DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 335

GEOLOGY AND UNDERGROUND WATERS OF THE SOUTHEASTERN PART OF THE TEXAS COASTAL PLAIN

BY

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1914

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GEOLOGY AND UNDERGROUND WATERS OF THE SOUTHEASTERN PART OF THE TEXAS COASTAL PLAIN.

By Alexander Deussen.

INTRODUCTION.

This contribution to the geology of the ground waters of east and northeast Texas is based on field work done by the writer during the summers of 1907 and 1908. The area described includes the part of the Coastal Plain of Texas occupied by the outcrop of Cenozoic rocks lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County. (See fig. 1, p. 14, and geologic map, Pl. I, in pocket.) It embraces 36,317 square miles, an area as great as that of the State of Indiana. The report describes the underground water horizons of the region and discusses the artesian conditions and prospects in the several counties.

Acknowledgments for valuable assistance rendered and for information furnished are due to Joe Lake, of Marshall; June Harris, of Nacogdoches; J. P. Mettauer, of Rockland; A. P. Kimmey, of Lufkin; E. T. Dumble, William Kennedy, and L. Garrett, of the Southern Pacific geologic corps; T. U. Taylor, dean of the engineering department, University of Texas; F. W. Simonds, professor of geology, University of Texas; A. T. Dickey, city engineer of Galveston; F. B. Brown, of Longview; C. F. W. Felt, chief engineer of the Gulf, Colorado & Santa Fe Railway; Patillo Higgins, of the Higgins Oil & Fuel Co.; F. W. Michaux, of Beaumont; Capt. F. I. Kellie, secretary of the Commercial Club of Beaumont; P. A. McCarthy, city engineer of Lufkin; and many others. Information has likewise been freely drawn from the following publications: Professional Paper 46, United States Geological Survey, Geology and underground water resources of northern Louisiana and southern Arkansas, by A. C. Veatch; Annual reports of the Geological Survey of Texas, 1889–1892; Water-Supply Paper 190, United States Geological Survey, Underground waters of the Coastal Plain of Texas, by T. U. Taylor; Bulletin 212, United States Geological Survey, Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes and William Kennedy; Bulletin 282, United States Geological Survey, Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman; and others. Detailed references are given in footnotes. The information relating to quality of water has been reviewed by R. B. Dole, who also recomputed the analyses of water into ionic form in parts per million. This report was prepared under the direction of T. Wayland Vaughan, to whom thanks are due for many suggestions.

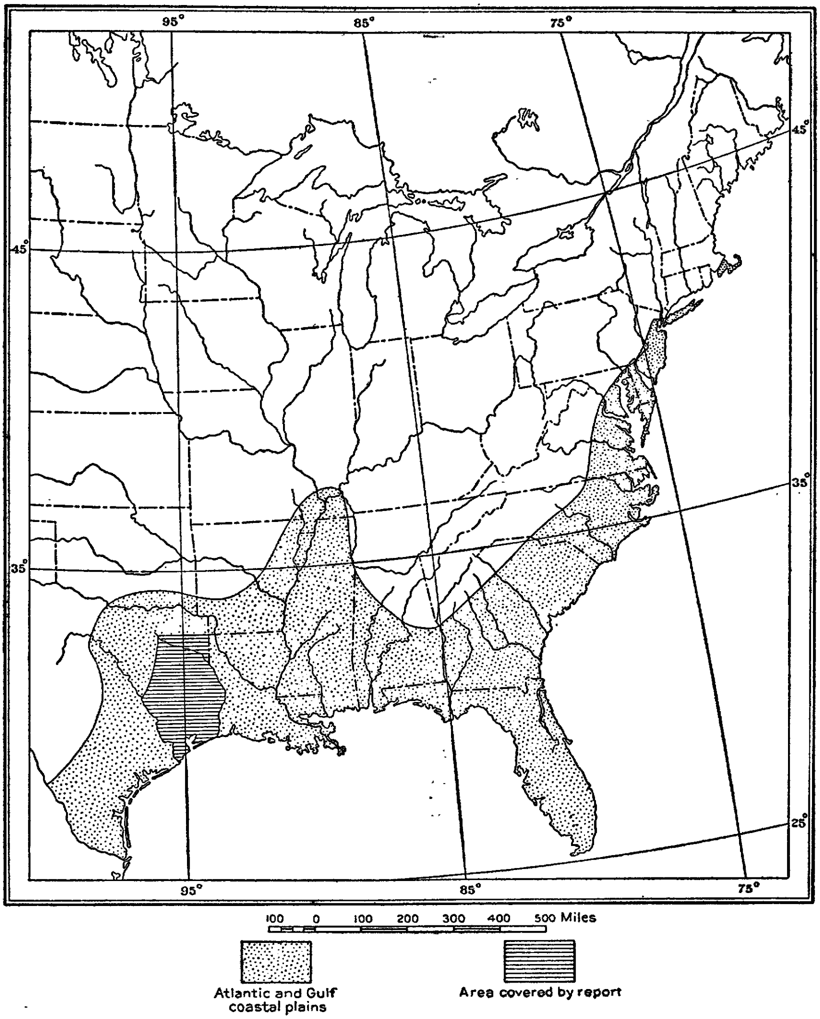


FIGURE 1.—Map of eastern United States, showing area treated in this report (indicated by horizontal lines), and its relations to the Atlantic and Gulf Coastal Plain (indicated by stippling).

PHYSIOGRAPHY.

GENERAL CHARACTER.

The Gulf of Mexico from Florida to Yucatan is fringed by a broad sublevel region that slopes gently toward the Gulf from an interior highland region. This natural physiographic province of North

America, which is known as the Gulf Coastal Plain and is the western continuation of a similar plain bordering the Atlantic, comprises all of Florida and Louisiana and portions of Georgia, Alabama, Mississippi, Kentucky, Arkansas, Texas, and Mexico, and a long reentrant from it extends northward up Mississippi River as far as southern Illinois. In the United States it is very broad, extending in places 500 miles back from the Gulf, but in Mexico it reaches mountains at a much shorter distance. Everywhere it is characterized by low relief and broad river valleys. Near the coast it is generally level, but in the interior it has been broadly but gently dissected and presents a hilly, undulating aspect. In Texas it comprises the following features, named from the coast inland: (1) The coast prairie;

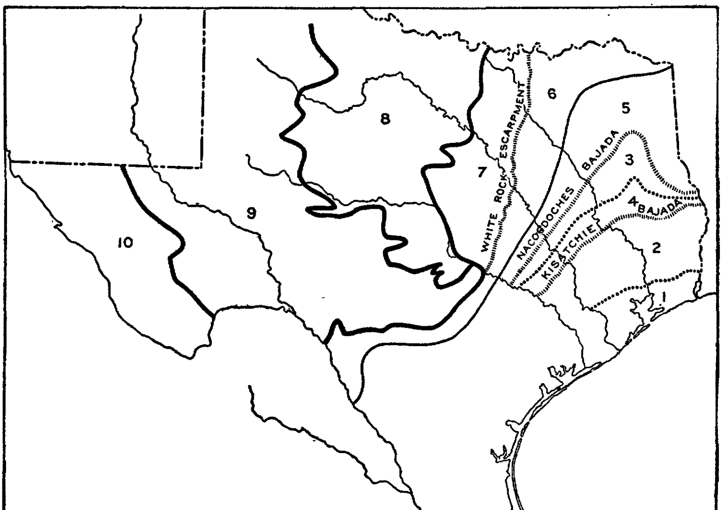


FIGURE 2.—Physiographic regions of Texas.

(2) the Kisatchie Wold;[1] (3) the red lands, and (4) the Yegua timber belt, the two constituting the Nacogdoches Wold; (5) the Corsicana Cuesta (including the Wilcox plain and the eastern marginal prairies); (6) the Black Prairie; (7) the Grand Prairie; (8) the central basin region; (9) the high plains and plateaus; and (10) the Cordilleran region. (See fig. 2.)

The area considered in this report comprises a small part of the Gulf Coastal Plain, stretching from the coast inland to and including the Wilcox plain and a part of the eastern marginal prairies.

[1] In this paper the term "wold" is used to designate a range of hills produced by differential erosion from inclined sedimentary rocks. A wold is made up of a cuesta or gently sloping dip plain on one side and a bajada or abruptly sloping face on the other. These terms were first so used by Veatch, A. C., Prof. Paper U. S. Geol. Survey No. 44, 1906, p. 29.

TOPOGRAPHIC FEATURES.

RELIEF.

Coast prairie.—Immediately fringing the Gulf is a narrow strip of level plain (see fig. 2), called the coast prairie, which has been slightly elevated above the sea in comparatively recent geologic time. It reaches inland about 50 miles. Near the Gulf its surface is flat and low, having an altitude of 20 to 30 feet above tide. Numerous rivers and creeks have excavated steep-sided channels across it. The divides between the drainways are grass covered, but the stream courses are bordered by narrow strips of timber. On its western margin this prairie merges into a rolling timber area.

Kisatchie Wold.—The coast prairies are succeeded on the interior by the Kisatchie Wold, comprising a gentle dip plain (the Kisatchie Cuesta) to the south, and a range of low hills (the Kisatchie Bajada) to the north.

The Kisatchie Cuesta occupies the counties of Newton, Jasper, Tyler, Hardin, Polk, Liberty, San Jacinto, Walker, Montgomery, and Waller, and parts of Grimes, Fort Bend, Harris, Jefferson, and Orange. The topography is generally undulating, the soils are for the most part sandy, and the uplands are forested in contrast to the prairie areas on the coast. (See fig. 2.)

The Kisatchie Cuesta terminates in the interior in the low hills of the Kisatchie Bajada. These hills, which represent the dissected portion of an interior-facing escarpment, which resulted from the greater hardness of the cap rock as compared with the underlying strata (figs. 2 and 3) are traceable across the entire extent of Texas from Sabine River to the Rio Grande. In places they attain a height of 150 feet above sea level. They are typically developed at Rockland in Tyler County, at Trinity in Trinity County, and near Fairmount in Sabine County.

This range of hills exerts an important influence on the streams of the Coastal Plain, all the rivers that cross it being noticeably deflected and caused to flow along its foot for greater or less distances. (See fig. 3.)

