Bates series, the stony loam, is mapped in this county.

BATES STONY LOAM.

The Bates stony loam typically consists of a dark-brown to black silt loam or loam, underlain at variable depths, usually about 8 to 15 inches, by tough, heavy, plastic clay, generally mottled with red

and yellow. In some places the color is mottled yellow and bluish. Blue is most conspicuous in the deep subsoil or substratum. Outcrops and large and small fragments of fine-grained sandstone are abundant.

The type characteristically occurs on the slopes of higher ridges in the prairie section of the county. Practically none of it is under cultivation. Stunted oak is established in some areas, while sumac is abundant in others.

Apples, peaches, and grapes probably could be grown successfully.

LESLIE SERIES.

The Leslie soils are typically black, with dark-gray or mottled, compact, tough clay subsoils. The depth of the soil and subsoil material varies from a few inches to several feet. There is ordinarily an underlying stratum of alternating beds of limestone and black fissile shale, from which the series is derived as a residual product. Fragments of limestone and shale are usually present to some extent in the soils and subsoils. The topography varies from steep to rolling. The Leslie series is represented in Muskogee County by a single type—the stony loam.

LESLIE STONY LOAM.

The Leslie stony loam is a very dark brown to black clay loam to loam, underlain by yellow plastic clay which in places is mottled with red.

The type occurs along the lower steep northern escarpment of Gibson Mountain and in the adjoining undulating valley and along the lower slope and valley of Greenleaf Mountain, southeast of Braggs.

On the escarpment the soil is mainly derived from pure limestone interbedded with what seems to be an arenaceous limestone, while over the smoother valley floor it is derived from interbedded pure limestone, thin argillaceous limestone, and dark-colored shales. On the escarpment slope, ledges of limestone and fragments of limestone, with some sandstone fragments from the sandstone underlying the Hanceville stony loam above, give the soil a decidedly stony character. In the valley-floor development, flaggy limestone fragments and small shale fragments are moderately abundant on the surface and throughout the soil section, while outcrops of these rocks are common. The rocks giving rise to this material are of the Morrow formation.

That part of the type occupying the escarpment is timbered with hardwood, while a part of the other phase is also forested. A part of the smoother valley area is used for cotton and corn, giving moderate yields where the bedrock is not encountered at shallow depths.

HANCEVILLE SERIES.

The Hanceville series comprises light-brown to reddish-brown surface soils, with red and moderately friable subsoils. These soils are derived from sandstones and shales and are associated with Dekalb soils. Four members of this series are recognized in Muskogee County—the Hanceville fine sand, stony loam, fine sandy loam, and very fine sandy loam.

HANCEVILLE FINE SAND.

The Hanceville fine sand to a depth of about 10 to 20 inches consists of a light-gray to gray loose-textured fine sand. This is underlain by a yellowish-gray loose fine sand, which becomes slightly sticky below and extends to a depth of more than 36 inches. In places the lower subsoil is mottled with red and yellow.

The type occupies undulating to rolling areas and is thoroughly to excessively drained. Owing to the incoherent open structure of the soil there is a tendency for crops to suffer from drought, and the yields are small when the growing season is unusually dry.

The Hanceville fine sand occurs only in the southern part of the county, the largest area being encountered in the extreme southwestern corner.

Under natural conditions the soil is a better soil for cowpeas, potatoes, watermelons, peanuts, and vegetables than for cotton, grains, and grass. The soil is in need of organic matter. In favorable seasons from one-third to one-half bale of cotton and from 8 to 25 bushels of corn per acre are the ordinary yield.

The natural timber growth consists of oak, with some hickory. The larger trees have been killed by girdling and left standing in nearly all the cultivated fields.

The value of the type ranges from about \$10 to \$20 an acre.

HANCEVILLE STONY LOAM.

The Hanceville stony loam is a rather variable type, especially in the color of its subsoil. In its typical development it consists of a dark-brown loam, underlain at about 5 inches by a compact silty loam, which at a depth of about 8 to 12 inches passes into a red, heavy, brittle clay slightly mottled with gray or yellow. Fragments of yellowish, flaggy fine-grained sandstone are present on the surface and throughout the soil section in quantities sufficient to interfere with cultivation. Frequently the subsoil is a yellowish-red or red clay without mottlings. In some places it is a rather intensely mottled red and yellow, plastic clay, while in others it consists of a red clay mottled with bluish, yellowish, and grayish colors.

The type is confined to the eastern part of the county, where it occupies steep slopes and high ridges. The largest areas are those

southeast of Muskogee and southeast of Fort Gibson. This type represents a part of the western extension of the Ozark uplift.

The type is largely forested with post oak, blackjack, and hickory. In a few cleared areas fair crops of cotton, corn, and cowpeas are produced. Peaches and apples should be grown successfully on this soil.

HANCEVILLE FINE SANDY LOAM.

The Hanceville fine sandy loam consists of a brown to reddish-brown or grayish-brown fine sandy loam, underlain at about 6 to 10 inches by red to reddish-brown, friable fine sandy loam. Red is the predominating color of the subsoil. A few areas of small extent on Gibson Mountain and elsewhere having a yellowish subsoil are included in this type. The area east of Oktaha is a grayish-brown medium to fine sandy loam having a yellowish-brown subsoil of similar texture, overlying a gray or brown sandstone. The areas having a yellow subsoil really comprise another soil, but were not separated on account of their small size.

Bedrock, consisting of reddish, yellowish, gray, and brown fine-grained sandstone, is encountered within the 3-foot section, usually between 15 and 24 inches, and frequent outcrops occur in small areas, especially on the slopes and along the intermittent stream courses. Fragments of rocks, both large and small, are abundant on the surface and throughout the soil section where the type occupies uneven country, while the more nearly level areas are practically free from stone. The latter topography, however, constitutes a very small percentage of the type.

It was found impracticable to make a separate classification showing the shallow or stony phase of the Hanceville fine sandy loam, owing to its irregular occurrence, and the type, therefore, includes areas of Hanceville stony sandy loam, which have been formed by erosion through the carrying away of the finer soil particles and by unequal weathering of the parent rock. As mapped the type also includes patches of stony sandy loam in which the soil is a brown to reddish-brown fine sandy loam, underlain at about 6 to 8 inches by a reddish-brown to red, friable fine sandy loam, which generally rests upon bedrock at a depth ranging from about 10 to 20 inches. The bedrock consists of yellowish and reddish thin-bedded fine-grained sandstone lying in a nearly horizontal position. This rock frequently outcrops in small areas, especially along stream slopes. Fragments of flaggy sandstone are abundant on the surface and throughout the soil section. This soil occurs on the flat to undulating benches of Gibson Mountain and to some extent on stream slopes, which as a rule are fairly steep. It is largely timbered with post oak and hickory. Small patches of cotton and cowpeas are grown. The cotton does not give very good returns, but the cowpeas fruit well. The land has

a rather droughty nature, especially where the bedrock is near the surface. Fruit possibly could be grown with some success.

