GEOLOGY AND AGRICULTURE OF LOUISIANA.

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APPENDIX.

PART I.

GEOLOGY AND AGRICULTURE.

A PRELIMINARY REPORT

UPON

THE HILLS OF LOUISIANA,

North of the Vicksburg, Shreveport and Pacific Railroad,

BY

OTTO LERCH, PH. D., Geologist,

MADE UNDER DIRECTION OF STATE EXPERIMENT STATIONS, BATON ROUGE, LA

WM. C. STUBBS. PH. D.

LOUISIANA STATE UNIVERSITY AND A. AND M. COLEGE.

BUREAU OF AGRICULTURE.

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The Bulletins and Reports will be sent free of charge to all farmers, by applying to Commissioner of Agriculture, Baton Rouge, La.

OFFICE OF EXPERIMENT STATIONS,
LOUISIANA STATE UNIVERSITY AND A. AND M. COLLEGE,
Baton Rouge, La., June, 1892.

To His Excellency, Murphy J. Foster, Governor of Louisiana:

SIR—Pending the appointment of a Commissioner of Agriculture as successor to Hon. T. S. Adams, elected to Secretary of State, I have the honor to present to you, the first preliminary report upon the Geological and Agricultural Survey of the State, instituted by the Stations. The necessity for such a survey was fully set forth in my last annual report to the Governor and his co-operation requested to secure such appropriation as would enable us to prosecute it with rapidity and thoroughness. I trust your Excellency will approve of this work and aid us in its successful prosecution. This survey has been undertaken mainly in the interest of agriculture. To this end soils have been classified and carefully mapped out, typical samples taken, character of vegetation noted, drainage systems established, and general elevation above sea level, with other special peculiarities. The soils have been sent to the laboratories of the Station and are now undergoing physical and chemical examination. Later a special report will be made upon "The soils of the State, their composition and wants, with best modes of supplying the latter." This report will cover the State and be beneficial to every planter and farmer.

Incidentally the geology of the State is being carefully studied, so as to locate each section of the State in its proper geological horizon. Especial attention is also being paid to the mineral resources of the State, particularly those which may be of agricultural value, such as phosphates, marls, gypsum, etc.

This survey has been conducted under instruction from me by Dr. Otto Lerch, a graduate of Roslock University in Germany and for some time connected with Geological Survey of Texas. His report will show how thoroughly his work has been accomplished.

This great work, a survey of the State, has been begun in the hills of North Louisiana for two reasons. 1st. Because this portion of the State is geologically considered the oldest; and

2nd, the high water now prevailing has prevented successful work everywhere else and even here somewhat interfered in the smaller streams. It is intended to continue the work until the entire State is covered, and if proper assistance be forthcoming, it will assume a magnitude of detail and thoroughness, which the wonderful resources of this State fully justifies, yea imperatively demands.

There is also appended a chemical report presenting the work done by Mr. M. Bird, in the Laboratory of North Louisiana Experiment Station. I trust that this report may be followed by others until our entire State shall have been surveyed.

Very respectfully submitted,

WM. C. STUBBS,

Director.

LETTER OF TRANSMISSION.

Dr. Wm. C. Stubbs, Director State Experiment Stations, Baton Rouge, La.:

SIR—I herewith respectfully submit a preliminary report of an Agricultural and Geological Survey of North Louisiana, located North of the Vicksburg, Shreveport & Pacific Railroad.

In accordance with your instructions. I took the field on the 1st of March and proceeded to make a section along that road and to survey the country between the Red river and Ouachita river to the South boundary line of the State of Arkansas as far as the limited time and inclemency of the weather has permitted me to do. On the 18th of May I closed field work and it is due to the short time allowed for the preparation of this report that not all the data and materials collected have received full discussion.

In conclusion, allow me to thank you for the many courtesies received, for your advice and personal assistance during the prosecution of this work.

Very respectfully,

OTTO LERCH,

Geologist in Charge.

NORTH LOUISIANA EXPERIMENT STATION,
Calhoun, La., June 5, 1892.

On the Geology of North Louisiana.

That portion of North Louisiana, a preliminary study of which is embraced in this report and which is located in one of the most interesting physiographic regions of the United States, stretches from the Ouachita river in the east to the Red river in the west, and from the Vicksburg, Shreveport & Pacific Railroad in the south to the south boundary line of the State of Arkansas in the north. Small as this section is, when compared with the entire State of Louisiana, and as uniform and simple its surface configuration and its structural geology seem to be, it presents so many and so varied problems that a detailed and extensive study of this region will be required to solve them, and this paper must therefore be considered a preliminary report, subject to changes as developed by future investigations. Meagre as the facts presented must necessarily be on account of the limited time allowed, it is hoped that their publication will prove valuable to the farmer, for whose special benefit the survey has been inaugurated, to the agricultural stations of the State, furnishing them with data aiding in the determination of their line of experiments, and to the emigrant who may find reliable information of the resources of the State as far as this preliminary survey has developed them.

TOPOGRAPHY.

North Louisiana is a portion of an immense crustal plain which but in recent geological times has been raised above the waters of the Gulf of Mexico. In proportion as the waves of the gulf were retreating, the rivers and creeks were advancing on the newly made land digging out their channels in the loose and friable sands and clays which constitute the surface material covering this portion of the State, leaving behind them a hilly upland clad with pine and oak. The country gently slopes southward from the Arkansas line to an average level of 400 feet above the mean tide of the gulf along the V., S. & P. R. R., which railway crosses the State almost in an air line from East to West. Only a few more prominent peaks raise their tops above the surrounding hills, hardly changing the general aspect of the topography of the country. A dividing ridge, frequently noticeable only on closest inspection, runs almost central through this region, dividing the Ouachita and Red river drainage system eastward and westward. Low and extensive bottoms stretch along the foot of the hills marking out the more prominent water courses which traverse the country, and narrower bottoms and steeper and higher hills characterize the central portion, higher and steeper the more we advance toward the watershed of the Red river and Ouachita river. Along the Red river eastward as far as Bayou Dorcheat, the hill tops are capped by a deposit of gray loam which has largely protected them from further wash, and frequently these hills somewhat resembling the Western buttes, form extensive low plateaus covering many square miles. A similar topographical feature is developed along the Ouachita river, though not nearly as extensive as the former and the protecting cover consists in a less stiff and more fertile yellow loam.

These, then, are the prominent topographical features of the region: gently sloping and steeper hillsides, low flats and more or less extensive bottoms, all covered with the most luxuriant forest growths. Tall pines, intermingled with varieties of oaks, hickory, ash, beach, maples and gums, yellow and variegated sands, red sandy clays exposed on roadside and hill, reveal the immediately underlying formation and extensive streams of gravel accompany the course of the Ouachita river, and the Bayou Dorcheat, east of the oak flats along Red river.

The flood plains of the two larger rivers and the second bottoms, or hammocks as they are locally called, *accompanying* smaller streams and creeks form another topographic feature of the landscape.

THE DRAINAGE.

The main drainage channels, the Red river and the Ouachita river, upon which the surface configuration almost entirely depends, traverse this portion of North Louisiana in a nearly due north and south course. The Red river flows through the western district, and the Ouachita river through the eastern portion of this part of the State. The Red river has its sources on the eastern borders of the Staked Plains, and the exceptional fertility of its extensive flood plain in Louisiana is due to the sediments derived from the gypsiferous marls and red loams of the Llano Estacado. The name of the river indicating its usual color implies sufficiently the large amount of sediment, carried by the stream in suspension, which amount is largely increased at certain times of the year, especially in the summer, when the sudden downpours in the arid region cause the river to rise and to deposit the rich sediments along its banks.

The Ouachita river has its sources in Arkansas, and though its sediments are not as rich as those carried by the Red river, its flood plain possesses great fertility, due, no doubt, to the calcareous strata of the cretaceous which it traverses in its upper course and to the sediment brought down by the Little Missouri, which stream traverses the whole series of the mesozoic strata, rich in minerals, constituting plant food. The tributaries of these two main channels traverse the former plateau between them in a southwesterly and southeasterly direction, respectively. They have carried off an immense amount of the loose superficial sands and sandy clays, leaving small ridges, meandering watersheds, rounded hills and peaks and plateaus with that main central ridge trending in a north southerly direction and dividing the two drainage systems of the Red river and the Ouachita river. This immense erosion, which has cut frequently deep into the underlying clay shales, is still progressing at a rapid rate and annually many thousands of cubic feet of North Louisiana lands are washed by each succeeding rain into this network of rivers and creeks, to be deposited along the shores of the gulf. The hills and ridges are nearly uniform throughout the region, usually gently, sometimes steeply, sloping toward the bottoms, which are flat and extensive and frequently accompanied by the formerly mentioned second bottoms, or hammocks, seldom of distinct marking. The bottoms are subject to annual overflow, influenced mostly by local rainfall.

The drainage and the topography which have been treated of in the foregoing pages, as well as the economic features of the region which will form the subjeet of a later chapter, can be easily understood by the study of the subjacent geological formations, the lithological material, dip and strike of which determine the direction of the water courses, the slope of hills and ridges, the composition of the soils, and the depth and purity of well waters.

GENERAL GEOLOGY.

Only a few pages of a small chapter of the world's history are recorded in this section, and yet it will take arduous and detailed work in the field and laboratory before a satisfactory correllation of the strata with other areas of the United States and of Europe can be successfully attempted. However, enough observations have been made to answer the purpose for which this report is intended, that is to assist the agriculturist, the experiment stations and the emigrant to fully understand, and to vouch for the economical features of this section of the State.

A small portion of cretaceous strata, consisting in hard limestones, gypsum, salt and marls laid down at the close of the mesozoic age of our planet at the bottom of a deep and gradually shallowing sea are exposed in North Louisiana. They are isolated spots, peaks of a ridge trending in a northwesterly direction through the State, cretaceous islands in a tertiary sea. Surrounding and directly resting upon them, we find finely laminated sands and lignitic shales. Their structural features are so peculiar, that if once seen they are easily recognized wherever they appear. The laminæ are thin, their weathering smooth surfaces. The shales are full of carbonaceous matter, and feel soapy between the fingers. They carry lignite deposits, covering square miles, and toward their exposed bottom the sand laminæ become predominating till they change into strata of packed sands, sometimes each several feet in thickness. They dip southeastward under an angle of from 15° to 20°, and reach a thickness of several hundred feet. According to their stratigraphic position, resting unconformably and directly upon the cretaceous strata carrying *ostrea ponderosa*, indicating the close of that age and overlaid by green sands and marls full of marine fossils of Claiborne origin, they must be assigned to the dawn of the tertiary, the only Eocene. They are poor strata containing fossil remains of animal life, but very rich in plant life. Leaves and stems and fruit of the vegetation have left their traces imprinted on the soft sandy clay shales, and they are especially rich wherever they constitute the covering or underlying beds of the lignite deposits. The green glauconitic sand and marls succeeding them are full of the most beautiful shells of the Claiborne. They are far less in thickness, lay conformably upon the lignitic shales and sands and have preserved the peculiar structure of the former, the gradation from one into the other of these formations is so gradual that frequently they only can be recognized by the fossil life they contain. About the age of these beds, so rich in animal life, well studied by a number of investigators, there can be no doubt. The fossils are all marine shells and assign these sands and marls to the Claiborne. Succeeding the glauconitic sands and marls we find a series of black shales lying conformably upon them with the same structural features and differing from the lignitic sands and shales only in their stratigraphical position and lithological character. They consist of argillaceous laminæ with mica and sand partings, weathering smooth surfaces possess a soapy feel between the fingers and carry lignite deposits. Broken pieces of these ink black shales, when moist, have been taken by the people of this section for petrified pine bark and the resemblance they bear to it is, perhaps, the best description which can be given. Generally they appear moist on exposures, the water slowly oozing along the sand partings trickles over the argillaceous laminæ, smoothing and rounding them and causing their peculiar appearance.

The history of these succeeding formations, if formations they may be termed, is easily deciphered, sandy flats with occasional mud bottoms and swamps with a vegetation luxurious enough to have formed the large coal deposits, covering frequently several square miles and no changing conditions in the deposition of the strata and the topography of the country for ages, till finally the waves of the gulf commenced encroaching upon the land and a marine fauna commenced to take the place of the rich vegetable life which had covered for many centuries the low flats of North Louisiana. Finally the ocean waves were sweeping over the whole country, covering every foot of ground and leaving a few peaks of the cretaceous ridge as islands in this sea, at the bottom of which was flourishing the fauna, the remnants of which are now found in these deposits. During many generations the process of deposition continued till a series of beds was laid down measuring over fifty feet in thickness, and again slowly and gradually the waters of the gulf commenced retreating.

Once more low lands, swampy mud bottoms, were extending over all of this section of North Louisiana. A luxurious vegetation favored by an abundance of heat and moisture was flourishing and covering the flats and extensive bottoms with a dense forest growth. The dropping leaves and stems and fruit mouldering in the soft muddy flats "imparted a rich black color to the soils and the sluggish waters carrying sand provided in the occasional parting sheets." This condition, the peculiar flat topography of the country with not a prominence, except the low, white cretaceous ridge crossing the swamps, the slow and undisturbed deposition of mud and sand, the burying and mouldering of plants favored in places so that the extensive brown coal (lignite) deposits could be formed, continued till a slow emergency of the land caused the Ouachita river and Red river to follow up the retreating waves of the gulf to cut deep beds into the soft, black shales and green sand marls, and with the complicated network of drainage—channels to carve out hills and ridges till at last the emergence ceased, leaving a country which, in its minutest topographichal features, was almost identical to our own of to-day. The landscape of this eocene age had an entirely different appearance, however. Instead of hills and ridges colored with deep and brilliant red and yellow, clad with pine and the varieties of oak, ash, hickory, maple, gum and beech, nothing but dark and black hillsides were seen, and no traces of pine trees have been found so far in these deposits. How long North Louisiana was dry land, how long the gulf was washing the shores of this eocene country, nothing can be said. A slow submergence commenced to set in, so slow that not the slightest disturbance in the deposits appears which were gradually shallowing and filling the water courses with a gray mud and finally burying the highest hilltops under a sheet of gray clay, and once more North Louisiana was the bottom of the gulf and its waters were reaching far northward into Aıkansas. Throughout this whole period of deposition the conditions did not change, the lithological material from whatever source derived remained the same, as well as the slow continued submergence which caused a smooth and level stratification of the soft gray mud, so that the strata appear to-day as fine gray clay shales varying in thickness from half an inch to an inch, breaking in angular pieces and weathering in spurs and ridges, covered with a network of fıactures on drying. They are so distinct in appearance from the underlying beds that they easily can be recognized everywhere. By the people of this section they are called joint and pipe clays in difference to the black finely laminated shales and green sands, generally called black dirt or soapstone. A paucity of fossils characterizes these deposits, and so far only near the line of contact with the underlying green sands, marine shells have been found which prove to be the same as those found in the underlying Claiborne formation. However, not alone the mentioned difference in the lithological material and the striking difference in structural features and in the weathering, their deposition on the deeply eroded surfaces of the black shales and a disconformity in the general dip, a southwesterly dip under an angle of about 10° assigns to these deposits the place of a new formation. Like an eternal pendulum the waters of the gulf commenced a slow retreat and again the Ouachita and Red rivers, with their tributaries, to hunt their old channels once more commenced carving out hills and ridges as they had stood before in past times, leaving, however, a covering of these gray clays, enclosing a black nucleus in the newly formed hills.

Again, we can study the same topography of North Louisiana under a different aspect. Grayish and whitish colored hills with stiff and cold tenaceous soils, poor in vegetation and here and there black exposures of the underlying deposits where the waters have eroded away the covering mantel of the gray clays. It is probable that this last rise extended into the ice period of the continent and that the climatological conditions remained till a slow submergence caused the glaciers of the northern half of the continent to melt and the downcoming floods to fill the drainage channels with the sands and quartz pebbles which had been ground down by the immense masses of moving ice, and again to bury the country under a sheet of these fine sands and sandy clays. The lithological material and the littoral structure of these deposits speak of shallow seas and the extensive pebble beds of strong currents along the Ouachita river and Red river. Once more the country slowly emerged and once more the same drainage which at various times had carved out the present topography commenced sculpturing hills and ridges and valleys, leaving North Louisiana as we find it to-day, and as described in previous pages. Three times since first the waves of the gulf were washing the shores of the cretaceous islands this country had to pass through a complete submergence and emergence, preserving in each dry land period the same topography and leaving unaltered and uncovered the cretaceous outcrops. Since the orange sands were converted into dry land and the destructive work of the atmospheric agencies commenced they have continued their work and still continue to work annually immense masses of sand and clay into the country drainage to be carried by streams and streamlets into the main rivers to the gulf to assist in building up new geological deposits at its bottom, to form new land for future ages.

CRETACEOUS.

The most prominent outcrops of this formation are located South of the V., S. & P. R. R., and though they do not exactly come into the province of this survey on account of their high geological importance, constituting the backbone along and upon which all succeeding geological formations of this section have been deposited, and on account of their high economical importance for North Louisiana they have been examined and a description of a few nearest this section may follow.

On section 34, township 15, range 5 west, about ten miles southeast of Bienville, the terminus of the Homer and Bienville Railroad, Rayburn's salt works are located on a cretaceous outcrop. The works are now deserted and only the ruins of broken down pits and furnaces testify to the fact that these works were once flourishing. During the late war they produced eighteen hundred bushels of salt per day. The whole area covers a space of about a square mile, in the center of which the wells are located, numbering eighty, all from fifteen to twenty feet deep, and constantly containing a strong brine. Pieces of hard blue, gray and yellowish limestone, granular gypsum and limestone banded together with gypsum and *bargta* were found scattered around the wells. About one hundred yards southeast of the house of Mr. Whitlow, the present owner of the works, soft white limestone crops out along a little knoll. The whole area is covered by a yellow loam which resembles the "ponderosa" marls, and a few well preserved specimens of the *exogyra costata* were found. This loam was penetrated in a well to a depth of twenty feet. The gray joint clays are occasionally cropping out beneath the red sands and sandy clays and the lignitic shales were traced in wells around this area, so that the following section conveys probably a correct idea of the geological structure:

Section No. 1.

*The gypsum bed was reached only in pits of the southeast side, and the salt water came up from beneath, in the other pits it came in through the crevices in the limestone.

*Report of geological reconnoisance of the State of Louisiana by Dr. E. W. Hilgard, page 30.

On section 32, township 14 north, range 7 west, a yellow marl crops out, covering about 400 acres with an ostrea in large numbers scattered over the ground. The outcrop is doubtless of cretaceous origin. The soil is of a rich black color and a marked break in the vegetation can be noticed.

Postoaks and hawthorns predominating over the short leaf pine, especially the hawthorns, seem to be peculiar to the cretaceous soils of this section. A number of similar outcrops are reported; especially on section 35, township 15, range 8 west, such an island must be mentioned, upon which during the war salt works were located. The material found around the wells, limestone and gypsum, and in fact the whole resembles so much the above described locality at Rayburn's salt works that it does not seem necessary to give a further description at this place. Dr. Hilgard reports *gryphœa pitcheri* and *exogyra costata* from this xposure.

THE TERTIARY FORMATIONS.

SECTIONS AND LOCALITIES.

The lignitic shales and sands, the characteristic features of which have been described on a former page, have been traced all over the country with the exception of that central portion where the glauconitic fossiliferous sands and marls have taken their place. Their stratigraphic position, above and below the green sands, as well as the difference in lithological material of the upper and lower horizon is indicated and illustrated in the general section along the V., S. & P. R. R. Their low position at the bottom of the strata exposed, makes it evident that they but little enter actively in the determination of the present surface configuration. Their economic importance consists in the lignite deposits and marls they contain. The artesian water they carry, and that sometimes they constitute the water bearing beds of this section, very rarely they enter in the composition of the soils and subsoils. They contain pyrites, alum, sulphate of magnesia and gypsum, which minerals enter in solution of the water running along the shales and makes it undrinkable, and, at least, unhealthy in all cases.

SECTION AND EXPOSURE OF LIGNITIC SHALES ON CHOUDRANT BAYOU, AT CROSSING OF ARKANSAS ROAD.

Red sandy clay	10 feet.
Gray joint clay	15 "
Black shales	25 "
	50 "

The black shales, as usual, are finely laminated with sand and mica partings and enclose lenses of cross-bedded sand.

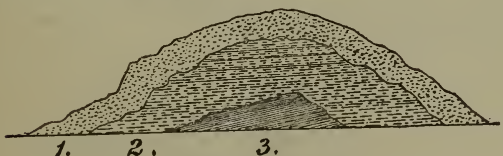
On section 14, range 1 east, township 18 north, in the bottom and along the bank of a little creek, a deposit of earthly lignite is exposed, overlaid by the lignitic shales. Eight miles west of Monroe, on the Trenton road, the same black shales, very rich in carbonaceous matter, can be seen overlaid by the gray clays. They appear in the same position, three miles west of Monroe, on the bank of the Ouachita river.

A fine exposure of the lignitic shales is found four miles west of the station at Calhoun, on the V., S. & P. R. R. They consist of thin lignitic laminæ, intercalated with sand, and, as usual, they are overlaid by the gray clays.

Three miles west of Station Choudrant we find the following section:

1. Yellow sand, 10 feet.
2. Reddish sandy clay, 15 feet.
   With angular pieces of gray clay in seams.
3. Black shales, 8 feet.

Section No. 2.



Along the line of contact of the gray and underlaying black lignitic shales the former frequently assume a chocolate color derived from the iron contained in them and in the underlaying strata. These chocolate colored clays never reach a thickness more than a few feet, and, as a rule, their extension is very limited horizontally; structure, lithological material and position is that of the gray clays. At the place where the Ruston road crosses the V., S. & P. R. R., a section of the lignitic shales over three miles long is found. They are overlaid by the gray clays and the whole mantled by a thick stratum of red sandy clays. Overlaying the eroded surfaces of the lignitic shales we frequently find a thin dolomitic and coarse sandstone, generally measuring less than six inches in thickness.

One mile west of Arcadia a section of the lignitic shales was observed, containing small patches of lignite and on some places a few inches of a soft, dark gray colored sandstone constitutes the parting between the black lignitic shales and gray clays.

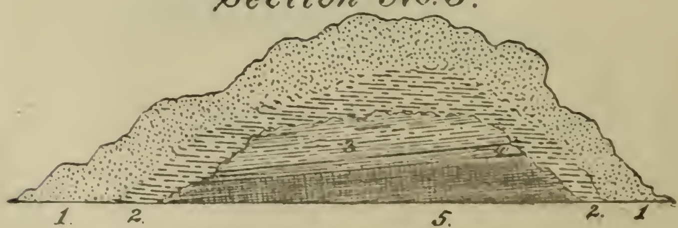
Six miles west of Homer in the bed of a little creek at Coal Springs, a lignite deposit crops out. The coal is firm and has preserved the woody structure exceedingly well, a true lignite. The coal exposure is four feet in thickness and is overlaid by the characteristic shales. About one-quarter of a mile from this place this coal basin was tapped in a well on top of a hill at a depth of 80 feet, and it is reported that outcrops of the same coal are observed in a distance of two miles from the place examined.

Nine miles south of Gibsland the following section of the lignitic shales was examined:

1. Red sandy clay and sand, 8 feet.
2. Gray clay, 6 feet.
3. Black shales, 10 feet.

The outcrop is a cut on the Homer and Bienville Railroad, and shows the south dip of both formations. Seventeen miles south of Gibsland, near the Bienville road, a lignite deposit forms banks and bed of a little creek.

Section No. 3.



1. Red sandy clay, 6 feet.
2. Gray clay, 5 feet.
3. Chocolate colored clay, 2 feet.

4. Lignitic shale, 7 feet.
5. Lignite, 6 feet.

The base of the lignite is exposed in an outcrop 300 feet in length along the bank of the creek. The same coal is reported in a distance one half mile from this place. The exposed lignite is finely taminated, soft and crumbling and burns well. The high water in the creek did not allow a thorough examination of the bed, but it is said that the coal becomes firmer at greater depth. At the crossing of the Bienville road of a little creek about one mile south of the lignite described several good exposures of the lignitic shales were seen. The water is abundant, but frequently bad in this section where the gray clays have been largely removed by erosion.

Another lignite deposit was examined near Sparta road, cropping out and constituting for a hundred feet the bed of Tope creek. This coal deposit is here the uppermost member of the lignite shales directly overlaid by the gray clays. The coal consists of a stratum of soft, crumbling brown coal, about one foot in thickness, underlaid by three feet of firm lignite, with well preserved woody structure. This same deposit has been tapped in a well, about one and a half miles west of this exposure.

On section 11, township 18, range 8, a lignite bed one and a half feet in thickness, crops out on the bank of a little creek. The coal is firm, possesses a conchoidal fracture and has been successfully used in a steam shovel when the V., S. & P. R. R. was built through this section. The bed is resting on lignitic shales and overlaid by them.

About one mile west of Taylor Station, on the V., S. & P. R. R., several thin lignite seams are seen imbedded in the shales and shining out in every direction. At this exposure the laminæ of sand are thicker than ever before seen, and continually increase in thickness in exposures examined westward of this place.

Three and one half miles south of Taylor Station, in bed and on bank of creek, a lignite outcrop is reported, which, however, on account of the high water, could not be examined.

On section 29, township 21, range 7, in bottom of Choctaw branch, lignite, with the characteristic shales overlaying it, was found. It is said to have been explored with a drill to a depth of fourteen feet. The top stratum is finely laminated and of earthy appearance. The lower strata, not exposed, are reported to be firm.

At Sibly, on the V., S. & P. R. R., a section of the lignitic shales was examined, consisting almost only of finely yellowish white and pink colored sands, with thin partings of clay. The peculiar banded, finely laminated structure dip and stratigraphic position of these sands below the gray clays leave no doubt that they belong and are a part of the lignite shales.

In the town of Minden the lignitic shales, consisting here mostly of finely laminated sands with occasional clay partings, and carrying a lignite bed from one to two feet in thickness near the top, are well exposed.

One and one-half miles west of Haughton, a fine section, about three and one-third miles in length, occurs in the railroad cuts of the V., S. & P. road. The upper beds consist of the characteristic black, finely laminated shales, about twenty feet in thickness, underlaid by light colored sands and clay partings, also of a light grayish color, preserving the finely laminated structure. Gradually the sand seams thicken till the bottom stratum has reached a thickness of two feet, showing cross-bedding.

A fine lignite bed is exposed at Bellevue. The basin as far as could be ascertained covers an area of several square miles, underlying the town. The coal seems to thicken toward the center of the deposit. At the edges it measures not over twelve inches and was bored into two feet without reaching base in wells in the town.

Section northeast, corner of Bodeau lake, near Bellevue:

Finely laminated sand with 5 feet thin clay partings.
Gray clay, 2 to 12 inches.
Lignite, 12 inches.
Finely laminated sand, 25 feet.

The sandy clay laminæ, especially directly above and below the lignite, are rich vegetable remains. Beautifully preserved leaves and stems and fruits which on account of the limited time have not been examined.

At Shreveport the shales are beautifully exposed at various places, and sections have been published by Dr. Lawrence Johnson in his report of the iron ores of Louisiana and Texas. The following exposure at Slaughter Pen Bluff, near the city, will suffice at this place:

1. Surface a red loam, a poor soil, 6 feet.
2. Clayey sands, compact, full of geodes, 6 feet.
3. Hard sandstone, with boulders of impure limestone, 2 feet.
4. Yellowish gray sand, with leaves, 8 feet.
5. Dark bluish laminated clay sand, 3 feet.
6. Sandy friable gray clay, with leaves, 6 feet.
7. Lignite, $1\frac{1}{2}$ feet.
8. Dark shaly clayey sand, 15 feet.

The lignite exposed at this place as well as in other outcrops near Shreveport is firm and apparently of good quality, and I am informed that it has been mined and used with advantage during the late civil war.

The foregoing sections demonstrate the area these lignitic sands and shales occupy in the region examined. They rest against the lower horizon most likely upon the cretaceous formation. They show a uniform southeast dip from 15° to 20°, except in places where they are locally disturbed and which will be mentioned hereafter.

The condition during their deposition as shown by their peculiar structure noticeable throughout their whole vertical and horizontal extension remained unchanged. From rich carbonaceous shales in their upper horizon they graduate in the lower into finely laminated sands toward the bottom with occasionally heavier seams of crossbedded packed sands. Their economic features have been mentioned before and will be treated of more fully in a succeeding chapter.

THE CLAIBORNE FORMATION

consists in this part of Louisiana of green glauconitic sands and marls containing marine shells so well preserved, and in such an abundance, that as to the age of the strata containing them there can be no doubt. The deposits differ little in structure, and lithological material from the underlying and overlying beds seem conformably to rest between them. Their geographical distribution of outcrops is limited, and only near the center of the region surveyed they have been uniformly found in the stratigraphical position indicated. Like the lignitic shales they contaminate the well water whenever they constitute the water-carrying beds, and like these they enter but little in the composition of the soils of this region. They are of the highest economic importance to North Louisiana on account of their fertilizing qualities consisting in their contents in phosphoric acid—lime, potash—which minerals these marls almost always contain. Only a minute study of the beds and a number of complete analyses of the varying material can fix their real economic value. At a few exposures the upper bed of these deposits has been found to consist of altered green sand; but, so far, it is difficult to say whether this marks a subdivision of the formation, or whether the alteration is due to local causes. In the artesian well bored at Monroe under supervision of Col. Will A. Strong, characteristic Claiborne shells were found at a depth of 185 feet, in a deposit of black clay. A list of the fossils found in the Claiborne strata of this section will be attached to this report.

One mile east of Gibsland, on the V., S. & P. R. R., in an old well, green sand marl has been struck containing the usual abundance of fossil shells, and at various places in wells near the town of Homer the shell marls have been found. On a little creek, near the road from Homer to Gibsland, between Athens and Homer, a green sand bed crops out and measures six feet in thickness.

*Section at Hammet's branch, near Gibsland:

1. Orange sand	1-20 feet.
2. Laminated lignitic clay corals, fusi and other fossils	6 feet.
3. Impure limestone (dolomitic sandstone)	½ foot.
4. Sandy calcareous gray clay—fossils numerous	5 feet.
	31½ feet.

The fossils are all of Claiborne type. The foregoing section will be sufficient to give the stratigraphic position of the fossiliferous beds of the Claiborne series, and analyses now being made of the marls obtained from the various outcrops will develop their economic properties, so important for this section of the State.

*This section has been published by L. Johnson and has been re-examined by the author.

THE GRAY CLAYS.

The series of these deposits resting unconformably upon the deeply eroded surfaces of the green sand marls and black lignitic shales, dips under an angle from 10° to 15° southwest and geographically extends over the whole section examined. Along every roadside, along every creek, its outcrops are found, easily recognized on the network of fractures covering the exposures, the angular and subangular pieces in which its layers break up and the uniform character of the gray hardened lithological material which only toward the base assumes sometimes a chocolate color. Its peculiar weathering in spurs and ridges can be recognized on larger exposures even at a distance. These clays are of the very greatest importance to North Louisiana; they are the water carrying beds throughout the section, except in those places where erosion has removed them and the underlying black shales and glauconitic marls have taken their place. They are comparatively free in minerals and the water running over them and appearing as springs along their outcrops on the foot of the hills, or being tapped in wells, is of great purity. Their nearness to the surface and their numerous outcrops have caused the material frequently to enter the composition of the soils and especially in the bottoms where often they carry the water of the sluggish creeks and streams; they give the cold and tenacious character to the soils, and cause the swamps and stagnant water which covers the low bottoms for a long time during the year.

In the western part of Bossier parish they have formed the large flats which characterize that part of the country. They are poor in valuable minerals but furnish pottery clays and brick and fire clays when mixed with the overlying sands. Their stratigraphic position can be studied in the general section hereto attached. A good exposure of the gray clays is found three miles east of Calhoun on the Trenton road, where they are seen in contact with the overlying red sand clays and ferruginous sands. They show their characteristic features, are very plastic when moist and break in angular pieces which have entered on many places unaltered the overlying sands. Their surface is deeply denuded, mantled by the red sands. A few miles east of Calhoun they are well exposed in cuts along the V., S. &

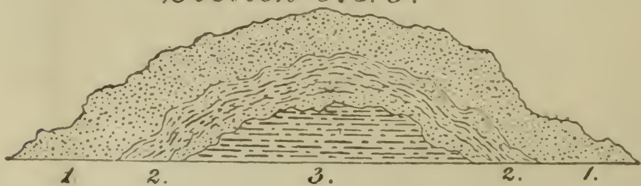
P. R. R., slightly disturbed, however. Whenever the rains have cut deeper into the hillsides they have exposed these gray jointed stratified clays and very frequently they can be traced up to the very top of hill and ridges. The bottom of Bayou Choudrant, especially in its lower course, rests directly upon the clays and consequently they make up the soils with the sands of the bordering hills which have mixed with them, forming a rather stiff and tenacious soil of gray color. Along the Claiborne road towards Monroe from the Station at Calhoun the clays appear constantly below the ferruginous sands and sandy clays, their continuity and their denuded surfaces can be studied without trouble. At Monroe these clays have been struck in the artesian well at the ice factory at a depth of seventy-five feet and have been found to measure forty eight feet in thickness at this place.

Section artesian well at Monroe:

Blue stiff clay, 35 feet.
Drift, 20 feet.
Gray clay, 48 feet.

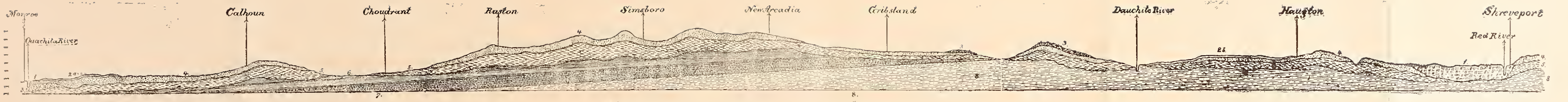
Three miles west of Calhoun Station, is a cut of the V., S. & P. R. R., the following section was observed:

Section No. 5.



1.	Yellow sand	8 feet
2.	Red sandy clay, streaked and mottled with gray clay	10 "
3.	Gray clay to base	6 "
		24 "

The characteristic weathering in spurs and ridges is well marked in these exposures. West of Choudrant Station a number of good exposures along the road are seen. The bottoms traversed all show in color and quality that they are partly derived from this formation. Along the Vienna road to crossing of the Bayou D'Arbonne the clays were traced, and at the crossing of the streams they were noticed to form its bed at this place.



Section between Monroe and Shreveport
along the Vicksburg, Shreveport & Pacific Rail Road

Horizontal Scale 5 miles = 1 inch, Vertical Scale 500 feet = 1 inch.

1. Alluvium
2a. Yellow loam, 2b. Gray loam
3. Gravel deposit
4. Gray sands and red sandy clays
5. Gray clays
6. Black shales with mica & sand partings
7. Glauconitic sands and marls
8. Laminated sands and shales

East of Ruston, very fine contacts of the gray clays and underlying black lignitic shales in cuts along the V., S. & P. R. R. are found, showing the denuded surfaces of the shales upon which the gray clays unconformably rest. At Ruston the following section was found, which frequently repeats itself in its prominent features and may be considered typical:

The gray clays, overlaid by ferruginous sandy clays with a few laminæ of gray clay and angular pieces of gray clay stratified, overlaid by red sandy clay, gray mottled streaked, and again in turn overlaid by red sandy and yellow quartz sand. The outcrop and exposures of the gray clays are so numerous all over the country and resemble each other so much that it is unnecessary to mention any more localities than already given. Their position is shown in the general section and their contact with the underlying and overlying formation is well illustrated in the sections given in the chapter treating of the lignitic shales. Though they are frequently locally disturbed, a general southwest dip could be made out. As mentioned before, the water flowing upon them saturating the overlying sands and sandy clays are almost always free of minerals.

THE RED SANDY CLAYS, SANDS AND GRAVEL BEDS.

This formation covers almost the whole area and its constitutents make up, to a large extent, the soils of the region. It lays unconformably upon the denuded surfaces of the gray clays and its subdivisions most likely embrace the Lafayette formation of McGee and the sands and gravels of the drift. However, the time of field work has been too short, and the time in which to prepare this report is by far too limited to even allow an attempt of a differentiation of these formations. A detailed survey of the various parishes, which will be undertaken hereafter, will furnish the material and a study of a number of detailed sections and localities only can lead to the necessary correlation of the sandy strata of North Louisiana, with these recognized formations. The deposits of sand and sandy clay are absent only in the valleys of the Ouachita and Red rivers, and feebly represented they are found in the bottoms of smaller creeks and streams and bayous where the present erosion has removed them to a very large extent. The thickness of the sand is very variable, and from a few feet it measures up to 150 feet at some exposures in vertical depth. As a rule the sands are horizontally stratified, and only in some instances they seem to conform to the outlines of the gray hills which form their nuclei. This stratification is extremely irregular, and from solid masses in a short distance they change and exhibit wave lines which leave no doubt that they have been deposited and sifted by shallow waters. Uniformly they show the structure due to the action of waves, tides or shallow water currents. In this portion of North Louisiana the sandy clays and sands are distinct and pass *in no place* gradually into the underlying tertiary clays. On the contrary, they rest, as mentioned, on their deeply denuded surfaces, and the lithological material and stratification is distinct and well and sharply defined from that of the underlying gray clays. In some exposures a restratification and mixing of the tertiary gray clays with the overlying red sands causes a resemblance of a gradual passage of one into the other beds, but on closer inspection the restratification is invariably revealed. The substratum consists of a red sandy clay, the color caused by peroxid of iron and frequently very brilliant, passing, in some localities, through all shades of red. Iron sandstone and clay ironstone varying in durability from a soft friable stone to a hard rock, and in thickness from a few inches to several feet, frequently cap the hills or are overlaid by a stratum of sand in various colors. Sometimes laminæ of these rocks are found near the top of the strata interlaminating the material. Pure quartz sands are frequently interstratified with these sandy clays or form lenses of large extent. Generally, however, a deposit of these sands lay on top of the sandy clays, varying in thickness from a few inches to many feet. A number of fossil casts have been collected from the strata but so far they have not been determined. Two large gravel streams cross this section, one in the eastern portion accompanying the Ouachita river, about three miles in width, and another accompanying Bayou Dorcheat. The gravel beds vary in thickness up to thirty feet, and blend and thin out and pass into the red sandy clays. They consist of pebbles or shingles, cemented into puddingstone by an iron cement, but generally they are loosely imbedded in the sand and red sandy clay. The pebbles consist mostly of quartz and vary in size averaging from a small pigeon's egg to a hen's egg. Well water worn, except pieces of quartzitic sandstone which are less rounded because derived from the sandstone found in these deposits. Pieces of fossil wood and even whole trunks of petrified trees have been traced along the line of contact between the sands and underlying gray clays constituting a characteristic *feature of this formation.* Accompanying the Ouachita river a sheet of yellow loam uniformly covering the hilltops and constituting small flats is found. This loam sheet varies in thickness but seldom measures over a few feet in vertical depth. Along the alluvial bottoms ot the Red river and Bayou Dorcheat a similar loam sheet, the material more tenacious and gray color, overlays the sands and form extensive flats in that western part of the country. These loam sheets record a subsidence and quieting of the floods which had brought down the gravels and sands.

LOCALITIES AND SECTIONS OF THE SANDS.

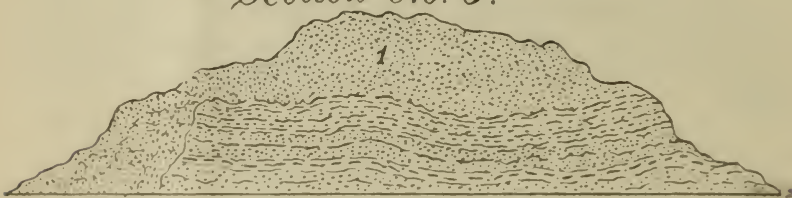
The country around the Experiment Station at Calhoun consists almost only of these sandy deposits. The hills measure from fifty to a hundred feet in height, and are covered by a yellowish gray sandy soil, more or less loamy, according to the vicinity of the substratum of red sandy clay. The vegetation is that characteristic for the hills of the whole region, shortleaf pine, oaks, hickory, ash, beech, maple, dogwood and gums, the pine by far predominating.

About six miles east of the Station at Calhoun on the old Trenton road in contact with the underlying gray clays and imbedded in the red sandy clay a silicified tree sixty feet in length and eighteen inches in diameter is found. On Millseed creek, about six miles northeast of the same Station, a ledge of very hard deep rusty colored siliceous sandstone crops out for over a mile along the bank of that creek. The ledge is 10 feet thick and covered by red sandy clays. The same sandstone has been struck in a well about one mile west of the bank of the creek. The rock is too hard for working it advantageously with a hammer and on that account, probably, could not be used as building material. The depth of wells range from twenty to forty feet. The water is pure and can almost be classed as freestone water.

West of Calhoun Station several exposures of red sandy clays measuring sixty feet in depth are found. The material contains near the top of the exposures thin laminæ of clay ironstone and iron concretion are scattered over the surface. The bottom deposits of the red sandy clays when exposed to wash assume a glazed rocky appearance which feature has been mentioned and described by Prof. McGee as characteristic of the Lafayette formation.

At two miles west of Calhoun Station, on the V., S. & P. R. R., the following section was found :

Section No. 6.



1. Gray and yellow sand.
2. Red sandy clay.
3. Red sandy clay, mottled with gray clay.

In some parts of this section the gray sands have been almost entirely removed and the substratum of red sandy clay has given the constituents and color to the soil. Vienna seems to be the center of a large area of these so called red lands and Bossier parish contains many thousands of acres of these lands, which are considered by the farmer the most productive of the upland soils. At Vienna, on the plantation of Judge Graham, fossil casts were found in clay ironstone boulders scattered over the ground.

About one mile northwest of Ruston a number of strong chalybeate springs were examined. Such springs are frequent throughout the whole area surveyed.

About one half mile east of Simsboro the following section, measuring 120 feet in thickness, was found :

The lowest deposits consist here of loose yellow sand, interstratified with thin laminæ of clay ironstone and a ledge of soft iron sandstone, about ten inches thick. The features of the formation, stratification of the sands and lithological material are all so similar throughout the region that the above localities will be sufficient to characterize them.

Section No. 7.

Disturbances East of Ruston on the V. S & P. R. R.

DISTURBANCES OF THE STRATA.

No volcanic eruptions and no violent contortions have disturbed the geological formations of North Louisiana, though the strata frequently have been broken and folded and slightly faulted through erosion. West of Ruston the disturbances of strata exposed extend over a section about three miles in length. The faults range from a few inches to ten feet in vertical depth, and have affected all the strata exposed. The material is entirely unchanged. The sands are loose, as at other points, and the clays are unchanged in color and hardness.

LIST OF FOSSILS FROM THE GREEN SAND MARL, TWO AND ONE-HALF MILES NORTHEAST OF MT. LEBANON, LA.

The fossils have been determined by Mr. G. D. Harris, of the United States Geological Survey, and according to examinations made by me they prove to be the same throughout the Claiborne formation of this section (Middle Eocene.)

Ostrea divaricata, Lea.
Anomia ephippoides, Gabb.
Pecten claiborensis, Conrad.
Arca rhomboidella, Lea.
Nucula magnifica, Conrad.
Corbula nasuta, Conrad.
Venericardia planicosta, Lam.
Astarte sp. nov.?
Pleurotoma wabe.
Conus sauridens, Conrad.
Volutilithes petrosa, Conrad.
Calyptrophorous velatus, Con.
Caricella demissa, Con.
Ancillaria staminea, Con.
Pseudoliva vetusta, Conrad.
Marginella larvata, Conrad.
Clavella humerosa, Conrad.
Latirus sp.
Fusus (Papillina) dumosus, Conrad.
Murex sp.?
Mesalia obruta, Conrad.
Turritella vetusta, Conrad (Var.)

Crepidula lirata, Conrad.
Solarium elaboratum, Conrad.
Natica limula, Conrad.
Cythara sp.
Flabellum Wailesii, Conrad.
Distortio septemdenta, Conrad.

ECONOMIC GEOLOGY.

Climate is a most important factor in the economy of a country. The health, and if we include soils and waters, the wealth of the inhabitants depends largely on it. Winds cool and purify the atmosphere, shift the sands and assort them, destroying old and forming new soils. The precipitations form with the soils the immediate cause of success or failure of agriculture and horticulture and hydraulic action of the waters has shaped our hillsides and valleys. The temperature determines the character of the vegetation and animal life and assures comfort or causes discomfort to men. Climatological factors are of so high an importance from an economic as well as from a geological point of view that they deserve a careful consideration.

The following data have been obtained through the kindness of Mr. M. J. Wright, observer in charge of the United States Signal Service at Shreveport, and will give a fair idea of the climate of the district surveyed:

MEAN TEMPERATURE AT SHREVEPORT, LA., FOR EACH MONTH THE PAST TWENTY YEARS, FROM 1871 TO 1890 INCLUSIVE.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual Mean Temperature.
1871	....	....	....	....	....	....	....	....	72.1	63.7	51.0	47.3	....
1872	40.7	50.6	54.4	66.5	73.5	80.4	84.4	84.5	78.6	66.6	48.1	41.8	64.1
1873	42.0	51.9	58.8	64.7	72.3	79.3	81.9	81.0	75.5	62.1	56.1	49.8	64.6
1874	50.4	51.6	60.7	60.8	74.9	82.6	82.6	87.2	74.8	71.5	58.8	59.7	64.4
1875	41.4	49.9	57.6	63.0	74.9	83.5	85.3	79.0	73.1	62.1	57.7	55.3	65.2
1876	53.5	55.0	53.7	66 7	72.1	78.0	82.7	82.6	74.6	63.7	52.6	40.9	64.7
1877	43.9	51.4	57.9	64.6	73.1	80.0	81.9	82.4	75.3	65.1	51.4	51.0	64.8
1878	46.0	50.0	64.2	69.3	73.4	78.6	83.4	82.8	74.3	65.6	56.3	43.1	65.6
1879	45.4	50.0	65.3	65.0	75.1	80.5	84.6	79.1	74.7	68.4	60.3	54.5	69.9
1880	60.5	53.1	58.5	68.9	76.1	78.9	80.2	80.5	72.7	63.1	46.9	46.5	65.5
1881	40.9	48.4	55.4	66.9	75.4	85.0	85.1	85.9	77.7	79.7	53.5	52.3	66.4
1882	50.4	57.3	63.9	68.0	70.4	80.4	79.7	78.9	73.5	69.2	54.9	47.8	66.2
1883	43.2	48.1	56.5	66.6	73.4	81.0	88.9	81.6	74.5	70.9	57.9	52.3	65.8
1884	38.9	53.7	59.5	62.8	71.6	79.4	86.2	80.8	80.2	68.0	53.1	46.7	65.1
1885	41.5	45.0	54.4	68.0	71.2	81.1	82.7	81.8	75.2	60.9	56.0	48.6	63.8
1886	31.1	48.8	54.1	64.5	75.9	78.7	81.6	82.0	76.9	64.7	54.6	46.3	63.9
1887	45.2	56.3	61.0	67.6	75.4	80.2	82.4	81.6	77.2	64.2	55.9	45.4	66.0
1888	44.5	51.6	54.7	69.3	72.7	78.2	81.4	79.8	72.0	63.4	53.4	48.0	64.1
1889	47.4	49.2	56.8	67.4	70.2	75.8	80.6	78.1	71.8	62.6	49.2	61.4	64.2
1890	56.0	55.9	58.6	65.0	72.0	77.4	80.7	78.1	71.4	62.6	55.8	50.6	65.0
Means	45.8	51.5	58.1	66.1	73.3	79.9	82.7	81.5	74.8	65.4	54.2	49.5	65.2

M. J. WRIGHT, JR., Observer in Charge.

DATES OF FIRST AND LAST FROSTS AND HIGHEST AND LOWEST TEMPERATURE, AT SHREVEPORT, LA.

Year.	Frosts.		Temperature.	
	Last in Spring.	First in Fall.	Highest.	Lowest.
1871....	....	....	....	....
1872....	....	....	....	....
1873....	April 9.......	October 20....	....	....
1874....	....	November 1...	101. August 10....	....
1875....	....	October 19....	107. July 16.....	13. January 10.
1876....	March 16.....	October 1.....	98. July 24......	17. December 30.
1877....	....	October 20....	99. July 6 and 8, August 2...	19. January 2, November 30.
1878....	April 5.......	October 18....	98. July 21, August 9.....	22. December 25.
1879....	February 9 ..	November 18..	100. July 14......	6. January 6.
1880....	February 14..	October 17....	96. July 3.......	10. December 29.
1881....	February 22..	November 20..	105. July 22, August 15 and 21.........	22. February 13.
1882....	March 21.....	November 14..	101. June 24 and 29.........	22. December 8.
1883....	....	November 13..	102. July 31, August 15....	12. January 21.
1884....	April 5.......	November 6...	104. July 9, August 29....	10. January 8.
1885....	March 29.....	October 14....	101. August 1.....	13. January 17.
1886....	April 7.......	November 7...	101. May 31....	1. January 8.
1887....	April 5.......	October 13....	104. July 31......	12. January 3.
1888....	March 21.....	November 10..	98. July 14......	15. January 15.
1889....	....	October 7.....	96. July 27......	25. January 27.
1890....	March 1......	October 27....	99. July 11	22 March 1.
1891....	March 17.....	October 8.....	91. June 25, August 25....	25. February 10, November 30.

TOTAL PRECIPITATION AT SHREVEPORT, LA., EACH MONTH THE PAST TWENTY YEARS, FROM 1871 TO 1890 INCLUSIVE.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual Mean Rainfall.
1871....	.....	....	.....	.....	.....	....	.....	....	.....	3.86	3.04	1.30	....
1872....	4.94	5.89	4.11	7.18	9.10	2.70	1.62	0.40	2.91	3.41	1.39	7.07	4.23
1873....	3.22	7.47	2.67	1.94	4.58	7.94	3.31	1.59	2.31	4.15	8.25	4.93	4.36
1874....	3.51	7.58	9.27	10.64	1.19	1.35	5.59	0.19	6.33	0.10	2.10	6.95	4.57
1875....	3.93	2.68	4.94	3.46	0.91	1.79	2.16	6.17	8.02	4.40	2.99	9.54	4.25
1876....	7.26	2.68	11.67	5.83	9.47	20.8	1.87	2.22	0.62	5.42	2 99	2.38	4.54
1877....	2.84	2.48	3.87	5.51	1.24	25.5	2.37	0.20	9.93	9.30	3.76	3.75	3.98
1878....	5.29	2.67	5.70	5.64	7.04	7.65	6.11	2.28	1.66	1.66	3.56	6.57	4.65
1879....	7.41	2.06	1.26	10.23	2.13	2.09	2.41	4.75	0.95	0.52	4 57	3.21	3.47
1880....	3.68	6.19	6.17	8.43	3.21	2.74	10.67	1.21	11.61	2.72	7.43	3.24	5.55
1881....	2.24	6.52	1.80	2.81	8.63	0.38	3.17	0 45	5.90	8.28	5.96	7.59	4.48
1882....	9.08	8.71	3.16	5.44	4.59	0.65	11.38	3.97	1.11	6.72	8.62	1.68	5.43
1883....	3.54	7.24	5.85	4.45	1.40	5.70	0.22	0.72	1.29	0.97	8.66	3.06	3.59
1884....	4.55	5.49	4.78	6.60	14.47	4.22	0.06	1.99	2.10	0.54	5.73	5.73	2.51
1885....	12.11	3.31	1.79	7.07	3.66	5.79	4.89	0.92	6.70	4.32	3.93	4.11	4.88
1886....	3.87	4.77	6.32	5.14	0.08	4.16	2.58	3.60	4.98	3.59	3.61	1.52	3.68
1887....	3.26	3.31	1.28	0.44	5.15	4.00	3.85	2.07	3.64	3.05	5.45	6.72	3.52
1888....	3.75	2.01	9.00	4.49	3.44	3.24	2.97	3.76	0.91	2.73	3.48	4.98	3.73
1889....	4.02	2.03	3.05	6.91	2.70	7.97	3.43	1.75	3.51	1.06	9.10	0.64	3.85
1890....	5.15	4.63	3.60	3.22	1.95	3.12	2.09	0.62	7.23	3.53	3.07	2.33	3.38
Means..	4.93	4.62	4.74	5.55	4.47	3.69	3.74	2.05	4.30	3.52	4.88	4.81	4.30

HUMIDITY, PREVAILING WIND AND HOURLY WIND VELOCITY, AT SHREVEPORT, LA.

MONTHS.	Mean Monthly relative humidity.	WIND. Prevailing Direction	Average hourly velocity.
	per ct.		
January	77	S	11.3
February	77	S	12.5
March	63	S	13.4
April	70	S	11.0
May	71	S	9.5
June	68	S	9.3
July	73	S	9.3
August	72	SE	8.0
September	73	SE	8.4
October	80	S	9.0
November	73	S	10.3
December	74	S	10.9

REMARKS.

Prevailing wind, direction and average hourly movement of wind deduced from record of twenty years' observation—1871-1890 inclusive.

Relative humidity deduced from sixteen years' observations—1875-1890 inclusive.

Relative humidity corresponds to the readings of dry and wet bulb thermometers. The relative humidity of the air at any time is the percentage of moisture contained in the air as compared with the whole amount it is capable of holding for the particular temperature at the time. Air containing no moisture is at zero relative humidity; when saturated the relative humidity is 100.

The foregoing tables are so full and complete that it is unnecessary to add any explanation, and it is hoped that the agriculturist will make full use of their contents. The late and severe frost has destroyed to a large extent the fruit of this section, and the attention of the farmer is called to the tables containing the data or early and late frost during a period of twenty years. A proper selection of the trees with due regard to these data may save large losses in the future. A careless selection of the sites of residences by placing the dwellings in the direction of the prevailing wind and swamps has caused destruction of health and life, which will be prevented by a study of the surrounding conditions in which the wind tables given will be found very serviceable. The data giving the precipitations, the temperature and the humidity of the air will assist the intelligent planter to select his crops and aid him in their cultivation.

WATER.

Subterranean waters are found in inexhaustible quantities throughout the section, varying in depth according to the topography of the country and sometimes influenced by the underlying impermeable clays which carry them. The water is generally of great purity, quartz sands constituting their filter, and gray clays, with no injurious mineral contents, their beds. The depth of wells range from ten to sixty feet, and only the shallow wells are affected by dry seasons. Sometimes the drainage area of these wells is so limited that the level of the water is fluctuating with each rain. In such cases the water ought not to be used for drinking purposes, as its use will invariably develop malarial disease. The water of the deeper wells, especially on account of the larger drainage, more thorough filtering and the lower temperature not affected by the daily changes, is agreeable to the taste cannot be considered injurious when used for drinking purposes.

MEDICINAL WATERS.

CHALYBEATE SPRINGS AND WELLS.

Whenever the red sandy clay contains alumina enough to become impermeable they sometimes carry water, and in such cases, as well as when the water has filtered through the red sands and sandy clays before striking an impermeable stratum, it has brought a part of the coloring matter, peroxid of iron in solution which may be enough to give it the chalybeatic character. Such springs are found all over the country, and this is not strange when we consider the distribution and stratigraphical position of the red sandy clays and sands. At Ruston the ground of the Chautauqua Society are located on a section with a large number of beautiful springs very rich in carbonate of iron. (See Chemical Report for analyses.)

As mentioned on a former page, the water is always entirely unfit, or, at least, injurious to health when constantly used, if found running along the lignite shales or green sands, but on account of the minerals these marls and shales contain, sulphate of magnesia, lime, alumina and iron, potash, sodium and chlorine, the water running along them will dissolve these minerals in various proportions, and in some cases, at least, the very qualities which make it undesirable for household use may give it medicinal properties and make it valuable after once its virtues are ascertained. Like the chalybeate springs, they are found all over the country, depending, of course, on the amount of erosion, the gray clays, overlying the green sands and lignitic shales, have sustained. X

ARTESIAN WELLS.

The necessary conditions to insure a flow of artesian water are: Porous strata deposited in form of a mould or dipping under a slight angle in one direction and underlaid and overlaid by impermeable beds. The outcrop of porous beds constitutes the catchment area and must be located above the mouth of the well in order to furnish the necessary hydrostatic pressure.

X In the country surveyed both the series of the lignitic shales as well as the glauconitic sands and marls are sloping in a southeasterly direction, and the lower series consists to a large extent of sandy beds very porous and freely absorbing the rain which may fall on its exposures. The necessary conditions to insure artesian water are therefore present and wells have been bored at Monroe successfully obtaining a good flow at 348 feet. X Minute data as to the extent of the receiving area and to amount of water which can be expected from these beds only can be ascertained by a more careful survey and especially by making minute geological sections along the Ouachita and Red river courses.

X At Shreveport artesian water has been obtained, which, however, comes from an entirely different basin, likely from the sands of the upper cretacious formation. The tables giving the annual rainfall demonstrate sufficiently the fact that cistern water may be secured wherever it may be needed throughout the year. X

SOILS AND THEIR DISTRIBUTION.

The soils of this region are derived chiefly from the gray sands and red sandy clays which constitute the surface formation.

The alluvium of the Red river and the Ouachita river covers large areas with soils peculiar to them, and the gray clays underlying the red sandy clays have formed a variety of soils from the stiff tenacious clay to a lighter loam containing sand in larger proportion, covering bottom and flats. Very rarely the lignitic shales enter directly with their constituents into the composition of the soils of this section of North Louisiana. The soils encountered may be classified as sandy soils, clay soils and loam soils. The geographical distribution conforms to the geological formation from which these soils are derived. That is, the sandy soils cover the uplands, the clay soils the bottoms and flats, and the loam soils the alluvium of the Red river and Ouachita river, and the hammocks, or second bottoms, of the smaller streams.

The sandy soils of this section proper consist chiefly of quartz and small well-rounded grains mixed with humus and sometimes peroxid of iron. Throughout this section these soils are underlaid by red sandy clay, which frequently constitutes the subsoil for many square miles. Its depth beneath the surface changes, however, and sometimes it is so far beneath the sand that its constituents do not even affect the subsoil. The red sandy clay consists mainly of sand and clay, colored deeply, frequently brilliant by peroxid of iron and its quality varies, more clayey and less sandy, or a reversed proportion, within small range. A numberless variety of soils are shading from the pure gray sand into the pure red sandy loam—the well-known, characteristic and highly valued redlands, covering large areas of the region. The consistency of these varied soils caused by an intermixture of the gray sands with the red sandy clays depends, of course, on the depth from the latter to the former. The composition of the soils of the red lands is that of the red sandy clay mixed with humus and they constitute the surface soils wherever erosion has removed the sheet of gray sand. A large amount of humus gives frequently a deep black color to the sandy soils.

The subdivisions of the sandy soil are —

1. Black sandy.
2. Gray sandy.
3. Yellowish red sandy.
4. Deep red sandy loam.

No. 4 contains a larger proportion of red clay and is the typical soil of the red lands. As mentioned, a large variety shades from one into the other division and frequently in one farm, nay, even in one acre, several of these minor subdivisions can be found always caused by the distance, more or less shallow position, of the red sandy clay to the surface. The peculiarities of these minor subdivisions must be studied by the planter.

The soil carries all vegetation; it is the place or medium for growth, a material furnishing the necessary support or foothold for the roots which penetrating the mass, hold the plant in that position in which the life functions can be best performed. The soil is, therefore, primarily simply the physical bearer of the plant, and on the performance of this office all other properties, and each other relation existing between them depend.*

The mechanical condition of the soil is therefore of the very highest importance and the attention of the farmer can not enough be called to this fact. Frequently, and especially in these uplands, soils which lack in one or the other ingredients which give it the right composition can be improved without cost or trouble by studying the soil, the subsoil and the undersoil and their relation to each other. In order to possess the right consistency the soil must be porous to allow the roots of the plants to penetrate its mass without difficulty and give access to the air. It must be dense enough to retain moisture and fertilizers. Sand gives porosity to the soil, clay conveys retentive qualities. If the soil contains too much sand it will be like a sieve through which moisture and fertilizer pass without obstacle till they strike an impermeable stratum along which they are carried into the country drainage. If it contains too much clay the soil will be cold and tenacious, crack in the dry season exposing the roots of the plants to the dry air and drowning them in wet weather by keeping the water like a sponge.

It will be easily understood now how the soil can be improved. Deep ploughing, when the surface soil is too sandy and the subsoil is clayey will obtain the proper composition. This is the usual condition in this section. If the soil and subsoil are too sandy and the under soil is clayey, by mixing the undersoil with the subsoil and surface soil this condition is sometimes found in the region. If the sand is too deep and none of

*Rocks and Soils—Stockbridge, page 195.

the former methods can be employed for its improvement, a condition very rarely found in these uplands as far as known to the author, marling or claying the land, bringing the material from other localities will obtain the same result, though with more cost. A large supply of humus—pine straw—will largely increase the retentive qualities of such soils. From the foregoing it may be easily enough concluded when deep ploughing and when shallow ploughing ought to be employed in these upland soils.

THE SOIL OF THE UPLAND FLATS.

The Gray Loam.—This soil, accompanying Bayou Dorcheat in extensive flats, is evidently derived from the gray clays. In solid sheets, several feet in thickness, it covers the gray sands and red sandy clays. Always of a gray color, it is cold and tenacious and possesses all the peculiarities of a typical clay soil, cracking in every direction during the dry season of the year and holding the water sponge-like and forming ponds and shallow swamps during the rainy time. A thorough and systematical drainage is required to make these lands available to cultivation. The natural drainage channels ought to be cleared from all rubbish, brush and tree trunks obstructing the descending water, and in places where the flats are too level and too extensive to allow conveniently to carry off the water, it ought to be drained into sinkholes, one in most cases enough for an area covering several hundred acres. The near vicinity of the sands to the surface would in such cases make this a cheap method to pursue and it has been done very successfully in other countries.

The position of the gray loam is indicated in the general section.

A supply of humus and sand would obtain favorable results by making these lands more loose. If the flats are surrounded by hills it will be found advantageous to conduct the wash, consisting mostly of sand on the fields, and distribute the material properly by changing the furrows.

Clay soils, containing from 60 to 80 per cent. of clay, form as a rule the most valuable and productive soils and yield good crops of all the more common agricultural plants, particularly wheat, roots, clover and grass. Those soils containing 80 and 90 per cent. of clay have a diminished utility, but yield profitable returns of wheat, clover, buckwheat and horsebeans. While more than 90 per cent. of clay reduces the limits of successful cultivation because of the difficulty of working and danger from excess of water.* The soils under discussion hardly ever will be found to contain more than 90 per cent., and their improvement is, therefore, of great importance to the economy of this country.

Nothing need be said at this place about the yellow loam accompanying the Ouachita river which in all cases where it has been observed possesses great fertility and the right composition. Its stratigraphic position can be studied in the general section.

The Bottom Soils resemble much the gray loam of the flats. Like these, they are derived from the underlying gray clays, of which they sometimes almost solely consist and the varieties they form depend on the amount of sand which has mixed with them, washed in by the rains from the joining hillsides. Like the gray loam soils, they are mostly cold and tenacious, form the habitat of the crayfish, crack when dry and hold the water like a sponge in wet weather. Generally they are under the present drainage conditions subject to annual overflow, and on that account entirely unfit for cultivation. The original vegetation they bear, and of which a list will be found attached hereto, denote them to be very fertile, and to include them into the cultivated lands of the country ought to be the aim of the planter. To obtain this result, they must be thoroughly drained. The natural drainage channels must be cleared and deepened sufficiently to carry off the largest amount of water which may fall on any given area in twenty four hours, and which may be calculated easily enough from the rain tables embodied in this report. Generally the material is tenacious enough to allow a subdrainage with an instrument now employed in many of the northern clay lands. The same consists of a knife, which, on its lower end, carries a cone. A hole about three feet square and three feet deep is dug in which the instrument is inserted. The dis-

*Rocks and Soils—Stockbridge, page 149.

tance of the cone from the surface can be regulated by the operator at will when pulled by a horse, the knife cuts into the stiff clay land and the cone presses the material aside. The cut made by the knife closes as soon as the instrument has passed, leaving a drainage channel pressed out by the cone. These sub drainage channels, which take the place of tiles, drain into a ditch. A more mellow condition of these lands can almost always be obtained by conducting the sandy wash of adjoining hills on the lands and by changing the furrows. A drainage of the water into underlying sands can seldom be employed as most of these bottoms rest directly upon the underlying gray clays.

ALLUVIUM.

Red River Alluvium Soils.—There are two chief varieties of soil observed in this portion of the valley of the river. Near the stream a yellowish red, or reddish loamy soil, deep and very productive, observed and termed by Dr. Hilgard at another place of the valley, "frontland soil." The second variety, also observed by the same author and termed back bottom soil, is located in the back bottom away from the channels. It is heavier and more difficult to till than the former, though unquestionably more lasting. A number of varieties shades from one into the other and will be studied more minutely hereafter.

Alluvium of the Ouachita River.—These soils resemble largely the varieties of the Red River alluvial soils and like in that bottom two chief varieties can be differentiated, one frontland lighter loam and a back bottom soil, stiffer and more difficult to till than the former.

Second Bottoms.—These soils are generally of a black or dark red color and consist of a very fertile sandy loam. A more minute study is required to classify them.

The above are the chief varieties of soils observed in the section surveyed and they are classified and studied in relation to the geological formations from which they are derived. Samples of them have been collected and analyses are now being made in the laboratories of the agricultural station of the State, and some of them will be found in the chemical report of Dr.

Wm. C. Stubbs, the Director of these Stations. It is not the province of this report to discuss the agricultural features of the section, the adaptability of the different soils to the various crops and the manures needed. These features will be fully treated of hereafter in the special report by the Director of the Station.

USEFUL MINERALS.

The most important of minerals found in North Louisiana are certainly the marls. Fortunately for this portion of the State, the blue and green colored tertiary marls occur in abundance, though their geographical distribution in limited, confined to the central portion of this section, embracing the outcrop of the Claiborne beds. All these marls are true fertilizers and not mere stimulants, they contain phosphoric acid and potash, besides lime in various proportions, which mineral acts as fertilizer and powerful stimulant unlocking otherwise unavailable compounds, containing potash and phosphoric acid ; soda, magnesia, iron and sulphuric acid, all to a more or less extent contained in the marls of this section. By applying, therefore, these marls to the exhausted fields we return to them fertility which in course of time they have lost through an injudicious cultivation and by marling the fields now in cultivation and adding from time to time vegetable manure we can sustain their fertility. Even the large amount of alumina these marls generally contain will materially improve our sandy soils by making them retentive and mellow. Dr. Hilgard in speaking of the efficacy of marls remarks that a dressing of 200 bushels per acre containing one fourth per cent. of potash and the same amount of phosphoric acid, ceases to be effective and therefore requires to be repeated in the course of ten years. The amount of lime present even in the blue and green marls of the tertiary formation is generally sufficient to be effective for a far longer period of time. Marls are most effective when used in connection with vegetable manure, the pine straw of the hills or the oak and beech leaves of the bottoms will be found handy and most serviceable for this purpose. The marl may be hauled to the field as it comes from the pit, being thrown from the cart in small piles; it will be in a favorable condition to be acted upon by the weather, especially in winter; it may then be scattered and turned under by the first plowing in the spring (R. T. Hill, p. 248, Arkansas Geological Survey, 1888). Hilgard recommends to turn the marls under together with green tops.

With most of the bluish marls of this region preliminary exposure becomes a matter of great importance, and often of necessity, on account of their frequently containing small amounts of iron pyrites. This mineral, by the action of the atmosphere, is transformed into green vitriol or copperas, and as such would, for the time being, prove highly injurious to plants, causing "dead spots" wherever a crystal or lump of mineral thus decays. In the presence of a plentiful supply of lime (with due access of air), however, the copperas would be rapidly transformed into gypsum or plaster and inert protoxide of iron, thus adding a useful ingredient to the components of the marl. This renders the previous exposure or weathering of the marls doubly important. (Robert T. Hill, Arkansas Geological Survey, '88.)

Samples of the various tertiary and cretacious marls have been collected and the analyses and their proper application to the different soils of this section will be given in the future agricultural reports of the director. Practical experiments with them will be made at the Stations.

Gypsum was only found in the cretacious islands. It is largely used as fertilizer and stimulant in agriculture and its application is especially useful to loam and clay soils. It is a special manure for clover, peas and leguminous plants.

Salt Wells.—The various works formerly operated in this part of the State and all located on the cretacious outcrops have been fully described in a former chapter. There is no practical reason why these wells should not be worked with advantage under the present conditions. Fuel is cheap in this section of Louisiana. Solar evaporation would be favorable, and at least the Rayborne works are located near a railroad.

Clays.—An abundance and a large variety of pottery, firebrick and common brick clays are found all over the country.

Their economic value can, however, not be discussed till the analyses and experiments have been made.

Building Material.—The region surveyed has practically none. With the exception of a few ledges of soft sandstone nothing could be used for that purpose.

Iron Ores have been examined in 1888 by Lawrence Johnson, of the United States Survey, and fully reported upon. Since then a number of the localities have been re-examined by other experts with the view to develop the deposits. On closer inspection they have so far proved invariably insufficient in quantity, though the quality of most of the ores tested is good.

Lignite or Brown Coal.—This coal occurs throughout the region surveyed, but seems to be more frequent in the western portion. Its deposits forming constituent members of the lignitic shales occur in basins, so far as examined never over a few square miles in extent. Their economic value can be determined only by minute surveys of the various deposits and by analyses to determine the quality of the material they contain.

The coal is largely used in Europe which is sufficiently shown by the following figures for 1890:

	Tons mined.	Value at mine.
Germany	15,468,434	$ 9,967,812
Austria	15,329,056	12,482,603
Total	30,797,490	$22,450,415
Of which		
Rhine provinces	661,590	$ 381,139
Halle, A. S.	14,077,382	9,031,238
Styria	2,270,023	2,942,327
Bohemia	12,190,932	8,240,780

This amount, over three hundred car loads, is nearly thirty per cent. of the entire coal (stone coal and brown coal) production of these empires, which was (for 1890) 104,702,370 tons. Of the total amount of brown coal mined, the district around Halle, Germany and Bohemia and Styria, in Austria, produced 80 per cent.

The amount of brown coal used in the manufacture of briquettes, coal bricks, tar, paraffine, etc., during the year was a little less than seven million tons, and the remainder—over twenty-three million tons—was used "raw," without preparation. These statistics were taken from the government reports by Prof. E. T. Dumble.

LITERATURE.

No reports or papers have been published on the region surveyed, with the exception of a Congressional document—"The Iron Ores of North Louisiana and Eastern Texas," by Lawrence C. Johnson, Assistant Geologist, United States Geological Survey, within the knowledge of the writer. However, a number of geologists have touched the region in their geological explorations, and published papers bearing on the subject. The time is too short to fully credit the work of each explorer, and we are on that account obliged to make the acknowledgment for previous work in this general way.

Hopkins & Locket's Report on the Geology of Louisiana, Bowes' Review, Vol. 26 and Vol. 27.

Topographical Survey of Louisiana, by Lockett, 1870.

Dr. Hilgard's series of publications in American Journal of Science.

Sketch of Louisiana Geology, by Forshay, 1852.

Geological Reconnoissance of the State of Louisiana, 1869, by Hilgard.

1881. Report on the Cotton Production of the State of Louisiana, by Dr. E. W. Hilgard.

Prof. McGee—The Lafayette Formation. Bulletin United States Geological Survey, in course of publication.

ACKNOWLEDGMENTS.

My thanks are due to all the citizens of the country who uniformly by their generous and courteous treatment have greatly facilitated my work. To Prof. McGee, of the United States Survey, who has kindly furnished me with the proof sheets of a manuscript treating of the Lafayette formation. To

Mr. L. W. Stubbs, Chief Engineer of the V., S. & P. R. R., for many courtesies extended, as well as to all the officials of that railroad I had the pleasure to meet. To Mr. E. C. Bright, C. E., Minden; Major McGuire, Monroe; A. R. Thompson, Benton; R. B. Patterson, Shreveport, and especially to Mr. Wright, Observer in Charge of the United States Signal Service Office. Prof. Vaughn, of Lebanon College, and Major J. G. Lee, the Assistant Director of the North Louisiana Experiment Station, and his staff, and J. H. Winard, Captain Corps of Engineers, U. S. A., for maps and papers.

CHEMICAL REPORT.

Soils, waters, marls, phosphates and iron ores have been collected on this survey and distributed among the different laboratories of the Stations. The laboratory of North Louisiana Experiment Station, under Mr. Maurice Bird, B. S., has made the following analyses. The other laboratories will make returns later:

WATERS.

These are from artesian wells, sipe wells and mineral springs. The first are getting common all over the State for industrial purposes and analytical determinations are needed to detect properties objectionable for the purposes designed. If for drinking purposes the purer the water the better. The same may be said when used for boilers, though the presence of highly objectionable substances in potable waters may be tolerated in boiler waters. Those salts which scale or rust the boilers are deemed most objectionable.

In mineral springs or wells the presence of certain medicinal salts gives value to the water and are to be recommended to invalids upon the advice of a physician.

ARTESIAN WATERS.

No. 1. From Planters' Oil Mill, Monroe, La., section 6, township 17, range 4 west.

No. 2. From Consolidated Ice Company, and known as the Jackson Artesian Well, Monroe, La., section 6, township 18, range 3 east.

No. 3. From same company, Boone Artesian Well, section 7, township 18, range 4 west.

SIPE WELLS.

No. 4. From Mr. Shelvy Baucune, Millerton, La., said to be highly corrosive upon boilers, due to small amounts of free hydrochloric and sulphuric acids.

No. 5. From Dr. J. C. Christian, Arcadia, La., southeast quarter of northeast quarter section 19, township 18 north, range 5 west. This water is used for medicinal purposes and is said to be giving great success.

SPRINGS.

No. 5. From Griffin Springs No. 1, Chautauqua Grounds, near Ruston, La.

No. 7. From Griffin Springs No. 2, Chautauqua Grounds near Ruston, La.

ANALYSES OF WATERS FROM WELLS AND SPRINGS EXPRESSED IN GRAINS PER GALLON OF 234 CUBIC INCHES.

No.	Sol. Silica.	Iron and Alumina.	Lime.	Magnesia.	Potash.	Soda.	Chlorine.	Sulphuric Acid.	Phosphoric Acid.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Nitrogen as Ammonia.	Carbolic Acid.	REMARKS
1...	4.20	3.08	.42	.84	.44	14.79	6.15	.54	None	None	None	None	6.02	Mainly Sodium Chloride and Carbonate.
2...	.82	1.58	.82	.14	.22	13.14	1.45	.44	.75	None	None	None	10.40	Mainly Sodium Carbonate
3...	2.98	1.78	1.05	.20	.22	15.17	1.58	.55	1.04	None	None	None	5.90	Mainly Sodium Compounds.
4...	1.53	3.27	.47	.29	......	......	......	......	......	......	......	......	......	Total Solids, 17.76 grs. per Gallon, of which 6.95 grs. are Organic Matter.
5...	65.20	13.26	33.56	31.59	.68	30.41	96.39	89.97	......	......	......	......	......	Mainly Sulphates and Chlorides of Alumina, Lime, Magnesia and Soda.
6...	2.80	1.54	1.54	.68	Trace	1.11	.42	.67	Trace	Trace	None	None	Not Dtd	*Slightly Chalybeate.*
7...	2.66	2.38	1.19	.88	Trace	1.19	.32	.75	Trace	Trace	None	None		

IRON ORES.

Everywhere the Lafayette group, formerly known as the Orange sand, comes in contact with the underlying formation, iron concretions in greater or less quantity occur. The quality of some of these specimens is excellent, but the quantity in no place sufficiently great to excite even the hope of working them.

No. 1. A sample obtained three miles south of Farmerville, in the D'Arbonne hills in the Arkansas hills, contained 51.94 per cent. metallic iron.

No. 2. A ferruginous sandstone from Old Settlement road, four miles northeast of Calhoun, section 30, township 18, range 2 west, contained 33.16 per cent. metallic iron.

No. 3. Clay iron stone, two miles west of Calhoun on Vicksburg, Shreveport and Pacific Railroad, section 29, township 18, range 1 east, had 35.56 per cent. metallic iron.

These are fair samples of what may be obtained all through the hills of North Louisiana.

LIGNITES.

These, it is believed, will some day be found in sufficient purity to justify transportation for use as a fuel. The high water prevailing has prevented a more extended examination for the present.

No. 1. Is a sample from section 14, township 18, range 1 west.

No. 2. Is a soft lignitic sandstone from crossing of Arkansas road and Bayou Choudrant, Ouachita parish, section 4, township 18, range 2 west, and contains a large quantity of iron pyrites.

These are local samples; better ones were obtained further west :

ANALYSES OF LIGNITES.

	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.
No. 1	37.27	25 02	22.30	15.41
No. 2	18.62	26.68		54 70

NATURAL PHOSPHATES.

On account of the great need of our hill soils for phosphoric acid, hopes have been entertained that deposits of phosphates might be found somewhere in these hills. So far only specimens of iron ores containing white nodules of phosphates have been found. One of these sent by T. R. Coleman, of Homer, La., gave 27.95 per cent. of phosphoric acid. Another from Mr. A. K Clingman contained several nodules rich in phosphoric acid. It is possible that the iron ores of this country all carry a small quantity of phosphoric acid and that the acknowledged fertility of the red lands, such as occur near Vienna, in Lincoln parish, may be due to the phosphates present. This point will be studied hereafter.

MARLS.

In several places in North Louisiana shell marl and green sand marl (glauconite) have been found. Wherever the former is easy of access it may be utilized upon adjoining lands. Scattered broadcast at rates of one to three hundred bushels per acre, followed by a crop of cow peas sown broadcast and turned under, good results should accrue. It must be borne in mind, however, that they contain mainly carbonate of lime. A sample of shell marl from a creek in section 2, township 18, range 6, of a thickness of three feet, with rock below and red clay above, and sent by Mr. W. M. Washburn, Gibbsland, La., gave 12.21 per cent. lime, equal to about 21 per cent. carbonate of lime, with traces of phosphoric acid and potash.

Green sand marl, on the contrary, contains notable quantities of phosphoric acid and potash, besides the lime and frequently of such a quality as to justify long transportation. In New Jersey quantities are annually used by the farmers of the State. A sample sent by Prof. Wayland Vaughn, Mt. Lebanon, La., from southwest quarter, section 30, township 18, range 6 west, gave upon analysis 7.16 per cent. of lime, .45 per cent. phosphoric acid and 1 per cent. potash. None of these marls should be used in quantity until their value be determined by chemical analysis. The Station at Calhoun will analyze samples sent it.

SOILS OF NORTH LOUISIANA.

It is to be regretted that so few analyses of the soils collected are ready for this report. It is expected after all laboratory work is completed to present a special report upon *soils*. Till then the following analyses are offered:

No. 1. Taken from Plat 2, Experiment Field of North Louisiana Experiment Station; character very sandy; in cultivation for seventy five years; yielded in 1887 prior to occupation of Station, three bales of cotton to fifteen acres; it has since been plowed and cultivated well and yearly manured with a fertilizer suitable to crop produced; last year it produced a bale to the acre. Sample taken six inches deep; section 27, township 18, range 1 east.

No. 2. Taken from rear end of the same field; not quite so sandy.

No. 3. Soil from old field adjoining above, grown up in pine saplings; has received no fertilizers; very sandy.

No. 4. Subsoil of No. 3.

No. 5. Soil taken from the top of a hill three quarters of a mile northeast of Calhoun, with one and a half inches of vegetable mould; soil twelve inches; gray sandy loam.

No. 6. Subsoil of No. 5; red clay (?) twenty inches in depth, both in section 27, township 18, range 1 east.

No. 7. Virgin soil from second bottoms of the Ouachita river three miles northwest of Monroe; depth, six inches; a brown loam of uniform chocolate color; rich in humus, crumbling between the fingers; productive when cultivated; section 36, township 18, range 3 east.

No. 8. Subsoil of No. 7.

No. 9. Soil of "crayfish land" two miles northwest of Monroe; section 10, township 18, range 3 east.

No. 10. Subsoil of No. 9.

ANALYSES OF SOILS AND SUBSOILS

No.	Soluble Silica.	Ferric Oxide.	Alumina.	Lime.	Magnesia.	Potash.	Soda.	Phosphoric Acid.	Sulphuric Acid.	Nitrogen.	Organic Matter.	Insoluble Matter.	Remarks.
1..	.120	.336	.762	.085	.018	.023	.041	.037	Trace	.025	1.575	97.010	From front of field of Station.
2..	.090	.529	.829	.145	.074	.029	.058	.048	Trace	.037	2.225	95.510	From rear of field of Station.
3..	.029	.463	.490	.027	.027	.011	.009	.021	Trace	.026	1.370	97.250	From old field with pine saplings.
4..	.039	2.561	4.137	.134	.177	.066	.051	.032	Trace	.024	5.220	87.530	Subsoil of No. 3.
5..	.022	.379	.495	.009	.011	.008	.014	.011	Trace	.029	2.050	96.490	Soil northeast of Calhoun.
6..	.016	1.776	1.831	.112	.041	.031	.016	.028	Trace	.025	4.020	92.210	Subsoil of No. 5.
7..	.085	1.303	2.550	.128	.180	069	.036	.072	.002	.088	7.350	88.350	Soil from second bottoms of Ouachita river.
8..	.131	1.977	3.164	.063	.089	.085	.024	.061	.004	.052	5.050	89.550	Subsoil from No. 7.
9..	.014	.680	1.133	.040	.036	.023	.021	.007	Trace	.026	1.510	96.720	"Crayfish soil."
10..	.049	1.179	1.153	.043	.054	.025	.015	.010	Trace	.016	2.060	95.730	Subsoil from No. 9.

The above soils are perhaps as poor as any to be found in North Louisiana and their analyses as well as experience saggest nutritive manures applied annually in increasing quantities and the incorporation of vegetable matter. They are easily cultivated and can be made to yield fair returns when judiciously manured.

PART II.

GEOLOGY AND AGRICULTURE.

A PRELIMINARY REPORT

UPON

THE HILLS OF LOUISIANA,

South of the Vicksburg, Shreveport and Pacific Railroad, to Alexandria, La.

BY

OTTO LERCH, PH. D., Geologist.

Made Under Direction of State Experiment Stations,

BATON ROUGE, LA.

WM. C. STUBBS, PH. D., Director.

LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE.

BUREAU OF AGRICULTURE.

GOV. MURPHY J. FOSTER, President.
WM. GARIG, Vice-President Board of Supervisors.
H. C. NEWSOM, Commissioner of Agriculture.

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IVY WATSON, Farm Manager, Calhoun, La.
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The Bulletins and Reports will be sent free of charge to all farmers, by applying to Commissioner of Agriculture, Baton Rouge, La.

OFFICE OF EXPERIMENT STATIONS,
LOUISIANA STATE UNIVERSITY AND A. AND M. COLLEGE,
Baton Rouge, La., May 1, 1893.

Hon. H. C. Newsom, Commissioner of Agriculture, Baton Rouge, La.:

Dear Sir—I have the honor of presenting to you the second preliminary report upon the Geological and Agricultural Survey of the State, conducted by Dr. Otto Lerch, under the direction of the Stations. This survey covers the hill country of this State from the Arkansas line to Alexandria, and is a continuation of the work reported in June last. In this report will be found a treatise upon the soils of this section, with analyses, etc., made in the laboratories of the Stations.