Nacogdoches Wold.—A second well-defined wold succeeds the Kisatchie Wold on the north and west. (See fig. 2.) On the divides and in areas near the Kisatchie Wold the country is for the most part rolling, but toward the interior margin it becomes hilly. This wold owes its existence to the superior hardness of the cap rock, which here consists of iron ore. On the interior margin the plain has been very much eroded and is now preserved only in a great number of iron-ore capped hills which rise to considerable altitudes above the surrounding lowlands. These hills constitute by far the greatest elevations in the region, the highest, such as those in Cherokee

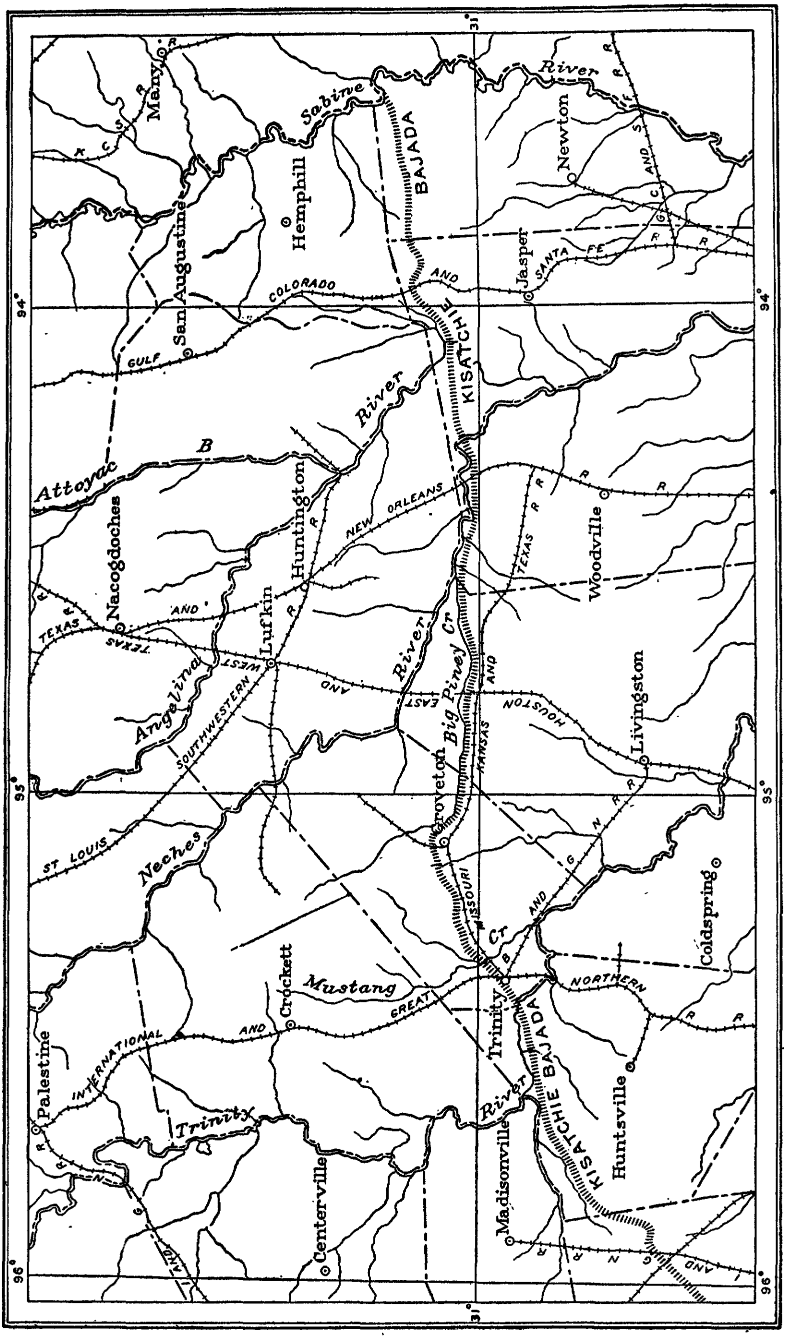


FIGURE 3.—Map showing the influence of the Kisatchie Bajada on the courses of the streams of Texas.

County, attaining an altitude of 666 feet above sea level.[1] As a type of these hills (locally called mountains) may be mentioned Gent Mountain in western Cherokee County, Grays Mountain, Grimes Mountain, Ragsdale Mountain, and many others.

The fringed and greatly dissected margin of the Nacogdoches Wold, represented by these iron-ore capped hills, which overlook the lowlands to the north and west, constitutes the Nacogdoches Bajada, whose approximate direction is indicated on the map (fig. 2).

Corsicana Cuesta and White Rock Escarpment.—The Nacogdoches Wold is succeeded in the interior by the Corsicana Cuesta. It includes the Black Prairie of Hill[2] and terminates in an inward-facing escarpment known as the White Rock Escarpment.[3] The cuesta is subdivisible into a number of geographic units, including the Wilcox timber belt (called by Dumble[4] the lignitic plain), the eastern marginal prairies, the Taylor prairies, and the White Rock Prairie.[5]

The Wilcox timber belt, which immediately borders the Nacogdoches Wold, is underlain by the Wilcox formation (p. 37). Its soils are predominatingly sandy, and it is entirely forested, in decided contrast to the subdivisions of the cuesta that lie farther west.

The eastern marginal prairies succeed the Wilcox timber belt on the west. Their soil is clayey and approaches the "black waxy" type. The area is grass covered, in contrast to the timbered country on the east.

The Wilcox timber belt and a portion of the eastern marginal prairies are the only parts of the Corsicana Cuesta that lie within the area described in this report.

Bottom lands.—The large through-flowing streams, such as the Brazos and the Trinity, and many of the smaller streams, such as the Sabine, Neches, Attoyac, and Cypress, have carved out wide valleys, and in these valleys have built up extensive alluvial plains 1 to 10 miles in width, which occupy in the aggregate a much larger area than the remnants of the ancient plains from which they were carved.

These alluvial or constructional[6] plains, through which the streams meander in irregular courses, are locally called bottom lands. For the most part they are sublevel and lie 100 to 200 feet beneath the

[1] Hill, R. T. Second Ann. Rept. Geol. Survey Texas, 1890, p. 19.

[2] Hill, R. T., Geography and geology of the Black and Grand prairies, Texas, etc.: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, p. 65.

[3] Idem, p. 68.

[4] Dumble, E. T., A comprehensive history of Texas, Dallas, 1898, vol. 2, p. 477.

[5] Hill, R. T., op. cit., pp. 67–68.

[6] Constructional plains are plains formed by the deposition of sediment in sublevel sheets along the stream ways or at the margin of the ocean. They may therefore be of fluviatile or marine origin. Destructional plains are sublevel areas formed as a result not of deposition but of erosion or degradation of older and higher surfaces.

A. ON FLAT FORK CREEK, 3 MILES FROM TENEHA, TEX.

Showing tree-covered top of mound and barren surrounding country. Substructure: Wilcox (Eocene). (After Veatch)

B. ON FLAT FORK CREEK, 3 MILES FROM TENEHA, TEX.

Symmetrical form partly destroyed by stream erosion. Substructure: Wilcox (Eocene). (After Veatch.)

C. ON PINE FLATS, NEAR TARBINGTON, TEX.

Substructure: Quaternary. Photograph by Vernon Bailey. (After Veatch.)

NATURAL MOUNDS.

general level of the rolling and hilly areas of the adjacent remnantal plains. They are covered with hardwood timber instead of with the pine of the upland plains. These bottom lands are exceedingly fertile and are justly prized for farming purposes. Their chief drawback is their liability to overflow where unprotected by levees. The Brazos bottom, for instance, is one of the most fertile farming regions in the world.

Owing to the lowness of their altitudes as compared with the surrounding country, many of these bottoms present ideal conditions for artesian wells (see pp. 87–90), and the artesian reservoirs which lie beneath them have been of inestimable economic importance in their industrial and agricultural development.

Mounds and pimple plains.—Besides the physiographic and topographic features previously enumerated, all of which were produced by water, the region contains certain elevations or physiographic features, the so-called mounds and pimple plains, which are of different origin.

The mounds are pronounced elevations, a few hundred acres in extent. Some of them rise 40 to 50 feet above the general level of the adjacent plains. They are irregularly distributed but are more conspicuous on the coast prairies. Big Hill and Spindletop in Jefferson County, High Island in Galveston County, Barbers Hill and Kiser Mound in Fort Bend County are typical.

The pimple plains, which are irregularly but widely distributed over both the remnantal and the constructional plains, are characterized by numerous conspicuous small rounded circular elevations 15 to 30 feet in diameter and 2 to 6 feet in height. They are typically developed in the Flat Fork Bottom south of Tenaha in Shelby County. (See Pl. II.)

DRAINAGE.

Two major types of streams prevail in the area—the antecedent and the consequent.

The antecedent streams antedate the formation of the Tertiary plain, having been in existence on the Cretaceous plain when the shore line of the gulf was far north of its present position. When the Tertiary area was added to the existing land, these streams extended their courses across the newer plain, growing at their mouths. The Brazos and the Trinity are of this type and constitute the largest and most important streams in the region.

The consequent streams developed after the formation of the Tertiary plain and occupied the territory between the extended or antecedent drainage. These have grown at their heads, having gradually worked their way backward. The Sabine, Angelina, Neches, and San Jacinto rivers are of this type.

Of these consequent streams, four distinct systems of drainage are recognizable: (1) System developed on Eocene and Oligocene areas during Miocene time; (2) system developed during the earlier Pleistocene time; (3) systems developed during later Pleistocene time; (4) system developed during recent time. (See fig. 4.)

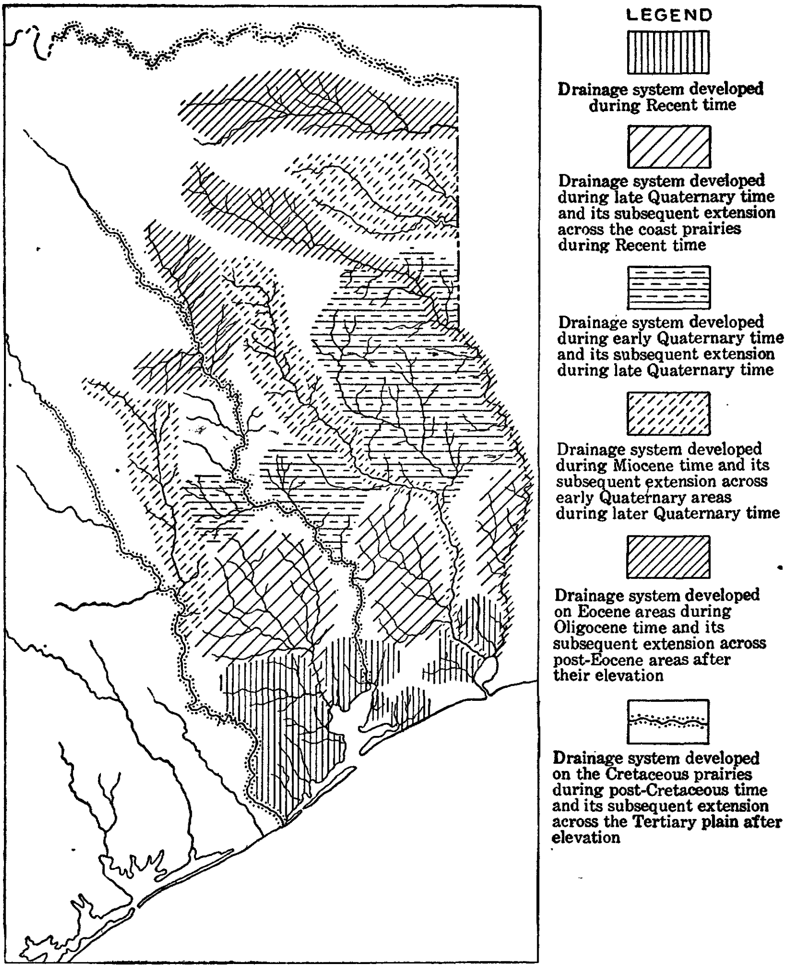


FIGURE 4.—Chronology of the development of drainage in east Texas.