The Hanceville fine sandy loam comprises nearly level to undulating and rolling, mountainous country, with steep slopes along the streams. The soil is well to excessively drained and of a rather droughty nature where bedrock lies near the surface.

During seasons of normal rainfall fair yields of corn, cotton, kafir, cowpeas, peanuts, sorghum, and oats are obtained.

Cultivated areas do not embrace many acres, owing to the variable depth of the soil and the frequent occurrence of stony patches. Farming on the Hanceville fine sandy loam may therefore be classed as patchy.

The type is a very desirable fruit soil, and of the fruits peaches do especially well. While the peach seems to thrive on a lighter textured soil than is considered best for the apple, apples of good flavor, color, and keeping quality are grown, in a limited way, on this type. The indications are that the fruit industry could be profitably established on a commercial basis, but at present fruit is grown only for home use and local markets.

A large percentage of the type is forested with oak and hickory.

The present land value ranges from about \$5 to \$25 an acre, depending largely on the topography and stony character of the land.

HANCEVILLE VERY FINE SANDY LOAM.

The Hanceville very fine sandy loam consists of a gray to grayish-brown very fine sandy loam about 6 to 20 inches deep, underlain by a red heavy clay or reddish fine sandy clay. The heavier subsoil is characteristic of the more hilly areas where the soil is shallow. The soil is deepest where it adjoins areas of the Hanceville fine sand. The organic content of the soil is low, except in the more loamy areas. The type is easily tilled, but washes badly on the steeper slopes.

The Hanceville very fine sandy loam is not an extensive soil. It is found only in the southern part of the county, the largest areas occurring in the vicinity of Briartown.

The latter area borders the river lands, and both in position and topography resembles an old, dissected terrace like that south of Braggs. However, no terrace gravel is found in boring or in deep excavations, and the area is accordingly mapped as a residual soil.

Practically all of the Hanceville very fine sandy loam is under cultivation. Cotton and corn are the principal crops. Cotton yields from one-third to three-fourths bale and corn from 10 to 25 bushels per acre. Kafir, sorghum, cowpeas, sweet potatoes, peanuts, watermelons, and vegetables do exceptionally well, but are not grown extensively. Peaches are grown in a small way for home use.

DEKALB SERIES.

The surface soils of the Dekalb series are gray to brown, while the subsoils are commonly some shade of yellow. These soils are derived from disintegration of sandstones and shales, from Silurian to Carboniferous in age. The series occupies gently rolling table-lands, hills, and mountains. Only one member of the Dekalb series, the loamy sand, is encountered in this county.

DEKALB LOAMY SAND.

The Dekalb loamy sand is a grayish loamy sand underlain at about 2 to 3 inches by a pale-yellow loamy sand, which usually overlies sandstone at a depth of about 18 to 20 inches.

This type occupies gently sloping areas on the comparatively smooth mountain tops. Only three areas are mapped, two in the vicinity of Warner and one southeast of Oktaha.

This is a droughty soil, apparently of low agricultural value. It is largely forested with post oak, blackjack, and hickory, and supports a good growth of grass.

OSAGE SERIES.

The Osage soils are dark gray to almost black. They consist of alluvial wash from the sandstone and shale soils of the prairie regions. They are poorly drained and subject to overflow. This series is represented in Muskogee County by four types—the Osage loam, silt loam, silty clay loam, and clay.

OSAGE LOAM.

The Osage loam consists of a brown loam to silty clay loam, underlain by slightly lighter colored material of about the same texture. Small fragments of shale and sandstone are of frequent occurrence, while larger fragments are common in the subsoil.

The type occurs as narrow strips in the first bottoms of streams. The material is derived from residual prairie and associated forest soils. It is a fairly good cotton, corn, and sorghum soil.

OSAGE SILT LOAM.

The Osage silt loam is a dark-brown, compact silt loam, faintly mottled with gray below 6 inches. The subsoil, beginning at about 18 to 24 inches, is a light-brown silty clay loam to silty clay, faintly mottled in places with gray and rusty brown.

The type occurs in the first bottoms of streams which are subject to overflow. The largest areas are confined to the bottoms of creeks which rise and flow through the residual prairie soils, such as Pecan, Elk, Butler, Cloud, and Ash Creeks. A few narrow strips are mapped in abandoned stream channels of the Arkansas River bottoms near

the confluence of this stream with the Neosho River. The surface is flat, with the exception of slight swales and ridges or swells.

Between overflows the drainage is very good and the soil is suitable for agriculture. It is a productive, durable type, and is best suited to the production of corn and alfalfa. A late crop can not be grown on those bottoms subject to lengthy overflows unless protected by dikes. Corn produces good yields in years of moderate rainfall. The type is well suited to the production of sorghum.

The best practice is to break this land to a depth of 8 to 10 inches, and where the subsurface is very compact, subsoiling is beneficial.

A large part of this type is forested with oak, hackberry, elm, hickory, ash, sycamore, and other hardwoods.

OSAGE SILTY CLAY LOAM.

The soil of the Osage silty clay loam is a brown to dark-brown silty clay loam, underlain at about 8 to 10 inches by a lighter brown, compact, heavy silty clay loam. The subsoil is a light-brown, compact clay extending to a depth of 3 feet or more. In places the lower part of the subsoil is faintly mottled with gray. Along the border of the Yahola soils chocolate-red material is sometimes encountered in the subsoil. This condition is due to a gradation from the typical Osage silty clay loam to the Yahola soils.

This is a first-bottom soil, composed of sediments derived partly from the residual prairie soils and partly from forested residual soils. It is confined to the bottoms of streams other than the Arkansas River, the broadest developments being those along Neosho and Verdigris Rivers and several of the larger creeks, such as Bayou Maynard, Georges Fork, and Cane and Cloud Creeks.

The surface is nearly flat, with occasional slight ridges and hummocks and some slight depressions, as well as an occasional abandoned stream channel. The type is subject to inundation, which generally occurs before crops are planted, so that little damage results, although planting is sometimes delayed by spring overflows. The greater part of the type has good drainage, only depressions here and there being in need of ditching and tiling.

The Osage silty clay loam is a strong, durable soil, admirably adapted to the production of corn and alfalfa. With proper management and during favorable seasons, corn yields as high as 75 bushels or more per acre and alfalfa 4 to 5 cuttings per year, or from 4 to 6 tons per acre. Cotton makes a rank growth at the expense of fruiting, except in dry seasons, when very good yields are secured. Sorghum does well. Best results are had in cultivating this soil where it is plowed to an average depth of not less than 8 to 10 inches. Subsoiling is beneficial. The type is valued at about \$50 to \$75 an acre.