With proper support from the State, it is expected to continue this survey until the entire State is covered. Unfortunately our limited means, now at hand, suspends temporarily this important work.

Please publish this as Part II., Geology and Agriculture, and oblige

Respectfully,
WM. C. STUBBS,
Director.

LETTER OF TRANSMISSION.

Sir—I have the honor to submit herewith the second report of the Agricultural and Geological Survey of Louisiana. On receipt of your letter of instructions, I proceeded to survey the country south of the Vicksburg, Shreveport and Pacific Railroad. On July 1, Mr. Wayland F. Vaughan volunteered as assistant and accompanied me till September 1, when I closed field work. The botanical portion of this report is written by Mr. Vaughan, who materially assisted me in the geological investigations and I take pleasure to thank him for his untiring zeal and energy. The grasses collected, some sixty samples, were sent you from the various postoffices near the places of collection.

I have endeavored to give full credit to all previous workers in this field, and if I have omitted, it has been done unintentionally.

None of the literature on the Lafayette formation has been accessible to me and I was therefore forced to conclude from the facts before me alone. Through the kindness of Prof. McGee, Chief of the Atlantic Division of the United States Geological Survey, I obtained the proof-sheets of a paper on this formation; however, only for a few days, in April, 1892, and since that time, I have not been able to procure this or any other publication on this formation. I have therefore divided the formations overlaying in North Louisiana "the Arcadia clays, the Jackson, Vicksburg and Grand Gulf beds." In a lower and an upper division, red sandy clays with Claiborne fossils, ferruginized, washed in, and an upper division of sands, and gravels along the borders of the great rivers. I have referred the lower division to the tertiary and the upper to the quaternary. It is, however, immaterial for the present report whether both these formations or the lower alone belong to the close of the tertiary or the beginning of the quaternary, the report being intended less for professional geologists than for the practical use of the citizens of the State and the interesting but purely scientific determinations of the age of these formations must be left to a time when more data and all the literature on the subject is at disposal.

I have retained all names of the formations given by Dr. Hilgard, with the exception of the Mansfield, which I take at present to represent a local development of the "lower lignitic of Louisiana."

The time has been too short for the determination of fossils collected, entrusted to Mr. Vaughan. A description of these will not be ready for publication till June, 1893. To your own constant aid and encouragement during the progress of the work the success it may deserve is due, and I regard it a pleasant duty to thank you most sincerely for your constant kindness and courtesy.

Very respectfully,

OTTO LERCH,

State Geologist.

Dr. Wm. C. Stubbs, Director State Experiment Stations,
Baton Rouge, La.

On the Geology of North Louisiana.

INTRODUCTION.

Since the publication of "A Preliminary Report Upon the Hills of Louisiana, North of the Vicksburg, Shreveport and Pacific Railroad," the survey has been continued southward to a line drawn through the town of Alexandria in an easterly and westerly course, bounded by the Ouachita river in the east and the Texas State line in the west. All that has been said in the introduction to the former report is applicable to the work done in this section—that is, a detailed and extensive study of the region under consideration will be required to solve the various problems it represents satisfactorily and, like the former, it is presented to the public as a preliminary report preceding detailed investigations which are to follow, and which are to settle finally the manifold problems developed by the present work. This paper is intended to outline the larger features of the interesting physiography, geology and economy of the region, and it is hoped that even this pioneer work which merely indicates how much is yet to be done till final and good results can be obtained, will aid our farmers in their efforts, will convey correct ideas to the immigrant of what this portion of our State promises to him and will suggest methods of experiment to the State Experiment Stations, assisting them to develop the agriculture of this State. For convenience, the plan of the former report has been retained and the topography, the drainage, geology and economy of the region will be treated of separately. Geologically and physiographically this section of the State is a continuation of Louisiana north of the Vicksburg, Shreveport and Pacific Railroad, but as each bulletin has to stand by itself and is sent and perhaps read by persons who have not received the former, repetitions cannot altogether be avoided and must be excused by those who are familiar with the former work.

TOPOGRAPHY.

Though this section of Louisiana, like the country north of the Vicksburg, Shreveport and Pacific Railroad, of which as mentioned, it is but a continuation, does not show any prominent peaks or mountain chains, it is by far not that flat low land the State is generally spoken of, but, on the contrary, consists of a number of various physiographic forms distinguished one from the other. South of the Vicksburg, Shreveport and Pacific Railroad, the country is gently sloping westward and eastward towards the main river bottoms and possesses a gradual, general fall towards the Gulf of Mexico. Every traveler in this part of the State has recognized the most prominent topographical feature; that the whole presents a former plateau traversed in a southerly trend by two large diluvial valleys, that of the Red river in the west and that accompanying the Ouachita and Missippi rivers in the east, both converging in their lower course. These immense valleys are cut by creeks of more recent origin into smaller plateaus and flat-topped hills and rise sometimes abruptly, sometimes more gradual along their borders to a higher plain between them, which is now converted by the same drainage channels into a hilly upland. The country immediately south of the railroad, traversing the State from east to west, presents the surface features, topography, soils and vegetation of that lying north of the road, crosses the Red river into Texas and is terminated abruptly in the east by the Mississippi valley. Here, like north of this artificial division line, we find the same central ridge dividing the Red river and Ouachita river drainage systems, eastward and westward, frequently cut into peaks which are raised above the surrounding hilly country. Here, like there, we find the same extensive low bottoms traversed by small streams which have given rise to the hilly surface configuration of this section of the State. Red sandy clays, variegated sands and gravels constitute the surface material, bearing a vegetation identical with that described in the former reporte

Short leaf pines, intermingled with oaks, hickory, ash, beech, maples and gums. This subdivision of North Louisiana extends southward to an irregular line, traversing the State in a southwesterly and northeasterly course and crossing the diluvial valleys of the Red and Ouachita rivers, coinciding with the change of the geological formation. The red sandy clays and clayey sands, with occasional outcrops of gray clays, thin out and give place to pure quartz sands of gray and red color, frequently of a vertical depth over a hundred feet. The gray clays gradually disappear altogether and in their stead yellow fossiliferous marls with fragments of rotten limestone have taken their place. These and the red sandy clays, which are noticed for some distance southward in this region mantled by the above described quartz sands, constitute the surface material. Though we still find gently rounded hills and ridges in its northern part, they are here and there intermingled with small flat calcareous prairies which become more frequent as we advance southward and at last form the most striking physiographic feature of the landscape crossing the State in a northeasterly and southwesterly course, subparallel to the boundaries of this subdivision, terminated by the diluvial valley of the Ouachita river in the east. The whole country shows the plain structure more prominently and yet is more diversified in its surface configuration than the country north of it, formerly described. Gently rounded hills and ridges, formed by the erosion of the red sandy clays, small flat calcareous prairies underlaid by yellow marls and more or less extensive high sandy plateaus bordered by steep escarpments and dentated and broken by small ravines and gulleys emptying in extensive valleys with the characteristic second bottoms mark the changes in the surface configuration from north to south. The vegetation is characteristic for the physiographic features described and the underlying lithological material may be easily recognized from a distance by the tree growth it bears. The short leaf pine, the large number of varieties of the oak, maple, gums (sweet and black), hickory and ash, cover the red hills and wide bottoms, here as they do in the more northern part of the State. The pine predominating on the hillsides and the dicotyledonous trees in the bottoms. However, bay and magnolia are now to be added to the bottom growth and continue and become more frequent southward. The outcrops of the yellow marls are characterized by prairies offering the aspect of meadows from a few to a hundred acres in extent. Almost destitute of tree growth they are covered by a dense turf of grasses and are surrounded by a vegetation consisting of sweet gum, short leaf pine, post oak, blackjack, hawthorns, persimmons, black haw and crab apples. Not quite infrequent a few persimmon bushes and some specimens of prairie ash are found scattered over the meadow, and limestone boulders are strewn over the grassy plain or gentle slope forming the prairie. These boulders are fossiliferous and of a yellow rotten appearance. The origin of these peculiar prairies is most likely due to the excess in lime of the soils. The sandy flats and steep ridges offer quite a different aspect to the view of the traveler. The long leaf pine covers the region wherever the quartz sands form the underlying lithological material.

The forest is open for miles, only obstructed in the distance by the tall pine trees standing from 30 to 50 feet apart. The loose sandy soils, generally of a black color, are covered with a large variety of grasses and herbs, but no undergrowth obstructs the view of the observer in these truly open woods.

This region, so diversified in its topography and vegetation, terminates abruptly along a line subparallel to its northern boundary, running from Red river to the Ouachita. This boundary consists of high embankments, steep hills and bluffs made up of sandstones, claystones and massive jointed sandy clays, all of a more or less gray color, abutting against and overlaying the above described varied country. So abrupt indeed does this change occur, that it has been termed a line of hills. Advancing southward, the region shows the former plain still more pronounced. Nearly all hills and ridges are flat-topped, valleys more frequently narrow with rarely a prestige of second bottom. Sometimes the hills gradate into level plateaus of many miles in extent, generally covered with drift material, sand and gravel. The vegetation is uniformly that of the sands of the drift, long leaf pine, with the exception of the bottoms. The growth of which resembles much that of the bottom growths in the hilly uplands. The diluvial valleys which accompany in broad bands the present valleys of the Red river and Ouachita (Mississippi) river have been spoken of in the first part of this survey as "upland flats," consisting of low plateaus, frequently of many miles in extent. Their course is marked by a considerable rise on either side, constituting the embankments of the diluvial rivers. Sometimes, however, the erosion has been so active that it becomes difficult to trace them, especially their tributaries, which only can be recognized in the extensive flats found in the interior of the country, generally showing a similar structure with that of the main valleys—a protecting cover of gray or yellow loam deposited upon the underlying geological strata. Only detailed future surveys can map out their exact courses. The vegetation of these flats is very uniform and consists mostly of blackjack, post oak, short leaf pine, and other species of oaks and hickories. Wherever these flats occur, low, well rounded mounds have been found associated with them, they have been termed very appropriately mammillæ, from their peculiar form. Frequently they stud the plain, sometimes they appear in groups, and sometimes they are singly scattered about. Their size varies, but averages 80 to 100 feet in diameter at base and 20 to 60 feet in height. They are structureless and consist of the surrounding material, gray sandy loam and red sandy clay. After close examination we can but take them for forms of erosion left by slowly subsiding waters, which were vacillating. In one word, they are the result of high and low water in sluggish lake-like river basins.

DRAINAGE.

The western half of North Louisiana is drained by the Red river, which stream traverses it from its northwest corner to the middle of the State. It is due to the waters of this river and its tributaries that this portion of Louisiana mainly owes its topography. An intricate network of drainage channels has carved out the hills of the upland, and in course of time the wide and shallow valley of the former stream has been abandoned and the river has cut deeper and deeper into the underlying geological formations, leaving behind the extensive flats accompanying its banks till finally we find the narrow tortuous river with steep embankments we see to-day. The southeasterly trend of the river follows the dip and crosses the strike of the underlying strata. Due to the many obstacles the waters encounter in this course by crossing the strike of the underlying deposits, as well as to the sudden changes from high to low water, the bed of the stream is exceptionally tortuous changing and frequently reversing its course within a few miles. The tributaries of the Red river—Bodeau, Dorcheat, Black lake, Saline—all have a southerly course till they empty into the stream. They receive the back water from the main river in times of flood and are therefore called bayous. The Ouachita river drains the eastern half of North Louisiana and has done for this portion of the State what the Red river has done for the western half. The conditions are analogous and the result a counterpart of the former. However, there is one difference, only in its northern portion the valley of the river is distinct. In its southerly course it is merged with the great Mississippi flood plain and the stream flows along the foot of the eastern edge of the North Louisiana hills. Its trend is like that of the Red river southeast, though it has a more southerly course than the former, passing through the shales of the upper lignitic formation and through the sandstones and claystones of the Grand Gulf series in its lower course. Its tributaries, D'Arbonne, Castor, Dugdemona and their branches possess an easterly and southeasterly direction till their junction with the main river. This drainage system of North Louisiana, a large river east and west with a complicated network of smaller streams, creeks and streamlets, would be sufficient to keep the country in a comparatively dry and healthy condition and to draw off quickly the waters resulting from the floods occurring usually during the spring and fall, if proper means were taken to widen or deepen the channels where necessary and to keep them free from all obstructions during the year.

THE LAKES.

North Louisiana is rich in lakes and though the question of origin is generally considered one of the most difficult to answer, in this case their distribution at once indicates it. Not-one is found in the central portion of this section of the State, but in two long chains they accompany the Red river and Mississippi river valley, located upon the diluvial plateaus sunk into the red sandy clays, or loose sands of the drift with the gray or yellow loam, constituting these cover of the plains, as their bottom. Only a few have been examined more carefully on account of limited time, but a cursory survey of quite a number seem to point to a common origin. They consist of elongated flat basins with a southerly course approximately from 10 to 200 square miles in extent and are drained by bayous entering the lake on the northernmost point and leaving it on the south. In a few cases their southern entrance joins the main rivers. Each flood of spring and fall will raise the water level and during the dry season of the year, in most cases, nothing is left of them but a narrow drain through a flat grassy basin surrounded by dense cypress swamps, the trees of which show the water-mark of preceding floods not unfrequently 20 feet from the bottom. The structure and distribution of the lakes leave no doubt that they simply consist of flat collecting basins, partly caused by insufficient drainage in times of flood, partly by back waters from the main river channels during those times. The almost undisturbed substructure of older underlying geological formations has nothing to do with these basins, which are merely remnants of, or better recall the extensive watersheds which covered the valleys in post-glacial times. Of special interest was the small Jatt lake located in the northwestern part of Grant parish, ~~which~~ illustrates well the characteristic type of these basins. Extremely irregular in outline, it covers a territory of about 10 square miles, surrounded by drift material overlaid with a sheet of gray loam. When visited, late in July, the lake sheet did not occupy more than a few hundred acres and was entered by a small drain, Jatt Bayou, which winds sluggishly several miles through the extensive swamp before entering this small sheet of water. The bottom growth is very dense and consists mainly of cypress, tupelo gum, and tall swamp grasses narrowing the channel, averaging not over 15 feet in width, to a minimum. The water is almost black and reeking, and the sunlight hardly penetrates the dense foliage of the cypress, whose branches overshadow it from both banks. Moccasins, bullfrogs and alligators seem to be the sole inhabitants of these dismal swamps.

Section No. 1.

Catahoula lake,* located in the central portion of Catahoula parish, was examined along its northwestern shores. The structure of the lake was found here to be identical with that described of Jatt lake. The basin has a northerly continuation in yellow loam flats marked on Lockett's map of 1872 as "Loess." The shore of the lake, which is far more extensive than the former, consists of drift material covered by yellow loam and is partly bluffy and deeply dentated, partly gentle sloping. Along the shores, at this place, a large number of sandstone fragments, frequently well rounded and derived from the Grand Gulf rocks, is scattered in some places, mixed with small lime concretions. The surrounding vegetation is the swamp growth so frequently described.

GENERAL GEOLOGY.

As mentioned in the first report of this survey, a cretaceous ridge is trending from the northwest to the southeast across the State and its outcrops are well represented in the southern half of North Louisiana, in Bienville and Winn parishes. It forms

*A survey has not been made of the lake and the above section is only approximately correct.

no prominent topographic feature of the region, but upon it and against it rest the deposits of succeeding ages, covering its hill-sides and leaving nothing to indicate its presence, except a few spots covered with limestone fragments and gypsum brought to light by the well-digger, who was in search for the salt water, which almost invariably is furnished in the wells associated with these outcrops. However, at the so-called marble quarry, located in the central portion of Winn parish, a large limestone bluff is exposed, showing the hard, banded crystalline cretaceous limestone in vertical height of about 60 feet. These cretaceous outcrops represent the oldest land in North Louisiana and have remained dry land to the present day unaltered through all the changes of level which followed its formation. The tertiary deposits which succeed in age can be divided in various distinct series, laying unconformably one upon the other and each again has its subdivisions.

The lower series consists of three distinct formations, which may be called, provisionally, "lower lignitic," marine Claiborne and upper lignitic. It has been fully described in the former report and it is only necessary here to add the geographical distribution of each as far as could be ascertained in this preliminary survey. As has been stated, these formations rest conformably upon each other, dip towards the southeast and bear close resemblance in structure and lithological material. The lower and the upper lignitic formations consist of laminated sands and lignitic shales carrying lignite deposits which increase in size and frequency of occurrence as we advance southward. An almost uniform change of color takes place in the sands, which assume a red and brown rusty color in the same direction. The distinction which was observed in the northern part of the formations* is almost completely lost in their southern exposures and they can be differentiated by their relative position. The marine Claiborne formation is distinguished by the richness of its fauna and the uniform and frequent occurrence of green sands.

*Pages 9 and 10, Part I of this survey.

The western portion of North Louisiana is occupied by the lower lignitic formation, which is bounded in the east by an irregular line of marine Claiborne rocks passing the Vicksburg, Shreveport and Pacific Railroad, near Lake Bisteneau and continuing a southerly course till below Natchitoches this boundary line seems to assume a more southwesterly trend. The marine Claiborne formation overlaying the lower lignitic rocks conformably passes in a narrow band the central portion of this country and disappearing under the deposits of the Grand Gulf rocks. The outcrops of the upper lignitic formation occupy the eastern section and overlay the eastern outcrops of the Claiborne formation, dipping southward beneath the sandstones and clays of the Grand Gulf group. Upon the eroded surfaces of this series rests unconformably a complex of formations, consisting of well stratified gray clays, yellow calcareous marls and limestone. Their dip is southerly, as well as could be made out, a southwest dip. In the west they cross the Texas State line, and in the east they are terminated only by the Mississippi valley reaching across the entire area surveyed. The gray clays, the lowest of this upper series, cover the northern portion of this country to a south boundary, coinciding with the northern borders of the prairie region along which they dip beneath the yellow marls and limestones which have given rise to this peculiar physiographic feature of North Louisiana. The boundaries between these two formations, the Jackson and Vicksburg, of Mississippi, have not been clearly made out, though their existence in this country is proved beyond a doubt by the fossils examined from these deposits. The lithological material of which both these formations consist varies so little in character that only a very detailed survey can succeed to clearly define them. They are, as indicated by material and fossils they carry, of marine origin and occupy a belt crossing the State in a northeast and southwest direction underlaying the prairies, which are the most charactetistic surface features of these formations and coincide with their north and south boundary lines. The lithological material consists of yellow, calcareous, fossiliferous marls, with selenite crystals. The zeuglodon bones have been found in the lower division and are the characteristic leading fossil of the Jackson group. Outcrops examined along the south boundary line of these formations carry an abundance of the Vicksburg fossils, leaving no doubt as to the age of these rocks. These two formations resting conformably upon the gray clays denote that after the deposition of these clays the slow subsidence continued across the entire State. The waters gradually cleared and chalky deposits were formed at the bottom from the decomposition of rich fauna now constituting the limestone scattered over the prairies and sometimes found in ledges capping the hills. These conditions were, however, not lasting, and the shallow waters preceding and succeeding the formation of the limestone were the depositories of the yellow calcareous marls enclosing ostrea and a number of other forms which denote the shallow depth of the waters in which they lived. Unconformably upon these formations along their south boundary line rest a series of sandstone, claystone and massive jointed clays, Hillgard's Grand Gulf group. The change from one into the other of these formations is abrupt. In a line of steep embankments, hills and bluffs the borders of this formation are easily traced across the State. They extend southward beyond the artificial division line which marks the south boundary of the present survey. The northern borders of this characteristic and interesting group coincides with the southern boundary line of the prairie region. They are poor in fossil remains, their material indicates sandy beaches and shallow, muddy seas with a slow but frequent change of level. The close of the tertiary, in North Louisiana, was inaugurated with the deposition of red sandy clays and clayey sands, which cover the country from the Arkansas line, stretching southward into the prairie region, westward into Texas and are terminated in the east by the Mississippi valley. They mantle the hills and occasional outcrops of the immediately underlying formations of the gray clays and the Jackson and Vicksburg marls and limestones and thin out from 30 to 40 miles south of the Vicksburg, Shreveport and Pacific Railroad, giving place to immense deposits of pure quartz sand at a number of places over 100 feet in thickness. These red sandy, sometimes tenaceous, clays, mottled and streaked with gray clay derived from the underlying deposits, were laid down in shallow waters. The stratification lines are seldom regular, change in a short distance, frequently conform to the outlines of the underlying hills of lower formations and show clearly that they have been deposited by waves, tides and shallow water currents. The steep embankments of the Grand Gulf rocks may have formed the southern shores of this shallow inland sea. The drift, consisting of quartz sands, the grains well rounded, succeeds the tertiary and has become an important factor in the formation of North Louisiana soils. Sometimes entirely wanting, removed by recent erosion, mixed with the upper strata of the red sandy clays, or covering the red hills and ridges with a thin sheet, they thicken southward and reach very abrupt their greatest thickness, "150 feet," about 20 miles south of the railroad. The gravels accompanying the Red river and Ouachita river spread fan-like south of the Vicksburg, Shreveport and Pacific railroad in the upper sands and pass over the Grand Gulf rocks, extending over and covering the surface of the area examined. In this quaternary drift, like in preceding formations, the larger river courses as well as a number of the smaller channels is well marked. The Red river was flowing in those post-glacial times in a valley over thirty miles in width in this portion of Louisiana, widening in its lower course. Extensive flats accompany the Ouachita river, then a part of the Mississippi valley which in those times must have covered nearly the eastern third of this section of the State. These immense valleys have been washed out by the melting water of retreating ice, continuing erosion has formed the extensive alluvial bottoms of the larger rivers and smaller streams and creeks which, like in all cases, become narrower and deeper with each succeeding flood and have cut the former flats into the many hills and ridges and plateaus we find to-day, giving to the country the diversified topography outlined in the underlying tertiary deposits.

In the lower, "the lignitic and Claiborne series," which, as it were, constitutes the ground floor of North Louisiana, we find the same conditions prevailing. Extensive marshes and low swampy bottoms with a luxuriant vegetation, a slow subsidence of the country beneath the waves of the gulf, leaving the relics of a rich marine fauna in the black lignitic marls and green sands and an equally slow emergence, returning this coastal district to former conditions with slow alternating changes of level during the subsidence. During these early tertiary times the shores of the gulf were not conforming to its present coast line, but its waves reached far north into an embayment with its western and northwestern coast in Texas and divided by the cretaceous ridge. During the following continued rise the present topography was outlined, and when again the country commenced sinking beneath the waters of the gulf the movement was altered. So that we find the boundaries of the succeeding series of rocks, the gray clays, the Jackson, Vicksburg and Grand Gulf formations subparallel to the shores of the gulf. They denote a gradual change from the muddy bottom to deeper sea and a return to shallow waters and sandy beaches followed by a continued rise, leaving the country a copy of the early tertiary topography cut out by the drainage proceeding southward with the upward movement. The shallow sea north of the Grand Gulf rocks follows and is succeeded by the glacial period with its sand and gravel, and during its decline the melting waters of the retreating ice scoured out the shallow wide river basins to be cut up by the present drainage, truly leaving North Louisiana in its topographical features a copy of former ages.

CRETACEOUS.

In the history of our earth the cretaceous deposits represent the close of the middle ages of the planet since the radiation of heat into space had enclosed the fiery globe with a solid crust, allowing the deposition of water and consequent contraction, the division of the surface into continent and ocean. The limestones, marls and sandstones of this period contain the first record of modern life on our globe, mingled and side by side with the now disappearing forms of past ages. Along the Atlantic, we find the northernmost outcrops of these rocks in New Jersey, from whence they extend southward through Delaware, Maryland, Virginia, North Carolina and South Carolina, Georgia, and changing their course to west and northwest, they reach up in a large bay over Alabama, Mississippi, Tennessee as far north as the mouth of the Ohio river, Arkansas, Louisiana and Texas, and trending northward they occupy almost the whole of the plains and prairies along the Pacific. This immense territory is frequently obscured and covered by the later tertiary deposits and this is especially the case in Louisiana, where their existence can only be traced along the summit of a cretaceous ridge which traverses the State diagonally from its northwest corner to the island of Petit Anse (Avery's Island). This highly interesting feature of the State's geology and physiography was first pointed out by Dr. Hillgard in 1869. The outcrops of the cretaceous, protruding through the dense cover of overlaying tertiary deposits mantled with the drift material, like islands, are distributed along this diagonal line crossing the State, and are quite numerous in the area surveyed on Section 21, T. S. 12, R. 5 W. "Drake salt works," a line of exposure extending along a bayou for a over a mile was examined. Each of those exposures covers a space from 40 to 60 acres in extent, bare of all vegetation, with an efflorescence of salt covering the surface so thickly that even a sparse growth of the usual salt grasses will not advance beyond the borders of these so-called licks. A number of shallow salt wells are located on each of these outcrops, which were extensively used in time of the civil war for the manufacture of salt. The strong, saturated brine is standing in the wells up to the surface. A yellow loam, impregnated with salt, constitutes the surface material of these "spots." These cretaceous knolls are surrounded by red sandy clays which in their turn are overlaid by the loose and pure gray and ferruginous quartz sands of the drift. Large and smaller fragments of hard banded crystalline limestone are scattered around the dumps of several of the wells. The material is identical in appearance with that observed at Rayborn's salt works, described in Part I of this paper, and is thrown out by the well-digger.

Section No. 2:

1. Hard blue banded crystalline limestone.
2. Red sandy, sometimes tenaceous, clay.
3. Red and gray sand with long leaf pine.
4. Lignite shales.

The foregoing section shows the various later deposits overlying the cretaceous. The black lignitic shales are struck by wells in the neighborhood. At the northern end an artesian well has been bored 1011 feet deep, said to have passed the limestone rock throughout its entire depth. The water is a strong brine, emitting an odor of hydrogen sulphide (sulphuretted hydrogen). Wells bored in the surrounding red sandy clays, flowing on gray clays, at a depth of 60 feet, furnish almost pure water with a cool and pleasant taste.

Near Winnfield, on Section 19, T. S. 11, R. 3 W., the cretaceous limestone is exposed in a cliff, forming here the bank of a bayou about 60 feet in vertical height. It is directly overlaid by the gray clays mantled by the red sandy clays, covered with drift. The exposure resembles in appearance the steep escarpments of the Western plains, and the cedar which is found abundantly around these limestone exposures recall to memory the cedar brakes of the West. The limestone is non-fossiliferous, resembles the rocks of other exposures very closely, and though crystalline is useless for ornamental purposes on account of numberless fractures, crevices, holes and pits which penetrate it in every direction, the rock being very pure in composition, almost pure carbonate, will make an excellent lime.

A number of similar outcrops have been described in the former report, and by the fossils examined from them they prove to be of cretaceous age. Cretaceous exposures, known at present and first explored and described by *Hillgard and later by †L. C. Johnson, are—

King's salt works on Section 35, T. S. 15, R. 8 W.
Rayborne's salt works on Section 34, T. S. 15, R. 5 W.
Price's salt works on Section 25, T. S. 13, R. 5 W.
Drake's salt works on Section 21, T. S. 12, R. 5 W.
Winnfield limestone hill on Section 19, T. S. 11, R. 3 W.
Winnfield limestone hill on Section 30, T. S. 11, R. 3 W.
Outcrops on Section 26, T. S. 6, R. 4 W., in Rapides parish.

If we connect the above localities, we obtain an irregular line with a northwesterly trend, revealing the distribution of the cretaceous deposits in North Louisiana as far as explored, over 1000 feet in thickness. Nowhere outside of these outcrops bores have reached the cretaceous, not even in the nearest vicinity, wells of considerable depth have penetrated the shales and green sands of the lower lignitic and marine Claiborne which surround these islands. It is most probable, however, that at Shreveport the artesian bore, 1100 feet in depth, has penetrated the tertiary strata, and that the water flows from the upper cretaceous sands. Judging from the bores and exposures of this substructure of Louisiana and excluding the overlying latter deposits, it represents a ridge with steep hillsides and occasional high peaks with almost perpendicular declivities. The exogyra costata and the gryphœa pitcheri found in close proximity in these outcrops, as well as the Eocene directly overlaying and resting against the cretaceous, seem to prove that at the close of the mesozoic time enormous plutonic forces convulsed, fractured, faulted and folded the cretaceous strata, throwing up mountain chains of vast extent and raising them far above the waters of the gulf. It seems to us more than probable that these grand disturbances involved the whole of the southern cretaceous; and that the enormous downthrow along the balcones in

*Report of a geological reconnoissance of the State of Louisiana, May and June, 1869, by E. W. Hillgard, pp. 28-32.

†Report on the iron ores of Louisiana and Eastern Texas, by Lawrence C. Johnson, pp. 23 and 24.

Texas and the basaltic outbreaks along that fault are contemporaneous with the origin of the mountain chains in the tertiary of that State and of Louisiana. In the basins and embayments formed, the Eocene strata were deposited, the very existence of which proves that there was no interval of a land period between the cretaceous and tertiary in this State, and if we could remove the covering mantle of tertiary and drift, we would yet see the chains and peaks of limestone ranges formed at the close of the middle ages of our planet, altered somewhat by latter erosion and denudation.

The immense shallow basins and embayments formed between the mountain chains in which the tertiary strata were deposited and many of which were flooded from time to time by the waves of the neighboring gulf, barring the outgoing tides, as well as the continuous process of slow subsidence during a vast period of time were especially favorable for the formation of numerous and vast salt deposits. It is a curious fact, that with each and every one of these cretaceous islands we find salt associated, and though the brine may flow from impregnated rocks at various places in South Louisiana, salt, gypsum and sulphur have been bored in immense deposits which may extend much further north than is yet known. The sulphur resulting from the decomposition of gypsum. Concluding from the facts at hand, it seems that the salt deposits of Louisiana must be referred to the early Eocene.

THE TERTIARY FORMATIONS.

The immense upheaval at the close of the cretaceous had left North Louisiana a proper and convenient territory for the deposition of the shallow water, estuary and swamp deposits of the tertiary. The cretaceous mountain chain trending diagonally across the State had divided Louisiana into two immense shallow basins, the Red river and the Mississippi basins of to-day. The one far-reaching into Texas, the other into the State of Mississippi. A number of lower cretaceous ridges, now covered by the succeeding deposits of the Eocene, were probably dividing the large embayments into smaller basins in which the strata of the early Eocene were deposited.

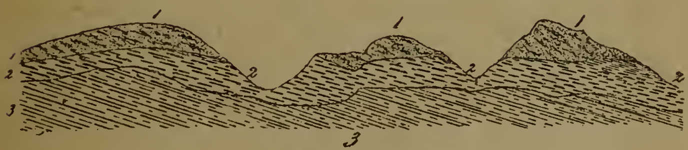
The formations of the mesozoic ages, even to their close, occupy uniformly immense territories in Europe, as well as on this continent, as has been outlined in the foregoing pages. The succeeding tertiary groups have isolated and detached positions well illustrated in the Gulf States. New life has commenced to flourish and all the genera which were so abundant in the preceding formations have disappeared, leaving but a few forms to reach up to "*the dawn of the existing state of the animate creation.*" A list of fossils found in these deposits and attached to the first report, as well as those found in the list attached to this paper, prove to be of Claiborne age, and this, according to Lea and others, is referred to the Eocene of Europe. Isaac Lea, as early as 1833, in his contribution to geology, says: "After a careful examination of a great number of genera and species, from the tertiary of Claiborne (Alabama), I had no hesitation in referring them to the same period as the London clay, of England, and the Calcaire Grossier, of Paris; although this deposit is composed of silcious sand, while that of the London clay is argillaceous and the calcaire Grossier is calcareous. This part of the tertiary formation is called by Mr. Lyell the Eocene period. I am not perfectly satisfied that a single species is strictly analogous to those from the Eocene period of Europe, but the number of turreted shells and similar genera prove it to be of the same epoch." The complete change of condition from deep to shallow waters from an open sea to comparatively small embayments. The direct superposition of these beds upon the cretaceous limestone all goes to show that a new era had commenced in Louisiana, and that the sand and shales and lignites of the lower lignitic represent the early Eocene. The lithological material of the lower series of the tertiary in North Louisiana, which is well represented in the country north of the Vicksburg, Shreveport and Pacific Railroad, has been fully described in the former report, and it has been endeavored to interpret their history of deposition in that paper. It is therefore only necessary to add some sections and localities representing these formations in the country recently surveyed.

SECTIONS AND LOCALITIES OF THE LOWER LIGNITIC.

The territory it covers and the position it occupies has been previously stated.

About four miles northwest of Cypress Station, on the Texas and Pacific Railroad, the deposits of this formation and their stratigraphical position are well exposed in cuts, extending for over a mile along that road. They consist of finely laminated, lignitic, dark colored clays, interstratified with laminated and packed cross-bedded sands, and upon their eroded surfaces rest gray calcareous clays with a thick cover of red sandy clay and drift material.

Section No. 3.



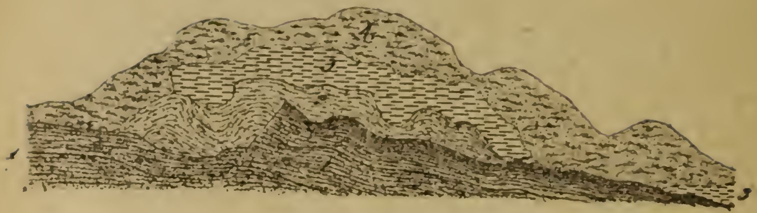
1. Red sandy clay.
2. Gray calcareous clay.
3. Sands and finely laminated lignitic clays.

The lignitic strata dip under a steeper angle than the overlaying clays.

Similar sections were observed along the road northward and especially commencing about two miles south of Robeline and reaching almost to that station, the lignitic strata are most beautfully exhibited, slightly disturbed, they consist of laminated lignitic clays interstratified with sand laminæ and seams of cross-bedded sands frequently from 1 to 5 feet in thickness. From here northward they are overlaid uniformly almost by the gray clays.

About three miles northwest of Victoria, the following more han usually disturbed section was seen:

Section No 4.



1. Lignitic laminated clays with sand partings.
2. Sands with clay laminæ.
3. Gray clays.
4. Red sandy clays.

In a railroad exposure, near Robeline, lignite was observed in two thin seams, rapidly thinning out northward and southward. The lignite is of fair quality and its position is shown in the following section.

Section No. 5.

Section near Robeline with lignite seams.

1. Red sandy clay.
2. Laminated grayish clay, 3 feet.
3. Lignite, 1 foot.
4. Sand and clay, interlaminated.
5. Lignite, 18 inches.
6. Laminated lignitic clay with sand partings.

In the Dolet hills, undisturbed deposits of the lower lignitic strata are exposed 160 feet below the cover of overlying formations.

Prof. G. Williams, of Grand Cane, has kindly furnished the following section of an exposure of lignite occurring on bank of gully in the Dolet hills:

Red sandy clay, 3 feet.

Dark, finely laminated lignitic clays, 2 feet.

Lignite, 4 feet.

He reports that this bed has been explored to a depth of 7 feet without reaching base.

The following section was taken at Mansfield:

1. Top of hill, red sandy clay.
2. Red sandy clay, mixed and streaked with fragment of gray clay, 5 feet.
3. Stratified gray clay, 7 feet.
4. Sandy limestone of grayish-green color, 2 feet.
5. Laminated dark and grayish colored clays and sand, 40 feet to bed of creek.

In some places, near the town, lignite is exposed near the base of the section 3 feet at its thickest exposure.

The fresh water limestone capping the lignitic at this place, which has been observed to reach as far as Shreveport, is of great interest and Dr. Hillgard, who first examined it, remarks that on that occount the strata resemble the interior basins of the far West. He reports the following section:

Moderate clayey sand or ("hard pan") of the drift age, 15 feet.

Clay and sand, gray, interstratified, 6 feet.

Impure laminated limestone, with leaves, 2 feet.

Stratified, gray clayey sand and gray or whitish laminated clay, interstratified, one clay stratum 6 feet thick, the rest a few inches—30 feet.

A layer of impure sandstone capping the strata was observed in a number of places in the lower lignitic.

From the Sabine river a lignitic bed 14 feet in thickness is reported to crop out along the banks. On account of high water it could not be seen.

About nine miles southwest of Mansfield a lignite bed was examined, which forms for nearly 100 yards, bed and bank of a small creek. It is 3½ feet in thickness and the coal is glossy and of great firmness. The coal has the woody structure well preserved, and it is said that a mixture of it with charcoal has been used by the blacksmiths of the neighborhood. A number of smaller lignite seams crop out near Mansfield, and a large number are reported from the vicinity. The Mansfield limestone was observed two miles northwest of Gloster, and again two miles northwest of Greenwood it was seen overlaying the lignitic deposits. Attention is here called to other sections described in the former report.

SECTIONS AND LOCALITIES OF THE MARINE CLAIBORNE.

The outcrops of this formation are somewhat centrally located, but most likely these strata, have covered formerly the lower lignitic to far a larger extent and have been removed and limited to their present outcrops by succeeding erosion. On account of their central position, exposures are rare, but wherever they occur they are easily recognized by the marine fossils they contain generally in great abundance and by the glauconitic sands they frequently consist of. The deposits of this formation are directly and conformably resting upon the lower lignitic. Their outcrops have been traced in a narrow band crossing this section of Louisiana almost in a due south line. Their western boundary, generally north and south, south of the Vicksburg, Shreveport and Pacific Railroad, and trending northwest north of it, was approximately pointed out and placed on a map by Lawrence C. Johnson, attached to his report, "The iron ores of North Louisiana and Eastern Texas." From the localities given in the former report of this survey along the Vicksburg, Shreveport and Pacific Railroad, with Gibsland near the east boundary, the marine Claiborne beds extend southward to the north boundary of the Grand Gulf rocks.

On Section 7, T. S. 17, R. 9, the following exposure was obtained from a well. The land slopes here gradually towards Lake Bisteneau:

Yellowish sandy loam, 4 feet.
Gravel in red sand, 15 feet.
Black clay with Claiborne fossils, 30 feet, without reaching base.

At Thornton's mills, T. S. 18, R. 10, S. 22—

Red sand, 11 feet.
Gray joint clay, 3 feet.
Black clay with Claiborne fossils, 35 feet.

Prof. Johnson reports the following section from one-half mile north of Natchitoches:

1. Prairie soil with scattered patches of shells.
2. Glauconite marl with nodules of carbonate of lime, no fossils.
3. Glauconitic marl, more laminated and sandy than 2, purplish gray; no fossils nor nodules seen.
4. Compact sand.
5. Talus of rubbish from above, hiding rest of 4 and all below to the water.

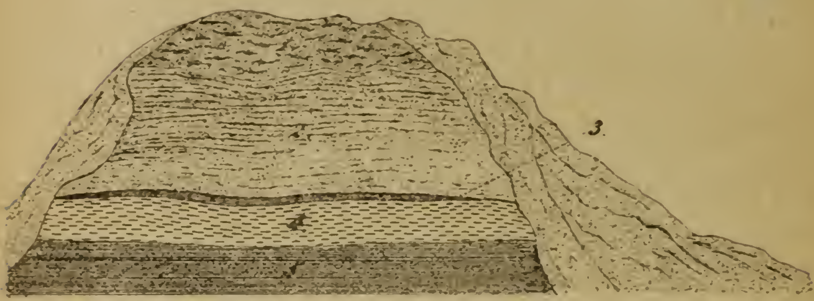
He remarks that he has seen stratified beds, with fossils similar to those observed in the foregoing locality along the course of Black Lake bayou, as far north as Webster parish. A similar line of Claiborne rocks has been traced by us. A few of the sections observed north of the Vicksburg, Shreveport and Pacific Railroad, not given in the first report, may be inserted at this place—6 miles north of Benton, at the farm belonging to Capt. Plair.

1. Red clay with iron gravel, 5 feet.
2. Black clay with Claiborne fossils, 30 feet.
3. Hard impure dolomitic limestone, 6 inches, of greenish color.

A similar section was obtained from a well on Section 2, T. S. 20, R. 13. In some places below the Vicksburg, Shreveport and Pacific Railroad the Claiborne strata were seen in contact with the upper lignitic formation.

On Section 33, T. S. 16, R. 5 W., the following exposure was observed :

Section No. 6.

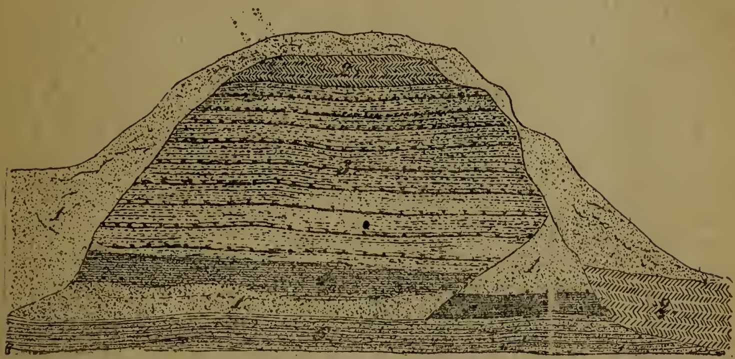


1. Red sandy clay, top of hill.
2. Laminated grayish and yellowish sand, 15 feet.
3. Lignite earthy, 8 inches.
4. Blue stratified clay, 2 feet.
5. Green sand to base of creek (with fossils).

There can be but little doubt that the green sand of this section belongs to the Claiborne formation.

We also refer the lower portion of the following section, on White Oak creek, Section 14, T. S. 11, R. 5 W., to the Claiborne:

Section No. 7.



1. Red sandy clay, top of hill.
2. Gray calcareous marl.
3. Stratified and laminated yellowish, red and white sand with seam of chocolate clay and laminæ of iron sandstone, 60 feet.
4. Green sand, 4 feet.
5. Lignite, 3 feet thick.
6. Dark laminated clay and sand to bed of creek.

On Section 10, T. S. 10, R. 5 W., the following record from a well 120 feet deep was obtained:

Gray sand, 1 foot.
Red sandy clay, 4 feet.
Yellow sand, 20 feet.
Yellow marl, 20 feet.
Black laminated clay and green sand with Claiborne fossils to base, 120 feet.

The foregoing sections and localities illustrate fairly well the geographical distribution and stratigraphical position of the

Claiborne rocks in Louisiana, as well as their approximate thickness. All the beds examined belonging to this horizon must be referred to the lower division of the Claiborne of Alabama. It seems that the upper division is not represented in this State. (See list of fossils).

SECTIONS AND LOCALITIES OF THE UPPER LIGNITIC.

This formation underlays the eastern portion of North Louisiana and its strata rests conformably upon the glauconitic sands and clays of the preceding Claiborne. The lithological material and the structural features of the deposits of the 3 formations of this early Eocene series are almost identical and especially the lower and upper lignitic could not be distinguished if it was not for the dividing Claiborne. In both, lignite seams are found imbedded in soft shales and sands. The lamination of lignitic clays and sands with occasional seams of cross bedded packed sands is common to all, as well as their peculiar weathering in smooth surfaces over which the water trickles, running along the sandy partings upon the clay laminæ, coloring them with a deep greenish black. Numerous sections and localities of this formation have been reported in the first part of this survey and only a few will be given here to characterize their position and lithological material as they appear south of the Vicksburg, Shreveport and Pacific Railroad. South of Columbia, where after passing the Ouachita river the railroad has to cross the high hills, forming the banks of the alluvial valley of this river, deep cuts were necessary to reduce the grade which have revealed excellent geological sections of the upper lignitic, overlaid by the fluviated deposits of the red sandy clays (Lafayette?) which here, however, mostly possess a grayish color. All exposures show a slight disturbance, especially when taken in connection.

The following section was drawn about a quarter of a mile south of the depot :

Section No. 8.

Top of hill, red sandy clay.

1. White and gray laminated sand.
2. Laminated dark colored lignitic clays.
3. Sand lenses with clay laminæ.
4. Gray sandy clay.

The foregoing section is 60 feet high and about 800 feet long.

The following two sections represent a line of about a dozen exposures extending southward along this road, all exhibiting, notwithstanding their disturbances, a uniform southeast dip :

Section No. 9.

1. Red and yellowish colored sand and sandy clay.
2. Finely laminated dark lignitic clay with sand partings.

Section No. 10.

1. Red sandy clay.
2. Gray clay, 20 feet.
3. Laminated gray sand, 3 feet.
4. Lignite seam, 6 inches.
5. Gray laminated sand and clay to base.

Near the town of Columbia, on bank of Coal creek, a fine lignite bed is reported to crop out. A contact of the upper lignitic strata with the subjacent Claiborne can be studied in Section No. 7 of this paper. It is not necessary to add further exposures to those given in this and the preceding report, as each is a repetition of the former. However, the deposition of these strata closes an epoch in the history of Louisiana. A slow, upward movement commences and long intervals of land in which rivers and creeks have sculptured a landscape similar to our own in its topographical features preceding a new submergence. It seems as if the deposits of this lower series upon which the strata of succeeding ages were to be laid down, represent a complete picture of the present topography, defaced only by the succeeding denudation and erosion, and it shows further that the forces raising the swamps and estuaries of the early Eocene landscape slowly above the waters of the gulf were from now on, working parallel or subparallel in all succeeding ages under an angle to those which had caused the former deposits.

THE UPPER SERIES OF TERTIARY FORMATIONS.

When after that long intervening period of land North Louisiana again commenced sinking beneath the gulf, the conditions had entirely changed. Muddy, shallow seas are followed by deeper and clearer waters and succeeded by beaches and shallow seas. Continued rise sent rivers and creeks again southward to re sculpture the early Eocene landscape, leaving each hill and each ridge with a mantle of gray clay or yellow marl. A succeeding subsidence submerged the northern part of the State to a shallow depth, not over 150 feet at its deepest point, to form an arm of the sea, bounded in the south by the Grand Gulf rocks, and passing into Mississippi and Texas and reaching northward into the State of Arkansas, in which the red sandy clays of fluviated structure were deposited, mantling the gray clay hills and ridges of North Louisiana.

SECTIONS AND LOCALITIES OF THE GRAY CLAYS,

which, provisionally, may be called "*Arcadia Clays*," from a town on the Vicksburg, Shreveport and Pacific Railroad, nearly centrally located in the area they occupy in Louisiana. Their southern boundary coincides with the north boundary line of the calcareous marls and limestones of the overlaying Jackson and Vicksburg groups of Hillgard, subparallel to the present coast line of the Gulf of Mexico. They cross the State from east to west, resting upon the deeply eroded surface of the lower lignitic, marine Claiborne and upper lignitic formations reaching northward into the State of Arkansas, westward into Texas, and are bounded in the east by the flood plain of the Mississippi river. Their south boundary, as far as traced, has been outlined in a former chapter. Their dip is southwesterly, though on account of the erosion they have sustained, the covering mantel of succeeding formations and slight disturbances in the deposits, it is frequently very difficult to make it out. They are of the highest economic importance for North Louisiana, as they enter largely, especially in the smaller bottoms, where they form the immediately underlying formation, into the composition of the soils and as throughout the country they underlay, they constitute very extensively the water-carrying beds. By far more numerous than the outcrops of the lower series, on account of their superposition, they can be traced easily over the country.

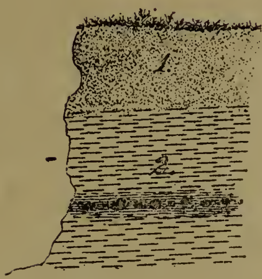
Their characteristic features have been fully described in the previous report, and as they do not exhibit any noticeable change in the country south of the railroad, it is unnecessary to repeat them in this paper.

The following sections will sufficiently illustrate their geographical position and their stratigraphy in the area recently surveyed :

Along a road from Arcadia to Liberty Hill the clays are continually seen cropping out beneath the sandy clays and on places where recent erosion has cut the wagon road a deep drain into the hills, they can be seen constituting the kernels reaching up almost to their tops. South of Liberty Hill they rapidly thin out and are only occasionally observed there overlaid by a heavy cover of drift. Their exposures, wherever seen, are almost identical with those observed north of the Vicksburg, Shreveport and Pacific Railroad. Eastward and westward they can be traced along every creek and every road, always occupying the same position beneath the red sandy clays and characterized by their stratification, peculiar weathering and angular and conchoidal fracture.

The following section was observed 5 miles west of Jonesville, on the Marshall and Shreveport Railroad, a few miles west of the Louisiana State line :

Section No. 11.

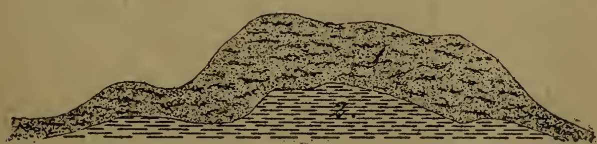


1. Red sandy clay with streaks and pebbles of gray clay, 10 feet.
2. Gray clay with lignite boulders, 8 feet.
3. Unexposed to base, 5 feet.

The lignite boulders are imbedded in gray clay. Some of them are perfectly rounded, and not larger than 3 inches in diameter, others measure 10 by 4 inches, possessing a discoidal form. The lignite having been derived from the underlying lignitic strata, which is some distance from this exposure, is exposed to view mantled as usual by the gray clays and forming the nucleus of hills and ridges.

Near the town of Columbia, the following section was seen:

Section No. 12.



1. Red sandy clay, mottled and streaked with gray clay.
2. Gray clay.

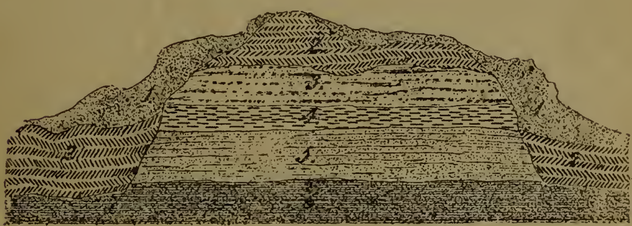
A number of similar sections were observed in this vicinity, and we are inclined to refer this section to the "gray clays" overlaid in localities of the neighborhood by the yellow marls of the succeeding formations, which have been removed by erosion at this place.

SECTIONS AND LOCALITIES FROM THE "JACKSON AND VICKSBURG GROUPS" OF HILLGARD OR "WHITE LIMESTONE OF ALABAMA."

These formations are well represented in North Louisiana, and though the boundary dividing them has not been clearly defined, it may be safely stated that the Jackson strata rest conformably upon the "Arcadia clays," and in fact they gradate into one another. The gray clays not effervescing with acids when tested north of the Vicksburg, Shreveport and Pacific Railroad, and for miles south become calcareous, till finally they pass into fossiliferous yellow marls, capped here and there with thin ledges of white limestone and giving rise to the peculiar physiographic feature previously noted—"the black prairies" of North Louisiana. They trend from west to east across the State in a band averaging about 30 miles in width. They are of high economic importance, not alone on account of the lithological material they consist of, and which will be discussed more fully hereafter, but especially on account of their position. They enter and frequently make up the soils of a vast extent of country solely, cause an entirely different vegetation, of which hawthorns, persimmons, black haw and crab apples are especially characteristic, and are the cause of the black bald prairies frequently mentioned. The soils derived from this formation are generally very fertile, though not easily worked. In the territory they occupy, they frequently protrude through the thick cover of red sandy clay and drift, island like, conspicuous through the break in the vegetation, as well as through their lithological material, mostly indurated yellow marls gradating downward into calcareous gray clays, especially exposed along their northern boundary line. Frequently white and yellow limestone boulders are scattered promiscuously over the outcrops, more rarely limestone ledges a few feet in thickness are found capping the hills. Zeuglodon bones have been found on the edge of the prairies the most characteristic fossil of the Jackson of Mississippi. The outcrops of the lower series are found frequently on a level with the Jackson beds, on account of the deep erosion they have sustained before these strata were deposited upon them.

The following section was observed on Vasherie branch of White Oak Creek, about 10 miles northwest of Winnfield, in Winn parish :

Section No. 13.



1. Detritus.
2. Calcareous marls and clays, 20 feet.
3. Red and yellowish, laminated and stratified sand, with laminæ of iron sandstone, 40 feet.
4. Chocolate-colored clay, 2 feet.
5. As 3, with streaks of green sand, 30 feet.
6. Green sand to bed of creek.

This section shows a contact of the Jackson marls, resting on the eroded surfaces of the sandy strata of the upper lignitic, which in their turn overlay the green sand of the Claiborne formation.

A similar section is seen in No. 7 of foregoing pages. The characteristic bald prairies are abundant in the neighborhood and on the dumps of wells with undrinkable water large selenite crystals and Jackson fossils have been collected.

In the town of Winnfield the marls are struck in a large number of wells, and "rotten shells" and gypsum crystals are found around them among the rubbish.

On Section 10, T. S. 10, R. 5 W—

1. Red sandy clay, 4 feet.
2. Mottled clay, 1 foot.
3. Light colored marl, 1½ feet.
4. Clay ironstone, 1 foot (nodules cemented); yellow calcareous marl, with pecten, to base, 13 feet.

For several miles south of Winfield the prairies with the fossiliferous limestone boulders become very abundant.

About one mile southeast of Victoria, the following section was observed, showing well the position of the limestone of this formation :

Section No. 14.

1. Red sandy clay.
2. Limestone with ostrea, 2 feet.
3. Gray clay.
4. Laminated black lignitic shales with sand partings, to base.

The foregoing exposure is 100 feet in vertical height. As this is the last section northward along this line, we refer the above limestone to the Jackson beds till the fossils have been studied.

A large number of fine exposures of the Jackson marls and limestone extend southward along this railroad as far as the Dugdemona Valley. Sometimes these single exposures reach a thickness of from 30 to 40 feet.

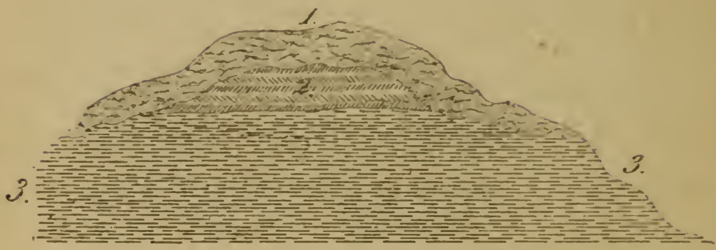
Some of the localities given above, especially upper division of No. 15, may prove to be of Vicksburg age, however, at present, we will refer it to the Jackson beds on account of its general position.

THE VICKSBURG GROUP.

If it was not for the paleontological evidence found in these strata marking a different geological horizon, they hardly could be distinguished from the underlying Jackson beds. Perfectly conformable, they rest upon them and no change in the topography of the territory they occupy, nor in the vegetation growing upon their line of outcrops, mark a new geological subdivision. With the underlying beds they have the bald prairies in common and the lithological material. They mostly consist of "yellow calcareous fossiliferous marls," are similar, if not identical in composition, with that of the Jackson group. The waters found in the region are like those carried by the underlying formation, of bad quality, and the soils possess the same qualities, like those of the former group. In a narrow band, their northern boundary very irregular, though subparallel to the northern boundary of the Jackson beds, they cross the State from west to east, with a south boundary coinciding with the boundary of the Grand Gulf rocks, beneath which formation they disappear. Their outcrops are frequently marked by the drift, appearing only isolated spots in the sandy sheet. They are of the same economic importance as the Jackson strata, and their economic features will be discussed in the same chapter.

On Section 34, T. S. 11, R. 2 E., the following section was seen :

Section No. 15.



1. Red sandy clay, 5 feet.
2. Yellow calcareous marl, 3 feet.
3. Gray clay to base, 20 feet.

The marls are very rich at this place in carbonate of lime, almost consisting of it, and thickly studded with lime pebbles. Some boulders, hard yellow limestone, with fossils, were found scattered over the country.

On Section 18, T. S. 10, R. 2 E., on railroad, the following exposure, slightly folded and faulted, was observed :

Section No. 16.

1. Red sandy clay, calcareous, 5 feet.
2. Yellow calcareous marl (with ostrea and pecten) and gray calcareous clay with limestone pebbles, 10 feet.
3. Brownish sandy clay, slightly effervescing, 1 foot.
4. Gray clay, 5 feet.
5. Sandy gray clay, to base.

SECTIONS AND LOCALITIES OF THE GRAND GULF ROCKS.

This formation, though the poorest of all described, is of the highest economic importance for Louisiana on account of the immense territory it occupies and the influence it has on other regions of the State. Along the south boundary line of the Vicksburg marls the sandstones and claystones and massive clays of the Grand Gulf group overlap them, and in a line of hills and bluffs cross the State from west to east, dipping southward, but under a far steeper angle than the underlying formations. Examining its northern boundary line and advancing in a southerly direction, we notice a rapid thickening of the strata and soon lose all sight of the contact of the underlying formation, notwithstanding the hills and bluffs are steep, not unfrequently rising along this boundary line over 150 feet above the country drainage. More than any of the previous regions described, it has the plain structure preserved, though erosion has been in this territory not less active it has chiseled out different forms. Instead of the well rounded hills and more gentle slopes of the ridges occupying the region north of its boundary, it slopes from its deeply dentated and broken north line southward under a steep angle beyond the boundary of the present survey, rapidly towards the gulf, presenting a plateau in which the rivers have cut wide valleys with steep walls and their tributaries, narrow gulleys with broken and dentated embankments, several over 100 feet in height. Frequently the country roads wind along a narrow ridge, falling steep to either side for many miles through this section. The features of erosion resemble somewhat the country north of it where the driftsands have accumulated, forming sections almost equally steep. They lessen in height in a southerly direction. The landscape these rocks offer is very monotonous. The open woods of the long leaf pine, as far as the eye can reach, and the green turf interrupted by bare spots of the gray sands derived from the underlying sandstones sometimes cropping out in high knolls along the road, or from the sands and gravels of the drift which generally cover the rocks of this formation in a thin sheet. The waters of streams and creeks are swift, rich in fish, especially trout and perch, and almost of crystalline clearness, unless they wind along a swampy bottom, and springs are even more numerous than in the northern part of the State.

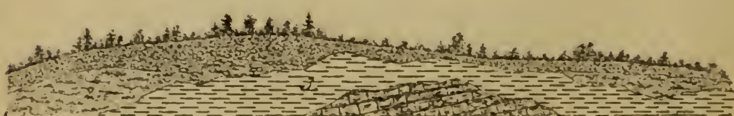
The following section was observed at the McEnery quarry:

Section No. 17

1. Drift, 10 feet.
2. Crossbedded gray sandstone, 6 feet.
3. Gray, soft sandstone, 5 feet.
4. Gray clay, 12 feet.
5. Unexposed to base, 20 feet.

About one-half a mile west of this locality, on the Texas and Pacific Railroad, the following section was observed, showing the eroded surface of the Grand Gulf rocks with a superposition of its restratified gray clays.

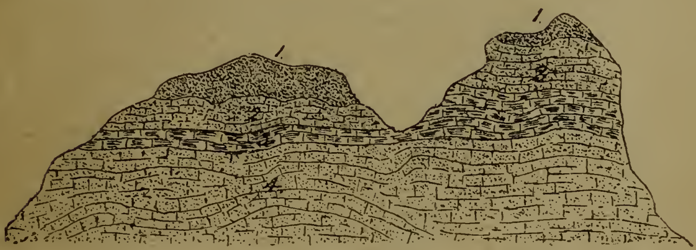
Section No. 18.



1. Silicious, black sandy soil, 2 feet.
2. Red sandy clay, 5 feet.
3. Gray greenish clay, 10 feet.
4. Hard silicious sandstone to base.

The following section, exhibiting well the forms and erosion of the Grand Gulf rocks, was seen east of Chopin Station, on the Texas and Pacific Railroad :

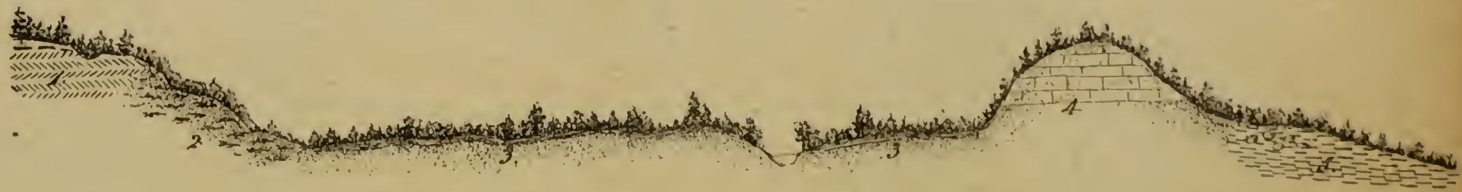
Section No. 19.



1. Sand, top of hill.
2. Sandy gray claystone in thin layers gradating into clay.
3. Hard silicious sandstone.
4. Soft sandstone and claystone of grey color.

This exposure is 70 feet in vertical height. Between Tullas and Little river, a very interesting contact of the Grand Gulf rocks and the underlying Vicksburg marls was seen.

Section No. 20.



1. Yellow calcareous marl of the Vicksburg formation.
2. Unexposed.
3. Creek bottom.
4. Bed of creek.
5. Sandstones and claystones of Grand Gulf rocks.
6. Fossiliferous limestone boulders, imbedded in yellow marl.
7. Gray calcareous clay.
8. Bottom of Little river.

This section is about 7 miles in length. Creek and river have cut down their channels to the underlying clays and marls of the Vickburg strata.

At Section 13, T. S. 8, R. 1 W., blue marls (with Vicksburg fossils ?) were found beneath the Grand Gulf rocks.

About 3 miles north of Antonio, a station on the Houston Central, Arkansas and Northern Railroad, a number of fine exposures of this formation were observed extending over 2 miles along the road.

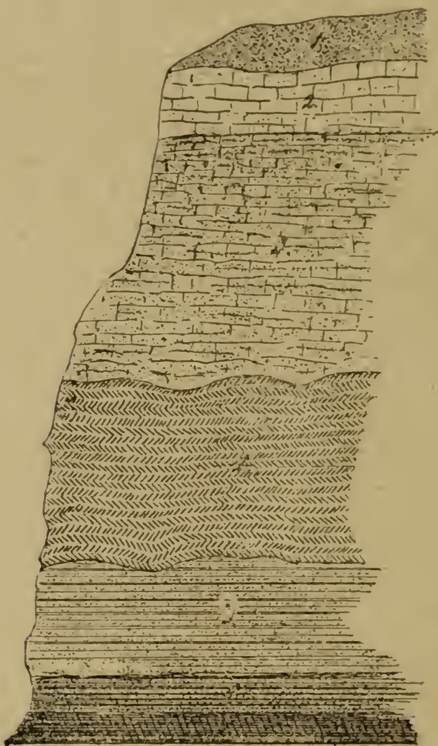
The following is a typical exposure :

1. Red sand and gravel, top of hill.
2. Gray soft sandstone, 1 foot.
3. Grayish sandy clay, 3 feet.
4. Gray soft sandstone, 2 feet.
5. Bluish and greenish sandy clay, 5 feet.
6. Hard silicious sandstone to base.

On the Alexandria and Harrisonburg road these rocks crop out, forming the bank of the Ouachita river bottom, thickly mantled and covered with drift, exposing sections of from 30 to 40 feet.

Near Rosefield, the following section was combined along a creek from exposures, about one mile in length. On Section 35, T. S. 11, R. 4 E—

Section No. 21.



1. Drift, 10 feet.
2. Claystones and sandstones, 40 feet.
3. Yellow calcareous marl, 30 feet—Vicksburg.
4. Laminated sands and lignitic clays, 20 feet.
5. Lignite, 3 feet, forming bed of creek.

This section is especially interesting, as it shows the contact of the Grand Gulf, Vicksburg and upper lignitic formations.

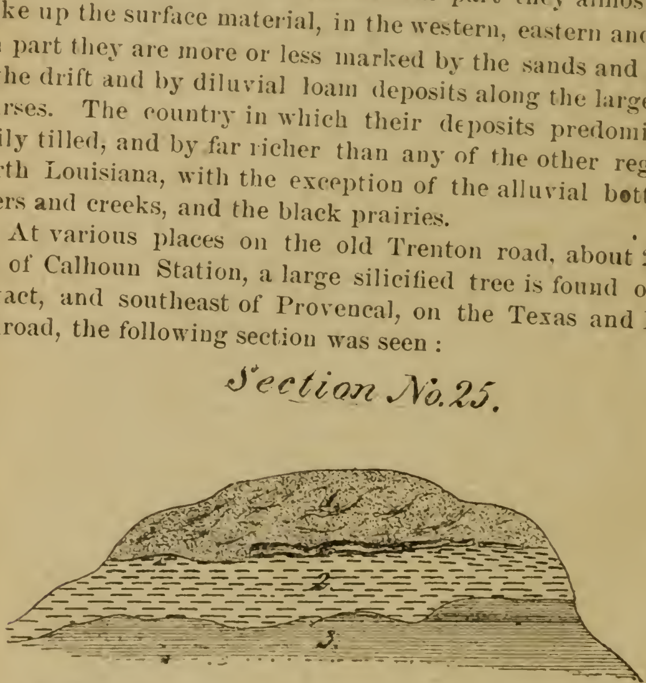
THE RED SANDY CLAYS.

SECTIONS AND LOCALITIES.

The strata of this formation, deposited at the close of the Tertiary in Louisiana, cover all of the territory north of the Vicksburg, Shreveport and Pacific Railroad, and can be traced, though frequently interrupted by drift material and outcrops of the underlaying formation, almost to the north boundary of the Grand Gulf rocks. They cover the eroded surfaces of the gray clays, the Jackson and Vicksburg rocks, and sometimes even mantle the outcrops of the laminated clays and sands of the lower series of tertiary rocks. To a large extent, the soils of the region they occupy are directly derived from them, sometimes they enter into their composition with the drift and, mixed with the clay of older formations, they form the bottom soils and the covering loam-sheet of the diluvial flats. There can be but little doubt as to the circumstances under which they have been deposited. Throughout their deposits they show the fluviated structure. To judge from their geographical distribution in this State, it seems that the sandstones of the Grand Gulf rocks formed their southern shore and that the shallow basin deepened towards the north, having a connection with the gulf through the wide Mississippi valley. Everywhere the formation is largely denuded and their outcrops can be seen in great abundance in the territory they occupy. They consist generally of highly ferruginous sandy clays, mottled and streaked and sometimes studded with pebbles derived from the underlying gray clays forming lines of stratification. The irregularity of these lines which show so clearly their process of deposition have been mentioned before. Ferruginous sandstones and claystones, which frequently cap the hills north of the Vicksburg, Shreveport and Pacific Railroad, are seldom found south of that line, and with the exception of a few localities in the Dolet hills none were seen. The fossil wood, however, remains to be a characteristic feature of this formation, and like in the northern localities, it is found south of the railroad in great abundance generally on the contact of the red sandy clays and underlying formations. Ferruginized fossils have been found in various localities. About one mile northwest of Homer, at the place of Mr. Klingman, associated with phosphate nodules, in a ferruginous claystone at Judge Graham's place, Vienna, and on top of a hill on Arcadia and Liberty Hill road, about 8 miles south of the former town, and various other places. Occupying more than one-half of North Louisiana, they impart to the country largely its characteristic topography and vegetation. The hills of the territory they underlay are caused by erosion in this formation, though foreshadowed in the older tertiary strata and the short leaf pine, oak varieties and gums and hickory grow most luxuriantly on soils derived from it. In the central part they almost solely make up the surface material, in the western, eastern and southern part they are more or less marked by the sands and gravels of the drift and by diluvial loam deposits along the larger river courses. The country in which their deposits predominate is easily tilled, and by far richer than any of the other regions of North Louisiana, with the exception of the alluvial bottoms of rivers and creeks, and the black prairies.

At various places on the old Trenton road, about 2 miles east of Calhoun Station, a large silicified tree is found on that contact, and southeast of Provencal, on the Texas and Pacific Railroad, the following section was seen :

Section No. 25.



1. Red sandy clay.
2. Gray clay.
3. Finely laminated lignitic clays with sand partings.
4. Silicified tree.

The tree is resting on the gray clays and is buried by the red sandy clay.

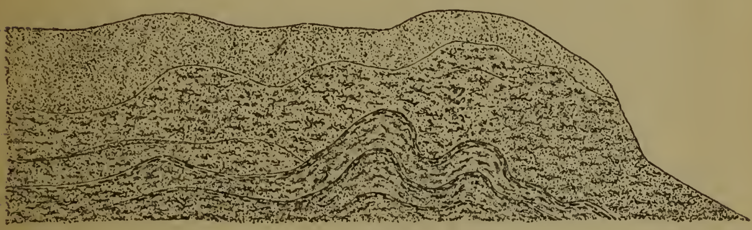
SECTIONS AND LOCALITIES OF THE RED SANDY CLAYS.

These outcrops are so frequent and so characteristic that only a few sections need be given.

East of Vernon, along the road to Columbia, a number of fine exposures of this formation were observed, showing *disturbances* in these deposits.

Section on old wagon road from Vernon to Coluumbia, one-half mile east of Vernon—

Section No. 22.

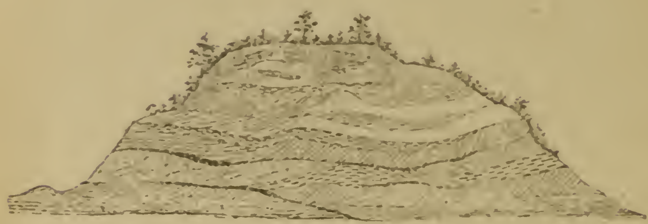


1. Gray sand.
2. Mottled red sandy clay.
3. Red sandy clay with lines of pebbles and laminæ of gray clay.

The exposure is 20 feet in vertical height. Similar exposures are not infrequent in the region of the red sandy clays.

Near the Ouachita river, at Columbia, about 2 miles west of bank of river, the following section, 60 feet in height, was taken :

Section No. 23.



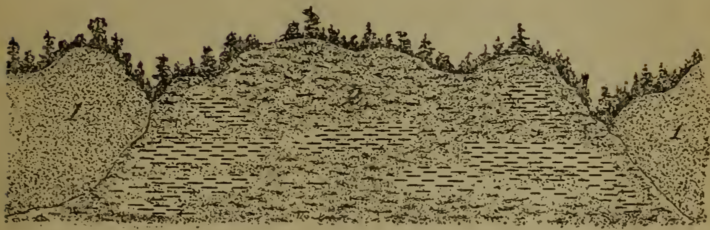
Gray sand crossbedded with some lignitiferous sand,-gray clay in lenses and seams.

Gray sands, crossbedded, and some dark lignitiferous sands with gray clay in lenses and thin seams. Several similar exposures were seen at this locality. The material is derived from the upper lignitic strata, which in a short distance west of these exposures extend for over a mile along the railroad and has been restratified.

The following section exhibits well the position of the red sandy clay as it frequently appears in the long leaf pine region of the drift :

On Section 8, T. S. 13, R. 5 W—

Section No. 24.



1. Red quartz sand, 20 feet.
2. Red sandy clay, with pebbles and laminæ of gray clay in its lower portion, 20 feet.
3. Gray quartz sand, 20 feet.

The island-like protrusion of the red sandy clay through the drift measures at this place about 60 acres.

The general position of this formation, covering all the underlying older tertiary, is shown in most of the previous sections. The above exposure, which has many repetitions in North Louisiana, proves sufficiently that before the deposition of the drift sands and gravels, the former bottom of the shallow sea had been again emerged and deeply eroded.

THE SANDS AND GRAVELS OF THE DRIFT.

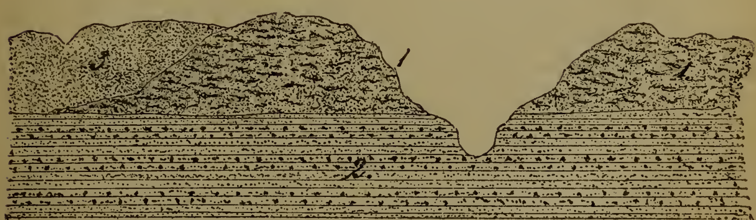
Not alone one of the most interesting formations from a scientific point of view, but also of the highest economic interest, especially on account of its stratigraphical position, forming the covering mantle over all that is beneath. We have seen in a previous chapter how its sands spread in a thin sheet over the northern portion of Louisiana, forming immense deposits centrally from west to east and thinning out and spreading again sheet-like over the Grand Gulf rocks. We have further noted how two gravel streams, many miles in extent, accompany the diluvial valleys of the Red river and Ouachita (Mississippi) river to join about 50 miles south of the Vicksburg, Shreveport and

Pacific Railroad, and to spread from there over the whole territory. Its sands are a component part of all the soils of the region. The alluvium along the present river courses, the loam sheets of ancient river bottoms and recent swamps, the soils of the hilly uplands, all with the exception of the red lands, centrally located from north to south from which recent erosion has removed them, are partly derived from these deposits. The well waters are cleared and filtered by them, especially in sections where these sands have reached sufficient thickness, all certainly features which make them worthy of our consideration. Wherever they are exposed they show stratification lines like in the underlying formation of irregularity, however, not nearly as irregular as found in those deposits. In their lower portions they gradate into the underlying red sandy clays which are sometimes found restratified in the drift, though generally the contact line of both these formations is well and sharply defined. Their direction is from north to south and their stratification, material, well-rounded gray and ferruginous quartz sands and gravels, leave no doubt that they were deposited in waters flowing in a general southerly direction. Silicified corals, favosites and cyathophilum, have been found among the gravels north of Alexandria, mostly they consist of quartz varieties and hard silicious sandstone pebbles, and on reaching the Grand Gulf rocks they are mixed with boulders derived from this formation. A few granite boulders have been found—one at Maj. McGuire's place, in bank of a little ravine, about 3 miles west of the town of Monroe. This specimen is about a foot square, with edges well worn. It is a gray granite, with black mica and hornblende. Several smaller pieces of gray and flesh-colored granite have been found by Prof. Williamson, of Grand Cane, in an old field. The sands consist generally of almost pure quartz grains, well rounded, and then again of deep, loose, red-colored quartz sands, the grains being coated with peroxide of iron. In the northern portion of the formation conglomerates have been found in extensive layers, consisting of the pebbles of the drift imbedded in an iron matrix, due to a process of lixiviation of overlying sands.

There can be no doubt that these sands and gravels represent the southern drift. Probably the glaciers reached to their northern boundary and the waters arising beneath them carried the sands and gravels, spreading them over the southern territory. The uniformity and thickness of the gravel deposits show that currents of greater force, likely derived from the main glaciers, rolled them southward to the drainage channels of the country, preceding the glacial period, were filled with the sands washed out from the northern moraines till they seem to have covered North Louisiana completely, with the two larger currents, the Red river and Mississippi river, west and east. When finally the streams derived from the subsiding ice sheets ceased to furnish new material, a large amount of the gravels and sands were removed to the sea, and the narrowing rivers, still of enormous size and lake-like appearance, deposited at their bottoms gradually the fine mud, forming now the loamsheets of our upland flats, skirted with the pebbles of former more violent floods.

Section No. 24 illustrates the position of the sands of the drift as frequently observed in this country south of the V., S. & P. R. R. A similar section was seen about six miles south of Drake's Salt Work, on a road crossing White Oak creek.

Section No. 26



1. Red sandy clay.
2. Laminated lignitic clays with sand laminæ interstratified.
3. Red and gray quartz sands with long leaf pine.

THE DILUVIAL VALLEY—THE UPLAND FLATS.

As has been said, towards the end of the drift period, with the retreat of the glaciers, the immense volumes of water, which had buried Louisiana under a sheet of sand and carried the gravels southward, became less and their channels narrower, a large amount of gravel and sand was washed down into the gulf, and with a quieter state of the waters they formed mud bottoms. The present course of the larger rivers at least coincides with the direction of these post glacial valleys, and they can be easily recognized in the wide diluvial plateaus which accompany the Red river and the Ouachita (Mississippi) river, and are frequently found inland along some narrow drainage channel of the present. Below Alexandria they join, forming southward one immense flood plain. Though much cut into and altered by the present drainage they have well preserved their characteristic features. Skirted with a line of hills forming their banks, they consist of a loam sheet varying in thickness from a few feet to 10 feet and more, which rests on the porous strata of the drift or red sandy clays, the immediately underlying geological formations. Along the Red river the loam sheet is of a gray color, whereas along the Ouachita river the prevailing color of the loam is a brilliant yellow, though not infrequently the one color will gradate into the other. Each of these valleys carries a line of lakes, the probable history of which has been given in preceding pages. The mamillæ, the little rounded hills, are invariably found associated with them, though they are also seen in the recent flats, witnessing the sluggishness and slow retreat of periodical floodwaters by which they have been peculiarly eroded, The soils are fertile but stiff and badly drained. The vegetation they carry is characterized by the predominance of oak varieties, from which they derived the name of oak flats.

The following is an approximate section of the Red river valley-south of Shreveport. :

Section No. 27.

Approximate profile of Red River Valley, South of Shreveport.

1. Red sandy clay. 2. Tertiary strata. 3. Upland flats. 4. Grayish loam with mamillæ.

The second bottoms of the smaller streams and creeks of the present period, generally raised but little above the water level seem to be of more recent origin and not to be cotemporaneous with the formation of these immense valleys.

THE ALLUVIUM.

Since the disappearance of the diluvial floods with the melting of the glaciers the outlines of Louisiana topography have remained the same, though the forms have been considerably diversified. The streams have narrowed and depeened their channels and an intricate network of smaller streams and creeks has eroded the surface, giving it a hilly configuration. Immense deposits have filled the deeper channels of the latest diluvium, and cypress swamps have been formed. It will take another season's work to study the history of the larger streams and their alluvial and recent deposits.

As seen in section 27 the Red river has cut its present channel in an alluvial valley at this place about 7 miles in width down to the tertiary strata. Northward the alluvial valley retains this average width, widening southeastward to its junction with the Mississippi valley. The bed of the stream is narrowed by natural levees, the land sloping inland, a condition which has been observed in all the rivers and bayous of this section and is uniformly found throughout this and other continents on rivers subject to overflows. Le Conte remarks: "On either side, just where the rapid current of the river comes in contact with the comparatively still water of the flood plain, and is checked by it, a line of abundant sediment is determined, which forms the natural levee. Except in very high freshets, these natural ridges are not entirely covered, so that the river in ordinary floods is often divided into three streams—the river proper and the river swamp water on either side. They cannot, however, confine the river within its banks and prevent overflows, since the river bed is also constantly rising by deposit. Thus the river bed, the natural levee and the river swamp all rise together, maintaining a certain constant relation to one another.*" Other geologists of

*Elements of Geology.—Le Conte, page 23.

note have maintained that these natural levees have been built, or rather the slope of the land backward from the river bank, by backwaters, bayous washing after each rain and, after floods, the sediments into the river, reducing gradually the level below the bank of the stream. After the recent flood we had occasion to observe several instances along the Red river, from which we conclude that in most cases both agencies are at work, though in some the one or the other may be sufficient to cause the natural levee. The cypress swamps not very extensive in North Louisiana, occupy the lowest places of the backlands along the rivers and bayous. The Ouachita river valley can be considered a counter part of the Red river valley. This stream, like the former possesses a wide alluvial bottom and has cut its present channel down to the tertiary strata. Subject to overflows, the bed of the stream has the natural levees and the sloping backland. The exceedingly fertile soils of these rivers will be discussed in a future report.

DISTURBANCES IN THE STRATA.

Though to a very large extent the disturbances, especially of the well stratified rocks of the tertiary formations, noticed throughout the region surveyed, are due to enormous erosion which repeatedly after the deposition of these terraines have followed their emergence above the waves of the gulf, not all can be explained by this agency. However, it is certain that after the immense disturbances which raised the cretaceous mountain chains at the close of that age, no further violent plutonic forces have disturbed Louisiana. Some of the faults and folds observed may be ascribed to the slow and repeated emergence and subsidence which have followed one another like the swings of a pendulum, since the sands and shales of the lignitic were deposited in the shallow cretaceous basins, and especially the steeper dip of the Grand Gulf formation. I take it is due to a partial or rather unequal subsidence. However, there are other disturbances not easily explained by either agency.

Section No. 28 was observed near the McEnery quarries, on the Texas and Pacific Railroad:

Section No. 28.

1. gray and black sandy soil, 2 feet.
2. Red sandy clay, 6 feet.
3. Gray clay.
4. Gray cross-bedded sandstone of the Grand Gulf group.
5. Laminated soft, sandy gray clay.

In this Section the much folded clays rest on undisturbed sandstones of the Grand Gulf rocks, and it seems that the force which has folded them, has pressed from above, or perhaps partly laterally. Other sections, for instance one of the red sandy clays, seem to have received their disturbances in a similar way. If this conjecture be true, then we must assume that immense icebergs have flooded down from their Northern homes during the drift period and stranding on shallow places have folded them with their enormous weight. The few granite boulders found may have come down with floating ice as already suggested by Dr. Hillgard, who found similar granite in Mississippi. The investigations of another season will probably develop how far the disturbances in the tertiary strata are due to the agency of ice.

ECONOMIC GEOLOGY.

WATER.

In the region directly south of the Vicksburg, Shreveport and Pacific Railroad, where the red sandy clays form the surface formation, the subterranean waters are abundant and generally of excellent quality. The material is commonly very porous and the rainfall sinks to a large extent into the sandy clays till it strikes an impermeable stratum upon which it pursues its downward course. The water carrying strata in this section are mostly the "Arcadia clays," *gray clays*, though sometimes the red sandy clays are argillaceous enough to prohibit a further sinking of the surface water, and wells in such localities may tap small basins. Silica and iron are the only perceptible mineral ingredients found in these waters and they of course are not injurious to health. The depth of the wells is varying and changes from a few feet to 100 feet, according to the varying topography of the section, that is, it is depending on the vertical distance of the mouth of the well to the water carrying bed. The deep denudation the underlying geological formation of the gray impermeable clays has maintained the deposition of the porous sandy clays, as well as the quality of this material to be sometimes impervious, or nearly so, to water is the cause that the depth of wells in this region frequently varies in neighborhoods sometimes very considerably, and deep wells may be located near those of moderate depth. The quantity of water is fluctuating, especially in the shallow wells with the seasons and some which were seen in rainy weather nearly filled up to the brim, are most likely to go dry, or to contain but little water during the hot summer months. These shallow wells are in times of epidemics (typhoid fevers) and malarial seasons of the year to be regarded with suspicion, as the moist girdle created by the slow subsidence of the water in the well is an especially favorable zone for the growth of the micro-organisms to which these diseases owe their origin. Further, the shallow depth of the wells implies as a rule in this region a very limited drainage area, and in consequence a poor filtration of the water which is liable to be contaminated with organic mould. In cases where the inhabitants are depending on the water drawn from the wells for household purposes, they ought not, under any circumstances, use it as drinking water without having it previously boiled. The high temperature will destroy the germ life and will make it uninjurious to health. This precaution is useful in all seasons of the year, but it becomes absolutely necessary in malarial districts, or in times of a raging epidemic.