The older consequent systems occupy the relatively higher surfaces between the extended streams. The longest and oldest rise along the interior margin of the Wilcox timber belt and are antecedent relative to the coast prairie, antedating its formation. This system includes Sabine River. The youngest system begins at the interior margin of the coast prairie, upon which it is established, and is consequent to it. It includes a number of creeks and bayous which head close to the coast and are sluggish and brackish.

TIMBER.

The region comprises both prairie and forest areas. The Kisatchie Wold, Nacogdoches Wold, and Wilcox timber belt constitute a timbered region wedged between the coast prairie on the south and the eastern marginal prairie on the west. This portion of Texas, which is very often spoken of as the east Texas timber belt, represents the western extension of the Atlantic timber belt. Its soils are predominatingly sandy compared with those of the prairies on the south and west.

The general character of the timber is indicated on the map (fig. 5). On the bottoms or alluvial plains hardwood forests flourish, made up of cow oak, bur oak, overcup oak, common white oak, red oak, Texas oak, willow oak, water oak, white ash, green ash, sweet pecan, bitter pecan, shagbark, white hickory, sweet gum, black gum, tupelo, cottonwood, sycamore, elm, and other trees. On the uplands and divides pine forests predominate, consisting of short leaf, loblolly, and long leaf (fig. 5), interspersed toward the interior with upland oaks, black jack, blue jack, and other trees.

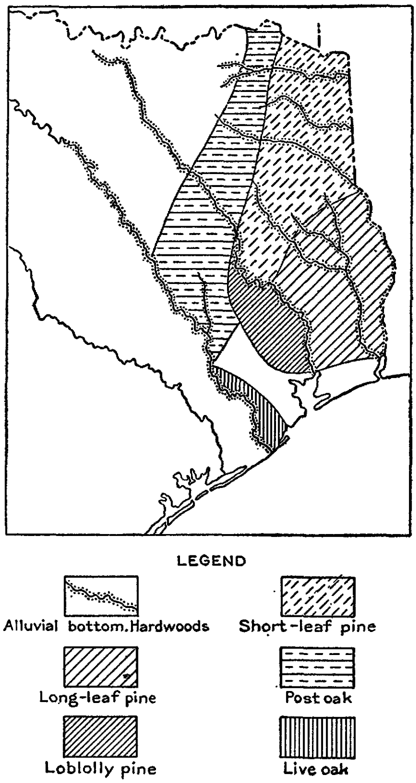


FIGURE 5.—Map showing the distribution of timber on the eastern third of the Texas Coastal Plain. After Bray. Note the close relation of the timber to the outcrops of the different geologic divisions.

GENERAL GEOLOGIC FEATURES.

RELATION OF GEOLOGY TO THE OCCURRENCE OF UNDERGROUND WATER.

The problems of underground and artesian water are problems in stratigraphy, the occurrence of such water being determined by the arrangement and relative positions of porous and nonporous (or impervious) beds. To ascertain whether flowing wells can be had at a given place before a hole is actually drilled, it is necessary to know what the arrangement, nature, and distribution of the rock sheets is in that region. To know whether a sufficient quantity of water can be economically secured from a well at a given place for a particular purpose, the same information is necessary. To know whether the water that may be obtained is of a quality suitable for the desired purpose, it is again necessary to know the same facts. These facts are the concern of the branch of geology known as stratigraphic and structural geology, and to ascertain them for any particular area it is necessary to know something concerning the stratigraphic and structural geology of the area.

PRINCIPLES OF STRATIGRAPHY.

EROSION AND SEDIMENTATION.

The most obvious natural processes now in operation on the earth are those of erosion and sedimentation. The exposed rocks disintegrate and decay into soils and rock detritus. Rains wash the soils and rock detritus into the streams, and the streams eventually carry the materials to the sea and deposit them on the sea floor. The removal of the soil and detritus by rain and wind constitutes erosion. The deposition of material on the sea floor constitutes sedimentation.

If these processes continued indefinitely, and no new land appeared, the land would in time be obliterated, the ocean would become universal, and subaerial erosion would cease. But so long as the present forces remain in operation this result can never be obtained. As the continents are worn down in one place, they are elevated in another, and new land is constantly being formed. Some continents are rising; others are sinking. Evidence shows that some seashores are rising while others are subsiding, some slowly (2 or 3 inches in a century), and others rapidly.

THE GEOLOGIC COLUMN.

Throughout the earth's history vast quantities of the products of rock decay and material taken from the sea water by organisms have accumulated on the sea floor, in some localities to a thickness of more than 20,000 feet. From time to time one area or another has been elevated into land, causing sedimentation to cease and erosion to begin. Fresh submergence may have again followed and sedimentation been resumed. In any given region periods of erosion may have alternated with periods of sedimentation.

The products of sedimentation are the sedimentary rocks, also called stratified, because arranged in layers or strata. They vary in character with the conditions of their deposition, gravels and sands usually being deposited close to shore, muds and clays in deeper water, and calcareous oozes, which ultimately form limestone, are deposited in areas to which earthy detritus derived from the land is not carried.

If the sea floor sinks, the place where sand was formerly deposited may be covered by clay, and if further depressed, by lime deposits. In time the sand, clay, and limy ooze will become indurated or lithified into sandstone, shale, and limestone through the action of pressure and cementing substances deposited by circulating water. Then, if the region is subsequently elevated into land and the materials are exposed (in a canyon, for instance) they will present, in columnar form, a typical stratified or sedimentary series, consisting of a bed of sandstone at the base, shale in the middle, and limestone at the top.

It is obvious that in any such stratified series the beds of greatest age are lowermost and those of least age uppermost. If a place could be observed where sedimentation had been continuous since the beginning of the process each period of the earth's history would be seen to be represented by certain divisions of the rocks. No such complete sedimentary series has ever been found in any one place, but portions of it are found at different localities, and by visiting a sufficient number of places the geologist may inspect the whole.

SUBDIVISIONS OF THE GEOLOGIC COLUMN.

Systems.—Certain names have been given to the different portions of this sedimentary series, and these different portions (called systems), taken in order, represent the accumulations during corresponding periods of the earth's history. The names of these systems in order from top to bottom, or from the youngest to the oldest, are: Quaternary, Tertiary, Cretaceous, Jurassic, Triassic, Carboniferous, Devonian, Silurian, Ordovician, Cambrian, Algonkian, and Archean.

The major units (systems) of the sedimentary series may be called time units, because the basis of their classification is time. The materials composing a given unit are not necessarily the same in different places, because the conditions of deposition (including depth of water) may have varied greatly; during a given period sands may have been deposited in one place and clays in another.

Formations.—The major units are divisible into smaller units according to the character of their materials. The lower part of a particular system may consist of sandstone, the middle part of clay, and the upper part of limestone. Such smaller units are known as lithologic units (or formations), because the classification may be based on the lithology or character of the constituent materials. They are named after places where they are well exposed.

Formations are essentially local. A given sandstone, for instance, may extend laterally for a considerable distance, but will eventually be succeeded or replaced by another kind of material, because sand is deposited only in shallow water. A sandstone formed from deposits along the stretches of a long coast on a sea floor of very steep slope will extend a long distance in one direction and a short distance in another, being cut off seaward by deep water in which clay was deposited in place of sand.

As long as the sea floor is neither elevated nor depressed, a sandstone formation deposited on it is of the same age throughout. With a sinking sea floor, however, the zone of deposition is constantly advancing with the advance of the shore line, and the formation may attain a wide distribution. The depression may continue for a long time, and the sand deposited along the shore may retain its character and may be laterally continuous throughout and therefore constitute one and the same formation; and yet one extremity of the formation represents deposition when the depression began and the other represents deposition when the depression ceased. A formation is, therefore, not necessarily of precisely the same age in different places of its occurrence.

Geologic maps and geologic sections are designed to show the distribution of geologic formations both at the surface and underground.

FOSSILS.

Nature and geologic distribution.—Along with the products of land decay and material chemically precipitated from oceanic water, the shells and skeletons of animals are deposited on the sea floor, where they are soon buried beneath sediment either as a whole or in broken pieces. Very many of the shells are subsequently removed, but perfect casts of the forms may remain. Such evidences of formerly existing life, now a part of the rock masses, are known as fossils. Wherever sedimentary rocks occur fossils may be found in greater or less abundance.

Study shows that fossil forms are unlike those of species now living, the greatest deviation being found in fossils deposited during the earliest periods of the earth's history. The simpler animals (animals not highly organized) characterize the lower divisions of the series and the higher types the upper divisions. Between the two there is a progressive increase in complexity. Each division is characterized by a certain set of fossils, which in the aggregate is distinctive of that division and is different from that of any other division.

These facts are of universal application. Fossils, for instance, that characterize the Cambrian system in one region of the globe characterize it in all other regions. Subdivision of the larger systems, however, may show local and specific variation. For example, a middle formation of the Cretaceous system in England and a middle formation of the same system in Texas may be characterized by slightly different sets of fossils.

Importance of fossils.—The fact that each division of the stratified series is characterized by a certain group of fossils is of the greatest importance to the practical working geologist, enabling him to recognize the division in widely separated places. If he finds certain fossils in a limestone exposed at a given place at the surface and finds them also in a similar-appearing limestone at a depth of 2,000 feet in a well 20 miles away, he may be confident that the same rock sheet is present in both places, and that it has a decided slope (dip) which in the course of the 20 miles has carried it 2,000 feet beneath the surface. If coal underlies the limestone where the latter is exposed at the surface it is probable that it also underlies it in the well and can be found by boring a little deeper.

Fossils are thus the earmarks of geologic formations and distinguish them as much as does the character of their rocks. In this paper, however, no attempt is made to describe the fossils of the respective formations, such matter being unessential in the present connection. Their occurrence, however, is noted and some characteristic forms are figured.

Paleontologic units.—In a sedimentary series given kinds of rock may be repeated many times. A limestone of a certain lithologic character may appear at the base, another in the center, and still another at the top. If it were not for the fossils it might be difficult to tell whether any particular limestone is the one in the middle or at the top or the bottom. If, however, a given fossil is known to characterize one of the beds and not the others, identification by its aid is easy. A sedimentary series may thus be divided not only into time units and into lithologic units or formations, but also into paleontologic units or biologic zones, each characterized by the presence of a given fossil or a set of fossils.

A paleontologic unit, like a time unit, is not characterized by any particular kind of rock. The shells of the same kind of animals may be accumulated in clay as well as in limestone. The clay and the limestone are parts of the same time unit and the same biologic zone but they belong to different lithologic units or formations. Again, certain animals may be living at a given time and may be accumulated in connection with a deposit of sand. If the sea floor is sinking, the same kind of sand may continue to be deposited (the zone of deposition constantly shifting), long after the race of animals has died out and has given place to other races. The sand is all a part of the same formation, but it is not a part of the same biologic zone nor of the same time unit.