OSAGE CLAY.

The Osage clay consists of a black or dark-brown silty clay having a depth of 3 feet or more. Faint mottlings of rusty-brown and grayish colors are usually present. The soil is very sticky and plastic when wet. A heavy farm equipment is required to break it to the proper depth.

The most important areas occur in the bottoms of Cane, Butler, and Dirty Creeks. Some patches too small to map separately are included with the Osage silty clay loam.

Practically all of the type is forested with cottonwood, elm, sycamore, ash, oak, hackberry, and other hardwoods. The wide area along Dirty Creek southwest of Webbers Falls is cultivated to cotton and corn, and when the crops are not damaged by overflows good yields are obtained. Cotton is inclined to produce an excessive growth of weed at the expense of fruiting, and when the rainfall is heavy or when the crop is seeded late on account of spring rains, late maturity renders it liable to damage by frosts. Good yields of sorghum are obtained.

YAHOLA SERIES.

The Yahola soils are characterized by the chocolate-red color of the surface portion, and the lighter color and lighter texture of the subsoils. They are confined to overflowed stream bottoms. The reddish color of the material is due to the presence of sediments from the Permian Red Beds region. The Yahola soils differ from those of the Miller series in having lighter colored and lighter textured subsoils. The series in this county comprises five types, the Yahola very fine sand, very fine sandy loam, silt loam, silty clay loam, and clay.

YAHOLA VERY FINE SAND.

The Yahola very fine sand consists of light chocolate red or salmon-red loamy very fine sand to rather loose very fine sand. The material usually becomes lighter in color with increase in depth, the lower subsoil frequently having a slightly reddish gray or sometimes a gray color. In the latter case the material is looser in structure, carrying very little silt. In areas having a loamy texture, due to the presence of considerable silt, the material becomes lighter with depth, grading within the 3-foot section into a loose very fine sand.

The type occurs in the Arkansas and Canadian River bottoms as a slight ridge or natural levee along the banks of the rivers and away from the river fronts. The surface is either flat or is characterized by the presence of numerous low roundish mounds or hummocks about 3 feet above the intervening depressions. The soil of the depressions

is a little darker in color and higher in organic-matter content in the surface section than that of the mounds.

The type is overflowed on rare occasions. It has excellent under-drainage, but conserves sufficient moisture for the ordinary need of crops, except during the more protracted dry spells.

The Yahola very fine sand is used chiefly for the production of cotton, corn, and Irish potatoes. This is an excellent soil for the production of Irish potatoes, sweet potatoes, watermelons, snap beans, onions, tomatoes, and a number of other vegetables. It is well suited to sorghum and cowpeas. The loamy areas of the type are more productive than those having a lighter surface soil. Owing to the good drainage, crops can generally be planted earlier than on the Yahola clay.

YAHOLA VERY FINE SANDY LOAM.

The Yahola very fine sandy loam in its typical development consists of a chocolate-red to chocolate reddish brown very fine sandy loam, underlain at about 6 to 8 inches by a chocolate-red, heavy very fine sandy loam. In places this subsurface material is a chocolate-red silty clay loam. The subsoil, beginning at 10 or 12 inches, is a chocolate-red very fine sand to loamy very fine sand, which passes downward into lighter colored material of about the same texture.

This soil occurs in the bottoms of the Arkansas and Canadian Rivers in association with the other types of the series. It is characteristically developed near the foot of bluffs marking the outer margins of the first bottoms. A few narrow areas having a somewhat heavier texture and a somewhat lower position than is usual, along the river front, are included with this type.

The Yahola very fine sandy loam is a moderately strong soil, well suited to the production of cotton, corn, sorghum, Irish and sweet potatoes, alfalfa, cabbage, and tomatoes. Crop yields are somewhat lighter than on the clay of this series, and heavier than on the very fine sand. Cotton and corn are the chief crops grown.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Yahola very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450301.....	Soil.....	0.0	0.1	0.1	1.5	54.2	35.7	8.3
450302.....	Subsoil.....	.0	.0	.1	1.4	56.8	34.7	7.1

YAHOLA SILT LOAM.

The Yahola silt loam is a chocolate-red mellow silt loam, which grades through a compact silt loam into very fine sandy loam or very fine sand of a lighter chocolate-red color. In some places the soil is dark chocolate brown. In such cases the color is influenced by darker sediments from local tributaries of the Arkansas River.

The type occurs as flat areas of the first bottoms along the east side of the Arkansas River. It is subject to overflows, but these usually occur in the winter or spring before crops are planted. Corn, alfalfa, sorghum, and cotton produce heavy yields.

YAHOLA SILTY CLAY LOAM.

The soil of the Yahola silty clay loam consists of a chocolate-red silty clay loam, extending to an average depth of about 12 to 14 inches. The subsoil is a light chocolate red very fine sandy loam, which becomes lighter in color and higher in content of sand as the depth increases, passing through yellowish-red or reddish-yellow, light very fine sandy loam into grayish, loose very fine sand. When moderately moist, the soil has good working qualities, but on drying out, fields which have not been properly stirred by cultivation assume a compact, unfavorable structure, except in the surface layer of 2 or 3 inches, which usually has a somewhat friable tilth. Clods are formed when the soil is plowed in either a very wet or a very dry condition. These disintegrate, however, with the first heavy rainfall.

The type is confined to those portions of the Arkansas and Canadian River bottoms which are subject to overflow during very high flood stages of the rivers, the greater part occurring along the Canadian River.

The surface varies from flat to slightly ridged, the ridges representing slight swells not more than a foot or two above the intervening depressions. All of the type is available for agriculture, and the greater part of it is under cultivation. It has good underdrainage, and with proper management conserves sufficient moisture to meet the requirements of crops even through long dry seasons.

This is a strong soil, giving good yields where properly handled. Corn and cotton are the most important crops. With careful treatment corn yields about 50 bushels per acre and cotton over one-half bale per acre without fertilization. Where the land is not deeply plowed and cultivated often, the yields of these crops are low during years of protracted drought, while on the other hand under the best conditions they surpass the yields stated. Cowpeas produce a luxuriant growth of vine and make a good hay crop. Alfalfa can be made a successful crop.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Yahola silty clay loam:

Mechanical analyses of Yahola silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
4503321.....	Soil.....	0.0	0.1	0.2	0.3	4.1	72.3	23.0
4503331.....	Subsoil.....	.0	.0	.1	.2	8.9	72.9	17.8

YAHOLA CLAY.