Water drawn from deep wells is less dangerous to use, even in malarial districts in times of epidemics, on account of a generally larger drainage and consequent better filtration and less fluctuation of the water contained in the well. Wells in the southern portion of this district, where the drift sands have accumulated to considerable thickness, have to penetrate these sands before reaching the water, which, if the well is deep enough, is invariably of excellent quality. However, there are exceptions to these conditions of the occurrence of water in the region of the "red sandy clays." Sometimes the well-borer will strike the lower series of tertiary formations, and in that case the water found is most frequently unfit for drinking purposes, containing large amounts of mineral ingredients, lime and magnesia salts, which having a purgative effect on the system, are highly debilitating. In such localities, search must be made for a proper location of another well, which generally will not be difficult in this region; cisterns are to be used if this is not convenient. Springs are abundant throughout the region and issue generally along the banks of bottoms and valleys running upon the gray clays and leaving them on their outcrops. The water of these springs, like the well water of this section, is generally free from all mineral ingredients, except silica and iron, and furnishes excellent drinking water. Creeks and bayous, mostly supplied by local rainfall, are winding in tortuous, narrow channels, rather sluggishly along wide bottoms, generally resting directly upon the underlying gray clays. The lower portions of these bottoms are frequently occupied during the larger part of the year by cypress swamps and the whole low flats not infrequently converted into shallow lakes extending for several miles from one bank to the other, according to the width of the valley during the rainy season. The small drain in this time of continuous downpours is insufficient to carry off the water. The water of these creeks and streams carrying a large amount of mouldering vegetable matter it is hardly necessary to caution against its use.

In the region south of this district characterized by the calcareous prairies which stretch in this section across the State, the conditions of the occurrence of water are much more diversified and the waters found differ much more in quality than those of the former region. The country is still largely occupied by the deposits of the red sandy clays resting on calcareous gray clays or yellow marls. Of course, if water is found in this material it is but little, differing from the former, and drinkable without injury to health, though generally somewhat limy. The same may be said if the water is found below the drift which marks the "red sandy clays" here as there. However, the strata of the underlying Jackson and Vicksburg groups contain but little sand suitable to carry water, and wherever these formations constitute the surface material it is of little use to search for it. If they contain water at all, it is so impregnated with minerals, especially lime and gypsum, not infrequently emitting an odor of hydrogen sulphide (sulphuretted hydrogen) that it cannot be used for household purposes, and if they do not contain it, it is to be sought for in the lower tertiary lignitic—Claiborne series, and generally proves to be not much better for domestic use. In such instances the people must depend on cisterns for drinking water. The many bayous and streamlets furnish, in all cases known to me, water sufficient for watering stock. Springs are less abundant than in the region of the "red sandy clay" and drainage channels of the country resembling in all peculiarities those of the northern section wind still more sluggishly through the valleys. It is self-evident that the waters carried by them are all more or less limy. X

South of this region we pass the northern borders of the Grand Gulf sand stones and clays covered with a sheet of drift and with the change of the geological formation a change of the quality and occurrence of water takes place. If the water is found below the sands and gravels of the drift it is of fine quality here as if found in other sections of North Louisiana under similar conditions. Generally, however, the water is found in the rocks of this group, and its quality varies with the contents of soluble mineral ingredients of the water carrying beds. The lithological material of this formation consists of sandstones of varying hardness, generally, however, soft; sandy claystones and massive gray and greenish colored clays. It is readily seen that a large portion of this material is very porous and eagerly will absorb a great amount of water after each rain allowing it to sink to the lower impervious bed upon which it flows, issuing as springs along the outcrops in beds of creeks and streams, or sinking to a still lower level through occasional fissures in the rocky structure. XThroughout the section occupied by this formatiom, water of generally good quality, can be found by tapping those sheets saturating the pervious standstone. Sometimes, however, the water is impregnated with mineral ingredients depending as stated on the soluble mineral contents of the rocks which it passes and which seem to change frequently at short distance. In such cases, as in similar instances in the northern localities, it is advisable for the inhabitants to use solely cistern water for domestic use. Springs are abundant in this region and the creeks and bayous are more swift than in any of the sections north of it. XThe water is invariably of crystal clearnesss, and even in deeper water every pebble on the bottom can be seen. They abound in fish, especially trout and perch.

XThe water of the upland flats, "diluvial valley," which accompany the Red river and Ouachita river from the Arkansas

a

b

line southward through North Louisiana to its southern boundary, the south line of this survey, and as formerlly stated are sometimes found in the interior accompanying some drainage channel of the present, depend, of course, on the underlying formations. Generally, however, they are underlaid by the "red sandy clays," or drift, and in either case the water found is good. Only when the water flows on top of the lignitic Claiborne formations, or is carried upon the yellow calcareous marls of the Jackson and Vicksburg formations, the water has the usual bad qualities. As a rule the wells are shallow upon these flats, though sometimes their depth will reach to 50 and 60 feet. Springs are found along the line of hills, which in most cases line the flats and the drains and bayous carried by them resemble the bottom streams, that is, they are almost dry during the hot summer season, and of lake like appearance in rainy weather.

The water found in the alluvial bottoms of the Red river and Ouachita river is without exception entirely unfit for household use on account of the high percentage of mineral salts it contains. In these valleys wells are not in use, and the people depend altogether for their supply on cistern water.

MEDICINAL WATERS.

As can be seen from the foregoing pages, mineral wells of various quality can be found throughout the entire region. In sections where the "red sandy clays" are predominant, the water obtained from them not infrequently contain some iron in solution and springs and wells possess a chalybeate character. At Ruston these springs attract a number of visitors every year and seem to be in great favor with the public on account of their stimulating properties. Waters derived from the Vicksburg and Jackson marls are limy and gypsiferous, and, as mentioned, emit frequently an odor of hydrogen sulphide. The mineral waters flowing from the lower series of the tertiary strata are magnesiam in character, but also contain chlorides of potash and sodium, are gypsiferous, and like the former waters, emit frequently hydrogen sulphide.

Waters associated with the cretaceous islands are brines containing common salt (sodium chloride) in very large quantities, and the waters obtained in the alluvial river bottoms are also saline in character. The use, or abuse rather, of any of these waters cannot be enough discouraged. It seems to be a common belief among the people of this section that "any mineral water" furnishes a panacea against all diseases and generally it is used in large quantities by people in the neighborhood of such well or spring—no matter whether they are healthy or sick, or of whatever disease they may suffer. If healthy, it must serve as a preventive; if sick, they believe it to be curative. Frequently these springs have acquired a high reputation for curing certain diseases, how much due to the imagination of the suffering pilgrims is hard to state. It is evident that these waters contain medicinal properties and that on that very account they ought never to be used by people in good health, as they invariably will cause disease which they are thought to prevent. If, however, analyses have been made and the properties of the waters are known, it is well enough to use them in cases of disease in which they are the proper remedy, under the instructions of a physician, and in that case, *but in that case only*, they may be found beneficial.

ARTESIAN WELLS.

The principles which govern the flow of artesian wells are widely understood, yet it may not be out of place to state them shortly, as some of the readers of this paper may not be familiar with them, and flowing wells promise to become of importance to Louisiana.

The name is derived from the county of Artois, in France, where they were first in common use, and it is generally understood to mean a flowing well, that is the water must rise above ground in order to be called artesian. There are many wells which are artesian in character in which the water rises considerably above the water-bearing bed and yet they are not called so, because they are not flowing. In either of these cases, the rise of the water, in the one above ground, in the other perhaps nearly to the surface, the cause is the same "hydrostatic pressure" under which the water is at the well. Conditions necessary to cause such a pressure are the confinement of a porous bed between two impermeable beds, one above and one below, the source of the water supply, the outcrop of the porous bed, above the mouth of the well. If the strata dip towards one side and the distance to the outlet is considerable, the friction the water seeking this outlet has to encounter on its downward course may be sufficient to be equal to a stop and the water will rise if at any given place the pressure is relieved by perforating the upper impervious stratum with the well augur. If the strata are deposited in a mould the conditions are perfect, the pressure being then from all sides. No matter, however, whether the wells can be obtained under the one or other of these conditions, the area in which they are found is spoken of as artesian basin. The pressure increases proportionally with the depth of the well, and the more porous the water bearing bed, the more abundant the flow under a given pressure. It is evident that unless one or the other of the conditions is present no artesian water can be obtained. The supply an artesian basin furnishes is depending on the size of the catchment area, the outcrops of the water-bearing beds, their porosity and the amount of annual rainfall in the region. Where the absorbing strata are found to crop out under slight angles, the cases are most favorable, much more so than in those where the angle under which they reach the surface is steep.

X In North Louisiana the conditions for obtaining artesian water are exceedingly favorable. The lower series of tertiary rocks—"the lower lignitic marine Claiborne and upper lignitic" formations consisting of sands inter-stratified with clay shales, spread in extensive, almost undisturbed sheets, with a slight southeast dip over the territory, their outcrops extending far into Texas and Arkansas. X The clays and marls of the upper series have been largely removed by erosion, and the present drainage channels have cut down their beds to the underlying strata, offering feeders to the porous sands of the artesian beds. Similar conditions more favorable almost are found in the Grand

Gulf region where the soft sandstones constitute the water-bearing beds, the clays, the impermeable strata, and the many steep channels of erosion favor the quick absorption of the rainfall. Quite a number of artesian wells have been bored successfully in this section. Several wells ranging from 350 to 400 feet at Monroe, used for manufacturing purposes, one at Arcadia at a depth of 400 feet, several in the Grand Gulf group at a depth of from 500 to 600 feet supplying the town of Alexandria with water, and one at Shreveport 1000 feet deep, derived most probably from the base of the lower lignitic or upper cretaceous sands. ~~All the wells at~~ Monroe and Arcadia are bored under ~~the~~ Superintendence of Col. Strong, to whose courtesy ~~we are indebted~~ for the foregoing figures. There can be no doubt that throughout North Louisiana artesian water can be found at comparatively shallow levels.

Some springs, or rather natural flowing wells, were examined at White Sulphur Springs, a little village located in Catahoula parish, a favorite health resort on account of the virtue of the waters and the abundance of fish in the streams, and deer in the open pine woods. A few large springs, emitting a very strong odor of hydrogen sulphide issue at this place from the rocks of the Grand Gulf group. Nowhere in the country for many miles around similar springs have been observed. It seems that the gypsiferous water of the underlying tertiary formation confined by shales comes here in contact with a fissure rising through it to the surface, constituting artesian wells.

As the sinking of wells has been but recently commenced in North Louisiana, a few words of caution may be found appropriate.

The casing of all wells ought to be perfect in order to avoid loss of water into intervening dry and porous beds which not alone will affect the individual well but the whole basin, lessening supply and pressure. The same will be the effect if the packing of the casing is imperfect when it passes through the confining beds. As by such and similar neglects not alone the owner of the well, but all the inhabitants of the district are affected, laws ought to secure against such practice, and it being shown that in every artesian basin known the demand is constantly increasing, it would be profitable to pass such laws at an early date.

The following analyses of waters have been made in the Laboratory of the North Louisiana Experiment Station, Calhoun, La.

No. 1—Spring water sent for analysis by Mr. N. Wise, Arcadia, taken from Southeast quarter of Southeast quarter of Section 15, Township 21, North Range 4 West :

ANALYSIS.

	Grains per gallon.
Silica	3.08
Peroxide of iron and alumina	.77
Lime	1.40
Magnesia	.41
Potash	.28
Soda	1.34
Sulphuric anhydride	1.34
Chlorine	.97
Carbonic acid	2.10
Oxygen absorbed from potassium permanganate in three hours	.0178

No ammonia, and mere traces of nitrates, nitrites and phosphoric acid.

The water is turbid from suspended silica, when filtered it is of a slightly yellowish cast caused by the dissolved iron.

When the evaporated residue is ignited it darkens slightly, becoming quickly white again, however.

The small amount of oxygen absorbed from potassium permanganate shows the water to be sufficiently free from organic matter to make it perfectly wholesome and desirable for drinking purposes.

The mineral matter is present mainly as sulphate and carbonate of soda and lime. and as free silica, and its proportion is so low that the water will answer well for washing and other domestic purposes.

The reaction with litmus paper is neutral.

No. 2—Well water sent by Mr. John Farrel, Pleasant Hill, who says : "The well is 22 feet deep. and is situated in a bluish, marly soil, in Northeast quarter of Section 2, Township 9, Range

12, in Sabine parish ; vegetation: post oak, and short leaf pine—clay foundation."

ANALYSES.

	Grains per gallon.	
Silica	3.6	
Peroxide of iron and alumina	.6	
Lime (Ca. O)	71.8	(Ca. 51.2)
Magnesia	66.2	
Potash	.2	
Soda (Na. 2 O)	69.7	(Na. 51.7)
Sulphuric anhydride	179.1	
Chlorine	123.4	
Carbonic acid	12.1	
Oxygen absorbed from potassium permanganate in three hours	.096	

The mineral content of the water may be regarded as approximately sodium chloride (common salt), 131 ; calcium chloride, 68 ; calcium sulphate, 80 ; magnesium sulphate, 189 ; and magnesium bi-carbonate, 10 grains per gallon.

On ignition of the residue obtained from evaporation, this fuses and darkens, quickly becoming white, however.

The water is perfectly clear and colorless, and does not contain sufficient organic matter to make it unwholesome.

The mineral ingredients of this water are so high that it may properly be called a medicine, and for this reason it should only be used in cases of sickness, and then only upon the prescription of a physician who is acquainted with its composition.

The reaction of the water with litmus is slightly acid.

USEFUL MINERALS.

NATURAL MANURES.

The most important of the natural manures are the marls, because they contain various mineral ingredients necessary for vegetable growth—potash, phosphoric acid, calcium, sulphur and iron. In North Louisiana those found in the tertiary strata may be classsified as green sand marls, containtng glauconite grains from which they have derived their name.

Calcareous marls are named from the element predominant in their composition--(calcium.) The former are largely composing the beds of the marine-Claiborne formations and can be obtained from almost all exposures belonging to it. They are confined to this formation and consequently their geographical distribution conforms to its boundary lines. The calcareous marls are found in the Jackson and Vicksburg formations, and with it they occupy a central position from west to east. All the marls found so far are of very low grade and can be used only to advantage in the neighborhood.

CARBONATE OF LIME.

The marls of the State have been but very little studied and the farmers of this section are not familiar with their use. They are therefore cautioned not to use any of them unless it be under advice of the stations. If they are used improperly, which may likely be the case, if their composition is not known, the quality of the land and the crops for which they are intended as manure, not suited to their fertilizing qualities, failure will most likely attend the experiment, and discourage their use throughout the region. If properly used they will be to the highest benefit of this section of the State, the soils of which respond so readily to fertilizers. The cost of obtaining them, if the expos ure is near at hand, is nominal, and farmers who are not able to buy fertilizers, will be able to avail themselves of these marls. According to Dr. Hillgard a dressing of 200 bushels of marl per acre containing one-fourth of one per cent. of phosphoric acid and the same amount of potash will be effective for 10 years, and it is understood in New Jersey, where green sand marls are in common use, that if they contain but little of either phosphoric acid or potash, they become active fertilizers when composted with quick lime, which will also remedy the acidity caused through pyrites which sometimes are mixed with them. Marls high in phosphoric acid have been found so far only at one place, near the town of Homer at Klingman's nursery, where they were seen as nodules coated with peroxide of iron scattered over the ground on the brow of a hill near the house. The following is the chemical report on

ANALYSES OF MARLS.

No. 1—Green sand marl, obtained from Mr. H. S. Methew's well, located in Northeast quarter, Section 7, Township 17, North Range 9 West, Webster parish.

No. 2—Green sand marl, obtained from Dr. T. J. Tabor's well, Doyline, Webster parish, in Section 20, Township 18, North Range 10 W.

No. 3—Green sand marl, sent by Mr. A. H. Dawson, Homer, La., taken from the bank of Mount Zion creek, Section 19, Township 22, North Range 6 W.

No. 4—Green sand marl, sent by Mr. H. C. Adams, Taylor, Claiborne parish, La., taken from Windsor creek, Section 29, Township 19, North Range 7 W.

No. 5—Green sand marl, sent by Mr. D. E. Hedgpeth, from Southeast quarter of Southeast quarter, Section 27, Township 20, North Range 5 W., Claiborne parish.

No. 6—Green sand marl, obtained from a well at a depth of 20 feet, in Section 26, Township 8, North Range 8 W, Natchitoches parish.

No. 7—Shell marl, from Section 34, Township 11, North Range 2 East, in Catahoula parish.

No. 8—Green sand marl, taken from a well at Georgetown, Grant parish.

No. 9.—Shell marl, from about three quarters of a mile north of Rosefield, Catahoula parish.

This bed is exposed in several places in a gully between two small ridges.

No. 10.—Green sand marl, taken from the bed of Vacherie creek, Winn parish, Section 11, Township 11, North Range, 5, West.

ANALYSES.

Number.	Potash.	Phosphoric Acid.	Lime.	Equivalent as Carbonate of Lime.
1	.42	.09	3.11	5.55
2	.58	.32	4.62	8.25
3	.28	.07	.46	.82
4	.04	.09	.36	64
5	.21	.15	1.10	1.96
6	.39	.26	1.57	2.80
7	13	.08	24.25	43.31
8	.31	.11	1.51	2.69
9	2.45	.83	39.28	70.14
10	.19	.18	.36	64

So far the green sand marls have not met our expectations. Most of the above samples are so low in potash and phosphoric acid as to render their use as fertilizers inexpedient. Possibly Nos. 2 and 6. if easily and cheaply obtained. and used in large quantities. 100 to 200 bushels per acre. on closely adjacent lands, might prove remunerative,

The shell or calcareous marls are much better. No. 7 could, with advantage, be used upon closely contiguous soils needing lime: provided it could be cheaply obtained and handled. A large quantity, not less than 100 bushels per acre would be required.

No. 9 is unusually rich in potash and lime, besides a fair content of phosphoric acid. This marl, if easily mined, should be used with profit by all the surrounding farmers—used in quantities in conjunction with green crops, cow peas, red clover, etc., the soils should rapidly improve. It will not bear long transportation.

GYPSUM.

This mineral, consisting of sulphuric acid and lime, is found disseminated in small crystals, generally associated with the green sands. It is found in larger crystals and sometimes even in thin seams in the Jackson and Vicksburg beds, and also in large beds at Reyborn's Salt Works, and other cretaceous outcrops. Both its constituents are valuable ingredients of plant food, and an application to soils which are deficient in them or in either will be accompanied with good results. Further, it is a well established fact, gained through long experience, that its use will frequently prove the thriftiness of all crops of the "leguminous" tribe: Peas, beans, vetches, clover of all kinds, alfalfa, etc. Its application will unlock other mineral ingredients, especially potash, and therefore will be used with good results on soils which contain them, as a compost with marls or stable manure, in which case its quality to retain carbonate of ammonia by forming carbonate of lime and sulphate of ammonia, will preserve this substance and keep it for the use of the crops.

LIMESTONE

Is found throughout the Jackson and Vicksburg territory, either in ledges, as boulders distributed over the surface, or forming a prominent constituent of the marls. It is found capping the lignitic strata at Mansfield, and the cretaceous islands consist almost solely of it. It is found as carbonate and generally more or less mixed with alumina and sand, except in some localities of the Jackson and Vicksburg groups and as constituent of the cretaceous outcrops. Its action on vegetable matter can be readily recognized in all soils containing a perceptible percentage of lime. It imparts a deep black color to these soils. Its effect is somewhat similar to that of gypsum, lime being the nutritive element it furnishes. It unlocks other chemical compounds, making them available to plants and being a powerful base, it cures acidity of soils. There is no other difference in an application of lime as carbonate or quick lime, except that the action of the former is slower.

See remarks on soils for further information on lime.

OTHER MINERALS OF ECONOMIC VALUE.

BUILDING STONES.

All intermediate stages, from a very soft rock to a very hard variety of sandstone can be found in the territory occupied by the Grand Gulf formation. The stone is generally of a pleasing light gray or green color, and suitable varieties easily worked with the hammer. The outcrops of the rock, wherever examined, show that they weather slowly and that the stone will withstand the atmospherical influences of Louisiana well.

The limestone, near Mansfield, of similar color, could be used as building stone, though for other purposes, except agricultural, it is too impure a variety. Rocks of the Grand Gulf formation have been used in the pillars of the railroad bridge at Shreveport, and have given full satisfaction, and the hard varieties are used in the streets of that city for macadamizing purposes. Transportation throughout the region by rail, as well as by water, is convenient, and there is no reason why these stones should not be used to a larger extent in other markets.

GRAVELS.

The largest gravel deposits examined accompany the flats of Red river, consisting mostly of quartz varieties, which have withstood the grinding of floods and transport from far off regions for ages; they are exceptionally well adapted as road material. All what is left from bulky granites and porphyries, of which they formerly constituted a part, they are now almost indestructible. They have been used with great advantage in this section for ballasting a large portion between Monroe and Alexandria, on the new railroad.

IRON

Occurs in the Dolet hills as clay ironstone and iron sandstone. No large deposits have been found in this section such as would promise an economic value. If they have been there, like they are now found in the adjoining State of Texas, they have been destroyed by succeeding erosion and nothing is left but boulders scattered over the ground,

CLAYS

Of various quality are found throughout the region. Pottery clays and jug clays are especially frequent in the territory occupied by the "red sandy clays," in contact with the underlying gray clays, which frequently unaltered furnish fair material for such purposes. Clay suitable for firebrick is found in similar localities and common brick clays nearer the surface. The loam flats furnish almost always good material for brick clays.

See analyses of soils, for samples of clays.

KAOLIN.

Silicate of alumina of a pure white color has been found in various localities on the Alexandria and Harrisonburg road, where they are known as "chalk hills." The material does not color nor do the edges melt when treated with the flame of the blow-pipe. An analysis has not been made so far, but it will prove to be suitable material for higher grade pottery if insufficient in quality for the manufacture of china.

SALT.

Strong brines are associated with the cretaceous islands and have been worked to a large extent during the civil war, and no doubt could be worked under present circumstances to advantage. Salt is a very cheap article, and freight even of a comparatively short distance, limits its shipment. With the favorable climate well suited for solar evaporation and an abundance of inexpensive fuel, these salt wells ought to supply at least North Louisiana and neighboring sections with this necessary.

LIGNITE.

This coal has not been in use on this continent within the knowledge of the writer, and only recently, experiments with it have been inaugurated by the Texas legislature passing a bill to send an expert to Europe. Prof. Dumble, who conducted these examinations, has so far not published the result. A few evident factories have been opened in several places in Texas, but it is not known whether they have worked successfully. Lignite deposits occur quite in abundance in North Louisiana in more or less thick deposits, forming lenses of considerable extent, associated with the lower and upper lignitic formations. The coal examined in the beds is generally hard, and, no doubt, would stand a short transport in a raw state.

Near Mansfield, in the Dolet hills, and other sections given in previous pages, the coal seems to be of good quality and of sufficient thickness for mining purposes. A profitable mining will of course depend on its cost, its distance to market, its heating capacity in a raw or prepared state, and the competition it has to enter with other material. Other factors may enter in such a calculation, but it is the office of the merchant rather the geologist to consider them. The great objection to the use of this coal has been, in this country especially, its content of water and its crumbling quality. These objections have been overcome in Europe, where the coal is now extensively mined. See page 44, I. Report of the Louisiana Geological and Agricultural Survey. * *Methods used in Germany for the manufacture of gas, briquettes, coke, etc., from lignites.*

We have frequently heard lt said that the lignites are useless, and therefore give a short resume of the utilization of these coals in Germany in order to show that the deposits in Louisiana are worthy of closer investigation. Their most important utilization is as fuel in a raw state if the coal is firm enough, and then generally used in the vicinity of the mines, as coke and as briquettes. The coal for the purpose of manufacturing coke is charred in kilns, that is the brown coal is heaped up and covered with earth. The coke obtained by this process, about 40 per cent., consists of small pieces of considerable hardness. Ovens constructed for the purpose of manufacturing coke contain retorts placed horizonally. The distilling vapors are drawn into an apparatus serving for the condensation of tar and ammonia and thence returned to the oven where they enter heated canals in which they are mixed with warm air for further combustion. The coke so manufactured is used as fuel, lamp black, in filters, in the manufacture

*Extract from paper written for the Texas State Geological Survey, II. Annual Report—Otto Lerch.

of gunpowder and even in iron smelting. The process of manufacturing briquettes consists of drying the coal and subjecting it to a pressure of from 1500 to 2000 atmospheres. The product generally of an elliptical or hexagonal form measures about 1 inch in thickness and 6 inches in length. Its form is convenient for shipment. It is most cleanly in use and its heating effect generally the same, sometimes better than that of common stone coal. The pressing machines resemble those used in the manufacture of pressed brick.

The coal as raw lignite or in form of briquettes is used for all heating and steam producing purposes, in households and factories of every description as well as on locomotives and steamships. The construction of the fireboxes and grates is adapted to the material and frequently the coal is converted into gas, freed from ammonia and tar in a condensator, and then used for heat production. Coal rich in bitumen is used for the manufacture of paraffine and mineral oil. Of lesser importance is the use of the lignites in the manufacture of illuminating gas, of dyes and tanning material and as fertilizers. Recently lignites have been advantageously used in the purification of juices in sugar factories. For this purpose the coal is thorougly dried, converted into a fine powder, well mixed with the juice and the purified liquid pressed or filtered from the mass. The lignite after having served for this purpose can be used as fuel.

The importance which the mining of brown coals in European countries has acquired the production for 1890 in Germany and Austria 30,697,490 tons, representing a cash value of $22,450,415.00, has been set forth in the former report, and attention is called to the statistics there given.

The following additional analyses have been made since the last report:

No. 1—Sent by Col. William Strong, from a seam penetrated in boring an artesian well at Monroe.

No. 2—From extensive beds, 8 miles southwest of Mansfield. It has been used locally as fuel with good results.

No. 3—Sent by Mr. H. T. Babcock, two miles south of Rosefield, Catahoula parish.

No. 4—From White Oak creek, overlaid by green sand, and underlaid by lignitic shales. Seam 3 feet thick.

The following are the analyses:

ANALYSES.

Number.	Water.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.
1	16.50	41.00	37.65	4.85	....
2	16.61	38.52	38.93	5.94	1.94
3	11.45	48.95	20.90	18.70	2.49
4	14.40	22.60	22.80	40.20	2.17

No. 1, although of good composition, is at too great a depth from the surface to be of practical value; hence, No. 2, which can easily be mined, is by far the most promising bed so far discovered. Its small ash content, as well as not excessive amount of sulphur renders it a desirable fuel for boiler use.

The quantity of water it contains is comparatively low for lignite, and the sample obtained has withstood the action of the atmosphere and shows little disposition to crumble.

FORESTRY.

Almost the whole country, with the exception of the cleared farms which are scattered throughout, is covered with forest. In the country north of the grand gulf formation a rational deforesting and forest culture does not demand that immediate attention as does the region underlaid by these rocks. The short leaf pine, which is the predominating timber tree of the former, is less desirable than the long leaf pine, and the more fertile soils and the more rapid growth of the short leaf pine will not cause that imminent danger which threatens the State from an irrational deforesting of the loose sandy soils of the Grand Gulf formation. As mentioned, the long leaf pine is of very slow growth and it takes about a hundred years to develop good timber. We have seen tracts deforested in this region, on which hardly a sapling had grown during several years, notwithstanding they were yet protected from winds by surrounding forest, and it is this feature, caused through the great poverty of the soils (loose quartz sands), which will cause the danger to the entire State and not alone to this section. Whenever the protecting cover of forest is removed from these sands they will commence to float southward with each rain and many a fertile tract will be buried underneath them in the coming years. Winds will assist in their speedy transports. The climate of the country will be materially changed and the drouthy weeks now occasionally occurring will be protracted into months and the floods during the rainy season will be by far more heavy and destructive. Glowing sands and naked rocks will be exchanged for grassy turf and cooling shades now prevailing, and with the destruction of the forest the national wealth will be forever impoverished.

A number of saw mills of immense capacity are now at work. Nay, even a railroad has been built for the single purpose to carry off the Louisiana forest. If this wholesale destruction is pursued it will certainly not take very many years to bring about the changes above mentioned. It is now the time to consider this matter, not when the evil has grown too far. Only a replanting of the deforested regions will prevent the consequences, and as not alone the welfare of the owners is concerned but of the inhabitants of the entire State, laws should be enacted to enforce such culture. Nearly every country of Europe has had to make a sad experience before taking proper measures to prohibit such devastation as is now practiced in Louisiana, and each State had to expend millions of dollars which could have been saved, as well as the destructive changes caused by the devastation if the measures had been enacted in proper time. It is well to learn from such experience. France has paid $50,000,000 to reforest the eastern mountain slopes of the Alps. Prussia, only one State of the German empire, has appropriated $6,000,000 for her forestry department.

CLIMATE.

Through the kindness of Mr. Robert E. Kerkam, director of the United States Signal Service of the State, we are enabled to give the following important climatological data which have been compiled by him from records obtained from all stations in North Louisiana. These data are complete and will be found of service not alone by the student of Geology and climatology, but will prove of the most practical value to the planter, the farmer and the immigrant. Hereto is added a history of destructive overflows in the Red river valley. The suggestions made as to to their cause by the observer at Shreveport, Mr. C. A. Smith, seem to bear out what has been said on the foregoing pages.

NORMAL METEOROLOGICAL DATA FOR NORTH LOUISIANA.

Nature of Data.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December
Mean Temperature....	45.0	52.0	58.5	65.8	73.4	80.0	82.3	81.1	75.1	65.4	54.8	49.2
Mean Max. Temp......	53.4	61.4	68.5	76.2	83.5	90.5	93.4	92.0	84.0	77.1	68.0	58.1
Mean Min. Temp......	35.4	41.8	47.9	55.6	63.0	70.2	73.2	72.0	66.8	56.6	45.4	39.7
Max. Temperature....	78.0	83.0	90.0	93.0	101.0	104.0	107.0	105.0	101.0	95.0	86.0	79.0
Min. Temperature....	13.0	15.0	26.0	31.0	47.0	53.0	62.0	58.0	47.0	31.0	18.0	10.0
Mean Rel'tive Humidity	73.8	69.0	64.9	66.0	68.0	71.3	72.0	71.8	71.9	72.4	71.0	72.1
Mean Cloudiness, 0-10	5.6	5.4	4.7	4.6	4.2	4.2	3.7	3.4	3.5	3.6	4.4	5.6
Av. No. Clear Days ...	7.4	7.8	10.2	10.8	11.8	10.4	11.4	12.0	13.0	15.8	11.0	9.6
Av. No. Pt. Cloudy Days	11.8	10.1	10.9	11.9	13.0	14.7	14.7	15.0	10.0	9.4	10.4	10.0
Av. No. Cloudy Days...	11.8	10.2	10.4	7.0	6.4	4.8	4.8	4.0	7.0	5.8	8.6	11.4
Av. No. Rainy Days....	11.6	10.1	10.2	9.8	7.7	9.2	9.0	7.7	7.5	6.6	9.7	10.6
Average Precipitation	5.25	4.94	54.9	6.14	5.02	3.71	3.95	2.84	4.36	3.42	4.98	5.18
Prev'g Wind Direction	N.	S.	S.	S.	S.	S.	S.	S. E.	S. E.	S.E	S.	S.

Compiled from the records of the Louisiana Weather Service.

ROBERT E. KERKAM, Director.

HIGH WATERS OF RED RIVER AT SHREVEPORT, LA.

River readings were begun May 18th, 1873, by the Signal Service, and from that time continuous daily readings have been taken. The highest water ever known at Shreveport was that of 1849, when the extreme high water reached 35.9 feet above the present zero of the gauge. The zero of the present river gauge is the low water of 1879: this point is 140.01 above the mean gulf level. All readings given are reduced to the present datum point. The danger line at Shreveport is 29.0 feet; at this height nearly all alluvial lands are threatened with overflow. There are some lands, however, that overflow at as low a stage as 25.0 feet.

The highest water in 1873 was 26.0 feet; in 1874 27.9 feet; in 1875 25.7 feet. The first water above the danger line after observations were begun by this service was that of 1876, when the highest stage of the river was 31.9 feet on July 28th. In this year there were two floods, the first occurring in April, and the second in July and August. On April 4th, the river passed the danger line, and stood 29.2 feet. It continued to rise steadily until the 9th, when it reached 31.5 feet, remaining stationary for four days, then receding and by the 20th passing below the danger line. This flood was followed by a greater and more damaging one in the summer. The river reached the danger line July 23d, and did not again fall below that point until August 5th.

In 1877 the river reached the danger line on May 5th, and its highest stage, 29.8 feet, on the 11th. After remaining at this stage for two days, it began falling and was again below danger line on the 17th.

In 1878 the highest stage was 28.4 feet on January 31st. The river, though full during the summer, did not reach any dangerous heights.

In 1879 the highest stage was 24.9 feet on may 16th and 17th; in 1880, 23.0 feet, April 3d and 4th; in 1881, 27.3 feet, March 7th.

In 1882 the river rose to 31.4 feet February 21st, but as the high water occurred in winter there was little damage. In the spring and summer there was only a fair stage of water for navigation.

In 1883 the highest water was 25.3 feet March 11th and 12th.

In 1884 there was another flood from May 8th to 28th. The highest stage was 32.7 feet on the 14th. The next year the high water began about the same time, reaching 30.5 feet on May 11th. On the 13th the water began to fall and passed below the danger line on the 16th.

In 1886 the highest water was 18.3 feet, April 29th; and in 1887, 21.6 feet on December 24th and 25th.

In 1888 the flood passed 30.3 feet, the water remaining above danger line from the 16th to the 24th.

In 1889 the river reached 31.9 feet February 3d, but during the spring did not rise above 24.0 feet.

One of the most destructive floods in many years occurred in 1890. The river passed the danger line on April 28th, and continued to rise rapidly until May 8th, when it reached

34.6 feet. The water did not again fall below danger line until May 22d. Many planters succeeded in replanting as the waters went down and made good crops which, in a measure, helped to compensate for the heavy losses by the flood.

In 1891 the highest water was 25.2 feet February 11th. During the spring there was no high water.

The present year, Red River Valley was visited by a flood equalled only by that of 1849, and probably never equalled in the destruction and damage to the planters along the river. The waters reached danger line May 20th, and rapidly rose until May 28th, when it reached 35.7 feet. This stage was 1.1 feet higher than in 1890 and only 0.2 foot lower than in 1849. Not more than eight or ten plantations in Red River Valley escaped overflow. The record of crevasses was unprecedented. In many places the river was from fifteen to eighteen miles in width, and nearly everywhere the water reached back from two to five miles from the channel. The river did not get below danger line until June 20th, when, in many instances, it was too late for planting.

To recapitulate, there have been eight severe floods since the establishment of continuous observations by the Signal Service in 1873. Two of these occurred early in the spring and, therefore, did little damage to agricultural interests. It is worthy of note that of the eight floods in the past twenty years, seven of them occurred in the last eleven years. In the more recent years the floods have been the most destructive.

This seems to result from the rapid drainage of the country, brought about by the destruction of forests and natural grass lands through the advance of population.

HIGH AND LOW WATERS AT SHREVEPORT, LA.

Year.	Highest and date.		Lowest and Date.		Mean Height.
1873	26.0	June 10	-4.4	December 12	....
1874	27.9	April 29 and 30	-1.2	September 6 and 7	*10.5
1875	25.7	April 22	5.4	December 1	15.9
1876	31.9	July 28	5.2	November 13	18.1
1877	29.8	May 11 and 12	5.0	October 15	17.7
1878	28.4	January 31	3.5	November 21	18.2
1879	24.9	May 16 and 17	0.0	November 1, 2, 3 and 4	8.9
1880	23.0	April 3 and 4	4.5	October 28 and 29	12.2
1881	27.3	March 7	-1.4	September 1 and 2	12.4
1882	31.4	February 21	8.0	July 30	17.4
1883	25.3	March 11 and 12	0.7	October 16 and 17	13.4
1884	32.7	May 14	-0.2	September 24	13.2
1885	30.5	May 11 and 12	0.7	October 24	14.2
1886	18.3	April 29	-1.0	September 12	7.7
1887	21.6	December 24 and 25	-0.6	September 6 to 11	8.0
1888	30.3	May 19	0.6	November 4, 5 and 6	15.2
1889	31.9	February 3	4.3	September 4	16.4
1890	34.6	May 8	-0.2	August 23 and 24	14.7
1891	25.2	February 11	1.7	Nov. 15, 16, 17, 19 and 20	11.1
1892	35.7	May 28	-1.9	October 14	....

*From record of nine (9) months' observations.

C. A. SMITH,
Observer, Weather Bureau.

SHREVEPORT, LA., November 15, 1892.

SOILS OF NORTH LOUISIANA.

RED SANDY CLAY REGION.

These soils, occupying the hills of North Louisiana, may be classified into—

a. Black sandy.
b. Gray sandy.
c. Yellowish red sandy.
d. Deep red sandy loam.

These varieties graduate the one into the other almost imperceptibly. Yet in the central portion, from north to south and in the Dolet hills, the red sandy loam predominates. These varieties are derived from the immediately underlying geological formations, the red sandy clays and the drift, or a mixture of the material of both. Occupying as they do, hillsides of more or less declivity, they drain well. Of sufficient porosity to permit of a thorough percolation through them of water, they may be classified as dry soils. With a clayey subsoil underlying them at shallow depths they obtain and appropriate fertilizers with great facility. The "black sandy soils" of this division, occurring particularly in the eastern and western portions of this district, owe their peculiarity of color to the presence of humus. They are derived mainly from the "drift" and underlaid by the red sandy clays and vary in thickness from a few inches to many feet. They consist mainly of rounded quartz grains with small proportions of humus and mineral matters. They are poor, drouthy and easily washed away by heavy rains under improvident culture. They are cold soils and hence bring better crops of corn than cotton. The ploughing in frequently of crops of clay peas, the application of mineral manures, together with a proper system of terracing will add materially to the productive capacity of these soils.

THE GRAY SANDY SOILS

Possess in an intensified form the properties described under the "black sandy soils." Being more deficient in humus, the remedies there prescribed, will apply with greater force here. Composts of cotton seed, stable manure, pine straw and acid phosphate, are especially valuable upon these soils. In the neighborhood, marls may be used with great success, in quantities of 50 to 100 bushels per acre. Both physical and chemical benefits will thus be obtained.

THE YELLOWISH RED SANDY SOILS

Occur in patches over the entire district, graduating on the one hand to gray sandy and on the other to sandy loams. They are superior in quality to either of the above and may be made very productive. They are mixtures of the "red sandy clays" and the "drift" and their physical properties are good, therefore they retain moisture fairly well and not so subject to wash as those already described.

THE RED SANDY LOAMS

Occupying chiefly the central portions of the district, but occurring elsewhere in patches of varying size, are the characteristic "red lands" of North Louisiana. They are derived from the underlying "red sandy clays" wherever the overlying sands have been washed away. Magnificent fields of this class of soils are found in many portions of this part of Louisiana, and although long in cultivation, are still yielding profitable crops. Its color is due to iron oxide, and with this latter is usually associated goodly percentages of phosphoric acid. This is an ideal soil, susceptible of the highest improvement and capable of producing enormous crops. With a similar subsoil, deep plowing, if gradually performed, will greatly enhance fertility and crop producing power.

The crying want of all these soils as demonstrated by the experiments at the North Louisiana Experiment Station at Calhoun, La., is nitrogen. To supply this ingredient, in its cheapest and best form, recourse may be had to some of our running varieties of cow peas. A rotation of oats, cow peas, cotton, corn (the latter also with cow peas), as practiced and recommended by the North Lousiana Experiment Station, wlll improve all of these soils and most rapidly, if each crop be fertilized with a suitable manure. The soluble phosphates used in conjunction with nitrogenous manures have been found highly beneficial. Alone they have proven of little value.

THE BOTTOM SOILS

Of this district have been derived wholly or in part from the underlying "Arcadia clays" (gray clays) described in the geological report, as everywhere underlying the "red sandy clays." These soils are found in all the creek bottoms and wide flat valleys of North Louisiana and may be classified under two heads:

a. Gray loams.

b. Gray clays.

When the soils of the hills have been washed down and mixed with the gray clays of the valleys, gray loams are to be found. Where no such washing has occurred the pure "gray clays" exist.

In small creek bottoms the former usually exist and are very productive. They are, however, subject to overflow, and therefore are usually not highly esteemed except for grasses and permanent pastures. Could they be properly drained and protected from floods, they would be very valuable. This could be accomplished by levees, and by deepening and widening the channels of the creeks which flow through them. In this way large areas of extremely fertile soils could be recovered and the general health of the country greatly improved by the removal of the stagnant water in the swamps, the present breeding places of malaria and fevers. These soils hug the hill sides, giving way in the middle of extended tracts of bottom lands to the true "gray clays" derived "in situ" from the underlying Arcadia clays. These clays form the chief soils of extensive tracts of bottom lands in many parishes of North Louisiana. They possess the characteristics of all clay soils, tenaceous, heavy and cold, drying and cracking in dry weather, and running together in seasons of heavy rainfall. They are very fertile if properly handled, which means that they must be well drained, thoroughly broken and have incorporated with them a goodly amount of vegetable matter.

These two classes of soils shade imperceptibly into each other, and in one bottom may be found every shade of soil, from pure sand (washed down from the hills) to pure clay.

SOILS OF THE PRAIRIE REGION.

As described in the geological part of this report, these soils occur in insular spots along a broad band stretching across the State. These soils, like the formations, from which they are wholly or partly derived, are calcareous, and may be properly denominated as "marl soils." They may be classified as (a) marly clay soils, or (b) marly loams—just in proportion as they have become mixed with the adjacent soils of the red sandy clays and drift—and like the other soils described they include soils of composition varying from one to the other. Yet they are all characterized by a goodly content of carbonate of lime. The marly clays are stiff, tenaceous of water, drying and shrinking during hot weather and difficult of cultivation. They are inky black in color, due to action of lime upon the vegetable matter, with a subsoil of similar composition but of lighter color. These soils usually lie well and are susceptible of easy drainage by the proper application of labor, on account of their occupying the tops of hills and ridges, which slope gradually on all sides and which are almost bare of vegetation, save excessive growth of nutritious grasses, giving them the appearance of fertile meadows.

The marly loams, of this same formation, contain also carbonate of lime and have a black color. They are underlaid by a similar subsoil of yellow marl, frequently in an almost unaltered condition. They are found surrounding the bare prairies and produce a vegetation peculiarly characteristic (described in the chapter on topography and botany). They are very fertile and well adapted to the production of large and various crops. They are, however, not yet appreciated, due perhaps to the difficulty of cultivation over the surrounding red sandy and drift soils. Where these soils have been washed into the bottoms, we fine mixtures, varying from gray clays and loams to marly clays and loams. All are subject to overflow—are deep black in color, due to excessive moisture always present in the low places, and can be improved only by the application of the remedies given elsewhere for bottom soils.

SOILS OF THE GRAND GULF REGION.

These are remarkable for their uniformity in texture and composition. Coming from the drift or soft sandstone of this formations, they are mainly sands, varying in color from gray to black. They are frequently mixed with pebbles, and in appearance resemble the sandy soils of the "Red Sandy Clays." They are, however, of greater depth and therefore less fertile—having no retentive sub-soil. Rarely a gray sandy loam is found in isolated patches in this formation, and while richer than the pure sands in soil ingredients, are yet far from fertile—supporting a growth of long leaf pine interspersced with shrubby oaks and gums.

The botton soils of this district rest upon the massive gray clays, intermediate strata of this formation, and are either pure clays or gray loams, just in proportion to their washings from the hills above. They possess the properties of the soils already described, and need no futher mention.

SOILS OF THE UPLAND FLATS—DILUVIAL VALLEYS.

Their geographical distribution is confined to these flats and are fully set forth in a previous chapter. They are directly derived from them and in composition and texture resemble the original material so much that they frequently can not be distinguished from it. They may be classified as:

1. Gray loam soil.
2. Yellow loam soil.
3. Brown loam soil.

The gray loam constituting the covering of the Red river flats, the yellow loam of those accompanying the Ouachita (Mississippi) river and the brown loam form the soils of the interior flats. This, however, is not quite correct, as sometimes either variety may be seen in patches intermingling with the other, and from the interior flats it may be stated that the gray variety not unfrequently occupies extensive areas, though more or less intermingled with the brown loam. All these varieties consist of generally *heavy* loams only in spots. They assume a lighter texture, the sand causing it, especially in the gray variety, of exceeding fineness. On account of their composition, clay predominating, the varieties frequently shading into clay soils, as well as on account of their lay, occupying extensive level or slightly undulating flats, they are poorly drained, and during the rainy season of the year every depression, frequently very extensive, is converted into a pond or a shallow lake. A thorough drainage is needed to bring them under the head of tillable land. As pointed out in the former report this can freqently be done by draining the waters of the flats through sink holes into the red sandy clay or the loose sands and gravels of the drift which most generally constitute the underlaying geological formations. Black Jack, though much mixed with other oak varieties, gums, maples, etc., is characteristic for the gray loam and brown loam soils. The vegetation of the yellow loam is intermediate between that of the red sandy clays and recent bottoms, supporting but little Black Jack. All are fertile, though the yellow loam variety is richer and higher valued than any of the other varieties. Generally, it is also a lighter loam and easier worked than the former soils, which makes it additionally preferable. On account of their bad drainage none of these valuable lands are extensively cultivated, and it can be often observed that the farmer rather will exhaust the sandy soils and change his home, moving from place to place in the parish, than to properly work these loam lands, which require more expenditure of labor but will pay double and treble for the effort. All the methods suggested to improve clay lands and heavy loam lands can be used with advantage on these soils.

THE HOMMOCK OR SECOND BOTTOMS.

The soils of this peculiar topographic feature of North Louisiana are the most highly valued of all. Though of high fertility wherever met with, they differ so much in quality that only their general characteristics can be given in a preliminary report, and it must be left to future detailed work to study and classify them. Occupying gentle slopes or narrow flats along the rivers and streams of this section, they vary in composition and physical properties with the geological formations which underlay them and which largely have furnished their material. On account of their favorable lay, they are but seldom subject to overflow and generally exceedingly well drained, consisting of wash derived from the adjoining hillsides, and the underlaying strata with very frequently a large amount of humus from a vigorous vegetation they support, they are loose and easily tilled. Their content of nutritive elements is especially varying, but the physical properties they share to a large extent throughout the region. They are preferred by the inhabitants to any of the other soils previously mentioned, and are used with almost equal success for the cultivation of cotton and corn, potatoes and other vegetables, always yielding a fair, frequently an excellent, crop in seasonable years. Their quality to stand exhaustive culture, so frequently practiced in North Louisiana, depends, of course, on their original composition, and that especially is varying with the geological section they occupy. As mentioned, it is best to study them with the geological and agricultural surveys to be made of each parish.

ALLUVIUM SOILS.

In the former report the general characteristics of the alluvial soils of the Red river and Ouachita river have been given, and it also has been attempted in that paper to show the cause of their fertility.

The alluvial lands of the larger rivers traversing North Louisiana occupy such an immense area, and are of so high an importance to the people of the State, that it will take more than a full season's work to study their geological and agricultural features enough to treat them with some justice, even in a preliminary report. One of the highest authorities on scientific agriculture in America. Dr. Eugene Hillgard, remarks of their soil: "Equalled by few, and surpassed by none in the world in productive capacity." They occupy an area of about 6000 square miles in North Louisiana, and must form for this, as well as the former reason, the subject of another report.

CHEMICAL ANALYSES OF SOILS.

It was intended to collect typical soils of each classification already given, and have them analyzed, but it was not accomplished. Soils representative of some of the formations described have, however, been collected and analyzed. A report of the analyses is herewith given.

REPORT ON SOILS.

RED SANDY CLAYS.

No. 1—Dark gray sandy soil, from D. M. Harper, Sodus, La., Section 11, Township 9 North, Range 11 West.

No. 2—Subsoil of No. 1, lighter in color.

No. 3—Subsoil of No. 1, taken at depth of 30 inches and of a pale yellow color.

No. 4—Blackish gray sandy soil from A. J. Whitlow, at the old salt works at Bienville. Southwest quarter of Section 31, Township 14 North, Range 5 West.

No. 5—Subsoil of No. 4, of pale yellow color.

No. 6—Yellowish red sandy soil, from James E. Adger, Hughes' Spur, Bossier parish. South half Section 2, Township 20 North, Range 13 West.

No. 7—Subsoil of No 6.

No. 8—Red sandy soil, from Judge E. M. Graham, Vienna, Lincoln parish, taken to depth of 8 inches.

No. 9—Subsoil of No. 8.

No. 10—Red sandy soil, from A. K. Clingman, Homer, La., Section 22, Township 21 North, Range 7 West.

No. 11—Subsoil of No. 10.

No. 12—Deep red sandy soil, from Jas. E. Adger, Hughes Spur, Bossier parish, Section 1, Township 20, Range 13, "characteristic red land of northwest Bossier.

No. 13—Subsoil of No. 12.

BOTTOM SOILS.

No. 14—Gray loamy soil, from Northwest quarter of Southwest quarter of Section 23, Township 18 North, Range 7 West, one-quarter of a mile from Gibsland, Bienville parish.

No. 15—Gray clayey soil, from a bottom on the old Claiborne road, 5 miles east of Forksville, Ouachita parish.

No. 16—Gray loam from same place as No. 15.

No. 17—Gray clay, from near Rosenfield, Catahoula parish.

No. 18—Gray clay, underlying Nos. 10 and 11.

No. 19—Brick clay, from A. K. Clingman, Homer, La., 2 feet from surface.

No. 20—Blackish gray soil, surrounding the calcareous prairie, Section 13, Township 11 North, Range 5 West; tree growth, short leaf pine, post oak, black jack, dog wood, red maple, hickory and hazel.

No. 21—Subsoil of No. 20 of yellowish red color.

No. 22—Calcareous soil from Section 13, Township 11 North, range 5 west. Prairie of 40 acres, surrounded by flat woods. Tree growth, few persimmons and hawthorns, covered with turf of grasses.

No. 23—Subsoil of No. 22. Soils of drift and Grand Gulf regions.

No. 24—Drift soil, dark gray sandy, from two miles southeast of Cheniere Station, Ouachita parish. Tree growth, long leaf pine, and a few black jacks.

No. 25—Subsoil of No. 24 of yellowish tint.

No. 26—Gray soil (drift) underlaid with "red sandy clay," from F. M. Clement, Minden, La. North one-half southeast one-fourth of Section 9, Township 18 North, Range 9 West. Tree growth, short leaf pine.

No. 27—Subsoil of No. 26.

No. 28—Dark gray, coarse grained sandy soil from near Chopin, La. Section 16, Township 6 North, Range 5 West—from disintegration of the Grand Gulf sandstone. Tree growth, short leaf pine and a few oaks.

No. 29—Subsoil of No. 28, of light drab color.

DILUVIAL SOILS.

No. 30—A typical soil of the flats between Dorcheat and Red rivers, from Mr. A. R. Thompson, Benton, La., Section 30, Township 20 North, Range 13 West. Light yellow, fine grained loamy soil, crawfishy and sticky—must be drained for success.

No. 31—Subsoil of No. 30, of lighter color.

No. 32—Brown loamy soil from Holloway's prairie, Rapides Parish, Section 29, Township 5 North, Range 2 East. Vegetation, mayhaws, persimmons and grasses.

No. 33—Subsoil of No. 32.

ALLUVIAL SOILS.

No. 34—Gray loamy soil, from near Columbia, Caldwell parish, Section 8, Township 13 North, Range 4 East. Tree growth: Willow, sweet gum, cow oak, willow oak and turkey oak. Typical soil of Ouachita bottoms.

No. 35—Subsoil of No. 34, of reddish color.

No. 36—Red loamy soil, from the front lands of Cane river, near Chopin, La., Section 16, Township 6 North, Range 5 West. Tree gowth: Cotton wood, sycamore, etc.

No. 37—Subsoil of No. 36, of lighter color.

No. 38—Red loamy soil, from front lands of Bayou Rapides, 10 miles Northwest of Alexandria, from C. D. Cooper, Section 19, Township 4 North, Range 2 West. Said to rust cotton.

No. 39—Subsoil of No. 38.

No. 40—Frontland Red river soil, from near Alexandria.

No. 41—Subsoil of No. 40.

No. 42—Intermediate Red river soil, from near Alexandria.

No. 43—Subsoil of No. 42.

No. 44—Backland Red river soil, from near Alexandria.

No. 45—Subsoil of No. 44.

ANALYSES OF SOILS.

Number of Soil.	Insoluble Matter.	Soluble Silica.	Potash.	Soda.	Lime.	Magnesia.	Ferric oxide.	Alumina.	Phosphoric Acid.	Sulphuric Acid.	Carbonic Acid.	Organic Matter.	Water.	Nitrogen.	Humus.	Available Inorganic.	Silica Soluble in Sodium Carbonate
Number 1	93.61	.051	.066	.113	.053	.042	.583	1.100	.067	....	....	2.440		.047	.150	.120	2.030
" 2	95.92	.062	.011	.103	.046	.031	.787	.789	.053	....	....	15.59		.023	.080	.210	1.140
" 3	88.48	.050	.113	.056	.014	.037	1.281	4.495	.051	....	....	2.64		.028	.060	.220	2.860
" 4	90.22	.091	.069	.032	.215	086	1.476	1.571	.026	....	....	4.820		.193	.374	.240	1.463
" 5	91.60	.121	.071	.065	.208	.135	1.947	2.249	.032	...	....	2.416		.032	.129	.190	1.271
" 6	91.80	.112	.091	.095	.146	.075	1.390	2.078	.064	.011	....	1.972	1.150	.094	....	....	......
" 7	84.21	.153	.110	.077	.067	.090	3.475	4.461	.123	.048	....	4.200	3.046	.015	....	....	......
" 8	90.88	.085	.071	.056	.015	.023	1.839	2.249	.036	.089	....	3.413	1.287	.077	....	....	......
" 9	91.91	.107	.151	.073	.092	.034	1.795	2.800	.031	.062	....	1.833	1.090	.041	....	....	......
" 10	86.81	.091	.084	.042	.048	.117	4.125	3.557	.015	.055	....	3.940	1.120	.035	....	....	......
" 11	87.83	.600	.058	.022	.120	.253	4.263	4.348	.017	.069	....	2.592	.600	.037	....	....	......
" 12	45.45	.095	.059	.015	.051	.022	23.423	18.193	.253	.120	....	9.760	2.510	.098	....	....	......
" 13	57.56	.103	.068	.054	.038	.031	17.057	17.345	.295	.089	....	5.738	1.872	.032	....	....	......
" 14	68.42	....	.780	.127	.380	.540	3.64	16.77	....	....	....	.....	7.58	....	....	....	......
" 15	58.43	....	1.310	.910	.840	.830	3.23	22.45	....	....	....	.....	11.01	....	....	....	......
" 16	80.51	....	.750	.480	.640	.360	2.31	10.76	....	....	....	.....	4.65	....	....	....	......
" 17	51.91	....	1.030	.770	.680	.490	2.14	18.38	....	....	....	.....	14.18	....	....	....	......
" 18	74.48	....	.....	.....	.250	.150	6.12	12.08	....	....	....	6.32	.70	....	....	....	......
" 19	82.83	....	.....	.....	.150	.080	1.42	6.48	....	....	....	7.20	1.84	....	....	....	......
" 20	77.51	.039	.168	.204	.212	.338	4.33	3.932	.059	....	....	8.080		.098	.513.	512	5.430

"	21	57.43	.022	.183	.178	.473	.576	6.60	9.87	.055	....	.....	13.104		.064	.287	.342	12.020
"	22	29.14	.012	.749	.493	16.48	1.31	5.81	6.11	.071	....	12.37	16.84		.116	.476	.113	11.270
"	23	27.01	.016	.640	.314	17.75	1.47	7.05	5.43	.095	....	13.24	16.08		.072	.232	.384	10.430
"	24	95.81	.036	.012	.082	.051	.032	.681	.700	.015	....	.....	1.75		.024	.213	.262	1.173
"	25	81.87	.038	.093	.106	.051	.082	2.68	4.65	.072	....	.....	5.110		.021	.211	.384	3.040
"	26	94.55	.228	.031	.035	.167	.087	.225	.835	.012	.075	.....	3.016	.920	.020	.....	....	......
"	27	96.41	.040	.081	.036	.060	.075	.318	1.01	.062	.041	.....	1.42	4.50	.035	.....	....	......
"	28	95.63	.035	.042	.023	.035	.058	.329	.875	.032	....	.....	2.220		.032	.303	.164	.987
"	29	96.71	.032	.031	.023	.033	.038	.403	.770	.045	....	.....	1.060		.014	.142	.220	.840
"	30	82.27	.031	.122	.087	.213	.216	2.04	4.88	.045	.009	.....	7.020		.075	.317	.181	3.65
"	31	78.10	.054	.204	.096	.255	.317	3.37	6.55	.083	.008	.....	7.680		.043	.234	.246	3.94
"	32	80.22	.048	.136	.251	.159	.248	2.45	4.01	.102	.006	.....	10.280		.175	.422	.081	2.42
"	33	82.13	.042	.161	.205	.167	.272	2.73	4.84	.062	.007	.....	6.580		.066	.127	.383	2.53
"	34	70.80	.056	.476	.202	.224	.702	4.27	7.95	.230	.004	.....	9.460		.077	.320	.180	6.14
"	35	58.60	.074	.764	.233	.262	1.11	5.26	10.02	.182	.006	.....	14.74		.068	.240	.360	8.98
"	36	73.77	.066	.493	.274	.467	.442	5.01	2.75	.134	.002	.....	8.78		.063	.260	.160	6.84
"	37	72.61	.053	.467	.243	1.256	1.252	3.44	3.77	.116	.003	.....	7.98		.055	.130	.020	7.45
"	38	81.72	....	.412	.093	1.630	2.080	6.72		.091	....	1.18	3.58	2.38	.085	.....	....	......
"	39	80.69	....	.417	.078	2.580	2.050	7.03		.107	....	2.00	3.86	2.29	.038	.....	....	......
"	40	90.41	....	.295	.052	.330	1.000	5.20		.120	....	.....	1.35	1.22	.034	.....	....	......
"	41	79.75	....	.255	.046	.600	.200	5.55		.090	....	.670	2.31	.910	.018	.....	....	......
"	42	75.94	....	.662	.053	1.900	2.140	9.84		.114	....	1.38	4.78	3.91	.084	.....	....	......
"	43	77.50	....	.486	.055	1.840	2.000	9.30		.129	....	1.23	3.93	3.83	.057	.....	....	......
"	44	72.83	....	.920	.170	.810	.500	13.03		.120	....	.....	4.95	7.34	.120	.....	....	......
"	45	68.74	....	.970	.258	2.55	1.46	14.06		.160	....	2.04	5.67	4.39	.052	.....	....	......

The foregoing analyses perhaps need interpretation to many farmers. The ingredients which give fertility to a soil are potash, lime, phosphoric acid and nitrogen. When a soil shows high percentages of these ingredients, and its physical qualities are good, it will yield under good cultivation, large crops. Lime perhaps, of all others, is the one ingredient which exercises the largest influence upon the fertility of a soil. Dr. E. W. Hillgard, who has made a most extensive study of soils, says: "Almost all the trees which the old farmer habitually selects as a guide to a good location, are such as frequent soils rich in lime. He has found that in order to manifest itself unequivocally in tree growth, the lime percentage should not fall below 0.1 per cent. in the lightest sandy soils. In clay loams not below 0.25 per cent.. and in heavy clay soils, not below 0.5 per cent., and may advantageously use to 1. and even 2. per cent. Beyond the latter figure it seems in no case to act more favorably than a less amount, unless mechanically." The same author says, that phosphoric acid percentage in connection with lime seems to govern most commonly the productiveness of virgin soils. In any of these less than 0.05 per cent. must be regarded as a serious deficiency unless accompanied by a large amount of lime. In sandy loam soils 0.1 per cent, when accompanied by a fair supply of lime, secures fair productiveness for from eight to fifteen years; with a deficiency of lime, twice that percentage will only serve for a similar time. Potash percentages in soils vary frequently with that of "clay," i. e., in clay, they are usually high, in sandy soils, low. Potash often rises above 1. per cent. in rich clay soils, averaging in clay loams and heavy clays from 0.5 to 0.8 per cent. In lighter loams, from 0.3 to 0.45 per cent. Sandy loams may fall below 0.3 per cent. and sandy soils of great depth may fall below 0.1 per cent. consistently with goodly productiveness and durability, provided the amounts of lime and phosphoric acid with which it is associated, are in goodly quantities. Virgin soils falling below 0.06 per cent. in the potash percentage are regarded as deficient, and application of some form of potash has been followed by immediate increase of production. Sometimes, however, a soil very rich in lime and phosphoric acid shows good productiveness despite a very low percentage of potash, and conversely a high potash percentage seems capable of offsetting a low one in lime. Few soils in the South are deficient in potash, and the universal preference given to phosphatic and nitrogenous fertilizers is in accord with this inference. Using the above, taken from the experience of Dr. Hillgard, we can approach our soils and measure their fertility. From our experience, 0.05 to 0.1 per cent. nitrogen are fair percentages for good soils. Here, too, the availability of nitrogen is largely determined by the lime present.

Examining the above soils by the rules established by Dr. Hillgard, we shall find much valuable data upon which to base future improvements.

Taking the soils and subsoils of the "red sandy clays," we find that most of them fall below the standard for lime, potash and phosphoric acid, and some are very low in nitrogen.

Attention is called to soil No. 12 and its subsoil, No. 13, to the large amount of phosphoric acid and the fair supply of nitrogen. They are very low in lime, and with only a moderate content of potash. The high percentage of phosphoric acid seems to be connected with the iron, since specimens of iron ore from this class of lands have been found containing imbedded concretions of phosphates. However, in soil No. 10, of a red color, with over 4 per cent. of iron oxide, the phosphoric acid falls to a very low percentage (0.015 per cent). Such soils, in fact, all of those which contain less than 0.1 per cent. of phosphoric acid, should be treated with phosphatic fertilizers. It may be asserted, that for most of the soils of this region, nitrogenous and phosphatic manures will prove beneficial.

CREEK BOTTOM SOILS.

As before remarked, these soils lack only drainage, and protection from overflow to make them highly productive. They are rich in potash and lime. It is unfortunate that neither the phosphoric acid nor nitrogen was determined. It is highly probable that the former exists in fair quantities.

PRAIRIE SOILS.

The prairie soil No. 22 is rather low in phosphoric acid, bu otherwise most excellent.

DRIFT SOILS

Are poor in every valuable ingredient. Complete fertilize with the incorporation of large quantities of vegetable matte are needed to insure good crops on these soils. When restin on or near the "red sandy clays," by deep plowing, the latte may be brought up to the surface and mixed advantageous with the former.

DILUVIAL SOILS.

While the general composition of these soils is fair, the are low in phosphoric acid and will doubtless respond well manures containing this ingredient. No. 30 will also be bene fited by nitrogenous fertilizers.

ALLUVIAL SOILS.

No comment is needed upon these soils further than to sa that applications of nitrogen in an available form, will enab them to grow the largest crop. All the other ingredients a present in sufficient quantities for present wants.

BOTANICAL NOTES.

From the botanical notes furnished by Mr. Thomas Wayland Vaughan, who accompanied Dr. Lerch on this survey, the following list of trees and shrubs are taken; also there is given a list of the medicinal plants found and determined by him in North Louisiana.

There is also given a list of grasses collected by the survey and carefully determined by Prof. S. M. Tracy, of Mississippi Agricultural Station.

It is a matter of regret that our space will not permit of the publication in full of Mr. Vaughan's interesting notes in this report.

The list of plants are given for each geological section.

TREES AND SHRUBS GROWING ON THE RED SANDY CLAYS.

Quercus alba—White Oak.
Quercus falcata—Spanish Oak (very common).
Quercus tinctoria—Black Oak.
Quercus nigra—Black Jack.
Quercus obtusiloba—Post Oak.

Black oak and Spanish oak, both called locally "red oaks;" the former has leaves smooth on both sides, and with slender lobes of a glossy green color, while the latter has underside of leaf covered with short down, and broader lobes. Neither of these are the genuine "red oak."

Carya porcina—Pignut.
Carya tomentosa—Black Hickory.
Ulmus alata—Wahoo or Winged Elm.
Vaccinium arboreum—Winter Whortleberry.

Liquidambar styraciflua—Sweet Gum.
Acer rubrum—Red Maple.
Ostrya virginica—Iron Wood.
Aesculus pavia—Red Buckeye.
Aesculus indet—Buckeye.
Bignonia capreolata—Woody Vine.
Viburnum prunifolium—Black Haw.
Cornus florida—Dogwood.
Nyssa sylvatica—Black Gum.
Prunus serotina—Wild Cherry.
Prunus Americana—American Plum.
Prunus angustifolia—Chickasaw Plum.
Sassafras officinale—Sassafras.
Diospyros virginiana—Persimmon.
Fraxinus viridis—Green Ash.
Pinus Tæda—Loblolly or Old Field Pine.
Pinus Mitis—Short Leaf Pine.
Asimina parviflora—Papaw.
Hibiscus incanus—Marshmallow.
Hibiscus moscheutos—Marshmallow.
Ptelea trifoliata—Hop Tree.
Rhus glabra—Sumach.
Rhus copallina—Sumach.
Acer saccharinum—Sugar Maple.
Gleditschia triacanthes—Honey Locust.
Prunus Serotina—Wild Black Cherry.
Rubus villosus—Blackberry.
Rosa laevigata—Cherokee Rose.

DEEP SANDY OR GRAVELLY SOILS.

Pinus palustris—Long Leaf Pine.
Quercus catesbaei—Turkey Oak.
Quercus nigra—Black Jack Oak.
Quercus obtusiloba—Post Oak.
Quercus cinerea—Sand Jack Oak.
Hamamelis virginica—Witch Hazel.
Oxydendrum arboreum—Sour Wood.

Magnolia—Several species.
Myrica cerifera—Wax Myrtle.
Alnus serrulata—Alder.
Castanea pumila—Chinquepin.

CALCAREOUS SOILS.

Few trees and shrubs.
Rubus villosus—Blackberry.
Diospyros virginica—Persimmon.
Cratægus apiifolia—Parsley Haw.
Cratægus crus galli—Cockspur Thorn.
Viburnum pinnifolium—Black Haw.
Fraxinus virides—Green Ash.
Cornus—Dogwood.
Juniperus virginiana—Red Cedar.
Rhamnus caroliniana—Bearberry.
Phytolacca decandra—Pokeberry.

GRAY LOAM FLATS.

Quercus tinctoria—Black Oak.
Quercus falcata—Spanish Oak.
Quercus obtusiloba—Post Oak (abundant).
Quercus nigra—Black Jack.
Quercus alba—White Oak.
Fagus ferruginea—Beech (abundant on beech flats).
Ostrya virginica—Iron Wood.
Acer barbatum—Hard Maple.
Magnolia grandiflora—Magnolia.
Quercus Michauxii—Cow Oak (occasionally).
Liquidambar Styraciflua—Sweet Gum.

CREEK BOTTOMS.

Quercus Michauxii—Cow Oak.
Quercus aquatica—Water Oak.
Quercus Phellos—Willow Oak.
Quercus Palustris—Pin Oak.
Quercus lyrata—Overcup Oak.

Quercus alba—White Oak.
Tilia Americana—Linden Tree.
Ostrya virginica—Iron Wood.
Carpinus Americana—Hornbeam.
Fagus ferruginea—Beech.
Cephalanthus occidentalis—Button Bush.
Cercis canadensis—Red Bud.
Ilex opaca—Holly.
Ulmus alata—Wahoo or Winged Elm.
Ulmus fulva—Slippery Elm.
Magnolia Macrophylla—Cucumber Tree.
Magnolia Glauca—Sweet Bay.
Magnolia Grandiflora--Magnolia.
Alnus serrulata—Black Alder.
Euonymus Americanus—Burning Bush.
Oxydendrum arboreum—Sour Wood.
Viburnum medium—Haw.
Acer rubrum—Red Maple.
Pinus Tæda—Loblolly Pine.
Hydrangea quercifolia—Seven Barks.
Myrica cerifera—Bayberry.
Brunnichia cirrhosa— ——— ———.
Rhus toxicodendron (var radicans)—Poison Oak.
Tecoma radicans—Trumpet Flower.
Liriodendron tulipifera—Tulip or Poplar.
Nyssa sylvatica—Black Gum.
Liquidambar styraciflua—Sweet Gum.
Arundinarea tecta—Switch Cane.
Nyssa uniflora—Tupelo Gum.
Taxodium distichum—Cypress.
Carya alba—Scaly Bark Hickory.
Carya aquatica—Water Hickory.
Carya amara—Swamp Hickory.
Asimina triloba—Papaw.
Cratægus apiifolia—Hawthorn.
Cratægus Crus Galli—Cockspur Thorn.
Hydrangea quercifolia—Seven Barks.

Sambucus canadensis—Alder.
Viburnum medium—Haw.
Viburnum scabrellum—Haw.
Cephalanthus occidentalis—Button Bush.
Chionanthus virginica—Fringe Tree.
Fraxinus viridis—Green Ash.
Morus rubra—Mulberry.
Maclura aurantiaca—Osage Orange.
Betula nigra—Red Birch.

With many species of willows, ash and cottonwood undetermined.

RIVER BOTTOMS.

Quercus lyrata--Overcup Oak.
Quercus aquatica--Water Oak.
Quercus Phellos--Willow Oak.
Quercus Michauxii--Cow Oak.
Quercus Palustris--Pin Oak.
Nyssa sylvatica--Black Gum.
Cratægus æstivalis--Mayhaw.
Liquidambar styraciflua--Sweet Gum.
Ulmus alata--Wahoo, or Winged Elm.
Fraxinus platycarpa--Water Ash.
Arundinarea tecta--Switch Cane.
Taxodium distichum--Cypress.
Pinus tæda--Loblolly Pine.
Carya aquatica--Swamp Hickory.
Fraxinus Americana--White Ash.
Liriodendron tulipifera--Yellow Poplar.
Populus Heterophylla--Cottonwood.
Salyx--Willow (several species).
Catalpa bignonioides--Catalpa.
Platanus occidentalis--Sycamore.
Negundo aceroides--Box Alder.
Acer rubrum--Red Maple.
Celtis occidentalis--Hackberry.
Rhus toxicodendron--Poison Oak.

Tecoma radicans--Trumpet Creeper.
Carya olivæformis--Pecan.
Taxodium distichum--Cypress.
Gleditschia monosperma--Water Locust.
Arundinarea gigantea--Giant Cane.
Ulmus Americana--White Elm.
Tillandsia usneoides--Spanish Moss.
Juglans nigra--Black Walnut.
Rhamnus Caroliniana--Bearberry.
Xanthoxylum clava--Prickly Ash.

The following Medicinal Herbs are found in North Louisiana:

MEDICINAL HERBS.

Delphinium consolida--Larkspur.
Podophyllum peltatum--Mayapple or Mandrake.
Nymphæa odorata--White Pond Lilly.
Mitchella repens--Partridge or Turkey Berry.
Oenothera biennis--Evening Primrose.
Gelsemium sempervirens--Yellow Jessamine.
Eupatorium perfoliatum--Boneset or Thorough Wort.
Erigeron strigosum--Fleabane.
Helenium tenuifolium--Bitter Weed.
Verbascum thapsus--Mullein.
Lobelia cardinalis--Cardinal Flower.
Monarda punctata--Horse Mint.
Solanum nigrum--Black Nightshade.
Datura tatula--Jamestown Weed.
Phytolacca decandra--Poke Weed.
Chenopodium anthelminticum--Worm Seed.
Phoradendron flavescens--Mistletoe.
Arisæma triphyllum--Wake Robin.
Acorus Calamus—Sweet Flag.
Cyprepedium pubescens--Lady Slipper.

GRASSES.

The following grasses collected by the survey were kindly named by Prof. S. M. Tracey, Director of the Mississippi Experiment Station, and then deposited in the Herbarium of the Louisiana State University and Agricultural and Mechanical College, Baton Rouge, La.:

No. 1--Carex glaucescens, wet places, Pollock, Grant parish.

No. 2--Leptochloa, mucronata No. 3--Panicum neuranthemum No. 4--Stipa avenacea No. 5--Panicum latifolium var, molle No. 6--Cyperus Baldwinii No. 7--Panicum dichotomum No. 8--Panicum filiforme.	From long leaf pine Drake's ridges, near Salt Works, Winn parish.
No. 9--Chrysopsis graminifolia No. 10--Paspalum setaceum No. 11--Cyperus nodosus, var megacephalus No. 12--Panicum sanguinale No. 13--Andropogon ———	From the drift forma now in Winn parish.
No. 14--Paspalum racemulosum No. 15-- " dilatatum No. 16-- " platycaule No. 17--Sporobulus indicus No. 18--Eragrostis Purshii	Pine Ridge, La.

No. 19--Zizaniopsis milacea--Grant parish.

No. 20--Scirpus eriophorum--Winn parish.

No. 21--Pyhncospora glomerata--Winn parish.

No. 22--Cyperus vegetus No. 23--Agrostis Stolonifera No. 24--Cyperus compressus No. 25--Rynchospora No. 26--Eleocharis ovata No. 27--Juncus tenuis	Marthaville, Natchitoches parish.

No. 28--Panicum microcarpon No. 29--Rynchospora inexpansa No. 30--Cyperus ovularis No. 31--Paspalum setaceum No. 32--Lespedeza striata No. 33--Panicum dichotomum var ramosum No. 34--Juncus tenuis	From four miles south of Liberty Hill. Soil—Gray Clays.
No. 35--Eatonia Pennsylvanica var filiformis No. 36--Panicum dichotomum No. 37--Paspalum setaceum No. 38--Phleum pratense	Near Kelly, Caldwell parish.
No. 39--Cyperus stenolepis No. 40--Elymus virginicus No. 41--Eleusine indica No. 42--Setaria glauca No. 43--Fibichia dactylon	Red River Bottoms, Rapides parish.
No. 44--Panicum anceps—Holloway Prairie. Rapides parish.	
No. 45--Uniola gracilis No. 46--Scirpus eriophorum No. 47--Andropogan provincialis No. 48--Cyperus haspan No. 49--Setaria glauca, var imberbis No. 50--Paspalum floridanum No. 51--Paspalum lentiferum	Holloway Prairie, near Catahoula Lake. Rapides parish.
No. 52--Panicum sanguinale, var celiare No. 53--Panicum viscidum No. 54--Gymnopogon racemosus No. 55--Tripsacum dactyloides No. 56--Eragrostis pilosa No. 57--Panicum crus galli	Locality unknown

ACKNOWLEDGMENTS.

I am indebted to the citizens of North Louisiana, who have uniformly assisted me whenever opportunity was offered. The number of these gentlemen is so great that it is impossible to name them, and I am forced, therefore, to express my thanks to all collectively.

Special thanks are due to Mr. A. K. Klingman, from whom I have repeatedly received courtesies; to Mr. Chapman, conductor of the Vicksburg, Shreveport and Pacific Railroad; to Hon. Mr. Pool, State Commissioner of Immigration, and to Major J. G. Lee, Assistant Director of North Louisiana Station, for continued kindness and hospitality; to Dr. Chas. G. Gill, Librarian of Tulane University for his ever kind and valuable assistance, and to the entire press of the State, for many courtesies received; to the Vicksburg, Shreveport and Pacific Railroad we return thanks for free passage over its entire line in Louisiana--a courtesy denied by all the other railroads traversing this State.

FOOTNOTE TO SECTION 2 OF FIRST REPORT.

Since studying the southern portion of North Louisiana, we have good reason to believe the yellow marls figured in Section 1, page 13, first report, and there referred to the upper cretaceous, are of Eocene Jackson age, *overlying the lignite shales* which surround the cretaceous island.

PART III.

GEOLOGY AND AGRICULTURE.

A PRELIMINARY REPORT

UPON

THE FLORIDA PARISHES OF EAST LOUISIANA

AND THE BLUFF, PRAIRIE AND HILL

LANDS OF SOUTHWEST LOUISIANA,

BY

W. W. CLENDENIN, A. M., M. S., Geologist.

Made Under Direction of State Experiment Stations,

BATON ROUGE, LA.

WM. C. STUBBS, PH. D., Director.

LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE.

BUREAU OF AGRICULTURE.

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H. SKOLFIELD, Treasurer, Baton Rouge, La.

The Bulletins and Reports will be sent free of charge to all farmers, by applying to Commissioner of Agriculture, Baton Rouge, La.

CORRECTIONS AND OMISSIONS.

Page 173, line 12, omit comma and substitute comma for semicolon.

Page 175, line 17, *emboyments* should read *embayments.*

Page 177, last line, omit *above.*

Page 181, line 16, paragraph should begin with quotation marks.

Page 190, line 31, instead of *rocks were removed,* read *disintegrated rocks were not removed.*

Page 190, line 36, omit *free.*

Page 201, line 4, *upon the highways* should read *upon the prevailingly windward side of highways.*

Page 214, line 28, instead of *cale spar* read *calc spar.*

Page 215, line 8, instead of *probably* read *possibly.*

Page 221, line 33, line should begin with quotation marks.

Page 223, line 25, *selsction* should be *selection.*

Page 229, line 1, instead of *Eeliciana* read *Feliciana.*

Page 237, line 14, instead of *Orange Island* read *Orange Sand.*

Page 238, line 30, *elevated* should be *eroded.*

Page 243, footnote, instead of *members* read *numbers.*

Page 250, line 24, *Fogus ferruginea* should be *Fagus ferruginea.*

The classification of all sections into *Lafayette* and *Columbia* is my own.

W. W. C.

Office of State Experiment Station,
Louisiana State University and A. and M. College,
Baton Rouge, La., April 1, 1896.

Hon. A. V. Carter, Commissioner of Agriculture, Baton Rouge, La.:

Dear Sir—The Geological and Agricultural Survey instituted in 1892 by the Stations under Dr. Otto Lerch, was discontinued for the want of funds. The appropriation by the last Legislature made immediate resumption of this important work possible. Accordingly the permanent services of Mr. W. W. Clendenin, Professor of Mineralogy and Geology in the State University and Agricultural and Mechanical College, were secured by the Station and field work inaugurated early in the summer of 1894. This work has since continued and is now being prosecuted.

Prof. Clendenin gives his services from October to March to the University and the rest of the time to field work of the survey. Dr. Lerch's reports cover the hills of North Louisiana. Prof. Clendenin took up the work where Dr. Lerch left it and has continued the survey through the Florida Parishes of East Louisiaua and the bluff, hill and prairie sections of Southwest Louisiana. I have the honor of presenting herewith his preliminary report upon these sections. During the progress of this survey typical soil samples have been carefully taken and are now undergoing chemical and physical examinations in the laboratories of the Station. When all of the characteristic soils of the State have been collected and analyzed, a special report upon them will be made. This report, besides giving such analyses, will contain also a full agricultural description of these soils, their chemical requirements and physical amendments, together with such other information as may be useful to the planters and farmers of this State. The bluff lands of North Louisiana and the alluvial lands of the entire State, will be examined during the coming summer. After the preliminary survey is completed, a detailed examination, geologically, agriculturally and topographically, will be made of the entire State, which will require many years for its completion. When finished it will be a valuable addition to the literature of our State and will afford information not only to our own citizens but to the stranger seeking a home in our midst. No such work as this has ever been performed in this State, and while Louisiana is classed among the earliest settled colonies, she stands almost alone of the States of this Union, without a comprehensive geological survey. If the appropriations be continued, such a survey will certainly be consummated.

I ask that you publish this report as Part III., "Geology and Agriculture."

Very respectfully submitted,
WILLIAM C. STUBBS,
Director.

LETTER OF TRANSMISSION.

Dr. Wm. C. Stubbs, Director State Experiment Stations, Baton Rouge, La.,

SIR:—I herewith present manuscript of a Preliminary Report upon the Florida Parishes of East Louisiana and the bluff, prairie and hill lands of Southwest Louisiana.

The material for this report was collected during the summers of 1894 and 1895. Much other material for a more detailed report is gradually accumulating, which it is hoped will soon be ready for publication.

Respectfully submitted,
W. W. CLENDENIN,
Geologist.

I. INTRODUCTION.

Adopting the plan of the two reports upon "The Hills of Louisiana" by Dr. Otto Lerch, the following brief preliminary report upon the greater part of the State south of the 31st degree of North Latitude is made. The purely alluvial parishes are not here considered, inasmuch as they, being the (up to the present) chief agricultural lands, it was thought best to make a separate report upon them. Only those alluvial soils that lie in proximity to the older soils, in parishes that contain both, are here treated.

The material for this report was collected during the summers of 1894 and 1895. The appropriation for the work being made available July 1st, 1894, and I being put in charge of the survey in connection with my work in the University, the remaining months of the summer of 1894 until the opening of the University in October, were given to an examination of the Florida parishes.

Several trips were made across the section of the State embraced in these parishes by wagon, on horseback and on foot; in most of these trips I was accompanied by Prof. W. R. Dodson, Professor of Botany in the Louisiana State University and Agricultural and Mechanical College and Botanist of the Louisiana State Experiment Station.

The object being to make an *agricultural* report rather than a purely *geological*, particular attention was given to the origin, nature and depth of soil; to water supply and questions of drainage, and especially to the character of the *natural* or virgin growth upon the lands, where obtainable, as being one of the truest indices of their nature and possibilities.

This report, designed primarily for the layman in geology, has been written in a popular rather than the techinal style usually adopted for such reports. However popular in its character, no sacrifice of scientific accuracy has been made.

Few sections have been introduced into the body of the report, and no attempt at presenting the ideal substructure of the State has been made.

The superficial deposits which give character to the soils are so independent of older, underlying formations; and the topography of the region furnishes so little opportunity to study these older strata, that with the present limited knowledge of these underlying beds such an ideal section seems hardly justified.

In a special chapter a few sections made by myself, and others extracted from reports, together with some sections obtained in artesian borings, are given.

A few photographs of typical regions are presented. It is to be regretted that the method of travel often prevented a more liberal illustration.

All available information upon the region studied has been freely used; and inasmuch as this information was obtained chiefly from short articles and pamphlets long since out of print, and of extremely limited distribution, no attempt has been made always to refer the reader to the source of information.

In general I may say that the writings of Thomassy, Wrotnowski, Hilgard, Hopkins, Lockett, McGee and Stubbs upon the State, and of Spencer, Smith and others upon homologous deposits elsewhere have furnished the principal literature of this report.

Many soil samples and samples of artesian and mineral waters were taken for analysis, and in due time the results of these analyses will appear as special bulletins of the survey.

We have at present a chemist at work upon these, and Mr. E. S. Matthews, one of our graduates, has been sent on to Prof. Whitney's laboratory at Washington, D. C., to carry on the physical analysis. It is the intention, by next fall, should the survey be continued, to fit a physical laboratory at the University and make all these analyses here.

By this means there will not only be a considerable saving to the survey, but the services of students doing graduate work in the University will be available.

As the work of soil analysis, chemical and physical, is exceedingly tedious and slow, and as it is desired that the entire State shall be represented in these analyses, some time will be required for the issuance of the bulletin embodying their results.

The half year allotted to the field work of the survey in 1895 was given to a study of Southwest Louisiana, north almost to the latitude of Alexandria.

Four trips east and west across the region between the Teche and the Sabine rivers were made, and a like number north and south. Special trips were made to places of special interest, as to each of the five islands: Orange Island, Petite Anse, Grand Cote, Cote Blanche and Belle Isle; and every stream extending from the cultivable lands to the gulf was followed by boat to its mouth.