GEOLOGY OF THE COASTAL PLAIN.

GENERAL FEATURES.

The materials exposed on the Coastal Plain of Texas and encountered in the wells drilled in the region are members of a sedimentary series, the deposition of which was at times interrupted by land epochs and periods of erosion, during which sedimentation ceased. Such times of erosion are indicated by gaps in the series, spoken of as unconformities.

Originally the beds composing this series were nearly horizontal. Since their formation, however, the region has been gradually elevated and the entire series slightly tilted toward the Gulf. Since their elevation, these beds have been subjected to erosion, those having the highest altitude and the longest period of exposure having suffered the most. The result is that the surface of the Coastal Plain no longer coincides with the surface of the uppermost rock layer, but bevels across the gently inclined layers at a small angle. Consequently, in passing from place to place different rock sheets or formations are exposed to view, the lowermost formation being exposed at the greatest distance from the coast, and the uppermost formation at the coast. Traveling from the coast toward the interior, the geologist may inspect the entire series just as he could by descending a shaft sunk to the bottom of the series at the coast. By determining the sequence in his cross-country travels, he can predict very accurately the sequence and the character of the materials that would be encountered in sinking such a shaft or well.

STRATIGRAPHY OF THE COASTAL PLAIN IN EASTERN TEXAS.

ROCK SYSTEMS REPRESENTED.

In the stratigraphy of the Coastal Plain in eastern Texas the Carboniferous, Cretaceous, Tertiary, and Quaternary systems are represented. These different systems comprise two structural divisions. The Carboniferous rocks, which make up one structural unit, constitute the basement upon which the Cretaceous and younger rocks have been deposited. The Cretaceous, Tertiary, and Quaternary rocks, which make up the other structural unit, and which constitute the outcropping formations of the Coastal Plain, lie unconformably upon the Carboniferous rocks and have a general southeast dip of 1 to 200 feet to the mile.

CARBONIFEROUS ROCKS.

The Carboniferous rocks are not exposed and have been reached by no drill holes within the limits of the region described in this paper. Their presence beneath it is inferred from their exposure farther west where they have a dip to the northwest, and from their occurrence in drill holes in the nearer Cretaceous area.

CRETACEOUS ROCKS.

The Cretaceous rocks, consisting for the most part of chalk, limestone, and marls, underlie the entire Coastal Plain. Their water-bearing beds, however, are too deeply embedded beneath nearly all the counties with which this report deals to make them available as sources of artesian supplies, and therefore they have little economic interest in the present connection.

That these beds occur beneath the later rocks is proved by drill holes that have reached them and by the existence of certain inliers (isolated bodies of rock lying at a distance from the main body and surrounded on all sides by rocks of later age) within the area of the post-Cretaceous sediments. At least three Cretaceous inliers are known to occur in the area—the Steen Dome and Brooks Dome in Smith County, and the Anderson Dome in Anderson County. Where these domes occur, they introduce complications into the artesian conditions.

TERTIARY AND QUATERNARY ROCKS.

Resting on the Cretaceous rocks are the Tertiary and Quaternary sediments, which constitute the exposed rocks and supply the water to artesian and other deep wells. The sequence of the rocks is shown in the following table:

Cenozoic deposits of the Texas Coastal Plain.

System.	Series.	Formation.	Thickness.	Lithology and characteristic fossils.	
			Feet.		
Quaternary.	Recent.		0-50	Fluviatile deposits, consisting of brown, red, or black sandy clay or silt of the low, overflow terraces of the streams; also present flood-plain materials, including sand and gravel bars. Recent buffalo bones, etc. Seaward, these fluviatile deposits grade into interstream deposits consisting of yellow and blue clays and yellow wave-formed sand, sand and shell beaches, bars, and barriers, carrying *Rangia cuneata* and other fossils.	
	Pleistocene.	Beaumont clay.	800 max.	Blue, calcareous clay, with numerous lime concretions about 1 inch through. Lenses of sand and sandy clay. The clays carry *Rangia cuneata*, etc.; embedded logs are common.	Farther inland the Lissie gravel and Beaumont clay are represented along the stream valleys by the lowest and the middle of the three Pleistocene terraces.
		Lissie gravel.	Thin to 900	Gravels and coarse sands, with some small lenses and pockets of red clay in places; limy clays, gravels, and limy conglomerates or "adobe" in others. The fossils include *Equus semiplicatus*, Megalonyx, etc.	
		—Unconformity—			
		Highest Pleistocene terrace (farther inland).	0-50	Fluviatile deposits consisting of gravels of granitic origin in and adjacent to certain drainage areas; flints, limestone débris, and limy conglomerates in others; ferruginous sands and silts, with fragments of iron ore, in still others. In the stream valleys these materials appear as terraces lying 200 to 225 feet above the level of the present stream channels, and grading laterally into an interstream or upland phase veneering the uplands with a sheet of gravel where the Yegua and Jackson formations constitute the country rock, but thinning and disappearing south of the Yegua-Catahoula or the Jackson-Catahoula boundary. No fossils.	
		—Unconformity—			

Cenozoic deposits of the Texas Coastal Plain—Continued.

System.	Series.	Formation.	Thickness.	Lithology and characteristic fossils.
			Feet.	
Tertiary.	Pliocene.	Uvalde formation (late Pliocene).	0–100	Fluviatile deposits, consisting of flint gravel and limestone débris embedded in a clay matrix. In the plateau region west of the Coastal Plain the formation appears as the uppermost terrace of the major streams, lying about 350 feet above the levels of the present stream channels. Along the Cretaceous-Tertiary boundary, the terraces grade laterally into an upland gravel deposit, which caps the interstream areas, but thins and disappears a short distance to the east and south.
		—Unconformity—		
	Miocene.	Dewitt formation.[a]	1,250–1,500	Lacustrine and littoral deposits, consisting of cross-bedded, coarse, gray, semi-indurated, highly calcareous sandstones. Lenses of clay in places. Aceratherium and other fossils. East of the Brazos these beds are almost completely overlapped by the Lissie gravel. Seaward, the time equivalent of the Dewitt formation is represented by about 800 feet of marine sands and clays, carrying *Arca carolinensis* and other upper Miocene marine fossils and believed to involve some of the lower Pliocene. These marine deposits do not outcrop and are not a part of the lacustrine Dewitt formation, which also includes some deposits of early Pliocene age.
		Fleming clay.[b]	200–500	Palustrine deposits, consisting of gray, white, and bluish-white, bedded, calcareous clays, with numerous small concretions of lime and some lenses of sand.
		—Unconformity—		
	Oligocene.	Catahoula sandstone.[c]	500–800	Littoral deposits, consisting of hard, blue, semiquartzitic, noncalcareous sandstones, with interbedded lenticular masses of green clays.
	Eocene.	Jackson formation.[c]	0–250	Marine deposits, consisting of calcareous blue clays, with large limestone concretions. Carry *Levifusus branneri* and other Eocene forms.
		Claiborne group. Yegua formation.	375–750	Palustrine deposits, consisting of green clays with concretions of selenite; in places, lenses of sand and lignite.
		Claiborne group. Cook Mountain formation.	400	Palustrine and marine deposits, consisting of lenticular masses of yellow sand and clay; in places, lenses of green calcareous, glauconitic, fossiliferous marl. Beds of limonite and lignite. Some of the clays carry fossiliferous calcareous concretions. Formation as a whole is decidedly ferruginous. Fossils: *Ostrea sellæformis, Ostrea divaricata, Anomia ephippioides,* and others.
		Claiborne group. Mount Selman formation.	350	Palustrine and marine deposits, consisting of red, ferruginous, indurated, and probably altered greensand, with casts of shells, lenses of lignite and clay, beds and concretions of limonite. The formation as a whole is conspicuously ferruginous. Carries casts of *Venericardia planicosta.*

[a] Studies made after the manuscript of this report was prepared seem to indicate that what is here called the Dewitt formation is represented along the Sabine by the beds described as the Fleming clay.

[b] As paleontologic studies made after the manuscript of this report was prepared show that deposits considered part of the Fleming clay are not older than Miocene, this formation is referred to the Miocene. (See subsequent list of fossils.) A discrepancy thus exists between the text of the report and the legend of Pl. I, which had already been printed.

[c] Studies made by the author since writing this report seem to indicate that the Catahoula sandstone as here described is not a stratigraphic unit but comprises two formations of similar lithologic character; the one at the base being of Jackson age, whereas the upper sandstone is of Oligocene age.

Cenozoic deposits of the Texas Coastal Plain—Continued.

System.	Series.	Formation.	Thickness.	Lithology and characteristic fossils.
			Feet.	
Tertiary.	Eocene.	Wilcox formation.	800–1,100	Palustrine, marine, and littoral deposits. The littoral deposits comprise the Queen City sand member, at the top of the formation, consisting of 50 to 200 feet of white, porous, loose, water-bearing sands, with some interstratified clays. The palustrine deposits consist of lenticular masses of sand, clay, and lignite, carrying large, especially characteristic concretions (20 to 30 feet in diameter) of hard flintlike sandstone; the palustrine clays are leaf bearing, and in places carry teeth of *Crocodylus grypus*. The marine deposits consist of calcareous, glauconitic, fossiliferous marls, alternating with beds of sand, clay, and lignite; they are exposed only on Sabine River. Characteristic fossils of the marine phase are *Kellia prima*, *Natica aperta*, and *Pleurotoma silicata*.
		Midway formation.	250–500	Marine deposits, consisting of black and blue clays with interbedded strata of limestone and some lenses of sand, which are somewhat rare north of the Brazos. *Plejona limopsis*, *Enclimatoceras ulrichi*, and other fossils.

In the descriptions of the several formations, the symbols used in the several synonymic tables have the following meanings: =Equal in every respect; ≡equal in a general way; <less than; >greater than.

TERTIARY SYSTEM.

EOCENE SERIES.

MIDWAY FORMATION.

NAME AND CORRELATION.

The formation here called the Midway takes its name from Midway Landing,[1] on the west side of Alabama River in Wilcox County, Ala., where it is exposed. The formation extends from Georgia on the east to Texas on the west. Smith and Johnson originally (1887) used the term Midway in describing the beds which represent the lowermost part of what is here termed the Midway formation.

In 1889 Penrose described the formation in Texas under the name "Wills Point or Basal clays," from the exposure at Wills Point, in Van Zandt County.

In 1892 Harris pointed out the fact that the calcareous beds lying above the Cretaceous and below the Wilcox in Alabama extend eastward into Georgia and westward into Texas and retain essentially throughout these States the same lithologic and paleontologic character. This stratigraphic division, which is the one recognized in this report, he called the Midway stage.

[1] Harris, G. D., The Tertiary geology of southern Arkansas: Ann. Rept. Geol. Survey Arkansas, vol. 2, 1894, pp. 8, 9, 22; The Midway stage: Bull. Am. Paleontology, vol. 1, 1896, pp. 11–13.