The soil of the Yahola clay consists of a chocolate-red clay which, with increase in depth, usually assumes a yellowish cast, being yellowish chocolate red. It has a compact structure when dry, is decidedly sticky when wet, and crumbly or friable in the immediate surface portion when moderately moist. In places the soil of the upper 2 or 3 inches has the texture of a silty clay loam. The subsoil, beginning at about 12 to 20 inches, usually is a light chocolate red very fine sandy loam or silt loam which becomes lighter in color and texture with increase in depth, generally passing within the 3-foot section into a reddish or reddish-gray loamy very fine sand or very fine sand. In places thin layers and pockets of heavier material, usually silty clay loam, are encountered at varying depths in the light-textured subsoil material.

On drying the soil cracks to a considerable depth, and clods are formed with cultivation. When the soil is thoroughly moistened, however, the clods disintegrate and the cracks close up. If plowed when moderately moist an excellent tilth can be worked up.

The surface of the type is prevailingly flat, although in local areas the topography is characterized by parallel, narrow, ridgelike swells with intervening depressions, about 3 feet below the crests of the ridges. There is some variation in the level of the bottoms occupied by this type as well as in the level of those occupied by the other types of the Yahola series. Occasionally there are abrupt rises of about 5 to 10 feet, the land sloping gradually from these higher levels.

The type is seldom overflowed, but crops are sometimes injured by standing water after rains, the surface of much of this type being lower than that of the adjoining lighter textured bottom-land types, so that surface drainage is often inadequate. While the type is eventually well drained by the downward movement of water, this process is slow, especially where the heavy clay soil is more than 15 inches deep.

The Yahola clay is a very productive soil. Under favorable conditions yields of about 75 bushels of corn per acre are obtained. Very little cotton is grown, but in dry years, when the plant does not go too much to weed, good yields are secured. Corn is the main crop.

With proper treatment alfalfa can be grown profitably. From one small field on this soil three good cuttings are secured each year.

The greater part of the type is under cultivation, the remainder being forested principally with elm, hackberry, box elder, ironwood, ash, bois d'arc, and some oak. Originally there was considerable walnut, but most of this has been removed.

Yahola clay, dark phase.—In the vicinity of Star Lake and Wybark and in other local relatively low and poorly drained situations in this section of the Arkansas River bottoms, a dark-chocolate clay with a subsoil of brownish to nearly black very fine sandy loam to silty clay loam subsoil is mapped as the dark phase of the Yahola clay. A part of this phase has an almost black soil.

This land really represents an intermediate soil in character of material and topographic situation between the Yahola clay and the Brewer silty clay loam. The surface soil is generally rather closely related in color to the Yahola clay, while the subsoil is more nearly like the material of the Brewer soils. Most of the phase is rather poorly drained, owing to its position. A part is used for the production of corn with good results. By ditching, most of it could be farmed. A considerable area is forested with hackberry, elm, sycamore, cottonwood, and ironwood.

In the following table the results of mechanical analyses of samples of the soil and subsoil of the Yahola clay are given:

Mechanical analyses of Yahola clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450312.....	Soil.....	0.0	0.3	0.3	2.1	3.7	56.4	37.3
450313.....	Subsoil.....	.0	.5	.5	.9	3.3	69.1	26.6

McLAIN SERIES.

The surface soils of the McLain series are chocolate red. The subsoils are dark brown to black. These soils occur on stream terraces, well above overflow, and have good underdrainage. The reddish color is due to the presence of material washed from the Permian Red Beds region. The subsoil material appears to have been deposited when the overflow waters carried very little sediment from this

region. The darker subsoil color may be due to the presence of a higher percentage of material washed from the dark-colored prairie soils than in case of the surface soil, or it may be due to peculiar local conditions of weathering. Four members of this series, the McLain very fine sandy loam, silt loam, silty clay loam, and clay, are encountered in Muskogee County.

M'LAIN VERY FINE SANDY LOAM.

The soil of the McLain very fine sandy loam is a light chocolate red or reddish-brown very fine sandy loam, having a depth of about 16 to 22 inches. In places the soil approaches the texture of a silt loam. The subsoil is a black or dark-brown silt loam. To a depth of 5 or 6 inches the surface soil is usually friable, but below, unless the land has been plowed deeply, the material is very compact.

The soil occupies flat terraces along the Arkansas River, about 15 to 25 feet above the first bottoms, which are occupied largely by the Yahola soils. This land is not now overflowed, but in a former stage of the river's activity it represented the first bottom or flood plain of the stream.

The surface soil contains a sufficient quantity of chocolate-red material derived from the Permian Red Beds to the northwest to give it a reddish color. The dark color of the subsoil, however, indicates that it is either composed mainly of deposits derived from other sources or represents material altered by local conditions of weathering. It may be that the material of the subsoil was deposited at a time when comparatively little wash was carried by the waters of the Arkansas River from the Permian Red Bed soils, while the deposits entering into the composition of the surface soil were laid down under changed conditions, not clearly understood, when the Permian Red Bed soils were more extensively eroded by the waters of the Arkansas River.

The McLain very fine sandy loam has excellent drainage. With proper deep plowing and frequent shallow cultivation it conserves moisture well, even better than the silty clay loam of this series, where the latter has been plowed shallow or permitted to assume a compact condition in the surface soil.

The type occurs mainly between the Teller soils, occupying the older higher terrace southwest of Braggs, and the first bottoms of the Arkansas River.

Practically the entire type is under cultivation to cotton, corn, and Irish potatoes, of which excellent yields are obtained. Cotton yields as high as 1 bale and corn 60 bushels per acre in years of normal rainfall, favorably distributed throughout the growing sea-

son. Irish potatoes do very well, two crops frequently being grown in one year. Alfalfa is grown successfully, but unless the land is freed from most of the grass seeds present by clean cultivation preceding the seeding of the crop the stand of alfalfa is likely to be thinned out by crab grass and other grasses.

The soil is adapted to a number of vegetables, such as Irish and sweet potatoes, cabbage, and beans. It is also well suited to water-melons and cucumbers.

The McLain very fine sandy loam is valued at \$50 or more an acre.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of McLain very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450372.....	Soil.....	0.0	0.1	0.1	4.2	62.0	29.6	4.2
450373.....	Subsoil.....	.0	.0	.1	.5	10.2	55.0	14.4

M'LAIN SILT LOAM.

The soil of the McLain silt loam is a chocolate-red to chocolate-brown, mellow silt loam about 8 to 10 inches deep. The subsoil consists of a nearly black, compact heavy clay, or a chocolate clay passing into a nearly black clay, grading below into dark-colored lighter textured material, usually a very fine sandy loam. In some places the lighter material is not encountered within the 3-foot section.