In the earlier part of the summer I was alone, but after the close of the session of the University, was joined by Mr. E. S. Matthews, who gave his time and services to the survey for the purpose of making as complete a collection as possible, of the flora of the region studied.

As in the Florida Parishes, many samples of soil were collected and shipped to the survey headquarters at the University, and are now being analyzed.

The field work of the survey for the present season will be upon the purely alluvial soils of the State, and upon the bounding "bluff" lands along the Mississippi.

The two sections of the State treated in this report, because they are widely separated by the Mississippi alluvium, and for convenience in referring to them as *geographic units*, will be described in detail in separate divisions; the Florida Parishes being considered always first and Southwest Louisiana second, being the order in which they were studied.

It should be borne in mind, however, that such a division is purely arbitrary and made for convenience; and that geologically and topographically they are similar, and belong alike to the great coastal zone that sweeps uninterruptedly from New Jersey to the Rio Grande.

The economic questions touched upon in this report are to be taken up and studied exhaustively, and the results will appear probably as bulletins.

A complete, detailed and final report upon any section of the State must wait upon a topographic survey, which, with the present limited appropriation cannot be undertaken.

Until then, though economic questions depending upon surface geology may be studied with much profit, profounder questions of scientific interest and also of economic importance must remain unsolved.

II. DESCRIPTION OF AREA.

GEOGRAPHY AND HISTORY.

The section of Louisiana styled the "Florida Parishes" lies south of the 31st parallel of latitude, between the Mississippi river on the west and the Pearl river on the east; and is bounded on the south by Lake Pontchartrain, Lake Maurepas and Bayou Manchac.

It includes eight parishes, viz.: St. Tammany, Washington, Tangipahoa, St. Helena, Livingston, East Baton Rouge, East Feliciana and West Feliciana; and comprises an area of about 4500 square miles.

This section was not a part of the Louisiana purchase made by President Jefferson in 1803, but continued as part of Florida until 1810, when it was taken possession of by Americans.

Bordering upon the Mississippi and Pearl rivers, with many smaller though navigable streams penetrating to its interior, and comprising both hill and alluvial lands, the Florida Parishes were early settled and became the seats of some of the handsomest plantation homes of the South.

The parish of Feliciana was so called by the Spaniards in recognition of its salubrity of climate, beautiful variety of forest, its clear waters and fertile soil.

Baton Rouge, the capital of the State, the seat of the University and A. & M. College and State Experiment Station, and the third largest city in the State, is the chief commercial and educational centre of these parishes. It is situated in the parish of East Baton Rouge, upon the Mississippi river at the southern limit of the river bluff, and the beginning, upon the eastern side, of the Mississippi alluvium.

Pre-eminently an agricultural section, the variety of soil is very great; and the diversity of crops has produced a diversity of interest that is displayed in the opposing views held by the residents, upon national questions of economics and finance.

St. Tammany parish, long the country home of many wealthy families of New Orleans, because of the delightfulness of its climate, is constantly growing in favor; and we find not only many summer hotels along the northern shore of Lake Pontchartrain, which are crowded to their utmost capacity during the summer months by people who wish to get out of the city for a time, but also several very pleasant resorts in the interior built up around artesian and other mineral waters that possess healing virtues.

When the question of mineral waters can be fully investigated it is more than probable that many who now go thousands of miles in search of health giving waters will find in their own State, and practically at their doors, springs and wells in every respect equal to those they annually make tedious and dangerous journeys to reach.

Southwest Louisiana, as here described, includes the greater part of the region west of the Atchafalaya river to the Sabine; and lying south of the latitude of Alexandria.

The parishes constituting this area are St. Mary, Iberia, St. Martin, Lafayette, Vermilion, Acadia, St. Landry, Cameron, Calcasieu, and parts of Vernon and Rapides.

The first five of these constitute what is known as the "Attakapas" country, which derives its name from a tribe of Indians who once occupied this region, and whose descendents are still found there in small numbers. The occupants of the "Attakapas" region have been pleased to style it the "Garden of Louisiana," with how much reason I leave it for this report and personal investigation to determine. This is the scene of much of the plot of the beautiful legendary poem, Evangeline; as also the home and safe retreat of that omnipresent, sometime pirate, Lafitte.

Search for this pirate king's buried treasures is constantly made by credulous people, using for the purpose "divining" rods varying in style from that used in the time of Moses to the modern peach or willow fork. Especially is this true upon and near the five islands, people coming scores of miles to join in the search.

Were but one-half the energy thus wasted employed in improving their farms, these people could much more justly claim for their section the proud title of "Garden of Louisiana."

On the south the area described is washed by Atchafalaya, Cote Blanche and Vermilion Bays, arms of the Gulf, and further west by the Gulf of Mexico itself. The Sabine river marks the entire western border between this area and Texas.

Much of the region has been recently reclaimed from the coast marsh and converted into prosperous farms. No other part of the State shows a greater degree of modern thrift and prosperity.

Growing and thriving towns are found along the railroads, and well equipped farms upon land that a decade ago was considered worthless for everything except a pasture ground for roaming herds of half-wild cattle and horses. New lines of railroad are building, and others have been projected through this part of Louisiana, and the era of prosperity seems only to have dawned.

The Attakapas country is the home of the Acadians, who found here a retreat when so ruthlessly driven out of their far off Canada homes. Their homes in Louisiana, with their accompanying grounds display a peculiar and distinct style of architecture and adornment.

The Teche country is too well and favorably known to require special description. Upon its banks are found some of the oldest and handsomest homes in the South. Some of the most prosperous, wide awake towns of the State are found along its banks, where the Southern Pacific railroad touches its western bends

Southwestern Louisiana includes even a greater variety of soil than the Florida parishes; having in addition to the hills, the flats, the "bluff" and the alluvial bottoms of that section, the "prairies" and a large area of redeemed coastal marsh. On this account a corresponding greater variety of crops is planted and living *at home* is much more generally the rule. Being recently largely settled by small farmers from the Northwest, who own and cultivate their own farms, this section, like much of

North Louisiana, exhibits the desirable condition of being owned in small tracts and occupied by the owner.

TOPOGRAPHY AND DRAINAGE.

Next to climate, perhaps the most important questions to the immigrant to any region are those of Topography and Drainage. Upon these will depend whether he may make his home in healthful regions of the well drained uplands, or be forced to the less healthful lowlands; whether the refreshing rains shall purify the atmosphere by removing the products of death and decay, or shall produce disease by bringing from other and more favored localities these same products to vitiate the air by decaying in stagnant lagoons and swamps.

Usually a geographically old region is a well drained region. Indeed the development of topographic form is usually so rapid, that any except *very recent* deposits exhibit more or less perfect systems of drainage. As the rapidity with which the topography of a region develops is a function of its attitude to sea level, and as oscillations of the land are continuous, a region geologically very young may be sufficiently elevated to display in a short time an adolescent or even mature topography. On the other hand, topographic forms in all stages of maturity may be arrested in their development by subsidence of the land; and if this subsidence is sufficient, be buried by newer deposits.

A section inland one hundred miles from almost any point upon the Louisiana coast would cross almost every stage of development of topographic form from the most helpless youth to full maturity.

Three distinct types of topography are displayed in the Florida Parishes, represented by the "pine hills," the "bluffs" and the "pine flats."

The "pine hills" constitute the inter-stream areas lying north of a limit, roughly drawn, beginning in West Feliciana near where the Woodville and Bayou Sara railroad crosses the State line, and extending thence southeast to the Amite a few miles north of the mouth of the Comite river; thence eastward by a zigzag course to the Pearl river near the mouth of the Bogue-chitto.

This region displays a topography characteristically mature. The hills are all water sheds, and there remain no undrained interstream uplands.

Here we see a topography developed in a former geologic age, and ushered into the present age without essential change. The burial and resurrection during and at the close of the last continental subsidence followed, so close the last upon the first, that only a thin veneering of sediment was deposited; shrouding but not concealing the mature character of the topography.

Albeit the shroud, is thin; subsequent time and attitude have not enabled the agents of degradation to remove it, and we see this section still in its grave clothes.

The streams occupy their resurrected valleys even to their tributaries of the third and fourth order. These latter begin often with such exceedingly steep gradients as to resemble enormous *bath tubs*; and their rapid fall carries them quickly to the level of the parent or remoter master streams.

The primary streams occupy trenches in deposits, made during subsidence and principally by themselves, in their own former valleys. In no case was I able to find where they had trenched to the old bed.

The character of the soil and the protection afforded by the grasses of this section have reduced erosion almost to a minimum ; and the streams, though rapid, are essentially clear.

The complete, dendritic systems of drainage, in steep-sloped, V-shaped valleys with strong gradients, bespeak rapid development upon a land that stood much higher above sea level than does the present land. Likewise the easy reference of the crests of hills and ridges to one plane shows this to be a dissected plane, originally topographically similar to the pine flats to the south.

"The "bluff" section includes the remaining portions of the Felicianas and East Baton Rouge south of the "pine hills," and Livingston parish eastward to the Tickfaw, excepting small areas of the Mississippi and Amite alluvium.

Here we have a topography that may be styled adolescent.

The primary streams run in channels with steep, often vertical banks; and the secondary and tertiary branches have cut gorge-like trenches through the latest deposit, the "bluff," and often deep into the underlying beds of the next previous geological age.

The narrow, V-shaped valleys with extensive level inter-stream areas attest the youthful character of the topography.

Beneath the mantle of "bluff" the dissections by the streams discover a mature topography in all respects like that of the "pine hills;" and, indeed, we find that the level, imperfectly drained uplands of this section are the result of a thickening of the veneer that mantles the pine hills, as we approach the principal sediment transporting stream, the Mississippi.

This thickening along the banks of the sediment-laden river, in essence a *natural levee*, was sufficient to entirely obliterate former topographic forms, filling up the valleys to the level of the ridges, and covering all with an even coat of sediment.

River valleys were buried beyond possible resurrection and the drainage lines of to-day are independent of former systems. Ten or twelve miles back from the river the influence of former topography begins to be seen in the streams reoccupying their resurrected channels.

Erosion over the "bluff" area is rapid, and the streams correspondingly muddy. Enormous quantities of silt and sand are carried into the master streams after every rain.

The third type of topography is displayed by the "pine flats," a topography as yet in its most helpless youth.

Limpid, clear streams meandering and loitering through stretches of level which rise but little above their own surface; with almost vertical banks and depth out of proportion to their width, they form a characteristic feature, with few homologies in the United States.

Broad, level, poorly drained inter stream areas—so smooth and level that the precipitation runs off in a practically unbroken sheet, thus having little effect as an agent of erosion—characterize these flats.

The larger streams flowing through them doubtless are extensions of resurrected valleys; but the smaller lines of drainage are but beginning their work, and their meandering courses show how completely they are at the mercy of the slightest obstacles.

With scarcely any draught upon them, for the work of transportation, the energy of their currents is expended in deepening their channels. These flats grade insensibly into the coastal sea marsh now forming, and are doubtless of similar origin.

In extent and position they occupy all of that section of the "Florida Parishes" south of the "pine hills" and lying between the Tickfaw and Pearl rivers. Northward along all the principal streams flowing through them, embayments of the flats extend; and in the cases of the Amite, Tangipahoa and Bogue-chitto these embayments reach beyond the State line. The emboyments of the Tickfaw and Chefuncta reach almost to the limits of the State, and of smaller streams, well into the hill section.

Each of the Florida parishes is reached by one or more navigable streams.

The topography of these parishes is on the whole extremely simple. No local disturbances seem to have occurred to interrupt the natural though varying processes of erosion and deposition.

The attitude of the strata indicate slow and gentle regional oscillation through a considerable vertical distance. The evidence points to the present attitude being much nearer the bottom of the swing than the top. The land probably stood thousands of feet higher than its present level; but during the deposition of present surface strata it was never more than a few hundred feet lower than at present.

Therefore we find only gentle dips in the strata, and the ridges have been carved out of approximately horizontal deposits.

The abnormally rapid fall of the tributary valleys to the bottoms of the master streams, and of side valleys of the second and third order, having often a bath tub appearance, indicates the great altitude of the land when they were formed.

The easy reference of the ridges to one plane, and the horizontal attitude of the strata cut through by the valleys show that the irregularity of surface is due to erosion of a once continuous plain like the present "flats."

Unconformities of strata are observed, but it is *unconformity* of *erosion*, and the overlying and underlying strata are essentially parallel. Within the pine flat embayments that accompany the principal streams into hills is usually a second lower flat, the flood plain of the present streams. This is a product of the streams now and in recent times.

All the types of topography displayed by the Florida parishes are found in Southwest Louisiana: the "pine flats," the "bluff" and the "pine hills;" and in addition the "prairies," which may be considered distinct from all.

The "pine flats" are confined to Calcasieu parish, and extend in an east and west zone along the southern base of the hills, southward as far as west fork of Calcasieu river. and from the Sabine on the west to the Calcasieu on the east. They cover an area of about twenty-five sections, and are from fifteen to twenty miles in width on the western border of the State and extend up the Calcasieu about to the junction of Black creek with that river.

While wet, and characterized by the same vegetation as the "pine flats" of St. Tammany, these flats differ from those considerably topographically, as also in character of soil.

The primary streams appear to follow mainly their resurrected valleys, or extensions of these, and the development of drainage systems has progressed far beyond anything displayed by the pine flats of the Florida parishes. However, the topography is still young, and the interstream areas poorly drained.

The flats grade imperceptibly into the hills, and *do not* extend headward along the primary streams as "second bottoms." On the other hand, they pass as imperceptibly into the "prairies" with scarcely noticeable change other than the failing of the forests.

All over these flats, but not confined to them, is found a peculiar topographic feature to be discussed later—the mounds.

While the subsoil and underlying formations are in general the same as found in the Florida Parishes, yet the chocolate colored, silty loam, found over the prairies to the east spreads as a very thin veneer over the flats.

The "bluff" regions are much more limited in extent than east of the Mississippi, and are found only as tattered remnants of a former much more extensive plane, capping hills and ridges that mark the sometime western shore of the greater Mississippi. Their surface extension is small, but their influence as a substratum is felt over the greater part of this section. Appearing in northeastern Rapides and northwestern Avoyelles in detached, island "prairies," in, or bordering along the Mississippi and Red river bottoms; appearing again in erosion tattered areas along Bayou Rouge; then reappearing along the west bank of Cocodrie and Courtableau bayous, above Washington in St. Landry parish, and extending thence southward to within a few miles of Cote Blance Bay, in a continuous zone of varying width, the "bluff" deposits present a characteristic soil, though too limited in area to be of importance in the development of topographic form. Westward the deposit, in modified form, sinks gradually, but nowhere deeply, beneath the chocolate colored loam of the prairies, of which more in a later paragraph.

The "bluff" deposits here, as in West Feliciana, have the same color and consistency, and weather into like steep-sloped minarets and spires, standing indefinitely in vertical walls without crumbling.

The bayous, "marais" and "coulees" that meander through or extend across this "bluff" area are very unlike the hastily developed drainage system of this formation in West Feliciana. Nowhere do we find the deep, gorge-like valleys; but instead meandering streams in what appear to be old channels, inherited from streams that from some cause became so inactive as to meander aimlessly over a region with faint slope, being turned aside by the slightest obstacle, as a river through its delta or in its extension across a level, recently elevated above sea bottom.

Lying well above the alluvial lands to the east, these "bluff" lands are capable of complete and thorough drainage.

Inasmuch as the eastern margin of the "bluff" is highest (being probably the natural levee along the western bank of the ancient Mississippi) and slopes gently to the west, the natural drainage of this region is westward into the "coulees" and "marais," and through those into the headwaters of the Mermentau, Vermilion or some of the shorter coastal streams.

These "coulees" and "marais" are remnants of old, abandoned river channels, that by their clogging have frequently produced extensive high level swamps.

Their meandering beds are seen in considerable numbers from Washington southward beyond Jeannerette, reaching their greatest development in Grand Marais south of New Iberia. It would appear that during the emergence of the "bluff" lands of this region, the Mississippi, during high floods, discharged waters to the southwest across these areas; but with further elevation, combined with decreasing volumes of water in the Mississippi, these channels were permanently abandoned, and gradually developed into the "coulees" and "marais" of to-day.

The "pine hills" of this section present no essentially new features from those of the Florida Parishes. The topography is mature, and the streams occupy their pre Columbian valleys. Erosion now goes on very slowly, and the streams are prevailingly clear and limpid. The same steep slopes of tributary streams, with their ultimate branches beginning with the peculiar "bath-tub" depressions are seen here as east of the Amite.

The "pine hills" here occupy the northern third of Calcasieu, the northwestern corner of St. Landry, most of Vernon, and Rapides parish with the exception of a zone of Red River alluvium about twelve miles wide, that crosses the parish in a northwest and southeast direction, and divides the hill section into two parts, occupying the northeastern corner and western half.

The "prairies" of Southwest Louisiana are worthy of being placed as a distinct class among the topographical features of the State. They have no counterpart in the State east of the Mississippi river, and only detached and very small homologies in other parts of the State. With their stream accompanying, narrow strips of hardwood trees, they constitute about one-half of the area between the base line and the sea marsh, into which they pass imperceptibly. With the exception of marginal strips of timber bordering the sluggish streams, they are treeless. They are probably contemporaneous in origin with or perhaps a little younger than the pine flats, from which they differ chiefly in the character of their deposits. For the most part level and poorly drained, their natural drainage lines seem to be inheritances from their former marsh condition, when they existed as marsh bayous, similar to those of the coastal marsh of to-day.

As all streams, even to their remote beginnings are tree-skirted, it would suggest that the prairie condition is a result of want of drainage.

Two special topographic features are prominent throughout the prairie region; in the west *mounds*, in the eastern part *natural ponds*. These are so noticeable, and in the case of the mounds, play such an important part in giving character to the region, that they deserve special consideration.

THE MOUNDS.

Though not distinctive of the prairie, as these mounds extend throughout the pine flats, into the sea marsh and even into the pine hills, they attain their greatest development in the prairies around and near the sulphur mine in Calcasieu parish. From this point as a center, these mounds become gradually less numerous and smaller in every direction until at a distance varying from 25 to 75 miles they cease to be of sufficient development to attract attention. Their limits are further in an east and west direction, extending eastward almost to Abbeville and westward far into Texas. In the direction of the pine hills the mounds extend beyond the flats, being found farthest along the bottoms of the larger streams. To the south, southeast and southwest they extend far into the sea marsh, but their limits in these directions have not been traced.

In their greatest development they may be fifty feet across the circular base, and their rounded dome like tops rise ten feet above the surrounding prairie; this after long erosion and tramping by the hosts of cattle and buffalo that have pastured here, and sought them because of their dryness and superior grass.

In structure they are found to be much more sandy than the surrounding land, and the deposit of calcareous clay that is found as a subsoil throughout the prairie is absent in them.

Always in zones and often in lines, many times having the appearance of being artificially laid out in intersecting systems of lines, they are never found solitary.

Several explanations have been offered to account for them, but as yet none has been generally accepted.

Immigrants from the northwest, having seen mounds accumulated by the winds about some obstruction, as a bush, have attributed them to wind action.

Their resemblance to colonies of ant hills seen in certain parts of the world has caused them to be attributed to these insects; and the fact that ants are found at the present time occupying some of them gives color to this explanation.

Dr. Hilgard accepted this as unquestionably the explanation of their origin, as shown by the following extract from his report of a "Geological Reconnoissance of the State of Louisiana." Speaking of "Prairie Faquetyke" he says:

"On this prairie we first observe, in considerable numbers, those singular rounded hillocks which dot so large a portion, both of the prairies and the woodlands of Southwestern Louisiana, and adjoining portions of Texas. With a maximum elevation of about two feet above the general surface, they have a diameter varying from a few feet to twenty or thirty; their number defies calculation.

"They do not show in their internal structure any vestige of their mode of origin; or rather, being totally devoid of structure of any kind, they merely prove by their material that there has been a mixing up of the surface soil with from two to four feet of the subsoil. They are altogether independent of formations underlying at a greater depth, and it seems impossible to assign to them any other origin than that historically known of their brethren in Texas, viz: that of *ant hills.*

"As to the physical or moral causes of the wholesale slaughter or emigration of this once teeming population, deponent saith not. Perhaps some of the aboriginal Attakapas tribes might, if consulted, still be able to bear testimony upon the subject."

Neither of these explanations will account for the gradual decrease in size and numbers as they are farther and farther from a given center, nor for their zonal and often linear arrangement; neither will they explain their more sandy character than surrounding surface deposits.

As coming much nearer their true explanation I quote the following from Dr. F. V. Hopkins' First Report upon the Geology of Louisiana. In speaking of the sulphur deposits of Calcasieu, found in boring for oil, he says:

The wells are bored in a marsh, often three feet under water. Now this marsh is dotted in every direction with mounds, generally circular, and from thirty to fifty feet in diameter and from three to five feet in height. Their appearance is singular, and is rendered yet more effective by the fact that while nothing but marsh grass can grow between them, they are covered with luxuriant clumps of timber trees, whose grouping could not be excelled by the best landscape gardener. These mounds are not peculiar to this marsh, but are widely scattered over our prairies, and the lower parts of the drift; * * * but they are larger and more numerous here than elsewhere. In structure they are always more sandy and porous than the surrounding soil. These phenomena admit of explanation upon theories already accepted by scientific men * * *.

"We have examples at the mouth of the river of the force exerted by the gases arising from the decay of buried driftwood. I refer to the formation of the "mud lumps" at or near the passes. These are described by Thomassy as heaped up by the continual flow of water and inflammable gas, i. e., marsh gas, bubbling up from a great depth, and bringing with them the lead colored clay of which they are formed. When the delta shall have made out past these mud lumps, and the decay of vegetable matter shall have been complete, the appearance presented will closely resemble that now seen in our "pimpled" prairies, and especially the marsh above the sulphur bed.

"The mud lumps will no longer have each its formative stream of gas and water, but will be mounds in a level, alluvial formation. The varied phenomena of the region thus aid in explaining each other. The sulphur was formed by reducing the gypsum with the vegetable matter. The carbonic acid, olefiant gas and marsh gas produced by the process have each left the appropriate proof of its presence, i. e., the limestone stratum No. 5 contains the former, the petroleum is made of the olefiant gas, and the mounds are the vent holes for the latter."

Now, however close the analogy in origin of these mounds to that of the mud lumps at the mouth of the Mississippi, their composition and structure both point to a force acting from *below*, and similarity of the underlying deposits to those of the cretaceous ridge which terminates southward in Belle Isle, where undoubted disturbance has occurred, suggests that here, too, earthshocks were produced, with more or less fracturing of the strata. Such fractures would radiate and rebranch from a central region, and along the radial and branching fractures the gases would find an easy passage, and above them, around the vents through which they reached the surface, mounds would be produced.

This would easily account for the zonar and linear arrangement of these mounds, and likewise for their composition and structure, the excess of sand coming from the underlying Lafayette.

If ants have to any considerable extent occupied these mounds I think the explanation of such occupancy in the past may be found in the fact that then, as now, these were the highest and driest spots in the region.

In Texas, forty miles southwest of Sulphur Mine, these mounds are found, and many of them are capped by ant colonies, while no such colonies are found in the surrounding intermound prairie.

Agriculturally these mounds exert a strong influence. In those regions devoted to rice they are difficult to flood, and being sandy and without the substratum of clay, when levelled serve as a slow means of draining off the flooding waters. On the other hand, for those crops that do not require flooding, these mounds and their immediate vicinity offer the most desirable conditions.

NATURAL PONDS.

With the disappearance of the mounds in the prairies eastward appear numerous circular shallow bodies of water or "natural ponds." In area varying usually from half an acre to two or three acres each, they constitute as characteristic a feature of the landscape as the mounds further west.

Covered with water for the greater part of the year, even during the months of least rainfall, they are for the most part occupied by water plants, both shrubs and annuals. Into these the cattle wade to escape the troublesome flies, and upon leaving, carry away with them an appreciable amount of mud. This suggests their origin.

The region, naturally flat and poorly drained, had originally an irregular surface upon which water stood in pools. The region was once the pasturing ground for enormons numbers of buffalo. These seeking the pools in which water remained longest, would wallow in them in order to cover themselves with a protecting coat of mud against pestiferous insects as flies, gnats and mosquitos. This process repeated day after day for century upon century resulted at last in these "natural ponds," which in all respects resemble the "buffalo wallows" of the great Western prairies.

Being easily and completely flooded, where it is possible to drain the water off from these ponds, they make excellent rice fields.

The streams bordering upon and transecting Southwest Louisiana are all navigable in their lower courses, and most of them far into the region. All are characterized by deep channels through the "flats," "prairies" and coastal marsh until the point where tide water is usually met, when the stream shallows and spreads into a lake like basin, below which, and especially at the mouth where comparatively dead water is met, the rivers are much shallower, and navigation is greatly impeded.

Such lakes are Sabine, Calcasieu, Grand, an expansion of the Mermentau, and Grand in the Atchafalaya.

The government has spent, and is annually spending considerable sums of money to keep the river mouths or "passes" open to admit large steamers, but so far only poor success has rewarded the outlay, and now only a few light draft steamers ply these waters.

The coastal marsh, which is much more important in Southwest Louisiana than in the Florida Parishes, is but an extension of the prairies, and with a slight elevation of the land would become such. In their gulfward half they are marked by a network of interbranching bayous, with river-like width and depth and with vertical banks that rise from one to three or four feet above the mean level.

In width and depth these bayous might suggest an inheritance from a former geological period, when the attitude of the land was such as to permit the development of perfect systems of drainage, and of such duration as to allow the streams to cut their beds deep and wide. Yet such inheritance is not at all probable, and the bayous are most certainly developments in the marsh itself.

With every incoming tide thousands of square miles of marsh are flooded, and with the fall of the tide to a considerable extent drained. The conditions being favorable to the growth of a multitude of marsh reeds and grasses, the entire region is covered by a dense growth and accumulation of vegetable matter, which retards both the flooding and draining of the marsh. Such obstruction being unevenly distributed, the inflowing and outflowing tides will follow the line of least obstruction, and thus we have the genesis of the bayou.

No sediment is brought to the region nor carried away from it save that gathered along the line of drainage itself; and as the energy of the current is reserved almost wholly for the work of erosion, down to a certain limit the depth of the bayou will be increased by every incoming and outgoing tide. The sediments gathered from the bayou bed by the rising tide are spread over the surrounding marsh, but most along the margins of the bayous themselves, the greatest check in the current being there. On that account we find the bayou margins higher than the further removed swamps, or the "front" and "back" lands so well recognized by all residents of river basins that are periodically flooded.

The sediments eroded from the bed by the outgoing tide are deposited near the mouth of the bayou, and in this they resemble all rivers reaching the gulf from the interior; becoming rapidly more shallow as they enter or near the gulf.

The course of the marsh bayous being a matter of accident, and in nowise dependent upon the inclinations or character of the deposits into which their beds are eroded, they branch and interbranch in the most perplexing manner; producing a maze of channels which can be traversed only by the aid of a chart.

True, by following the current at ebb tide one would come eventually to the gulf, but at what particular point, unless perfectly acquainted with the marsh it would be impossible for him to predict; for connecting cross-bayous are frequently wider and apparently of greater extent than those that reach the gulf.

One of the most notable features that breaks the monotony of the almost featureless topography of the coast marsh is the series of long, narrow, bar-like islands in the southern half of the marsh; which, because of their usual growth of live oaks are known as "chenieres." Their slight width and general parallellism to the coast, as well as their composition and structure proclaim them to be homologues of the shell beaches that are forming in various places along the present coast. They support a considerable population, whose chief occupation is the herding and shipping of great numbers of half wild cattle that thrive and fatten on these marshes.

The coast marsh occupies almost one hundred sections of land west of the Atchafalaya river, and is in general about thirty miles in width. Many thousand acres in Calcasieu and Cameron parishes have been reclaimed, and are now in profitable cultivation. Hardly an acre of this land but is likewise reclaimable, and when so reclaimed will take its place among the most desirable agricultural sections of Louisiana.

Concerning the five "islands," Orange, Petite Anse, Grand Cote, Cote Blanche and Belle Isle, which rise as lone sentinels in the midst of the coast marsh or on the margin of the prairies, their description is reserved for a special section.

GEOLOGICAL HISTORY.

The Florida Parishes are a part of the coastal plain that borders the Atlantic Ocean and Gulf of Mexico from New England to and beyond the Rio Grande river. The coastal lowland, averaging about 150 miles in width may everywhere be divided into two and often three distinct types of topography.

The "low grounds" of the Carolinas and the "pine meadows" and "pine flats" of Alabama, Mississippi and Louisiana constituting the seaward division of the coastal plain are, as has been described, topographically young. Their illy drained areas extend up all the transecting primary streams and many of the secondary.

The landward division of the coastal plain is topographically mature. Its perfectly drained surface is made up of a succession of hills and ridges whose even crests show them to be the tattered remnants of a former peneplain.

The third type of topography is found as bordering zones along the great streams whose tributary sources were in the regions of the northern continental ice sheet. While the sediments constituting the strata of this type were deposited quite as late as those of the pine flats, yet the attitude of the land is such that topographic forms have been of rapid development, and the topography of these areas is not inaptly styled adolescent.

This coastal lowland, constituting the most recent important addition to our continent, belongs to the *Lafayette* and *Columbia* formations.

These formations, recent subdivisions of the *Orange Sand* of Hilgard and other geologists who studied this region, while not fully determined as to exact geological position, are probably late Tertiary and Quarternary. Being almost destitute of fossils, biologic criteria cannot be used in fixing them in the geologic section, and resort must be had to the principle that "geologic history may be read from the configuration of the land as readily as from the contemporaneous rocks and fossils." This being the case a geologic province should include alike the areas of degradation and concurrent deposition.

This new significance of topographic forms enables us to correlate widely separate deposits by means of their concurrent, intermerging area of degradation. It is now recognized that any formation "represents a series of deposits laid down by a definitely limited set of agencies in a definitely limited area within a definitely limited period of time;" and that it "thus expresses tangibly certain conditions of a certain part of the continent during a certain period of geologic time."

The Lafayette formation must therefore be studied alike in the deposits of clay, sand and gravel, and in the vastly degraded region which furnished these materials; and the history of the Columbia formation is read equally well in the deposits of the time and in the deeply eroded strata of the Lafayette.

Both Lafayette and Columbia formations are well developed in the Florida parishes. The Lafayette constitutes the "pine hills," with the exception of a thin veneer of yellowish brown loam, and extends beneath the Columbia in the flats. The Columbia formation is chiefly confined to the "pine flats" and "second bottoms" of the streams; but in its upper member, the yellowish brown loam, spreads mantlewise over all the hills.

BRIEF HISTORY OF THE LAFAYETTE FORMATION.

While the geologic age of the Lafayette formation has not been exactly determined, this much is definitely known: It is directly overlain, though uncomformably by the Quaternary Columbia, and underlain, with similar unconformity, by the Grand gulf and other formations of Tertiary age. There is reason to believe that it forms a connecting link between these geologic periods, and belongs in part to both. Of its general characters and distribution, the following from the Twelfth Annual Report of the United States Geological Survey,* very accurately describes the formation in the Florida parishes:

"The Lafayette formation may briefly be described as an extensive sheet of loams, clays and sands of prevailing orange hues, generally massive above, generally stratified below, with local accumulations of gravel along waterways. The deposit varies in thickness with the strength of local streams; and the materials combine the characters of the areas drained with those of the underlying formation. On the whole the formation is so characteristic as to be recognized wherever seen. This formation is "the most extensive in the United States" and "is more uniform, petrographically, than any other formation of even one fourth of its extent."

"In general distribution the formation is known to expand and strengthen southward from a few isolated remnants crowning the central axis of peninsular New Jersey, a few miles south of the Raritan, to a thick deposit forming a terrane 40 or 50 miles wide on the Roanoke; to expand thence southward, in a broad zone, at first widening, but afterward narrowing with the encroachment of the overlapping coastal sands upon its area, quite across the Carolinas; to form the most conspicuous terrane of Central Georgia, where it strethes from the Falls line to the inland margin of the coastal sands all the way from the Savannah to the Chattahoochee; to again expand greatly in Alabama with the contraction of the overlying coast sands until it forms an essentially continuous terrane, stretching from the fall line at Montgomery and Tuscaloosa to the waters of Mobile bay and to within a dozen miles of the gulf in the southwestern corner of the State; to expand still more in the Mississippi embayment until it overlooks the great river in a practically continuous scarp from Baton Rouge to the mouth of the Ohio; to reappear in extensive remnants beyond the Mississippi in Central and Southwestern Arkansas; and to extend over a vast area in Northwestern Louisiana and Southeastern Texas, and almost certainly to stretch thence southwestward in a con-

*The Lafayette Formation—W. J. McGee.

tinuous belt toward the coast and as erosion tattered remnants inland, quite to the Rio Grande."

"If the direct observation be supplemented by legitimate and necessary inference, the formation must be so extended as to bridge the valleys from which it has been degraded and stretch beneath the various phases of the Columbia formation well toward the Atlantic and gulf coasts."

"With this inferential extension the field of the formation becomes co-extensive with the coastal plain of the Atlantic and gulf slopes (including perhaps Florida) and assumes an area of 200,000 or 250,000 square miles. Over the whole of this vast area the Lafayette formation must originally have stretched, and over all of this area, except in the deeper Mississippi embayment and in the southwesternmost gulf slope, it must have possessed the wonderfully uniform composition and structure exhibited to-day by its stream carved remnants."

The Florida parishes lie wholly within the area above described, and though veneered or deeply buried by the later Columbia formation, undoubtedly have for their foundation the deposits of the Lafayette. In the pine hills of the northern section the thin coating of Columbia deposits is readily cut through, and the characteristic Lafayette is displayed in all the road cuts and washes.

The streams, though having their valleys eroded in the Lafayette, usually run through alluvial deposits of their own recent formation, so that few sections of this epoch are seen in their banks. Though deeply dissected by them, no evidence was discovered of any of the streams bordering on or extending into this region, except the Mississippi, having cut entirely through the Lafayette and revealing the underlying Grand Gulf formation.

The Pearl river, the second deepest and most active stream of the region, where it is deflected against the hills in Northeast Louisiana, displays in its bank characteristic Lafayette deposits and nothing lower.

The materials of the Lafayette, as a rule, are not far travelled, being largely from local sources. Only in the vicinity of considerable streams that have their sources far in the interior of the continent do we find materials that cannot be traced to their nearby source.

The numerous lines of pebbles observed in the red sandy clay and loam are as a rule subangular, thus attesting their brief journey. They are generally cherty in character. In the pebble beds near the large streams these are mixed with much more rounded pebbles of quartz, agate, jasper, and frequently of crystalline rocks that are found far to the north. Their rounding betrays their long journey, and their mineral character proves them strangers to the older neighboring terranes.

By far the greater portion of the materials of the Lafayette formation is sand mixed with red loamy clay. This constitutes more than three-fourths of the deposit. The color, red at the surface, grading into buff below, is due to the oxides of iron so abundant in all the newer deposits of the coastal plain. The red color of the sand and pebbles is not inherent, being imparted by the iron as a coating, and may be washed away leaving beautiful snow white sand banks.

This disseminated iron often becomes concentrated into nodules and shells, or as a cement forms the beds of iron conglomerate so common at or near the surface in the hills of the Florida parishes. The beds of sand and pebbles often show cross-bedding and frequent partings of clay. This variation in structure and materials indicates varying and fitful currents and wave-action.

The vast accumulations of sediments in the brief epoch of the Lafayette formation suggests two opposite and consecutive conditions: a pre-Lafayette depression of the continent to the north that brought the surface so near to the base-level of erosion that rocks were removed by the greatly reduced activity of the streams; followed by an upward oscillation about an axis at first within the land but which migrated far to the southward.

The low altitude of the sediment producing land and sluggish character of the streams of immediately free pre-Lafayette time is shown by the fine-grained character of the underlying

Grand Gulf formation, and the deeply weathered but unremoved rock materials in the areas which furnished sediments for the Grand Gulf strata.

The subsequent upward swing about an axis at first within the continental limits is indicated by the renewed activity of the streams which deeply eroded the Grand Gulf formation, and the gradual encroachment of the Lafayette sediments upon this eroded surface.

That the Lafayette sediments were deposited first upon a *sinking* area is indicated by the underlying coarse sand and pebble bed; and that the formation closed upon a *rising* surface is equally clearly indicated by the capping of conglomerate so common throughout the region.

It would seem highly probable that this *continued* elevation during later Lafayette deposition and erosion is that which raised the continent to such an altitude as to make the accumulation of ice of the Glacial Period possible.

This shifting of the axis of oscillation from an interior position southward will explain the greater thicknesses of the formation toward its interior margin than nearer the coast. What the extent of the migration was is not known.

If, as Dr. J. W. Spencer's studies in the West Indies* seem to prove, those islands became part of the continent and received Lafayette sediments, the axis must have shifted to a position far south of them. It will oppear that the Columbia formation seems to have been formed first upon the rising and later upon the sinking surface of the Lafayette.

The unequal heights at which Lafayette sediments are found is due in part to unequal erosion and removal, but in much larger part to a slight warping during oscillation. A notable feature of the formation is the greatly decomposed, semi angular pebbles of chert, feldspar, and other silico-aluminous minerals. These contribute largely to the mottled appearance of sections, and are sometimes of sufficiently large deposits to be of economic importance. While their decomposition has unquestionably continued since deposition in their

* "Reconstruction of the Antillean Continent."—J. W. Spencer.

present position, it is quite probable they were in a high state of disintegration before removal from their parent source.

BRIEF HISTORY OF THE COLUMBIA FORMATION.

The geologic position of this formation is above and contiguous to the Lafayette, upon which it rests uncomformably. Its age is almost certainly Pleistocene Quatenary.

Though in its upper members, the brownish-yellow clayey loam and loess, extending over the hills of most of the area of the Lafayette, in the main it is a valley and low level deposit, which partially fills the deeply excavated valleys of the Lafayette erosion, and laps upon the slopes of its thousand hills.

With the retreat of the axis of oscillation southward during the closing stages of the Lafayette, when the continent was reaching its greatest altitude, the materials from the eroded Lafayette and other formations began to be deposited upon the yet rising slopes of the Lafayette.

In Louisiana these materials constitute the basal pebble and gravel bed of the Columbia formation.

While the continent stood at this great altitude, which enabled the enormously more active streams to cut deep and wide their old channels, it is probable that the ice of the Glacial period accumulated, and inaugurated the continental subsidence which succeeded that period. At any rate subsidence began, and during the remainder of the Columbian period its sediments appear to have been deposited upon a *sinking* bottom.

The streams, though weakened by reason of decrease of slope, seem to have been greatly strengthened in volume from the melting ice in the North, and their waters came sediment-laden with the rock flour of the glacial mill. This sediment, mixed with the finer materials furnished by local land areas rapidly silted up the lower stream beds, and the materials deposited at their mouths were distributed by the waves and currents along the shore, forming a broad, submarine terrace.

In this we have the Port Hudson group of clays and the broad stretches of "pine flats" in their greater part.

With further subsidence and submergence of local land areas, local supply of materials was greatly diminished, and only "rock flour" from the glacier region, and materials from the upper courses of the now sluggish streams were furnished. These form the brownish-yellow clayey loam and loess, the upper member of the Columbia formation.

These in varying proportions and relative positions, showing their contemporaneous origin, form the surface deposits over the region described, save in the river bottoms where the deposits are annually forming over the flood plains of the streams.

The volume of the upper Columbia deposits seem to have been a function of the vigor of the producing streams; and as local supply was reduced, only the Mississippi seems to have been effective in producing the final upper member, the loess, of the region.

This deposit of glacial materials, collected by the great northern branches of the Mississippi, which sent their feeders into the glacial field of Northern United States, was formed as a broad natural levee upon the submerged banks of that stream. This is the so-called "bluff" of West Feliciana, East Baton Rouge and Livingston parishes.

The "bluff" is absent from the banks of the Amite, Tangipahoa and Pearl, for the reason that these streams did not have their headwaters in glaciated regions; or at any rate not in regions of the great continental ice sheet which furnished these deposits to the Mississippi.

That the axis of oscillation still remained far to the south during all this period of subsidence is indicated by the deeply drowned valleys in the West Indies made in Lafayette deposits.

Characteristic of the upper members of this formation are the *vertical walls* and steep slopes where erosion occurs. These remain for long periods without crumbling, probably owing to the fine grained, homogeneous character of the deposit. Though yielding readily to the action of sediment-charged flowing streams, the ordinary processes of weathering are very slow.

McGee says of this "loess" deposit: "As usual it displays the paradox of friability so perfect that it may be impressed by the fingers, combined with obduracy so great that it stands in vertical cliffs for a decade without even losing the marks of spade and pick."

This of course only in the Southern section of this deposit where frost is seldom formed.

The Columbia formation thus presents four distinct phases:

1. The *basal gravel* deposited upon and contiguous to the capping conglomerate of the Lafayette as subsidence began and the sea began to encroach upon the land; and when the continent still stood at a great altitude.

2. The *Port Hudson clays*, a valley and low level deposit upon the still subsiding Lafayette, which clogged the rivers and spread along the coast producing the broad flats.

3. The *brown loam* which mantled both hills and valleys when continued subsidence brought them below sea level.

4. The "loess" proper or "*bluff*," a product of the Mississippi river, the materials of which were obtained almost entirely from the glaciated region to the far North.

While these various deposits are characteristic phases of a practically continuous deposit, there exist, locally, deposits of gravel, sand, and clay derived locally from Lafayette strata and hardly distinguishable from it. The influence of local supply is best seen along the margin of the Lafayette hills. The basal gravel of the formation except along the larger streams, is plainly local, or at least not far travelled; whereas the later members were increasingly foreign in the origin of their materials.

Southwest Louisiana, excepting a few very limited and detached areas, belongs like the Florida parishes to the Lafayette and Columbia formations. While just north of this region outcrops of the underlying Grand Gulf formation are found; and extending through it in a northwest and southeast direction, from Belle Isle in the southeast to Chicot in the northwest, is what has been termed a "Cretaceous backbone," these formations are on the whole so deeply covered by Quaternary sediments as to exercise little or no influence upon either topography or soil.

While perhaps effective during Lafayette and earlier Columbia times in *directing* the courses of the sediment-bearing streams, this cretaceous ridge, if it existed, furnished little material for later deposits, and for the most part was in an attitude to receive sediments, even so large as coarse gravel and pebbles; as attested by the beds of that character found more than 150 feet above the gulf level on Petite Anse and others of the five islands.

Though of the same geological age as the surface formations of the Florida parishes, the difference in character of the soils is marked and distinctive. This difference is not one resulting from a difference in the attitude of the bottom receiving sediments, but rather a difference in source for these sediments.

Geologically this section offers little additional to the results obtained from a study of the Florida parishes. The "pine hills" are Lafayette clays and sands, of the prevailing red and yellow colors, and contain the same subangular cherty pebbles. In Calcasieu as in St. Helena, wells are sunk to the basal gravel bed of the Lafayette which is found at depths varying with surface topography from 50 to 150 feet, and which always furnishes an excellent and unfailing supply of water. In such wells the upper, massive member of the Lafayette stands indefinitely without curbing, while the lower, sandier and stratified member requires to be curbed.

East and south these deposits sink beneath the prairies, and though too deeply buried to affect surface conditions may be found in Artesian wells.

The most southerly point at which these Lafayette sands and clays may be seen, is upon Belle Isle. This in common with the other four islands to the northwest, Cote Blanche, Grand Cote, Petite Anse and Orange, display Lafayette gravels and sandy clays in their sections, underlying later Columbia deposits; all of which show disturbance since their deposition. We will find, when we come to treat of these islands more in detail, that these sediments have probably been raised to their present height since the time of Columbia deposition, rather than deposited mantlewise over hills of cretaceous rock produced by differential erosion.

The origin of Lafayette materials was the local and not di tant land areas to the north, and their carriers were probab streams of rapid and somewhat local development, rather tha any of the present streams of the region.

There is a slight difference in the nature of the pebbl from those commonly found in the "pebble streams" of Ea Feliciana and St. Helena, that might suggest a slightly differe source.

Common among the pebbles east of the Mississippi a cherty casts of palæozoic fossils; and similar fossiliferous pe bles have been found in Southwest Louisiana.

As the Mississippi river undoubtedly existed in Lafayet times, it seems hardly probable that any considerable quantit of pebbles were carried across this broad basin from the Nort east; and we are to seek the source of these materials in t older terranes west of the Mississippi rather than east of th stream.

No other present stream of the region seems to have existe in pre-Lafayette times.

The Red river, that plays so important a part in the rece development of topographic form in Western Louisiana is post-Lafayette, and possibly of late Columbia origin; at an rate it cuts through all the deposits of both, and its valley d posits are later than the "loess."

The Columbia formation of Southwest Louisiana, while i general like that of the Florida Parishes, is not the latest d posit over most of the area over which it occurs.

The Port Hudson group is found in the substratum of cla in the pine flats, and at a greater depth beneath the prairies ar coast marsh.

All artesian wells pass through it, and it has more tha once been mistaken for the Lignitic Group. Only in the fla and along the margin of the prairies is it near enough to t surface to make its presence felt in the soil; but along t eastern border of the "bluff," as at New Iberia, its clays a worked for brick.

Where near enough to the surface to affect the soils, they are considered cold and unresponsive.

The brownish yellow, clayey loam is found over all the region south and east of the hills and flats and extending to Bayous Cocodrie, Cortableau and Teche; or over the distinctively prairie section of the State. Though not the surface deposit—and in that it differs from the similar deposit of the Florida Parishes—it lies near enough the surface to give character to the soil, and within reach of the plow.

It extends at a slightly increasing depth beneath the coastal marsh, and may be recognized in the banks of all rivers and bayous, as also in the deeper ditches artificially cut for embankment or drainage.

This stratum is rich in lime; and this has collected into irregular concretions that are similar in character and origin to the concretions found in the true loess. These are the "children of the loess" of the Germans, and they make this deposit easily recognizable wherever seen.

On either side of the Salt Mine Railroad where it crosses the marsh this concretionary stratum outcrops in the ditches; and in the ditches produced in building the embankments for irrigating canals east of Lake Arthur, and in grading the streets of Lake Charles, the same stratum is cut.

This deposit thickens toward the east, and is found in its greatest development and with its upper silt member along the zone extending southward from Washington, and overlooking in a scarp, the alluvial lands of the Mississippi and its tributary and accompanying streams.

This, together with a similar thickening of the same deposit of the Florida Parishes toward the Mississippi river, suggests very strongly that the upper members of the Columbia are the product of this stream.

That the broad valley between these eastern and western "bluff" deposits, now occupied by the Mississippi and Atchafalaya rivers, and a score or more of bayous, with their respective "bottoms" is the valley of the greater Columbia-producing Mississippi, seems highly probable.

The general parallelism of the erosion tattered remnant on the west side with the continuous scarp on the east; and th presence of the similar "loess" deposits in front gradin rapidly into the yellow loamy clay farther back, both point t those as the probable riverward limits of this deposit.

That the main current of the greater Mississippi or th river in a more contracted form has at different times occupie various positions within this broad channel, is shown by th three distinct and deeply submerged channels* extending acros the coastal shelf between Belle Isle and Lake Pontchartrain made when the continent stood at a greater elevation.

The axis of oscillation during post-Columbia elevation seems to have been northwest and southeast; so that even after th Florida Parishes were raised above the gulf level, Southwes Louisiana continued to receive sediments, and the surface, chocolate colored loam, was deposited over the prairies and mor thinly over the pine flats.

Probably at this time the principal current of the contracting Mississippi was directed against its western bank—not ye emerged—and the numerous coulees across the "bluff," sout of Washington, were produced.

With continued elevation to the southwest, the Mississipp gradually shifted the current of its contracted volume towar the eastern bank, until it impinged against the "bluff" escarpment of the Florida Parishes.

To what extent the river, with its present volume, is able t shift its bed by reason of meanderings and cut-offs may be show by lines drawn tangent to the outer bends of those abandone sections, or "horse shoe" lakes.

These will show that the river with its present volume ca never migrate far from its present position, unless aided by differential elevation of its banks; and therefore it has been shifte to the eastern side of its valley by such elevation.

Perhaps second only in importanee to the withdrawal of th Mississippi as an active geological agent in Soutwest Louisiana

*See map accompanying Dr. J. W. Spencer's "Reconstruction of the Antillean Continent."

by elevation to the southwest and west, was the development of the Red river and its possible diversion from a southerly outlet into the gulf.

That the Red river has been at some time a much larger and more active stream is shown by its broad valley and the multitude of lakes in Northwest Louisiana produced in its sometime strong tributaries by clogging of the main valley.

Certain clays worked at Lake Charles, from a pit not far from the Calcasieu have suggested to me that possibly the earlier Red river might have found an outlet by way of the Boeuf and Lake Cocodrie into the gulf along the route of the Calcasieu. These clays are very like undoubted Red river clays, worked at Washington from the banks of the Cortableau.

With the elevation to the southwest the course of the Red river was changed (if indeed it had a southerly outlet) and a new channel was cut through the yellow loam deposits of the western escarpment of the Mississippi, and old abandoned channels of that stream, as the Teche and Atchafalaya were occupied. These streams give evidence of that occupancy in the veneering of their beds, especially the Teche, by a stratum of unquestioned Red river sediment. In times of excessive floods in the Red river, the surplus water found escape through the Vermilion and Mermentau which find their sources in the coulees of the prairies east and north. Both of these rivers display Red river sediments in their banks.

Even yet, during excessively high water in Red river, some of the overflow finds an outlet through Vermilion river.

With further elevation in the southwest, the Mississippi continued to shift eastward and the Red river northward, sweeping away as its channel migrated, the broad zone of yellow clayey loams of the Columbia, leaving only here and there, as in Northeast Rapides and Northwest Avoyelles, tattered remnants or "islands."

With the Red river as with the Mississippi, the shifting of the current seems to have been accompanied by a decrease in volume ; and the supply of sediments, while lessened seems not to have kept pace with the decreasing volume, and there resulted a clogging of the lower valleys with sediment—in the Mississippi chocolate colored, in the Red a bright vermilion.

It is this chocolate colored loam, supplied by the Mississippi and spread over a shallow marsh, that forms the surface layer of the prairies of Southwest Louisiana.

One of the effects of this clogging of the main valley of the Red river was the production of lakes at the mouths of its tributary branches. Such are Sabine lake, Black lake, Lake Bisteneau, Lake Bodcau, Bayou Pierre Lake and many others.

III. SOILS.

Soils are the residual product of the weathering of rocks. They may be produced where found, but more often are removed from their place of origin. The agents of removal are *gravity*, *wind* and *running water*.

Under the influence of gravity all soils *creep* down the slopes upon which they lie. This process goes on continuously as a result of variation in temperature, and is most pronounced in latitudes and regions where range of temperature is greatest. If frost is formed creeping is greatly accelerated.

In northern regions, mountainous or hilly regions, and regions of crystalline rocks this is an important factor in soil formation and soil removal.

The wind is likewise an active agent in soil removal, especially in those regions that have a distinctly dry season.

The power of the wind to lift and transport particles of considerable weight during storms, and especially whirling storms, is recognized by every one ; and those who have seen the coarse sand of the northern lake beaches piled 200 feet high, overwhelming forests and villages, recognize in the straight, steady wind of considerable velocity an active and powerful transporting agent.

Pebbles upon the seabeach, worn by wind-driven sand into angular and fantastic shapes illustrate the efficiency of the wind when surcharged with sediment, as an agent of erosion.

The custom in certain parts of the country of building residences and planting orchards upon the highways illustrates the forced recognition of the wind as a transporter of dust.

But it is from the wind swept prairies of the northwest, where during the frequent long droughts it is necessary to protect the cultivated lands from the denuding action of the winds by planting in narrow strips separated by strips of meadow turf, that we glean the most important lessons concerning the wind as a geological agent.

By far the most important agent in soil production, soil removal and distribution is running water.

Physical agencies combine with chemical to break down all surface rocks, and reduce them to a finely divided condition.

This weather rock is soil; and while in the main partaking of the parent rock, always loses something in solution and may likewise gain other elements during transportation and deposition.

According as soils are found where formed, or at most only slightly shifted by gravity and wind; or are transported by and deposited in running water, and hence show some degree of stratification, they are *colluvial* or *alluvial* soils.

The soils of our ridges and hill slopes belong to the former class, while our valley soils are alluvial. These groups are necessarily indistinctly separated, and all degrees of inter-gradation exist.

All soils may be considered as composed essentially of *sand clay* and *vegetable matter*; and the predominance of these elements respectively gives the classification of soils as *light* (sandy), *heavy* (clayey), and *humus*.

This classification, chiefly upon physical characters, is of the greatest importance, inasmuch as our treatment of any soil must be largely determined by our recognition of its belonging to one or the other of these groups.

While depth and character of any soil are largely affected by topography and climate, yet there are few *virgin* soils that have not in them the necessary elements of plant food. We are chiefly concerned in knowing how to *preserve* and to *increase* their producing power.

Aside from the withdrawal of plant food by growing crops the chief loss of fertility in the soil is due to *leaching*, or the removal of elements of plant food by solution in water percolating through the soil. The lighter or more sandy the soil the greater the liability to leach.

On the other hand heavy or clayey soils are apt to be unproductive because of lack of drainage.

Whether decaying vegetable matter shall or shall not be a valuable element in the soil is also largely a question of drainage.

In wet, poorly drained land the result of decomposition is a brownish, partially soluble product that because of its acid qualities produces what is termed a *sour* soil which is unproductive.

In well drained land the decay of vegetable matter underground produces the black, insoluble *humus* universally recognized as giving fertility to the soil.

In the Florida parishes the three classes of soil mentioned are found over large areas.

From the nature of the deposit the greatest amount of humus is found in the soils of the river bottoms, especially the *first* bottoms, that are subject to overflow.

The "second bottoms" and "pine flats" while containing considerable amounts of humus are more especially characterized by the development of that distinctly clayey group of strata, the Port Hudson, which produces a heavy soil.

Moreover, much of the soluble plant food from the hill soils has been deposited there.

These all combine to make these soils inherently fertile or *strong*. This has long been recognized in the *modern* alluvial deposits over the flood plains of streams, but as yet unappreciated in the "flats" and "second bottoms" that constitute nearly one half of those parishes east of the Amite.

In their present undrained condition these soils are *sour* and unproductive. This can be completely corrected by *thorough* *drainage* and some addition of lime to assist in changing the brown, soluble humus into the true black humus desired.

When this is done these lands will become among the most valuable in the State.

Over the hills of these parishes, east of the zone of "bluff" bordering the Mississippi river, is spread a thin coating of brownish-yellow, clayey loam that is highly productive. Immediately underlying it at a depth varying from a few inches to a few feet is the much more sandy Lafayette; which, when it becomes the upper soil from removal of the yellow loam by erosion, loses its soluble plant food rapidly by leaching. Great care should therefore be exercised to preserve this protective coating from being removed by washing. This can be done by proper cultivation, and by resorting as much as possible to those crops that require the least stirring of the soil.

Cultivate the valleys, and reserve the steep slopes and ridges for pasture and meadow.

Throughout these parishes are found "old fields" aggregating thousands of acres, that were once productive, but lost their productiveness by inattention to this matter of preservation of the fertile, but easily removable coating of loam.

Along the banks overlooking the ancient Mississippi is found a soil, the loess or "bluff" which combines perhaps more of the elements of productiveness than any other soil in the State.

Being well above the flood plains of the streams it is easily drained; and containing much more of clay than sand it does not leach rapidly.

Rich in lime, humification, even in poorly drained areas, is rapid and of the desirable kind.

Yet, being so fine grained and incoherent, this deposit erodes rapidly, and the greatest care should be exercised to prevent this wastage by erosion.

Four classes of soils are then found in the Florida Parishes, corresponding to the three upper members of the Columbia formation, and the modern alluvial deposits in our river bottoms.

Each has its characteristic vegetation, which is probably in part a result of the chemical composition, and in part of the physical consitution of the soil and underlying subsoil.

The alluvial soils of modern formation along the streams are characterized by hard wood, deciduous and evergreen trees, with a thick undergrowth of shrubs and vines.

The pine hills west of the Amite, the "good uplands" of Lockett's map, are clothed with short leaved pine, generously interspersed with magnolia, oak and beech.

East of that stream the prevailing growth upon the hills is long leaved pine with sparse undergrowth of black jack oak.

Toward the Mississippi river, as the yellow loam thickens the pine gradully gives place to hard wood, and within the zone on Lockett's map marked "bluff," entirely disappears.

The soil of the "pine hills" is shallow, and the closely underlying deposit is a semi-indurated clayey sand rock, that is very impervious to the roots of trees. Uprooted pines show their central roots twisted and gnarled into a knotty mass.

Whether from lack of proper food elements, or as seems equally probable, from insufficient anchorage against strong winds, heavy topped, hard wood trees are wanting.

Black jack, and a few other scrubby representatives of the oak family constitute the group of hard wood trees in this region.

The area is practically exclusively occupied by splendid forests of virgin pine.

The warm, responsive, well drained soil is ideal for pasturage.

The "flats" bordering the hills have essentially the same vegetation as the hills; but as we approach the sea marsh the live oak makes its appearance and becomes a characteristic member of the flora.

Here, too, as in the alluvial swamps, we find the stream margins afford abundant bay, gum and cypress.

The "bluff" is covered with forests of hardwood; beech, magnolia, oak and hickory are the families chiefly represented, with a dense undergrowth of cane, dogwood, holly and numerous species of the haw family.

The better drained alluvial lands have much the same character of forest as the "bluff," though gums are much more abundant; while the swampy bottoms are given over almost exclusively to willow, gum and cypress.

Upon certain sandy bottom lands, as islands in the streams and recently formed land on the inner curves of bends of rivers; as also in certain regions where by a break of a levee a stream has suddenly spread a thick coating of sand over the bottom, cottonwood is abundant.

We are thus almost able to classify the soils in the order of their desirability by the character of the virgin vegetation.

In Southwest Louisiana all the types of soil found in the Florida parishes are represented. The "bluff" and "pine hill" areas are the same in both regions, but the "flats" are modified by a thin surface layer of the chocolate colored silt that overspreads the prairies. The treatment of these soils and their adaptibilities are the same as their homologues east of the Mississippi.

The so called "good uplands" of the Felicianas, while they have no representative in the Southwest country, are but an intermediate grade between the "bluff" and the "pine hills" and therefore cannot be considered a type.

Differing from any soil described, however, and peculiar to the southwestern section of the State, are the soils of the prairies.

Excepting the Red river and more modern alluvium, these are the most recent deposits in the State. When the rest of the State was above the Gulf level, this region was still receiving a deposit of silt-like loam from the increasingly sluggish current of the Mississippi. This chocolate colored silt, spread upon a stratum of the calcareous yellowish brown loam, in an increasingly marshy area, has produced one of the mort fertile soils in Louisiana. The upper stratum of silt, varying from two or three inches to a foot in thickness, while producing excellently as a virgin soil, by reason of its light, porous character soon becomes exhausted. On this occount many of these lands are held in low esteem.

There lies beneath, however, and within reach of the plow, the elements lacking to make these selfsame soils fertile, strong and retentive. The concretionary clayey loam, that everywhere constitutes the subsoil, if mixed with the chocolate loams produces a soil that as Lockett has expressed it is "good enough."

The admixture of the clayey loam has a twofold effect: by adding *lime* to the silt humification is accelerated and a blacker, more desirable soil produced; and by increasing the *clay* constituent the soil is made more retentive of easily removable plant food.

The old idea that *any* soil is inexhaustible in its fertility has occasioned deterioration in much of the most productive land of the State that will require years to correct.

All soils are not only exhaustible, but as a rule rapidly so; and unless their productive power is fostered and their fertility constantly renewed even the most productive become worthless.

The "black prairies" of St. Landry and the Attakapas country owe their color to the fact that the silt covering is sufficiently attenuated to place the calcareous substratum within easy reach of the plow even in ordinary cultivation. All these silt covered prairies would become equally "black" and productive with a like mixture of the clayey, concretionary subsoil.

Along the coulees and bayous are certain black or grayish black, waxy lands known as "buckshot" lands. These are very productive when properly drained and worked in season, but are difficult to cultivate, requiring often specially adapted implements.

So far as superficial examination could settle the matter, these are of the nature of swamp deposits; and are forming in many swampy regions in the Mississippi bottoms of to-day.

The Port Hudson clays, where deposited with sufficient quantities of vegetable matter would produce just such soils. Some of these may indeed belong to this group, but most of them are swamp deposits of more recent date.

The prairies, where level and imperfectly drained, are treeless; but along the streams there is a luxuriant growth of timber.

Back near the remoter beginning of the streams, where the prairies become broken into knolls, as in the northern part of

"Prairie Mammou" and "Pine Prairie," the long-leaved pine is gradually extending its dominion and occupying the region.

As we pass westward into the region of the mounds or "pimpled prairies," the soil becomes more and more sandy—the sand furnished by the mounds themselves.

This sandy soil is most excellently adapted to the production of small fruits, and many vegetables. Some of the most luscious pears and peaches I have eaten in Louisiana grew upon these "pimpled prairies;" and the splendid dewberries and blackberries that come spontaneously in neglected fields and by the roadside everywhere give ample proof of the suitability of the soil for this class of fruits.

Vegetables of the cucurbit family, as watermelons, musk-melons, cucumbers, etc., find here a most congenial home; and when more direct communication with northern markets is secured must become an important product of the region.

For the present these soils are very largely *compelled* to produce rice, though much better adapted to a score of other products.

In the regions of the bayous, *e. g.*, the Boeuf, the Cortableau and the Teche; and as we approach the coastal marsh, where the streams annually or periodically overflow their bottoms, there is always a marked difference in the "front" lands and "back" lands.

Both are the gift of the streams; but the front lands are coarser grained, sandier, and higher than those farther back. They form a broad, low natural levee upon either side of the stream ;and are always selected as residence sites, because better drained and healthier.

Before the State was divided into townships and sections, "grants" were laid off with so many *arpents* frontage upon these bayous and so many *arpents* deep. Upon the front lands the homes were built, and the back lands reserved entirely for cultivation.

This natural distribution of the sediments by a stream upon its flood plain is based upon their weight and size. The coarser, heavier particles are dropped where there is a maximum checking of the current, *i. e.*, along its banks; and the finer loams and clays are carried to the quieter waters farther back. The soils of the "back" lands are therefore finer grained and more clayey, and at the same time less easily drained. Though of similar origin and but different phases of the same formation, these two classes of soils are as a rule so unlike as to require entirely different methods of cultivation.

The front lands are light, easily drained and responsive; the back lands heavy, wet and cold. The first consideration for these latter is thorough drainage; and this accomplished they prove the more fertile and enduring of the two.

IV. ECONOMIC PRODUCTS.

MINERAL PRODUCTS.

Few mineral products of economic value are found in the Florida Parishes.

Iron.—Capping the hills in the north, and immediately underlying the thin veneering of Columbia yellow loam, is a thin bedded ferruginous sand rock and conglomerate.

Though reported elsewhere in the coastal plain as of sufficient richness to be treated as an iron ore, nowhere in the Florida Parishes does this *ferruginous sandrock* or *arenaceous ironstone* occur either in sufficient quantities or rich enough in iron to be considered a valuable ore of iron.

The only use made of it, so far as observed, was as foundation stones for houses and fences; which purpose it serves excellently, being very durable and occurring in thin beds easily worked.

The iron concretions seen in road cuts, and often having the appearance of cannon balls and pots, while rich in iron, are only objects of curious interest and scientific value.

Clay.—Much the most important mineral product of these parishes is the extensive deposits of Columbian clays. These exist throughout the flats and second bottoms of the streams. They are not the *typical* Port Hudson clays, which are too "fat" for manipulation by the ordinary methods used in the brick factories of this section, but a mixture of these with the later sandy loams that overspread their coastal representative and produced the flats and second bottoms of the larger streams.

Along the Illinois Central and Northeastern railroads through these clays, brick-yards have been established; and throughout the older settled parts of the pine flats, as in St. Tammany, evidences of *ante bellum* brick kilns are seen.

This deposit of clay, coextensive with the flats and second bottoms, is practically inexhaustible.

By the ordinary methods used to the depth of four to ten feet, many times that depth is available by processes that utilize clays now considered too fat.

The clays of the hills are as a rule too lean for brick making.

In the valleys of the smaller streams, *e. g.*, at Clinton, East Feliciana parish, the clay is of workable quality.

In the region of the "bluffs" it is only where this deposit is cut through and reveals the mixed loess and yellow clayey loam that brick manufacture is carried on.

The brick works at Baton Rouge are using this mixed product.

The extensive deposits of brick clay in the Florida Parishes which produces a most excellent quality of building and paving bricks, make the clay industry one of the most important industries of the near future.

Sand.—Though intimately intermixed with red clay, and loam, thus giving the impression that the red color of the sand is inherent, when washed by the streams the sand of the Lafayette group of strata collects in beautifully white banks, and may be used in building.

It is chiefly siliceous and retains a fair degree of sharpness.

Gravel.—Though not found in the extensive accumulations common farther north, yet along the old and modern waterways gravel and pebbles have been deposited in quantities sufficient to make them valuable as sources of ballast for railroads and highways.

In northern East and West Feliciana especially, were such gravel pits noted.

Marls and Phosphates.—In one or two instances reports of marl deposits came to me, but no such deposits were found. I think none of importance need be looked for in the Florida Parishes. The formations in which workable deposits of phosphates and marls occur in adjoining States lie considerably below any surface deposit in these parishes. The strata here are not to any extent fossil bearing, and though vertebrate remains are found in the valley deposits of the Columbia, it is probable that the decomposition of the organisms was extremely local in its effects.

The sedimentary strata are fragmental in character, and the sediments were borne by streams which, as a rule, did not flow through a limestone country. The "bluff" producing Mississippi is an exception, and in the "bluff" we find an abundance of the marl element finely divided and universally distributed.

Building Materials.—No beds of limestome or sandstone exist in this section of Louisiana.

The compact, upper member of the Lafayette, while presenting a glazed, rock like appearance in an exposed section, is far too friable and incoherent to be used in construction. The clays and sands are the only valuable mineral constructional materials.

Water.—The matter of water supply is one of the most important of economic questions to be considered in determining the desirability of any section for residence. In this the Florida Parishes are particularly blessed.

Throughout the hill region, the basal pebble bed of the Lafayette furnishes a never failing supply of clear and wholesome water.

Though impossible to secure accurate sections, as the well makers questioned had not been interested in preserving a record of materials passed through, yet it was the invariable rule to sink the well until the red mottled deposits of sand and clay were passed through and a bed of "white sand and pebbles" was reached.

Further sinking was said to "spoil the well," as it passed into a stratum of bluish clay, probably Grand Gulf, which taints the water.

Throughout the hill parishes of this section the wells vary in depth from 30 to 150 feet with the surface topography; thus indicating a comparatively regular and constant bed of basal gravel beneath the Lafayette sands. As no exact elevations were taken, the relation of this water bearing stratum of gravel to the beds of the larger streams cannot be definitely stated ; though they do not differ greatly in elevation.

These are in no case Artesian wells. When they are *dug* wells only the lower part requires curbing, as the massive upper member of the Lafayette in the vertical walls of the shaft becomes glazed and hardened, and stands indefinitely without caving.

Waterbearing strata are found in the Lafayette above the basal gravel, but the flow in wells remains so long discolored by the ferruginous clays that wells are rarely stopped short of the basal gravel, and higher water supplies are curbed out.

These upper water bearing strata, by their outcrops furnish the numerous springs at the bases of the hills along the secondary valleys. Numerous spring branches are thus supplied throughout the year with most wholesome crystal clear water.

Only one Artesian well in this section is known to me ; this is at Baker, on the Yazoo & Mississippi Valley Railroad, about seven miles above Baton Rouge. This well, which is something over 700 feet deep, rises in a stand pipe twenty or thirty feet above the surface of the ground. The water is pure and palatable.

The same water bearing stratum was struck in a well of the Water Works Company in Baton Rouge, at a little less than 800 feet, but this well is not Artesian, probably because the higher water bearing strata which were not curbed out act as drains upon rather than contributors to the deeper supply.

A new well is being sunk near the old, and it is the intention to exclude all but the deep supply, and a flowing well is confidently expected.

In the "flats" wells sunk to the basal gravels of the Lafayette become flowing wells. In many instances, however, deeper boring has discovered stronger flowing streams of better water.

The mineral wells about Covington, in St. Tammany parish, are of this deeper class.

Many of these Artesian wells have valuable medicinal qualities, and hundreds of people go annually to test their healing properties. When better known they will probably become favorite health resorts for the thousands who now go to other wells and springs.

Abita Springs, in St. Tammany parish, are already well and favorably known.

Few of these Artesian wells have been analyzed. The following is an analysis of Abita Springs water, made by A. L. Metz, Ph. G., of New Orleans. The analysis gives the *number of grains in a United States gallon:*

Sodium Chloride	1.473
Sodium Carbonate	1.294
Magnesium Bicarbonate	3.946
Calcium Bicarbonate	3.084
Ferrous Bicarbonate	1.303
Calcium Sulphate	5.122
Potassa	0.201
Alumina	0.109
Silica	1.075
Organic Matter	1.347
Total	18 854

Mr. Metz says: "The above results show that the water is of superior quality from a sanitary and hygienic point of view."

An analysis of the Roche well at Covington, St. Tammany parish, made by the same chemist, but expressed in *parts in one thousand*, is as follows:

Sodium Chloride	.0842
Sodium Carbonate	.0249
Magnesium Bicarbonate	.0692
Calcium Bicarbonate	.2802
Ferrous Bicarbonate	.1418
Calcium Sulphate	.0716
Ferric Oxide	.0759
Aluminum Oxide	.0879
Potassium Silicate	.0999
Silica	.3637
Organic Matter	.0760
Total	1.3753

An Artesian well belonging to Mr. Charles Thiery, near Covington, is 400 feet deep, and flows with such force as to furnish power for running fans in his hotel. Mr. Thiery thinks the water would rise 100 feet above the surface of the ground.

At Summer Camp Farm, on Bogue Falaya river, two and one half miles north of Covington, Mr. W. H. Ellermann has an artesian well 410 feet deep, from which the water rises about 30 feet and flows 55 to 60 gallons a minute through a 1¼ inch pipe. This measured flow, the result of many measurements, is found by Mr. Ellermann to vary with the phase of the moon; being 5 gallons greater when the moon is young than a week earlier or later.

On Millhaven Farm, north of Covington, are two Artesian wells; one 425 feet deep, flowing about 90 gallons a minute through a 2½ inch pipe, and the other 375 feet deep, furnishing 100 gallons a minute through a 2 inch pipe.

In and around Hammond are numerous Artesian wells, which vary in depth from 40 to 300 feet, the deeper passing through several water bearing strata.

As a rule here the deeper the well the stronger the flow.

At from 75 to 125 feet below the surface a stratum of organic matter is here passed through, and the flow brings up fragments of wood, bark and cones of pine.

No well reported here that raises water more than 20 feet above the surface of ground.

Southwest Louisiana, while in no sense a mineral section, is pre eminently the most important mineral section of the State.

What has been said of the mineral products of the various formations in the Florida Parishes may be equally well said of the corresponding formations here.

Clay.—In addition to the Columbia clays described on previous pages there is worked at Washington and New Iberia clays of most excellent quality and of later deposit. These are clays of Red river origin.

No analyses of these clays have yet been made, nor have the manufactured products—bricks and tiles—so far as I know been tested as to strength, etc. These are lines of investigation mapped out for the future.

Gravel.—In the hills "streams" of gravel similar to those mentioned in the Felicianas are found; but so far as learned only one such accumulation is exploited. In the hills of southern Rapides, east of the Kansas City, Watkins and Gulf Railroad, immense quantities of gravel are obtained for road ballast.

With further development of the region these excellent deposits of road metal will be appreciated and in greater demand.

Building Stones.—In Northwestern St. Landry is found a very limited area and inferior quality of limestone. Though Dr. Hopkins says of this deposit that it can supply "lime and building stone for the State," my examination of the deposit leads me to believe that it is not sufficient either in quantity or quality to be of much economic value.

While under the pressure of necessity lime has been manufactured from it, I could find no evidence that it had ever been otherwise used as a constructional material. Indeed it contains a fatal weakness, as a building stone, in the abundance of iron pyrites whose crystals glisten upon every broken surface.

Dr. Hopkins* describes it as "a grey limestone of good quality for burning into lime, and of sufficient hardness to be used as a building stone. It occurs in a hill of drift, on the territory of the Grand Gulf strata. The drift clay has to be removed in order to expose the stone, which has been quarried to some extent, during the war, for lime. The stone is of the variety known as anthraconite, from its giving a foetid odor when struck. Parts of it are studded with minute crystals of iron pyrites, while others contain natural fissures, whose sides glitter with calc spar. This quarry will prove a valuable property on the opening of railroads in the vicinity. At present the expense of transportation is too great to allow of successful competition with the West, in supplying our State with lime and building stone."

This stone is believed by Dr. Hopkins to be of Cretaceous age, though in the absence of fossils it is impossible definitely to classify it. It is in the line of the "Cretaceous backbone" of

*First Annual Report of the Louisiana State Geological Survey, 1869.—By F. V. Hopkins, M. D.

the State, and is undoubtedly older than the Lafayette. Its fissured condition, wherever observed, either in outcrop or from Artesian borings, shows that it has been subjected to considerable strains, that have not only shattered it, but have produced slight metamorphism—shown by its compact nature and semi-crystalline character.

In a ravine on Petite Anse is exposed a thin bed of slightly metamorphic sandrock, which is probably Grand Gulf, and which, if in sufficient quantity, and not too deeply buried beneath Lafayette sands and gravels and Columbia loams, would make a good constructional stone.

There is great demand for quarries of building stone in this section, not only for the ordinary uses in houses, culverts and bridges, but by the government in its efforts to secure deep water at the mouths of the Sabine, Calcasieu and other rivers. So far the search has proved and is likely to prove fruitless.

Water.—No single feature is more strongly impressed upon the notice of one passing from the hills to the lowlands of Southwest Louisiana than the character of the water supply.

In the hills one sees everywhere springs and spring creeks supplied from the sand strata of the Lafayette, and the supply of drinking water is obtained by rich and poor alike from wells dug or bored to the basal gravels of the Lafayette. As east of the Mississippi this is an unfailing source of pure and wholesome water.

In the flats and the prairies, as in the alluvial regions, the main supply of drinking water is from accumulated rainfall stored in casks and overground cisterns.

The wealthier class of these sections have Artesian wells, that may be had anywhere for the boring, and if sunk to sufficient depth furnish excellent water. Many of the larger sugar plantations obtain their chief supply of water from this source.

There are few "mineral springs" in this part of the State. The only springs that have attracted sufficient notice to become a "resort" are the Belle Chaney springs in northern St. Landry parish.

In the alluvial flat in the bottom of Vermilion river, east of

Lafayette, is a large and locally well known chalybeate spring, that has by its overflow built up around itself a broad, basin-like rim of iron.

In the vicinity of the sulphur mine are numerous springs with varying mineral properties. One of the most remarkable of these is the so called "sour" spring; which probably owes its acidity to a small percentage of sulphuric acid.

Precisely similar "sour" springs are found upon Belle Isle; and as this is thought to be a geologically similar region to the underlying sulphur bearing rocks of Calcasieu, and as here as there gas and oil escape in the surrounding marsh, it may be that similar mineral deposits will here be found.

All of the five "islands" have an abundance of excellent spring water, from Lafayette sands.

Salt.—By far the most unique and probably the most important mineral product of Louisiana is the deposit of *rock salt* known to exist upon Petite Anse and Orange Islands, and in all probability upon Grand Cote, Cote Blanche and Belle Isle as well; as also beneath the intermediate marshes.

These salt deposits, supposed to be cretaceous in age, are at the southern extremity of the socalled "cretaceous backbone of the State.

For a long time salt springs have been known to issue along this line, as the names "Saline Bayou" and "Saline Lake" attest, and old abandoned saltworks in the northern part of the State show that at an early date in the history of Louisiana salt manufactured from these springs and wells became a commercial product.

But it was only during the Civil War that the deposit on Petite Anse was discovered, and in 1894 or 1895 that a like discovery was made upon Orange Island.

At Petite Anse salt has been for years extensively mined; and a cave in one section of the mine shows the rock salt lying within fifteen feet of the surface and directly overlain by Lafayette gravels.

In another part of this island the salt deposit has been penetrated to a depth of 1000 feet without reaching the bottom; and at Orange Island recent reports from Capt. A. F. Lucas (in charge at Petite Anse) show a continuous bed of rock salt penetrated for 1800 feet without passing through it.

Such thickness of rock salt is known nowhere else in the United States, and but few places in the world.

If, as is generally assumed, this immense thickness is the result of evaporation of a land locked sea, its continuity and purity proclaim a *constancy* of conditions that subsequent frequent and profound oscillations of the region discredit.

Analyses of the rock salt from Petite Anse show it to be almost 99 per cent. pure; and it is difficult to imagine a constant supply of sea water during the accumulation of more than 1000 feet of salt, without any admixture of mechanical sediments or other impurities.

It is such immense deposits of salt that make us doubtful of the sufficiency of the generally accepted theory of evaporation of land locked seas to account for them, and feel that we must find for them another explanation.

Concerning the *age* of the Petite Anse deposit, Hilgard* writes as follows: "It remains to be shown that the rock salt mass may, with a considerable degree of probability be claimed as a cretaceous outlier; and reasoning by exclusion, I think this can be done, by considering successively the formations to which it might be referred."

"Since the lowest (clay and pebble) strata of the stratified drift† are found overlying the rock salt mass, its age is at once removed beyond the limits of the Quaternary period."

"As regards the Grand Gulf group, though much impregnated with salts of various kinds, its general character as a fresh or brackish water formation renders it peculiarly ill adapted to the genesis of rock salt deposits. It is, moreover, a very predominantly littoral formation, whose deep water equivalents appear to be so thin that the drift currents have in most cases destroyed them. They have not been found in any bore near the coast.

*"Geology of Lower Louisiana and the Salt Deposit on Petite Anse Island." Smithsonian Contributions to Knowledge.—E. W. Hilgard, Ph. D.

†Lafayette.

"The Vicksburg rocks even (which are thinner and of less resisting material in Louisiana than in Mississippi) have been removed in a great measure by the drift, which in Calcasieu seems to be immediately underlaid by the Jackson group of the Eocene.

"But the marine groups of the older Eocene are of such inconsiderable thickness, each so variable in its nature, and so scantily supplied with salt, that to attribute to either of them the formation of so large and pure a mass of rock salt, seems to involve an utter incongruity.

"Not so with the Cretaceous formation that underlies them. Not only is salt water the invariable feature of the Cretaceous outcrops of North Louisiana, * * * , but it is there accompanied by that almost necessary complement, gypsum, which thickens to the southward, until, as demonstrated by the Calcasieu bores, it passes beneath the gulf with the surprising thickness of over six hundred feet.

"It is well known that the end of the Cretaceous period on this continent was characterized by a 'wholesale' conversion of ocean into inland lakes and dry land. What was, at that time, the condition of the Mexican Gulf basin, we have not the data to determine. But inasmuch as even in early Eocene times water connection still existed between the interior and the gulf; so of course the same must have been true of the Cretaceous inland sea, which by a continuance of elevation inland, was gradually receding toward the Gulf.

"The existence of the great gypsum formation, both in the interior and beneath the Gulf, argues the concentration and evaporation of a vast amount of sea water as a consequence of the general emergence; and it is but reasonable that the other chief ingredient—salt—should be found somewhere in connection with the great gypsum beds. And the great rock salt bed of Petite Anse, now known to exeeed seventy* feet in thickness, without such change of character, as must characterize any deposit formed on a small scale, seems a fit counterpart to the great gypsum bed of Calcasieu, with which the general dip of the formation would naturally connect it."

**Now* known to exceed 1000 feet in thickness.

Sulphur.—In Southwest Calcasieu parish, about nine miles west of Lake Charles, are known to exist considerable deposits of sulphur. For a long time before any explorations were made, gas was observed to escape in bubbles through the boggy marsh and in certain places globules of oil could be seen rising and rapidly spreading over the surface of the pools.

This led to borings being made in search of marketable quantities of these two minerals.

Though the search in this direction proved fruitless—no gas being obtained and oil only in such limited quantities as to be of merely local value—yet it was discovered that beneath the region existed enormous deposits of sulphur.

Rich stock companies were formed and expensive machinery imported with a view to mining the sulphur; but misfortune followed so close upon the inauguration of every enterprise looking to the development of these mines, that though more than 30 years have elapsed since the first discovery of sulphur here, its successful extraction may be said to be yet in the experimental stage.

It is thought that a process has been discovered by which the sulphur may be easily and cheaply obtained, and in the *experiment* the new process proved *very* successful. Beautiful specimens of almost pure sulphur were presented to the Survey by the superintendent, Mr. J. C. Hoffman, and a considerable mass was displayed as the product of the initial run.

The principle involved in the new method is to force superheated steam by one pipe down into the deposit, which melts the sulphur and forces it up by another pipe. The principle and method seem both simple and rational; but certain difficulties were revealed by the experimental test, that had not been corrected when I visited the mine in the summer of 1895.

The following section furnished me by Mr. Hoffman from a bore 540 feet deep will give a very good general notion of the strata overlying the sulphur, and of the probable *age* of the deposit:

(1)	Yellow and blue clay	80	feet	
(2)	Blue clay and fine sand	55	"	
(3)	Blue clay, hard and almost pure, with many sandy pockets	30	"	Columbia.
(4)	Fine gray sand, water bearing	135	"	
(5)	Gravelly sand, increasing in size	45	"	Lafayette.
(6)	Gray sand, coarse	10	"	
(7)	Marl (Petroleum and Tar.)	2½	"	
(8)	Blue sandy limestone	30½	"	Grand Gulf,
(9)	Calcareous marl	4	"	or
(10)	Hard, rough, gray calcareous marl	5	"	Vicksburg.
(11)	White saccharoidal calcareous marl	10	"	
(12)	White saccharoidal calcareous marl reduced to sand.	7	"	
(13)	Hard, compact limestone	25	"	Cretaceous.
(14)	Sulphur	112	"	

The upper yellow member of No. 1 is the attenuated stratum of yellow clayey loams; while the "blue clays" of 1, 2 and 3 are probably Port Hudson. No. 4 is probably the basal member of the Columbia and derived chiefly from the sandy clays of the Lafayette. Nos. 5 and 6 are pretty surely Lafayette. The next 60 feet are not so certainly identified, but in the main very nearly resemble the only Grand Gulf outcrops I have examined, in northern Vernon and southern Natchitoches parishes. They may be partly Vicksburg. No. 13 I have called Cretaceous because of its resemblance to St. Landry limestone.

In five other bores the bottom of the sulphur was reached at: 552, 621, 603, 593, and 568 feet respectively.