The formation in Arkansas and Louisiana has been described by Harris, in Mississippi by Crider, in Alabama by Smith, and in Georgia by Harris.

Beds now recognized as belonging to the Midway have been referred to and described as—

<*Eolignitic,* Heilprin, Angelo, Notes on the Tertiary geology of the southern United States: Proc. Acad. Nat. Sci. Philadelphia, vol. 33, 1881, p. 159.

>*Black Bluff* division of the Lignitic in Alabama (representing the medial portion of the present Midway). Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama rivers: Bull. U. S. Geol. Survey No. 43, 1887, p. 18.

>*Midway* division of the Lignitic in Alabama (representing the lower portion of the Midway as here recognized). Idem, p. 18.

>*Naheola* division of the Lignitic in Alabama (representing the upper portion of the Midway as here recognized). Idem, p. 18.

<*Lignitic* in Alabama (the present Midway constitutes the lower portion). Idem, pp. 18, 38–63.

>*Matthews Landing* division of the Lignitic in Alabama (representing the upper portion of the Midway as now recognized). Idem, pp. 18, 57–60; and Smith, E. A., and Johnson, L. C., Report on the geology of the Coastal Plain of Alabama: Geol. Survey Alabama, 1894, pp. 27, 181–185.

=*Basal* or *Wills Point clays* in Texas (representing the equivalent of the Midway as here recognized). Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiaries of Texas from Red River to the Rio Grande: First Ann. Rept. Geol. Survey Texas, 1890, p. 19.

>*Clayton* in Alabama (corresponding to the lower portion of the present Midway). Langdon, D. W., Variations in the Cretaceous and Tertiary strata of Alabama: Bull. Geol. Soc. America, vol. 2, 1891, p. 594.

=*Basal* or *Wills Point clays* in Texas (equivalent of the Midway as here recognized). Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass, on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 47–50.

=*Midway* in Arkansas (equivalent of the Midway as here recognized). Harris, G. D., The Tertiary geology of southern Arkansas: Ann. Rept. Arkansas Geol. Survey, vol. 2, 1892, pp. 8, 9, 22; The Midway stage: Bull. Am. Paleontology, vol. 1, 1896, pp. 11–13, 36–37.

=*Oak Hill-Pine Barren group* in Alabama (representing the exact equivalent of the Midway as here recognized). Smith, E. A., Johnson, L. C., and Langdon, D. W., jr., Report on the geology of the Coastal Plain of Alabama: Geol. Survey Alabama, 1894, p. 188.

>*Sucarnochee* or *Black Bluff* division of the Lignitic in Alabama (representing the medial portion of the Midway as here recognized). Idem, p. 186.

>*Clayton* (*Midway*) in Alabama (representing the lower portion of the Midway as here recognized). Idem, pp. 192 et seq.

=*Basal beds* or *Wills Point clays* in Texas (representing the Midway as here recognized). Kennedy, William, The Eocene Tertiary east of the Brazos River: Proc. Acad. Sci. Philadelphia, 1895, pp. 144–149.

≡*Myrick formation* in Texas (including in a general way the Midway and perhaps portions of the Wilcox). Vaughan, T. W., Uvalde folio (No. 64), Geol. Atlas U. S., U. S. Geol. Survey, 1900, p. 2.

=*Lytton formation* in Texas (equivalent of the Midway as here recognized). Hill, R. T., and Vaughan, T. W., Austin folio (No. 76), Geol. Atlas U. S., U. S. Geol. Survey, 1902, p. 6.

=*Midway group* in Mississippi (subdivided into a lower formation, the *Clayton limestone*, and an upper formation, the *Porters Creek clay;* representing the equivalent of the Midway as here recognized). Crider, A. F., Geology and mineral resources of Mississippi: Bull. U. S. Geol. Survey No. 283, 1906, pp. 22–24.

=*Midway group* in Alabama (consisting of a lower formation, the Clayton limestone, a medial formation, the Sucarnochee clay, and an upper formation, the Naheola or "Matthews Landing" formation; representing the equivalent of the Midway as here recognized). Smith, E. A., The underground water resources of Alabama: Geol. Survey Alabama, 1907, pp. 5, 15.

OCCURRENCE AND CHARACTER.

The Midway is the lowermost of the Tertiary formations in the Coastal Plain of Texas. It lies unconformably above the Cretaceous and conformably below the Wilcox formation.

The formation consists of a series of clays and limestones of marine origin. At the base are usually found bluish micaceous clays or clayey sands, containing some light-yellowish fossiliferous limestone layers of marine origin. These are succeeded by sandy ledges, on top of which generally rest black selenitic clays. In Texas the formation is from 250 to 500 feet thick and dips from 1° to 5° SE.

The geographic location of the outcrop of the Midway formation in the area is shown on the map (Pl. I). The outcrop constitutes the eastern marginal prairies and occupies a narrow belt extending approximately north and south in Robertson, Falls, Limestone, Freestone, Navarro, Henderson, Kaufman, and Van Zandt counties. Much of the exposure is obscured by materials of later age.

The impervious clay, which is the preponderating material in the composition of the Midway, makes the formation a very poor water carrier. It serves, however, as a confining sheet for the waters of the overlying porous sands of the Wilcox formation and constitutes an important datum plane to guide the well driller.

RELATIONS TO ADJACENT FORMATIONS.

The structural relations of the Midway formation to the underlying Cretaceous deposits and to the overlying Wilcox formation are indicated in the geologic sections. (Pl. I, in pocket.)

Owing to the absence of good exposures it has not thus far been possible to recognize a structural unconformity between these beds and the underlying Cretaceous deposits. The only satisfactory section showing the relation to the underlying terranes is found on the Brazos, 1½ miles above the Milam County line, and here the Midway apparently rests conformably upon the Cretaceous. But in Mississippi,[1] in Alabama,[1] in Arkansas,[1] and on Frio River in Texas,[2] where the

[1] Harris, G. D., The Midway stage: Bull. Am. Paleontology, vol. 1, 1896, pp. 38, 39.

[2] Vaughan, T. W., Geological reconnaissance in the Rio Grande coal fields of Texas: Bull. U. S. Geol. Survey No. 164, 1900, p. 36.

Tertiary-Cretaceous contact is exposed, an unconformity is evident, proving the intervention of a land epoch between the Cretaceous and the Tertiary deposition, and it may be safely inferred that similar conditions exist in the east Texas area.

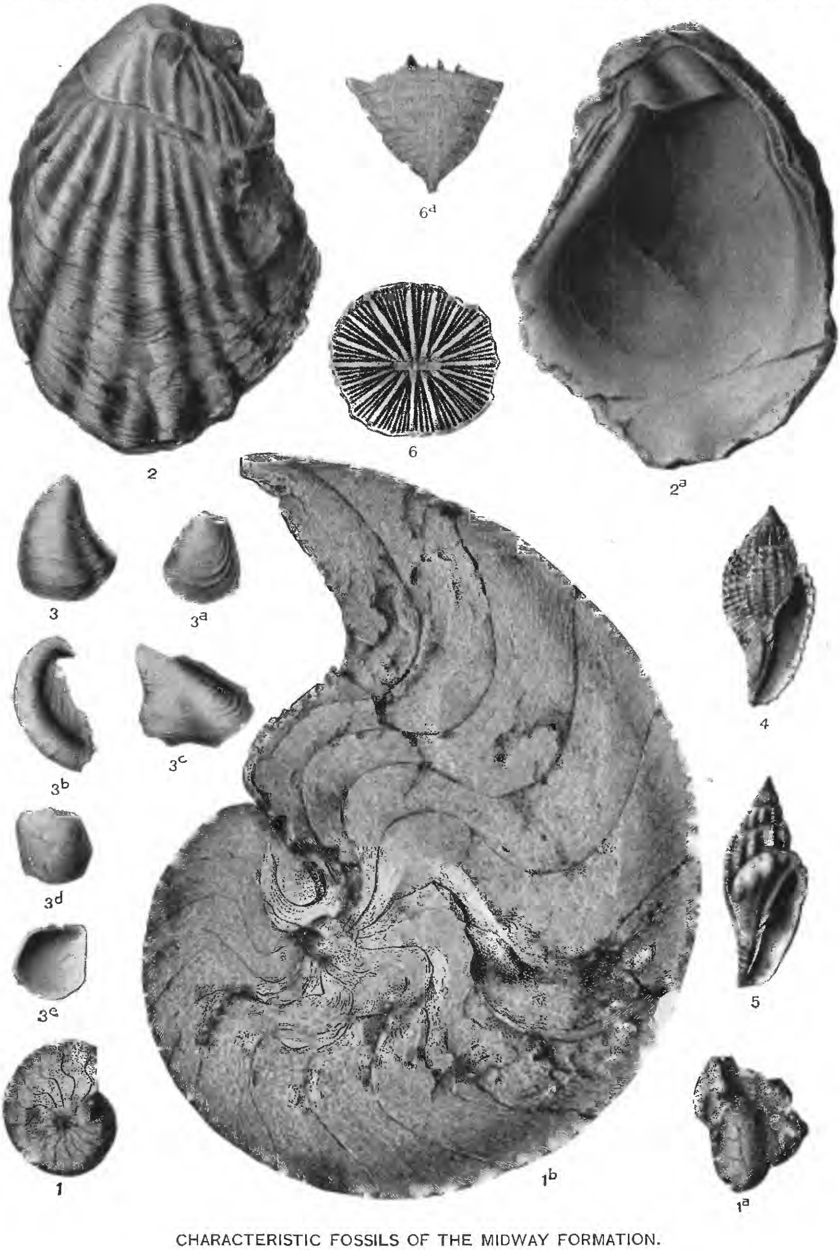
In the region of the Brazos no sharp lithologic differentiation exists between the clays of the Midway and the underlying Cretaceous marls, and the two can be discriminated only by the aid of fossils. The paleontologic break, however, is very marked.

PALEONTOLOGY.

In Texas the Midway is characterized by the presence of *Enclimatoceras ulrichi* White, *Ostrea pulaskensis* Harris, *Cucullæa macrodonta* Whitfield, *Plejona limopsis* (Conrad), *Pseudoliva unicarinata* Aldrich, and other fossils. (See Pl. III.) *Plejona limopsis* has not thus far been found in the Midway east of the Brazos, but has been found in some material taken from a well at Elgin, in Bastrop County.