This relatively old alluvial soil occurs on flat terraces usually 25 to 30 feet above the first bottoms. The largest areas are situated to the southwest of Fort Gibson and northwest of Braggs on the intermediate terraces of the Arkansas River. They are bordered on the river side by the Yahola soils and on the other side by higher terrace soils. Only one other area was mapped, that 2 miles south of Star Lake.

The surface of the type is flat. The soil has good underdrainage and conserves moisture well where deeply plowed and properly mulched.

The McLain silt loam is a very productive soil, well suited to corn, cotton, alfalfa, and Irish potatoes. For best results it is necessary to break the land to a depth of at least 10 inches, subsoiling to a greater depth and cultivating shallow at frequent intervals during dry seasons.

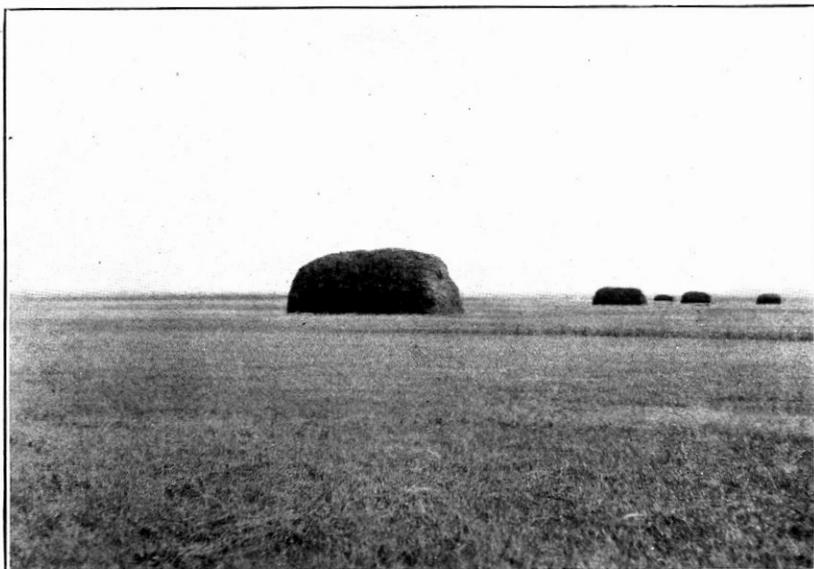


FIG. 1.—PRAIRIE HAY ON THE GERALD SILT LOAM.

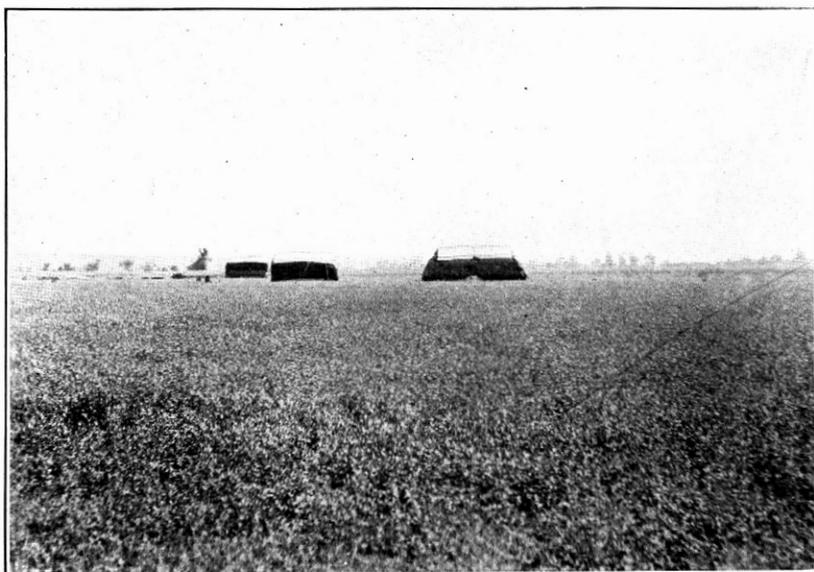


FIG. 2 —ALFALFA ON THE REINACH SILT LOAM.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the McLain silt loam:

Mechanical analyses of McLain silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450334.....	Soil.....	0.0	0.1	0.2	1.0	18.1	63.0	17.5
450335.....	Subsoil.....	.0	.1	.1	4.1	36.4	49.5	9.8

M'LAIN SILTY CLAY LOAM.

The McLain silty clay loam consists of a dark chocolate red to chocolate-brown silt loam or silty clay loam underlain at about 4 inches by less friable silty clay loam, which at about 8 to 20 inches passes into dark-brown to nearly black silty clay loam or silt loam. In places the upper part of the subsoil has a lighter brown color, while in other situations it is nearly black, passing at lower depths into lighter brown. Occasionally the lower part of the subsoil is as light as a very fine sandy loam.

This type occupies second bottoms or terraces of the Arkansas River, having an elevation of 10 to 20 or 25 feet above the first bottoms. Prevaingly the surface is flat and practically level, but some areas have a gently undulating topography.

This type has excellent underdrainage, except in an occasional slight depression. Unless plowed deeply and cultivated shallow at frequent intervals the soil has a tendency to become compact, permitting a rapid loss of moisture through surface evaporation. For this reason crops sometimes suffer more than on the McLain very fine sandy loam, which has a natural tendency toward mulching.

This is one of the best cotton and corn soils in the county. In years of well-distributed rainfall yields of 2,000 pounds of seed cotton and of 75 bushels of corn per acre are obtained. With deep plowing at a time when the soil is not sufficiently wet to be sticky or so dry as to form clods, supplemented by frequent shallow cultivation, such yields can at least be approached in dry years. On the other hand, the yield of cotton drops to one-half bale or less, and of corn to 35 bushels or less per acre in dry seasons on land not properly cultivated.

Alfalfa can be profitably grown on this soil, provided proper care is taken to destroy grass and weed seeds before the land is sowed to this crop.

The excellent natural productiveness of this soil is evidenced by the luxuriant growth of all crops without fertilization. This land is valued at \$50 to \$75 an acre.

The results of mechanical analyses of samples of the soil and subsoil of the McLain silty clay loam are given in the following table:

Mechanical analyses of McLain silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450330.....	Soil.....	0.0	0.1	0.1	0.6	3.9	72.4	23.0
450331.....	Subsoil.....	.0	.0	.1	.9	11.4	60.4	27.2

M'LAIN CLAY.

The McLain clay is a dark-chocolate clay which generally passes below into a black or bluish-black, plastic heavy clay. The soil is very sticky and plastic when wet, but becomes hard and cracks deeply on drying. It breaks into small aggregates, like the buckshot "clay" (Sharkey clay) of the Mississippi bottoms.