The following is the section of a well here, taken from Dr. Hopkins' First Report:

(1)	Blue clay, layers of sand	160	feet	—Prairie Diluvium.
(2)	Sand	173	"	—Drift.
(3)	Clay rock, soapstone	10	"	—Grand Gulf.
(4)	Blue anthraconitic limestone, fissured	40	"	—Vicksburg.
(5)	Gray limestone	60	"	
(6)	Pure crystalline sulphur	100	"	
(7)	Gypsum with sulphur	137	"	Cretaceous.
(8)	Sulphur	10	"	
(9)	Gypsum, grayish blue	540	"	

"The first four strata were all more or less oil bearing. Several streams of water were struck, one below No. 4 and the other below No. 5. The latter was a strong solution of sulphide of hydrogen, and was flowing during my visit, killing all the vegetation that its water reached. Stratum No. 4 is the one that seems to me to be identical with that of Chicot."

No. 1 corresponds to the *Columbia* of my section, and No. 2 to my *Lafayette.* No. 4, while pronounced here as *Vicksburg,* is recognized as similar to the St. Landry limestone, and Dr. Hopkins, in his Second Report classifies that as Cretaceous. With these amendations it will be seen that the records are fairly agreeable.

Concerning the origin of the sulphur here little is known. Being far removed from any volcanic outburst, we can hardly attribute its origin to volcanic agencies.

There have been unquestionable convulsions of the earth in this and neighboring regions in Southwest Louisiana that have fissured and to some extent metamorphosed the rocks; but it seems that these were more probably attendant phenomena upon the formation of the sulphur bed than results of volcanic activity.

The following, extracted from Dr. Hopkins' first report, for want of a more plausible one, is here offered as a probable explanation of the sulpur deposits in Calcasieu parish:

"The sulphur is of unequaled thickness and purity, and the gypsum is also of unusual quantity. Above them we have the remarkable fact of newer Tertiary and post-Tertiary strata, full of petroleum. Southern California and Trinidad furnish examples of oil from the Tertiary series, but here the drift and diluvium seem equally full."

"Dufrenoy states that sulphur is commonly associated with gypsum, rock salt and bituminous strata; and that in fact it is formed from the gypsum by deoxidation by organic matter.

"Whether the organic matter is of vegetable or animal origin is a debatable question. Either source would supply carbon and hydrogen, to remove the oxygen from the gypsum on the one hand, and to furnish petroleum and marsh gas on the other.

In this instance the large amount of sulphur produced points to the vegetable kingdom as the probable source; for the accumulation of animal matter sufficient for the purpose at this one spot, would have been an unexampled occurrence.

"The reaction between lignite and gypsum is very complicated in nature, but may be thus approximately expressed:

$C_{12} H_{12} O_4 + 4 Ca S O_4 = 4 Ca C O_3 + 4 S + 4 C O_2 + 2 C H_4 + 2 C H_2$. Or, one equivalent of lignite, and four of gypsum give four each of limestone, sulphur and carbonic acid, with two each of marsh gas and olefiant gas.

"Now marsh gas and carbonic acid gas often issue from earth containing decomposing vegetable matter alone, but olefiant gas seldom or never.

"By a further reaction with marsh gas and water the olefiant gas becomes equivalent to petroleum, thus:

$32 C H_2 + C H_4 + 2 H_2 O = 3 (C_6 H_{14}) + C_8 H_{18} + \frac{1}{2} (C_{12} H_{24}) + C O_2$. Or, thirty two equivalents of olefiant gas, and one of marsh gas with two of water, contain the elements of one of petroleum, and one of carbonic acid gas."

"The sulphur was formed by reducing the gypsum with vegetable matter. The carbonic acid, olefiant gas and marsh gas produced by the process, have each left the appropriate proof of its presence, *i. e.*, the limestone stratum No. 5 contains the former, the petroleum is made of the olefiant gas, and the mounds were the vent holes for the latter."

Petroleum and Gas.—As already stated, the sulphur was discovered in the search for petroleum and gas. In all the marshy region round about the sulphur mine evidences of both these minerals are seen. The clays and loams of the Columbia and gravel and sand beds of the Lafayette seem to be impregnated with them. Wells stopped in these deposits, while furnishing fairly good water for a time, eventually become foul with crude oil and have to be abandoned. As far west as Vinton, in the Sabine Prairie, this was found to be so.

In the edge of the marsh east of Belle Isle numerous gas springs occur, and in several places pools of oil collect, in every respect like the gas and oil springs of Calcasieu. It remains to be proven if here too sulphur may be found.

Economically, these flows of gas and petroleum are of no value, and are only useful as probable indicators of the existence of other valuable mineral deposits.

VEGETABLE PRODUCTS.

With variation in the soil of any section goes always a corresponding variation in its vegetable products. Each plant requires its peculiar soil and climate.

As almost every type of soil is found in the Florida parishes, it is not surprising that we find there a wide range in the variety of vegetation.

Lumber.—Most of the region is or has been forest clad, and the source of vast quantities of pine and some hard wood lumber.

East of the Amite river long leaved pine (Pinus Australis) prevails; and the forests of this wood have long been an important source of revenue to the owners situated near a stream or railroad. In the hills thousands of acres of virgin pine of the very best quality yet remain. In the pine flats, especially of St. Tammany, numerous turpentine orchards are worked, and large quantities of turpentine and rosin are exported.

This has practically ruined these orchards for future sources of lumber, as large and small trees have been bled indiscriminately, and it will be many years before a new growth of this timber can be produced, if indeed, it ever can.

It seems to be the general experience that when the long leaved pine is entirely destroyed from any considerable area, it does not again spring up naturally, but is succeeded by the "old field" or loblolly pine (P. tæda) which is worthless for lumber.

By a judicious selsction of mature trees, and preservation of the vigorous young growth of the long leaved pine, splendid forests of this invaluable timber may perpetually furnish good supplies of lumber from both hills and flats.

The hills west of the Amite, with two or three small areas near that stream excepted, have only short leaved pine of an inferior grade for lumber. Toward the Mississippi, in the region occupied by the "bluff," the pine entirely disappears, being replaced by beech, magnolia, oak, hickory, ash, pecan and gum, which furnish limited quantities of hard wood lumber.

The alluvial bottoms of all the streams in these parishes likewise furnish small amounts of hard wood lumber, and the swamps important quantities of cypress and cottonwood.

Southwest Louisiana offers nothing new in the line of lumber. The hills and flats furnish enormous quantities of long leaved pine, and the alluvial bottom lands an abundance of cypress and much oak and ash.

The lumber industry is the principal industry of these regions. The Calcasieu and its tributaries are filled with rafts of logs for the score or more mills upon their banks; and many miles of tram road are built to bring logs from the interior. At present most of the lumber is shipped away for manufacture, though factories are beginning to seek these lumber centers.

When this more rational plan of manufacturing the lumber where produced is more generally adopted, this section will have an era of prosperity before unknown.

Rosin and Turpentine.—An industry that has obtained some footing in St. Tammany parish only, so far as I have been able to learn, is the manufacture of rosin and turpentine. Several extensive orchards are worked east and north of Covington in the long leaved pine flats. This pine is exceedingly "fat" and produces well for three years.

If only trees large enough for lumber were bled for turpentine, both this industry and the lumber industry might be perpetuated in these flats and in the hills indefinitely; for bleeding a mature tree does not materially damage it for lumber.

But the vandalism practiced in these orchards in bleeding half mature trees yields but slight returns and perpetually blights the young forest, thus destroying the lumber industry for the future.

Charcoal.—In St. Tammany small amounts of charcoal are burned, but the industry has not assumed as yet any considerable proportions. It is here made from the long leaved pine.

Fruits and Flowers.—The hard wood areas furnish abundant beech and oak mast, and pecans in considerable variety grow naturally. Persimmons of several varieties are found native; and muscadines (Vitis vulpina) and two or three less importont varieties of grapes are found in the alluvial regions.

One or two edible varieties of wild plum, and several varieties of blackberries and dewberries are found. Papaws occur but scantily, and do not attain the tree-like size which characterize them further north. Maypops are abundant everywhere.

As to the cultivated fruits we are but beginning to realize the advantages offered by this section of the State for their culture.

Oranges have long been successfully grown, but the adaptability of our soil and climate to the growth of pears, peaches, (?) plums, persimmons and a long list of Japanese fruits ; to strawberries and blackberries and the whole category of garden vegetables is only beginning to be appreciated.

Japanese fruits, flowers and vegetables seem to find a congenial home in the Florida parishes.

The sandy soils of the Lafayette hills are well suited to grape culture ; and while imported varieties of grapes require much attention to preserve them against fungous diseases, yet there is found native in this region a grape, the muscadine, which with culture, I think bids fair to make these lands much sought after for vineyards.

This grape and its near kinsman, the scuppernong, seem to possess immunity from the diseases that prey upon imported varieties ; and while not of value as table grapes produce wines pronounced by connoisseurs to possess a bouquet equal to the Italian and French wines.

Wines for domestic use are made by many from these grapes obtained from the open woodland ; but so far as known to me no attempt has been made in the state to grow these grapes for the manufacture of wines for the market.

It seems to me to be a field as inviting as it is unoccupied.

Probably no other region in the United States is known where climate and soil so conspire to produce variety of flowering and decorative shrubs and trees as does the "bluff" section of these parishes. Magnolias of half a dozen varieties ; camellias in variety more than a score ; sweet olive, dogwood, holly, spirea, Cape jessamines, crepe myrtle ; numerous species of the honey suckle family ; oleanders and roses in infinite variety and profusion.

Probably no other flower or plant is more distinctive of these bluff lands, and certainly none more beautiful, than the tangled clumps and dense hedges of Cherokee rose. With its broad spreading white petals, and mass of yellow stamens it is easily the superior in perfection and beauty of any other rose, wild or cultivated, it has been my pleasure to see. One is surprised and disappointed, however, to find with all its exquisite beauty it is devoid of odor. The Cherokee rose is ever the exponent of a warm, fertile, responsive soil.

Growing profusely throughout the section, it is rarely or never cultivated as an ornamental shrub; but because of its vigorous growth, and sharp, strong, recurving thorns is much used as hedges.

An equally characteristic flowering plant of the "good up lands," extending also into the "bluff" region, is the fragrant yellow jessamine. With its long trailing branches, overrunning the fences, and climbing even into the low branching trees, it produces a carpet of yellow, which puts to shame any artificial "Field of Gold," and makes the early spring breezes heavy with its fragrant sweetness.

The plant, however, is considered a pest to be exterminated or at least confined to legitimate bounds as a decorative plant; inasmuch as it not only is not a forage plant, but chokes out the better grasses and occupies the land with its mat of twining branches.

It contains a poisonous element, and is to some extent used in medicine.

This is but one of the multitude of yellow flowers found in the Florida parishes, and the prevalence of yellows among the flowers of every season cannot fail to attract the attention of one passing through the section.

While the variety of annual wild flowers is not so great as in more northern latitudes, probably because of the slight range of temperature, yet no season is without its characteristic wild flowers.

The flats both of these parishes and of Southwest Louisiana have not nearly so varied a flora as the uplands, and the flowering annuals are chiefly aquatic.

"Water lilies," "water hyacinths" and numerous varieties of iris make the lake margins, gum "swamps" and bayous of the coast marsh gorgeous; indeed in many places, *e. g.*, in Bayou Bon Fouca, Bayou Vincent and Bayou Liberty in St. Tammany it is difficult to prevent these aquatic plants from choking up the streams to the extent of stopping navigation.

Forage Plants.—Louisiana is fairly well off in the line of native forage crops. In the hills and flats, until within the past decade, the chief dependence for native forage plants was in crab grass (Panicum sanguinale) and two or three species of Paspalum, or carpet grass. The last only has been of much value in the hills, and while furnishing good pasturage does not attain sufficient height to be cut for hay.

The Panicums and Paspalums, in the low lands and flats, furnish excellent hay.

About ten years ago there was introduced into Louisiana a forage plant that has won for itself unstinted praise. This is the Lespedeza striata or Japan clover.

Introduced, probably by accident, it has taken such vigorous hold upon the soil, both hill and flat, that but for its so recent introduction one might believe it indigenous here. Though appearing late in the spring, and maturing and dying long before winter, during its stay it is the most important native forage crop of the hills and among the best in the lowlands. In addition to being an excellent crop for grazing it furnishes abundant crops of hay.

It is found throughout the hills and flats of the Florida Parishes and Southwest Louisiana.

Another native forage plant of the "piney" woods is the "Beggar tick" (Desmodium molle), which is held in considerable esteem.

Upon the "bluff" soils Bermuda grass is the best grazing grass, and the native cane here furnishes good winter and early spring forage.

The prairies of the Southwest produce a grass that, while inferior to the grasses above enumerated, furnishes good summer pasturage; while stock in the coast marsh find nutritious grass the year round.

In addition to the native forage crops described we have a long list of cultivated crops that furnish abundant forage the entire year.

Without attempting to describe them or even to enumerate them entirely or in the order of importance, the following may be named: Corn, oats, cane, sorghum, cow peas, alfalfa, clover and peanuts.

The last four of these, as also lespedeza, possessing the power of taking up free nitrogen from the air, are important also as fertilizers.

Money Crops.—For a long time, practically only three "money crops" have been grown in the Florida parishes; cotton on the uplands and hills, and rice and cane in the alluvial lands.

Until within recent years these crops have been so remunerative, that no thought was given to any other, and the economic system of the section has been organized and developed upon the production of these three crops as a basis.

Changed conditions have greatly decreased the remunerative returns from these crops, and from sheer force of necessity farmers and planters are beginning to turn their attention to other and varied crops.

This will surely prove to be a "blessing in disguise." As a "one idea" man is a narrow man, so a "one crop" section of country is bound to be narrowing and discriminating in tendency—constantly widening the gap between the owner and tiller of the soil.

Variety of crops means diversity of interests, which in turn means competition and development.

We will now find what our soils are best *suited* for, and not what they may be *made* to produce.

It has been thoroughly demonstrated that *corn* will make a good crop throughout these parishes, and with the forage crops before named will make the raising and preparing for the market of stock—sheep, hogs and cattle—profitable.

Experiment has shown the Lafayette lands of North Louisiana well adapted to the cultivation of *tobacco;* and as the hills of East Eeliciana, St. Helena, Tangipahoa and Washington parishes are of similar deposits, why should not the farmers of these parishes find in this another money crop?

The "flats" of Southwest Louisiana have proven most excellent *rice* lands; and about Hammond flats of similar character and origin are found to be well adapted to the growth of strawberries and other small fruits, as also for a host of vegetables that find a ready sale in the early Northern markets.

Almost half of the area east of the Amite river is a similar deposit, and has precisely the same culture possibilities as those lands that have been tested. It only remains for men of enterprise to take hold of these lands that have been considered worthless, to convert them into the most profitable fruit and truck farms of the state. The soil, usually considered too wet and cold for profitable cultivation, is so only so long as it is undrained.

The "bluff" lands of the Florida parishes need no further experiment to show their capabilities of producing almost any crop suited to the climate of these parishes.

The experiment at Baton Rouge to test whether these lands are suited to the growth of a high grade cigar tobacco has proven very satisfactory and favorable; and it is probable that this will become a valuable addition to the money crops of this section.

Here, too, the experiment with that most promising of fibre plants, ramie, has shown these lands eminently suited to its growth; and when suitable machinery for the preparation of its fibre is perfected, will doubtless take an important place among our crops.

The suitability of these "bluff" lands for sugar cane is no longer a question of doubt, as our upland cane, while not yielding so large a tonnage as that from the alluvial lands, possesses a higher percentage of sugar.

About the same conditions obtain in Southwest Louisiana as those enumerated in the Florida Parishes. The large prairie section, being peculiar to this part of the State, presents to some extent peculiar conditions. In the better drained, eastern part, variety of crops, in which corn, perhaps, holds the leading place, has long been the rule.

The flatter, western prairies have been so recently put in cultivation, and the mania for rice culture has been so general, that the culture possibilities of these lands have scarcely been tested. Where orchards have been planted, however, pears, plums and peaches (?) have been found to attain great perfection, and strawberries, dewberries and blackberries are certain and abundant crops.

The long list of vining fruits, *e. g.*, watermelons, muskmelons, cantaloupes, cucumbers, squashes, etc., wherever tried in these western prairies have shown wonderful adaptability to the soil; so also beans, peas, cabbages, tomatoes and potatoes.

As perhaps most universally grown both here and in the Florida Parishes, and suitable alike for human and animal food, should be mentioned the sweet potato.

Adapted especially to the sandy soils of the hills, and the sandy loams of the prairies, its yield is rich and sure.

Though visited at rare intervals by killing frosts, the southern coasts, especially the islands and chenieres, are sufficiently safe from these low temperatures to make them suited to the growth of semi-tropical fruits. Previous to the blighting "cold wave" of February, 1895, splendid orange orchards existed upon these islands and along the margins of the lower rivers. These orchards, though injured and in some cases killed, are being renewed, and will shortly be as productive as before.

Perhaps the surest and favorite fruit of the entire State is the fig. Grown alike on hill and in flat; on the bluff and in the alluvial bottom, and throughout the prairies, it has established its claim to supremacy among the fruits of the State.

Whether or not any or all of the crops mentioned, whether fruit or vegetable, shall become a "money" crop, depends upon the enterprise with which markets are obtained. Being products common to the entire South, home markets are not of primary importance. The profit will arise from the ability to place these products upon an *early* Northern market before the similar home grown crops are available.

Being so readily perishable, the first and chief consideration must be direct railroad communication with these markets. That obtained, the agricultural, horticultural and fructicultural possibilities of Southwest Louisiana can scarcely be foreshadowed.

V. CLIMATE.

Among the first questions to be considered in determining the desirability of any region is concerning its climate; and especially is this true of an agricultural region.

While no region is so inhospitable in climate as to be entirely uninhabitable, yet the question of soil is so intimately associated with that of climate that any agricultural report that omits a consideration of the climatic elements must be considered incomplete.

The questions of temperature, and especially *range* of temperature; of moisture and the distribution of precipitation throughout the year; of winds and their local and often violent manifestations in thunderstorms and tornadoes are of primary importance to the farmer and planter, inasmuch as they control not only seed time and harvest, but also the character of crop he may profitably raise.

Far too little importance has heretofore been attached to the careful study of these questions, and it is to be hoped that soon there may be voluntary stations established in every village. It is only by such multiplicity of observations, carried on for a long series of years, that the influence of local though limited water-bodies, timber-areas and topographic relief may be seen.

From a study of the weather charts, and much better from an examination of the records of the separate stations, some striking facts may be gleaned.

Though the section treated in this report covers less than one degree of latitude, yet the northern portion records in some years ten degrees lower temperature than the southern; and the *range* of temperature for the former is frequently fifteen degrees greater than for the latter.

The precipitation over the level coastal marsh and prairie is distinctly less than over the broken and wooded uplands. The hills have apparently the greater influence in inducing rainfall, probably by reason of the forced convectional motion in the prevailingly southeast winds.

Immunity from killing frosts is often had in the vicinity of considerable water-areas; partially because of their tempering nature, and partially as a result of the fogs that rise from them and protect adjacent lands, while lands farther removed are unprotected. This latter effect is very noticeable upon the front and back lands of our rivers, especially the Mississippi.

Perhaps no other illustration of the necessity for consulting the meteorological records before embarking in any expensive agricultural enterprise will appeal more strongly or universally to the readers of this report than the failure to make peach growing profitable in Southwest Louisiana. By reason of the mildness of our winters the peach tree is induced to put forth its fruit so early as to be killed by the last frosts. While the trees are vigorous and the fruit luscious; and while each year there is an abundant promise of fruit, yet it is found that not more than one crop in five years can be relied upon.

Such small returns do not justify the labor and expense required, and therefore many vigorous young peach orchards have been cut down.

Should later blooming varieties be developed, or means discovered for retarding their putting forth, peaches may take their place among the profitable fruits of this section.

Though fronting upon the Gulf of Mexico, and on that account having its climate tempered by that large body of warm water, South Louisiana in common with the rest of the Mississippi valley has a distinctly continental climate, and its weather is chiefly under cyclonic control.

The prevailing direction of the wind is from some southern quarter, and is chiefly determined by the relative position of the section with regard to the tracks of "lows" and "highs" as they cross the continent.

These "lows" (atmospheric *hollows*) and "highs" (atmospheric *hills*), bringing successively cloudy and fair weather, follow a pretty definite course across the United States, being a great southward bending curve with its apex in the Mississippi valley. First appearing upon the Pacific coast they move southeast to about the longitude of the great river, when the direction of progression changes and the remainder of the transcontinental journey is made in a northeasterly direction.

The direction of the wind and character of the weather at any place will depend largely upon its distance and direction from a passing atmospheric disturbance.

A "low" passing to the north or a "high" to the south of a place, if near enough to affect its weather will bring, generally, warmer winds and clouding weather. The reverse of these conditions will produce contrary results.

As the section here considered lies for the most part south of the tracks of the systematic succession of "lows" and "highs" across the Mississippi valley; and as these "lows" *strengthen* while the "highs" *weaken*, as a rule, upon reaching their greatest southing, southerly winds are most frequent. These come from the Gulf moisture laden; and being cooled, both by convectional ascent and by moving into cooler regions, produce an abundant rainfall over the entire section. This is well distributed throughout the year, so that destructive droughts are uncommon.

The tempering effects of Lakes Maurepas and Pontchartrain are felt far into the adjacent flats, and frosts are much less common or damaging than in the hills. Similar effects are produced in Southwest Louisiana by the bordering bays and Gulf.

Throughout South Louisiana maximum temperatures of 100° F. are extremely uncommon, and minimum temperatures below 20° F. are even more rare. Upon the coast freezing temperatures are infrequent.

The range of temperature is about 70° F. in the northern portion of the section and decreases as we approach the coast.

The annual precipitation varies from 50 to 70 inches, being in the northern part usually between 60 and 65 inches, and decreasing toward the coast where it is commonly under 50 inches. This is well distributed throughout the year. Though there is a minimum of rainfall in midsummer, no season can be considered as distinctively dry.

The winds are variable though prevailingly southern. Thunderstorms are common, and are usually accompanied by strong winds.

Though south of the most frequented tracks of tornadoes, many destructive storms pass through the section ; following, as elsewhere in the Mississippi valley a course from southwest to northeast. Their paths through the pine hills and flats may be traced years after their passage by the prostrate trunks of trees.

Summing up we may say : The section is one of *moderate* range of temperature, being less as we approach the coast ; of sufficient though not excessive rainfall, likewise diminishing toward the coast, and being well distributed through the year ; of variable though prevailingly southern winds, and occasional destructive storms.

Taken as a whole the climate may be properly called temperate.

VI. THE FIVE ISLANDS.

The "islands" of Orange, Petite Anse, Grand Cote, Cote Blanche, and Belle Isle, lying in a northwest and southeast line in Southwest Louisiana, constitute a topographic feature of the coastal plain that has no other American homologue.

While not in the strictest sense islands, yet these detached and limited areas rise so conspicuously above the surrounding prairie and marsh that they are and have ever been referred to as islands.

The most northwestern of the series, Orange Island, lies in the southern part of township 12 south, range 5 east; and is washed on its northern side by Lake Peigneur. The sometime marshy land to the south has been redeemed and converted into firm pasture land.

About seven miles to the southeast, across several miles of unredeemed marsh, lies the second of the series, Petite Anse, township 12 south, ranges 5 and 6 east. It is entirely surrounded by an easily redeemable marsh, which is drained to the north by Bayou Petite Anse, and to the south by several small bayous that find their sources in the marais along the western slope of the "bluff."

Continuing southeast for six miles through an increasingly swampy marsh, the third and probably largest island of the five, Grand Cote, is reached in township 14 south, ranges 6 and 7 east.

Six miles farther, in the same direction, after crossing Bayou Cypremort, reaches the next of the series, Cote Blanche, in township 15 south, range 7 east. The east, north and west sides face a somewhat deep salt marsh, while the south side rises 50 feet precipitously from Cote Blanche Bay, which is slowly but unceasingly encroaching upon the island. East and west along the bay for several miles stretches the narrow, wave-formed beach, which remains above even high tide except when made excessive by stormy south winds.

A distance of twenty-five miles in a continuous southeast direction from Cote Blanche must be traversed before reaching Belle Isle, the last of the series, in township 17 south, ranges 10 and 11 east. Wholly surrounded by the sea marsh with its branching and inter-branching bayous, and separated by this marsh from the nearest continuous land by a distance of eight or ten miles, Belle Isle is truly an island.

The "Five Islands" thus constitute a series that extends from the south shore of Lake Peigneur in Iberia parish to the shore of the Atchafalaya Bay in St. Mary's parish, a distance of about forty five miles, and upon an almost exact right line.

They all display similar sedimentary deposits; none being probably older than Lafayette, and the Columbia being the invariable surface deposits. Characteristic mottled clayey sands, and well rounded pebbles and gravel, with casts of fossils, fix their identity.

Distorted sand and gravel beds, and faulted, indurated and semi-metamorphic beds of sandrock, observed on all the islands, bespeak considerable disturbance since these deposits were made. As such distortions do not extend to the Columbia clays and loams, and as these sink beneath the marsh and reappear in like relation over the prairies, it is fair to presume that the disturbances which produced these dislocations preceded the deposition of those sediments.

The trend of these islands being a continuation of the line connecting the Cretaceous outcrops in Louisiana; and inasmuch as they are underlaid, so far as investigation has gone, by the rock salt deposit which is usually accounted Cretaceous, it has been generally assumed that they are "remnants" of a former continuous Cretaceous ridge, or "back bone" through the State.

In his report "On the Geological History of the Gulf of Mexico" Prof. Hilgard says of these islands, in speaking of the Cretaceous Period: "The outliers in Louisiana are too limited in extent for determinations of dip; but it can scarcely be doubted that they represent the summits of an (more or less interrupted) ancient ridge, a kind of backbone to the State of Louisiana, whose resistance to denudation has measurably influenced the nature and conformation of subsequent deposits.

"It is fair to presume that from this ridge the strata dip toward the axis of the Mississippi valley, to meet those on the opposite side, and the depth at which those beds are found in the Calcasieu bores, seem to indicate, on the western slope, a southwesterly dip of three or four feet per mile.

"A glance at the map shows, nevertheless, that the general form of the northern Gulf shore was not materially influenced by the existence of this axis of elevation, which probably was marked merely by a series of disconnected islands in the early Tertiary sea that, after the emergence of the immense Cretaceous area, already prefigured the present Gulf of Mexico."

Colonel Samuel H. Lockett* in speaking of Cote Blanche

*Second Annual Report of the Topographical Survey of Louisiana, 1870.

and Belle Isle says : "These belong to a chain of five islands, running from northwest to southeast, through the marshes of Iberia and St. Mary parishes. * * * * . The two extreme islands are considerably smaller than the others, but similar to them in every other respect.

"In both a geological and topographical view, these islands are objects of very great interest. Geologically, they evidently belong to the same epoch as the bluff formation of the eastern bank of the Mississippi river. Their surface presents the same water worn appearance, being an alternation of irregular ranges of hills and sinuous valleys. We observe the same precipitous bluffs, with a capping of yellow siliceous silt, underlaid by the lower members of the bluff and the sand and pebbles of the Orange Island formation, while the exact coincidence of the forest growth with that peculiar to other bluff localities, would make a resident of Vicksburg, Port Hudson or Baton Rouge, if suddenly transported to these islands, believe that he was still in the immediate vicinity of his own home.

"Topographically, these islands are a continuation of the Cote Gelee hills, running north and south through the parish of Lafayette. This same range of hills, continuing northward, receives the names Carencro hills in the northern part of Lafayette, Grand Coteau in south St. Landry, the Opelousas hills in the vicinity of the town of that name, and finally abut against the Bayou Boeuf at Washington and Moundville.

"Further north I have not yet traced them, but am of the opinion that future investigations will discover connecting links between the points last named and Sicily Island in Catahoula parish, which is itself but a continuation of the hills of Bayou Maçon.

"This line, thus marked out by broken chains of hills and detached islands in the sea marsh swamps, I believe to have been the western shore of a once vast estuary whose limits are coextensive with the present alluvial bottom of the Mississippi river.

"To account for these islands in their present positions, we have but to suppose a series of mighty crevasses through the great natural levee formed along the border of the estuary. These crevasses were made during the movement of elevation which evidently once occurred throughout the valley of the Mississippi.

"The city of Baton Rouge might have been situated on a similar island, had the erosion that produced the Devil's Swamp, just north of it, been continued a little further so as to meet the head of the valley of Ward's Creek. The rush of waters which would have followed such a result, in some unusually high stage of the ancient Mississippi, can easily be imagined sufficient to sweep away the country for miles back, while the circling eddies just below this hypothetical crevasse would have left unhurt the hills upon which Baton Rouge now stands."

Thomassy found in all the islands proof of "powerful volcanic convulsions," and compared them to the mudlumps of the lower Mississippi delta.

While there are unquestionable evidences of disturbances and earthshocks in these islands, *e. g.*, the arching, folding, and faulting of the Lafayette sands, and the faulting and semi metamorphism of the sand rock, yet I was unable to discover upon any of them any volcanic product whatever. There were undoubtedly earthshocks, but I could not interpret any evidences seen as proofs of "powerful volcanic convulsions."

Although the surface deposits here are like those from Washington south, yet I think we are hardly justified in considering these islands as continuations of the Carencro and Cote Gelee hills. These hills are plainly the products of *erosion*, and show no evidence of disturbance; while the Columbia loams of the islands were spread as a veneering over much disturbed and probably elevated Lafayette deposits. At any rate there was nothing seen to indicate disturbance of the Columbia clays and loams.

The accounting for these islands as remnants of a once continuous ridge, produced by the sweeping away of the intermediate sections in a "series of mighty crevasses through this great natural levee," is hardly tenable, for *crevasses do not occur* in *natural* levees. Moreover, these islands *not* being a *continua-*

tion of the natural levee along the western bank of the ancient Mississippi, but lying to the west of this, it is difficut to see how so great an erosion could be produced at the distance of the islands by streams that could only cut channels now represented by the coulees and marais upon the immediate front lands.

The islands are in all probability, to some extent at least, the result of differential erosion, and as Prof. Hilgard says, an "interrupted ridge;" but this ridge was of *pre* Columbian formation and *interruption.* Whether borings in the marsh between the islands would reveal the same sequence of deposits that the borings upon Petite Anse and Orange Island show, remains to be determined.

In the light of all evidence obtainable, both from published descriptions and personal examination of all of these islands, the following are the conclusions at which I have arrived:

1st. The "Five Islands" are situated upon and are probably remnants of a ridge that has a northwest trend from Belle Isle, and displays outcrops in St. Landry and on Lake Bisteneau.

2d. These outcrops, determined by their characters as Cretaceous, and the rock salt that is known to underlie at a shallow depth at least two of these islands being probably of the same age, the *foundation*, at least, of these islands is Cretaceous.

3d. The fractured, semi-crystalline condition of the limestones in the northern outcrops of this ridge, and the disturbed, faulted and sometimes semi-metamorphic condition of the sand and clay beds on the islands point to *differential elevation* rather than *differential erosion* as the explanation of the origin of the ridge or so-called "Cretaceous backbone" in Louisiana.

4th. Whatever the date of the *origin* of this ridge, and whatever height it may have attained in a former geological period, it was materially increased in the region of the islands during the time of Lafayette elevation and erosion.

This is attested by the following evidence: Lafayette gravels and pebbles that occur in the hills only along old waterways, and could only be brought to their present position by being *rolled along the bottom* are found upon these islands more than fifty feet above the level of the Gulf; while in Artesian borings to the east and west of this ridge these gravels are reached at depths varying from one hundred to two hundred feet. Gravel and pebbles of this size could not be carried up such an incline by our strongest streams, and the difference between these levels may be taken as a measure of the warping since these beds were deposited. Moreover, these beds of sand and gravel have been *folded* and *faulted*, thus giving unmistakable evidence of differential motion.

5th. The Columbia deposits, especially in its later members, are spread mantle-wise over the disturbed Lafayette, and show no disturbance. This would indicate deposition upon a submerged ridge, and will account for the steep dips observed in these surface deposits.

It would therefore appear, inasmuch as the Lafayette gravels rest directly upon the rock salt, that the "Cretaceous backbone" of Southwest Louisiana had at least an *initial* existence in pre Lafayette times, and the rock salt was unevenly eroded; that during Lafayette emergence and later submergence the strength of the topography was increased by further differential motion; That during early Columbia times this ridge was trenched by strong currents, thus leaving the "interrupted" submerged ridge, which with its later veneering of Columbia sediments was elevated and produced the islands of to-day.

Special descriptions of these islands would be of little economic or scientific interest. They vary chiefly in their surface features. While Grand Cote is distinctly more sandy than Cote Blanche, this is probably due to more extensive removal of Columbia clays and loams.

Belle Isle and Orange Island, the extremes of the series, are smaller than the other islands, and rise one hundred and twenty five and eighty-five feet respectively above the Gulf. Belle Isle gives most evidence of disturbance, and in addition to its sour springs and its evidences of gas and oil, exhibits strata of clay well studded with sulphur crystals.

Orange Island is known to be underlaid by *eighteen hundred* feet of rock salt, and the limit not yet reached.

The rock salt mine on Petite Anse displays in section a distinct and almost vertical *banding* of the salt, which suggests bedding, and if so, the enormous thickness of salt passed through is due to this high inclination of the bed rather than great thickness of the original deposit. Investigation of the horizontal extent of these deposits will throw much light upon this question, as will also a critical study of the banded structure of the salt.

Cote Blanche and Grand Cote have up to the present been chiefly devoted to agricultural purposes, for which they are eminently suited.

VII. SOME GEOLOGICAL SECTIONS.

While the geological examination of Louisiana has been too cursory, and the opportunities for determining the sequence of deposits too limited to justify the presentation of a *general* geological section for the State, yet it seems worth while to bring together the sections obtained by former examinations and by my own study of South Louisiana, both east and west of the Mississippi.

As before stated, we are largely dependent upon sections obtained in dug and bored wells for more than the extremely superficial sections afforded by the streams; and as these sections are generally given from *memory* by men who are not geologists, only *general* conclusions may be drawn from them. The increasing popularity of Artesian wells, which sometimes reach a depth of one thousand feet, offers exceptional opportunities for determining the substructure of the State if the companies or individuals boring the wells will take the trouble to preserve specimens of the materials obtained. These specimens should be taken at short intervals—say every five feet, and sent to the Survey headquarters at Baton Rouge. The Survey will pay all freights, and it is hoped that all intelligent citizens will interest themselves in securing this information for us.

The sections presented by the streams that have trenched their beds deepest display only incoherent, geologically recent sediments.

The following are the sections :

IN THE PINE HILLS.

"*Fluker's Cave*," on Amite river, in St. Helena parish.

1.	Soil and subsoil	18 inches	Columbia.
2.	Mottled sand and clay	10 feet.	Lafayette.
3.	Red sand rock with pebbles	15 "	Lafayette.
4.	Reddish yellow sand with layers of fine grained clay	25 "	Lafayette.

Some of the pebbles were well rounded, and contained casts of fossil mollusks and crinoids.

The best sections of this portion of Louisiana are obtained from dug wells. These always display beneath a few inches of Columbia veneering first ten to twenty-five feet of mottled clayey sand, massive and glazing upon exposed surfaces ; then more stratified deposits of the same general character down to the basal bed of sand, gravel and pebbles. Numerous partings of fine grained, white, or red and white mottled "pipe clay" occur, and sometimes these are reported as much as ten feet in thickness. These deposits indicate formation in a shallow marginal sea with fitful and varying currents.

IN THE PINE FLATS.

1.	Soil and yellowish, sandy Clay	1-3 feet	Columbia.
2.	Mottled clay	10-20 "	Columbia.
3.	Yellow clay	12-20 "	Columbia.
4.	Continuous blue clay with frequent water bearing sand layers		Columbia.

At 40-75 feet, beds of organic matter—logs, leaves, bark, pine cones, etc. are obtained. Water from this horizon has H_2 S odor. Artesian water rises 1—20 feet.

The above data were obtained from a well borer at Hammond, La. The Artesian water here is chiefly obtained from what seems to be the basal Columbia gravels. Deeper boring gives stronger flows, and purer water.

IN THE PRAIRIES.

Waterworks well at Jeannerette, Iberia parish :

1.	Red clay	20 feet	Red River deposit.
2.	Sandy mottled clay	60 "	Columbia.
3.	Organic bed—leaves, twigs, etc	10 "	Columbia.
4.	Sand and gravel	90 "	Lafayette.

Ice factory well at Jeannerette :

1.	Red clay	15 feet	—Red River deposit.
2.	Mottled clay and sand	80 "	Columbia.
3.	Organic bed	10 "	
4.	Sand and gravel	70 "	—Lafayette.
5.	An additional 175 feet in yellow clay		

Artesian well 1 3 5 miles southwest of Jeannerette :

1.	Soil and gray mottled clay	175 feet	Columbia.
2.	Chalky hard pan	18 "	
3.	Blue clay	20 "	
4.	Sand and gravel	20 "	—Lafayette.

Artesian well 3½ miles southwest of Jeannerette :

1.	Soil and gray mottled clay	140 feet	Columbia.
2.	Shell bed	2 "	
3.	Organic bed	10 "	
4.	Sand and gravel	65 "	—Lafayette.

The above four sections were furnished me by Mr. E. P. Moresi, a well borer of Jeannerette.

Artesian Well at Glencoe, St. Mary parish, La.:

1.	Soil	12— 18 inches	Columbia.
2.	Yellow clay	11 feet.	
3.	Quicksand	12 "	
4.	Blue clay	200 "	
5.	Shale	Undetermined.	
6.	Tough gray clay		
7.	Coarse sand and gravel and water at	615 feet.	—Lafayette.

The above well is situated near Bayou Cypremont, and the section was furnished me by Dr. Simmons, of Glencoe.

Prairie north of Petite Anse, after Prof. Hilgard. :*

1.	Brownish black surface soil	1 foot.
2.	Ferruginous or calcareous gravel, concretionary	½—⅔ feet.
3.	Bluish-white silt, mottled with yellow. and hog-ore spots	2½—3 feet.
4.	Blue clay, "similar to that in bed of Bayou Petite Anse"	Not known.

The above section is plainly Columbia.

*I have reversed the *order* of strata members to agree with order used in Artesian well sections.

Well at Welch, Calcasieu parish, La.:

1. Soil	6— 8 inches.		Columbia.
2. Mottled clay	70 feet		
3. Red quicksand, water bearing	20 "		
4. Chalky clay	50 "		
5. Blue clay	15 "		
6. Beach sand and gravel at	100 "		—Lafayette.

This section was furnished by E. L. Earll, a well digger of Welch, La.

Average Section at Lake Charles, La., (contributed):

1. Soil	10— 15 inches.	Columbia.
2. Sandy mottled clay	10— 12 feet.	
3. Red sand	1— 2 feet.	
4. Mottled clay	40— 50 feet.	
5. Mottled clayey sand	70—100 feet.	—Lafayette.

Artesian Well at Lake Charles, La., (contributed):

1. Soil and mottled clay	20 feet.	Columbia.
2. Yellow clay	15 "	
3. Blue clay	20 "	
4. Shale	10 "	
5. Dark brown clay	135 "	
6. Variegated sand	127 "	Lafayette.
7. Sand and pebbles	185 "	

Artesian water at this level rose 16 feet above surface.

8. Continued through quicksand for about 75 feet, when tools became fast and well abandoned.

Wells at sugar refinery, Lake Charles, La., are Artesian and water very pure from about the 500 foot horizon.

John Buck & Son's brick works in south Lake Charles use soil and clay to depth of 10 or 12 feet. At this depth 2 or 3 feet of quick-sand, and below this 60 to 70 feet of good brick clay.

Brick Works in north Lake Charles:

1. Soil	10—12 inches.	Columbia.
2. Mottled sandy clay	2— 4 feet.	
3. Reddish sand	2— 4 "	
4. *Pure* red clay	10—12 "	
5. Fine grained, foul smelling, bluish clay	7— 9 "	
6. Sand	3— 5 "	Lafayette.
7. Sand, shells and boulders(?)	3— 5 "	

This section was furnished by Mr. Burnett, the proprietor of the works. No. 4 of the section is possibly Red River deposit, and if so, points to the Calcasieu as the former course of the Red river.

Section of bore at Sulphur Mine, Calcasieu parish, La.:

1.	Yellow and blue clay	80	feet	Columbia.
2.	Sandy blue clay	55	"	
3.	Almost pure blue clay with many sand pockets	30	"	
4.	Fine gray sand—water bearing	135	"	Lafayette.
5.	Coarser, gravelly sand	45	"	
6.	Coarse gray sand	10	"	
7.	Marl (oil and tar)	2½	"	Grand Gulf, or Vicksburg.
8.	Blue, sandy limestone	30½	"	
9.	Calcareous marl	4	"	
10.	Hard, rough, gray Calcareous marl	5	"	
11.	White saccharoidal Calcareous marl	10	"	
12.	Same reduced to sand	7	"	
13.	Hard, compact limestone	25	"	Cretaceous.
14.	Sulphur	112	"	
	Bottom of sulphur at	540	"	

Section of present working hole at Sulphur Mine:

1.	Clay, sand, gravel, etc	300 feet	—Columbia and Lafayette.
2.	Shelly (bastard) limestone	80—100 "	—Grand Gulf, or Vicksburg.
3.	Solid limestone	6—7 "	Cretaceous.
4.	Sulphur	110 "	
5.	Soft, white rock	200 "	

Piping stops at upper surface of No. 3. The above two sections at Sulphur Mine kindly furnished by Mr. J. C. Hoffman, superintendent of the works.

Approximate Section at Edgerly, La., (contributed):

1.	Sandy, chocolate colored soil	12—15 inches.	Columbia.
2.	Mottled clay	3— 5 feet.	
3.	Gray sand	4— 6 "	
4.	Clay	3— 5 "	
5.	Red quick-sand, water bearing, undetermined...		—Lafayette.

IN THE "BLUFF."

River Section at Tunica Hills, West Feliciana parish, La.:

1.	Yellow loam	Undetermined.	Columbia.
2.	Loess	150 feet.	
3.	White clay with calcareous concretions	Port Hudson strata, undetermined.	
4.	Whitish blue clay		

Section at St. Francisville, West Feliciana parish, La.:

1.	Yellow loam	10 feet.	Columbia.
2.	Yellow sand (like the transition between the loess and drift)	9 "	
3	Whitish sandy clay and sand in several alterations	Port Hudson group, undetermined....	
4.	Sandy silt with roots		
5.	Whitish-blue clay		

River Section at Port Hudson, East Feliciana parish, La.:

1.	Yellow loam	5 feet.	Columbia.
2.	White and yellow hardpan	20 "	
3.	Three layers of bluish joint clay	21 "	
4.	Sand, indurated above and below, loose and white in middle	24 "	
5.	Ledge of layers of clay solidified by iron rust	3 "	
6.	Massive clay, blue and very smooth	13 "	
7.	Stump stratum and leaf bed in blue shale	4 "	
8.	White clay	3 "	

River section, five miles above Baton Rouge, La.:

1.	White hard pan, yellow above	17 feet	Columbia.
2.	Indurated clayey sand, laminated	11 "	
3.	White and yellow spotted clay, with clayey lime concretions	24 "	

River section at Baton Rouge, La.:

1.	Brownish yellow loam	23½ feet	Columbia.
2.	Yellow and white hard pan, with ferruginous concretions	15 "	
3.	Yellow clay, with limy concretions	16½ "	

The foregoing five sections, extracted from Hopkins' Third Report, represent the only *natural* sections of importance in the "bluff" region east of the Mississippi in Louisiana. As always I have numbered the members of the section from top down; otherwise the sections are unchanged.

Railroad cut at Washington, St. Landry parish, La.:

1.	Yellowish brown loam	10 feet	Columbia.
2.	Yellow clay, with lime concretions	5 "	
3.	Mottled clay, with iron concretions	5 "	

Sea cliff at Cote Blanche—After Hilgard:

1.	Soil and (brown loam) subsoil	5 feet	Columbia.
2.	Stiff greenish brown clay with dendrites	5 "	
3.	Stiff brown clay with black streaks	7 "	
4.	Reddish gray loam with ferruginous spots and Calcareous nodules	8—18 "	
5.	Hard pan, mottled white and yellow	4 "	
6.	Tough greenish clay with Calcareous concretions	—	
7.	Same, non-Calcareous	2 "	
8.	Gray loam (partly hidden by talus) about	8 "	
9.	Reddish, orange, gray or mottled loam, with ferruginous concretions	2 "	
10.	Cypress muck and lignite about tops of stumps	½ foot	
11.	Blue and green sandy clay with cypress roots—visible.	1 "	

The sections here presented suffice to show that in South Louisiana, hill, flat and prairie alike display only Columbia and Lafayette deposits in *natural* sections made by streams ; and that dug wells never, and Artesian wells but rarely reach below these deposits.

The mottled Columbia clays are displayed in the vertical banks along the north shore of Lake Pontchartrain, and along the north shore of the Gulf in Southwest Louisiana ; and the stratum of organic matter is persistent over the flats and prairies.

It is possible as Prof. Hopkins says, that the Cretaceous formation underlies the whole State ; but in most places at such depth that deep Artesian wells fail to reach it.

A deep well is now boring at Baton Rouge, and it is hoped that a study of the section which is being carefully taken, will throw new light upon the substructure of the State.

THE FLORA OF THE SECTIONS REPORTED UPON IN THIS BULLETIN.

The following notes on the botanical features of these sections are made by Prof. W. R. Dodson, Botanist of the State Experiment Station, who accompanied the Survey through the Florida Parishes and made, personally, the collections; and who examined the collections made by Cadet Matthews under his direction, who accompanied the Geological Survey through Southwest Louisiana. These lists constitute only a part of the plants of these sections, being confined chiefly to those of an economic value. At some early day a bulletin will be issued covering all of the plants of the State so far investigated by this department.

WM. C. STUBBS,
Director.

After making a careful study of the notes and collections of Mr. Matthews on the flora of Southwest Louisiana, and comparing them with my own on the Florida Parishes, I find the regions so strikingly similar that a separation of the two reports would be useless repetition, hence the two sections are included in the following.

There are a good number of plants found in each section not found in the other, but they are not of importance here.

Respectfully,
W. R. DODSON.

THE PRINCIPAL PLANTS OF ECONOMIC VALUE IN THE FLORIDA PARISHES AND SOUTHWEST LOUISIANA.

BY W. R. DODSON, BOTANIST.

TREES.

Long leaf Pine (*Pinus australis*) may be said to be the principal forest growth, both in the hills and in the pine flats. An immense quantity of marketable timber remains yet untouched.

Short leaf Pine, Loblolly Pine, Old Field Pine (*Pinus tæda*), is the principal pine west of the Amite river, to within a few miles of the Mississippi river, and is scattered all over the Florida Parishes and the southwest, but becomes the predominant forest growth only in very limited spots and in land that has once been under cultivation.

Northern short leaved Pine (*Pinus mitis*), is found sparingly in the bottoms of the Amite, Tangipahoa and Pearl rivers, and south of Alexandria.

White Pine (*Pinus strobus*). A few trees are frequently met with in the creek and river bottoms.

Pond Pine (*Pinus serotina*) is frequently met with in the vicinity of Pearl river.

Cypress (*Taxodium distichum*) occurs in all the river bottoms in the sloughs and low places, and in considerable quantities in most of the swamps.

OAKS.

White Oak (*Quercus alba*) moderately abundant and of good size on most of the creek bluffs ; frequently along branches in the hills, but seldom exceeding 12 inches in diameter there.

Cow Oak (*Quercus michauxii*) is not generally distinguished from the White Oak, the timber qualities being just as good in every respect. It is found in moderate abundance in the bottoms of all the streams. It is generally a larger growth than the White Oak.

Water Oak (*Quercus aquatica*) is quite plentiful along most of the streams:

Willow Oak (*Quercus phellos*). Large trees frequently seen about the margins of swampy places and on creek banks, but not abundant anywhere.

Shingle Oak (*Quercus imbricaria*) is found occasionally in the upper bottoms of most rivers in the upper parishes.

Post Oak (*Quercus obtusiloba*) is found in considerable quantities in the hills for several miles on each side of the Amite river, and is occasionally met with throughout the hills and the northern portion of the flats.

Black Oak (*Quercus tinctoria*) in moderate quantities through the northern parishes, but mostly limited to hillsides near streams.

Black Jack (*Quercus nigra*), scrubby growth throughout the hills, but never predominant, accompanying long leaf pine.

Spanish Oak (*Quercus falcata*); mostly associated with Black Oak, not quite as abundant.

Live Oak (*Quercus virens*) is quite abundant in the lower parishes, especially on bayous and in the vicinity of the lakes.

Beech (*Fagus ferruginea*) is abundant in most all creek bottoms, a few areas in the uplands and what is called the bluff lands along the Mississippi river. Large trees are plentiful.

Magnolia (*Magnolia grandiflora*) is quite abundant in bluff lands and in most of the creek and river bottoms, and in the flats in the vicinity of bayous.

Sweet Bay (*Magnolia glauca*), generally found with Magnolia in wet places and near standing pools.

Sweet Gum (*Liquidamber styraciflua*). Large trees are moderately abundant in the bottoms of rivers and larger creeks and in the more or less swampy lands.

Black Gum (*Nyssa sylvatica*) sparingly through the hills, common on the branches that are running water most of the season.

White Ash (*Fraxinus Americana*) is moderately abundant in low places in the bluff lands, and many creek and river bottoms throughout.

Pecan Nut (*Carya olivæformis*) is frequently met with in the bottoms of nearly all the streams and bayous.

The following trees and shrubs of minor importance are found more or less abundant in the bottoms of most all streams and branches, and on hillsides bordering on streams, and some of them less abundant through the hills :

Magnolia umbrella, Umbrella Magnolia.
Magnolia macrophylla, Large leaved Magnolia.
Liriodendron Tulipifera, Poplar.
Illicium Floridonum, Anise Tree.
Asimina triloba, Papaw or Crusted Apple.
Tilia Americana, Bass wood Linden.
Zanthoxylum Carolinianum, Prickly ash, Toothache tree.
Rhus glabra, Sumac, smooth.
Rhus capollina, Dwarf sumac.
Rhus aromatica, Polecat Bush.
Rhus Toxicodendron, Poison Ivy, Poison Oak.
Vitis bipinnata, Goose Grape.
Vitus Labrusca, Fox Grape.
Vitis vulpina, Muscadine.
Ceanothus Americanus, Jersey Tea.
Aesculus Pavia, Smooth Buck Eye.
Acer dasycarpum, Silver Maple.
Acer rubrum, Red Maple.
Negundo aceroides, Box Elder.
Wistaria frutescens, Wistaria.
Cercis Canadensis, Red Bud, Judas Tree.
Gleditchia triacanthos, Honey Locust.
Gleditchia monosperma, Honey Locust.
Prunus Americana, Plum.
Prunus Pennsylvanica, Wild Cherry.
Rubus Villosus, High Black Berry.
Rubus Canadensis, Dew Berry.
Rubus hispidus, Swamp Blackberry.

Rosa loevigata, Cherokee Rose.
Crataegus crus-galli, Cockspur Thorn.
Crataegus flava, Summer Haw.
Cornus florida, Flowering Dogwood.
Cornus stricta, Stiff Carnel.
Cornus sericea, Kinnikinnik.
Nyssa uniflora, Tupelo Gum.
Sambucus Canadensis, Common Elder.
Lonicera sempervirens, Honeysuckle.
Viburnum prunifolium, Black Haw.
Cephalanthus occidentalis, Button Bush.
Gelsemium sempervirens, Yellow Jessamine.
Vaccinium arboreum, Huckleberry.
Oxydendrum arboreum, Sour Wood, Sorrel Tree.
Ilex opaca, Holly.
Ilex decidua, Deciduous Holly.
Diospyrus Virginiana, Persimmon.
Bumelia lanuginosa.
Tecoma radicans.
Solanum, shrubby species undetermined.
Fraxinus viridus, Green Ash.
Sassafras officinalis, Sassafras.
Morus rubra, Mulberry.
Ulmus fulva, Slippery Elm.
Ulmus Americana, Elm.
Ulmus alata, Winged Elm, Whahoo.
Celtis occidentalis, Hackberry.
Platanus occidentalis, Plane Tree, Sycamore.
Carya alba, Shellbark Hickory.
Carpinus Americana, Hornbean.
Salix nigra, Willow.

The following are some of the medicinal and economic herbs :

Clematis crispa, Virgin's Bower.
Clematis viorna, Leather Flower.
Ranunculus sceleratus, Cursed Crowfoot.
Cocculus Carolinus.
Podophyllum peltatum, May Apple.
Nymphæa odorata, Pond Lily.
Sarracenia purpurea, Huntsman's Cup.
Sarracenia Psittacina, Parrot Beaked Pitcher Plant.]
Sarracenia flava, Trumpet leaf, Watches.
Nasturtium officinalis, Water Cress.
Sisymbrium canescens, Tansy Mustard.
Lepidium Virginicum, Peppergrass.
Capselly Bursa-pastoris, Shepherd's Purse.
Viola cuculata, Blue Violet.
Viola pedata, Bird foot Violet.
Viola primuloefolia.
Helianthemum canadense, Rock Rose.
Drosera capillaris, Sundew.
Drosera brevifolia.
Ascyrum Crux Andreæ, St. Peter's Wort.
Hypericum—several species, St. John's wort.
Portulaca oleracea, Purslane.
Mollugo verticillata, Indian Chick weed.
Stellaria media, Chick weed, Troublesome weed.
Stellaria prostrate.
Sida spinosa, Troublesome weed.
Modiola multifida, Modiola.
Hibiscus Moscheutos, Wild cotton.
Hibiscus incanus, Wild cotton.
Oxalis stricta, Yellow Wood sorrel.
Geranium Carolinianum, Cranesbill.
Cardiospermun Halicacabum,
Polygala, several species.
Psoralea melilotoides.
Tephrosia Virginiana, Goat's Rue.
Astragalus Canadensis, Milk Vetch.

Vicia Caroliniana, Vetch or Tare.
Apios tuberosa, bearing edible tubers.
Phaseolus diversifolius, Wild Bean.
Baptisia, several species
Cassia Marilandica, Senna.
Cassia nictitans.
Potentilla Canadensis, Cinquefoil.
Fragaria Indica, False strawberry.
Passiflora incarnata, May Pop, Passion Flower.
Passiflora lutea.
Eryngium Virginianum, Button Snake Root.
Elephantopus Carolinianus, Elephant's Foot.
Tiatris elegans, Button Snake Root.
Tiatris spicata, Button Snake Root.
Solidago—several species, Golden Rod.
Helenium tenuifolium, Bitter Weed.
Helenium quadrangulatun, Sneeze Weed.
Maruta cotula, May Weed Chamomile.
Gnophalium polycephalum, Everlasting.
Senecio aureus, Golden Butter Weed.
Lobelia cardinalis, Cardinal Flower.
Specularia perfoliata, Venus' Looking Glass.
Verbascum Thapsus, Mullein. Introduced.
Mimulus rivgens, Monkey Flower.
Veronica arvensis, Speedwell.
Callicarpa Americana, French Mulberry, shrub.
Mentha viridis, Mint. Introduced.
Calamintha Caroliniana, Calamint.
Brunella vulgaris, Self Heal.
Lamium amplexicaule, Dead Nettle, weed.
Cuscuta compacta, Dodder.
Solanum nigrum, Black Nightshade.
Solonum Carolinianum, Horse Nettle.
Physalis pubescens, Ground Cherry.
Datura stramonium, Jamestown weed, Thorn Apple.
Asclepias tuberosa, Butterfly weed, Pleurisy Root.
Aristolochia serpentaria, Virginia Snake Root.

Phytolacca decandra, Poke weed.
Chenopodium album, Pig weed.
Chenopodium anthelminticum, Worm seed.
Benzoin odorifera, Spice Bush, shrub.
Phoradendron fllavescens, Mistletoe.
Croton Elliottii, Croton.
Urtica urens, Dwarf nettle.

FORAGE PLANTS AND GRASSES.

Almost the entire area of the southern portion of the State is clothed to some extent with sedges, that are valueless, but the number of valuable forage plants that have refused to be crowded out demonstrates that they would flourish profusely if given a chance by cultivation. Lespedeza (*Lespedeza striata*), a valuable hay and forage plant, is becoming very generally distributed through the woods and is taking possession of hills and valleys alike. It is said to have made its appearance only within the last few years.

The frequent occurrence of various species of the Pulse family is striking. Two or three species of Desmodium, that are relished by cattle, are abundant. Quite a number of native grasses are found scattered through the forests that would afford good grazing for pasture if the timber was cleared off. Also a large number of grasses that are of no value as forage plants are found. All these will be included in a later report which will attempt to give all that is known of the flora of the State.

The following are some of the common grasses relished by stock that occur in considerable abundance, either wild, in open fields, or spontaneous in cultivated grounds:

Alopecurus pratensis, Meadow Foxtail.
Sporobolus Indicus, Smut Grass.
Sporobolus junceus, Wire Grass.
Cynodon Dactylon, Bermuda Grass. Introduced.
Elensine Indica. Cultivated grounds. Introduced.
Eragrostis Purshii.
Paspalum platycaule, Louisiana Grass.
Paspalum dilatatum, Hairy flowered Paspalum, Bull Grass.

Paspalum distichum.
Panicum sanguinale, Crab Grass.
Panicum filiforme, Hairy Crab Grass.
Panicum Crus-galli, Tall Panic Grass, Barn yard Grass.
Panicum filiforme.
Panicum virgatum.
Andropogon furcatus, Broom Grass.
Poa annus, Meadow Grass. Introduced.

PART IV.

GEOLOGY AND AGRICULTURE.

A PRELIMINARY REPORT

UPON

The Bluff and Mississippi Alluvial Lands

OF

LOUISIANA.

BY

W. W. CLENDENIN, M. S., M. A., Geologist.

MADE UNDER DIRECTION OF STATE EXPERIMENT STATION,

Baton Rouge, La.

WM. C. STUBBS, PH. D., Director.

LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE.

BUREAU OF AGRICULTURE.

GOV. MURPHY J. FOSTER, President.
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J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans, La.
H. SKOLFIELD, Treasurer, Baton Rouge, La.

The Bulletins and Reports will be sent free of charge to all farmers, by applying to Commissioner of Agriculture, Baton Rouge, La.

Office of State Experiment Station,
Louisiana State University and A. and M. College.
Baton Rouge, La.

Major J. G. Lee, Commissioner of Agriculture and Immigration, Baton Rouge, La.:

Dear Sir—I hand you herewith a report upon "The Bluff and Mississippi Alluvial Lands of Louisiana," by Prof. W. W. Clendenin, who has recently made a preliminary survey of these sections of the State. This completes the preliminary survey of the State, and work has already been begun in a detailed survey by parishes. Beginning at the northwestern corner of the State, this work has already covered the parishes of Caddo and Bossier, and will be prosecuted in order until the entire State has been traversed.

A large number of typical soils, marls, clays, etc., have been collected and are now being analyzed by the chemical and physical laboratories of the Station. Mr. E. Stanley Matthews, the physicist, has already completed the mechanical analyses of nearly four hundred samples of soils. At an early day a special report upon "The Soils of Louisiana" will be made, containing a detailed description of the various soils of this State, together with their chemical and mechanical analyses.

Please publish this report as Part IV, Geology and Agriculture.

Very respectfully submitted,
WM. C. STUBBS,
Director.

LETTER OF TRANSMISSION.

Dr. Wm. C. Stubbs, Director State Experiment Stations, Raton Rouge, La.:

Sir—I herewith present to you a preliminary report upon "The Bluff and Mississippi Alluvial Lands of Louisiana." The material for this report was collected during the summer of 1895. The soils collected are being analyzed as rapidly as the force of the laboratories permits.

Respectfully submitted,
W. W. CLENDENIN,
Geologist.

Bluff and Mississippi Alluvial Lands of Louisiana.

I. INTRODUCTION.

In Part III, "Geology and Agriculture of Louisiana," a brief consideration was given to the Bluff Lands of East and Southwest Louisiana. The following report will be limited to a preliminary study of the border lands of the Mississippi River, which are directly the product of the river itself. The data of this report were collected during the field season of 1896, when the bluff lands and Mississippi alluvial lands were examined from the Arkansas line to the Gulf of Mexico. Being of most recent geologic age, and simple and uniform in attitude, the study of these lands was almost exclusively along the lines of physical geology. As these constitute an important part of the agricultural lands of the State, a very complete and typical set of soil samples were taken for analysis and study. Being the immediate product of the Mississippi River, in order to a better understanding of the conditions and features discussed, the following brief consideration of the development and work of a river and its application to the Mississippi is here presented:

LIFE HISTORY OF A RIVER.

We are too prone to look upon so large a geographic feature as a river, and especially the Mississippi, as something that has always existed and will ever continue to exist practically as we know it. We see indeed, that certain changes occur, such as a slight shifting of channel, and, may be, what appears to us to be a *permanent* change of channel; a cutting of banks, no matter their height, in one place and filling of bed in another; once in a lifetime, perhaps, observing a *natural* cut-off made by the river to secure a more direct route to its goal, the sea, yet we find it difficult to look upon these as more than mere *accidents* to the river, and still more difficult to conceive of the river's having had a *beginning*.

Our fields are scarred with ever-branching and troublesome washes, which extend headward and deepen and broaden with every rain, and we may have discovered that the creeks and smaller branches have their beginnings in these self-same washes, yet we do not ordinarily comprehend the unbroken chain of which the furrow we make to drain our field and the mighty Mississippi are the end links. When we do realize this fact we can then appreciate the broader fact, viz.: That rivers, as men, have their *youth*, their *adolescence*, their *maturity* and their *old age*, and just as a man is more active and able to do work in his early manhood, so with the river in its adolescence.

THE RIVER'S BIRTH.

As no land area of sufficient extent for the development of a river upon it has emerged from the sea in historic time, we have no record of the birth of a river; yet upon islands of the sea and the coast lands of Louisiana we have the principle exemplified, and these may be taken as types of larger areas that have emerged.

Whenever a land area appears above sea level for the first time, and precipitation falls upon it, rivers are *born*. If the surface be an even one the river's course is definitely down the slope on the steepest gradient. The precipitation uniting along lines rather than flowing off in an unbroken sheet (which could occur only upon an ideally smooth surface) has power to do work. This work, which is constantly being done by all running water, is chiefly of two kinds: *erosion of the surface and transportation of the materials eroded.* These two species of work are inseparable. Each is a function of the other. *Pure* water has little power to erode, and water loaded with sediment is equally ineffective as an agent of erosion. Atmospheric agencies and gravity are active in furnishing materials for transportation, and these serve as tools for the work of erosion. Transportation of material must be first attended to, and erosion follows after.

The ability of a stream, both to transport material and erode its bed, depends upon its volume (which in turn depends upon drainage area and amount of precipitation), and in a multiplied ratio upon its velocity. If the velocity be *doubled* the power to erode is increased *four* times, and the transporting power is increased *sixty-four* times. We will find this to be most important in explaining certain topographic features of the area under discussion.

ADOLESCENCE OF RIVER.

With the development of the primary stream *down* the slope, lateral branches oblique to it are developed, and in like manner branches of a third, fourth and indefinitely higher order until the area is covered by a branching and rebranching *system* of drainage lines not unlike the branching of a tree, and is completely drained. During this period of *adolescence* when new branches are forming and older ones are extending headward and widening and deepening their channels, the *rate* of development will be largely determined by the slope of the region or its altitude above sea level.

The final slope toward which every stream wears its bed, and which, if time is sufficient, it will attain, is one so slight that the water flows down it without erosion and without load. This slope is rapidly approached during the youth of the stream, but is attained only in old age, and soonest in its lower course. On this account young rivers have valleys that are deep in comparison with their breadth, and are V-shaped. Another youthful feature is waterfalls, which result from great inequalities of hardness of strata cut through by the stream. These, as also the V-shaped valleys, disappear long before old age of the stream.

MATURITY OF RIVER.

When the branches of the stream have been multiplied and extended until every part of the area has been reached, and no broad, undrained inter-stream areas remain, the stream is said to be *mature*. The water sheds are sharp ridges. Long before this period is reached lateral waste of valley sides exceeds the rate of cutting along bed of stream, and the valley widens much faster than it deepens. Any further erosion of area now tends to reduce the inequalities of surface topography, and to bring the region to its final goal, sea level. The stream no longer, or but slowly, cuts down its bed, and this spasmodically, occasioned by flood stages. During ordinary stages no deepening of channel occurs, and at extreme low water there may even be deposit upon the bed.

OLD AGE OF RIVER.

With the nearer approach of tributaries and upper courses of the stream to the base level of erosion there follows a reduction in velocity of current, and often a partial filling of former valley in lower courses. Old age draws on. What with extended channel, built with sediment gathered from its entire basin and deposited at its mouth, and the decreased slope, due to cutting toward base level in its upper part, the current is so weakened that near its mouth it cannot longer do the work imposed upon it by its more vigorous upper members, and some of the load must be laid down. If, at the same time, by depression of land in its upper courses, the slope is further decreased, deposit in the lower part is accelerated. If now, by change in climatic conditions, a smaller volume of water is supplied, the river may sink to a mere pigmy representative of its former self, and occupy but a small channel in its more or less completely filled valley.

NATURAL LEVEES.

With every flood the river now overflows its flood plain and deposits much of the sediment from its head waters. As with a *slight* increase in velocity the transporting power is *vastly* increased, so with a slight checking of velocity, as occurs over the flood plain outside of the channel, deposit takes place. As the greatest decrease in velocity takes place *near* the channel, there the heaviest and coarsest sediment is deposited, and in greatest quantity. The river banks are thus built higher by each flood and a system of *natural levees* are produced. There is thus a marked difference in the "front lands" and the "back lands" along the river. The former are higher and coarser textured than the latter, and therefore much more easily cultivated and drained.

DISTRIBUTARIES.

Drainage from the very channel margin is away from the river, and unless forced by the topography of the land, will not reach the river proper, but unite with some outlet of the river produced during some extraordinary flood period and kept open by the escape of water during ordinary periodic flood stages. As the feeders of the river are called *tributaries*, these outlets have not inaptly been styled *distributaries*.

MEANDERS AND CUT-OFFS.

With weakened powers, characteristic of old age, the stream frequently finds it easier to go *around* an obstacle in its path than to *remove* it. Thus, a stranded log or deposit made by the river at low stage may serve to deflect the current from its course and thus change the course of the main channel. With a slight departure of the channel from a right line there follows an increased bending of the line of swiftest current, and though the channel may not be perceptibly deepened, the impinging current will cut away the bank against which it is thrown, while the opposite bank builds up. By continued and augmented deflection of the current with its consequent erosion upon the convex side of the curve and deposit of materials upon the concave, the channel is finally made to assume the form of an ox-bow. This increased length of course, due to meandering, is accompanied by a decreased average slope of the river bed. Where the direct course had a fall of six inches to the mile, the meandering stream may have to traverse several miles to secure the same fall. As a consequence, at flood stages, when the river spreads over its flood plain, there is a tendency to find a more direct route with steeper slope. In doing so, the longer course is abandoned and a "cut-off" produced. In course of time the ends of the abandoned course become silted up and a "horseshoe" lake is formed.

These abandoned sections of a former course are unfailing evidence of the old age and weakened powers of the river. By a comparison of streams that meander, it will readily be seen that the extent of the meandering, measured by the diameter of the loops made when cut-offs occur, is largely a function of the volume of the stream.

By depression of the land at its mouth a river in any stage of development may in its lower course be drowned; while, on the other hand, by elevation of the land the river may be extended mouthward, and its activities renewed.

As development proceeds headward, the river may, and does display all stages of development in its various parts. As the conditions of volume and load are usually such as to bring the lower course of the river soonest to base level, this, together with the fact that the lower course is usually the *oldest* part of the river, will explain why the average slope gradually increases as we go toward the source.

APPLICATION TO MISSISSIPPI RIVER.

The Mississippi river was in existence previous to the last great continental subsidence that submerged almost all, if, indeed, not every portion of Louisiana. If our interpretation is correct its valley was cut by a vastly greater stream than its present self, and when the continent stood at a much greater elevation. At any rate *river* deposits have been penetrated at New Orleans to the depth of over 600 feet; and when the Mississippi again assumed the functions of a river upon the emergence of the State from the sea, it seems to have produced *natural levees* at Vicksburg, Natchez and Baton Rouge upon the eastern bank, and upon the west along the Macon hills, at Sicily Island, at Marksville, and from Washington to New Iberia and Belle Isle. These seem therefore just and proper east and west limits to fix upon for the ancestor of our present Mississippi.

While the ancient Mississippi was not by natural development an *old* river when its cycle of existence was ended by subsidence of the continent, yet upon its renewal by re-elevation the attitude of the land was such as to impress upon it all the characteristics of an old stream. Within limits determined by its volume and the varying attitude of the land it has meandered as only streams that have reached their base level of erosion do; has built high, broad natural levees; and, until modified by the hand of man, maintained such distributaries as were needed for the disposition of its waters at flood stages. Within the limits of Louisiana it has but one tributary flowing from the deposits in its ancient bed, the Red river, and even this would, unless prevented by human devices, find a passage to the sea by one of the distributaries, the Atchafalaya. Only from New Orleans to the Gulf, which is plainly a geologically *very modern* extension of the river, has the life of the river been too short for any considerable meanders and consequent cut-offs. From Donaldsonville, the head of the last considerable distributary, to Port Hudson, the greater age of the river is shown by its more sinuous course, and above Port Hudson *all* the features of an *old* river are displayed.

II. DESCRIPTION OF REGION.

GEOGRAPHY.

The area covered by this report has no natural geopraphic boundaries. As previously stated, it comprises all the lands in Louisiana which are the product of the Mississippi river, both the modern alluvial lands, and that more ancient alluvium, the "bluff" lands that border the modern alluvium. This forms a somewhat irregular zone stretching over about four degrees of latitude, and varying in width from about fifteen miles at the Arkansas line to about one hundred miles from the line of the Five Islands on the southwest to Tickfaw river on the northeast. As measured by the present channel of the Mississippi River the distance from the Arkansas line to the Gulf is about four hundred and fifty miles. The eastern boundary is the Mississippi river, from the Arkansas line to the northern border of West Feliciana parish, and from thence an indefinite and irregular line extending roughly southeast from near Laurel Hill in West Feliciana parish to the mouth of the Tickfaw river, and passing near Jackson and Ethel in East Feliciana, and crossing the Amite river near the mouth of Sandy creek. The western boundary is an equally irregular line skirting the eastern edge of Bœuf river alluvium from the Arkansas line to Sicily Island; thence southwest to the Red River, about ten miles below Alexandria, passing near Harrisonburg and through Catahoula lake; thence southeast along the northern border of Red River alluvium to the western boundary of Avoyelles parish; thence by an interrupted line to Washington La., passing through Evergreen in Avoyelles parish and crossing Bayou Cocodrie in Tp. 4 S., R. 3 E.; thence southward to Lake Peigneur and southeastward through the Five Islands to the Gulf.

From the nature of the case these boundaries are indefinite and only approximate. While in some places definitely marked by differences of soil and growth, as a rule these grade so imperceptibly into those of adjacent regions as to make their definite separation impossible. No such difficulty obtains in regard to the separation of the bluff, or ancient alluvium, from the modern. These are sharply defined by natural geographic boundaries, which are easily traced. The bluff lands invariably rise above the modern alluvium in the form of an escarpment, closely bordered by a bayou. In the Florida parishes this escarpment rises from a few feet, near the mouth of the Tickfaw, to about seventy-five feet at Baton Rouge, and if we consider the average level of the Mississippi as the level of the modern alluvium, to several hundred feet in the Tunica Hills of West Feliciana parish. The western escarpment varies from fifteen to twenty-five feet throughout most of its length. The modern Mississippi closely follows the eastern escarpment from the northern boundary of West Feliciana parish to Baton Rouge, where it bears away from it, leaving a large area of impenetrable marsh and swamp, and a narrow zone of cultivable land between.

In most essential features the bluff and modern alluvial lands are so unlike, it seems best to consider them separately.

THE BLUFF LANDS.

These are believed to be the border lands of the ancient Mississippi River. They display many characters of natural levees, being highest in front and sloping back until they feather out or lose their distinctive character at distances varying from one to twenty-five miles. Being built of materials very homogeneous in character they do not display the variation in coarseness seen in similar modern deposits between "front" and "back" lands, but rather proclaim their origin in their greater thickness upon the front.

As stated in "Part III Geology and Agriculture" of Louisiana, we believe these deposits to be glacial rock-flour, carried by greatly strengthened streams from the melting ice of the glaciers in the North, and therefore *post-glacial* in their formation. They are so even textured and homogeneous in character as to enable them to resist the ordinary processes of weathering almost indefinitely, and yet so friable as to yield most rapidly to sediment-laden running water. These characters enable them to stand unsupported for decades in vertical walls, but they erode rapidly when put in cultivation.

The bluff lands east of the Mississippi river comprise about a thousand square miles, distributed as follows: West Feliciana, 250; East Feliciana, 75; East Baton Rouge, 300; Livingston, 325; Ascension, 50. In the Felicianas and East Baton Rouge parishes they grade insensibly upon the northeast into the "good uplands," characterized by a mixed growth of hardwood and pine; and in Livingston they pass as gradually into the long leaf pine hills and flats. In Ascension the bluff lands are comprised in a few island-like masses that border Bayous Manchac and Chene Blanc.

The bluff area bordering the modern Mississippi alluvium upon the west is of such irregular and indeterminable extent that it is difficult even to estimate the amount in square miles. It is usually locally designated as "hills," "islands" or "prairies." Beginning at the north, we have the Bayou Macon hills, which border Bayou Macon on the west; and gently sloping westward with little change of character to the alluvial lands of Bœuf river, comprise in the parishes of West Carroll, Richland and Franklin an area of scarcely less than a thousand square miles. These deposits, while bearing the same relation in position to the ancient Mississippi as the bluff lands in a corresponding latitude in Mississippi, and as those in the Felicianas, and while evidently of Columbian age, have not many of the characteristics of the loess. They are more of a loamy clay than they are of the genuine loam of the loess.

Crossing Deer creek southward from the Macon hill—a creek of *very* modern origin—we arrive at Sicily Island, which, in addition to its rocky hills of a more ancient geologic age, comprises about forty square miles of genuine bluff land.

Continuing southwestward along the margins of the pine hills to Red river, small areas of bluff are found at Harrisonburg and about the outlet of Catahoula lake, and again, south of that lake. Catahoula prairie, Holloway prairie and Long prairie are local names for parts of these.

Between Red river and Bayou Courtableau the bluff lands appear as small, detached areas, as Avoyelles prairie (the largest), Grand Ile, Grand Cote, Bayou Rouge prairie, and a few other small areas without particular names.

A few miles above Washington, in St. Landry parish, upon the right bank of Bayou Cocodrie, the bluff reappears and continues with only slight interruption, by modern streams, in an unbroken zone almost to Franklin, in St. Mary parish. Various local names for this deposit are Opelousas hills, Carencro hills and Cote Gelee hills, all of which slope gradually to the west and merge imperceptibly into the prairies of Southwest Louisiana.

The Five Islands display bluff deposits, but at a much greater altitude, due probably to elevation since their deposition.

As described in a former report, the topography of the bluff lands of the Florida parishes and of Southwest Louisiana may be described as *young;* although on account of their altitude, the drainage is fairly developed. The Macon hills display an even more youthful phase of topography, owing, no doubt, to inferior elevation. In them there are wide undrained, or, at least, poorly drained inter-stream flats, and the streams are of the simplest unbranched type. This is not because the region is not sufficiently elevated for complete drainage, but because, with its given elevation, time has not been sufficiently long to permit a widely branched system of drainage to be developed. Only near the eastern and western margins is drainage anything like complete. The streams are apparently of post-Columbia development, there being none like Rio Feliciana apparent inheritances from Lafayette times. Whatever the character of Lafayette topography and drainage in the Macon hills its burial and obliteration by Columbia sediments has been so complete as to leave no trace of it. The streams almost invariably begin in gum swamps, or hickory and oak flats, and pursue their sinuous courses with but few tributaries and in steep-banked channels.

Throughout the parishes of West Carroll, Richland and Franklin, the zone of Columbia deposits is crossed from northeast to southwest by a series of low ridges enclosing the flats or swamps. These seem to be the homologues of those south of Opelousas to Franklin produced by the "coulees" and "marais," and are doubtless of similar origin. Thus, the Macon hills, as the Opelousas hills and Cote Gelee hills, date back to the time when elevation, differentially greatest to the northeast, brought the land to such a level that it was ordinarily above the level of the Mississippi waters, being submerged or crossed by them only at extraordinary flood stages. Precisely similar ridges may be seen in the alluvial deposits of almost any stream, great or small. By subsequent greater elevation of the land above even flood stages of the diminishing Mississippi, with a probable differential elevation to the southwest, these transecting channels became clogged and were converted into the flats and swamps as we see them today. These are bottomed at a few inches, or at most two or three feet depth by the yellow loamy clay of the ridges. Only Deer creek of all the numerous *coulees* from the Arkansas line to Sicily Island has maintained and deepened its channel across this zone of bluff deposits, and this was made possible by the near approach upon the west of the Bœuf and Ouachita rivers.

South of Sicily Island to the Red River the detached areas of bluff deposits lap upon the hills of an earlier geologic period; and the drainage lines across these areas are but extensions of those from the older region, that were partially clogged but not obliterated by the later Columbia clays and loams.

Upon Avoyelles prairie, just south of Marksville, advantage has been taken of one of these coulees—Coulee des

Grus—to connect Choctaw Bayou upon the west with Old River on the east; which was accomplished by a small amount of excavation.

Between Avoyelles prairie and Bayou Cortableau in St. Landry parish, the bluff areas are so small that their drainage is accomplished by short marginal gorges, with steep banks and rapid fall to the surrounding alluvial plain, where they join some small bayou that almost invariably closely borders these island-like areas of bluff.

A noticeable topographic feature of the bluff lands from the Arkansas line southward as far as the Avoyelles prairie, though not so marked as in Southwest Louisiana, is the mounds. Though neither so large nor so numerous as about Lake Charles, they are in all other respects similar. The explanation of their origin offered in a former report applies equally well here. They were there supposed to have been produced by the escape of gases, resulting as one of the products of the reaction between beds of gypsum and decaying vegetable matter. Sulphur was another one of the products. The gypsum is probably of cretaceous age, and the adjacent vegetable bed of lignitic.

Now, the bluff areas under consideration occupy somewhat the same positions upon the *eastern* slope of the cretaceous ridge through the state that the "pimpled prairies" of Southwest Louisiana do upon the *western* slope. Moreover, the existence of *salt* and *sulphur* (probably cretaceous) beneath this region is indicated by the names "Saline Lake," "Saline Bayou" and "White Sulphur Springs"; besides crystals of gypsum are found, and the lignitic group of strata are known to exist a short distance to the west and northwest. Connecting these various evidences, it seems justifiable to draw the conclusion that we had here, upon the eastern slope of the cretaceous backbone of the State, beds of gypsum and beds of lignitic strata; and that the reaction between them has generated the gas, which escaping, has produced the mounds. The smaller size and number of the mounds in this region may be the result of the less thickness of one or both deposits.

Johnson, in his report upon "The Iron Regions of Northern Louisiana and Eastern Texas," makes mention of these "small mounds or mammillæ" in DeSoto parish; and if it shall develop that these mounds are *general* upon both eastern and western slopes of the cretacious ridge through the State, the proposed explanation will have in this fact strong confirmation. Moreover, the occurrence of these mounds in great numbers and considerable size in any region might suggest the possibility of the existence of important deposits of gypsum or sulphur there. Their small size and infrequency over the bluff areas would hardly indicate mineral deposits of value.

Upon Avoyelles prairie, about Marksville, are also seen the natural ponds described formerly as occurring about New Iberia, and northward along the eastern margin of the mound zone. There is no reason to believe that these are in any particular different in origin from their homologues to the south, and the explanation there proposed is offered again for these.

For a fuller consideration of the bluff lands of the Florida parishes and Southwest Louisiana, the reader is referred to the report upon those sections in "Part III Geology and Agriculture."

The water supply for domestic purposes upon the bluff lands north of the Red river is, so far as learned, obtained chiefly from the water-bearing sands and gravels at the base of the Columbia deposits. This water-bearing stratum is reached upon the *front* lands of Bayou Macon at depths varying from twenty-five to fifty feet; and further west at increasingly shallower depths until near the western edge overlooking Bœuf River bottom, it is not an infrequent occurrence that water is obtained at a depth of ten feet. At Floyd, in West Carroll parish, numerous springs emerge from the base of the bluff fronting in Bayou Macon, and it is believed that this is the outer-crop of the water-bearing stratum to which wells are ordinarly sunk. If so, then the height of the bluff here, which, ~~by aneroid measurement~~ is sixty-eight feet, represents approximately the maximum thickness of Columbia deposits.

The section here, repeated on a reduced scale at Delhi, may therefore be taken as typical of the Columbia deposits in Louisiana west of the Mississippi alluvium, and north of Bayou Courtableau.

Following is the section:

1. Surface loamy clay, 1 to 3 feet.
2. Yellow clay, slightly mottled, 15 to 20 feet.
3. Red clay, fine grained, with little sand, 20 to 25 feet.
4. Talus, from which springs issue, 5 to 8 feet.

Nos. 1 and 2 of this section find their counterparts in the sections of the Florida parishes and Southwest Louisiana. No. 3 is characteristic of this section of the State, and probably owes its origin to the greater thickness of Lafayette sands and clays to the northwest.

The section displayed by banks of Red river at ferry crossing, about a mile below Cassandria, Avoyelles parish, shows:

1. Red river alluvium thinning toward hills, 10 to 12 feet.
2. Organic deposit, logs, stumps, etc., 1 to 2 feet.
3. Yellow and mottled sandy clay to water, 25 to 30 feet.
4. Bluish quicksand at water level.

This section shows that the Red river in its course *north* of Marksville is a thing of *very* recent date (geologically), having cut through the Columbia deposits and thus separated Avoyelles prairie from Long prairie to the north. A former course was by way of Bayous Bœuf and des Glaises, and its present course was probably made possible by the existence of a coulee analogous to that appropriated by Deer creek north of Sicily Island. This represents the section at extreme low water stage, and when taken the river at this point was so brackish that stock would not drink. Sharks twelve feet long were caught here. The bluish quicksand probably represents the base of the Columbia. The red clay (No. 3) of the Floyd section does not occur in this.

The only mineral deposit of the bluff lands that promises to be of economic importance so far discovered is the extensive and varied deposit of clay. No factories except of the very crudest kind for the manufacture of these clays were seen. The out-crops of excellent clay along Bayou Macon offer splendid opportunities for the manufacture of bricks and tiles.

This bayou is navigable for flats and small boats for much of the year, and the V., S. and P. and N. O. and N. W. railroads and the Mississippi river are within easy reach for shipment of the manufactured products. The parishes of West Carroll, Richland and Franklin have great possible resources in their undeveloped clays.

The vegetable products of these lands are not essentially different from those of other bluff deposits, except insofar as differences in climate and drainage modify them. This is especially noticeable in the tree growth.