Fossils were found (1) at Blue Shoals Bluff, (2) at Black Bluff, (3) half a mile up Salt Branch of Little Brazos River, (4) at Smileys Bluff, (5) 5 miles east of Elmo, (6) at Cribbs League Bluff, (7) at Tehuacana, (8) at Josiah Hogan League Bluff, (9) near Tehuacana (10) 4 miles northeast of Kemp, (11) 1 mile up Salt Branch of Little Brazos River, (12) near Kemp, (13) 5 miles northeast of Kemp, (14) near Elmo, (15) at Horn Hill, (16) on Rocky Cedar Creek near Elmo, (17) and on Salt Branch on Dennis Herald survey. A detailed list, with references to the above numbers, follows:

Enclimatoceras ulrichi White, 1, 2, 3.
Pleurotoma (Pleurotomella?) anacona Harris, 4, 5.
P. (Surcula) ostrarupis Harris, 4.
Plejona rugata (Conrad), 2, 6.
P. precursor (Dall), 4.
P. sp., 7.
Fusus ostrarupis Harris, 4, 6.
Pseudoliva ostrarupis Harris, 4.
P. ostrarupis var. pauper Harris, 4.
Calyptraphorus velatus var. compressus (Aldrich), 1, 2, 6, 8.
Aporrhais gracilis Aldrich, 8.
Aporrhais sp., 7, 8.
Cerithium penrosei Harris, 4.
C. whitfieldi Heilprin, 4.
Turritella alabamiensis Whitfield, 1, 8, 9, 10.
T. mortoni Conrad var., 2, 6, 7.
T. mortoni Conrad, 6.
T. nerinexa Harris, 2.
T. humerosa Conrad, 9.
Mesalia pumila var. wilcoxiana Harris, 11.
M. var. hardemanensis Harris, 12.
M. alabamiensis (Whitfield), 10.
Nucula magnifica Conrad, 2, 6.
Leda milamensis Harris, 4.
Yoldia eborea (Conrad), 1, 2, 6, 8.
Cucullæa macrodonta Whitfield, 1, 2, 6, 8. 13, 14.
C. saffordi Gabb, 10.
Ostrea crenulimarginata Gabb, jr., 4, 9, 15.
O. pulaskensis Harris, 1, 6, 8, 16.
Modiola saffordi Gabb, jr., 15.
Crassatellites gabbi (Safford), 1, 2, 5, 6, 8.
Venericardia planicosta Lamarck, 5, 7, 15, 17.
V. alticostata Conrad, 5, 17.
V. alticostata Conrad var., 1, 2, 6, 8.
Cytherea ripleyana Gabb, 10.
C. sp., 7, 10.



CHARACTERISTIC FOSSILS OF THE MIDWAY FORMATION.

1, 1a, 1b. Enclimatoceras ulrichi White.
2, 2a. Ostrea crenulimarginata Gabb.
3, 3a, 3b, 3c, 3d, 3e. Ostrea pulaskensis Harris.
4. Plejona limopsis (Conrad).
5. Plejona rugatus (Conrad).
6, 6a. Flabellum conoideum Vaughan.

DETAILED SECTIONS.

Brazos River section.—The beds belonging to the Midway formation are typically exposed along Brazos River (see Pl. I, in pocket) from 1½ miles by river north of the Milam–Falls county line to 2 miles north of the mouth of Pond Creek in Milam County, a total distance of 5¾ miles by river or about 4½ miles by linear measure across the outcrop at right angles to the strike.

The bluff highest upstream that shows these beds and also their contact with the underlying Cretaceous is about 1½ miles north of the Milam–Falls county line:[1]

Section exposed in bluff on west bank of Brazos River, southeast line of the Josiah Hogan League, Falls County, Tex.

	Feet.
Quaternary:	
River alluvium	4
Gravel	1
Unconformity.	
Eocene:	
Midway formation:	
Blue clay and sand breaking into nodules and conchoidal pieces, weathering into a grayish-yellow clay and containing fossils as follows: *Calyptraphorus velatus* var. *compressus* Ald.; *Aporrhais gracilis* Aldrich; *Turritella alabamiensis* Whitf.; *Yoldia eborea* (Con.); *Cucullæa macrodonta* Whitf.; *Ostrea pulaskensis* Harris; *Crassatellites gabbi* (Safford)	5
Transitional blue clay	1
Cretaceous: Massive blue clay with Baculites and other Cretaceous fossils	14
	25

One-half mile below the Cretaceous-Tertiary contact just described a bluff at Blue Shoals shows the following section:[2]

Section about 1 mile above the Milam County line, west bank of Brazos River, Falls County, Tex.

	Feet.
Pleistocene: Brown sand and river alluvium	10
Unconformity.	
Eocene:	
Midway formation:	
Blue indurated clay with concretions of limestone, containing the following fossils: *Enclimatoceras ulrichi* White; *Calyptraphorus velatus* Con. var. *compressus* Ald.; *Turritella alabamiensis* Whitf.; *Yoldia eborea* (Con.); *Cucullæa macrodonta* Whitf., var.; *Ostrea pulaskensis* Harris; *Crassatellites gabbi* (Safford); *Venericardia alticostata* Con. var.	5
Laminated blue, almost black fossiliferous clay	4
	19

[1] Kennedy, William, The Eocene Tertiary east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, p. 145. The fossils were determined by Harris; the list has been partly revised.

[2] Idem, p. 148. The fossils were determined by Harris; the list has been partly revised.

At the very northern limit of Milam County, 1 mile below the preceding section, on the west bank of the river, is Black, or Milam Bluff, about one-third mile long and 40 feet high. Its lower part is composed of very dark, almost black clays containing shell fragments and running into lighter yellowish and greenish clays toward the top. The upper part contains highly calcareous indurated strata showing a nodular structure and containing many fossils. The lower part of the bluff is not so calcareous as the upper part.

The beds dip southeast 276 feet to the mile. From them have been collected[1] *Enclimatoceras ulrichi* White; *Plejona rugata* (Con.); *Calyptraphorus velatus* Con. var. *compressus* Ald.; *Turritella mortoni* Con. var.; *T. nerinexa* Harris; *Nucula magnifica* Con.; *Yoldia eborea* (Con.); *Cucullæa macrodonta* Whitf.; *Crassatellites gabbi* (Safford); and *Venericardia alticostata* Con. var.

About three-fourths mile below Milam or Black Bluff on the west bank of the river, on the C. Cribbs League of Milam County in Cribbs League Bluff, the following section is exposed:[2]

Section exposed at Cribbs League Bluff, Milam County, Tex.

	Feet.
Quaternary: Surface soil, brown sand and gravel	2
Eocene:	
Midway formation:	
Yellow clay	4
Ledge of fossiliferous siliceous limestone	2
Yellow clay; similar to No. 2	5
Ledge of fossiliferous siliceous limestone	2
Dark-blue laminated jointed clay	30–35
	45–50

The fossils collected at this locality include *Plejona rugata* (Con.), *Fusus ostrarupis* Harris, *Calyptraphorus velatus* Ald. var. *compressus*, *Turritella mortoni* Con., *Yoldia eborea* (Con.), *Cucullæa macrodonta* Whitf., *Ostrea pulaskensis* Harris, *Venericardia alticostata* Con. var., and *Crassatellites gabbi* (Safford).

Three miles by river below Cribbs League Bluff and 2 miles above the mouth of Pond Creek, on the west side of Brazos River and on the northeast corner of the Byrum Wickson League of Milam County, is located Oyster Bluff or Smileys Bluff. The beds exposed represent the uppermost portion of the Midway formation and are the equivalent of the Naheola ("Matthews Landing") formation of the Alabama section.[3]

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[1] Harris, G. D., The Midway stage: Bull. Am. Paleontology, vol. 1, 1896, p. 128.

[2] Kennedy, William, The Eocene Tertiary of Texas east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, p. 147. The list of fossils has been partly revised.

[3] Harris, G. D., New and otherwise interesting Tertiary mollusca from Texas: Proc. Acad. Nat. Sci. Philadelphia, 1895, p. 45.

Section exposed at Smileys Bluff, west bank of Brazos River and northeast corner of Byrum Wickson League, Milam County, Tex.

	Feet.
Quaternary:	
River alluvium	4
Conglomerate	2
Coarse conglomerate with bowlders	2±
Eocene:	
Wilcox formation: Thinly stratified, yellowish-gray clay, sand and blue clay, with some rounded concretions of calcareous sandstone	10
Midway formation:	
Blue laminated clay, fossiliferous	4
Thin bed of concretions and hard fossiliferous limestone	1
Thinly laminated gray clay and sand	3
Bluish-gray sand	1
Thinly laminated dark-blue clay and sand	3
Dark-blue laminated fossiliferous sand	2
	32

The fossiliferous beds of the Midway carry *Pleurotoma* (*Pleurotomella*) *anacona* Harris, *P.* (*Surcula*) *ostrarupis* Harris, *Plejona precursor* Dall, *Fusus ostrarupis* Harris, *Pseudoliva ostrarupis* Harris, *Cerithium penrosei* Harris, *C. whitfieldi* Heilprin, *Leda milamensis* Harris, and *L. milamensis* Harris, large var.[1]

The complete section along Brazos River is indicated in the diagram on Plate IV (in pocket).

Falls County.—Along Salt Branch of Little Brazos River on the Dennis Herald Survey in Falls County, limestone of the Midway formation is exposed. One-half mile above the confluence of the two streams specimens of *Enclimatoceras ulrichi* White, *Venericardia planicosta* Lam., and *Venericardia alticostata* Con. var. are found, and a mile above the confluence, *Mesalia pumila* var. *wilcoxiana* (Ald.) occurs.[2]

Limestone County.—At Horn Hill in Limestone County, the Midway formation is exposed and carries *Turritella humerosa* Con., *Ostrea crenulimarginata* Gabb, jr., *Modiola saffordi* Gabb, jr., and *Venericardia planicosta* Lam.

In the vicinity of Tehuacana are exposed limestones of the Midway formation, which are probably the correlative of limestone No. 14 in Smith and Johnson's section near Oak Hill, Wilcox County, Ala.[3] The stratum is probably the same as that exposed at Horn Hill and represents about the medial portion of the Midway formation. The section follows.[1]

[1] Kennedy, William, The Eocene Tertiary of Texas east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, p. 146. The list of fossils has been partly revised.

[2] Harris, G. D., The Midway stage: Bull. Am. Paleontology, vol. 1, 1896, p. 129.

[3] Harris, G. D., The geology of the Mississippi embayment, with special reference to the State of Louisiana: Rept. Geol. Survey Louisiana, 1902, p. 9.

Section of Midway formation near Tehuacana, Limestone County, Tex.

	Feet.
Whitish to grayish-white limestone carrying Plejona sp., *Turritella humerosa* Con., *T. alabamiensis* Whitf., *Venericardia planicosta* Lam., and Cytherea sp	40
Brownish-gray sand changing to brown near base.	
Black shaly clay.	

The brownish-gray sand near the base carries many indefinite fossil remains, among them fairly well preserved imprints of *Turritella mortoni* var. These fossils occur about 45 feet below the base of the limestone. About 70 feet below the base of the limestone, in black shaly clay, the same fauna includes fragments of Nautilus?, Pleurotoma and Aporrhais; and large calcareous concretions are common. *Ostrea crenulimarginata* has been found in the vicinity of Tehuacana. The attitude of the limestone varies considerably; in places it dips 45°; the direction is generally to the south-southeast.[1]

Kaufman County.—Four miles northeast of Kemp the Midway formation is represented by light-gray and yellowish calcareous sandstones yielding *Turritella alabamiensis* Whitf., *Mesalia alabamiensis* (Whitf.), *M. pumila* var. *hardemanensis* (Gabb), *Cucullæa macrodonta* Whitf., and *Cytherea ripleyana* Gabb.