This type is encountered only in second-bottom situations along the tributaries, mainly Coata, Spaniard, and Pecan Creeks, of the Arkansas River adjoining the Arkansas bottoms. Upstream the type passes insensibly, both from a standpoint of topography and soil material, into the first-bottom Osage soils. This soil is not overflowed, for the reason that the streams along which it occurs have cut deep channels near the Arkansas bottoms capable of carrying the entire volume of flood waters.

This is a strong soil, but only a small part of it is under cultivation. Its productiveness is indicated by the rank growth of cocklebur, "horse weed," and other wild plants. It is well suited to the production of corn.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the McLain clay:

Mechanical analyses of McLain clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450362.....	Soil.....	0.0	0.2	0.4	1.4	3.4	46.8	47.6
450363.....	Subsoil.....	.4	.6	.4	1.3	6.4	56.6	34.1

REINACH SERIES.

The soils of the Reinach series are chocolate red to chocolate brown. The subsoils are lighter in color and in texture than the surface soils. The Reinach series is the terrace equivalent of the Yahola series. It has the same characteristics of color, structure, and textural variation throughout the soil section as the Yahola, the essential difference being that the Reinach soils are composed of older

alluvium occupying terraces well above overflow. Enough material from the Red Beds soils is present to give the characteristic chocolate-red color. These soils are well drained. Two types, the Reinach very fine sandy loam and silt loam, are mapped in this county.

REINACH VERY FINE SANDY LOAM.

The Reinach very fine sandy loam is a chocolate-red to brown, friable very fine sandy loam, underlain at about 6 to 8 inches by compact material of about the same character. This becomes sandier and lighter in color with increasing depth, grading into a yellow or slightly reddish very fine sand or light very fine sandy loam. The surface soil of the area along the Canadian River is more grayish than the typical.

This type differs from the Yahola in being situated on older, higher terraces above overflow. The drainage of the type is well established, but where it is plowed to sufficient depths and kept well cultivated crops are not severely injured by drought during ordinary dry seasons. Crop yields, however, are lowered from the effects of continued dry weather, if the land is not properly prepared and cultivated.

The Reinach very fine sandy loam is developed southwest of Fort Gibson, southwest of Braggs, at Bluffs on the east side of the Arkansas River, west of Webbers Falls, and south of the junction of the Arkansas and Canadian Rivers.

This type is well suited to cotton, corn, peanuts, sweet and Irish potatoes, melons, sorghum, and a number of vegetables. The yields are lower than on the Reinach silt loam, except in the case of cotton, which makes relatively better yields on this type, the plant not being so inclined to produce stalk and foliage rather than fruit. Cotton and corn are the principal crops grown. Alfalfa undoubtedly could be grown.

In the following table the results of mechanical analyses of samples of the soil and subsoil of the Reinach very fine sandy loam are given:

Mechanical analyses of Reinach very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450336.....	Soil.....	0.0	0.2	0.2	0.4	28.8	59.9	10.7
450337.....	Subsoil.....	.0	.1	.1	.1	30.7	60.3	8.7

REINACH SILT LOAM.

The Reinach silt loam in its typical development is a chocolate-brown to dark chocolate red, friable silt loam, underlain at about 8 to 12 inches by a more compact light chocolate brown silt loam which grades below into yellowish-red to light chocolate red very fine sandy loam to very fine sand.

This soil occupies intermediate terraces of the Arkansas River, ranging from about 10 to 30 feet above the first bottoms. It occurs in a single area near Fort Gibson. It is really a terrace development of the Yahola silt loam, the most important difference being its higher elevation above overflow, with resulting better drainage and a more completely weathered condition.

The surface is prevailingly flat, although there are a few low hummocks, the soil of which has a lighter texture than the typical. The material was deposited largely from overflows from the Arkansas River when this stream flowed at a higher level than at present.

The Reinach silt loam is one of the most productive soils in Muskegee County. Corn, with favorable seasons and good, deep plowing, produces upward of 100 bushels per acre, alfalfa, with five cuttings, one-half ton to 2 tons per cutting (see Pl. II, fig. 2), and Irish potatoes, with two crops each year, from 80 to 160 bushels from each crop. The average yield of corn is about 60 bushels per acre, except during occasional years of extreme droughts. Cotton makes a very rank growth of stalk with frequently a low yield of lint. When grown in widely spaced rows yields of nearly 1 bale per acre are secured during seasons of normal rainfall.

"Horse weed," cocklebur, and lamb's-quarter make a rank growth. Unless weeded out, cocklebur is very troublesome in corn fields. The prevailing practice of allowing this plant to establish itself thickly in cornfields tends to lower the average yields of corn and to make its harvesting a matter of considerable difficulty.

The value of the land ranges from about \$100 to \$125 an acre. Practically all of it is under cultivation.

Reinach silt loam, brown phase.—The brown phase of the Reinach silt loam is a chocolate-brown to brown silt loam, underlain at about 6 to 8 inches by lighter chocolate brown or brown, compact loam or silty clay loam which grades, usually between 16 and 30 inches, into either a yellowish-brown, compact very fine sandy loam, or dark-brown, compact silty clay loam. This passes below into a brownish or chocolate-brownish silt loam or silty clay.

This phase is adapted to the same crops as the typical soil. It has about the same crop value.

The results of mechanical analyses of samples of the soil and subsoil of the typical Reinach silt loam are given in the following table:

Mechanical analyses of Reinach silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450340.....	Soil.....	0.0	0.2	0.2	0.4	16.2	77.4	5.9
450341.....	Subsoil.....	.0	.0	.0	.1	15.2	71.7	13.0

BREWER SERIES.

The Brewer series is the terrace equivalent of the Osage. The surface soils are dark gray to black, and the subsoils drab to black, with grayish and rusty-brown mottlings. This series occupies stream terraces. The material is derived mainly from residual prairie soils. In the lower situations drainage is poor. The Brewer silty clay loam is the only type of this series mapped in Muskogee County.

BREWER SILTY CLAY LOAM.

The Brewer silty clay loam in the surface section consists of a dark-drab to black silty clay loam, faintly mottled in places with rusty brown. The subsoil, beginning at depths of 14 to 20 inches, is a dark-drab to black heavy silty clay loam, mottled with gray, and in places with reddish yellow, in the substratum.

The type is characteristically developed in slight depressions in association with the McLain and Reinach soils. The largest areas occur south of Fort Gibson, northwest of Bacone, and in a rather poorly drained swale along the foot of the old terrace soils, the Teller, southwest of Braggs. The material is probably identical with that of the subsoils of the McLain series. Its situation on the Arkansas River terraces precludes the possibility of its being overflowed, but owing to its depressed surface and inadequate drainage outlets the surface drainage is poor.