Much better and more abundant supplies of oak are obtained here than from the bluff lands of any other section of Louisiana. This has proved an important source of revenue. The merchantable kinds are varieties of white oak, and it is sold in the rough form and shipped to other points chiefly for the manufacture of staves. The trees are sawed into sections of stave length, split up into sizes convenient for hauling, and either hauled to the banks of navigable streams or thrown into smaller streams and floated down to points where they can be taken up by passing boats. I think no factory has yet been built in this section for the preparation of the finished product for commercial purposes. The willow oak grows larger and is much more abundant in the oak and hickory flats of this region than elsewhere in the bluff lands of the State.

On the other hand, the magnolia, which is so characteristic of the bluff lands of the Florida parishes, is entirely lacking between the Arkansas line and Deer creek bottom bordering Sicily Island. This seems to be a result of the want of the genuine loess over this region. There is almost the same lack of wild cane. Upon Sicily Island both the magnolia and cane occur in luxuriant abundance, and are found thence southward. Here the true loess is recognized.

With these modifications, what has been said for the bluff, applies here. It is naturally fertile and productive where proper attention is given to drainage and restoration. The flats, while in their present condition unsuited to cultivation and considered cold and valueless, may be thoroughly drained, and then come to be considered among the best of soils. On account of the even-textured, clayey character of the land, drainage is largely surface in character, and unless properly directed will rapidly develop destructive washes.

THE MODERN ALLUVIUM.

Under this division is here considered the broad zone (twenty-five to forty miles broad) of modern Mississippi deposits that lie between the bluff-capped hills of Mississippi and Louisiana on the east and the zone of bluff previously described upon the west. This constitutes the present flood plain of the Mississippi River, and in geologic age belongs to the immediate present. Like all flood plains, its topography has scarcely reached the formative stage, being altered by each flood stage of the river, and scarcely to any extent the product of ordinary topographic form-producing agencies. The topography of this section is the result rather of a differential *building up* than of differential *wearing down*.

These alluvial lands are threaded by an irregular network of bayous—sometime channels of the Mississippi itself—which, though sinuous and sluggish, are deep and usually clear. Their ordinary level is much below that of the average flood-plain, and this makes complete and thorough drainage of these alluvial lands by artificial means possible. The natural drainage lines, the bayous, are amply sufficient to dispose of the precipitation upon the flood plain; and it is only when the master stream, the Mississippi, reaches flood stage that drainage is insufficient and the area subject to inundation. The bayous are miniature reproductions of the ~~parent~~ Mississippi, in that each is bounded by its own natural levees, and has its "front" and "back" lands that differ not only in level but in character of deposit. The front lands are invariably higher, coarser grained and more sandy than those back from the bayou; and on this account are more easily drained and first chosen for cultivation.

The alluvial lands of the Mississippi may be classified under four heads, based upon texture and character of drainage. These are: (1) Front lands; (2) back lands; (3) swamp; (4) deep swamp.

THE FRONT LANDS.

As stated above these are the border lands of the Mississippi and all its bayous. They constitute the *natural levees* of all the streams of the region. Marking the lines of greatest checking of current of the sediment bearing streams, here we find the coarsest deposits of the region. As may be seen by reference to physical analyses upon subsequent pages, *sand* is an important constituent of these lands.

The border zone of front lands varies in width from a few hundred yards upon the smaller bayous to several miles upon the Mississippi; the width of the zone at any point being determined by its position upon the concave or convex side of the curve in the river's meanderings.

The *natural* drainage of these lands is *away* from the stream that produced them; but at ordinary stages of the water they may by artificial ditches be made to drain directly into the stream.

The principal tree growth includes several species of oak, water oak and red oak being most abundant; several hickories, including the pecan; sweet gum, and if the soil be very sandy, abundant cottonwood and willow. Perhaps the most characteristic tree of these front lands, especially south of Red river, is the live oak. With its beautiful evergreen foliage and perfect symmetry it is ever the mark of fertile, cultivable lands. A dense undergrowth of cane and vines accompanies these forests. The front lands pass imperceptibly into:

THE BACK LANDS.

Here the soil becomes finer grained, and the clay element largely replaces the sand. The waters which produced them, after depositing their coarser, heavier sediments near the margin of the channel, became more and more sluggish the farther they receded from that channel, and were thereby compelled to further reduce their load of finer sediments. These lands, chiefly on account of the excess of clay, when under cultivation break up into small rounded masses, and thus justify the name, "buckshot," applied to these soils. Being from one to four or five feet lower than the front lands, drainage is more difficult and less perfect, and is into the back swamps.

The tree growth is marked by an increase in the number and size of species adapted to a clayey soil and an excess of moisture. Water oak and willow oak become more numerous and larger in size, as do also the hickories. Elm, hackberry and ash begin to appear, and varieties of white oak assume greater importance. Live oak, cottonwood and willow disappear. The same dense undergrowth of cane and vines is found. The percentage of sweet gum increases and an occasional black gum is found.

The back lands in connecfion with the front lands constitute at present the cultivated portion of the Mississippi alluvium. Plantations are laid off with a prescribed frontage upon the river or bayou, and extending a prescribed distance back, usually to or into the back swamp. The front lands, because of their nearness to an unfailing supply of water, their superior drainage and more healthful general conditions are selected as building sites; and those not so utilized together with the back lands constitute the cultivated portion of the plantation.

While requiring different methods of cultivation and best adapted to different crops, the two classes of land are equally prized by the planter. The front lands are more easily cultivated, but they are likewise more easily exhausted than the back lands.

The two questions of *drainage* and *water supply* are perhaps the most important for planters in these alluvial lands. While the hill farmer must use every means in his power to conserve the moisture in his soils, at the same time so directing natural drainage as to protect his lands from waste, the farmer of the alluvial lands is most concerned about being able to dispose of the precipitation rapidly enough for his growing crops. The one must be ever alert lest his drainage ditches get the better of him; the other, lest his ditches become clogged and his crops thereby injured. There is never any fear that the artificial drainage ditches will develop into troublesome gulches as in the hills.

Planters whose plantations front upon the Mississippi usually find the river so inaccessible, because of steep and muddy banks, that it is little used as a source of water supply. For household purposes two sources are here available: cisterns and wells. In driven or bored wells, water is obtained at shallow depths, but is not considered wholesome. Deeper supplies are better, though so long as the well does not reach the bottom of the alluvium the water will hardly be palatable. Although I am not aware of any wells having been sunk below the alluvial deposits, there is no sufficient reason why they should *not* be, when a pure and wholesome supply would undoubtedly be found in abundance. A well at Baton Rouge, less than 800 feet deep, furnishes a supply of water sufficient for the city and almost chemically pure; and at Baker, La., is an Artesian well which probably has its source in the same water-bearing stratum. May not this same source be found at Port Allen or Plaquemine? Should it be, or should *any* water-bearing stratum be reached *below* the alluvium, the probabilities are that it would produce a *flowing* well. The other source of water for domestic supply is cisterns, either overground or underground. Either of these, if properly cared for, furnishes wholesome supplies of water. As a matter of fact, they are so frequently neglected that they become disease-producing rather than health-giving. Underground cisterns, if walled with brick and then cemented so as to exclude all seapage, and if supplied from a *clean* roof, and, better still, if filled *only* during the winter months, furnish cool, palatable and wholesome water.

Unfortunately the idea is too prevalent that, while man requires wholesome water, *anything* is good enough for domestic animals. Hence we often see horses and mules, from which hard and faithful service is expected, and cows, from which we expect wholesome supplies of milk and butter furnished with water from shallow, stagnant and often muddy pools, which are often little better than cesspools. Plagues, which are directly traceable to these impure sources of water supply carry off thousands of dollars worth of stock annually, and yet there is wonder where the trouble lies. Give the stock, if possible, the same wholesome water we require for ourselves and disease will be much less frequent and fatal.

Unquestionably the cheapest and a very good water supply for stock is that obtained from wells—the deeper the better.

Plantations fronting upon the bayous are rather more fortunate so far as water supply is concerned. For much of the year, during the growing season and periods of abundant precipitation, the bayous furnish very good supplies of water. While not to be compared to cisterns, or wells sunk *beneath* the alluvium, yet they are infintely better than surface pools, and to be preferred to shallow wells. During the long dry summer season, and in the autumn when the leaves from the forests of deciduous trees fall or are carried into them, they become stagnant and foul and should be avoided. This supply could be greatly improved by giving attention to the removal of trunks and branches of trees that fall or are washed or thrown into them and become stranded. These bayous, having no large lateral branches, being supplied chiefly by numerous small streams near their sources are generally clear, and the abode of a great variety of edible fishes.

THE SWAMP.

As the front lands grade into the back lands so these grade into the swamp. The areas thus designated, while not so easily drained as the back lands, are nevertheless capable of *thorough* drainage. They are considered as swamp and useless for cultivation, only because under conditions that have existed in the past they have been too frequently overflowed to make their clearing and cultivation profitable. Under a system of protection that will shut out the flood waters from the master streams they will become available for cultivation. At present they are not so.

Their tree growth consists chiefly of sweet and black with some tupelo gum, large and abundant; abundant ash of sufficient size and quality to make it valuable for manufactures; scaly bark hickory, elm and red maple, white, water and willow oaks, sycamore and cypress. The undergrowth while still dense is marked by a failing of the cane. At present these swamp lands are chiefly valuable for their supplies of hard wood lumber. Their adaptation to cultivable uses while possible must wait upon their greater security from inundation.

THE DEEP SWAMP.

—This area, chiefly valuable for its forests of cypress and gum, is subject to too deep and too frequent inundation ever to be used for cultivation, at any rate not until more available lands prove insufficient for the increased population. These are not only subject to inundation from the master streams, but they are the catch basins from which the bayous take their rise. Their inundation is often more than ten feet. They are not sharply defined from swamp lands—from the nature of their origin they could not be—but pass gradually the one into the other. Both are in process of building up, but being checked in this by having their source of materials cut off by the extension of the levees, their further elevation will be exceedingly slow or well nigh cease.

NAVIGABLE STREAMS.

No other section of this State, or indeed of the United States, is so well provided with navigable streams as the alluvial lands of Louisiana. The chief of these is of course the Mississippi, which borders the section upon the east for over three hundred miles from the northern boundary of the State to Baton Rouge, and *passes through* the section thence to the Gulf, a distance of almost two hundred and fifty more, thus giving these lands a frontage of over seven hundred and fifty miles upon the greatest river of the whole earth.

Like all streams flowing into bodies of salt water, there is a rapid shoaling of the river as it nears the Gulf; but by confining the water to a narrower channel and thus increasing the current by means of the jetties a sufficient depth is maintained to permit the entrance of the largest ocean steamers. Once past the shoals there is no physical obstacle to the passage of these vessels at all times as high as Baton Rouge, and for much of the year far beyond the northern imits of this region.

The Mississippi River exceeds all other rivers of the United States in its importance in promoting interstate commerce; so much so that there is a growing disposition to place all means for its improvement wholly in the hands of the National Government. The maintenance of a sufficient channel at low water stages has long been considered the legitimate work of the National Government; and as the depth of channel at low water stage is directly dependent upon the proper control and direction of the river at flood stage, all means looking to such control should likewise be in the hands of the National Government.

An estimate of the importance attaching to frontage upon this great waterway may be had by a consideration of the increased valuation of these lands over equally productive lands more remote from the river. While cultivated lands fronting upon the Mississippi River are valued at from $75 to $100 an acre, and are not in the market, lands in every other particular similar, but removed from a navigable stream may be had in almost any desired amounts at from $5 to $25 an acre. The vast difference in price now existing is abnormal, and must eventually decrease.

Next in importance to the Mississippi River proper is its principal tributary, the Atchafalaya. While vast amounts of money have been spent in *maintaining* a sufficiently deep channel in the parent river, here we see engineering skill taxed to *prevent* a further deepening of the channel. The former task has proven the easier and has been much more successfully accomplished.

A probable former route of the main channel of the Mississippi, but abandoned because of differential elevation to the southwest, the Atchafalaya has continued to the present a distributary for the flood waters of the parent stream. During the ages that record the eastward shifting of the Mississippi the mighty river has carried its burden of sediment to the sea, and consequently lengthened its course and decreased its slope. At varying intervals long and sinuous routes have been abandoned for shorter and more direct, while at the same time distributaries have been maintained for the disposal of flood waters.

As differential elevation to the southwest was probably influential in causing the river to shift from the western to the eastern side of its broad valley, so it may be that a similar differential elevation in the southeast has hastened the abandonment of its outlet through Lake Pontchartrain for a more westerly and present course. Whatever the combination of causes a greater and greater volume of water at flood stages pours through the Atchafalya, until now the prospect is that this may, in the *natural* order of events, *again* become the route of the main river to the gulf. It offers a shorter, more direct and consequently much steeper gradient than the present channel of the Mississippi, and there is an increasing tendency to follow it.

The Atchafalaya has rapidly increased in breadth and depth in recent years, having increased in cross-section more that fifteen per cent. since 1890.

At this unprecedented rate of development it would not require many years for it to divert first the waters of Red river, and but little later the upper Mississippi. This would be river piracy on the grandest scale perhaps known to history, and to prevent it is now the work of engineers.

The increase of volume of the Atchafalaya has been attended by an increase in importance for commercial ends. Its upper waters are plied regularly by numerous smaller craft, and would accommodate the largest river steamers were its connection with the Mississippi sufficient. This will almost certainly be made sufficient in the near future, when the development of this fertile district begins in earnest.

The Atchafalaya, in common with every river of importance in Southwest Louisiana, expands in its lower course into a broad, shallow lake. Below these lakes is a deep channel to the sea. In them the current of the streams is so checked as to permit the deposition of almost all of the sediment carried down to them. This deposition is hastened by their proximity to the gulf, which often renders them brackish. These lakes offer the chief hindrance to coastwise vessels ascending the rivers, often for a distance of from fifty to seventy-five miles, and, in the case of the Atchafalaya, to its source.

The expansion in the Atchafalaya, known as Grand Lake, is the obstacle in that stream to its wide usefulness as a water communication with the gulf. By judicious dredging and construction of retaining dikes, it is believed a navigable channel can be maintained through this and similar lakes, and the advantages of deep and safe harbors thus secured to points far inland. The invariable shoaling at the extreme mouths of the streams may be overcome as it has been at the mouth of the Mississippi.

Grand River and Bayou Lafourche, by reason of their connection with the Mississippi, thus establishing a permanent water supply, are important navigable streams in the lower alluvial regions. Bayou Manchac could in similar manner be made a valuable stream upon the east, as also numerous shorter distributaries for the lower river. East of the Atchafalaya and north of Bayou Plaquemine the bayous are too small to be of more than local importance, but these could be made much more useful by clearing them of the drift with which they have become clogged.

Tributary to the Atchafalaya upon the west are the two important bayous, Teche and Cortableau. These, though dependent upon precipitation over their basins for their supply for a considerable period during the year, are navigable to Arnaudville and Washington, and are important carriers for the produce along their routes.

The Red River has more than fifty miles of its lower course through the Mississippi alluvium and is navigable throughout the year; and its only important tributary in this region from the north—Black River—is of about equal length and likewise permanently navigable. North of Trinity, in Concordia parish, the Ouachita and the Bœuf rivers pass west of the bluff lands, and are both navigable streams, the Ouachita permanently and the Bœuf at flood stages, while in the alluvial lands proper no permanently navigable stream for other than extremely small craft occurs. The Tensas River and Bayou as far north as the V., S. and P. R. R. and Bayou Macon and Joe's Bayou to the latitude of Floyd are locally of great importance, inasmuch as they not only put the section through which they pass in touch with distant markets through the Ouachita River, but by way of the V., S. and P. R. R. as well. These bayous could be made navigable for much larger boats and for considerably longer periods with very small expense devoted to judicious dredging and clearing of rafts and drift. A channel once opened in these streams does not readily silt up for the reason that the waters entering them are filtered in the swamps, and thus bring but little sediment. The streams are clear, except when the Mississippi breaks through its levees in Arkansas or North Louisiana and pours a flood of sediment-charged water into them. Such unnatural flood stages are the only times when they overflow their banks.

No section of the State offers greater returns for improvement of its water courses than the alluvial lands of the Mississippi north of Red river, comprised in the parishes of Concordia, Tensas, Madison and East Carroll. The intricate network of bayous makes this region, for much the greater part, easily and thoroughly drainable, and reduces the area of deep and uncultivable swamp land to an exceedingly small one. The larger bayous, having their channels cut deep and wide by volumes of water that no longer pass regularly through them are scarcely different from so many great, sinuous, artificial canals, which serve to bring the products of the farm within easy reach of the markets.

This section has likewise been the greatest sufferer from insufficient protection against pent-up floods of the Mississippi River. Many thousand acres of most fertile land, which was considered safe from inundation when the Mississsippi had simply to overflow its natural levees to spread over its flood plain, and which had reached a high state of cultivation, have been practically abandoned as unsafe, or at least unprofitable, since the development of the levee system began. The floods in the Mississippi, restrained for a time, have finally burst their bonds and practically depopulated many formerly populous sections; witness the once beautiful and prosperous, but now almost forgotten village of Monticello, in East Carroll parish, on the bank of the Macon. With the perfection of the levees, loss from inundation has become less frequent, but the feeling of insecurity even yet prevents this section from taking the former high rank it once occupied among the agricultural sections of the State.

PROTECTION AGAINST OVERFLOW.

While it may not seem the province of this report to enter into a detailed consideration of the vexing question of protection against Mississippi floods, yet inasmuch as it is to some extent, at least, a question for the geologist, brief consideration is here given. This seems all the more proper when it is remembered that the primary object of the report is agricultural, and anything that looks to the betterment of lands now under cultivation, or the reclamation of other available lands, finds a proper place here. Already one of the most important agricultural sections of the State, the Mississippi alluvial lands, would be many times multiplied in their assessed valuation were there a feeling of *perfect* security against floods from the parent stream. Any proposed means looking to increased security should be welcomed.

It would seem a safe principle that any *artificial* means for protection against floods are the better the nearer they follow *natural* means adopted by the river itself. If this be true, then the bitter controversy between the advocates of the "all-levee" and of the "outlet" systems of protection must be settled upon compromise ground.

Every river emptying into the sea through a broad flood-plain builds *natural levees* along the borders of its channel, and maintains distributaries, or *natural outlets*, that serve as means of protection to the flood-plain against all except flood stages of the river. Not only the parent stream, but, on a smaller scale, the distributaries themselves build natural levees. If all streams, in their natural state, adopt these methods, then an extension of these would seem to be the safe and proper means of complete protection against floods. The master stream and all distributaries would require a strengthening and enlarging of their natural levees. Such distributaries that might thus be made to do service as outlets in time of flood are, Bœuf River, Bayous Bartholomew, Macon and Tensas, Atchafalaya River, and Bayous Plaquemine and Lafourche upon the west, and Bayou Manchac upon the east. Other short artificial canals would make outlets into Lake Pontchartrain and into the series of lakes opening into Barataria bay.

If necessary the Red River could be easily made to empty its waters through the Atchafalaya river when the stage of the Mississippi demanded it. As the maintenance of an unobstructed Mississippi as a highway of commerce not only between states, but between this and foreign countries is a question of national concern, the maintenance of the levees and proper connection with outlets are matters that may very properly be turned over to the National Government. The leveeing of the distributaries, being for the advantage of the state in which they occur, is properly a matter for the state to attend to.

With well constructed levees along the parent stream, and properly maintained outlets, the danger from overflow would be reduced to such an extent as to amount almost to security, and the immediate effect would be to make available and give value to many thousand acres of most excellent farming land that is now avoided from fear of inundation.

To make assurance against overflow doubly sure, the following suggestion is offered in regard to the further protection by the construction of additional levees: It is a well established principle that a stream of given volume flowing through its flood plain will meander within certain prescribed limits. In the case of the Mississippi these limits are marked by the convex sides of "horseshoe lakes," "old rivers" and other sections of the old and temporarily abandoned channels. Beyond these limits the river has no power to go, and within them it may periodically occupy every part. The present system of levees follows the present channel as closely as seems advisable, and must from time to time be rebuilt, because of encroachment of the river upon them. About the location of such levees we have nothing to say. A system of levees, built by the State, equally strong with the present levees, but located so as to be *tangent* to the abandoned sections of the old channel would be much less expensive in their initial construction than the present levees, as they would be much shorter; would never have to be rebuilt by reason of the encroaching river, and would reduce the danger of inundation from crevasses to a minimum. It is such a system we would advocate for the reclamation of the alluvial lands of the Mississippi. Such levees would make most desirable railroad beds, both because of directness and of location in one of the richest agricultural regions of the globe, and would, no doubt, be sought for such and thus be of but slight or no ultimate cost to the State. If desirable, these levees could, with but slight additional cost, be connected with the front levees at intervals by short cross levees. The drainage of the inter-levee region could be easily maintained, and the main objection to the scheme would be its initial cost. This would be far more than repaid to the State in the increased valuation of its lands, produced by absolute security against inundation from crevasses.

CULTIVATED CROPS.

But little need be added to what was said in "Part III Geology and Agriculture," concerning the cultivated crops of the bluff lands. These, perhaps, above all other lands in the State, offer the best opportunities for diversified agriculture; and offering, as they do, so many advantages for the building and beautifying of homes they are naturally sought by those planters and farmers who prefer country life. Though formerly considered valuable chiefly as cotton lands, recent experiments at Baton Rouge have demonstrated their suitability to the growth of a superior grade of cigar wrapper tobacco. The possibilities of these lands for tobacco culture are very promising. Their value as sugar lands is likewise increasing. Long ago sugar cane was successfully and profitably grown upon the bluff lands at Baton Rouge, but with the advent of central factories that bought cane by the ton without regard to the sugar content, cane culture on the highlands was abandoned for the more productive alluvial lands. Now that there is a growing disposition on the part of sugar factories to recognize the higher value of a cane with high percentage of sugar; and since it is a well established fact that cane grown upon bluff lands contains a higher percentage of sugar than that grown on the alluvial lands, sugar planters are again turning their attention to the highlands, since these lands are more easily and cheaply cultivated than the modern alluvium.

The alluvial lands have been pre-eminently the homes of the large planters. The great staple crops, cotton, sugar and rice, have been, and are still produced in abundance. As each in turn has been most profitable planters have turned their attention to its culture. Since the discovery of the suitability of the great prairie region of Southwest Louisiana for rice culture, the Mississippi alluvial lands have been turned almost exclusively to cotton north of Red River and cotton and cane south of it. Below Baton Rouge but little cotton is grown. These cane lands of South Louisiana are divided up into large holdings, and diversified agriculture for profit upon them is a thing unknown.

Although it would be to the interest of the State for these lands to be owned in smaller tracts by men who lived upon them, and thus had an interest in building up educationally and morally the sections in which they lived, yet, so long as our economic system is such as to make possible the accumulation of large fortunes in a few years by planting vast tracts in a single crop, planted, cultivated and harvested by ignorant and uninterested labor under intelligent though equally uninterested direction, just so long will our rich alluvial lands yield up their riches to the few rather than support the teeming home-making population of which they are capable.

In these alluvial lands, in the parish of St. James, is the now famous Perique tobacco section. No doubt the same intelligent cultivation and handling of the crop would secure equally good returns of this much-prized variety of tobacco in almost every other section of our alluvial lands. Without physical and chemical analyses of the soils it is impossible to discover here any peculiarities of soil that would make this particular region suitable for any single crop above other alluvial lands.

Recent experiments at Audubon Park with alfalfa have demonstrated very fully the pre-eminent suitability of Louisiana alluvial lands for that desirable crop. From five to eight cuttings a year, yielding as much as one and one-half tons of hay per acre per cutting, have been obtained. When it is remembered that most of our hay is shipped from the Northwest and costs us from $10 to $15 per ton, and that this may be to a great extent replaced by alfalfa, we may arrive at an appreciation of the value of this crop, whether grown for home consumption or for profit. Bermuda and carpet grass are the chief grazing crops of the alluvial lands and furnish good pasturage for most of the year. Sorghum, Indian corn and cow-peas are important cultivated forage crops.

Near New Orleans, market gardening has proven very profitable, and with quicker time and cheaper rates to the Northern markets this industry will be capable of almost indefinite extension.

In the extreme southern part of this region orange culture has brought good returns. It is believed that many fruits will be found suited to this soil and climate, but beyond the experiments made at Audubon Park but little is known of the possibilities along this line.

FISH AND OYSTERS.

Scarcely better fishing grounds can be found than those offered by the multitude of bayous, lakes and rivers of these alluvial regions. From the Arkansas line to the Gulf the waters teem with the greatest variety of edible fishes. Though chiefly of local importance, furnishing to a vast majority of the population a very good substitute for beef and pork, in a few places the fish industry assumes importance. At Melville and other points along the Atchafalaya, great quantities of catfish are shipped. The markets of all the villages are supplied with a good variety of fishes from nearby streams. As we approach New Orleans and the Gulf, the industry assumes greater importance, and the lakes and coastal waters teem with fishing craft.

In the coastal bayous and bays along the gulf the oyster culture has developed rapidly, and now our Louisiana oysters may be seen in distant markets, and are esteemed by many superior even to the Chesapeake Bay oysters. The oyster industry, already important, is rapidly expanding.

III. SOILS.

Although it was the original intention to include in this report a discussion of the soils of the region examined, it is now thought best to present this as the final supplement of the reports upon the preliminary survey of the State. A large number of typical soils have been collected and are now being analyzed in the chemical and physical laboratories of the survey. Upon the completion of these analyses a full discussion of them, together with a soil map for the entire State, will be published. It seems sufficient here to say, that in regard to the "bluff" lands from the northern limit of the State southwest there is a gradual, though not regular, decrease of the *loam* and a corresponding increase of the *clay* element in the soil. In like manner the more recent alluvium is characterized by a failing of the sand constituent as we go southward. There is not, however, as great a variation in the physical constitution of the soil from the Arkansas line to the Gulf as may be observed in passing from the "front" lands along the Mississippi back to the "deep swamp." In both cases the difference is due to deposition of sediment from checking of current upon less steep gradients.

Aside from the variation of the chemical composition of the soil, due to a difference in the amount of sand, there is little difference chemically in the character of the alluvium in East Carroll parish and at New Orleans. The difference of plant growth in the two regions is due chiefly to differences of climate.

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APPENDIX.

A HAND-BOOK

. . . OF . . .

LOUISIANA,

. . . GIVING . . .

GEOGRAPHICAL AND AGRICULTURAL FEATURES

. . . TOGETHER WITH . .

Crops that Can be Grown,

Description of each Parish, Climate, Health, Education, Fish and Oysters, Rail-roads, and Watercourses.

COMPILED AND WRITTEN BY REQUEST

. . . FOR . . .

The State Immigration Association,

. . . BY . . .

WM. C. STUBBS, Ph. D.,

. . . DIRECTOR . . .

STATE EXPERIMENTAL STATIONS.

NEW ORLEANS:
PRINTED BY NEW ORLEANS PICAYUNE.
1895.

IF you know of a farmer who desires to better his condition, you will do him an act of kindness by handing him this pamphlet

Louisiana can furnish homes for thousands of farmers who will be welcomed.

Those desiring information about location and lands should address,

HARRY ALLEN, President,
STATE IMMIGRATION ASSOCIATION,
620 Common Street,
New Orleans, La.

SUGAR EXPERIMENTAL STATION,
AUDUBON PARK,
NEW ORLEANS, LA., Jan. 1st, 1895.

HIS EXCELLENCY MURPHY J. FOSTER,
Governor of Louisiana:

SIR—I hand you herewith the M. S. of the hand-book of Louisiana, which your Excellency requested me to write for publication through the State Immigration Association. It has scarcely been a month since this request was communicated to me and the very short time allowed has proven inadequate for an exhaustive treatise upon so fertile a subject as Louisiana. Besides, my official duties have been particularly heavy during the grinding season, and hence only a small portion of the time given me was available for the work assigned. However, I have collected hastily, the salient facts relative to Louisiana and trust they may subserve the purpose of attracting to our State many worthy immigrants. I have freely used all *reliable data* obtainable without giving credit to any one, since such a pamphlet must be largely a "compilation."

Respectfully submitted,

WM. C. STUBBS,
Director.

"Of the typical population of Louisiana, also, a special mystery seems to be made, but Louisianians have much reason to be proud of their historical descent. They have a history as authentic and as valuable as the annals of the Puritans of Massachusetts, or that of Catholic Maryland. The rearing of the States' colonial structure by one nation and its blending into colonial dependance upon another, contains no special mystery. They are hospitable, brave and generous people, whether tracing their history back to French Bienville or Lausatt; to Spanish O'Reily or Salcedo, or to American Claiborne.

That is the native State antonomy, which, blended with English, Irish, and Scotch emigration and the descendants of the Cavalier and Huguenot settlers from Virginia, Kentucky, Georgia, Alabama and the Carolinas, make up the population of Louisiana. A people exhibiting all those finer traits which betoken the cultivation of noble traditions and refined associations, evidenced in the generous hospitality, the chivalric spirit, the punctilious courtesy, the knightly hand, the Christian knee, the clean firesides and the holy altars cherished in the hearts and homes of as proud and pure an aristocracy as the world has ever known."

LOUISIANA

Governor Murphy J. Foster, in his last message to the legislature of this state, used the following forcible language relative to the agricultural interests of Louisiana:

Louisiana has nearly 45,000 square miles of territory, containing some 28,000,000 acres. Of this amount about 13,000,000 is of alluvial origin and the rest good upland. The alluvial region is now only cultivated along the banks of rivers, and the rivers protected mostly by public and private levees. The uplands are almost all susceptible of cultivation.

The geological position of Louisiana forbids the existence of mineral products, save salt and sulphur, and the general low topography furnishes no water power for the wheels of manufactories. Louisiana must therefore remain for a long time as an agricultural state. Of her 28,000,000 acres, not quite 3,000,000 are in cultivation. Upon these acres there were grown last year products valued at some $75,000,000, distributed as follows:

Sugar	$35,000,000
Cotton	21,000,000
Rice	3,000,000
Fruits and vegetables	2,000,000
Corn, oats and hay	10,000,000
Oranges	1,000,000
Live stock and other products.	3,000,000

From these figures very interesting and instructive deductions might be drawn of the per capita distribution of money resulting from the value of agricultural products alone.

All of her uplands can be cultivated under scientific methods, and be made to yield profitable returns. This has been demonstrated by the settlements made on the Illinois Central Railroad, in the piny woods of east Louisiana, and on the Southern Pacific, in the prairies of southwestern Louisiana. A thrifty, industrious and intelligent yeomanry from the northwest has converted these lands into prosperous village farms, profitable to the owners, to the parishes in which they are located, and to the state.

After our present levee system has been perfected, much of our alluvial lands, by proper drainage, can be reclaimed, adding to our present arable area thousands of acres of the most fertile land on the globe. To improve the land now occupied, by introducing the best systems, rotation of crops, preparation, cultivation and fertilization of the soil, is the present duty of our state. Simultaneous with this development must come at an early day a large demand for unimproved lands by the inhabitants of the colder regions of the north.

To the thoughtful students of Louisiana's resources, as well as to the true patriotic citizen striving for the future welfare of his state, it is apparent that every effort must be made by the state to develop our rural interests along the lines of the most advanced agricultural teaching.

Louisiana is situated between the parallels of 28 degrees 56 minutes and 33 degrees north latitude, and the meridians of 89 degrees and 94 degrees west longitude. The Mississippi river splits it in twain, with far the larger portion, about 37,000 square miles, upon its western banks. Exclusive of lakes and bays, it has 45,440 square miles of territory, of which about 20,000 are of alluvial origin and the rest are uplands of varying character. In north Louisiana the hills attain to the height of 500 feet, and from this height may be found every altitude, until we reach the sky-skirting prairies of the southwest, where the general topography is only 30 to 50 feet above the sea level.

CLIMATE.

Its proximity to the gulf of Mexico secures a prevalence of southern winds, cool and moisture laden, which mitigate the extremes of weather, experienced by states to the north. Though our summers are prolonged, the heat is never oppressive, the thermometer rarely reaching 95 degrees. In carefully kept records of the three experiment stations for the past eight years, 98 degrees has been the highest recorded temperature at New Orleans, 99 degrees at Baton Rouge and 100 degrees at Calhoun, in the extreme northern portion of the state. These maximums have been rarely reached, not oftener than one or two days in a summer. The winters are usually mild, with an average temperature of about 53 degrees in the southern, and about 45 degrees in the northern part of the state. Occasionally the tail end of a northwest blizzard, which has spent its greatest violence in more northern regions, reaches this state and remains for a few days to destroy tender vegetation and chill its inhabitants. These visits are not frequent, rarely occurring more than once or twice in a season. They are, however, so destructive as to force the culture of tropical fruit (oranges, etc.) to the immediate section bordering on the gulf. In 1886, during the prevalence of one of these blizzards, the temperature at New Orleans fell to 17 degrees Fahrenheit, the lowest ever known. Since that time 20 degrees has been the minimum attained. But for these occasional blizzards tropical fruits could be grown over most of the state and ordinary summer vegetables raised the year round.

RAINFALL.

The average yearly rainfall at New Orleans is about 70 inches, decreasing in quantity as one goes northward, with 45 inches as an average in the extreme northern portion. The heaviest showers fall in summer during the growing season. Winter comes next in its quantity of rainfall, while our springs and autumns are our dry seasons, with only occasional showers. Such seasons are conducive to the welfare of our staple crops, cotton, sugar cane and rice; dry springs, permitting a successful planting and cultivation of these crops and dry autumns, so essential to the rapid and economical harvesting of them. Our regular rains are from the southwest, yet in summer they sometimes come from the northwest, and when they do, they are usually accompanied by thunder and lightning.

The climate of the entire state, from October till May, is an ideal one, attractive alike to the invalid and tourist, and thousands of visitors from the north are yearly seeking this state in quest of health or enjoyment. The hotels of New Orleans furnish attractive homes for the opulent and fashionable, while men of moderate means can find cheap and excellent homes in the similar hostelries and private boarding-houses of this city, in the towns and villages scattered over this state and along the gulf coast of Mississippi.

GEOLOGICAL FEATURES.

An erroneous impression generally prevails that Louisiana is wholly alluvial—a low-lying swamp which has to be drained, ditched and leveled to make inhabitable. An examination of the figures given above refutes in unmistakable terms this error. Not only the larger area of the state is upland and above any possible flood, but a slight majority of the population of the state, outside of the city of New Orleans, reside on these uplands. To this portion of the state belongs nearly seven-tenths of her rural white population.

GEOLOGICALLY

speaking, Louisiana is a very young state. It had no existence at the end of the paleozoic age. Only a few closing chapters of the world's history are here recorded, and these have been written by water, which is now, as ever, the great factor in landmaking in this state.

CRETACEOUS.

A small portion of cretaceous strata, consisting of hard limestones, gypsum, salt, sulphur and marls, have been laid down at the close of the mesozoic age of our earth at the bottom of a deep but gradually shallowing sea, extending from Arkansas into northwestern Louisiana, and on in a southeasterly direction through the state to Avery's island (salt works), which rises out of the salt marshes of the gulf of Mexico. This geological period is found now only in isolated spots, ancient peaks of this ridge, former cretaceous islands in a tertiary sea. Outcrops of this period are found in Bienville, Winn, Rapides, St. Landry and other parishes, but no prominent topographical features are given to the country by its presence. It forms the backbone of this state, and upon it and against it are deposited the debris of subsequent ages. In many instances it is revealed only by the well-diggers' spade, bringing up fragments of crystalline limestone and gypsum. These strata are nearly always accompanied by salt, and the old salt works of Webster, Bienville, Winn and Rapides parishes are along this ancient ridge. In Winn and St. Landry parishes occur marble quarries, large bluffs of hard horizontally banded crystalline cretaceous limestone, nearly 60 feet in height. Such cretaceous outcrops are the oldest lands in Louisiana, and have perhaps remained ever since as dry land, unaltered by subsequent geological changes. Frequently the overlying tertiary and quaternary deposits have been removed by the force of water, exposing areas of 40 to 60 acres in extent, usually along the courses of the smaller streams. These exposures are bare of vegetation and covered with an efflorescence of salt, forming the licks of this country. In these exposures shallow wells were sunk, and from their saturated brine, standing nearly or quite up to the surface, large quantities of salt were manufactured during the late war. Drake's, Rayburn's, King's, Price's and other salt works extensively operated during the war were located on these outcrops. Since the war, on Petit Anse (Avery's) island, in the extreme southern portion of the state, situated on this same ridge, has been found enormous deposits of nearly pure salt. These mines have been for years extensively worked, and the present output gives no sign of exhaustion.

It is inferred from borings and exposures that this cretaceous ridge is a narrow one, with occasional high promontories. Its sides are steep, and in many instances, almost perpendicular. Wells of considerable depth have been dug in close proximity to this ridge without striking this foundation. An artesian well at Shreveport, 1100 feet deep, has furnished a water strongly impregnated with salt, and it is thought that this water is furnished by the upper cretaceous sands. Again, at Sulphur City, twelve miles west of Lake Charles, in Calcasieu parish, the sulphur mines occur, at (circa), 500 feet below the surface, another revelation of this formation. These borings prove a west, or southwest, dip of this foundation.

In the history of our earth the cretaceous deposits represent the close of the middle, or mesozoic, age. The limestones, marls and sands of this period contain the first record of modern life on our globe, mingled side by side with the forms of past ages, now fast disappearing. These cretaceous deposits are found all along the Atlantic coast from New Jersey, through Delaware, Maryland, Virginia, North and South Carolina and Georgia. In these states their course is nearly parallel with the Atlantic coast, but on reaching Alabama they change direction to the west, and spread out into a wide belt, forming the famous prairies and cane brakes of this state. Entering Mississippi, they assume a northerly direction, and give to that state her famous lime processes. From Mississippi they invade Tennessee, as far north as the mouth of the Ohio river. Beginning again in the trans-Mississippi region, in Louisiana, they pass through Arkansas and Texas, and tending northward, occupy almost the entire plains and prairies along the Pacific.

This formation serves in Louisiana as the axis, against which subsequent geological deposits were made, and, agriculturally, is of no value, owing to small areas exposed. But on this formation have been found the extensive salt and sulphur deposits of the state, and on account of the future relation of these articles to the wealth of this country, it is of great economical importance.

Prof. Hilyard, on reporting to the New Orleans Academy of Science the results of his reconnoissance, has this to say relative to the salt mines of Avery's island, and the sulphur beds of Calcasieu:

"In view of the grand scale upon which the conversion of ocean into land occurred towards the close of the cretaceous period, as exemplified by the magnitude of the gypsum bed, it is probable that the original extent of the rock salt bed was correspondingly great, and that, however it may have been encroached upon by solution and erosion during the tertiary and quaternary periods, it will still be found of sufficient thickness and accessibility for exploitation at numerous points outside of Petite Anse."

The same probabilities hold good, though in a much more restricted sense, of the Calcasieu sulphur bed. The obvious fact that the drift currents have encroached heavily upon both deposits, renders the determination of their occurrence in particular localities a matter of considerable difficulty and delicacy.

It is, therefore, highly probable that similar deposits of salt, gypsum and sulphur to those now known may be discovered in the near future.

THE TERTIARY FORMATIONS.

At the close of the mesozoic age powerful forces produced an upheaval of this cretaceous ridge, causing many fractures and folds, and gave to Louisiana an outline of its future drainage channels. This ridge, trending diagonally across the state, formed two immense shallow basins, the Red on the west and the Mississippi on the east. Into these shallow waters were deposited the sand and shales of lignites of the early

EOCENE.

In Louisiana this is known as the "lower lignitic," since lignite and lignitic clays abound. In DeSoto and Sabine parishes beds of lignite occur in many places. The country underlaid by this formation covers nearly the entire northwestern portion of the state, but while this geological formation underlies this entire section, it rarely reaches the surface, and, therefore, takes little or no part in soil formation. The soils here, as in other parts of the state, are being formed from the yellow, sandy clays and drift sands of the quaternary age, deposited after the state had definite form and shape. But this section is to be emphasized by virtue of a large amount of lignite which it contains. On the Sabine river an outcrop of 14 feet in thickness is reported in the banks. Nine miles southwest of Mansfield a lignite seam 3 1-2 feet thick forms the bed and bank of the stream. The coal preserves its woody structure, is glossy and very firm. Mixed with charcoal, it is used by local blacksmiths with success. This coal contains, by analysis, 5.94 per cent ash, 38.93 per cent fixed carbon, 38.52 per cent volatile matter, and 16.61 per cent moisture. It has also 1.94 per cent sulphur.

MARINE CLAIBORNE.

The deposits of this group are resting directly and conformably upon the lower lignitic. North of the Vicksburg, Shreveport and Pacific Railroad these deposits along their western boundary trend northwest. South of this railroad their course is nearly due south. The eastern boundary of this group passes through Gibbsland, in Bienville parish. This formation runs as far south as Alexandria, where it is crossed by the sands of the grand gulf group. This formation nowhere reaches the surface, and therefore, takes no part in the formation of the soils, but it is characterized by the presence of marls and glauconite, which can, under proper conditions, be utilized as valuable amendments to soil fertility.

UPPER LIGNITIC.

The eastern portion of the hills of north Louisiana are underlaid by this formation, which rests conformably upon the Claiborne sands and clays. In lithological material and physical structure this group is strangely similar to the lower lignitic, from which it is separated by the marine Claiborne. Beds of lignite occur also in this formation, but they are rarer and not so thick as in the lower lignitic.

While the above groups were being deposited, the dry land was slowly emerging from the gulf and the rivers and creeks were sculpturing a landscape similar in topographical features to that presented to-day. But here the scene changes and a slow submergence takes place. Muddy shallow seas prevail and a heavy deposit of gray clay is placed over all the hills of north Louisiana. These clays are called by Dr. Lerch

ARCADIA CLAYS.

"They cross the state from east to west, resting upon the deeply eroded surface of the lower lignitic, marine Claiborne and upper lignitic formations, reaching northward into Arkansas, westward into Texas and eastward to the flood-planes of the Mississippi and southward to the calcereous marls and limestones of the overlying Jackson and Vicksburg groups." They are of the highest economic importance, since they form the water-carrying beds for the springs and wells of north Louisiana, and enter largely into the composition of the soils of the creek bottoms. The water coming from them is remarkably pure, while the soils made from them are cold, tenacious and hard to drain. When mixed with the sands and sandy clays of the surrounding hills, they give soils of fair fertility and susceptible of great improvement. In Bossier and Webster parishes they constitute the soils of the large flats which characterize this section of the state. These clays can be used for pottery and, when properly mixed with sand, make good brick and fire clay.

THE JACKSON AND VICKSBURG GROUPS.

have not been clearly separated in this state. They occur, resting conformably upon the Arcadia clays, in the southern portion of the hills of north Louisiana, and constitute the "black prairies" of this section. They run in a band about thirty miles wide across the state. From the preliminary report upon the hills of Louisiana, made by Dr. Lerch, under the auspices of the experimental station, and published as Part II, Geology and Agriculture, the following is extracted:

JACKSON GROUP.

They are of high economic importance, not alone on account of the lithological material they consist of, but especially on account of their position. They enter and frequently make up the soils of a vast extent of country solely, cause an entirely different vegetation, of which hawthorns, persimmons, black haw and crab apples are especially characteristic, and are the cause of the black bald prairies frequently mentioned. The soils derived from this formation are generally very fertile, though not easily worked. In the territory they occupy they frequently protrude through the thick cover of red, sandy clay and drift, island-like, conspicuous through the break in the vegetation, as well as through their lithological material, mostly indurated yellow marls gradating downward into calcareous gray clays, especially exposed along their northern boundary line. Frequently white and yellow limestone bowlders are scattered promiscuously over the outcrops, more rarely limestone ledges a few feet in thickness are found capping the hills. Zeuglodon bones have been found on the edge of the parishes, the most characteristic fossil of the Jackson of Mississippi. The outcrops of the lower series are found frequently on a level with the Jackson beds, on account of the deep erosion they have sustained before these strata were deposited upon them.

THE VICKSBURG GROUP.

If it were not for the paleontological evidence found in these strata, marking a different geological horizon, they hardly could be distinguished from the underlying Jackson beds. Perfectly conformable, they rest upon them, and no change in the topography of the territory they occupy, nor in the vegetation growing upon their line of outcrops, marks a new geological subdivision. With the underlying beds they have the bald prairies and the lithological material in common. They mostly consist of "yellow calcareous fossiliferous marls," are similar, if not identical, in composition, with that of the Jackson group. The waters found in the region are like those carried by the underlying formation, of bad quality, and the soils possess the same qualities, like those of the former group. In a narrow band, their northern boundary very irregular, though subparallel to the northern boundary of the Jackson beds, they cross the state from west to east, with a south boundary coinciding with the boundary of the grand gulf rocks, beneath which formation they disappear. Their outcrops are frequently marked by the drift, appearing only in isolated spots in the sandy sheet. They are of the same economic importance as the Jackson strata.

THE GRAND GULF ROCKS.

This formation, though the poorest of all described, is of the highest economic importance to Louisiana on account of the immense territory it occupies and the influence it has on other regions of the state. Along the south boundary line of the Vicksburg marls the sandstones and claystones and massive clays of the grand gulf group overlap them, and in a line of hills and bluffs cross the state from west to east, dipping southward, but under a far steeper angle than the underlying formations. Examining its northern boundary line and advancing in a southerly direction, we notice a rapid thickening of the strata and soon lose all sight of the contact of the underlying formation, notwithstanding the hills and bluffs are steep, not unfrequently rising along this boundary line over 150 feet above the country drainage. More than any of the previous regions described, it has the plain structure preserved, though erosion has chiseled out different forms. Instead of the well rounded hills and more gentle slopes of the ridges occupying the region north of its boundary, it slopes from its deeply dentated and broken north line southward under a steep angle, rapidly towards the gulf, presenting a plateau in which the rivers have cut wide valleys with steep walls, and their tributaries, narrow gulleys with broken and dentated embankments, several over 100 feet in height. Frequently the country roads wind along a narrow ridge, falling steep to either side for many miles through this section. The features of erosion resemble somewhat the country north of it, where the drift-sands have accumulated, forming sections almost equally steep. They lessen in height in a southerly direction. The landscape these rocks offer is very monotonous. The open woods of the long-leaf pine, as far as the eye can reach, and the green turf, interrupted by bare spots of the gray sands, derived from the underlying sandstones, sometimes cropping out in high knolls along the road, or from the sands and gravels of the drift which generally cover the rocks of this formation in a thin sheet. The waters of streams and creeks are swift, rich in fish, especially trout and perch, and almost of crystalline clearness, unless they wind along a swampy bottom, and springs are even more numerous than in the northern part of the state.

THE RED SANDY CLAYS.

The strata of this formation, deposited at the close of the tertiary in Louisiana, cover all the territory north of the Vicksburg, Shreveport and Pacific Railroad, and can be traced, though frequently interrupted by drift material and outcrops of the underlying formation, almost to the north boundary of the grand gulf rocks. They cover the eroded surfaces of the gray clays, the Jackson and Vicksburg rocks, and sometimes even mantle the outcrops of the laminated clays and sands of the lower series of tertiary rocks. To a large extent, the soils of the region they occupy are directly derived from them, sometimes they enter into their composition with the drift and, mixed with the clay of older formations, they form the bottom soils and the covering loam-sheet of the diluvial flats. There can be but little doubt as to the circumstances under which they have been deposited. Throughout their deposits they show the fluviated structure. To judge from their geographical distribution in this state, it seems that the sandstones of the grand gulf rocks formed their southern shore and that the shallow basin deepened towards the north, having a connection with the gulf through the wide Mississippi valley. Everywhere the formation is largely denuded and their outcrops can be seen in great abundance in the territory they occupy. They consist generally of highly ferruginous sandy clays, mottled and streaked and sometimes studded with pebbles derived from the underlying gray clays forming lines of stratification. The irregularity of these lines which show so clearly their process of deposition have been mentioned before. Ferruginous sandstones and claystones, which frequently cap the hills north of the Vicksburg, Shreveport and Pacific Railroad, are seldom found south of that line, and with the exception of a few localities in the Dolet hills none were seen. The fossil wood, however, remains to be a characteristic feature of this formation, and like in the northern localities, it is found south of the railroad in great abundance, generally on the contact of the red sandy clays and underlying formations. Ferruginous fossils are frequently found, often associated with phosphatic nodules in ferruginous claystones. Occupying more than one-half of north Louisiana, they impart to the country largely its characteristic topography and vegetation. The hills of the territory they underlie are caused by erosion in this formation, though foreshadowed in the older tertiary strata and the short-leaf pine, oak varieties and gums and hickory grow most luxuriantly on soils derived from it. In the central part they almost solely make up the surface material, in the western, eastern and southern parts they are more or less marked by the sands and gravels of the drift and by diluvial loam deposits along the larger river courses. The country in which their deposits predominate is easily tilled, and by far richer than any of the other regions of north Louisiana, with the exception of the alluvial bottoms of rivers and creeks, and the black prairies.

The Sands and Gravels of the Drift.

Not alone one of the most interesting formations from a scientific point of view, but also of the highest economic interest, especially on account of its stratigraphical position, forming the covering mantle over all that is beneath. Its sands spread in a thin sheet over the northern portion of Louisiana, forming immense deposits centrally from west to east, and thinning out and spreading again, sheetlike, over the grand gulf rocks. Two gravel streams, many miles in extent, accompany the diluvial valleys of the Red river and Ouachita (Mississippi) river to join about fifty miles south of the Vicksburg, Shreveport and Pacific Railroad, and to spread from there over the whole territory. Its sands are a component part of all the soils of the region. The alluvium along the present river courses, the loam sheets of ancient river bottoms and recent swamps, the soils of the hilly uplands, all with the exception of the red lands, centrally located from north to south, from which recent erosion has removed them, are partly derived from these deposits. The well waters are cleared and filtered by them, especially in sections where these sands have reached sufficient thickness, all certainly features which make them worthy of our consideration. Wherever they are exposed they show stratification lines like in the underlying formation of irregularity, however not nearly as irregular as found in those deposits. In their lower portions they gradate into the underlying red sandy clays which are some times found restratified in the drift, though generally the contact line of both these formations is well and sharply defined. Their direction is from north to south, and their stratification and material (well-rounded gray and ferruginous quartz sands and gravels) leave no doubt that they were deposited in waters flowing in a generally southerly direction. Silicified corals, favosites and cyathopilum have been found among the gravels north of Alexandria. Mostly they consist of quartz varieties and hard silicious sandstone pebbles, and on reaching the grand gulf rocks they are mixed with bowlders derived from this formation. A few granite bowlders have been found, and also worn. They consist of a gray granite, with black mica and hornblende; and also several smaller pieces of gray and flesh-colored granite. The sands consist generally of almost pure quartz grains, well-rounded, and then again of deep, loose red-colored quartz sands, the grain being coated with peroxide of iron. In the northern portion of the formation conglomerates have been found in extensive layers, consisting of the pebbles of the drift imbedded in an iron matrix, due to a process of lixiviation of overlying sands.

There can be no doubt that these sands and gravels represent the southern drift. Probably the glaciers reached to their northern boundary and the waters arising beneath them carried the sands and gravels, spreading them over the southern territory. The uniformity and thickness of the gravel deposits show that currents of greater force, likely derived from the main glaciers, rolled them southward to the drainage channels of the country, preceding the glacial period, were filled with the sands washed out from the northern moraines till they seem to have covered north Louisiana completely, with the two larger currents, the Red river and Mississippi river, west and east. When finally the streams derived from the subsiding ice sheets ceased to furnish new material, a large amount of the gravels and sands were removed to the sea, and the narrowing rivers, still of enormous size and lake-like appearance, deposited at their bottoms gradually the fine mud, forming now the loam sheets of our upland flats, skirted with the pebbles of former more violent floods.

COAST FORMATION.

In the extreme southeastern and in the extreme southwestern portions of this state, including a part of the parishes of St. Tammany, Tangipahoa and Livingston in the east and Calcasieu in the west, occur low "pine flats," or "meadows," the exact geological position of which is not yet fully determined. Field examinations are now being made, with a view of throwing some light on this subject. This formation may be anterior to the "blue clay" (Champlain) period, or coincident with it. The entire country is covered with small, scattered long-leaf pines. Most of it is covered with "orange sand," which overlies a partly marine and partly fresh water formation, consisting mainly of gray, mossy clays, which gives the impervious stratum to which these "pine flats" owe their peculiar features. To the eastward they extend beneath the littoral alluvium of lakes Maurepas, Pontchartrain and Borgne, and perhaps form the clay bottoms of these lakes beyond the sand and clay deposited by the tides and streams running into them. This formation is found along the entire Mississippi coast, and is reached at moderate depths in many of the wells, rendering the water therefrom undrinkable. In the west, in Calcasieu parish, it is covered on the south by the silty prairie, a subsequent formation, as explained above.

THE BLUE CLAY, LOESS AND BLUFF,

may together be classified as the Champlain formation.

Strictly speaking, all of the soils of the large bottoms of this state are not alluvial. The rivers have cut their way through a thick deposit made long before the existence of our present channels. From Memphis and Shreveport to the gulf the entire bottoms are underlaid by a stiff clay of variable depths, through which the present rivers have carved their channels. This deposit was made at a time when the entire valleys were depressed below their present levels and were stagnant, continuous swamps. By subsequent elevation sufficient fall was given to produce currents strong enough to establish channels, through which the rivers have been ever since emptying their floods. Upon this clay (blue in the Mississippi bottoms) these rivers have ever since been depositing their alluvium. Frequently, however, large areas are found still uncovered, and when cultivated give us the famous "buckshot" soils. These buckshot clays are the lowest strata of the Champlain formation, whose higher ones give us the "loess" and "bluff" of the cane hills on both sides of the Mississippi and of the southwestern prairies.

The bluff region in this state is underlaid by a calcareous silt belonging to the loess formation, and this in turn is overlaid by a rich brown loam, the lime bluff formation varying in thickness from a few inches to 8 or 10 feet. At Port Hudson these formations are together well exposed, superimposed the one above the other. At the foot of the bluff occurs dark-colored clays, with calcareous and ferruginous concretions, fossil wood, stumps, cypress knees, etc. From these clays the buckshot soils already mentioned are derived. Above these clays occur the calcareous silts of the loess, while nearer the surface are 7 feet or more of brown loam, the thin surface soil of the bluff formation.

The following condensed table will give the geological ages and groups found in Louisiana and the material and fossils of each:

GEOLOGY OF LOUISIANA.

AGE	NAME OF GROUP	CHIEF MATERIALS.	KIND OF FOSSILS FOUND.
QUATENARY.	Alluvium.	Soils.	Living plants and animals.
	Second bottoms.	Soils.	Living plants and animals.
	Bluff lands.	Brown loams.	
	Loess.	Calcareous silts.	
	Blue Clay.	Clays.	
	Drift.	Sands, pebbles, etc.	Living shells and trees.
	Yellow sandy clays.	Sands, loams and clay.	Living shells and trees.
	Coast formation.	Sands and clay.	Living shells and trees.
TERTIARY.	Grand Gulf group.	Light clays and white sandstones.	Plants partly extinct.
	Vicksburg group.	Marls and limestone.	Marine animals.
	Jackson's group.	Marls and limestone.	Marine animals.
	Arcadia clays.	Gray clays.	No fossils.
	Upper Lignitic.	Dark-colored clays.	Plants—Lignite.
	Claiborne	Marls.	Marine animals.
	Lower Lignitic.	Dark-colored clays.	Plants—Lignite.
CRETACEOUS.	Ripley.	Marls and limestone.	Marine animals.

Only three of the principal geological periods are here represented, and one of these by its uppermost group, with only an occasional outcrop.

While all of these groups are represented in Louisiana very few of them occupy excessive surface development, and therefore take but little part in the formation of soils.

Extent of These Formations.

Beginning in the southern part of the state one finds the coast marshes, consisting of the blue clay of the Champlain period, upon which the mud and clay, brought in by modern floods and tides, have been deposited. They are now in the process of formation and are overflowed daily by the tides. Near the bayous and rivers the alluvium brought down by the floods has been piled upon this clay, elevating the adjacent surfaces above the level of the marshes and making arable land. By leveeing against high waters these lands have become the permanent abode of a prosperous population engaged in cultivating the soil. Throughout this territory (sea marshes) liveoak ridges are found, which were reserved until recently from sale or pre-emption. The timber from these ridges was formerly used by the government in building its ships. In modern times iron ships have supplanted wooden ones, and accordingly these ridges are now subject to the same laws as apply to other public lands. Much of these coast marshes that are now covered with reeds and grasses are susceptible of reclamation. Dikes similar to those constructed in Holland for the reclamation of the land from the Zuyder Zee could be built here and thousands of acres of extremely fertile lands could be placed under cultivation. This, to a limited extent, has already been accomplished in southwest Louisiana. (See Mr. Watkins' letter further on.) Recent contracts, involving the modest sum of $35,000,000, have been made for further land reclamation in Holland. Similar sums spent here would reclaim much larger and more fertile areas.

BLUFF LANDS.

Above this blue clay occur the calcareous silts and brown loams, brought down by streams which antedate those which exist at the present time. After the deposition of this clay in a sluggish, shallow sea, running well up to Cairo, Ill., a gradual elevation took place, and this bottom became the outlet for the great volume of water falling between the Appalachian and Rocky mountains. This ancient, enormous river extended from the present bayou Macon on the west to Vicksburg on the east. It had, like our present Mississippi, its high waters and overflows. The current was, however, not so great, and hence its deposits were of a silty or loaming character. These deposits continued until both sides of this great stream were walled in by high bluffs ten to fifteen miles wide. From Vicksburg, Miss., to Baton Rouge, La., on the eastern banks, these bluffs are continuous. At the latter place they swerve to the left and are soon lost against the older formations. On the western side these bluffs have been partially destroyed, but enough remains to trace the exact position in former times. Upon the western banks of bayou Macon may now be plainly discerned the bluff formation constituting what are known as bayou Macon hills. These bluffs follow this stream through West Carroll, Richland and Franklin. They constitute a large part of Sicily island. At the southern extremity of this island their continuity has been broken by the waters of the Ouachita and Boeuf rivers. From Harrisonburg, in Catahoula parish, they may be traced by occasional outcrops through Rapides, Avoyelles, St. Landry, Lafayette, Iberia and St. Mary parishes. The five islands jutting out of the sea marshes are of this formation and give unmistakable evidence that the western mouth of this great inland stream was near Belle island. The hills of Opelousas, Grande Coteau, Carencro and Cote Gele are remains of these bluffs. The western banks of this ancient stream have been almost destroyed by water. Between the Ouachita and bayou Macon they have been spread out over nearly the entire country, forming some of the best lands of the state. Jefferson and Mer Rouge prairies of Morehouse, Holloway of Rapides and Marksville of Avoyelles have all originated from disintegrated materials of this ancient ridge. But the largest results from this disintegration is to be found in the parishes of west Louisiana. They extend from Franklin, St. Mary parish, on the east to the Texas line on the west, and from the coast marshes of the south to near the extreme northern limit of St. Landry parish. This entire prairie has been reclaimed from the salt marshes by the deposition of the material derived from the western bluffs of this ancient stream. The area of this bluff formation is therefore quite large in this state.

STRATIFIED DRIFT.

North of the pine flats and participating in the general southward dip of the formations of the state, occur, at or near the surface, beds of sand or gravel of the startified drift. This formation is found on the tops of the hills of the State as well as below the blue clay of the Mississippi river. It is the presence of these sands or gravels which cause so much trouble with caving banks along this stream. The channel of the river has cut its way through the blue clay into these sands or gravels. At high water the velocity of this stream is considerably augmented and, therefore, the increased erosive force of its waters wear away these underlying sands and gravels and leave the superimposed clay stratum undermined, which, when the flood recedes, unsupported by the buoyancy of water, yields to the force of gravity and falls into the river, giving, in many instances, disastrous caves. The gravel of this formation is found overlying the salt beds of Avery Island and underlying the bluff strata. This is its most southern exposure. Rising as one proceeds northward, it becomes more or less abundant throughout all of the uplands of the State.

GRAND GULF GROUP.

North of the sands or gravels which border the pine flats and prairies of this State occur the grand gulf formation. Rising in height northward, the clays and sandstones of this formation form a prominent hilly belt, running across the State through the parishes of Vernon, Sabine, Natchitoches, Grant and Catahoula, terminating in the last parish at Sicily island. Long-leaf pine mark the boundaries of this section, as well as a similar section in eastern Louisiana.

VICKSBURG AND JACKSON GROUPS.

North, and parallel with the transverse ridge just described in the parishes of Vernon, Sabine, Natchitoches, Grant, Winn, Catahoula and Caldwell, occurs a narrow belt, within which the calcareous marls and limestones of these groups approach the surface, giving occasional calcareous prairies. It terminates in the high bluffs on the Ouachita River, at Columbia, Caldwell parish. This belt is about thirty miles wide.

So far these strata appear to have a general southward dip, but north of this prairie the stratification conforms to the calcareous ridge, or backbone, already described and which originally determined the divide between the Red and Ouachita rivers. In northwestern Louisiana, covering the parishes of Caddo, De Soto, and parts of Bienville, Bossier and Sabine, occur

THE LOWER LIGNITIC

rocks, rising conformably against this cretaceous ridge. In this section are the most prominent lignite beds of the State. Against this is superimposed the Marine Claiborne, which occupy portions of Bossier, Claiborne, Webster, Bienville and Natchitoches. Here the calcareous and green sand marls abound, which, under proper conditions, may be advantageously used as fertilizers.

THE UPPER LIGNITIC

is found underlying the parishes of Claiborne, Union, Bienville, Jackson, Lincoln and parts of Morehouse, Ouachita and Caldwell.

Superimposed over these last three formations, stretching over the entire hill portion of North Louisiana, is the formation known locally as

THE ARCADIA CLAYS.

In Webster and Bossier it has the largest surface exposure, forming the soils of the flats of these parishes. It is also fully developed in every creek bottom in this section.

But while these formations underlie the sections given, the surface exposures are of limited areas, taking but little part in the formation of soils. Nearly the entire upland of the state has for its surface covering the stratified drift already mentioned or the red, sandy clays. The latter constitutes the chief material of the soils of the hills of north Louisiana, and as such obscures, except in ravines and cuts, the geological formations given.

RIVERS AND WATER COURSES.

No state in the union has so much alluvial lands or so many miles of navigable waters. The widest part of the flood plain, as well as the delta of the Mississippi river, lies within its border. The alluvial and marsh lands derivable from this river are over 13,000 square miles. The bottoms of the Red, and its tributaries before it enters this valley, about 1700, the marsh lands west of the delta about 4000, other alluvial and swamp lands about 600 square miles, making in the aggregate a little over 19,000 square miles of alluvial land, or nearly one-half of the state.

The Mississippi and the Red are the chief drainage channels of the state, and almost all of the larger streams of these basins diverge from them, and hence, are called bayous. Before the days of levees they formed so many channels, or outlets for the escape of water in floods. Such a network of connections has thus been formed that it is now difficult sometimes to trace the course of an individual stream. As a rule, some large bayou flows along the edge of the bottom plain. Bayou Macon is on the west of the Mississippi flood plain, Ouachita River on the extreme west of the central plain, bayous Boeuf, Cocodrie and Teche on the west of the flood plain of the Red river. In north Louisiana the rivers follow the trend of the subterranean rocks. In the east they flow southeasterly in the Ouachita and southward into the Red. In the extreme south those west of Mississippi flow southward into the gulf; those east, southeast, into the lakes.

Agricultural Divisions of the State.

The state may be divided agriculturally into five parts: First, alluvial region; second, bluff soils; third, good uplands; fourth, long-leaf pine region; fifth, central prairie region.

FIRST ALLUVIAL REGION.

This region may be conveniently subdivided into three parts:

First—Alluvial of Mississippi river and its outlying bayous.

Second—Alluvial of Red river and its outlying bayous.

Third—The marshes of the coast and lakes.

As before remarked, this region occupies about 19,000 square miles, and its vast possibilities in the near future for supporting millions of beings are simply inconceivable. The lands of this section are now leveed against the annual encroaching floods of the rivers which traverse them. Several millions of dollars are annually spent in enlarging and strengthening these protecting earth walls. When these streams, as they will be in a few years, shall be safely controlled in their annual rises and the confidence of the people established in the ability of levees to thoroughly protect, then will a full appreciation of the intrinsic merits of these lands be realized and high values be established.

Dr. Hilgard speaks of this region as "the most fertile agricultural lands of the state, equaled by few and surpassed by none in the world in productive capacity."

ALLUVIAL REGION OF THE MISSISSIPPI RIVER AND ITS OUTLYING BAYOUS.

The parishes of this region north of the mouth of Red river are East Carroll, Madison, Tensas and Concordia entirely and parts of Morehouse, Ouachita, Union, West Carroll, Richland, Franklin, Caldwell and Catahoula. South of the mouth of Red river the whole of the following parishes are included in this region: Pointe Coupee, West Baton Rouge, Iberville, Ascension, Assumption, St. James, St. John, St. Charles, Jefferson, Orleans, St. Bernard, Plaquemines, Lafourche and Terrebonne. Parts of Avoyelles, West Feliciana and East Baton Rouge are also alluvial. In treating of the soils of this region it would be best, perhaps, to adopt the local custom and call all of that portion north of the mouth of Red river north Louisiana and all south of it south Louisiana. This should be done also from an agricultural standpoint, since the soils of the northern section are of a lighter, sandier character than those of the southern section. Cotton is the chief crop in the former, while sugar cane dominates among crops in the latter.

ALLUVIAL LANDS OF MISSISSIPPI RIVER IN NORTH LOUISIANA.

Crossing the state from the Mississippi river westward along the Arkansas line, one encounters alluvial bottoms separated by spurs of hill land running down from Arkansas, until the hills west of the Ouachita are encountered. Bayous Macon and Tiger are encountered after a journey over alluvial bottoms of eight miles from the river. Westward of these bayous begin the bayou Macon hills (bluff formation), which are here about eight miles wide. They extend in a widening belt to the southward eighty-five miles, terminating in Sicily Island. Their widest extent occurs just north of Winnsboro, in Franklin parish, and is here nearly twenty-five miles.

Descending from these hills, going westward along the Arkansas line, the valley of the Boeuf river is entered. This extremely fertile valley is here also about eight miles wide and extends southward, with about the same width until it merges into the valley of the Ouachita river, eighty miles distant

Westward of the Boeuf river "alluvials" we encounter a true ridge of the tertiary formation stretching out from Arkansas well down into Louisiana, and cut off at some remote day from the main hills by the Ouachita river and its tributaries.

This ridge has been intersected by bayou Bartholomew (which empties into the Ouachita), leaving a narrow tongue between it and its confluent. This ridge varies in width from four to thirty-five miles, and is known locally as Bastrop hills, the town of Bastrop, the county seat of Morehouse parish, being situated thereon.

The Ouachita river forms the western boundary of the flood plain of the Mississippi valley and borders the hill country (good uplands) of Union, Ouachita, Caldwell and Catahoula parishes. Along this river and its tributaries, bayous d'Arbonne, De Siard and Bartholomew, some of the finest cotton plantations of the state are situated. These alluvial lands are in many respects most desirable, since their easy culture, profuse fertility and absence of levees (the upper Ouachita being above the highest overflow) all conspire to give profitable returns under good culture and management. The tertiary ridges mentioned above are similar to the good uplands described elsewhere. There are some "prairies" scattered through these ridges, with soils varying from pure sand to whitish clays. In Ashley county, Ark., similar prairies, with the latter soils, have, by drainage and tillage, been made highly profitable.

Seymour's and Dubull's in northern Morehouse, and Prairie ou Bois, in southern Ouachita, are of sufficient size to merit a distinct coloring on the agricultural map of the state. Prairies Mer Rouge and Jefferson lie at the eastern foot of the ridge in Morehouse parish. They are extremely fertile tracts of a few thousand acres each, and properly belong to the "bluff formation." The name of the former, Mer Rouge (Red sea), is derived from the prevalence of a sumac (Rhus copallina), whose berries in autumn are brilliantly red. This shrub and a few hawthorn are the only tree growth on these prairies.

Descending the western banks of the Mississippi river from the Arkansas line to the gulf, no uplands are found, and the entire country adjacent is wholly alluvial. Levees constructed and maintained at public expense extend this entire distance, and protect the lands from overflow in high water. Examination will show that the highest lands of this alluvial region are immediately on the banks of the river. This is true of every stream that overflows its banks in high water. It is accompanied throughout its course by a ridge, the resultant of the debris deposited by it in each successive overflow. From this ridge the lands slope gently to a low-lying cypress swamp, which is usually the drainage basin between the two streams.

The bank of the Mississippi river in Louisiana, opposite Vicksburg, Miss., is 8 feet above the banks of the Tensas, 20 above the Lafourche and 10 above Monroe on the banks of the Ouachita. Before the days of levees, every overflow carried the waters to these lower levels and frequently filled the entire alluvial district, even up to the banks on both streams. These floods restricted settlement on these lands in the past, but now, with our system of levees perfected, it is expected that they will be rapidly occupied.

The soil next to the river is not only the highest in elevation, but is, as a rule, the lightest, or sandiest—the amount of sand depending largely upon the size and velocity of the stream depositing it. Hence, on the Mississippi river, soils too sandy for profitable cultivation are sometimes found. These sandy or loamy front lands can easily be distinguished from the stiff back lands by the tree growth. In north Louisiana the tree growth of the front land is cottonwood, which is supplanted by the willow on similar lands in south Louisiana. As explained elsewhere, the front lands are formed of the deposits from the present river, while the back lands are the deposits from an ancient stream which antedated our present river, and one which possessed little or no current. They closely resemble the clay soils now being formed in our swamps. They are universally known in north Louisiana as "buckshot" lands, on account of the excellent quality which they possess of crumbling into small roundish fragments on drying—a property which gives them the highest agricultural value, since they combine the high fertility of clay soils with the easy tilth of light, loamy ones. The dark, buckshot soils are esteemed for permanent productiveness the finest soils in the world.

Analyses made of similar soils from Mississippi by Dr. Hilgard show them to contain the largest amount of plant food, and "justify the reputation of being the most productive and durable soil of the Mississippi bottoms. Unlike most other clay soils, they may be tilled at almost any time when the plow can be propelled through them, because, on drying, they crumble spontaneously into a loose mass of better tilth than many an elaborately tilled upland soil. It is of such a depth that the deepest tillage, even by the steam plow, would not reach beyond the true soil material; and its high absorptive power secures crops against injury from drought. At the same time (owing doubtless to its being traversed by innumerable fine cracks and underlaid by gravel or sand) it drains quite readily. The front lands are also highly esteemed, and but for the proximity of the "buckshot lands," with which they are compared, they would be held of the highest value. Drainage and proper tillage will always evoke from these soils the highest yields.

SOUTH OF RED RIVER

the scene changes. Both the crops and the landscape vary from those described. Sugar cane now becomes the chief crop, while the cultivatable soil adjacent to the banks decreases in width as we descend the river. Above the Red River all of the so-called bayous became ultimately tributaries of the Mississippi. Below Red river there is a perfect network of bayous leaving the river, outlets to the gulf for the enormous volumes of water pouring through the Mississippi in times of flood. Along these bayous lie extensive areas of arable land, cultivated in sugar cane, corn, rice, etc. Here, as well as on the banks of the Mississippi, extensive and highly improved sugar plantations, with palatial homes, large and splendidly equipped sugar-houses and well arranged laborers' quarters, are everywhere to be found. Between the bayous and back from the main river occur extensive swamps of cypress and swamp cane, the latter less abundant near the coast. The land cultivated on the river varies in breadth from one to three miles, while on the bayous it is from a few hundred yards to one or two miles. Back of the cultivated lands are the wooded swamps, into which the drainage of the plantation is sent.

Sometimes detached portions of high land, having no present reference to any of the existing streams, are found four to ten miles from the present water courses. They are usually covered with timber and in clearing, the latter is burnt, hence such clearings are usually known as "Brulees." Again small islands jut up out of the marsh and abound in swamp cane, which furnishes excellent grazing for stock in the winter. To these islands cattle were formerly sent in large numbers, and hence were called "Vacheries."

As we descend the Mississippi, the soils are less varied in character. As a rule they are less sandy and true buckshot soils are rare. The latter are probably too deep to take part in soil formation. Usually the soils of this region are divided into three classes—"sandy," "mixed" and "stiff." They vary only in the proportion of clay they contain—those with the least are called sandy, and those with the largest amount stiff. The mixed soils are intermediate in character. As a rule the sandy soils are the most esteemed, being easier tilled and drained. Their relation to heat is such that they are the last to start vegetation in the spring and the last in the fall to be affected by frosts. The converse of this is true in regard to the stiff soils. Being dark in color, they absorb heat rapidly in the spring, and thus force an early vegetation. In the fall, on account of rapid radiation of heat, they are the first to be hurt by the frost. They are difficult to drain and cultivate, and hence are not in high request. On the other hand, they usually give a sweeter cane, but a lower tonnage per acre than other soils. Mixed soils possess properties intermediate between those described, and are very valuable. It is probable that for all purposes they are the most valuable of the three. It frequently happens that all three of these soils may occur in a small field. In fact, so frequent in the immediate past have been crevasses and overflows that the entire alluvial soil of south Louisiana may be ascribed to them. The original deposits made by the river when its banks were being formed, and before the days of the levees, are rarely within the reach of the plow. Hence the diversification of soils within a small area.

Numerous analyses of soils taken throughout south Louisiana have been made, covering every variety from the sandiest to the stiffest clay, and they all show them to be rich in the essential elements of plant food, and, as a rule, require only physical amelioration (chiefly drainage and good culture) to produce excellent crops. Since all these lands slope away from the river to the swamps, they can, as a rule, be easily drained by open ditches. Tiles have also been used successfully and extensively. Their great cost have prevented their general use.

ALLUVIAL PARISHES NORTH OF RED RIVER—EAST CARROLL, MADISON, TENSAS AND CONCORDIA

are so nearly alike in all their characteristics as to require no separate description. They are all wholly alluvial and are bounded on the east by the Mississippi river and on the west by bayous Macon and Tensas. Tensas bayou leaves the Mississippi river in the northeastern portion of East Carroll parish, and flows in a southwesterly direction, through Madison and Tensas, and forms a part of the western boundary of Concordia. X A characteristic feature of these parishes is the presence of so many lakes, cut-offs from the Mississippi river. The banks of these lakes furnish desirable sites for homes and many a handsome building is to be found dotting the banks of lakes Providence, Palmyra, St. Joseph, Bruin and Concordia In Madison parish fine plantations are located on the Mississippi and Tensas rivers, bayous Walnut and Roundaway. In fact, some of the best soils of the state are to be found on the smaller bayous of this section. X

Tensas parish has comparatively little cypress swamps, and while most of the plantations occupy the banks of the bayous and rivers, on account of ease of culture and transportation, there is yet a vast amount of back land occupied by a dense forest that but awaits the woodman's ax to be transformed into excellent fertile plantations. In this parish along the Tensas bayou may be found the largest development of the rich buckshot soil. Tensas claims to be the richest parish in the state and to produce the largest yield of cotton. While the latter claim may hold good in other years, yet the census of 1880 shows that East Carroll led the state in the average acre yields, averaging .95 of a bale per acre, or 451 pounds of lint. Tensas and Madison follow with .83 of a bale, or 394 pounds of lint

Issaquena county, Miss., Chicot county, Ark., and East Carroll, La., each averaged about the same yield per acre, and at the intersection of these three states may be located the point of maximum production of cotton on the globe.

Concordia parish is almost surrounded by large streams, and, therefore, has an unusually large quantity of excellent lands. The black buckshot lands cover the interior of the parish, sandy lands being found only on the banks of the Mississippi river.

The other parishes, Ouachita, Caldwell, Morehouse, Richland, Franklin and Catahoula, are only partially alluvial and will be described under the hill and bluff parishes.

ALLUVIAL PARISHES SOUTH OF RED RIVER.

Immediately south of the mouth of Red river the uppermost parish in this district is situated.

Pointe Coupee is regarded by many as the most desirable parish in the state. Being on the confines of the sugar and cotton belt, with an equal capacity to grow both, one will here find what is rare in other sections—immense sugar and cotton estates contiguous.

The elegant homes and well improved plantations lying along "False river," an old cut-off of the Mississippi river, furnish pictures which for attractiveness and beauty are unexcelled in this or any other state. Besides the large amounts of cultivatable lands adjacent to the Mississippi and Atchafalaya rivers, this parish contains also considerable belts along the bayous of Moreau, Telsworth, Couteau, Cowhead, Latanache, Fisher's and Fordoche In fact the lands along the Fordoche are not only extensive, but famous for their profuse fertility. This parish has the largest levees in the state, and they protect from overflow thirteen of the most fertile parishes of the state. Morganza and Grand levees, now solid and substantial, have been in the past the center of attraction during the flood season of at least one thousand large planters. Recently cane culture has been considerably extende in this parish.

Immediately south of Pointe Coupee are the parishes of West Baton Rouge and Iberville. Both are wholly alluvial. The former is included between the Mississippi river on the east and bayou Poydras and Grosse Tete on the west. The farming lands, cultivated chiefly in cane, are mainly along the Mississippi river, though bayous Poydras and Clause and lake Clause furnish some handsome homes and excellent plantations along their borders.

Iberville, between the Mississippi river and bayou Grosse Tete on the east and the Grand river and the chain of lakes and bayous which separate it from St. Martin parish on the west, is one of the noted sugar parishes of the state. Nearly every bayou has habitable homes and arable lands on its banks.

Bayous Grosse Tete, Maringouin and Des Glaise furnish belts of highly productive lands, from one-half to two miles in width.

Between the above mentioned bayous extensive swamps prevail, rich in timber.

Bayou Alabama and Grand river both furnish plantations on their banks, while on the tributaries of the latter, bayous Pigeon and Sorrel, lands have been partially settled and will, when the levees prove protective, be extensively occupied by farms and plantations.

Bayou Plaquemine, the connecting link between the Mississippi and Grand rivers, now closed at the former, is a large and navigable stream, thickly dotted on its banks with well improved farms and homes. The thriving town of Plaquemine, situated at the intersection of this bayou with the Mississippi river, owes much of its prosperity to the transportation of products (now chiefly cypress lumber) on this bayou. In the southern part of this parish bayous Goula and Manufactury furnish arable lands back almost to lake Natchez, by which they are thoroughly drained. A small portion of Iberville parish is on the east bank of the Mississippi river.

Descending the Mississippi river the next parish encountered is Ascension, covering both sides of the river with its larger area on the eastern side. This is one of the leading sugar parishes of the state and contains some of the finest estates in this or any other country. Bayou Lafourche, one of the few original bayous of the Mississippi river still left unclosed, debouches from the river at this point and flows on to the gulf through the parishes of Assumption and Lafourche, furnishing along its banks some of the most fertile lands on the globe. The town of Donaldsonville, once the rival of New Orleans and Baton Rouge, is situated at the intersection of these streams and is the county seat.

The large plantations of this parish are along the river and bayou Lafourche, but small and prosperous farms are found on the smaller bayous in the eastern portion of the parish. It is highly probable that some of the lands in the northern portion of the parish are not alluvial, but belong to the bluff formation, which here finds its southernmost extension on the eastern side of the Mississippi river.

A further descent of the river brings us to the parish of St. James occupying also both sides of the river, with much the larger portion on the eastern or rather here, the northern side, for at Jefferson College, in this parish, the river turns almost due east, and pursues this general direction until it has passed the city of New Orleans. The high land on the river is mainly occupied with extensive sugar plantations, and is extremely fertile. North of this land are to be found the vacheries upon which the famous Perique tobacco is grown. Here the drainage is into lake Maurepas, mainly through Des Acadiens.

South of the river the cultivated border belt on the bayous is suddenly contracted by the appearance of the marsh prairies which fringe lake Des Allemands, and extend westward in a belt of about six miles in width a little beyond the principal meridian of the public survey of this state.

ST. JOHN THE BAPTIST

parish comes next in order, occupying both sides of the river, with the larger portion also on the northern or eastern bank of the river. It includes the whole of lake Maurepas (the upper edge of which is the northern boundary of the parish) and pass Manchac on the north, and lake Des Allemands on the south. Between these lakes and the river are to be found extensive tracts of highly productive lands, all in excellent state of cultivation. In this parish the raising of vegetables for market is quite extensively practiced, and the fields of cane and market gardens frequently alternate.

The parish of

ST. CHARLES,

on both sides of the river, with the larger portion on the southern or western bank, though small in actual area (only 284 square miles), has comparatively a large area of fine arable lands on both banks of the river, nearly three miles deep, which are highly improved and thickly populated.

Bayou des Allemands, which unites lakes Des Allemands and Washa, and forms the southern boundary of this parish, is also sparsely settled. Beyond this bayou is the grassy prairie Des Allemands, situated in Lafourche parish and across which the Southern Pacific has constructed its roadbed.

Jefferson parish stretches from lake Pontchartrain, on the north, to Barataria bay and the gulf, on the south. Only a small portion is north of the Mississippi river, but this small portion, together with the belt on the south side, constitutes the chief tillable land of the parish. On the higher ridges accompanying bayous Barataria, Dauphine and Des Familles may be found sugar and rice plantations, and truck gardens. The southern portion is covered with swamp, marsh parairies and sea marsh, intersected by a network of bayous and lakes—resorts of fishermen and duck hunters. Numerous shell heaps are found rising above the general level, the remains of the clam or gnathodon, which furnished food to a race which occupied this state long before its settlement by the French.

Bayou Barataria is navigable for small steamers and sailing vessels, and several canals (Harvey's, Company and Verret's) permit of their passage from the Mississippi river through this bayou to the gulf.

Grand Isle, a favorite pleasure resort, situated at the lower extremity of Barataria bay, is reached by a line of steamers, whose return trip is always made by this route.

Metairie ridge, running though this parish, between the river lands and lake Pontchartrain, is densely settled with market gardeners, who raise fruit and vegetables for the market of New Orleans.

ORLEANS PARISH.

The city of New Orleans occupies nearly all of the high land in Orleans parish, and its constantly increasing population are encroaching upon the swamp lands in the rear of the city. In the rear of the city are many market gardens. This parish extends in a northeasterly direction as far as the Rigolets and includes all the lands lying between lakes Borgne and Pontchartrain. This section is traversed by the Louisville and Nashville Railroad and is almost entirely a swamp or marsh prairie, small tracts of which have been reclaimed for market gardens. Below the city in this parish are a few plantations devoted to sugar, rice and trucks. Below New Orleans on the river occur the parishes of St. Bernard and Plaquemines, the former lying wholly on the north side of the river and the latter on both sides, following it to its mouth. St. Bernard has extensive sugar plantations and market gardens on the Mississippi river and bayou Terre-aux-Boeufs. Beyond these streams the tracts of cultivatable land are few and incontinuous. Most of the parish is marsh and is occupied by fishermen or hunters in pursuit of their game. On the gulf coast there are a number of low lying islands, which are for the most part uninhabited, save temporarily by sportsmen seeking fish or game.