Five miles east of Elmo, on the public road crossing of Rocky Cedar Creek, outcropping limestones of the Midway formation carry [2] *Pleurotoma anacona* Harris, *Cucullæa macrodonta* Whitf., *Ostrea pulaskensis* Harris, *Crassatellites gabbi* (Safford), *Venericardia planicosta* Lam., and *V. alticostata* Con. var.

Van Zandt County.—It was from the exposure of the Midway formation in the vicinity of Wills Point, in Van Zandt County, that Penrose gave it the name "Wills Point clays." The general section exposed in this vicinity, as reported by Kennedy,[3] is as follows:

Section exposed in the region around Wills Point, Tex.

	Feet.
Midway formation:	
Yellowish-brown sand containing calcareous bowlders of sandstone, limestone with thin veins or seams, some nodules of crystalline calcite, and occasional fossil remains	30
Yellow laminated clay with thin partings of yellow sand and some bowlders of siliceous limestone	90
Massive bedded clay, showing no signs of lamination, containing numerous bowlders similar to those of No. 1	30
White limestone containing great quantities of fossil casts, chiefly Turritella (?), *Cardita* (*Venericardia*) *planicosta*, Ostrea (?), and other bivalve shells	8

[1] Harris, G. D., The Midway stage: Bull. Am. Paleontology, vol. 1, 1896, p. 129.
[2] Idem, pp. 129–130.
[3] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, p. 49.

Midway formation—Continued.

Brown sand	2
Limestone similar to the white limestone above	10
Bluish-gray sand	30
Dark-blue laminated and much-jointed clays with thin sandy partings, containing occasional small bivalve shells chiefly, and having a thin pavement of siliceous nodules near its upper surface	62
	262

The beds dip southeast 91 to 276 feet to the mile.

WILCOX FORMATION.

NAME AND CORRELATION.

The formation here considered is called the Wilcox,[1] after Wilcox County in Alabama, where it is characteristically exposed. It was first recognized and described in 1894 by Harris, who gave it the name "Lignitic." The same group of beds was called "Chickasaw" by Dall in 1896, "Sabine" by Veatch in 1906, and Wilcox by Crider in 1906. "Lignitic" is a lithologic and not a geographic name and therefore is not in accord with the rules of geologic nomenclature. "Chickasaw" was originally proposed by Hilgard as an equivalent for the beds he called the "Northern Lignitic," in which he included beds belonging to the Wilcox, Claiborne, and Jackson; Dall used the term later to apply to beds here recognized as Wilcox. "Sabine River beds" was applied by Penrose in 1890 to deposits that included a portion of the Claiborne, and his use of this term would have precedence over Veatch's use of "Sabine." Wilcox is thus the only name to which there are no objections, and it is therefore adopted in this report as the proper designation for this division of the Eocene.

The Wilcox formation occurs in Texas, Arkansas, Louisiana, Mississippi, Alabama,[2] and Georgia.[3]

In his classification of the Tertiary sediments of Mississippi, Hilgard in 1860 recognized at the base of the system a group of beds containing lignite which he called the "Northern Lignitic" and in which he included the Midway formation and the Wilcox formation as here recognized.

In 1881 Heilprin called attention to the fact that the basal Tertiary deposits in Alabama contained lignite, and he named the deposits that appeared below the Claiborne and above the Cretaceous the "Eolignitic." These beds were the same as those called by Hilgard

[1] Crider, A. F., Geology and mineral resources of Mississippi: Bull. U. S. Geol. Survey No. 283, 1906, pp. 25-28.

[2] Smith, E. A., The underground water resources of Alabama: Geol. Survey Alabama, 1907, pp. 15, 16.

[3] McCallie, S. W., A preliminary report on the underground waters of Georgia: Bull. Geol. Survey Georgia No. 15, 1908, pp. 34, 35.

"Northern Lignitic." Later (1887) Smith and Johnson substituted "Lignitic" for "Eolignitic."

The first authentic account of the Texas representatives of the Wilcox was given in 1890 by Penrose, who described them, in conjunction with what are now called the Mount Selman and Cook Mountain formations, as the "Timber Belt or Sabine River beds." He fixed their stratigraphic position correctly as lower Tertiary overlying the Midway, but made no attempt to correlate them with the various divisions of the Tertiary established by Hilgard in Mississippi in 1860, and by Smith and Johnson in Alabama in 1887.

In 1894, Harris pointed out for the first time that the group of beds that contained lignite in the Coastal Plain region was stratigraphically continuous from Alabama on the east to Texas on the west, and that it was lithologically distinct from the formation below now recognized as Midway, which had been considered heretofore as a part of the lignitiferous group. He, therefore, recognized two units in place of the "Northern Lignitic" of Hilgard and the "Lignitic" of Smith and Johnson. The lowermost he called the Midway and the uppermost the "Lignitic." This classification has been found to be valid, and is the one followed in this report, though the name Wilcox is substituted for "Lignitic," because the latter is not a geographic name.

In 1897, Harris proved that the lower lignitiferous formation in Texas was also paleontologically equivalent to the lithologically and stratigraphically similar group in Alabama and Mississippi.

Beds here considered as constituting the Wilcox formation have been previously referred to as—

<*Northern Lignitic* in Mississippi (included also the Midway). Hilgard, E. W., Report on the geology and agriculture of the State of Mississippi, 1860, pp. 110–123, and map.

<*Lagrange group* (included portions of all the Eocene beds above the Midway). Safford, J. M., On the Cretaceous and superior formations of western Tennessee: Am. Jour. Sci., 2d ser., vol. 37, 1864, pp. 369–370.

<*Lignite formation* in Alabama and Mississippi (included also the underlying Midway as here recognized). Conrad, T. A., Observations on the Eocene lignite formation of the United States: Proc. Acad. Nat. Sci. Philadelphia, vol. 17, 1865.

>*Mansfield group* (included only a portion of the Wilcox as here recognized; referred by Hilgard to the Vicksburg). Hilgard, E. W., Summary of results of a late geological reconnaissance of Louisiana: Am. Jour. Sci., 2d ser., vol. 48, 1869, p. 340.

<*Eolignitic* (included also the Midway). Heilprin, Angelo, Notes on the Tertiary geology of the southern United States: Proc. Acad. Nat. Sci. Philadelphia, 1881, vol. 33, p. 159.

<*Lignitic* in Alabama (included also the Midway). Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama rivers: Bull. U. S. Geol. Survey No. 43, 1887, pp. 38–71.

<*Timber Belt or Sabine River beds* in Texas (included also a portion of the Claiborne). Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiaries of Texas from Red River to the Rio Grande: First Ann. Rept. Geol. Survey Texas, 1890, pp. 22–47.

≡*Lignitic beds* in Texas. Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, p. 50; also, The Eocene Tertiary east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, pp. 134–144.

<*Camden series* in Arkansas (included the fossiliferous Jackson, the Wilcox as here recognized, and a portion of the Cretaceous). Hill, R. T., Neozoic geology of southwestern Arkansas: Rept. Geol. Survey Arkansas, vol. 2, 1888, pp. 48–53.

<*Lower Lignitic* in northern Louisiana. Lerch, Otto, A preliminary report upon the hills of Louisiana: Bull. Louisiana Experiment Station, 1893, pt. 2.

<*Lignitic* in Alabama (included the upper portions of the Midway, but not the lowest portion). Smith, E. A., Johnson, L. C., and Langdon, D. W., jr. Report on the geology of the Coastal Plain of Alabama: Geol. Survey Alabama, 1894.

=*Lignitic* (represents the exact equivalent of the Wilcox as here recognized). Harris, G. D., On the geological position of the Eocene deposits of Maryland and Virginia: Am. Jour. Sci., 3d ser., vol. 47, 1894, pp. 391–394; also, A preliminary report on the geology of Louisiana: Rept. Geol. Survey Louisiana, 1899, pp. 64–73; also, The geology of the Mississippi embayment with special reference to the State of Louisiana: Rept. Geol. Survey Louisiana, 1902, pp. 11–17; also, The Tertiary geology of southern Arkansas: Second Ann. Rept. Arkansas Geol. Survey, 1894, pp. 55 et seq.; also, The Lignitic stage: Bull. Am. Paleontology, vol. 3, No. 9, 1897, p. 202.

=*Chickasawan stage* (included the same division of the Eocene here called Wilcox). Dall, W. H., A table of North American Tertiary horizons correlated with one another and with those of western Europe, with annotations: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1898, pp. 334, 344–345.

=*Sabine formation* in Texas and Louisiana (identical with the beds here called Wilcox). Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, pp. 34 et seq.

=*Wilcox formation* (identical with the beds given the same name in this report). Crider, A. F., Geology and mineral resources of Mississippi: Bull. U. S. Geol. Survey No. 283, 1906, pp. 25–28; Smith, E. A., The underground water resources of Alabama: Geol. Survey Alabama, 1907, p. 5.

OCCURRENCE AND CHARACTER.

The conformable series of strata constituting the Wilcox formation lies stratigraphically above the Midway formation and below the Mount Selman formation, the latter being the basal formation of the Claiborne group in this region.

The exposed part of the formation as well as the part which lies beneath the outcrop of the Claiborne group consists almost entirely of deposits of shallow-water origin, including lenticular beds of sand, large leaf-bearing calcareous sandstone concretions, sandstones, clays, sandy clays, lignites, and cross-bedded sands and sandstones. Only along Sabine River, in Sabine County, so far as is at present known, do fossiliferous beds of marine origin outcrop. In the deeper embedded parts, however, it is very probable that the formation consists wholly of marine deposits, in which are included beds of fossiliferous glauconitic marl.

The shallow-water origin of the exposed parts of the Wilcox is proved not only by the character of the formation which comprises deposits, such as the lignites and the cross-bedded sands, but also by the fossil leaves and plant remains, which occur in it at a great number of places.

The Wilcox is from 800 to 1,000 feet in thickness, making it probable that it was laid down on a steadily subsiding sea floor.

The areas of outcrop of the Wilcox lie east and south of the Midway exposures and include large portions of Robertson, Limestone, Leon, Freestone, Navarro, Anderson, Henderson, Van Zandt, Smith, Gregg, Harrison, Rusk, Shelby, Panola, and Sabine counties. Where not covered by deposits of later age, the Wilcox almost invariably gives rise to sandy soils, easily eroded. The sandy outcrop constitutes a portion of the east Texas timber belt.

Economically, the Wilcox is of great importance. The soils derived from the constituent sands and sandstones favor the growth of trees suitable for the manufacture of lumber or for fuel. The thicker lenses of lignite are mined at numerous places. Some of the indurated sands and sandstones are locally used for building stone. In a great many places beds of clay suitable for the manufacture of building brick, paving brick, and pottery may be found. And, finally, the numerous sands and sandstones imbibe a large quantity of water which may be drawn on in wells, making the Wilcox one of the most important water bearers of the Coastal Plain. The wells at Hearne, Calvert, Mineola, and Marshall derive their water from the Wilcox.