A part of the type is cultivated to corn, but most of it is forested with elm, sycamore, oak, hickory, and ash. By ditching and tiling the entire type could be utilized. Corn produces heavy yields when the rainfall is not too heavy.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Brewer silty clay loam:

Mechanical analyses of Brewer silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450328.....	Soil.....	0.0	0.1	0.3	1.5	3.0	72.2	22.9
450329.....	Subsoil.....	.0	.0	.3	1.0	3.3	67.9	27.5

SHAWNEE SERIES.

The surface soils of the Shawnee series are brown to dark brown. The subsurface material is lighter in color and has a compact structure. The subsoils are mottled red, yellow, and gray in color and usually consist of tough, heavy clay. The red frequently gives way with increase in depth, the lower subsoil being mottled yellow and drab. Water-rounded gravel, chert, and sandstone are often encountered in the subsoil and substratum, and in some areas black oxide of iron

concretions are present in this part of the soil section. The Shawnee soils occupy stream terraces. The topography is prevailingly nearly level. Owing to the flat surface and the impervious character of the subsoil the drainage is in some places not well established. The material consists of old alluvium derived from residual prairie soils which are mainly of limestone, sandstone, and shale origin. These soils are related to those of the Neosho series, differing from the Neosho principally in the brown color of the material. The Shawnee series is represented in this county by a single type, the very fine sandy loam.

SHAWNEE VERY FINE SANDY LOAM.

The Shawnee very fine sandy loam typically consists of a brown or dark-brown, mellow very fine sandy loam, underlain at about 8 inches by a yellowish-brown compact very fine sandy loam. At a depth of approximately 20 inches this passes into a pale-yellow or grayish-yellow, moderately friable silt loam faintly mottled with rusty brown. The lower subsoil consists of a tough, heavy clay having a mottled red or yellow or mottled red, yellow, and gray color. Usually this heavy clay stratum is not encountered at less than 28 inches, but in some places it is within 18 to 24 inches of the surface, and here the friable upper subsoil is generally absent. Also the color of the subsoil occasionally is yellow and mottled yellow and gray, without any mottling of red. Black oxide of iron concretions are common in the subsoil. Rounded chert and sandstone gravel occur in the subsoil and substratum in some places.

This type occurs on terraces standing well above overflow. The most important areas are those in the vicinity of Claiborne and those on the north side of Bayou Maynard. The topography is generally flat to gently undulating, with usually a gentle slope from the foot of the residual prairie soils toward the stream.

The type has very good surface drainage, and where properly plowed and cultivated it conserves moisture well. It is a good vegetable soil. Corn, cotton, cowpeas, and sorghum can be successfully grown.

TELLER SERIES.

The soils of the Teller series are gray, with yellow to red subsoils. They occupy well-drained stream terraces. These soils consist of old alluvium, washed mainly from residual prairie material. Two members of the Teller series, the sand and loamy sand, are recognized in this county.

TELLER SAND.

The Teller sand consists of a gray loose sand grading below into a pale-yellow to light-gray sand of about the same texture. In occasional patches the silt content causes the soil to have a more coherent structure than the typical.

This type comprises 6.7 square miles of moderately rolling old-terrace land south and southwest of Braggs. It mainly occupies the outer southern, eastern, and western sections of the terrace adjoining the lower terraces of the Arkansas River and the bottoms of Little Greenleaf Creek. The soil extends from the outer edge of the more recent alluvium to an elevation ranging from 40 to 100 feet above the McLain, Brewer, and Greenleaf Creek bottom soils. Its topography is much more rolling than that of the other soils of the terrace, there being many rather steep slopes extending from the crest of ridges to the small drainage ways which have cut into the terrace in a rather intricate way. The slopes, however, are not broken or gullied, and most of the type can be cultivated.

This soil was deposited by the Arkansas River during the early stages of its development. It has weathered out so thoroughly that the soil body is composed largely of medium and fine sand carrying very little vegetable matter. The substratum, which is frequently encountered at about 2½ feet on slopes and at about 4 to 10 feet in the nearly level positions, consists in most places of a reddish sandy clay. The type is so thoroughly drained that crops suffer seriously from continued droughts, the soil drying out to a light-gray color.

A large part of this type is used for the production of cotton and corn. The yields obtained are somewhat better than those commonly produced on soils of such light texture, especially in view of the fact that no fertilizers or vegetable matter is added. It is estimated that cotton yields from 100 to 150 pounds of lint per acre, and corn about 10 to 20 bushels per acre even during exceptionally dry years. With better moisture conditions the land is capable of producing heavier yields.

Among other crops that give fairly good results are cowpeas, which fruit well, sweet potatoes, watermelons, and kafir. The most important need of this land is vegetable matter.

About half of the type is forested with blackjack, post, and other varieties of oak and some hickory. Many of these trees have a diameter of nearly 2½ feet, but they do not usually attain great height. In many fields the small trees have been cut out and the larger ones killed by girdling and left standing.

The results of mechanical analyses of samples of the soil and subsoil of the Teller sand are given in the following table:

Mechanical analyses of Teller sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450314.....	Soil.....	0.1	13.2	25.2	31.0	11.7	15.7	3.2
450315.....	Subsoil....	.1	9.1	20.9	31.9	9.6	9.5	19.1

TELLER LOAMY SAND.

The soil of the Teller loamy sand consists of a grayish loamy sand which usually extends to a depth of 28 to 36 inches, the subsurface material generally having a slightly lighter gray color than the surface portion, or a pale-yellow color. The subsoil is a buff or dull-red to red, friable sandy clay, faintly mottled in places with grayish and yellowish colors. The loamy texture of the soil is due to an admixture of a moderate amount of silt with the sand and fine sand which constitutes the main portion of the soil body.

The soil is largely developed on the higher and smoother part of the old alluvial terrace south and southwest of Braggs. The surface is characteristically undulating with occasional slight depressions about the heads of drainage ways. In a few places erosion has partly or wholly removed the sandy material, exposing or bringing near to the surface the sandy clay subsoil.

This land has thorough drainage, and crops are inclined to suffer from the effects of protracted droughts. They are, however, not so quickly affected as on the Teller sand, on account of the greater proximity of the sandy clay to the surface.

The greater part of the type is under cultivation to cotton and corn. Sweet potatoes and watermelons are grown also. This soil is adapted to about the same crops and requires about the same treatment as the Teller sand. With similar treatment crop yields average somewhat heavier. Under the prevailing methods the yields show a gradual decrease. There is a general need for the rotation of crops, to include a crop of cowpeas at least once every two years. The occasional plowing under of a green crop of cowpeas supplies needed vegetable matter. The use of barnyard manure and of moderate applications of commercial fertilizer is beneficial. The value of this type ranges from \$10 to \$15 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Teller loamy sand:

Mechanical analyses of Teller loamy sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450316.....	Soil.....	0.1	7.6	18.5	30.0	8.4	24.9	10.4
450317.....	Subsoil.....	.0	6.6	17.2	31.5	8.9	21.3	14.7

MUSKOGEE SERIES.