THE PARISH OF PLAQUEMINES

has its cultivatable land lying entirely on the banks of the river. At and a little below New Orleans the belt of high cultivatable land varies from one to three miles in width, but in descending the river this belt gradually narrows, until at Forts Jackson and St. Philip the marshes encroach upon the banks of the river. Below the forts the great river pursues its way to the gulf through a narrow neck, walled in by clay banks formed from the mud lumps peculiar to the mouth of this great river. This neck is so narrow that the visiting stranger wonders that the river does not cut through it and thus shorten its route to the sea. These mud lumps have impeded navigation, checked the free flow of the waters of this river and divided its current into the several passes. Only a few settlers are found on these narrow banks below the forts, save at Port Eads, at the month of South pass, where the jetties have been so successfully established by Captain Eads. Port Eads is quite a village, inhabited by employes of the jetty company, which maintain the guaranteed depth of the stream; the custom-house inspector and the quarantine officer. In the upper portion of the parish some excellent sugar estates, with well-appointed sugar-houses and palatial residences, are found on the banks of the river. Lower down, orange orchards line the river, particularly on its right bank. Truck growing is also largely pursued and in no country is the product of an acre of land well cultivated of higher value. As we descend the river, the levees gradually fall in height and diminish in size until beyond the forts no artificial protection is needed.

Leaving the Mississippi river at Donaldsonville, and following the bayou Lafourche through Ascension, we reach

ASSUMPTION PARISH.

situated on both sides of this bayou, long famed for its sugar estates, truck farms and thrifty inhabitants. The belt of high land on both sides of bayou Lafourche is from one to one and one-half miles wide, and is very densely populated. In fact, it has the appearance of a continuous, straggling town, with many beautiful homes and fine plantations.

Beyond the lands cultivated on the bayou are detached bodies, called brulees, situated from four to ten miles from the bayou, which have been cleared and cultivated. The soils of these brulees are extremely productive, and could the big levees on the Mississippi river be made permanent walls of protection these brulees would be extremely valuable and desirable. Sacramento, Pierpart, Grand bayou, St. Vincent, Big and Little Texas and l'Abadie are the most noted of these brulees. The Attakapas canal, constructed long ago, to connect the Lafourche with lake Verret, has a large quantity of cultivated lands along its banks, and is very thickly settled. This canal has been closed at the bayou, and is now used only for drainage.

A further descent of bayou Lafourche brings one to the parish of Lafourche, which lies on both sides of the bayou and follows it to the gulf. This is an extremely long and narrow parish, the upper portion of which is similar to Assumption, while the southern portion contains only narrow strips of cultivatable lands, surrounded by sea marsh. The lands along the bayou are in a high state of cultivation within twenty-five miles of the gulf. Large sugar estates, well kept and improved, follow the bayou as far down as Lockport. Truck gardening and poultry raising are much practiced by the small farmers of this parish. Below Thibodaux the ridge of high land gradually diminishes in width, and in the lower part of the parish it scarcely obtains a width of a few hundred yards.

Narrow ridges of tillable land are found on bayous Checby and Challainahan in the northern, and bayou Boeuf in the southern part of the parish. Some arable soils lie adjacent to lakes Des Allemands and Boeuf. Extensive and excellent tracts of land exist, bordering on bayons de la Vacherie, Coquille and Middle. Scattered tracts, capable of habitation, are found on bayou Des Allemands. Live oak ridges are found on bayou Bleu and in the open grassy prairies, which constitute a peculiar feature in the landscape of this parish. "Trembling prairies" also abound. They consist of matted roots and decayed vegetation, partially floating upon a subterranean stream, upon which cattle graze, vibrating with each tread. Beyond these prairies the tidal marshes extend into the gulf, forming islands and peninsulas, and penetrated by numerous tide water bayous.

Almost due south of Lafourche is the immense

PARISH OF TERREBONNE.

Though the area is large, the extent of arable soils is limited to the numerous bayous which traverse it, all else being salt marshes, trembling prairies and open prairies. Bayous Terrebonne, Bleu, Little and Big Caillon, DuChien, Au Large and Cade, run nearly north and south through the parish, while bayons Black, Chackahoula, Tigre, L'Ours, Chene and Penchant have a westerly direction. These bayous are small streams save when serving as outlets to the Mississippi in times of high water. In the upper portions they are narrow and shallow, frequently running dry in summer and fall, while lower down they widen out, and with constant attention can be kept navigable the entire year.

X In the vicinity of Houma, as elsewhere in the parish, contiguous bayous meet and increase the extent of arable land. In such places large plantations occur.

Elsewhere small farms prevail. Here, too, as on the bayou Lafourche, the cultivatable land extends within ten or twenty miles of the gulf and is succeeded by live oak ridges, which in time give way to the salt marsh nearly at the gulf. This parish has a chain of islands off its coast, the most important being Timbalier and Last Island. They are sometimes swept by tidal waves, and notwithstanding the awful catastrophe which visited Last island years ago, they are still visited by pleasure-hunters.

Avoyelles parish is almost wholly alluvial, lying squarely in the great flood plain, with the Red river on its northern and Atchafalaya on its eastern boundary. The upland is prairie and bluff, both of similar origin, jutting down between the flood plains of the Red and Mississippi rivers. These are the remains of the great western bluffs, the rest having been removed by the floods and spread over southwest Louisiana. Holloway's prairie, beginning in Rapides, runs down into this parish, at the southern extremity of which the Red river terminates its own plain and afterwards enters the great flood plains of the Mississippi river. Cut off from the mainland are the prairies of Avoyelles (on which the parish town of Marksville is situated) and Clausee des Grus.

Southwest of these prairies are isolated patches of bluff lands, extending from near Egg bend of Red river to bayou Rouge. The general surface of these bluffs and prairies is well above high water, and their soils resemble those of the bluff lands of West Feliciana and East Baton Rouge. Some of it is grayish silt, while others are of the brown loam character. The alluvial lands of western Avoyelles are like those of Rapides, of which they are a continuation. In the Atchafalaya district will be found strata of both the Red and Mississippi rivers deposits, with the latter predominating.

ALLUVIAL OF RED RIVER AND ITS OUTLYING BAYOUS.

The general topographical features of the Red river are similar to those described under the Mississippi. Two special features mark this river. First—The great raft in the extreme northwest portion of the state, and, second, the falls below Alexandria, due to the river crossing the sandstone ledges of the grand gulf group.

Elsewhere Red river is a fine, swiftly-flowing stream, with solid banks, which has cut its channel deep down into strata of clay, which was deposited before the birth of the present river. This clay is of similar origin and date with the buckshot clays of the Mississippi bottoms. The soils deposited by the river are light and loamy, and can be cultivated up to the levees. In Bossier and Caddo parishes have been created special levee districts, and most of the river bottoms of these parishes are now well protected from overflow. Dr. Hillgard classifies the soils of this region into four classes, viz:

First—Front land soils lying near the river and main bayous, and of a reddish or yellowish red loam, light and easily tilled; deep and very productive. Back from the banks they become heavier and more difficult to till and farm.

Second—Back bottom soils, very productive, and doubtless more lasting than No. 1.

Third—Bottom prairie soil. A black calcareous soil fully 12 inches deep, with large ash, water oak, cottonwood, huckleberry and horn locust occurring about it in patches. This soil is very productive. A capital soil.

Fourth—Waxy soil, occurring in patches, an exceedingly heavy, close intractable clay, mostly in low ground. It bears a stunted growth of hackberry, ash and elm, with fine growth of overcup oaks. It seems practically worthless at present.

The last two soils are doubtless derived from the older clay strata seen in the river banks; No. 4 from the stiff red and brown non-calcareous clays, while No. 3, similar to the buckshot soils of Tensas, is derived from the lighter calcareous clays of the ancient swamp formation.

A large number of analyses of these soils have been made. The front land soils contain from 90 to 95 per cent of insoluble matter, which is fine sand, and about 2 per cent each of potash, lime and phosphoric acid—goodly quantities when the large amount of inert matter is considered. It rarely has over 2 to 3 per cent of iron in it, and therefore the color is due simply to the fine diffusion of this substance through the soil. This is the most prevalent, and therefore the most important, of the soils of this valley. It yields good crops, even in adverse seasons.

One characteristic feature of all Red river soils is the relatively large amount of magnesia present, frequently reaching as high as 2 per cent.

Soil No. 2 varies from No. 1 in a relatively larger amount of clay and lime.

Soil No. 3 is the finest of the valley and permeates it as far south as Avoyelles parish. It contains large percentages of potash and lime and magnesia and a fair quantity of phosphoric acid. Besides, it is very rich in nitrogen, and therefore produces good "weed," as well as fruit.

Soil No. 4 is rarely cultivated, being too stiff and intractable for profitable use.

It is often asserted that the fertility of the Red river lands is due mainly to the large amount of sulphate of lime (gypsum or plaster), brought down from the Llano Estacado (or staked plains) of Texas.

Analysis shows that whatever influence this substance may have originally produced upon the transported material which now forms the valley, it has been so altered in the effect produced as to leave only the lime remaining, since only a small percentage of sulphuric acid has been found in any of these soils. On the other hand, carbonate of lime exists in them all, and in some to a large extent. In the region under consideration there have been included the Atchafalaya basin, with the bayous Boeuf, Cocadrie, Courtableau and Teche. The peculiar red tint of the Red river soils is visible throughout the banks of these streams and reveal a common origin. Even in the banks of the Atchafalaya and the banks of the Mississippi river below the mouth of Red river the thin, narrow red seams, alternating with grayish deposits, tell of floods from Red river, as well as from the Mississippi. Even the red tints of the soils of some of the western rivers tell, in unmistakable terms, of a common origin in a remote period. Bayou Vermillion owes its name to the character of the soil on its banks, which is in striking contrast to the brown loam prairies through which it has cut its channel.

All along the banks of the Teche can be seen this red soil, and its junction with the black prairie is everywhere noticeable. Since these soils occupy only portions of the parishes in which they occur, a detailed description of them will be given under other heads. It may be said here, however, that these soils occupy a part of Bossier, Caddo, Red River, Natchitoches, Grant, Rapides, Avoyelles, St. Tammany, Iberia, St. Martin, Vermillion and St. Mary parishes. Large portions of some and very small portions of others.

THE MARSHES OF THE COAST AND LAKES.

These have been described fully in our description of the parishes St. James, St. John the Baptist, St. Charles, Jefferson, Orleans, St. Bernard, Plaquemines, Lafourche and Terrebonne. To these add St. Mary, Iberia, Vermillion and Cameron, described further, and we have the marsh parishes of the state.

These lands can, in many instances, be reclaimed at moderate cost and be changed into excellent, fertile soils, capable of producing heavy crops of sugar cane, rice, oranges, etc.

The Louisiana Reclamation Company reclaimed 13,000 acres in 1883 and 1884, and was restrained from further work by the breaking of the levees during the great flood of 1884. Since that time Mr. J. B. Watkins has reclaimed a large area in southwest Louisiana, and is now having it successfully cultivated in rice and other crops. In special report No. 7, Tide Marshes of the United States, Mr. Watkins makes a report of his methods, from which the following is taken:

"Our plan of reclamation is to build dikes along the gulf, rivers, lakes and bayous of sufficient height and strength to prevent overflow of each in the event of floods from rain and storm tides, and in this we will be materially assisted by the natural levees found in many places along these waters. We cut, parallel to each other, and half a mile apart, canals 18 feet wide and 6 feet deep. At right angles with these, at intervals of two and a half miles, we cut larger canals, thus forming the land into oblong blocks half a mile by two and a half miles, each containing 800 acres. Across these blocks, at proper intervals, we cut lateral ditches 30 inches deep by 8 inches wide at the bottom, flared to 30 inches wide at the top.

"The canals are cut, the levees formed, and the dikes are, to a considerable extent, built by the use of powerful floating steam dredges. The smaller ditches are cut by ditchers propelled by steam power, passing through but once, at the rate of one and a half miles per hour. At proper localities, we erect automatic flood gates, by means of which we control the stage of water in the canals, and the necessary volume of water is regulated to some extent by the ebb and flow of the tide. This is supplemented by the use of powerful wind pumps, and when the natural elements will not accomplish the work we readily move upon the canals to the spot our ditching, plowing and cultivating engines and attach them to pumps. Thus arranged, with control of the water, these blocks of land are in condition for the most successful rice culture. Rice may be planted any time from February to June, very much the same as wheat and upon ground similarly prepared. When it has reached a growth two inches high water is let in upon it and the ground gradually flooded; care being taken not to cover any of the plants with the water. The land is kept flooded sufficiently to kill all the grass and weeds, until the rice is about 18 inches high, It then has sufficient start to choke down any foreign growth, and the water may be drawn off and the ground allowed to become dry and firm for harvest time, which may extend over several months, according to the times the seed was sown. Rice is harvested and threshed in the same manner and with about the same kind of machinery as used for wheat.

"Our operations were begun in December, 1882, and we have since then built and have in use machinery as follows: Three steam dredges, with a capacity of a mile of 6 by 18 feet canal per month each, two ditchers, four traction engines, which propel the ditchers, plows, cultivators, sowers, reapers, etc.; thirty-two plows in gangs, having a capacity of 70 acres per day; two steamboats, and nine auxiliary boats, barges, quarter boats, etc."

BLUFF LANDS.

On the eastern side of the river is a belt of bluff lands running from the Mississippi line through West and East Feliciana, East Baton Rouge, Livingston, and perhaps small portions of Ascension and St. Helena. In length this belt is about fifty miles. Its width in the northern portion is not over 15 to 18 miles, but further south it widens to nearly double this distance. Just below the city of Baton Rouge these bluffs turn to the southeast and east, and parallel bayou Manchac, nearly to lake Maurepas. These bluffs on the Mississippi line rise to a height of 100 feet or more, are hilly and broken. Further south they flatten out, being only about 75 feet at Port Hudson, and 45 feet at Baton Rouge. Further eastward they continue to fall, until they reach the level of the pine flats and alluvial bottoms.

Although the soils of this section have been in cultivation for a long time (it is one of the oldest portions of the state), and treated in a most irrational and unscientific manner, yet they can be made, with proper attention, to produce even now the largest yields. Nowhere in the state can be found more prosperous and intelligent farmers, and nowhere on earth can a general diversified farming be more advantageously conducted. These are probably the finest hill lands in the world. Far above overflow, here the farmer enjoys the enviable privilege of cultivating alluvial lands elevated above the floods, and susceptible of the best of drainage.

On the western side of the Mississippi river only scattered remains of these bluffs are found. They run through West Carroll, Richland, Franklin, and then in scattered patches on to the gulf. Though no lofty hills are left in this section, yet the materials which once formed them have been used to adulterate, commingle with and overspread all of the latest formations of the western portion of the alluvial plain of Louisiana.

All of the prairies of southwest Louisiana owe their origin to the deposition of materials from the disintegrated bluffs spread out over the coast marshes or pine flats. The area in this state occupied by bluff materials is therefore large. In places these bluffs consist of an upper stratum of brown loam, underlaid by the calcareous silts of the loess formation, which in turn overlie the blue clays of the Mississippi bottoms. In the general degradation of these western bluffs and their subsequent transportation, assortment and deposition by running water, soils of all grades from a rich, stiff black prairie to a poor, gray, silty piny woods, have been formed. Accordingly we find, to the east and south, in southwest Louisiana, extensive developments of the black prairie, changing gradually westward and northward into the brown loam prairie, and this in turn giving away to the gray, silty pines of the extreme western portion.

These prairies lie in Calcasieu, Acadia, St. Landry, Lafayette, Vermilion, Iberia, St. Martin, St. Mary and a small portion of Cameron. This section includes what was originally known as the Attakapas and Opelousas prairies, and has been rendered famous by Longfellow, who has styled it the "Eden of Louisiana." Until recently it was occupied only by countless herdes of cattle and ponies, but now it is entirely under fence, and most of it under cultivation, and happy homes and thrifty towns are everywhere to be seen. Over 7000 families from the prairies of Iowa, Nebraska, Kansas and Illinois have enthroned their "Lares and Penates" in this balmy land and more prosperous agriculturists cannot be found anywhere on earth than these recent settlers upon southern soil.

BLUFF PARISHES OF THE STATE.

West Feliciana, adjoining the state of Mississippi, has alluvial, bluff and good oak and hickory uplands. The bluff lands largely predominate. They lie between the alluvial lands on the river and the hill lands of the extreme east, and are quite hilly and broken, with ridges rising several hundred feet, with ravines or narrow valleys between. In some places there are tracts of level or slightly rolling plateaus, with the brown loam on the top, and on their sides a mixture of the loam with the calcareous silts, which gives an excellent soil. In the southern portion of the parish the ridges are not so elevated—the level areas more extensive and large tracts are cultivated. The oak uplands are similar to those in the adjoining parish of East Feliciana.

East Feliciana has its southeastern extremity composed of bluff lands—the dividing line between them and the oak uplands crossing from West Feliciana to East Baton Rouge parish, a few miles south of Jackson. This belt is here about twelve miles wide, and has the same characteristics as similar soils in East Baton Rouge. Beyond the line described alternations and intermixtures of bluff and pine soils prevail for a short distance, when the latter continues on through the parish. East of the Comite the lands are more broken, the short-leaf pine predominating in the woods. The appearance of the long-leaf pine is first encountered near the Amite, which, after passing this stream, is the prevailing timber. A small section of this parish in the northeast corner may be classified with the long-leaf pine region.

This is one of the best hill parishes in the state.

East Baton Rouge is emphatically the bluff parish of the state. A small portion of the extreme northwest corner is of the oak and pine uplands. It has two tracts of alluvial lands, one bordering the Mississippi and the other along bayou Manchac. The bluff soils of this parish are light loams, with the dark orange colored subsoil near the surface. These soils were originally covered with a forest of magnolia, beech, swamp chestnut, oaks, sweet gum and sassafras, with an undergrowth of swamp cane everywhere.

The original soil was a black, deep, easily tilled loam of such profuse fertility that few settlers could be persuaded to leave it for the bottoms. But the removal of the timber and cane and general improvident cultivation has caused much of the original soil to be washed away. Bermuda and carpet grasses have taken possession of these lands and checked the denudation by rains, at same time furnishing excellent pasturage for stock of all kinds. These soils require only deep and thorough tillage and rational rotation of crops to more than restore the original fertility.

As the river lands were reclaimed from the floods they were occupied by the large planters from the hills, and hence this parish became more and more the abode of small farmers and under their thrifty management it is fast becoming one of the most productive parishes of the state. One would not wonder at this, when the many advantages of rich soil, easy tillage, high elevation and enlightened yeomanry all conspire to make it one of the finest farming countries in the world.

Livingston Parish—Undoubtedly a part of this parish is bluff formation. How much a detailed survey will have to decide. Lockett, in his topographical map, makes over one-half of this parish of this formation, the rest being long-leaf pine flats and alluvial bottoms along the Amite river. Hilgard in his report on the cotton production of Louisiana, makes the larger part long-leaf pine flats and the rest long-leaf pine hills and alluvial bottoms.

The alluvium along the Amite are second bottoms, elevated from 25 to 30 feet above the river bottom, and covered, where not cleared, with oaks, beech, gums, dogwood, short-leaf pine, and a few magnolias. The surface soil is grayish brown, or brown overlying a red sandy clay subsoil, and is good. The grass on these bottoms when abandoned furnishes excellent pasturage for stock. The rest of the parish is divided between the bluff formation, long-leaf pine hills and flats.

Along the tributaries of the Amite and Tickfaw are small bottoms densely covered with swamp cane, which furnishes food for cattle during the winter. This parish is noted for its fine timber, turpentine and cattle.

West Carroll parish lies between bayons Macon and Boeuf, and consists of bluff and alluvial soils. On the east a narrow belt of the Tensas bottoms fringes the parish, while on the west a larger belt of the Boeuf bottoms runs the entire length of the parish. On the banks of the Macon the bluffs often reach the height of 20 feet, sloping gradually to the westward, the lands gradually improve as we descend, the loam of the bluff often penetrating the Boeuf bottoms, forming frequently the subsoils of the latter. These soils are highly productive. The alluvial lands of this parish are more extensively cultivated than the hills.

South of this parish, and adjoining it, is Richland parish, similar in every respect to West Carroll. Through this parish the floods of the Mississippi river pour whenever the levees of the Mississippi river in lower Arkansas break. By the continual abrasion in the past the bluff lands of this parish have been disintegrated and spread over the entire flood plain. Occasional islands of bluff formation, elevated several feet above the general level of the country, are encountered This parish has greatly suffered in the past by these periodical floods through Arkansas, and if the levees now constructed at the joint expense of Arkansas and Louisiana can be made permanent, it will become one of the most attractive parishes in the state.

Franklin parish, south and east of Richland, is almost entirely of bluff formation, with a narrow belt of alluvium lying between bayou Macon and the hills, and a similar belt on the west with bayou Boeuf. The lands of this parish improve as we go south and yield fine crops of corn and cotton.

Patches of bluff lands occur in Catahoula, Rapides and Avoyelles, but no extensive tracts are encountered until we reach St. Landry, the beginning of the prairies of southwestern Louisiana.

St. Landry parish is partly alluvial, partly prairie and partly bluff, with a small portion in the northern part of long-leaf pine. The hills of the parish are the remains of the western bluffs of the Mississippi river, while the prairies are the spread-out materials from these bluffs. The eastern part of St. Landry is wholly alluvial, forming a part of the great Atchafalaya basin. Bayou Courtableau, a tributary of the Atchafalaya, is navigable as far as Washington, in this parish. From Washington and Opelousas the prairies extend to its western boundary. These prairies are, in the extreme northwest, of the silty character. South and east of this, running nearly to Opelousas and Washington, are the brown loam; while in the extreme southern part of the parish occurs the black prairie. Belts of timber extend only along the streams of this parish.

Bayous Cocodrie and Boeuf (which together form the Coutableau) and Teche flow along the foot of the uplands of this parish and have derived their waters mainly from Red river, and the alluvium along their banks are predominantly Red river alluvium.

Acadia parish, recently formed from St. Landry, is entirely prairie, the latter consisting mainly of the brown loam and black characters. This is one of the most prosperous parishes in the state, and when properly drained, as it will be in the near future, will be one of the most fertile. Nearly the whole of this prairie is underlaid at a few inches with a stratum of impervious clay, strongly calcereous, which retains the water falling on the surface, and on account of the general level character of the prairies, preventing drainage, this water has to be evaporated. The result is seen in the numerous water grasses found everywhere. Running, however, through this parish are numerous bayous and rivers, which have cut channels 20 to 40 feet deep, which would, if utilized, furnish drainage canals for the country.

If a system of drainage ditches were established connecting every farm with these water courses and ridge culture with deep plowing practiced, quarter drains leading to ditches dug so that the rains could be rapidly removed and the subsoils thoroughly aerated, these soils could be made profusely productive. The rapid influx of intelligent immigrants to this parish will soon realize the necessity for such action and secure proper laws, either through state, legislative or parochial police jury. In the underlying clays are frequently found white concretions of nearly pure carbonate of lime.

Lafayette parish consists largely of bluff lands and rolling prairies of the brown loam type. In the southern portion the black calcareous prairie occurs. A belt of alluvium follows the Vermillion river through the parish and another runs along the entire length of the northeastern boundary of the parish. The bluff lands are well developed in the Carencro and Cote Gelee hills. This is one of the smallest but most fertile parishes of the state.

Vermillion parish, in the northern part, is mainly black prairie, where the alluvial lands lie along bayous Vermillion, Queue de Tortue and Mermentau. These lands have long been cultivated, and are highly esteemed. Along the banks of the Vermillion river, which is navigable as far as Lafayette, in Lafayette parish, were once fine sugar plantations. A few of the latter still survive, and more will be resurrected now, since Abbeville, the county seat, has recently been connected by rail with New Iberia. The southern portion is mainly coast marshes, and, with the exception of two islands with cultivatable ridges, near the gulf, are uninhabited and uncultivatable. This parish is mainly occupied by the Acadians, of French-Canadian origin, but large numbers of western men have recently settled therein, and, from present prospects, will soon fill up this fertile parish.

Calcasieu parish has increased in taxable values and population in last ten yeras more than any other parish in the state. In area it is the largest parish in the state. Its extreme southeastern portion is black prairie, the northeast and southwest portions are silty prairies, while the northwest is pine flats. A small portion of the extreme south is coast marsh and a similar portion of the extreme northwest is long-leaf pine hills.

The lumber trade of this parish is enormous and finds an outlet through the Calcasieu river to the markets along the gulf coast and by rail to the states north and west. This parish has recently been extensively settled by intelligent farmers from the northwest, who have established farms all over the prairies and are growing rice and sugar cane, fruits, garden trucks, etc. The thriving towns of Jennings, Lake Charles, Welch, Iowa City, etc., attest their thrift and prosperity. The prairie soils, like those of Arcadia, need drainage before they will show their true productive power, and some general system must be established for the benefit of all concerned. In the western part of the parish the soils are of the silty order and less productive . All over the parish mounds of 2 to 4 feet in height and 25 or more feet in diameter occur. These are immense ant hills, made by animals now extinct. These greatly interfere with cultivation until levelled. In this parish occurs also the famous sulphur mine and petroleum wells, all the product of the last being taken by the Southern Pacific Railroad.

Iberia parish presents a variety of features. It is largely alluvial, belonging to the great Atchafalaya plain. Directly along the banks of the Teche lies a belt of red lands, about 50 yards wide on each side, evidently the deposits of Red river, made long ago. This is above overflow and yet below the general level of the country. From this belt there is a rise of 2 to 6 feet to the black prairies, which extend southward to the sea marshes. Grand Marais, a fresh water marsh, one mile wide and ten long, running northwest and southeast, three or four miles from the Teche, is a notable feature of this parish. The sugar plantations lie mainly along the Teche, though the prairies are now being ditched and brought into cultivation. These prairie lands are highly esteemed for their sweet canes. In the coast marshes of this parish occur three island rising to the height of 160 to 180 feet—the last remains of the former bluffs of the western mouth of the great river—viz: Petite Anse, now called Avery's island (2240 acres); Grande Cote, or Week's island (2500 acres), and Orange island, on the shore of lake Peigneur (2250 acres), now the property of Mr. Joseph Jefferson, the great comedian. These islands were originally covered with timber and the soil is of the brown loam character, peculiar to the undisturbed bluff formation. Avery's island is noted for its great beds of pure rock salt, which are now extensively mined. Orange island is chiefly used in the production of oranges.

St. Martin's parish should more properly be classified as an alluvial parish, since much of the larger portion lies in the great alluvial basin of the Atchafalaya.

Between the bayous Teche and Tortue the land is mainly of the brown loam rolling prairie. The band of red alluvium borders the Teche here as in Iberia. On the east it shades off into the alluvial prairie, which extend three to five miles, and then in turn are bordered by arable wooded ridges of brown loam character. East of these the land is low and wet to the Atchafalaya. Immediately on the Atchafalaya is a tract of high land called Butte a la Rose. On the west side of the Teche the brown loam prairies are about three miles wide and extend to the alluvial lands of bayous Vermillion and Tortue. The Teche is navigable to St. Martinville. All along this stream sugar plantations occur. Mixed farming is also practiced by the frugal Acadians, which mostly populate this parish.

St. Mary parish is almost wholly alluvial, yet the northwestern portion, south of the Teche, including the Cypremont prairie and the islands of Cote Blanche and Belle Isle, are undoubted bluff formation. This is the largest sugar-producing parish in the state, and the magnificent sugar estates lying on bayou Teche, with their palatial residences surrounded by regal liveoaks, their neatly kept quarters, and the immense sugar-houses, present a scene that would justify much time and trouble to witness. By many this is regarded as the loveliest portion of Louisiana, and certainly as fertile as the best. The arable land on the Teche varies from one to five miles. The lands on the east bank are lower, and in the lower portion of the stream liable to overflows when crevasses occur in the Mississippi near the head of the Atchafalaya. Sugar estates also exist on Berwick's bay, bayous Boeuf and Atchafalaya.

Bayou Sale furnishes the finest sugar lands in the state. The characteristic red tint of the Teche lands can be seen as far down as Franklin. Cote Blanche island, with an area of about 2000 acres, lies on Cote Blanche bay, and resembles in all its features those islands described under Iberia parish. So, too, with Belle Isle (area 350 acres), which lies on the western headland of Atchafalaya bay, the most southernmost point of the ancient bluff formation.

Cameron parish is mainly sea marsh, with only a small portion of the northern part of plains. Along the Calcasieu, Sabine and Mermentau rivers occur ridges of excellent arable lands, which are thickly settled and well cultivated.

Grand Chenere on the Mermentau pass, Cameron on the Calcasieu pass, Hackbury Island, and Grand Lake on the Calcasieu lake and Shell Bank on the Sabine are prosperous settlements. Along the coast ridge running from the Mermentau across the parish to the Sabine, are to be found many prosperous farmers. Orange culture, with fishing and oystering is the chief employment of these coast dwellers. The soils are excellent and the climate delightful, rendering a home here pleasant, save for inaccessability. Along Johnson and Black bayous are also a few settlements.

GOOD UPLANDS

constitute the main portion of northwestern Louisiana, and include wholly or in part the following parishes: Caddo, Bossier, Webster, Claiborne, Union, Ouachita, Morehouse, Caldwell, Catahoula, Lincoln, Jackson, Bienville, Red River, De Soto, Natchitoches and Sabine. East Feliciana, West Feliciana and East Baton Rouge, in the eastern part of the state, are partly of this formation. These lands have a forest growth of short-leaf pine, intermixed with oaks and hickory, the latter predominating on the best soils, and their presence may be used as a guide in the purchase of lands. The surface soils of this region are supplied mainly by the sands and clays of the "red sandy clay" formation, while the creeks' bottoms are lying in the Arcadia clays, and their soils are derived from them alone, or mixed more or less intimately with the sandy clays washed down from the hills. This country is settled mainly by small farmers, who, as a rule, are prosperous, happy and contented. They practice "mixed" farming and grow cotton or tobacco as money crops only, raising their supplies for stock and families. No portion of the state, by its own unaided efforts, is more rapidly improving. Little or no immigration has yet been secured, yet the evidences of thrift and improvement are visible in most every neighborhood. No part of Louisiana is more inviting to the man of moderate means, accustomed to do his own work, than the good uplands of this state. The soil is easily cultivated and susceptible of the highest improvement, responding well and readily to proper fertilizers. The drainage is excellent, the rainfall abundant and the climate most congenial to health and outdoor exercise the year round. The greatest variety of crops can be grown here. Churches are abundant and schools numerous and well attended. Lumber abundant and cheap. The best of springs and wells are to be found almost everywhere.

The following description of the soils of this section is taken from a recent report of the geological survey made by Dr. Leich, under the auspices of the state experiment stations.

SOILS OF THE HILL LANDS

OF NORTHERN LOUISIANA

Red Sandy Clay Region—These soils, occupying the hills of north Louisiana, may be classified into—

a. Black sandy.
b. Gray sandy.
c. Yellowish red sandy.
d. Deep red sandy loam.

These varieties graduate the one into the other almost imperceptibly. Yet in the central portion, from north to south and in the Dolet hills, the red sandy loam predominates. These varieties are derived from the immediately underlying geological formations, the red sandy clays and the drift, or a mixture of the material of both. Occupying, as they do, hillsides of more or less declivity, they drain well. Of sufficient porosity to permit of a thorough percolation through them of water, they may be classified as dry soils. With a clayey subsoil underlying them at shallow depths, they obtain and appropriate fertilizers with great facility. The "black sandy soils" of this division, occurring particularly in the eastern and western portions of this district, owe their peculiarity of color to the presence of humus. They are derived mainly from the "drift" and underlaid by the red sandy clays, and vary in thickness from a few inches to many feet. They consist mainly of rounded quartz grains, with small proportions of humus and mineral matters. They are poor, droughty and easily washed away by heavy rains under improvident culture. They are cold soils, and hence bring better crops of corn than cotton. The plowing in frequently of crops of clay peas, the application of mineral manures, together with a proper system of terracing, will add materially to the productive capacity of these soils.

The gray sandy soils possess in an intensified form the properties described under the "black sandy soils." Being more deficient in humus, the remedies there prescribed, will apply with greater force here. Composts of cotton seed, stable manure, pine straw and acid phosphate, are especially valuable on these soils. In the neighborhood, marls may be used with great success, in quantities of fifty to one hundred bushels per acre. Both physical and chemical benefits will thus be obtained.

The yellowish red sandy soils occur in patches over the entire district, graduating on the one hand to gray sandy and on the other to sandy loams. They are superior in quality to either of the above and may be made very productive. They are mixtures of the "red sandy clays" and the "drift" and their physical properties are good, therefore they retain moisture fairly well and are not so subject to wash as those already described.

The red sandy loams, occupying chiefly the central portions of the district, but occurring elsewhere in patches of varying size, are the characteristic "red lands" of north Louisiana. They are derived from the underlying "red sandy clays" wherever the overlying sands have been washed away. Magnificent fields of this class of soils are found in many portion of this part of Louisiana, and, although long in cultivation, are still yielding profitable crops. Its color is due to iron oxide, and with this latter is usually associated goodly percentage of phosphoric acid. This is an ideal soil, susceptible of the highest improvement and capable of producing enormous crops. With a similar subsoil, deep plowing, if gradually performed, will greatly enhance fertility and crop producing power.

The crying want of all these soils as demonstrated by the experiments at the north Louisiana experiment station at Calhoun, La., is nitrogen. To supply this ingredient, in its cheapest and best form, recourse may be had to some of our running varieties of cow peas. A rotation of oats, cow peas, cotton, corn (the latter also with cow peas), as practiced and recommended by the north Lousian experiment station, will improve all of these soils and most rapidly, if each crop be fertilized with a suitable manure. The soluble phosphates used in conjunction with nitrogenous manures have been found highly beneficial. Alone, they have proven of little value.

The bottom soils of this district have been derived wholly or in part from the underlying "Arcadia clays" (gray clays), described in the geological report as everywhere underlying the "red sandy clays." These soils are found in all the creek bottoms and wide flat valleys of north Louisiana and may be classified under two heads: (a) Gray loams. (b) Gray clays.

When the soils of the hills have been washed down and mixed with the gray clays of the valleys, gray loams are to be found. Where no such washing has occurred the pure "gray clays" exist.

In small creek bottoms the former usually exist and are very productive. They are, however, subject to overflow, and, therefore, are usually not highly esteemed except for grasses and permanent pastures. Could they be properly drained and protected from floods, they would be very valuable. This could be accomplished by levees, and by deepening and widening the channels of the creeks which flow through them. In this way large areas of extremely fertile soils could be recovered and the general health of the country greatly improved by the removal of the stagnant water in the swamps, the present breeding places of malaria and fevers. These soils hug the hillsides giving way in the middle of extended tracts of bottom lands to the true "gray clays" derived "in situ" from the underlying Arcadia clays. These clays form the chief soils of extensive tracts of bottom lands in many parishes of north Louisiana. They possess the characteristics of all clay soils, tenacious, heavy and old, drying and cracking in dry weather, and running together in seasons of heavy rainfall. They are very fertile if properly handled, which means that they must be well drained, thoroughly broken and have incorporated with them a goodly amount of vegetable matter.

These two classes of soils shade imperceptibly into each other, and in one bottom may be found every shade of soil, from pure sand (washed down from the hills) to pure clay.

DESCRIPTION OF THE PARISHES.

CADDO PARISH

occupies the extreme northwest portion of the state, and is greatly cut up by numerous lakes and bayous, with a large portion of the northern part of the parish covered with overflows from the great raft of Red river.

The uplands are everywhere esteemed as good farming lands, while the bottoms of the Red river are simply superb. Shreveport, the parish seat, and second city in size in the state, is situated on the eastern terminus of a ridge dividing Cross lake from Boggy bayou. It is immediately on the Red river and has an extensive trade. The establishment of a levee district in this parish has given promise of the permanency of the levees which protect the alluvial lands from the overflows of the Red river. During the greater part of the year this city can be reached by steamers from New Orleans.

BOSSIER PARISH

is composed of good uplands and splendid alluvial bottoms. The former lie mainly in the northern and eastern, and latter in the southwestern part of the parish, and is protected from overflow by levees built and guarded by the Bossier levee district. The peninsula running down between Red river and lake Bistineau, including portions of Bossier and Webster parishes, and locally known as the "Point," has soils somewhat peculiar, consisting of three kinds: First, constituting about three-fourths of the area, a fine sandy, blackish loam, with a yellow sandy loam subsoil, with oak and hickory lumber and a few scattered short-leaf pines; second, a heavy brown clay loam with similar subsoil, with few short-leaf pines; third, blackjack ridges but little cultivated and very unfertile.

Between Red river and Cypress bayou a fair rolling upland country prevails. East of Cypress bayou there is a belt of red ridge land, with occasional high hills covered with red ferruginous earth. East of this ridge occurs a belt of level post oak land, in the southern part of which are treeless prairies, with white unproductive soil.

WEBSTER PARISH.

In the center lies the broad, alluvial bottoms of bayou Dorchite, which, alternately, in the southern portion, is covered by lake Bistineau. In the northwest is the flood plain of bayou Bodeau. A level country extends from the Arkansas line to lake Bistineau, between bayous Dorchite and Bodeau. This country is of variable fertility. Some of it is covered with short-leaf pines and is of only fair quality. Some covered with dogwood and post oak, with white, crawfishy soil, is but slightly better, while another portion, well drained, gives excellent crops of corn and cotton. East of the Dorchite, the lands are rolling, with alternations of red and gray soils. On lake Bistineau and Black lake bayou is whitish, clayey soils, with water oak and black gum prevailing. This parish is connected by rail to Minden with the outside world.

CLAIBORNE PARISH

This parish is truly one of uplands, without any alluvial lands save small creek bottoms. It is also one of the best upland parishes, having a considerable area of red lands. It contains the highest elevations in the state. The dividing ridge between the waters of d'Arbonne and Black lake is said to be the highest elevation in the state. North of the d'Arbonne the country is slightly broken, the soils mainly gray sandy with red subsoil. This parish consists almost entirely of small but well-tilled farms, with numerous villages, scattered throughout the parish. A railroad running from Homer to Bienville, in Bienville parish, and crossing the Vicksburg Shreveport and Pacific at Gibbsland, gives easy access to the outside world.

UNION PARISH.

This parish is similar in every respect to Claiborne, with probably a little more inferior soil. The ridges between the forks of the d'Arbonne are high and level, and upon them occur some of the best lands of the parish. The ridges between the bayous Corney and l'Ouire are high and broken, but are of the red land character. Farmerville, located on a ridge of the former, is the county seat, and is surrounded by numerous small, but well tilled, farms.

The northeastern section is hilly, with red sandy soil, but more sparsely settled. Southeast, towards Ouachita parish, there is considerable hill land, too broken for cultivation, but south of this the country is less rolling and nice farming lands exist. A considerable area of alluvial lands lie along the bayou d'Arbonne and the Ouachita river. This parish is without railroad connection with the outside world. In high water small steamers ascend bayou d'Arborne as high as Farmerville. A railroad is, however, projected to Farmerville, and when it is built will give new life to the parish and higher values to land, now greatly depressed by exclusion from the world.

OUACHITA PARISH

consists of hills and alluvial lands in almost equal areas, the former mainly on the west and the latter on the east of Ouachita river. The hills are mainly of oak and hickory uplands, though in the southwestern part of the parish is a considerable area of long-leaf pine. In the timber of the northwestern hills occur the large-leaved magnolia (magnolia macio phylla), a rare tree elsewhere in the state. In the swamps of the bottoms the tupelo (Nyssa uniflora) is the chief timber. Between the oak uplands and long-leaf pine region occur the famous swamps covering several square miles, known as the Cheniere au Toudre. The beautiful red land plateau running at the foot of an oak ridge, upon which Indian Village is situated, is both alluvial and fertile. East of the river is a narrow ridge dividing the waters of the Ouachita from the Lafourche. All the rest of the land is alluvial or deposited bluff. The island, formed by bayou de Siard and the river, is noted for its fertility and is above overflow. In the south part of the parish is a prairie known as Du Bois, which is similar to those in Morehouse and Caldwell parishes. The north Louisiana experiment station is located at Calhoun, in the oak uplands of this parish.

MOREHOUSE PARISH.

Like Ouachita, it is composed of alluvial plains, oak upland hills and bluff or prairie. The first, however, constitutes nearly two-thirds of the parish. Two upland peninsulas reach down from Arkansas in this parish, separated by bayou Bartholomew. On the eastern and larger one Bastrop, the parish seat, is situated. These ridges gradually sink beneath the prairies and alluvial flats. It is inferred from the red subsoil of these flats and prairies that they have been formed from the disintegrated bluff lands and spread out over a sandy plain. These lands are excellent, drain well and bring annually large crops.

The Boeuf bottoms are esteemed rather higher than those on the Ouachita, especially the "gum lands," which rank as the equal of any in the state. These are followed in order of fertility by the prairie, the stiff cane lands and the hummock lands. The uplands of this parish furnish excellent lumber, but are not extensively cultivated.

CALDWELL PARISH

consists of a variety of lands, long-leaf pine hills, alluvial plains of Boeuf and Ouachita rivers, central prairie region and oak uplands. The last constituting only a small portion of the parish, with the other three about equally divided.

The eastern and southeastern portion of the parish is long-leaf pine hills, interspersed with the lime prairies. Between it and the alluvial flats of the Ouachita occurs a bed of good uplands; also interspersed with prairie outcrops. The land between the Ouachita and the Boeuf is in this parish almost wholly alluvial, only a very narrow ridge running down to their forks, remaining out of the water in high water. Strong levees on the Mississippi river in Arkansas would protect these bottoms from overflow and make them extremely valuable. It is hoped that those recently constructed will prove permanent and effective. In the southern part of this parish occurs prairie du Cote, with yellow loamy soil, another remnant of the bluff formation.

CATAHOULA PARISH,

known in early history as Ocatahoula, is, perhaps, the most diversified parish, so far as soils are concerned, in the state. It consits of alluvial land, long-leaf pine hills, central prairies, bluff lands and oak uplands.

A large part of the parish is alluvial and includes all of the southern and part of the eastern portions. The long-leaf pine hills come next in size and occupy the southwestern portion. A lowland belt of the central prairie region covers the northwestern portion of the parish, while the bluff formation insinuates itself between this alluvial and the long-leaf pine hills, starting at Sicily island and ending at Catahoula lake. These bluffs are several times severed by water courses, but their general direction is maintained.

The narrow slip of oak uplands occurring in Caldwell continues until it reaches Harrisonburg, the parish seat. The pine hills of this parish are not so abruptly steep as elsewhere and near the Ouachita are pebbly and of a better character than elsewhere. The prairie region is also quite hilly and in the eastern portion black prairie soil may be found high up on the ridges. On the slopes of these ridges are found such lime loving lilies as the walnut tulip, etc.

In the western portion "hog wallow" and post oak flats prevail, with occasional patches of true black prairie. The largest tract of black prairie (Pendarvis') is in the fork of bayous Castor and Dugdemona in Winn parish. Sicily island, cut off from the bluff lands of Franklin by the Ouachita river and from the great alluvial plain by bayou Louis, is mainly of bluff formation and marks the course of the western boundary of the ancient river which preceded the present Father of Waters. Catahoula prairie and one just south of it, in this parish, as well as Holloway's and Avoyelles prairies, further south, are further remnants of this same formation.

Catahoula Lake—Sixty square miles of surface is wholly in this parish.

LINCOLN PARISH

is perhaps the best upland parish in the state. It is wholly oak uplands, and has a larger exposure of red soils than any other parish, estimated at one-half of the parish. These lands, though hilly and broken, are quite productive. The remainder of the parish is gently rolling, with the prevailing yellow sandy soil. Here, as elsewhere in this district, the character of the soil can be best determined by its rice growth. A preponderance of hickory over oak, and oak over short-leaf pine, are fair indices for guidance in the purchase of land. This parish is filled with small but intelligent, progressive farmers, and is rapidly improving, both in material wealth and in social and intellectual development. Ruston, its county seat, is a thriving town, with excellent churches and schools

JACKSON PARISH,

lying south of Lincoln, is composed of oak uplands and long-leaf pine flats. The soil is chiefly of the yellow sandy clays, but north of Vernon, the county seat, occurs prominent red land ridges, which are very productive. Similar lands occur southeast of Vernon on bayou Castor, where a number of good farms occur.

In the southern part of the parish the long-leaf pine prevails generally on the tops of the ridges, while their slopes are timbered with oaks, mixed with the short-leaf pine, and are fairly productive. A small exposure of cretaceous black prairie, underlaid by limestones, is reported near Rochester in this parish, which is similar to those outcrops in Winn and Bienville.

BIENVILLE PARISH

is mainly oak uplands, with the yellow sandy clay predominating. The lands are gently rolling, somtimes nearly level, especially in the western porlon. The Arcadia clays are well developed in the level portion of the parish, and on them the water and black oaks predominate. The bottom lands of the streams and the flats bordering lake Bristineau are of this character. Where the country is rolling the red subsoil appears, often with concretions of limonite (iron ore). In the extreme southeastern part of the parish, as in Jackson parish, are ridges with long-leaf pine on their tops, but oaks with short-leaf pine on their slopes. In Brushy valley and northward red lands occur and excellent crops are grown both on the hills and in the valleys, which are here not subject to overflow. In this parish occur several salt licks, where much salt was made during the war. These are underlaid by gypsum and cretaceous limestone, and from the latter good lime could be burnt. It might be found profitable to use such lime on these soils. There occur also in this parish outcrops of calcareous and green sand marls, which also might find utilization by application to near-by lands.

RED RIVER PARISH

is partly oak uplands and partly alluvial, with a slight preponderance of the former. The uplands form the divide between the waters of Grand bayou, of Black lake and the Red river. They vary in character from light sandy to reddish sandy clays, the latter readily told by the prevalence of Spanish oaks in the timber.

The front lands of the alluvial plain are comparatively free from overflow, while the back lands are less protected on account of numerous bayous which traverse them. Large plantations occupy the banks of this river throughout this parish.

DE SOTO PARISH

is one of the best upland parishes. The dividing ridge that lies between the waters of the Sabine and Red river crosses this parish diagonally. Mansfield, the parish seat, is situated on it. Near the Red river the country is hilly and broken, constituting what is known as the Dolet hills. The ridges have a reddish subsoil, and are not very thrifty, though the valleys are fairly productive. Lakes and bayous interlacing each other lie at the foot of these hills, against the western edge of Red river. On many of the bayous of this parish occur many large, flat tracts of the Arcadia clays, which, when well drained, make fairly remunerative crops. On the Sabine slope of the divide occur generally rolling plateau's, with wide and fairly fertile valleys between. Grand Cane bayou furnishes the richest part of the parish.

NATCHITOCHES PARISH

is made up of a variety of formations, with the long-leaf pine hills constituting nearly one-half of the parish. The river bottoms are next in area, followed by oak uplands. Small outcrops of central prairie region also prevail. The long-leaf pine hills prevail in the northern part of the parish, north of Black lake. Here also occur the salt rocks, underlaid with cretaceous gypsum and limestone. Between Black lake and the alluvial plain of Red river occurs the ridge of oak uplands, running down from Red River parish. South and west of the alluvial plain is another ridge of oak uplands, coming down from De Soto, which terminates a few miles below Robeline. South of this line, the long-leaf pine continues to the lower end of the parish. Natchitoches is one of the oldest, largest and most productive parishes in the state. The large areas of cultivatable lands lying on the Red river, Cane river and other old beds of the river are all occupied by large plantations and fine old homes. These lands are as fertile as any in the state, and by their large annual yields make Natchitoches one of the largest cotton-producing parishes of the state. Natchitoches, on Cane river, is the oldest settlement in the state, and is now connected with the outside world by a branch road to Cypress, on the Texas and Pacific Railroad.

SABINE PARISH.

The lands of this parish are divided between the good uplands, central prairies and long-leaf pine hills, with the first largely predominating. The last has only a small development in the southern part of the parish. West of bayou Toreau is a sudden transition from long-leaf pine sands to the better lands of the central prairie.

On the hills, oaks, with short-leaf pine, growing in a deeper colored soil, take the place of long-leaf pines, while the valleys exhibit true black lime prairies, which indicate the presence of the marine tertiary formation. A belt of this character, six to seven miles wide, runs in a northeastly direction across the parish. Ridges, crested by long-leaf pine, but sloped with oaks and short-leaf pine, run out into the uplands north of Many and continue to the edge of De Soto parish.

Bayous Negreet and San Patricio furnish the best lands of the parish.

Sabine is noted for numerous small but thrifty farmers. It is said that there is not a mortgage upon the record books of the parish, showing the independent and self-reliant character of its people.

THE LONG-LEAF PINE REGION

covers a part of Calcasieu, all of Vernon, except Anacoco prairies, all of Rapides outside of alluvial bottoms, parts of Natchitoches and Sabine, nearly all of Grant and Winn, parts of Bienville and Jackson, a small part of Ouachita and large portions of Caldwell and Catahoula. East of the Mississippi river it embraces nearly all of the parishes of St. Tammany, Washington, Tangipahoa and St. Helena and a part of East Feliciana.

All of this section abounds, except in the bottoms, with the long-leaf pine (Pinus Australis). Occasionally, on the improvement of the soil, a few straggling oaks (chiefly black jack and post) and short-leaf pines will be found intermingling with them. The prevalence of these trees will generally measure the capacity of the soil. The long-leaf pine follows a certain class of soils and mainly confines itself to such, but it is frequently found on sandy ridges, running into other formations. Isolated tracts are also found considerably beyond the formations here described. There are two divisions of this region. One, the "long-leaf pine hills," and known geographically in Louisiana as the "grand gulf group"; the other as the pine flats, which is either coast pliocene or post pliocene, and occur either adjoining the gulf or the coast marshes of the gulf.

THE PINE HILLS

present a great uniformity of soil, surface features, growth and undergrowth, from Georgia to Texas. A poor, sandy soil, resting upon a pale yellow sub-soil of great porosity and depth, prevents these lands from washing into gullies. The waters that fall on them permeate them with facility, and the ridges which divide the water courses are usually broad, gently rolling plateaus, without any definite water channels between.

Wells are sometimes dug nearly 100 feet before water is obtained. These forests are so open that vehicles can be freely driven through them, and grass and other plants grow luxuriantly throughout them. Hence these lands are valuable for timber and grazing, and thousands of sheep and cattle are supported in the piny woods of Georgia, Alabama, Florida, and Mississippi, as well as in this state and Texas.

The soils on the ridges are poor and unretentive. In fact, the old settler will not make a clearing unless a notable amount of oak and hickory mingle with the pine. The bottoms are always better and these constitute the chief arable lands of the country.

Hill Parishes of the Long-Leaf Pine.

Those not already described are Grant, Winn, Rapides and Vernon, in western Louisiana, and St. Helena and Washington in east Louisiana.

GRANT PARISH

embraces, besides the long-leaf pine hills, a small portion of the Red river bottoms, some tracts of the "central prairie" region with some level lowlands, timbered with oak and short-leaf pines. The last occupy the northeastern portion of the parish, with a heavy gray clay (Arcadia clays) mixed with small detached tracts or belts of black prairie, treeless or with scattered clumps of hawthorn, crab-apple and honey locust. These soils are badly drained and potable water is hard to obtain in the vicinity and, therefore, they are not occupied and cultivated as largely as their intrinsic merits would warrant. Some day artesian wells and thorough drainage may cause them to be thickly settled and highly appreciated.

The second bottoms on Little river are above overflow and are highly esteemed, while the first bottoms, covered with heavy timber, are often overflowed to a goodly depth. This river is navigable the year round, as far as the junction of bayou Castor.

WINN PARISH

is rolling, but rarely hilly, and consisting mainly of long-leaf pine hills, furnishes an immense area of excellent timber. In the southern portion of the parish, the slopes of the ridges are frequently covered with oaks and short-leaf pines, with the underlying subsoil of a deeper tint than usually prevail below the soil of the long-leaf pine region. On the Dugdemona and its tributaries are found tracts of good upland farming lands.

The bottoms, however, are narrow and subject to overflow and are therefore not much cultivated.

Pendarvis prairie in the fork of the Dudgemona and Castor, is of true cretaceous black prairie formation. The salt licks with salt springs or wells, underlaid by cretaceous limestone, occur in various parts of the parish. Price's lick, Drake's salt works, Cedar lick and others are notable instances of these outcrops. The cretaceous limestone hill, near Winnfield, is of the same origin and from it can be made most excellent lime, which could be used to advantage on most of the soils of the parish. At Louisville, in the northeastern part of the parish, this character of limestone comes to the surface and furnishes a small track of black prairie circular to Pendarvis prairie.

RAPIDES PARISH.

This parish, while classified under the long-leaf pine hills, on account of the latter constituting about two-thirds of its area, has yet a large and magnificent development of alluvial lands, which are well cultivated and thickly settled, and give immense wealth to the parish. The Red river plain runs diagonally through the parish from northwest to southeast, with an average width of about twelve miles. East and west of this plain are the gently rolling hills, with the usual sandy soil of this formation, supporting a long-leaf pine forest, with narrow but fertile hollows skirting the streams. In the southern portion of the parish bayou Cocodrie forms a great swamp. In the extreme northwestern part of the parish Holloway's prairie begins and runs southward into Avoyelles.' This prairie is of bluff origin, and supports a growth of timber entirely different from that to be found on the adjoining hills. At the foot of this prairie the Red river valley proper terminates, and thereafter is mingled with the great flood plain of the Mississippi. The alluvial lands of Rapides are claimed by many as the finest lands of the state. Near the river and bayous the light, sandy, red lands prevail, superseded further off by the back lands, which are brown mahogany loams. Both of these are very fertile. Further back occurs a heavy red buckshot, hard to drain and difficult to cultivate. This is known locally as the "saltpeter" soil, and is not held in high esteem, although it is rich in the ingredients required for plant growth.

VERNON PARISH,

with the exception of Anacoco prairie region, is entirely of the long-leaf pine hills. The bulk of the cotton grown in the parish is in the former. This parish is at present inaccessible, and, therefore, its settlement has been only along the prairie region and fertile bottoms of its streams, the hills being as yet but sparsely inhabited, though clothed with the finest kind of timber. The headwaters of the Calcasieu, Castor and Bundick streams furnish some wide bottoms, which are thickly settled, as also the best character of uplands surrounding them. The bottoms of the Sabine are not very extensively cultivated.

ST. HELENA PARISH

is cultivated chiefly along the bottoms of the smaller streams and the second bottoms of the Amite and Tickfaw rivers. The uplands are mainly rolling, undulating pine-hill country, with the characteristic sandy loam soil, underlaid at a few inches depth by a pale yellow subsoil, changing in local spots to gray, with bog on concretions intermixed. These soils are poor but susceptible of of great improvement and with excellent water and good health, the country must be thickly settled as soon as railroad facilities are offered, just as has been done in the adjoining parish of Tangipahoa, along the line of the Illinois Central Railroad. When transportation is furnished, all of these soils will, by fertilizers, be converted into truck gardens, for which, on account of their physical qualities, they are so specially adapted.

WASHINGTON PARISH

is almost entirely undulating pinewoods, like those of northern Tangipahoa and St. Helena, the bottoms and hammocks of the streams forming the only exception. The latter, however, furnish mainly the arable lands, the settlements being almost entirely along the water courses. Bogue Chitto, running through the center of the parish, furnishes a considerable area of cultivatable soils. Pearl river bottoms are subject to overflow, but when reclaimed, the soils are very fertile. Like similar soils elsewhere, the hill lands can be easily improved and made very fertile with proper manures and rotation of crops. Lumber, turpentine and charcoal are the products of the forest. Stock-raising is also extensively carried on in the open woods.

THE LONG-LEAF PINE FLATS

exist in the extreme eastern and western portions of the state. In the west, north of the pine prairies of Calcasieu parish, directly north of the west fork of the Calcasieu river, occurs a strip of pine flats nearly twenty miles wide. It is included between the pine hills and the pine prairies. The soil here is a gray, unretentive silt, underlaid by brown ferruginous concretions, resting at 18 to 30 inches upon a compact blue subsoil, full of bog, on gravels or sand, cemented into an impervious mass by clay. The roots of the pine remain above this last stratum, and hence are easily uprooted by the storms. Further north this crayfishy stratum is gradually displaced by a yellow sandy or silty loam, and the lands become more rolling, forming a gradual transition to the pine hills. In the east the pine flats of St. Tammany, Tangipahoa and parts of Livingston and St. Helena are somewhat different. A heavy gray clay underlies most of the region, which at times approaches the surface, forming cold, undrained soils, or is covered to a few inches by a silty soil of poor quality. Lake Pontchartrain is partly belted with a fair but ill-drained soil, bearing a growth of sweet gum and lowland oaks. Along the courses of the streams, notably Amite and Tangipahoa rivers, occur belts of oaks, beach, dogwood and short-leaf pine, with a brown soil, easily tilled and fairly productive, which rests upon a foundation of sandy red clay. Most of the settlements in this country are, therefore, along these bottoms. However, as pasture and for lumbering and the manufacture of turpentine and charcoal, these forests excel.

Parishes of the Long-Leaf Pine Flats

Under this head are included the parishes of Tangipahoa and St. Tammany. The other parishes, Calcasieu, Livingston and St. Helena, in which areas of this formation occur, have been already described.

TANGIPAHOA PARISH

Is, like St. Helena in its northern part, with gently rolling pine woods, full of healthfulness and with easy accessibility to the outside world by the Illinois Central Railroad, which runs through its entire length. In the southern part of the parish the pine flats prevail. The entire parish is susceptible of wonderful improvement, as has been shown by the efforts of the large number of northern men who have settled all along the line of the above mentioned railroad and converted these lands into excellent gardens and fine orchards. The lands bordering on the Tangipahoa river are naturally fair and are capable of being improved to any desired extent. The climate and soils of this parish permit the growth of most every crop. Sugar cane, rice, cotton, corn, oats, grasses, trucks and fruits—in fact, a more varied product of the soil is now obtainable in this parish than in any other in the state. It is the great strawberry and Japanese plum parish of the state, and many hundred carloads of the former are annually shipped to Chicago and other western markets.

At Ponchatoula, Hammond, Tickfaw, Roseland, Amite, Kentwood and Tangipahoa, have been established large and prosperous farming villages, cultivating fruits and vegetables for western markets.

Many thousand western people have here established successfully "village farms" and are enjoying comfortable homes in a delightful climate, with moderate toil.

ST. TAMMANY PARISH

Is almost entirely a pine flat parish, only the margins of lake Pontchartrain and the lower lands on the Pearl river excepted.

The pine lands are like those described as occurring in the lower part of Tangipahoa parish, and are used largely for the same purposes, viz: pasture, lumber, turpentine and charcoal. The bottoms are mainly cultivated. The lowland belt fringing lake Pontchartrain is occupied by summer residences of many of the citizens of New Orleans. Mandeville and Lewisburg are small towns, situated on the lake, and are mainly composed of houses which belong to citizens of New Orleans, who occupy them as summer homes. Covington, the county seat, situated on Tchefuncta river, ten miles from the lake, is also largely filled with summer residents from the Crescent city. A railroad connects this city with New Orleans.

CENTRAL PRAIRIE REGION

constitutes a narrow belt, twenty to thirty miles wide, running across the state from the Ouachita to the Sabine. On the Ouachita it extends from Columbia to Harrisonburg, and on the Sabine from Sabinetown to Toledo, with a large outcrop on the Anacoco bayous, in Vernon parish, below this line. While this peculiar geological formation occupies this extended area, it covers a comparatively small portion of the surface. It occurs in isolated patches of ranging areas all through this belt, giving us distinctly two classes of prairies, viz., black calcareous prairies, covered with luxuriant grasses, with occasional clumps of wild plum and crabapple and hawthorn. These are exceedingly fertile, and give large returns when properly cultivated. The second class are known locally as the "hog wallow" prairies, which are composed of stiff, non-calcareous, intractable clays, with a rough surface, an effect produced by alternations of wet and dry weather upon this character of clay. These soils are, as a rule, poor and unthrifty, and are cultivated only in very limited areas, and with no positively profitable results. Neither of these classes have tracts more than a few miles in extent, being interrupted by ridges of long-leaf pine or oak uplands. Frequently these ridges may be underlaid with prairie material, and the bottom soils resulting from the washings from these ridges may contain an admixture of clay and sand in such excellent proportions as to form very fertile and desirable soils. Surface wells, though deep and expansive, furnish a very impure drinking water, and hence have proven a drawback to the more extensive occupancy of these prairies. Artesian wells, however, will remove this obstruction. Since all the parishes included in this belt are treated of in detail elsewhere, it is only necessary to repeat here that parts of the following parishes are occupied by this formation, viz.: Caldwell, Catahoula, Winn, Grant, Natchitoches, Sabine and Vernon (Anacoco prairies).

The Parishes of Louisiana.

EXTENT, CULTIVATION, POPULATION.

	Area in square miles.	Acres in culti- vation.	Popu- lation.	Bales of cotton.	Hhds. of 1000 lbs. of Sugar.
Acadia	616	61.316	13,231	1.200	...
Ascension	373	37.908	19,545	1,000	43,172
Assumption	327	36,511	19.629	200	39.569
Avoyelles	843	84.787	25,112	30,121	3,584
Baton Rouge, East	395	40,026	25,922	12,640	3,133
Baton Rouge, West	210	26,753	8,363	3,460	9,916
Bienville	856	45,048	14,108	10.256	..
Bossier	773	69,420	20,330	28,960	...
Caddo	852	95,409	31,559	25,360	...
Calcasieu	3.409	14,003	20,176	2,300	3.033
Caldwell	535	18 267	5,814	8.060	...
Cameron	1,545	5,743	2,825	965	...
Carroll, East	400	56.793	12,362	45.620	...
Carroll, West	380	10,071	3,748	6,124	...
Catahoula	1,350	29,823	12,062	13,624	...
Claiborne	765	126,000	23,312	25.568	...
Concordia	620	45,816	14.871	38.570	...
DeSoto	856	82,239	19,860	14 298	...
Feliciana, East	450	53,118	17,903	12.359	...
Feliciana, West	302	21,115	15,062	14,365	...
Franklin	550	22 104	6,900	10,230	...
Grant	578	24,414	8,270	7.230	...
Iberia	536	49,604	20,997	4.560	34.290
Iberville	646	42,112	21,848	1,560	48.894
Jackson	576	26,604	7,453	4,750	..
Jefferson	395	19,767	13.221	...	7,926
Lafayette	262	62,704	15.966	6,762	995
Lafourche	1,024	44,802	22,095	...	50,508
Livingston	575	10,467	5,700	1,505	...
Lincoln	485	108,084	14,753	12,362	..
Madison	670	48,395	14,135	25,362	...
Morehouse	760	57,379	16,786	26,485	...
Natchitoches	1.290	58,969	25,836	20,165	...
Orleans	187	4,436	242,630	..	2.627
Ouachita	640	48,847	17,985	21,720	..
Plaquemines	930	36,908	12,541	...	19,717
Pointe Coupee	575	56,594	19,613	19,367	9,156
Rapides	1,498	76,149	27,642	18,275	8,753
Red River	386	33,930	11,318	13,786	..
Richland	578	31,409	10,230	12,167	...
Sabine	1,008	18,524	9,390	3,567	...
St. Bernard	680	11,850	4,326	...	2,690
St. Charles	284	21,177	7,737	...	21,655
St. Helena	413	28,285	8,062	6,759	...
St. James	308	54,675	15,715	–	40,890
St. John	190	29,213	11,359	..	23,965
St. Landry	1,683	112,680	40,250	23,975	8,218
St. Martin	618	39,876	14,884	3,467	14 113
St. Mary	648	66,326	22,416	..	119,865
St. Tammany	923	3,895	10,160	400	..
Tangipahoa	790	21,021	12,655	3,671	80
Tensas	612	78,679	16,647	46,584	...
Terrebonne	1,806	40,403	20,167	...	48,512
Union	880	62 661	17,304	12,960	..
Vermillion	1,226	25,330	14,234	1,350	5,337
Vernon	1,540	16,303	5,903	2,198	-
Washington	668	18,224	6,700	3,672	...
Webster	594	42,402	12,466	8,970	.
Winn	954	22,548	7,082	4,230	...
	44,426	2,507,935	1,118,587	622,511	595,473

From the above it will be seen that upon a little over 2 1-2 millions of acres there has been made 622,511 bales of cotton and 595,473 hogsheads of sugar. The total area in the state is over 28 millions of acres; there is, therefore, not over one-tenth of the state under cultivation. When all of these lands shall be occupied and the arable portion placed under good culture, what a wealth of products will be produced!

The total area of the state is 45,440 square miles of land, with several thousand acres of fresh and salt water. The land is distributed as follows:

	Sq. Miles.
Alluvial lands	13,255
Bluff and bluff prairies	5,739
Oak and hickory uplands	8,103
Long-leaf pine hills	7,582
Long-leaf pine flats	2,556
Central prairie region	785
Coast marshes	7,420

Such are the geological and agricultural features of this state. A state of marvelous fertility of soil, with the largest length of water courses, with splendid railroad connections, with superb climatic conditions. A state connected inland by the great father of waters with an immense territory stretching from the Appalachian to the Rocky mountains, and outward, through its mouth, with every port of the globe. A distinguished son of another state has truly said: "The northern coast of the gulf of Mexico is the natural center of trade for the western hemisphere. The configuration of the continent, the direction of the great rivers, the sweep of the ocean currents, and the prevailing winds, all point to the mouth of the Mississippi as the natural center. There is land enough adapted to the growth of sugar contiguous to New Orleans to supply the wants of the continent and to furnish vast quantities for exportation. It only needs the proper application of machinery and labor to effect this great result. New Orleans is to be the grandest emporium of trade for the continent. When ship communication is made across the isthmus, New Orleans must become the great center of trade for North America, and nothing can divert it but an imperial despotism holding huge investments of capital elsewhere."

This prophecy is being fulfilled, and the millions of acres of land adjoining this river, and tributary to this already great emporium, must at an early day become peopled with busy millions of souls striving in this balmy climate for the mastery of the agricultural world, as

NEW ORLEANS DOMINATES THE COMMERCE OF NATIONS.

To prepare for this great contest the first question to ask is:

What Will These Lands Grow?

The general impression prevails that the south can only grow cotton, sugar cane, tobacco and rice; that other crops cannot be grown successfully, and that hay-making and stock raising are impossibilities in this sunny land.

This erroneous impression has been produced by the persistency of our planters and farmers in growing the above crops, a persistency largely inherited and acquired, with our large plantations filled with ignorant, unskilled laborers, who have been disciplined since youth in planting methods. But the climax has been reached. Planting on a large scale is no longer popular. Unreliable labor, low prices, soil exhaustion and high money rates have shorn this business of all its pleasures and most of its profits. Disintegration and division is now the order of the day, and the large plantation of yesterday will be to-morrow the abode of many happy and prosperous farms.

The question may be asked, What else can be grown in Louisiana? The reply is a sweeping one; nearly everything capable of growth in a temperate or subtropical country. Wheat has been, and can be, grown in the northern part of the state. Oats sown in the early fall, and using the rust proof varieties for seed, will make as finely here as anywhere on earth. Over 100 bushels per acre have been grown on the alluvial and bluff lands of the state, while the hill lands of north Louisiana have frequently given over sixty bushels per acre. Spring oats are sometimes successful, but are not generally to be recommended. Rye and barley, if home-grown seed be used, will thrive all over the state, and are frequently sown for winter pastures. The stock are turned on during the winter, and at the beginning of spring they are removed and the grain permitted to mature, frequently with large results. Two successive crops of buckwheat have been grown in this state on the same soil in one year.

Corn can be grown easily all over the state, and if the same attention and methods of cultivation were given it here as in the corn-growing states of the west the average yield per acre would be but little under that produced there. But corn is a side issue with the cotton and cane planter, and is cultivated as little as possible. Under this "touch and go" method the yield of this state during the present year is but little below 20,000,000 bushels. By proper rotation, fertilization and cultivation, this yield could easily be doubled. Upon the al-

alluvial lands of south Louisiana the sugar experiment station has for several years averaged over 100 bushels per acre upon a field of eight or ten acres. Sixty to ninety bushels have been obtained at the state experiment station at Baton Rouge upon the bluff lands, and thirty to sixty bushels are the average yields upon the rotation fields of the north Louisiana experiment station, situated at Calhoun, upon the yellow sandy loams of the oak and short leaf pine hills.

One caution is needed in planting grains of all kinds here, that is, for a general crop use home grown, acclimated seed. E. g., corn grown here is planted in early March and harvested in August and September, while seed from the extreme north planted at the same time will probably mature in May, and that, too, with only a partial crop. Wheat and oats, per contra, planted in the fall from seed raised in the extreme north, will not ripen before June or July, if at all (the rust frequently destroying it before ripening), while home-raised seed sown at the same time, will be ready for harvest in May. If, therefore, we desire an early crop of corn, we obtain seed from the north, and if an early crop of oats, wheat, barley or rye be desired, we send south for the seed. The reasons are obvious, when we remember that each comes to us inheriting the habits of the country from which it came. In the north the summers are short and the time of the growth of the corn is, therefore, limited. In the south, the winters are short, and, therefore, the period of repose is materially shortened and early maturity follows. This involves the whole question of acclimation. In Louisiana, under good culture, the corn crop will always be from twenty to 100 bushels per acre.

German and cat-tail millets the sorghums, both saccharine and non-saccharine, clovers, grasses and root crops, cow peas, teosinte and other forage crops can be grown over the entire state in larger quantities per acre than elsewhere, since the tendency of our climate and the extreme fertility of our soils are to make "weed."

Vegetables of all kinds can and are grown in large quantities. Besides those grown in the north and west are many others peculiar to the south, such as okra, globe artichoke, lima beans, etc., beets, cabbage, lettuce, radishes, turnips, mustard, cauliflower, English peas, etc., are grown through the winter in open ground. In fact, every home, however humble, has its garden, in which most of the vegetables are grown. Beside these home gardens there are thousands of acres devoted to truck growing and market gardening. From the latter our own cities and towns are supplied, while the former utilize many thousands of cars in transporting their products to the western markets.

Of fruits a great variety of superior excellence can be grown here. The apple is grown in the northern part of the state. The pear, particularly the Chinese type, all over the state. The peach will grow everywhere, but it fruits best in the hill lands. The native and Japanese varieties of the plums do well everywhere. The apricot, nectrine and cherry are not successful anywhere in this state. Grapes can be grown in every parish, but succeed best in the uplands. Black berries, dewberries and mulberries grow wild in every parish; so do the wild plums in the hill lands. Strawberries are perfectly at home everywhere, and in some sections are largely grown for the markets. Raspberries, currants and gooseberries do not thrive so far south.

Oranges, kumquats, and pomelos are grown throughout south Louisiana, while lemons, guavas, bananas and pineapples are grown on the extreme gulf coast. The loquat and pomegranate are found in nearly every yard of south Louisiana. Figs are cultivated in every parish, while in south Louisiana they are largely grown for the canneries.

No mention is made of our staple crops—cotton, sugar cane and rice—since they are inseparably connected in every man's mind with Louisiana and New Orleans.

This bare recital will show the wonderful capabilities of our soil and climate from an agricultural standpoint. Turning to the forests, we find a wealth of nature's products ready for the harvest, to be turned by man's skill and ingenuity into the various forms and shapes suitable for man's varied wants. Timber and lumber trees, stave timber, box timber, hut timber, spoke timber, tray timber, hoop timber, ship timber, bucket timber, etc., crown our hills decorate our valleys and fill our swamps. Shade trees of the densest foliage and of most beautiful shape everywhere abound. The evergreens and deciduous trees grow side by side in every forest. The magnolia and the liveoak intertwine their boughs with the beech and the ash, while the holly and the dogwood bask in their shadows. Willows abound in our swamps, ready for conversion into charcoal or to be twisted into baskets.

Louisiana does not appeal alone to the utilitarian. Her aesthetic products are perhaps more wonderful than her useful ones. Flowers of brilliant tints and attractive forms fill her fields, her woods and her swamps. Her climate favors the growth of native flowers as well as the delicate and highly-prized exotics. Roses bloom in great profusion throughout the winter in open air, while japonicas, hibiscus and poinsettias of beautiful shades and brilliant tints are found in many yards. Tea olives and magnolias (fuscata) and cape jasmines perfume the air with their delicious fragrance, while chrysanthemums, geraniums and plumbagos give brilliancy to every garden.

Palms of endless varieties furnish the center pieces of many private yards and ornament our parks and public squares.

Such in brief are the products of our soils. For the guidance of those seeking a home in our midst the following details of crops from here are given:

CANE CULTURE.

Formerly every cane culturist was also a manufacturer, and upon every plantation of sugar cane was to be found a sugar-house of sufficient capacity to work up the crop grown. To-day the scene is changing, changing rapidly. Central factories exist—some that do not cultivate cane at all, but purchase every stalk crushed; others that grow only a part, large or small, of the large amount consumed. The presence of central factories presupposes the existence of cane farmers in close proximity. Many central factories already exist, and others will soon be built. The fierce conflict between low prices and profitable returns has forced out of existence many a small and incomplete sugar-house, and will ultimately drive out the remaining ones. Ponderous machines, with extensive capacities, must hereafter manufacture the crystalline product of sugar cane. It requires a large amount of cane to supply the daily demands of a large central factory; 1000 to 1500 tons per day is now a moderate allowance for the largest. Under these new conditions, the growing of sugar cane for sale to these factories is quite extensively practiced. Small farmers, with ten acres of sugar cane, can find a ready market for it, just as readily as the large planter, with one hundred times this crop. The crops of both are in demand. Until the recent removal of the bounty on sugar, growing cane by the ton for sale to central factories was quite a profitable business, and many embarked therein. The removal of the bounty occurred simultaneously with an overproduction of beet sugar in Europe, by which the prices of sugar everywhere had been greatly depressed. This combination of bad conditions has temporarily depressed the grower of cane, but it is hoped and expected that another year will bring with it higher prices for sugar, and. therefore, higher values for sugar cane. Sugar cane is bought upon a basis of values for a certain grade of sugar, and hence, when the latter is ruling low the former conforms to it in price. If, however. values are restored, no enterprise is more inviting than that of raising sugar cane by the ton for the factories. Lands in any quantity may be purchased or rented well adapted to the growth of cane. The capital required will depend largely upon the magnitude of the enterprise. One's own labor, if intelligently decided, will accomplish a great deal towards the cultivation of twenty to thirty acres of cane. Additional help will be required in planting and harvesting the crop. Good land will make from twenty to forty tons of cane per acre, and at present the factories are paying 85 cents per ton for each cent per pound that prime yellow sugar brings in the market of New Orleans. There is a large field in Louisiana for the investment of capital in central factories and for intelligent labor to grow the cane. Both will come rapidly with the return of better prices for sugar.

RICE CULTURE.

Formerly rice was cultivated only on the banks of the Mississippi river and its bayous, and watered by these streams. Pumps, or siphons, were used to lift the water over the walls. Upon these alluvial lands growing rice was an expensive business. A few years since southwest Louisiana began the cultivation of rice upon its open prairies. Rain water was collected by levees and used when needed upon the fields of growing rice. The bayous and coulees of this country were drafted upon for water; and pumps conveyed it to the ditches, which carried it to the rice fields. The following are their methods: Lands are broken with riding plows and pulverized with large harrows The rice is seeded with broadcast seeders. After germination the fields are flooded. The rains are ample during the growing season, if properly husbanded, to make a crop, and many a field is grown with rain water alone. Some large fields are flooded with water from the bayous and coulees. When the rice is mature the water is withdrawn and the harvesting is quickly performed by self-binding reapers. Steam threshing machines convert the rice into a marketable form (rough rice), which is sold in sacks to the numerous rice mills of the state, where the finished rice of commerce is prepared, with the accompanying by-products: "Rice polish," "rice bran" and "hulls." The straw is left on the fields of the farm. So cheaply and successfully has rice been grown on the praries that they are now but little more than rice fields, and have driven the alluvial planters out of the business. Louisiana grows to-day four-fifths of the crop of the United States, and by its present methods of culture is reaping a goodly profit.

TOBACCO GROWING.

The oak and short-leaf pine hills and the long-leaf pine country are eminently adapted to the growth of the forest type of yellow leaf tobacco, which is now in such large demand for plug wrappers and smoking tobacco. Experiments at the north Louisiana experiment station have so conclusively demonstrated this fact that many of the farmers of the country have embarked in its cultivation, and a plug and smoking tobacco factory has been established at Calhoun, with a capital of $25,000. which is now busily engaged daily in its manufacture. This factory will purchase the tobacco directly from the grower, and thus save freight to market and commissions for selling. Similar factories will soon start all over north and east Louisiana. At Hammond, in eastern Louisiana, similar field experiments to those conducted at Calhoun have been successfully made, and confirms the opinion previously entertained of the adaptability of the pine lands of the Florida parishes of Louisiana to the growth of the yellow leaf tobacco. In growing tobacco care must be taken to grow the best, since the inferior articles have small values. The process of curing is by the "new barn" of Captain W. H. Snow, and is accomplished in about three days. This yellow leaf tobacco was sold by the station to Lorillard & Co., New Jersey, for 45 cents per pound, and at such prices gave a very profitable return.

On the alluvial bluff and prairie lands of the state it is best to attempt the growth of the cigar leaf tobacco. Experiments at Baton Rouge and Audubon park give promise of success in this direction. Some fine cigars made from tobacco grown at Baton Rouge have been tested by the writer, and it is thought that experience would improve the quality and quantity of the product

At Calhoun as much as 1600 pounds per acre of bright yellow leaf have been produced. In south Louisiana, with the cigar types of tobacco, the yield has reached over 2000 pounds. It is usual to obtain two crops a year from the same planting. This is accomplished by leaving a sucker in the axil of the lower leaf when topping the plant. When the leaves of the first crop are gathered, the old stalk is removed and the young sucker soon takes its place and with favorable seasons makes nearly as large and fine a crop as the first one.

Tobacco growing is one of the coming industries of the state and soon our factories will be supplying the states west of us with smoking and chewing material. The following are the opinions of the leading tobacconist of this country upon the merits of our yellow leaf:

Carr & Richardson, manufacturers, of Richmond, Va., write.

"We pronounce it as fine in quality and texture as the best average of the best section and among the best and most skilled planters in North Carolina. In short, we think its quality could hardly be excelled. * * * You have as clear color for the ripeness and quality as we have ever seen. We have seen cutters and light press wrappers of a fraction better color than this, but the white yellow was at the expense of its chewing and smoking qualities. The samples you sent are what we pronounce the ideal cigarette stock, excepting the heavier bundles, which is a light press wrapper. * * * Our advice to you, if you continue to make tobacco, is to make the very best, like the samples sent, getting as much off an acre as possible, and then securing a second crop if possible."

These gentlemen write further that it is their opinion that no other country could successfully compete with Louisiana in raising tobacco, owing to our long summer, which insures a ripe crop, which is not always the case in Virginia and North Carolina.

From P. Lorrillard & Co., New Jersey, the following was received:

"We beg to acknowledge receipt of your favor of the 14th ult., also type samples referred to therein, which we have carefully examined, and note with pleasure the success attained in the growing and curing of bright tobacco. As indicated by these types, the soil is evidently well adapted to the growth of bright tobacco, and with a proper knowledge of curing and handling the same, we believe the farmers of your state will find tobacco raising a profitable industry."

Pemberton & Penn, of Henderson, N. C., wrote: "It cannot fail to bring a good price."

G. W. Smith & Co., manufacturers, Lynchburg, Va., write:

"We were quite interested in examining your samples and surprised to see such tobacco from Louisiana. It is a valuable crop, and if exhibited in any market in Virginia and North Carolina, in proper condition, would command prices that would probably be very satisfactory to you."

Messrs. J. P. Taylor & Co., Danville, Va., write: "We are sure it will bring you a good price."

Mr E. J Parrish, of Durham, N. C., says: "Samples received They show to be very good stock and worth from 15 to 30 cents per pound."

The Addison Tinsley Tobacco Company, of Louisiana, Mo., write: "We find on examination, your samples to be a very good quality of wrappers. We cannot make an intelligent bid without knowing proportion of long and short wrappers, but lumping the lot, we make you an offer of $20 per 100 pounds on the entire lot."

GRASSES, CLOVERS AND FORAGE CROPS.

Throughout the entire south two well known grasses furnish pastures and hay of the best quality, and in practically large abundance. These are Bermuda (cynodon dactyton), the finest pasture grass in the world, and crab grass (panicum sanguinale), which springs up in every cultivated field in early spring, and if not disturbed will furnish a large cutting of excellent hay in summer. These grasses grow all over the south, and, in the past, have been considered our worst enemies.

In south and middle Louisiana, upon the alluvial plains, bluff and pine lands occur many varieties of paspulums, several of which are highly esteemed, both for hay and pasturage, viz. P. distichum and P. platycaule. These are known by the Creoles as gazon and by the Americans as carpet grass.

A fox-tail grass (setaria glauca) also grows luxuriantly all over south Louisiana, and furnishes a fairly good hay and pasturage.

In north and middle Louisiana, and even upon the pine hills and flats of east Louisiana lespedeza stnata, Japan clover, covers every available space of unoccupied ground, even in the forest, affording excellent grazing throughout the summer for stock. When cultivated, particularly upon the bluff lands of the state, it makes large crops of a very palatable hay. Many thousands of acres are now annually grown, and a number of colts and calves are raised exclusively upon it. It is especially luxuriant upon the bluff lands, and is there worthy of cultivation. In the alluvial lands it has not been given extensive trials.

The varities of grasses cultivated successfully in the north should here be tried only on a small scale, since experiments so far conducted have proven them to be, in many cases, unprofitable. The first essential for successful growth of grasses and clovers is to sow them in the early fall upon well prepared seed beds. They spring up at once and get sufficiently rooted by spring to resist the encroachments of the native grasses, and withstand our long summers, the chief obstacles to successful grass culture all over the south. The best cultivated grasses are the following:

Tall meadow oat grass (arrhenathirum avenaceum), planted in early fall upon good, well-pulverized soil, will secure a good start by spring and make one or two cuttings of hay during the summer. It will last for several years, and affords an excellent pasturage. It has succeeded on the alluvial, bluff and oak uplands One bushel (fourteen pounds) of seed required for an acre.

Italian rye grass (lolium italicum) sown early in the fall upon rich, moist land (not wet) will afford two large cuttings of excellent hay. The first cutting must be made before it flowers, since this grass is an annual, and after seeding dies; forty-five pounds of seed required for an acre. Succeeds everywhere on good, moist soil.

Rescue grass (bromus shraderi) sown in the first cool days of the fall upon well-prepared, fertile soils, will give excellent results. Cut before it goes to seed. It will give two crops of hay. The last cut (after the seed are matured) will drop enough seed to reseed the ground the next fall. A good annual for this climate, and, if properly managed, will make a perpetual winter grass.

The following have been partial successes: Red top (agrostis vulgaris) on damp, low soils; orchard (dactylis glomerata), on good soil; English blue grass (festuca pratensis), especially in shady, damp places; velvet grass (holcus lanatus), Kentucky blue ragss (poa pratensis), on good soils containing lime, and crested dogtail (cynosau rus enstatus).

The following new and imported grasses have been very successful, but the seed are difficult to obtain:

Hairy oat (avena steriles), growth like common oat (avena saliva), and is an annual, Japanese rye (agropyrum japonicum), a perennial of great merit, growing through the fall, winter and spring and eaten greedily by stock.

Bromus pinnatus, a coarse, rank grass, growing mainly in winter; phalaris coerulescens, a summer grass of great merit, and panicum palmeri, a summer grass of wonderful growth and strong reproductive power, with large, wide blades and full seed heads.

Bromus inermis has succeeded upon dry, rich soils. Texas blue grass, propagated best from roots, is strongly recommended for high lands as a winter pasture.

It must be remembered that no cultivated grasses will succeed upon poor, badly prepared soils; therefore, in going into grass culture prepare lands thoroughhly by growing first crops of—

Clovers, cowpeas, vetches or alfalfa, which prepare the soil for all kinds of gramnaceae. Of the clovers: White clover grows in great luxuriance naturally all over the bluff and alluvial lands of south Louisiana. It furnishes an abundant pasturage in winter and early spring.

Red clover can be grown anywhere in the state, provided the soil be first enriched and sown in early fall. It is, however, not so certain a crop as common clover, which, when sown in the fall upon fairly good soil, will nearly always give a remunerative return of hay. It is an annual, and the seed must be carefully harvested each year for reseeding, since those dropped by the plant germinate at once and are killed by the heat of the summer. This clover is particularly to be recommended upon the light lands of the state, as the clover best adapted to them, but it would be better even here to grow and turn under a good crop of cowpeas before seeding the land in it. Alfalfa (medicago saliva) is especially applicable to the rich alluvial bottoms of the state, or to very rich uplands. It should be seeded in September or October, at the rate of fifteen pounds per acre. The land should be well drained and deeply plowed and well pulverized. If a good stand be secured as many as eight cuttings per year may be obtained. It will, if properly cared for, last several years. It is the only crop on our bottom lands that will occupy the ground throughout the year.

Lathyrus—Of the three varieties, sativus, suvestris and hirsutus, which have been tested, only the last is to be recommended. It springs up in the late fall, grows through the winter, fruits in the spring and dies. From the seed dropped, it springs up again the next year.

Vetches—Vicca villosa, sown in the fall, have given fairly good results. The other species have not proven successful.

Soja beans (geycene hispida) have done well upon the light hill lands of north and east Louisiana. Elsewhere in the state they have produced good vines, but little fruit.

California, or burr clover (medicajo maculata), grows well all over the state, but it makes an inferior hay not generally relished by stock.

Beggar lice, or ticks (desmodrum molle), grows luxuriantly most anywhere in the state, and when cut young gives a hay which is greatly relished by stock.

Spanish Peanuts—This plant is now largely grown for forage. The vines, with their adherent pods, are cured into hays and fed to all kinds of stock. They also are great soil improvers.

GERMAN AND GOLDEN WONDER MILLET

have been grown successfully all over the state. For hay purposes it should be cut before it forms seed.

Cowpeas (dolichos sinensis) is the "boss" crop of the southern states. It can be used as a soil restorer, a hay crop and a grain crop. There are many varieties—some bunch and some runners. When the berries are desired for food the former is best used; when hay or soil improvement is desired the latter subserves our purposes. The caly, red tory, black and unknown are running varieties. The last is perhaps the best pea known, making a large quantity of vines, and, late in the season, a full crop of berries.

There is not a well-drained acre in the state that cannot, by the application of mineral manners, in conjunction with the growing of cowpeas, be made very rich. All rational farming involves a system of rotation of crops, and any rotation of crops in the south that omits the cowpea is an egregious blunder.

SOILING AND FORAGE CROPS.

The saccharine sorghums are perhaps to be preferred to all others. Planted in early spring, two or more crops can be cut during the year. All stock relish them and at least 6 to 10 tons of dry fodder may be had at a cutting.

Next to these come teosinte (reana luxunaus), which on rich land gives an immense crop. Of the non-saccharine sorghums the yellow millo maize is probably to be preferred, if forage is desired, followed by white millo maize, large African millet, Kaffir corn, Jerusalem corn, Egyptian corn and wheat. If seed be desired the large African millet and Kaffir corn will give the best results.

Pearl millet (penicellaria specala), is used largely for soiling in the spring and fall.

VEGETABLES AND FRUITS.

All of the leading varieties of vegetables are grown all over Louisiana. Except around New Orleans and along the lines of our leading railroads, they are grown only for home use. However, the aggregate of trucks raised for market in this state is enormous and is constantly on the increase. Most of our railroads now furnish quick transportation in refrigerator cars. Around New Orleans and along the Illinois Central Railroad the bulk of the vegetables and fruits for market is grown. Immense quantities of cabbages, onions, tomatoes, beans, peas, strawberries, Japanese plums, canteloupes, etc., are shipped every day during the season. Cucumbers and eggplants raised both under glass and in the open air are special subjects of profit, and are grown in great quantities. In the parish of Tangipahoa are many thousand acres of strawberries, which return yearly many thousands of dollars to the owners. Japanese plums and persimmons. Le Conte and Keiffir pears are also raised largely and perfectly here, and can be successfully grown everywhere in the state. The country along the line of the Illinois Central Railroad is especially adapted to truck gardening and fruit growing. So, too, with the lands adjacent to the Yazoo and Mississippi Valley Road, north of Baton Rouge, and the hill country on the Vicksburg, Shreveport and Pacific Railroad, west of Monroe, and on the Texas and Pacific, above Alexandria. Near Wilson, La., on the former road, are large truck farms, which, though recently established, promise to be very successful. On these farms immense quantities of tomatoes were grown last year and shipped to western markets.

Besides the vegetables named, grown in special localities for market, may be mentioned the Irish potato, which has become in this state a staple crop and grown in most every parish for market. Planted from December to February, they are harvested from March to June, and reach the markets in turn to command the highest prices of spring. By planting again in July or August a second crop is obtained in the fall, which can be shipped or used for seed in the winter or spring. Hundreds of thousands of barrels of Irish potatoes are annually shipped from this state to the markets of the west and north, always with fair returns. New Orleans and Baton Rouge are the chief centers of collection and shipment. Watermelons of large size and of delicious quality are raised all over the state for home purposes and local markets, but as yet few are shipped to a distance. Apples are not grown extensively anywhere in the state. Apricots and nectarines are not a success anywhere Peaches do well in the hills of north Louisiana, and many varieties of this luscious fruit are grown throughout this section, both for home consumption and for markets.

Grapes do well also in this section as well as the hill country of east Louisiana. Certain varieties, with proper use of fungicides, can be made to grow anywhere in the state, but the grape sections are those given.

Strawberries are wonderfully successful in the hills and pine flats of the state, and are grown elsewhere also, but with additional risk and cost of keeping down the grasses and weeds through our long summers.

Blackberries and dewberries grow wild in great profusion all over the state. Raspberries, currants, gooseberries and cherries are not successfully grown in this state.

Of pears, only the Chinese type, Le Conte, Smith, Garber, Von Seebold, Keifer, etc., are extensively grown. The French type, so largely cultivated in the north, is not grown successfully there. So, too, with plums, only the Japanese varieties and our native plums will grow. Some varieties of the former are great successes, both in growth of trees and size and quality of the fruit. The Botan, Burbank and several others are highly esteemed.

Figs of excellent quality are grown throughout the state. In south Louisiana several preserving factories take annually at good prices the product of many fig orchards.

Pomegranates and olives can easily be grown in the southern part of the state, while pecans, indigenous to the state, are now grown in extensive groves all over the entire state. Many improved varieties are now being grafted or budded upon the common pecan, and the fruit from them is greatly improved in quality and fetches much higher prices. This nut is now a source of a large income to many of our people, and in the near future will be one of the chief products of the state.

SWEET POTATOES, CONVOLVULUS BATATAS (LINN.) BATATAS EDULIS CHOISY.

This crop is universally grown throughout the south. It is a popular root, found on the table of the rich and the poor. The state of Louisiana is credited with a crop of 3,000,000 bushels, large quantities being grown in every parish and upon every variety of soil. While most of this crop is consumed at home, increasing quantities are annually finding their way to northern markets at remunerative figures. As much as 1000 bushels per acre have been grown in this state and crops of 300 to 500 bushels are frequent. It is also highly relished by stock of all kinds. The cattle and horses are frequently fed upon the harvested roots, while hogs are nearly always permitted to root for those which are overlooked in gathering. Thirty-six varieties, including five new ones, recently received from Java, have recently been tested by the state experimenting station at Baton Rouge and the following concluding remarks are taken from a bulletin reporting the results

By far the greatest acquisition in sweet potatoes obtained so far is the Vineless. It is very easily cultivated, prolific, early, keeps well, and has high table qualities, making it one of the most desirable varieties of our whole list. This is our choice for first place. The next variety demanding especial attention is the Providence, noted above all others for being prolific, and at the same time being well suited for either the table or stock. It does not keep so well as the Hayman or the Southern Queen, but has better table qualities.

For late spring use the Hayman serves well. There are other old sorts which are desirable and popular, namely, the Georgia, Spanish yam and the Nansemonds (for northern markets). But the Vineless, Providence and Hayman offer such additional advantages that it seems in our judgment they will give more and better returns for labor expended.

ORANGE-GROWING IN LOUISIANA.

Formerly it was supposed that only the extreme southern portion of Louisiana could grow oranges. In fact, little or no effort was made prior to 1880. Seeds from sweet oranges were planted in some corner of the yard, garden or lot, and when germinated permitted to grow unaided by cultivation, pruning or fertilization. In the course of time the straggling, neglected trees bore fruit—delicious fruit—for home uses. Thus a home knowledge was obtained of the character of Louisiana fruit, but so few found their way to the outside world that the latter knew absolutely nothing of their merits. The neglected, enfeebled trees were frequently killed by cold, by insects or by diseases. The rapidity with which orange trees under such adverse conditions, were destroyed, soon engendered a popular sentiment that oranges could not be profitably grown in Louisiana. This opinion has, however, been now almost entirely dissipated. Profitable orange groves are found all along the gulf coast, and these groves receive careful cultivation, pruning and removal of insects. Since 1880 one grove of 100 acres, planted in sweet seedlings, has brought to its owner $257,000 for the fruit on the trees. The Italians buy the fruit on the trees and then gather them and ship to market. Since 1880 a decided change has come over our orange groves.

The sweet seedling is used now only to furnish buds for insertion and growth upon the hardier stocks. The sour and bitter-sweet oranges, the rough lemon, the grape fruit and the citrus trifoliata all now furnish stock for our groves. The sour orange is hardier than the sweet and will endure a much lower temperature without injury. The citrus trifoliata is very hardy, standing the climate of Philadelphia. It is dwarfish in its habits, and, therefore, is to the orange what the quince is to the pear. By budding on this stock, small trees are obtained which may be planted closer together in the orchard. Like the dwarf pears, they bear earlier than the standards.

New varieties of oranges have been introduced from all over the world; some of these, notably the Japanese contributions, are very hardy. The Satsuma, the Kewachai, Dai-Dai, etc., all grow and bear fruit up to the central portion of the state. The first when budded on the citrus trifoliata is very hardy, enduring, perhaps, the greatest cold of any citrus fruit. This combination is now sold largely for growth in half-barrels in northern conservatories. Frequently a tree thus treated will in three years bear over 100 oranges. It may, therefore, be asserted, with our present knowledge of oranges, that successful culture of this fruit can be carried on all through south Louisiana, provided proper attention be paid to the following.

First—Selection of the hardier varieties upon the hardiest stocks.

Second—Windbreaks, natural or artificial, upon the north and west of the grove.

Third—To shade each row upon its eastern side.

Fourth—To provide temporary means of mitigating the cold (which comes with severity only for a day or two) by fire. smoke, smudges, etc.

Rows of olives (much hardier than oranges) have been suggested for the accomplishment of the third object.

These precautions are given for the guidance of those who propose to locate groves above the city of New Orleans. Below the city little or no danger is apprehended to an orange grove from cold. These precautions are necessary in most every orange-growing country. Florida and California both suffer occasionally from freezes and many thousands of dollars have been spent in both states for the protection of groves from cold.

The following directions are given for the guidance of those proposing to start a grove:

SELECTION OF LAND

is of first importance. After selecting the locality look well to the character of the soil. Its physical and chemical properties should be examined. Drainage is of the first consideration, and your soil should be naturally or artificially relieved of any superfluous water. Open ditches and tile drains are both used for this purpose; the latter has been found to be very efficient when properly laid. Select no piece of land for an orange grove that the bottom, or ground, water cannot be held at least three feet below the surface. After selecting your ground have it well broken in the late summer, or early fall. If a crop of cowpeas could be turned under it would be better. The best time to plant here is in December and January.

HOW TO START A GROVE.

Two ways of doing this, first by direct purchase of trees from some reliable nursery and plant the entire grove at once, or, second, by procuring a large quantity of sour oranges or fruit of the citrus trifoliata. From these obtain the seed and plant the latter in nursery rows, 5 feet apart and 4 inches in the drill. Cover about 1 to 2 inches deep. They will quickly germinate, and if properly worked and fertilized will be ready for budding the next spring. Buds of any variety at very low figures can be obtained of any reliable nurseryman. In two or three years, with proper care and skill, enough trees will be obtained to plant out the entire grove. The first way will insure an early grove, but at greater expense. The second is slower but much cheaper, and will, in the end, prove more satisfactory. Good one-year buds on sour or trifoliata stock can now be bought for from $15 to $40 per thousand.

HOW TO PLANT A GROVE.

Use only, in this climate, sour or trifoliata stock, and plant only strong, well-grown trees. The distance apart in the orchard will depend upon, first, kind of stock, and, second, variety of oranges used. If Satsumas, Tangerenes, Mandarins, etc., are budded on some stock, they should be planted at least 15 feet each way; 20 feet would be ultimately better. If on trifoliata 10 to 12 feet each way will do. The sweet oranges on some stock should have from 30 to 40 feet each way—on trifoliata 15 to 20 feet each way.

Lay off lands in beds of desired width, open holes (large and deep) at proper distances, and plant trees, in the latter so that the crown roots will be just at the surface of the ground, and at no time during subsequent cultivation must they be covered deeper. This is a most positive requirement for success in orange growing in alluvial lands.

WHAT VARIETY TO PLANT

will depend upon the pleasure of the grower and the demand of the markets. As a rule, early varieties sell best, therefore, an orchard for profit should have a large majority of early ripening varieties. The Satsuma, the mandarin, Boone's Early, Parson Brown, Sweet Saville, Brazilian, Baldwin's No. 1 and many of our Creole seedlings are quite early. The tangerines, navels and some of the Bloods follow next, while Hart's Tardiff, Rivers' unknown, etc., are late bearers. It should be remembered that all oranges ripen earlier here than in Florida or California. The sugar experiment station at Audubon park, New Orleans, has over 100 varieties under cultivation and the merits of each are being studied.

CULTIVATION OF GROVE.

Shallow cultivation with plow and cultivator is practiced by many. Some sow the grove each year in cow peas and turn the latter in late in the fall. Alfalfa sown in October upon alluvial lands will occupy the ground to the exclusion of weeds for several years and afford several cuttings of fine hay each year. Crimson clover (an annual) sown in October may also be used. Others cultivate vegetables between the trees, particularly when young, and make the profits therefrom bear the expense of the grove until the latter bears a profitable crop. While, lastly, others prefer clean culture the entire year.

FERTILIZATION OF GROVE.

The rich alluvial lands of the southern part of the state will grow fine, thrifty trees without fertilization. After bearing several heavy crops, fertilization may be necessary. However, every orchard does better by proper manuring. The young trees require growth and therefore need large additions of nitrogen. A mixture of two parts of cotton seed meal and one part of acid phosphate will meet their requirements.

Later on, when the tree begins bearing, equal parts, with, perhaps, the addition of one-fourth potash salts will do better. A tree one year old should receive about one pound of above fertilizer scattered around it in a circle whose radius equals the height of the tree, and lightly plowed or raked in. For every year after the amount applied should be doubled, viz: two pounds for two years old, four pounds for three years old, eight pounds for four years old, sixteen pounds for five years old, etc., until you are satisfied from the growth and yield of the tree that a maximum quantity has been used, after that apply this quantity.

Before the orchard is old enough to bear fruit, every grower will have posted himself as to best methods of gathering and shipping. In planting the trees, do not let their roots get dry or even exposed to the sun, and cut back the top to the point at which you wish it to branch. It is yet uncertain at what height it is best to have it branch, though all are agreed that very high branching is a disadvantage.

The above details are given because of the conviction of the adaptability of a large amount of south Louisiana to orange growing and of the profits involved in orange planting here. The writer sold, a few days ago, to an Italian the first fruit upon six trees, not quite three years from the bud, for $15. Louisiana oranges, coming in earlier than those from Florida, find nearly always a good market right at home, and hence profits larger than elsewhere. Our soils require neither fertilization nor irrigation, though both would insure larger and better crops.

Immediately on the gulf coast, anywhere from the Sabine to the Pearl river, all varieties of oranges can be successfully grown. At present the chief locations of extensive groves are on the Mississippi river below New Orleans—in lower Vermillion, on lake Arthur and Shell Beach, and in Cameron, all along the coast, but especially on Grand Chenière. Elsewhere orange growing has been suppressed by the larger industries of sugar cane and rice, rather than of the inadaptability of the country to orange culture.

Above the latitude of New Orleans, the hardiest varities should be planted, and these upon sour or trifoliate stock, while middle Louisiana may successfully grow some of the Japanese varieties (Satsuma, Kewachai, Dai-Dai, etc). There are thousands of acres all through southern Louisiana that might be very profitably turned into orange groves.

The scale insects (red and purple), which are everywhere troublesome to orange growers, can be kept in subjection, or entirely destroyed, by proper application of kerosene and rosin emulsion. The experimental station has published a bulletin on orange culture, giving complete instructions for the destruction of these pests.

FIBER CROPS

Ramie (boehmeria nivea), which furnishes a fiber nearly equal in value to silk, can be easily grown all over the state and nothing is needed to make it a leading crop in Louisiana but a successful machine to decorticate it.

The recent trials of machines for decorticating this plant, at the sugar experiment station, Audubon park, New Orleans, gave promise of an early solution of this vexatious problem. When the farmer can obtain a machine to work up the product of his soil, he will not be slow in cultivating this plant, since the demand for this fiber is practically unlimited.

So, too, with jutes (corchorus capsularis and olitorius), the fiber from which is used to make grain sacks and cotton bagging. These plants can be grown to great perfection and will be largely cultivated when the fiber can be succesfully detached by machinery.

Kentucky hemp (cannabis sativa) can also be grown successfully upon the alluvial lands of the state.

STOCK RAISING.

No portion of the globe is better adapted to stock raising than the state of Louisiana. Our soils, unaided, will supply native grasses sufficient to maintain cattle and horses through at least nine months in the year. The great variety of grasses, clovers and forage crops which can be grown so successfully upon all of our soils; our short winters, requiring shelter and extra feed for only a few months in the year; our numerous water courses, with their infinite number of tributaries, furnishing an abundant supply of water at all seasons, all conspire to make Louisiana a most desirable location for stock raising. The question may be asked: If these natural advantages exist, why is it that more have not engaged in this industry? The ready reply is found in the fact that heretofore our entire agricultural world has been absorbed in the growing of our leading staples, sugar cane, rice and cotton. Another potent reason may be found in the absence of packing factories, where a ready market for cattle, sheep and hogs might be found the year round. Both of these reasons are now gradually melting away. Sugar cane and cotton no longer afford the handsome profits of the past to the planter, and the latter, particularly the cotton planter, is now diversifying his crops and paying more attention to the raising of stock. A large majority of the horses of the state have been raised at home. Mules have been raised in sufficent quantities to demonstrate that with proper care and attention, the finest and largest can be grown here, but only in a few instances has mule raising been pursued as a profession or special occupation. The question of packing factories is now being discussed all over the state, and the city of Monroe has taken the initiative by organizing the first corporate body proposing to establish such a foctory. Assurances are given that this factory will be in successful operation by another year, and with its establishment new life will be given to the farmers of north Louisiana, whose experience in stock raising justify the belief that under proper management, they can grow hogs and cattle as cheaply as anywhere else in the world. Packing factories are needed also at Shreveport, Alexandria, Lake Charles, Opelousas, Baton Rouge and New Orleans and elsewhere, and capitalists will find this field an inviting and profitable one for the investment of surplus capital. Farmers will grow the hogs and cattle as soon as they are assured that near markets can be obtained for them.

CATTLE RAISING

on the ranch system was once largely practiced in the prairies of southwest Louisiana and the profits were large. This industry has been destroyed by the private entry and occupancy of all these prairie lands by sturdy settlers from the northwest, who have transformed them into beautiful homes and prosperous farms. The raising of cattle, improved cattle, by farmers is now the question for solution. Many are essaying it with success. Improved breeds have been introduced and tried. The Jersey has so far been the most popular breed. Many excellent cows of this breed are to be found all over the state, and the tables of many a farmer is daily supplied with gilt-edged butter made on his own farm. The Devons have also been successfully tried, and the opinion is fast growing that "for all-round purposes" it is the best breed for the small farmer to grow. The Guernseys have been tried to a limited extent and are quite popular. The Holsteins, short-horns and Herefords have also been experimented with, and upon rich alluvial lands, where "long croppings" of grass can be obtained, they do well. Upon uplands, prairies and pine woods the smaller breeds are to be preferred. There is one serious drawback to southern cattle raising, which will be overcome by the establishment of packing factories in the south, i. e., the southern cattle fever, known also as the "Texas fever," "Spanish fever," and, locally, as "murrain," "red water," etc. There is an imaginary line running down the Atlantic coast south of Richmond, Va., through North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas and Texas, which marks the limit of the infected district. Louisiana and Florida are wholly in this district. All cattle brought from above this line into this district are subject to this disease, which is alarmingly fatal. Native cattle, raised below this line, while really healthy, carry along with them the seed of the disease and convey them to the cattle with which they come in contact. Hence, a national quarantine is established by the United States government against all cattle going from this section to northern markets during certain months of the year. It has been definitely determined that the vehicles of transmission of this disease is the southern tick —boophilus (ixodes) bovis and our southern cattle carry them on their bodies when transported elsewhere. These ticks drop from them in the cars, on the pastures, or in the stable yards, and afterwards, reaching other cattle, inoculate them with the virus of the southern fever. The bureau of animal industry at Washington has published many interesting investigations upon this line in their reports, to which the reader is referred for details. This quarantine has seriously militated against general cattle raising in the south, since all our markets and packing-houses are north of us. Could packing-houses be established in the south, this embargo would be virtually removed, and a great impetus would be given to cattle raising.

Conversely, it is found that nearly every head of cattle imported from the north to the south suffers the first summer afterwards from an attack of this fever. Of the number attacked a large number die. The amount of money spent in the south since the war by the loss of imported cattle from this disease, would endow liberally a bureau of veterinary science for the special study of cattle diseases. It is, therefore, in order here to caution all persons against the reckless importation of high-priced cattle from the north into the south. If cattle must be imported it would be best to do it when they are calves or yearlings, since at this age the disease is not near so virulent.

FATTENING CATTLE FOR MARKET.

Immense numbers of cattle are now annually fattened throughout the south at the numerous cotton seed oil mills. It has been found that a mixture of cotton seed hulls and cotton seed meal will rapidly fatten cattle for market. This knowledge has enabled the oil mills to utilize their hulls, which were formerly used as fuel under their boilers, as a supplement, in feeding, to cotton seed meal, and a much higher value is thus obtained from them. Most of the mills which feed these cattle utterly neglect one of the chief profits of feeding, viz: the proper saving of the manure or drippings of the cattle, which, to the small farmer, would be of great value. Hence the expediency of the small farmer, particularly the cotton farmer, who can easily exchange his cotton seed for hulls and meal, buying annually from ten to twenty head of cattle and feeding them systematically through the winter, carefully husbanding the manure and applying to his soil, and selling the cattle as fat beeves in early spring. This practice, if skillfully manipulated, would furnish profitable employment to the farmer during winter, when he would otherwise be comparatively idle, and at the same time furnish an abundance of manure for his fields and save the amount now expended in the annual purchase of commercial fertilizers. Another benefit would be the utilization of the "roughness" of the farm, which would improve the above ration and increase the value of the manure. That this can be profitably done and that stock-raising of all kinds can be successfully carried on, the following letter from Mr. F. L. Maxwell will prove. Mr. Maxwell is a native of Indiana, has been living south since 1867, is a large planter and a man of high intelligence and probity. He is well known to the writer, who will vouch for the truth of every assertion in the letter:

FEEDING CATTLE IN LOUISIANA.

MOUND, La., Oct. 29, 1893.

Dr. W. H. Dalrymple, Baton Rouge, La: My Dear Sir—Complying with your request of the 9th inst., I will give you the benefit of my limited experience in feeding cattle in Louisiana. I have fed a few head of cattle nearly every year for the past ten years. I have used corn meal, cotton seed, pea hay, turnips, pumpkins, cabbage leaves and sweet potatoes, all with success. All of the above can be raised very cheap on our southern farms and all can be used in feeding cattle, hogs and sheep with success. In connection with the above I would recommend to farmers that have facilities for shipping at cheap rates, to sell their cotton seed and buy hulls and cotton seed meal instead.

I made the following test this year on cotton seed hulls and meal alone: I purchased twenty-six tons of cotton seed hulls and five tons of cotton seed meal, the former at a cost of $3.90 and the latter at $22 per ton delivered. The above was all fed to twenty-three head of steers in forty-three days; the gain per head, per day, was three and one-half pounds. I was offered 2 cents per pound gross for the cattle the day they were put in the lot; at the end of the 43d day I shipped them to market and sold them at 4 cents per pound gross. I knew of other gentlemen that have had more experience in feeding than myself, and they have made plenty of money, but on land that they could not raise more than fifteen to twenty bushels of corn they are now raising eighty bushels of first-class corn and good crops of peas on the same land.

The farmers of Louisiana ought to raise their own horses, mules, cattle, sheep and hogs, and can do so with greater profit than farmers in the northwest. They have advantages in climate and soil, and can raise so many things in abundance and so cheaply that our northern brothers cannot raise. I would recommend our Louisiana farmers to try a few head of good steers or cows and prepare plenty of food crops, and then feed hulls and cotton seed meal with it; they will be surprised to see how quick they can fatten the cattle and what profit there is in it besides the rich fertilizer they make clear if they will only save it. After experimenting with these things I am thoroughly convinced there is money in it. I am preparing large pastures, and am now buying all the cattle I can with a view of feeding on a large scale. I know of a gentleman in Illinois who has just invested in a large tract of land in the Tensas river swamp and fencing it, and will put 600 head of cattle in it at once.

In regard to feeding horses and mules while at hard work, I have had splendid success with cut oats, ground corn and peas mixed, two parts of corn to one of peas. I would advise all farmers to raise plenty of oats and feed less corn. I cut my oats with a large ensilage cutter and use a three horse tread power. In regard to raising mules, I think I can safely say it is a success. I have them from sucking colts to 5 years old, and am pleased with the experiment. I have 19 colts this year. I will add that I always feed my mules and horses when at work, three times a day. Hoping that you may find something that will prove interesting to you in the above, I am yours truly,

F. L. MAXWELL.

RAISING HORSES AND MULES

have already been referred to. In this climate, with proper pastures and forage crops, mules and horses can be raised very cheaply. Before attempting it on a large scale a portion of the land must be put into permanent grass or clover pastures; another portion must be utilized for the growth of forage for their maintenance during our short winters. Mules are especially adapted to our climate, and thousands are bought annually by our sugar and cotton planters from the western farmers. They can more easily and cheaply be raised at home. From the number of jacks now being imported into this state, it is fair to infer that hereafter a much larger number will be raised.

The Percheron and Clydesdale horses have not yet found favor in this state outside of New Orleans. The mule being the draft animal, the horse is desired more as a roadster, or for the saddle. Therefore, the smaller trotting or riding stock are in larger request and are chiefly grown.

SHEEP RAISING

has been done heretofore mainly upon the ranch system. A few farmers have kept a small flock for their home supply of mutton. As a rule, it would pay every farmer to keep a small flock of an improved breed or grades. Spring lambs and good mutton will always sell. The Southdown and Shropshires have proven so far best adapted to this state.

HOG RAISING,

by the adoption of a proper rotation of crops, making the hog gather each crop, can be made exceptionally profitable, provided one can find a ready home market when they are fit for the shambles. At present the coldest spell of winter has to be patiently waited for before the fat porkers can be slaughtered with safety, and during that time they may eat their "heads off," or become victims to disease or disaster. Hence, few persons raise more hogs than are absolutely necessary for home purposes. With packing-houses convenient hog raising would soon become a leading industry of this state and a most profitable one. By planting an acre or two in February or early March of a variety of early ripening sugar cane in rows 3-4 of a foot apart and 6 to 12 inches in drill, it will be ready for the hogs in May. Succeed this with a similar patch of early amber sorghum, which will be ripe in June. Follow with Spanish peanuts, ripe in July, or early cowpeas, ripe at same time. Add to these chufas, a late corn field with cowpeas and a good lot of sweet potatoes, and you have the material to grow and fatten many hogs. These lots should be arranged so that the hogs could gather them all, and simultaneously have access to a field of grass or clover, with an abundance of fresh, pure water. By adopting such a plan as the above, some of our best farmers have raised hogs for less than a half of a cent per pound. The Berkshire, Jersey Red and Poland China have proven excellent porkers in this climate, while the Essex as a lot hog for the small farmer is unexcelled.

HOW TO RESTORE OUR WORN SOILS.

The following, taken from a late bulletin of the state experiment station, shows how quickly tired soils may be restored to more than virgin fertility, if proper rotation with fertilization be adopted:

Under this exclusive cotton culture much of the lands of north and middle and east Louisiana have become so depleted of their original fertility as to fail to give remunerative returns for the labor of cultivation. The question of paramount importance to every patriotic citizen of Louisiana is how to restore these worn and tired soils. It is of vital interest to the owners of these lands to know how to do this, and at the same time receive a fair remuneration for the labor and expense involved in its accomplishment. This the stations have attempted to solve, and a recital here of the results obtained through five years will, it is hoped, convince a few that the plan is a feasible one, and worthy of trial. At Baton Rouge and Calhoun, nearly six years ago, six acres were laid off in acre plats, and the system of rotation of crops, with and without fertilizers, began. The crops selected were oats, cowpeas, cotton, corn and cowpeas, or five crops in three years. It would be more in accordance with science to follow a crop of cowpeas with corn, but experience has proven that the rust-proof oat (the only variety which can be successfully grown here) must be planted in October to insure a certain crop, and to plant it in this month it must follow a crop of corn, since the cotton crop could not be gathered by this time, hence, the order adopted. Three palallel plats of two acres of each are used for the experiment. The front acre of each is fertilized with a fertilizer suitable to the crop occupying it, while the rear acre is left unfertilized. Otherwise the plats are treated alike. The rotation began with oats in plat No. 1 (front acre fertilized and the rear acre not). Plat No. 2 in corn and cowpeas (front acre fertilized, rear acre not). Plat No. 3 (front acre fertilized, rear acre not). The oats were removed in May or early in June, and land sown at once in cowpeas, using for front acre a mixture of 100 pounds acid phosphate and 50 pounds kainite broadcasted and harrowed in with peas. Each crop now goes forward in the circle one step each year. This year we complete the second round of the rotation. At Baton Rouge defective drainage in two of the plats have prevented such decisive results as have been obtained at Calhoun. However, they are sufficient to establish the value of the rotation. The following are the condensed results at Calhoun:

With oats the yield in 1889 was 7 1-4 bushels, 8 2-3 bushels in 1890, 25.5 bushels in 1891, 22.5 bushels in 1892 and 22 bushels in 1893, a total of 85.92 bushels, or an average of 17.18 bushels per year. The yields of corn were 13.09, 20.6, 4.8, 16.6 and 6.4 bushels, a total of 59.49 bushels, or an average of 11.90 bushels per year. The cotton yields were 528, 429, 620, 331 and 560 pounds of seed cotton, a total of 2468 pounds, or an average of 493.6 pounds per year.

The fertilized plats gave for oats 12, 24.5, 55.2, 41.8 and 40 bushels, a total of 179.5. The fertilized corn gave 17.73, 28, 16.8, 34.3 and 24.4 bushels, a total of 121.23 bushels, or an average of 24.25 bushels per year.

The fertilized cotton gave 829, 708, 1719, 1558 and 1440 pounds seed cotton, a total of 6260 pounds, or an average of 1252 pounds per year.

In the five years' trial two seasons have been very dry and yields accordingly depressed. It is, however, worthy of note that the unfertilized plats have suffered the worst by droughts. The aggregate yields of the unfertilized plats have been 85.92 bushels of oats, 59.49 bushels corn, and 2468 pounds seed cotton per acre. The total yields of the fertilized plats have been 179.5 bushels oats, 121.23 bushels corn, and 6260 pounds seed cotton per acre. The excess of fertilized over the unfertilized plats have been 93.58 bushels oats, 61.74 bushels corn, and 3792 pounds seed cotton per acre. The fertilizers used cost $3 for oats, $2 70 for corn, and $3 20 for cotton per acre every year. In this estimate the cotton seed is reckoned at 10 cents per bushel. In five years the fertilizers of the three acres cost $44 50. Estimating the oats at 30 cents per bushel, corn at 50 cents and seed cotton at 2 1-2 cents per pound, the increase due to the fertilizers would be $153 84. Deducting cost of fertilizers there would remain $109 34 as clear profit from the use of fertilizers for five years on three acres, or $7 29 per acre each year. This is an excellent showing and renders certain this plan of rotation with fertilizers as one which will build up the hill lands of north Louisiana, and at the same time leave a handsome yearly profit for the labor applied. The results from the rotation without fertilizers are not satisfactory, but shows that upon poor lands the process of restoring without fertilizers is slow and gradual. With fertilizers under each crop the process is rapid and profitable. An inspection of the table given will show that the Texas rust proof oats, properly seeded in October, is a more reliable crop in north Louisiana than corn. This will doubtless remain true until these soils become charged with vegetable matter sufficient to enable the corn crop to withstand the droughts which occur at too frequent intervals in the spring and summer.

The following, taken from a pamphlet on Louisiana recently published by the state commissioner of immigration, Colonel J. G. Hawks, gives the names and chief stations of all

THE RAILROADS IN THE STATE

The Illinois Central System.—This system has two trunk lines extending from the city of New Orleans. The eastern line enters the state of Mississippi near Osyka.

It passes through five parishes of this state, the stations being New Orleans; Sauve and Kenner, Jefferson parish; Frenier and Manchac, St. John's parish, and Ponchatoula, Hammond, Tickfaw, Independence, Amite City, Arcola, Tangipahoa and Kentwood in Tangipahoa parish.

This route penetrates the states of Mississippi, Tennessee, Kentucky, Illinois, Indiana, Ohio, Wisconsin and South Dakota, and touches the borders of Arkansas, Missouri, Nebraska and Minnesota.

The western line of this system, or the Yazoo and Mississippi Valley Railroad, extends along or near the Mississippi river from New Orleans to Memphis, Tenn., having two tap lines in Louisiana and a number of branch roads in Mississippi.

It passes through ten parishes in this state, the following being the most important stations along the line: New Orleans, in Orleans parish; Carrollton and Kenner, Jefferson parish; Sarpys, St. Charles parish; St. Peters and Bonnet Carre, St. John parish; Angelina, and Convent, St. James parish; Burnside, New River and Lane post office, Ascension parish; Iberville and St. Gabriel, Iberville parish; Gardere, Baton Rouge, Baker and Zachary, East Baton Rouge parish; Slaughter, Lindsay, Ethel, Clinton, Wilson and Norwood, East Feliciana parish, and Bayou Sara and Laurel Hill in West Feliciana parish.

The Queen and Crescent System.—The Queen and Crescent System embraces the New Orleans and Northeastern and the Vicksburg, Shreveport and Pacific lines, which extend through the state.

The New Orleans and Northeastern Route passes through two parishes.

The important stations are New Orleans; and Slidell and West Pearl River stations in St. Tammany parish. It enters the state of Mississippi at East Pearl River.

The Vicksburg, Shreveport and Pacific line extends from Vicksburg, Miss., to Shreveport, and passes through eight parishes, having tap lines from Gibb's station to Homer; from Gibb's station to Bienville, and from Sibley or Minden junction to Minden.

The most important stations are Delta, Tallulah, Barnes, Dallas and Waverly, in Madison parish; Delhi, Rayville and Girard, in Richland parish; Gordon, Monroe, Cheniere and Calhoun, in Ouachita parish; Choudrant, Ruston, Allen Greene and Simsboro, in Lincoln parish; New Arcadia, Gibbs, Talyors and Bienville, in Bienville parish; Homer, in Claiborne parish; Dubberly, Sibley, Doyle and Minden, in Webster parish; Houghton and Dodcaw, in Bossier parish, and Shreveport, in Caddo parish.

The East Louisiana Railroad extends from West Pearl River station, on the New Orleans and Northeastern line of the Queen and Crescent route, to Covington and lies within St. Tammany parish. Its principal stations are West Pearl River, Abita and Covington.

The Louiville and Nashville Route.—This great trunk line penetrates the states of Mississippi, Alabama, Tennessee and Kentucky.

It passes through two parishes and enters the state of Mississippi at the mouth of Pearl river.

The stations along this line are New Orleans, Lee, Gentilly, Chef Menteur, Lake Catherine and Rigolets, in Orleans parish, and Lookout, in St. Tammany parish.

The Texas and Pacific Route. — The Texas and Pacific Railway extends from New Orleans, in a northwestern direction and enters the state of Texas near Waskom station.

It has one branch road in the state, extending from Baton Rouge Junction to the city of Baton Rouge.

There is an independent branch line, connecting with the main line at Cypress station, and connecting Mansfield with the main line at Mansfield Junction.

This route passes through sixteen parishes, and principal stations are New Orleans, Gouldsboro, Gretna and Jefferson, in Jefferson parish; Davis, St. Charles and Dugan, St. Charles parish; St. John and Johnson, St. John parish; Vacherie, Delogney, St. James and Winchester, St. James parish; Donaldsonville and McCalls, Ascension parish; White Castle, Bayou Goula, Indian Village, Plaquemine and Grosse Tete, Iberville parish; Baton Rouge Junction, Brusly Landing and Port Allen, West Baton Rouge parish; Maringouin, Fordoche and Ravenwood, Pointe Coupee parish; Melville, Goshen, Rosa and Morrows, St. Landry parish; Bunkie, Avoyelles parish; Cheneyville, Lecompte, Lamourie, Moreland, Alexandria, Rapides, Boyce and Lena, Rapides parish; Chopin, Derry, Cypress, Provencal, Robeline and Marthaville, Natchitoches parish; Sodus, Sabine parish; Oxford, Mansfield, Grand Cane, Gloster and Stonewall, De Soto parish, and Keithville, Reisor, Shreveport, Jewella, Becks and Greenwood, in Caddo parish.

The Southern Pacific Route.—This line extends from New Orleans in a westerly direction, and has the following branches leading from the main line: From Schriever to Thibodaux, from Schriever to Houma, from Baldwin station to Cypremort, from New Iberia to Petit Anse island (or Avery's Salt Mines), from Cade's station to St. Martinville and Breaux's Bridge, and an extensive line from Lafayette to Cheneyville, connecting there with the Texas Pacific Route, and from Crowley to Eunice, in St. Landry parish.

The Southern Pacific passes through thirteen parishes, and the main line enters the state of Texas at Echo station, on the Sabine river.

The most important stations in this state are New Orleans; Gretna, Powell, Murragh and Jefferson, in Jefferson parish; Boutte and des Allemands, St. Charles parish; Raceland, Ewings, Bousseau, Schriever and Thibodaux, Lafourche parish; Houma, Chacahoula and Tigerville, Terrebonne parish; Gibson and Boeuf, Assumption parish; Ramos, Morgan City, Berwick, Patterson, Ricohoc, Bayou Sale, Franklin, Baldwin, Glencoe, Cypremort and Sorrell, St. Mary parish; Jeanerette, Olivier, New Iberia, Petit Anse, Segura and Burkes, Iberia parish; Cades, St. Martinville and Breaux's Bridge, St. Martin parish; Duchamp, Broussard, Lafayette, Scott, and Carencro, Lafayette parish; Duson, Rayne, Crowley, Estherwood and Mermenteau, Acadia parish; Jennings, Evangeline, Welch, Lacassine, Iowa, Chloe, Lake Charles, West Lake, Lock Moore, Sulphur Mine, Edgerly, Vinton, Sabine, Jacksonville and Echo, Calcasieu parish; Grand Coteau, Bellevue, Opelousas, Washington, Beggs, Garland, Whiteville and Barbreck, St. Landry parish; Milburn, Avoyelles parish, and Eola, Haasville and Cheneyville, in Rapides parish.

The Kansas City, Gulf and Watkins Railroad.—This line extends from Alexandria to Watkins, situated on the gulf of Mexico, at the Calcasieu pass.

It has branch roads leading from Bon Air to Lake Charles and Grand Lake.

It passes through three parishes, and its most important stations are Alexandria, Anandale, Vilderouge, Forest Hill and Glenmora, in Rapides parish; Oakdale, Oberlin, Kinder, Fenton, Iowa, Bon Air and Lake Charles, in Calcasieu parish, and Grand Lake and Watkins, in Cameron parish.

The Houston, Central Arkansas and Northern Railroad.—This road extends from Alexandria, in a northeastern direction, and enters the state of Arkansas in the northeastern portion of Morehouse.

It passes through six parishes, and its most important stations are: Alexandria, in Rapides parish; Pollock and Dugdemona, Grant parish; Tullos and Olla, Catahoula parish; Kelly, Grayson, Bridges, Columbia, Riverton and Eureka, Caldwell parish; Boser, Caplin, Monroe and Sicard, Ouachita parish, and Collins, Doss, Mer Rouge, Galion, Bonita and Jones, in Morehouse parish.

The Texas, Shreveport and Houston Railroad.—This line of railway extends in a southwestern direction from Shreveport and enters the state of Texas at Logansport, on the Sabine river.

It passes through two parishes and the principal stations are Shreveport, Larosen and Keithville, in Caddo parish, and Preston, Keatchie, Longstreet and Logansport, in DeSoto parish.

The St. Louis and Southwestern, or St. Louis, Arkansas and Texas Railroad, extends northward from Shreveport, and enters the state of Arkansas at Rudge station, Bossier parish.

The important stations are Shady Grove, Benton, Alder, Gernsheim and Rudge, all in Bossier parish.

The New Orleans and Northwestern Railroad.—This line extends from Natchez to Collins' station, on the Houston, Central Arkansas and Northern Railroad, and passes through five parishes.

The most important stations are Vidalia, Concordia, Frogmore and Tensas, in Concordia parish; Greenville, Wildwood, Florence and Pecks, in Catahoula parish; Bryan, Gilbert and Winnsborough, in Franklin parish; Archibald and Rayville, in Richland parish, and Collins, in Morehouse.

The Natchez, Red River and Texas Narrow-Gauge Railroad extends from Vidalia to Trinity through Concordia parish. Principal stations, Vidalia, Sycamore, and Trinity, in Concordia parish.

The Baton Rouge, Grosse Tete and Opelousas Railroad.—This line extends in a westerly direction from Port Allen to Rosedale. It is twenty-eight miles long and lies within the confines of two parishes.

Its stations are Port Allen, in West Baton Rouge parish, and Rosedale and Musson, in Iberville parish.

The Mississippi, Terres-aux-Boeufs and Lake Railroad.—This line extends down along the eastern coast of the Mississippi river to Bohemia.

It has a branch line from St. Bernard station to Shell Beach, on lake Borgne, and passes through three parishes.

The stations are: New Orleans and Jacksonborough, in Orleans parish; Versailles, Arabi, Poydras, St. Bernard, Toca, Kenilworth, Reggio, Florisant and Shell Beach in St. Bernard parish, and English Turn, St. Clair, Stella, Mary, Greenwood, Mouncella, Sordelet, Nero, Pointe-a-la-Hache and Bohemia, in Plaquemines parish.

The New Orleans, Fort Jackson and Grand Isle Railroad.—This line extends down the western coast of the Mississippi river through two parishes.

The principal stations being Algiers, in Orleans parish, and For Leon, Concession, Belair, Myrtle Grove, Wood Park and Grand Isle.

The City and Lake Railroad extends to Spanish Fort and the Pontchartrain Railroad to West End. These are pleasure resorts on lake Pontchartrain.

The track-laying during the year 1893 in the state was on five lines and amounted to 2036 miles of road.

Rivers, Bayous and Lakes of the State

Having spoken several times of our water courses, and the large number of miles of navigable waters in the state, it will probably convey a better idea of the marvelous facility of getting our lumber and soil products to the outside world, by the cheapest transportation known (navigable waters which penetrate every parish of the fifty nine in the state, save four), if a detailed description of these water courses is given. The following, taken from the pamphlet recently published by Commissioner Hawkes, will fully explain:

The navigable rivers bayous and lakes and the parshes in which they are navigable:

Names of Waters.	Miles of Navigation.	Head of Navigation.	Navigable in the Parishes of
Amite river	61	Port Vincent	Livingston. Ascension.
Atchafalaya river	218	Red river	Avoyelles. Pointe Coupee. St. Landry. Iberville. St. Martin. Iberia. St. Mary. Terrebonne.
Barataria bayou	78	Harvey's canal	Jefferson.
Bartholomew bayou (There is also a bayou Bartholomew in St. Mary's parish.)	40	Baxter, Ark	Morehouse. Ouachita.
Bistineau lake	30	Mouth of Dorchite bayou	Webster. Bienville. Bossier. Red River.
Black river	126	Mouth of Black river	Catahoula. Concordia.
Bodcau lake	10	Bellevue	Bossier.
Boeuf river	55	Rayville	Richland. Caldwell. Franklin. Catahoula.
Boeuf bayou (There is also a bayou Boeuf and a river Boeuf in Rapides parish, both unnavigable.)	11		St. Mary.
Calcasieu river	131		Calcasieu. Cameron.
Cane river	60	Grand Ecore	Natchitoches.
Cross lake	25		Caddo.
Courtableau bayou	36	Washington	St. Landry.
D'Arbonne bayou	50	Farmerville	Union. Ouachita.
De Glaise bayou	29	Evergreen	Avoyelles.
De Large bayou	20		Terrebonne.
Dorchite (or Dauchite) bayou	6	Minden	Webster.
Grand Caillou bayou	13		Terrebonne.
Lafourche (There is a bayou Lafourche also, in the parishes of Morehouse, Ouachita, Richland and Caldwell, not navigable.)	318	Donaldsonville	Ascension. Assumption. Lafourche.
Little river	12	Catahoula lake	Catahoula.
Louis bayou	15	Bayou Castor	Catahoula.

Names of Waters.	Miles of Navigation.	Head of Navigation.	Navigable in the Parishes of
Macon bayou	138	Floyd	East Carroll. West Carroll. Richland. Madison. Franklin.
Manchac bayou	18	Hope Villa	East Baton Rouge. Iberville. Ascension.
Mermentau river	81	Lake Arthur	Acadia. Cameron. Calcasieu. Vermillion.
Mississippi river	585 2,161	Miles in the state Miles to St. Anthony's Falls, Minn	East Carroll. Madison. Tensas. Concordia. Pointe Coupee. West Feliciana. East Feliciana. East Baton Rouge. West Baton Rouge Iberville. Ascension. St. James. St. John. St. Charles. Orleans. Jefferson. St. Bernard. Plaquemines.
Natalbany river	12	Springfield, La	Livingston. Tangipahoa.
Ouachita river	217	Camden, Ark	Morehouse. Union. Ouachita. Caldwell. Catahoula.
Pearl river	103	Carthage, Miss	Washington. St. Tammany.
Petit Anse bayou	8	Avery's Salt Mine	Iberia.
Red river	510	State Shoals	Caddo. Bossier. De Soto. Red River. Natchitoches. Winn. Grant. Rapides. Catahoula. Concordia. Avoyelles.
Rouge bayou	15		St. Landry.
Sabine river	387	Tensas	De Soto. Sabine. Vernon. Calcasieu. Cameron.
Teche bayou	91	St. Martinville	St. Martin. Iberia. St. Mary.
Tensas river	112	Lake Providence	East Carroll. Madison. Tensas. Concordia. Catahoula.
Ticfaw river	16		Livingston. Tangipahoa.
Terrebonne bayou	27		Terrebonne.
Tangipahoa river	15		Tangipahoa.
Tchefuncta, or Chefunctee.	20	Old Landing	St. Tammany.
Vermillion river	49	Pin Hook Bridge	Vermillion. Lafayette.

The navigable waters within the boundaries of the state are estimated to be 3819 miles.

The coast line, bordering on the gulf of Mexico, is 1256 miles long.

Fish and Oysters of Louisiana.

Apropos of lakes, rivers and streams may be mentioned the varied and abundant fish supply found in them all over the state, affording unending sport to the lovers of the piscatorial art Every stream and lake has its own peculiar fish, fancied by the dweller on its banks to be unexcelled in gastronomic qualities. Besides, the inland streams lakes Pontchartrain, Maurepas and others along the gulf coast, furnish an abundance of fish, and are often resorted to by amateur sportsmen from New Orleans. But beyond these, on the gulf coast, lies a mine of wealth but partially developed. The fish and oyster industry, which, if prosecuted to the same extent as is done on the north Atlantic coast, or on the Chesapeake bay, would render Louisiana more famous in this line than she is now for her profusely fertile soils. The redfish, the pompano, the mullet, the trout, the red snapper and the perch and many other fish of large size and excellent quality are to be found all along the gulf coast from the Pearl to the Sabine river. So, too, with oysters, that delicious bivalve, which here rivals in flavor the far-famed Cherrystone and Horn harbor products of the Chesapeake bay. If the cultivation of oysters was practiced upon our bays inlets and bayous to the same extent and with the same intelligence as is followed upon the Chesapeake bay, New Orleans would soon become a center of oyster packing-houses, and share with Baltimore in the enormous profits now incident to such an industry. The west should be supplied exclusively with gulf oysters, and nowhere can they be more cheaply or profitably grown than along the gulf coast, bordering Louisiana. The followin, written by Colonel F C. Zacharie, in the Southern States Magazine, will give further information upon this much-neglected industry.

THE LOUISIANA OYSTER BEDS.

The great resources of Louisiana, in its large production of sugar cane. cotton, rice, lumber and fruits, have hitherto kept in comparative obscurity what are generally deemed the minor—and wrongly considered the less remunerative—fields for the employmnt of capital and intelligent labor Prominent, if not the principal, among these neglected industries are the vast fishery interests of the state, which, under energetic labor and scientific cultivation, would in a few years equal, if they did not surpass in the way of pecuniary profit, the aggregate value of the entire state. The extent of the oyster territory is so vast. the supply so abundant and cheap, and so little labor and capital are required for its development, that its wonderful advantages and enormous profits once known, capital and labor will inevitably seek employment in what must eventually become a leading industry, far surpassing that of any state in the union.

On the eastern boundary, starting from the Rigolets, the small gut or strait connecting lakes Borgne and Pontchartrain. the mouths of the Mississippi river to the Texas line, there is a coast of about 600 miles in length, if measured on straight lines from point to point. Making an allowance for the curvatures of the coast, the shores of salt water bays. bayous, inlets, lakes and islands, which fret this part of the state like net work. the littoral line will not fall short of 1500 or 2000 miles. Taking into consideration the shelving, shallow beach adjacent to it, experts well acquainted with its geographical features estimate that the area suitable to planting and growing oysters is double the amount of acreage available in all the other states of the union combined. The coast abounds in suitable places to which the mollusk can be transplanted from the seed bed, and under proper care developed into an oyster which for the delicacy of its flavor cannot be excelled the world over East of the Mississippi river these natural beds are still numerous and transplanting is carried on to but a limited extent Not only do these beds supply the wants of the people of the lower coast, but small quantities are shipped to the New Orleans markets, and hundreds of poachers or "pirates," so called, from Mississippi, carry away anually hundreds of schooner loads of the shell fish.

The flavor of these bivalves here taken, although of excellent qua[illegible], compared with those of the Atlantic states, yet is by no means equal to those taken from the choice planting grounds across the Mississippi, going west from the great river. Bayou Cook, Grand bayou, bayou Lachuto, Grand lake, bayou Lafourche. Timbalier bay Last island, Barataria bay, Vine Island lake, Vermillion bay and the Calcasieu grounds furnish the best, those of bayou Cook having par excellence the highest reputation in the markets of Louisiana and the neighboring states, and bringing a correspondingly higher price.

The difficulties, dangers and delays of transportation are being rapidly overcome by railways and canals, some already built and others projected, penetrating the best oyster regions, and if capital be properly encouraged and protected in its investments, as it assuredly will be, the day is not far distant when the production will be immeasurably increased, the price for home consumption greatly reduced, and an export trade established which will supply the whole of the western territory of the United States, from the Mississippi to the Pacific coast, at reduced prices. Not only to the capitalist is the field open, but to the skilled oyster culturist of Chesapeake and Delaware bays, Long Island sound and the shores of Connecticut, the state offers cheap oyster lands for sale or to rent, and a free supply of seed. To all such, with a minimum of capital and skilled industry and energy, she opens her arms to welcome them to a home on the verge of her "summer sea," beneath skies which is hardly known what winter is, and to cheer them on to fortune and her own industrial development. This is no fair-seeming false promise, but one tendered in all sincerity, and based on facts which the writer has been careful to understate rather than to overestimate.

FORESTRY.

The following are a partial list of the more important trees and shubs of the state:

Oaks—Quercus alba, white oak; quercus aquatica, water oak; quercus catisbaei, turkey oak; quercus cinirea, sand jack oak; quercus falcata, Spanish oak; quercus lyrata, overcup oak; quercus michauxii, cow oak; quercus nigra, black-jack oak; quercus obtusiloba, post oak; quercus palustris, pin oak; quercus phellos, willow oak; quercus punus, swamp chestnut oak; quercus tinctoria, black chestnut oak; quercus virens, live oak.

Hickories—Carya alba, scaly-bark hickory; carya amara, swamp hickory; carya aqualica, water hickory; carya porcina, pignut hickory; carya tomentosa, black hickory; carya olivaeformis, pecan.

Ash—Fraximus Americana, white ash; fraximus platycarpa, water ash; fraximus veredis, green ash.

Elms—Ulmus alata, wahoo or winged elm; ulmus fulva, slippery elm; ulmus Americana, white elm.

Gums—Nyssa syloatica, black gum; nyssa uniflora, tupelo gum; liquidambar styraciflua, sweet gum.

Magnolia—Glauca, sweet bay; grandiflora, magnolia macrophylla, cucumber tree.

Pines—Mites, short-leaf pine; palustus, long-leaf pine; taeda, loblolly, or old field pine.

Maples—Acci bactatum, hard maple; acci rubicum, red maple; acci saccharinum, sugar maple.

Prunus—Americana, American plum; augustifolia, Chickasaw plum; serolina, wild cherry.

Buckeye—Aesculus indet, buckeye; aesculus pavia, red buckeye.

Marshmallow—Hibiscus incanus, marshmallow; hibiscus moschentos, marshmallow.

Sumach—Rhus glabia, sumach; rhus copallina, sumach.

Haw—Vibunum, medium haw; vibunum, pinnifoleum, black haw; vibunum scabrellum, haw.

Other trees — Ostuja Virginica, ironwood; cornus floida, dogwood; sassafras officinale, sassafras; diospyras Virginiana, persimmon; asimiara parviflora, Papaw; gleditschia triacauthes, honey locust; gleditschia monosperma, water locust; hamamelis Virginica, witch hazel; oxydendrum arboreum, sour wood; myrica cerifera, wax myrtle; alnus serrulata, alder; castanea pumila, chinquepin; juniperus Virginiana, red cedar; fagus ferruginea, beech; tilia Americana, linden tree; carpinus Americana, horubeam; ilex opaca, holly; enonymus Americanus, burning bush; lenodendron tulipifera, tulip, or poplar; crataegus apiifolia, hawthorn; sambucus Canadensis, alder; chronanthus Virginica, fringe tree; morus rubia, mulberry; maclura aurantiaca, Osage orange; betula rubra, red birch; populus heterophylla, cottonwood; salyx ——, willow (many species); catalpa bignoides, catalpa; platarius occidentales, sycamore; negundo aceroides, box alder; celtis occidentales, hackberry; taxodium distichum, cypress; juglaus nigra, black walnut; xanthoxylum clava, prickly ash.

When the areas devoted to the above trees are known, some idea of the quantity of timber existing in Louisiana will be formed. Of the entire forest wealth of the United States over 60 per cent is situated in the south, and of this amount Louisiana possesses the lion's share. In fact, it may be said that 75 per cent of this wonderful forest wealth is lying along the tributaries of the Mississippi river or gulf of Mexico, and is readily accessible to the wharves of New Orleans and Baton Rouge. Millions of dollars have been recently invested in these timber resources, and the saw mills and planing machines of the north, like the cotton factories, are gradually moving south for large profits. The greatest timber wealth of this state is in its immense areas of long and short-leaf pine and its unparalleled forests of cypress. While other southern states share with us the claims for superiority, in both quality and quantity of the former, of the latter we stand without a rival, in both the immense quantity available and the excellent quality of the lumber made therefrom. Only a few years ago and our cypress lumber was but little known and appreciated; to-day it ranks with other varieties of timber in quantity and surpasses all other in quality. The Cypress Lumber Manufacturing Association, which meets monthly in New Orleans, represents an output of over 300,000,000 feet of finished lumber per year.

The adaptability of the cypress to the many uses in building—doors, blinds, windows, floors, inside finish, outside work, bevels and drop siding, etc., and its wonderful powers of duration, even when exposed to the vicissitudes of sunshine and rain, heat and cold, dry and wet climates, have made it a favorite wherever known since the times of the Pharaoh of Egypt. So highly has it been appreciated of late, that its current market prices have scarcely depreciated at all during the recent trying financial depression. It will receive paint easily or can be hard-finished with the most beautiful effect.

Other Woods—Next to cypress stands in importance, both as regards the quantity and excellent quality, our long-leaf pine. This tree furnishes also a large industry in each of the states of Alabama, Georgia, Florida, Mississippi, Arkansas and Texas, and is well known all over the Americas, if not over the civilized globe. The area covered by the long-leaf pine in this state is enormous and may be approximately estimated by the total area given for the long-leaf pine hills and flats given in the agricultural part of this pamphlet, for very little comparatively of the original growth has yet been removed.

The short-leaf pine forests abound in the region of oak uplands, and furnish a large number of square miles of available timber.

Ash, oaks, magnolia, beech, walnut, gums, cottonwood, maples, etc., are found in large quantities upon the bluff lands and inland streams of the state, and nowhere on earth is there presented finer opportunities for all manufactories of wood than here in Louisiana. Factories for wagons and carriages hollowware, barrels, staves, hoops, ax and hoe handles, etc., could all be carried on here successfully with the materials gathered cheaply from our forests. Our cottonwood and tulip (poplar) trees could be converted into boxes and paper, right on the banks of our streams, with cheap, deep water transportation to almost everywhere. Next to the wealth of our existing soils, comes the wealth already drawn from these soils in the shape of forest growth.

The forestry bulletins of the last census of the United States give the following estimates of long and short-leaf pine standing June 1, 1880, viz:

	Long Leaf. Feet.	Short Leaf. Feet.
Alabama ..	18,885,000,000	....
Florida	6,615,000,000	....
Arkansas ..	....	41,315,000,000
Georgia ...	16,778,000,000	....
Louisiana .	26,588,000,000	21,625,000,000
Mississippi	17,200,000,000	6,775,000,000
N. Carolina.	5,229,000,000	....
S. Carolina.	5,316,000,000	26,093,200,000
Texas	20,508,000,000	26,093,200,000
Total. ..	117,119,000,000	121,991,400,000

EDUCATION

in this state is largely done by private schools and colleges, though the state supports liberally public schools in every parish, a state normal school, well-administered and attended, at Natchitoches; a state industrial school at Ruston, recently organized, and the Louisiana State University, Agricultural and Mechanical College at Baton Rouge, La. The last is an institution of high grade, well officered and attended by over 200 young men from all parts of the state.

Connected with the latter are three agricultural experimental stations: No. 1, the sugar experiment station, located at Audubon park, New Orleans; No. 2, state experiment station, at Baton Rouge, and No. 3, north Louisiana experiment station at Calhoun, in the hills of the state. These stations are well equipped and are doing extensive work along the lines of agricultural research. Over a thousand different varieties of plants are under cultivation, and one of the leading objects of these stations is the introduction and trial of new crops. Bulletins are issued regularly, giving the results of the numerous experiments in the field, laboratories and sugar-house. The Audubon Sugar School, located at Audubon park, New Orleans, in connection with the sugar experiment station, gives thorough instruction in the agriculture, mechanics and chemistry of sugar growing and manufacture.

Besides the above public system of instruction, from the public school to the State University and Agricultural and Mechanical College, each city, town or village has its graded schools, reaching through an academic course. To these must be added the private and denominational schools and colleges. The Methodists have a college for young men at

Jackson. The Catholics have male colleges in St . James and St Landry parishes. Female colleges or convents exist in St. James, Baton Rouge, Alexandria, Shreveport, Opelousas and Monroe. There are several Catholic colleges for both boys and girls in New Orleans.

Clinton has a flourishing female college (the Silliman Institute) and a fine military academy. Shreveport has also a flourishing female college and military academy, besides an excellent system of graded public schools.

Arcadia, Ruston, Minden and Homer have excellent private colleges.

The Methodists maintain an excellent female college at Mansfield, and the Baptist at Keatchie and the Masons at Fort Jessup.

Monroe, Lake Charles, Iberia, and other towns maintain excellent graded schools

Tulane University, situated in New Orleans, established by the munificence of Paul Tulane, has recently fitted out in handsome style all of its colleges. Its colleges of arts and science, letters, engineering, law and medicine are numerously attended and enjoy high rank. Its female department, the Sophie Newcomb College, stands in the front rank of female colleges, and its graduates are noted for their thorough scholarship. The above are for the education of the whites. The negroes have been provided for with separate public schools and an institution of high grade, the Southern University, located in New Orleans, all supported by the state. There are also about a half-dozen colleges or universities supported by private or missionary contributions, which are well managed and attended.

HEALTH OF LOUISIANA.

The erroneous impression prevails throughout the country that Louisiana is a low-lying swamp, full of deadly malaria, the implacable mosquito and the slothful alligator, uninhabited and uninhabitable save by the negroes. This impression is further accentuated by publications emanating from public officers, who are credited by the public with a full knowledge of the facts which they record, when really they know no more about Louisiana than a 12-year-old pupil in the public schools of the country. In the compendium of the eleventh census, 1890, part I, population, Robert B. Porter, superintendent, page 58, a description of the alluvial region of the Mississippi is given. At the close of the section, the following language is used: "The soil is of the highest degree of fertility, but the climate is hostile to the white race, and by far the larger proportion of the inhabitants is of the colored race." This fact!!! is announced in several other places in the same volume.

What would the numerous planters who reside in this valley respond to such an unjust aspersion upon their homes? New Orleans, situated in this region, with its 300,000 inhabitants, three-fourths of whom are white, and of the white, 75 per cent are permanent dwellers there winter and summer, would refute such a slander, if the writer would visit and see the number of rosy-faced children, robust men and pretty women filling her streets and her homes. Of course, when men high in official circles will promulgate as an official fact, collected like other census data, by reliable agents, at government expense, such untrue aspersions upon a large section of the country, lay readers must accept them as truths beyond cavil. But the writer, with a large corps of assistants gathered from a dozen states and countries, himself coming from a high country free from malaria, has been a dweller upon the banks of the Mississippi river for nine years, and can state that in that time all have enjoyed excellent health, without a serious illness; nor have a single one been forced to leave this fertile country because "the climate was hostile to the white race." In fact, with proper care and diet, nowhere can a white person live with greater immunity from diseases of all kinds than on the banks of the Mississippi river in this state.

But facts are worth more than opinions and here are some taken from a recent address by the president of the board of health of this state:

The average mortality for the whole United States is 14.70 per 1000 for the whites and 17.29 for the blacks.

For the white, Oregon is first, with a mortality of 11.04 per 1000, with Minnesota, an excellent second at 11.51 and Arkansas brings up the foot of the list with a mortality of 19.11, very closely pushed by educated and scientific Massachusetts with a mortality of 18.56.

For the blacks, the negro enjoys the greatest exemption in Florida, having a rate of mortality in that state of 11.36 per 1000. He has a very hard time in Rhode Island, where his mortality is 27.10, and he is very much worse, and the very worst off, under the very eye of his particular guardian, the general government, for his mortality in the district of Columbia is 35.62 per 1000.

Now as to the position which Louisiana occupies in the white list. I am very sure that Vermont, Tennessee, Indiana and Texas have each of them enviable reputations for healthfulness, and a favorable comparison of Louisiana with any of the four would undoubtedly excite derision.

What are the facts? Vermont has a white mortality of 15.13 per 1000, Tennessee, 15.21; Louisiana, 15.45, Indiana, 15.88, and Texas, 15.86; or, in this group of known healthy states, Louisiana stands superior to two and presents only a very small fractional inferiority to the others.

The highest on record of percentage of deaths from malarial fever stands Florida, with .53 per cent of its total mortality from this disease; the lowest Rhode Island, with only .08 per cent. In between these two extremes come the other states, those adjacent to our great streams showing a higher rate than the others. Arkansas has 7.65 per cent, Alabama 7.35, Mississippi 7.06, Louisiana 6.06, and Texas 6.04. Our own state showing more favorably than any of her neighbors, save one, in a mortality springing from a disease largely preventable by ordinary attention, by the mass of the people, to the plainest and simplest laws of hygiene.

The least infant mortality is exhibited in New Hampshire, which has 20.88 per cent of infant to the total mortality; Maine, 23.57; Vermont, 24.10; California, 25.31; New York, 25.39; Connecticut, 26.75; Massachusetts, 20.21; Ohio, 33.36; Rhode Island, 33.69; Oregon, 34.99; New Jersey, 35.52; Wisconsin, 35.61; Pennsylvania, 36.15; and then Louisiana, with 38.05, the list ending with Kansas and Nebraska, the highest rates in the union—Kansas with 47.56 and Nebraska with 49.12 per cent.

In this list Louisiana is not preceded by any southern state. And should the calculation be based on the white population only or on an equal percent of colored to white which exists in each of the northern states ahead of her, her rank would not be fifteenth, but third or fourth. The infant mortality among negroes is enormously large, as from their habits it must be. Substitute a comparison between the whites in the rural sections of the union, north and south, and many of our southern states would show that our people cared well for their young.

The mortality from consumption, that dreaded universal and almost hopelessly fatal disease, can in the country, where the close confinement of people engaged in sedentary occupations, in ill-ventilated, crowded apartments does not exist, may be taken as a fair criterion of the actual influence of climatic conditions on the inhabitants. Arkansas enjoys great exemption from this disease with percentage to its total mortality of 6.42; Texas second, with 6.05 per cent; Nebraska third, with 6.93; Kansas fourth, with 7.54; Louisiana fifth, with 7.41; Florida sixth, with 8.14; Oregon twentieth, with 12.12 per cent; California thirty-third, with 15.80, and Maine the very last, with 19.16 per cent.

From the foregoing facts we may conclude with certainty:

First—That Louisiana enjoys relatively to her neighbors a favorable position in regard to mortality from malarial fevers, being superior to Arkansas, Alabama, Mississippi and Florida, and only a small fraction inferior to Texas.

Second—That her percentage of deaths of children places her above any of the southern states, and, if like population be compared with like, her position will be third or fourth among all the United States.

Third—That her position in reference to lowest rate of deaths from consumption, a disease very dependent upon climatic conditions, is fifth.

Fourth—That her percentage of deaths of old people places her second among the states for possibilities of long life.

Cities and Towns of Louisiana.

The city of New Orleans, the great commercial metropolis of the southwest, situated upon both banks of the Mississippi river, is too large and important for a full description here. Hand-books of the city have been compiled by the Young Men's Business League of New Orleans, and Captain J. F. Merry, assistant general passenger agent of the Illinois Central Railroad, Manchester, Iowa. Copies can be obtained by addressing as above.

This city lies near the mouth of the Mississippi river, and should be the gateway of exports and imports for the entire Mississippi valley, which contains a population, according to last census, of over 27,000,000 of people. It has an aggregate of over 30 miles of river front, along the wharves of which the largest ocean steamer can load. She receives over 2,000,000 bales of cotton, 600,000,000 pounds of sugar, 1,000,000 sacks of rice, 300,000 barrels of molasses, many millions of bushels of wheat, corn and oats; 150,000,000 feet of lumber, with immense quantities of shingles, laths, brick and lime. It has six of the largest railroads centering here, reaching out to every part of the country, besides several local lines. It has an immense river trade by steamers and barges, and with an ocean trade averaging four ships per day leaving her port loaded. It is the second largest exporting city in the union, and should occupy the same position as an importing city. It has sixteen commercial banks, with $9,000,000 capital, handling $220,000,000 exchange annually. It has twelve insurance companies, doing a business of $30,000,000 annually. It has numerous building and loan associations. It has a commerce of 8,500,000 tons. It is the largest importer of tropical fruit. It is the center of the extensive lumber interest of the south. It has over 2500 manufacturing plants, with $50,000,000 invested, paying out annually $15,000,000 in wages and producing $70,000,000 of finished products. It has a population of about 300,000 people. It has over 150 miles of electric railways. Largest freight ships in the world can enter the river. It has a fine system of graded public schools. Is the seat of the Tulane University and H. Sophie Newcomb College for girls. It is one of the best locations in the world for manufactories of all kinds. It will soon have a railroad bridge over the Mississippi river. It already has five large grain elevators. The total value of its commerce is nearly $600,000,000. Its exports are $129,000,000. Its imports are $31,000,000. It will soon have a United States navy yard. It already has several private dry docks. It has a large number of handsome churches, excellent public buildings and superb commercial exchanges. When the Nicaragua canal is completed its trade will quickly double. Its climate is salubrious; people refined and hospitable. Further information can be furnished by the Young Men's Business League, Captain Harry Allen, secretary, New Orleans, La.

Shreveport, situated on Red river, is the second city in size of the state, claiming 18,000 inhabitants. It has a tributary coast line of 1000 miles, besides splendid railroad facilities. It has five completed roads, three incomplete and four projected lines. When all are completed it will be the great railroad center of the northwestern portion of the state. By river it is 600 miles to New Orleans; by rail, 328 miles. It is fully equipped as a city, with handsome public buildings, electric street railways, electric lights, fire alarm, water works, city telephone, etc. It has four banks with a capital of $700,000, and one insurance company. It receives about 100,000 bales cotton and enormous quantities of hides and wool. It has extensive cotton seed oil mills, fertilizer factories, ice works and other minor industries. It has fine churches, excellent graded schools and a most excelcellent male academy and female college. The people are noted for their liberal hospitality and business push. Factories of all kinds are desired, and public and private aid will be given to those locating there. The Development Club, with Mr. L. M. Carter president, and V. Grosjean, secretary, will give further information.

Baton Rouge, situated on the first bluffs of the Mississippi river, is the third city in size in the state. It is the capital of the state, and here, besides the handsome state capital building, are located the state penitentiary, the Deaf and Dumb Asylum and the State School for the Blind. The insane asylum is located at Jackson. This city boasts of 13,000 inhabitants. It is one of the finest located cities in the world; on a bluff 60 to 70 feet high overlooking the river, and with a natural drainage basin. It has three railroads completed and several projected. It has three banks and one local insurance comapny, all doing a profitable business. It has two large brickyards, two immense lumber mills, one hoop factory, one barrel factory, one lrage central sugar factory and two ice plants, besides two cotton seed oil mills and one fertilizer factory. It is one of the best locations for manufactures in the state. Being on the Mississippi river, it enjoys the benefits of low freights both for the raw material and the manufactured products. It is situated in one of the richest sections of the state, and does a thriving mercantile trade. The State University and Agricultural and Mechanical College is located here, and is largely attended. The State Experiment Station is also located here, and its investigations are published in bulletins which are distributed free to any applicant. The health is excellent. The people refined and cultivated. It is surrounded by a country splendidly adapted to truck growing, market gardening and stock raising. Further information will be furnished by the Young Men's Business League, H. A. Morgan president, Baton Rouge.

Alexandria, Monroe, Lake Charles, Iberia, Opelousas, Natchitoches, Donadlsonville, Plaquemine, Lafayette, Franklin and Thibodaux are all towns of over 2000 inhabitants and have aspirations for fuller development and larger importance. Each have one to three banks, several manufactories and are centers of trade.

HOMES FOR ALL IN LOUISIANA.

There are lands enough in this state to meet all demands for several years. The prices are low, far below their intrinsic value.

To those seeking a home in our midst, the following information is given. The lands to be obtained in this state are of five classes, viz:

First—United States government lands, of which there are yet about 2,000,000 acres left in the state, subject to homesteads. Full information can be obtained by addressing the United States land office at New Orleans for south Louisiana, or same at Natchitoches for north Louisiana.

Second—State lands, of which there are 3,423,190 acres. Full information in regard to these can be given by Major Jno. S. Lanier, register of state land office, Baton Rouge, La.

Third—Railroad lands. There are large bodies of these lands in the state.

The Vicksburg, Shreveport and Pacific Railroad owns 400,000 acres in the parishes of De Soto, Caddo, Bossier, Webster, Claiborne, Bienville, Jackson, Lincoln, Union, Ouachita, Morehouse, West Carroll, Richland and Madison. Mr. Jno. M. Lee, Jr., Monroe, La., is general land agent and will give full information in regard to these lands.

Fourth—Land companies, of which many exist in this state. The following can give information:

The Watkins Land Company, Lake Charles, La.

The English Syndicate, Dr. S. A. Knapp, president, Lake Charles.

The Louisiana Land and Development Company, D. L. McPherson, secretary, Abbeville, La.

Messrs. Duson Bros., Crowley, La.

Mr. S. L. Carey, Jennings, La.

Mr. F. M. Welch, Alexandria, La.

The Development Club, Shreveport, La.

The Young Men's Business League, Baton Rouge, La.

The Young Men's Business League, New Orleans, La.

Howcott Land Company, New Orleans.

Curtis & Walmsley, New Orleans.

J. W. Coleman & Co., New Orleans.

Northwestern Land Company, J. H. Hilliard, secretary, Shreveport, La.

Fifth—Private lands in each parish, which can be bought only through the owner.

The following railroad agents can also furnish information relative to prices of lands and descriptive matter of the country through which their respective roads pass:

Captain J. F. Merry, assistant passenger agent Illinois Central Railroad, Manchester, Iowa.

Mr. E. Hawley, asistant general traffic agent Southern Pacific Company, 343 Broadway, New York.

Mr. Frank G. Anderson, land commissioner V., S. and P. Railroad, Birmingham, Ala.

STATEMENT OF NORMAL WEATHER CONDITIONS AT NEW ORLEANS, LA., DURING EACH MONTH OF THE YEAR.

Compiled from Weather Bureau records extending back to Nov. 1, 1870, except the rainfall, which includes non-official (but reliable) records that extend back to 1840.

Nature of Data.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Mean temperature	54.0	58.7	62.3	69.0	74.8	80.6	82.6	81.8	78.2	70.1	61.3	55.9
Mean maximum temperature	61.5	66.0	69.9	76.2	82.0	87.1	89.0	88.1	84.4	76.8	68.5	63.2
Mean minimum temperature	46.6	51.4	54.7	61.7	67.6	74.0	76.1	75.4	72.0	63.4	54.0	48.6
Highest daily record	82.0	82.0	84.0	88.0	92.0	97.0	99.0	96.0	94.0	90.0	85.0	80.0
Lowest daily record	15.0	25.0	30.0	38.0	53.0	58.0	67.0	63.0	56.0	40.0	30.0	20.0
Average rainfall	5.44	4.68	5.46	4.96	4.95	6.49	6.88	6.20	5.05	3.21	4.26	4.63
Days clear	9	9	11	11	12	9	9	8	12	16	12	9
Days partly cloudy	12	10	11	12	14	15	17	17	12	10	9	11
Days cloudy	10	9	9	7	5	6	5	6	6	5	9	11
Days with rain	11	10	10	6	9	14	16	14	11	7	9	11
Prevailing wind	N.	N.	S. E.	S. E.	S. E.	S. E.	S. E.	S. E.	E.	N.	N.	N.

The lowest temperatures recorded each year for twenty years at New Orleans are: 1875, Jan. 10, 28 degrees; 1876, Dec. 30, 28 degrees; 1877, Jan. 29, 26 degrees; 1878, Dec. 28, 27 degrees; 1879, Jan. 6, 20 degrees; 1880, Dec. 30, 20 degrees; 1881, Jan. 1, 31 degrees; 1882, Dec. 8, 30 degrees; 1883, Jan. 22, 31 degrees; 1884, Jan. 6, 22 degrees; 1885, Jan. 2 and 18, 28 degrees; 1886, Jan. 9, 15 degrees, 1887, Jan. 3, 21 degrees, 1888, Jan. 19, 29 degrees; 1889, Feb. 7, 32 degrees; 1890, Dec. 9, 35 degrees; 1891, Nov. 30, 30 degrees. 1892, Dec. 27, 23 degrees; 1893, Jan. 20, 29 degrees; 1894, Dec. 29, 21 degrees.

LETTER OF STATE REGISTRAR.

STATE OF LOUISIANA,
State Land Office,
Baton Rouge, Nov. 23, 1893.

Commissioner of Immigration, New Orleans, La.: Dear Sir—Replying to your letter of the 21st inst., I have to inform you that the within copy of act is still in force, and is the law. This does not apply at all to homesteaders, that the governing law as to these is act. No. 64, of the session of 1883, which you will find on page 70 of the acts of that year.

Homesteaders are not required to pay any fees or price whatever, except when they require copies of survey and certificates, which they seldom do.

The inclosed copy of act 85 of 1880 refers entirely to purchasers of state lands. The public lands donated by the acts of congress to the state are all swampy and overflowed, and were so donated because they were not fit for settlement and cultivation; hence there are few homestead entries made at this office.

The United States owns large areas of land in this state which is reserved for actual settlers or homesteaders; of these and all laws bearing on the subject you can obtain from the registrar United States land office in your city.

Very respectfully,
JOHN S. LANIER, Registrar.

PUBLIC SCHOOLS.

State Constitution, Art. 208. The general assembly shall levy an annual poll tax for the maintenance of public schools, upon every male inhabitant in the state over twenty-one years, which shall never be less than one dollar and a half per capita, and the general assembly shall pass laws to enforce payment of said tax.

Art. 224. There shall be free public schools established by the general assembly throughout the state for the education of all the children of the state between the ages of six and eighteen years; and the general assembly shall provide for their establishment, maintenance and support by taxation, or otherwise, and all moneys so raised except in proportion to the number of children between the ages of six and eighteen years.

Art. 227. The funds derived from the collection of the poll tax shall be applied to the maintenance of public schools as organized under this constitution, and shall be applied exclusively to the support of public schools in the parish in which the same shall have been collected, and shall be accounted for and paid by the collecting officers to the competent school authorities of each parish.

Art. 229. The school funds of the state shall consist of: 1. The proceeds of taxation for school purposes, as provided in the constitution. 2. The interest on the proceeds of all public lands heretofore granted by the United States for the use and support of public schools. 3. Of lands and other property which may hereafter be bequeathed, granted or donated to the state or generally for school purposes. 4. All funds or property other than unimproved lands, bequeathed or granted to the state, not designated for other purposes. 5. The proceeds of vacant estates falling under the law to the state of Louisiana.

The legislature may appropriate to the same fund the proceeds, in whole or in part, of the public lands not designated for any other purpose, and shall provide that every parish may levy a special tax for the public schools therein, which shall not exceed the state tax; provided, that with such tax the whole amount shall not exceed the limits of parish taxation fixed by this constitution.

Article 230 provides that the Louisiana State University and Agricultural and Mechanical College, located in the city of Baton Rouge, shall be maintained, and all the revenues derived from the sale of land donated by the United States to the state, shall be used for the support of the same.

"Property dedicated to the use and belonging to the public schools, or employed by municipal corporations for that purpose, shall be and is hereby exempted from seizure."

"GENERAL OBSERVATIONS."

"The public school system is rapidly growing in popular favor in this state; and it may be truthfully said that there are but few communities to be found so callous and benighted as not to fully appreciate the importance of educating their children, and fitting them for the duties and responsibilities of life.

"In our cities and throughout the rural districts, very many of our best and ablest men and women are giving their aid and influence to the advancement of the cause, and the great masses of the people are beginning to realize the pressure of a new and higher civilization. Elements of success are combining in this state that must assuredly triumph over all obstacles and disadvantages, and soon place the public school system of Louisiana in the front rank of the forty-four state systems now prevailing in this country.

"It is not pretended that our system is perfect, or that its success is commensurate with our desires, but we do mean that there has been a steady advance, an orderly progress, and that however inadequate our school revenues may still be, they exceeded a million last year, and that we have abundant reason to feel gratified and encouraged with the general outlook. We feel satisfied that the table and diagrams appearing in this report will bear us out in what we say."

The Newspapers of Louisiana.

NO presentation of the advantages offered by Louisiana to immigration would be satisfactory or complete without some allusion to the press of the State.

This great agent and engine of popular education and enlightenment is represented by 172 serial publications, of which, 14 are issued daily; 2 semi-weekly; 147 weekly; 3 semi-monthly, and 6 monthly. Of these, 7 are printed in both French and English; 3 in French wholly; 3 in German; 2 in Italian, and 1 in Spanish. They are for the most part well-conducted and are excellent exponents of the local interests of the several parishes and districts in which they are printed. The intending settler can thus learn all that he desires short of a visit to the locality which he proposes to examine, and therefore they should be carefully consulted by persons at a distance. The States press is made up of secular, religious, trade, professional and literary publications representing all classes and every important interest.

The leading newspaper published in Louisiana is the New Orleans PICAYUNE. It was started in January, 1837, and has attained its 58th year. It is the oldest English paper in the city or in the State, its age being surpassed only by that of L'Abeille (the Bee), which is ten years older and is printed in the French language, and with the two exceptions of the Bee and the Deutsche Zeitung or German Gazette, it is the only paper in New Orleans that has survived the civil war.

The PICAYUNE has always been an able, conservative, enlightened representative of the best interests of Louisiana and of the great southwest in whose progress and development it has had a large share, and no paper in this country has been so close to the people themselves. It is their great tribune and advocate, ever standing against political trickery and official dishonesty, and being free from all corrupt jobs and selfish schemes it has always maintained the highest place in public confidence and favor.

The PICAYUNE was started by the brilliant and famous George Wilkins Kendall, one of the most distinguished wits of his day, and, perhaps, the first journalist in the world who played the part of a correspondent for the press from military headquarters in the field, Mr. Kendall having accompanied the United States army of invasion to Mexico during the war of 1846-47, sending to the PICAYUNE the first and freshest news of all the military operations of that important war.

Since then, the PICAYUNE has been conducted by many able and often distinguished men, constantly improving its excellent qualities as a newspaper, and always growing in influence and ability to represent and work for the people of New Orleans, of Louisiana, and of the South, until under its present proprietors, Mrs. E. J. Nicholson and Col. George Nicholson, it has reached the summit of journalism and is the leading paper in the great Southwest.

A volume could be filled with accounts of the PICAYUNE's enterprise in getting news, from the time of the Mexican war down to the present, but what has been said will suffice. Its complete offices of publication containing the most improved machinery and perfect appliances which science has provided for the production of newspapers and its able and skilled corps of thinkers and workers, combine to make it what it is, one of the great American dailies and the chief of all the journals of the Southwest.

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Date Due