The Muskogee series comprises gray to grayish-brown surface soils, with yellowish, friable, and somewhat heavier subsurface material, and yellow or mottled yellow and gray, plastic heavy clay subsoils. Water-rounded chert and sandstone pebbles are of common occurrence in the subsoil and substratum. These soils consist of old

alluvium. They occupy high stream terraces. The material is derived largely from residual prairie soils. Weathering has reached an advanced stage in the surface soil, but is not nearly so complete in the subsoil material. The topography varies from flat to gently rolling, and the drainage is good. Some areas are dissected by erosion. The Muskogee series is represented only by the very fine sandy loam in this county.

MUSKOGEE VERY FINE SANDY LOAM.

The Muskogee very fine sandy loam is a gray to grayish-brown very fine sandy loam, underlain at about 12 to 24 inches by a pale-yellow to yellowish-brown, friable, heavy very fine sandy loam to friable very fine sandy clay, which grades below into a yellow or pale-yellow, moderate to very plastic clay, in places somewhat mottled with red and grayish colors. Water-rounded chert gravel is of frequent occurrence in the subsoil. In places the texture of the soil ranges close to that of a silt loam, while in other localities some coarser grains are noticeable in the surface material. The type includes a few small patches along the slopes of drainage ways, too small to map separately, in which a yellowish very plastic clay is exposed or lies very near the surface.

This type is confined mainly to the northern part of the old alluvial terrace in the vicinity of Braggs.

The plastic heavy clay subsoil has a close resemblance to the subsoil of some areas of the residual prairie soils, such as the Oswego and Gerald, but the presence of waterworn gravel indicates an alluvial origin. In the vicinity of Braggs it is difficult to determine a definite boundary between this type and the residual prairie soils. The residual types here, however, are more silty, and lie at lower levels.

The topography is gently sloping to undulating, with some rather steep slopes along the drainage ways and where the land drops to the level of the Arkansas River second bottoms.

A large part of the type is under cultivation to cotton and corn. The yields range from moderate to fairly good, except in very dry seasons, when the soil loses moisture rapidly where it is not plowed deeply and given frequent shallow cultivation. The type gives good yields of Irish and sweet potatoes, sorghum, kafir, and milo.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Muskogee very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
450318.....	Soil.....	0.2	10.2	11.6	8.0	23.4	38.5	8.7
450319.....	Subsoil.....	.2	6.4	8.0	6.6	18.0	31.4	29.7

MISCELLANEOUS MATERIAL.

ROUGH STONY LAND.

The classification Rough stony land comprises steep rocky slopes which have no agricultural value. This land supports a stunted growth of oak and some hickory. It occurs as narrow bands, occupying the steeper slopes and escarpments of the mountains, and includes steep, stony land and bare ledges and outcrops of sandstone and limestone.

ROCK OUTCROP.

The classification Rock outcrop comprises narrow strips of sandstone outcrop occurring in the prairie northeast and southeast of Warner, 4 miles southeast of Summit, northeast of Boynton, and north of Vann School. Other areas too small to be shown on the map are included with the Rough stony land, Hanceville stony loam, and Hanceville fine sandy loam. These areas of Rock outcrop are without agricultural value.

SUMMARY.

Muskogee County is situated in the eastern part of Oklahoma and comprises an area of 814 square miles, or 520,960 acres.

The county may be divided into three physiographic divisions: The Prairie Plains, of nearly level to rolling topography; the wooded uplands, a part of the Ozark Uplift, and consisting of a rugged escarpment with a nearly level crest, deeply intersected by an extensive system of small and intermittent streams; and bottoms and terraces along the Arkansas and Canadian Rivers.

The county is drained by the Arkansas and Canadian Rivers, through numerous tributaries.

The county has a population of 52,743. Muskogee, the county seat, has a population of somewhat over 25,000.

The Midland Valley, the Missouri, Kansas & Texas, the Missouri, Oklahoma & Gulf, and the St. Louis & San Francisco Railroads pass through the city of Muskogee. An interurban electric line connects that city with the St. Louis, Iron Mountain & Southern Railroad at Fort Gibson. The county is supplied with an extensive system of public roads.

The climate is adapted to the production of a variety of crops. The mean annual temperature is 60° F. and the mean annual precipitation about 38 inches. The rainfall is usually well distributed throughout the growing season.

Corn and cotton are the most important crops, supplemented by oats, kafir, milo, sorghum, and hay from native prairie grasses. Alfalfa is grown exclusively on the river-bottom soils, and the acreage is being increased gradually. Irish and sweet potatoes, truck

crops, sugar cane, peanuts, peaches, and apples are minor crops growing in favor. Irish potatoes are grown on a commercial scale, principally on the bottom soils near Webbers Falls and Fort Gibson.

The alluvial soils are generally recognized as best suited to corn, cotton, alfalfa, and Irish potatoes. The mountain soils are regarded as best for the production of fruit, while the prairie soils are devoted to cotton, corn, oats, kafir, milo, sorghum, cowpeas, peanuts, fruit, and native prairie hay.

No systematic rotation of crops is practiced, and the adaptation of the various soils to particular crops is not generally recognized.

Labor is scarce, and a large part of the cotton crop remains un-gathered until late in the winter.

According to the census of 1910, there are 320,891 acres in farms in Muskogee County, with 217,522 acres improved. The average size of the farms is about 212 acres. About one-third of the farms are operated by the owners.

The value of farm lands ranges from \$8 to \$20 an acre for the sandy mountain soils, from \$40 to \$100 for prairie land, and from \$100 to \$125 or more for the first and second bottom lands.

The county has a great diversity of soils, 40 types in all being recognized. These are grouped in three classes—the prairie soils, mountain soils, and bottom-land soils.

The first division includes the Gerald, Oswego, Spearfish, and Bates series, the soils of which are residual in origin from the sandstone and shale of the Winslow formation; and the Leslie series, which is residual from shale and limestone of the Morrow formation. Rock outcrop also occurs in the prairie section.

The second division includes the Hanceville and DeKalb series and Rough stony land.

The third division, the bottom-land soils, comprise the Yahola and Osage series, occupying the first bottoms, and the McLain, Reinach, Brewer, Muskogee, Shawnee, and Teller series, occurring on second bottoms to high terraces. ○

[PUBLIC RESOLUTION--No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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