PALEONTOLOGY.

Fossils were found in the Wilcox at (1) Port Caddo Landing, on Cypress Bayou, (2) Pendleton, (3) Sabinetown, and (4) Rockdale. In the following list all the species from Port Caddo Landing were collected by Vaughan and identified by Knowlton.[1] Fossils marked with an asterisk were collected by Deussen and determined by Vaughan, except *Crocodylus grypus*, which was determined by Gidley. All the other fossils in the list were reported by Harris.[2]

[1] Knowlton, F. H., Am. Geologist, vol. 16, 1895, p. 308.
[2] Rept. Geol. Survey Louisiana, 1899, pp. 299–309.

Salix tabellaris? Lx., 1.
Magnolia laurifolia? Lx., 1.
M. ovalis Lx., 1.
Juglans appressa Lx., 1.
J.? n. sp., 1.
Ficus schimperi Lx., 1.
F. n. sp., 1.
F. n. sp., 1.
Cinnamomum affine Lx., 1.
C. mississippiense Lx., 1.
Laurus or Litsæa n. sp., 1.
Pleurotoma silicata Ald., 2.
P. veatchi Harris, 2.
P. huppertzi var. Harris, 3.
Cancellaria quercollis var. greggi Harris, 2.
Buccinanops ellipticum Harris, 2, 3.
B. altile Con., 3.
Pseudoliva vetusta var. Harris, 2.
P. vetusta (Con.), 3.
Plejona petrosa (Con.) var., 2, 3.
Levifusus indentus Harris, 2.
L. supraplanus Harris, 2.
L. pagoda Harris, 2.
L. trabeatus var.? Harris, 2, 3.
Mazzalina plena (Ald.), 2.
Tritonidea pachecoi Harris, 2.
Nassa exilis Con., 2.
Calyptraphorus trinodiferus Con., 2, 3.
Cassidaria brevidentata Ald. var., 2.
Fusoficula juvenis Harris, 3.
Turritella mortoni Con., 2.
T. præcincta Con., 2.
Natica eminula Con., 2, 3.
N. aperta Whitf., 2.
N. alabamiensis Whitf., 2.
Sigaretus declivus Con., 3.
Solarium bellense Harris, 2.
Leda corpulentoides Ald., var., 2.
L. aldrichiana var. Harris, 3.
Barbatia cuculloides Con. var , 2.
Modiola alabamiensis Ald., 2.
*Venericardia planicosta Lam., 3
*V. planicosta var. hornii Gabb, 3.
Lucina ozarkana Harris, 3.
Kellia prima Ald., 3.
Cardium tuomeyi Ald., 3.
Mactra bistriata Harris, 3.
Corbula alabamiensis Lea var., 3.
Ceronia sp., 2, 3.
Pholas alatoideus Ald., 3.
*Crocodylus grypus Cope, 4.

DETAILED SECTIONS.

Brazos River section.—All the beds exposed in the bluffs along Brazos River between Smileys Bluff in northern Milam County and Valley Junction in northern Robertson County are referred to the Wilcox formation.

The section observed at Smileys Bluff, 2 miles above the mouth of Pond Creek, has already been given. (See p. 35.) In this bluff the lower beds, which carry fossils characteristic of the Midway, underlie 10 feet of nonfossiliferous yellowish-gray clay, sand, and blue clay (containing concretions of calcareous sandstone), which probably represents the basal portion of the Wilcox.

About 1½ miles below the mouth of Pond Creek, on the Milam County side of Brazos River, a sand belonging to the Wilcox formation is capped by a deposit of Pleistocene gravel containing black specks and rendered plastic by a white clay. Large calcareous concretions (locally called "kettle bottoms"), 1 to 8 feet in diameter, are embedded in the sand or have been loosened from the bluff and piled up in the bed of the river, obstructing its course and forming rapids.[1]

Three miles below the mouth of Pond Creek, a sand similar to that just described is seen close to the water's edge and is overlain by

[1] Dumble, E. T., Report on the brown coal and lignite of Texas; character, formation, occurrence, and fuel uses: Geol. Survey Texas, 1892, p. 135.

gray clays carrying beds of lignite.[1] Four miles below Pond Creek the clays dip beneath the water and are overlain by gray sands carrying calcareous concretions similar to those above described.

Eight miles by river below this point, at a location known as the Cannon Ball Shoals, a bluff overlooking the river is made up of beds of gray sand 5 to 15 feet in thickness and thin calcareous sandstones one-half to 1 foot in thickness.[2]

One-half mile below Cannon Ball Shoals, at Black Shoals,[3] not far below Black Bridge on the Calvert-Cameron road, the section is as follows:

Section exposed at Black Shoals on Brazos River.

	Feet.
Pleistocene:	
Brown loam	10
Gravel	1
Unconformity.	
Wilcox formation:	
Gray sand	5
Black or dark-blue clay, jointed and broken into cuboidal blocks	1
Broken seams of lignite, running out 300 feet from foot of shoals	½
Black clay similar to No. 4	5
Sandstone	1–6
Black clay	4
Gray calcareous sandstone	½±
Gray sand, laminated, and containing thin layers of dark clay	10
Bed of rounded, waterworn bowlders, containing streaks of calcite	1
Gray sand with pyrites	5

The Black Shoals are about 400 feet long, and the beds dip southeast from 91 to 276 feet to the mile.[4]

One mile below Black Shoals a bluff on the west side of the river in Milam County exposes the following section:[5]

Section exposed in bluff on Brazos River, in Milam County, Tex., 1 mile below Black Shoals.

	Feet.
Quaternary:	
Brown soil	1
Yellow sandy clay	12
Wilcox formation:	
Pale-blue sandy clay, with limy concretions	8
Lignite	3
Iron ore	1
Dark-blue clay	2
Lignite.	

[1] Dumble, E. T., loc. cit.

[2] Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol, Survey Texas, 1893, p. 71.

[3] Kennedy (loc. cit.) calls these the "Bee Shoals," but on the War Department map of Brazos River. survey of 1900, they are labeled "Black Shoals," and this is probably correct.

[4] Kennedy, William, op. cit., p. 71.

[5] Idem, p. 70.

The lignite at the bottom of the section is apparently the same as that in the Black Shoals section.

One-half mile below the bluff last described are the Herndon Shoals, which extend down the river for a mile. Calvert Bluff, which overlooks the shoals, is on the Jesse Webb League in Robertson County. The strata composing it have been slightly disturbed, the crest of a gentle anticline being visible at Herndon Landing.[1] The section follows:

Section of Calvert Bluff on Jesse Webb League, Robertson County.

	Feet.
Quaternary:	
Brown loamy clay	4
Light-brown sand	7
Brown sand and gravel	1½
Unconformity.	
Wilcox formation:	
Gray sand	3
Lignite	12
Dark-blue clay	3
Lignite	3
Dark-blue clay	6
Lignite	3–4
Dark grayish-blue sand	15
Calcareous sandstone	½
Dark-gray sand	2
Lignite, poor quality	½
Dark-gray sand	8
Gray calcareous sandstone	1
Dark bluish-gray sand, with iron pyrites	8
Bowlders of clay ironstone and gray calcareous sandstone, with nodules of iron ore and thin seams of ferruginous sandstones with fossil leaves	2
Gray sandstone	1½
Laminated bluish-gray sand to water line	2

Between Calvert Bluff and the International & Great Northern Railroad bridge, a distance of 14 miles by river, the bluffs expose sand beds with calcareous concretions similar to those described.[2] At the railroad bridge the following section is exposed:

Section exposed on Brazos River at the International & Great Northern Railroad bridge, Robertson County, Tex.

	Feet.
Quaternary: Calcareous light-green and yellow clay with white concretions	15
Unconformity.	
Mount Selman formation (?): Nonfossiliferous greensand marl	6
Wilcox formation (?): Black clay to water line	10

[1] Johnston, L. C., The iron regions of northern Louisiana and eastern Texas: House Ex. Doc., 1st sess., 50th Cong., vol. 26, No. 195, 1889, p. 21.

[2] Dumble, E. T., Report on the brown coal and lignite of Texas; character, formation, occurrence, and fuel uses: Geol. Survey Texas, 1892, p. 135.

The complete section of the Wilcox formation along the Brazos is indicated on Plate IV (in pocket). At no point is there found a marine fossil which would prove the marine origin of any of these beds. On the contrary, fossil leaves indicative of a palustrine origin are found at a number of localities, notably at Calvert Bluff. Doubtless if these beds could be followed down the dip they would be found to grade into marine deposits. How far the palustrine phase persists is a matter for future investigation.

North of the Brazos.—In the region north of the Brazos numerous exposures of the Wilcox formation occur, but these do not differ materially from the sections along the river. All the sections indicate the lenticular nature of the different sands, clays, and lignites which largely make up this formation. No two sections any distance apart reveal the same sequence of strata; at the same horizon in one place will be a sand bed, in another a clay, in still another a lignite. This is, of course, to be expected in a palustrine deposit.

The character of the Wilcox formation in this portion of the Coastal Plain is admirably shown in the section of a well at Mineola in Wood County (pp. 359–360), from which it appears that the formation is not less than 500 feet in thickness in this vicinity.

Northeast Texas.—In northeast Texas, in Cass, Marion, Harrison, Panola, Gregg, Smith, and Upshur counties, the Wilcox formation commonly underlies a red sandstone carrying casts of *Venericardia planicosta.* This sandstone, which appears to be an altered greensand, is referred to the Mount Selman formation of the Claiborne group.

What is provisionally considered to be the uppermost part of the Wilcox formation in this portion of the State consists of littoral deposits of laminated or thinly stratified white and red sands and sandy clays which in places merge into one another but which, so far as known, contain neither lignite nor organic remains. These upper beds, which are from 50 to 200 feet thick, are so distinctive that it is considered desirable to follow the practice of Kennedy [1] and refer to them as the Queen City sand member of the Wilcox formation.

Economically, the Queen City sand member is important. At Marshall, Tex., its sands are used for molding, and they supply many wells with water free from the mineral matter that is a common ingredient elsewhere.

The lower beds of the Wilcox in northeast Texas are similar in all respects to the lower Wilcox deposits on the Brazos. The details of the sections follow:

[1] Kennedy, William, The Eocene Tertiary of Texas east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia for 1895, 1896, p. 135.

Section at Queen City in Cass County.[1]

	Feet.
Quaternary (?): Gravelly iron ore, and broken pieces of nodular iron ore, sandstones, and sand	5
Claiborne group: Laminated iron ore and sand in thin strata	4
Wilcox formation:	
Stratified white and red sand with white sandy clay (Queen City sand member)	65
Brown sand and clay	25
Lignite	1½

In Harrison County, and particularly in the vicinity of Marshall, the same general section is observed.

At Marshall, opposite the depot, in a low erosion bluff about 15 feet high, a red ferruginous sandstone (probably an altered glauconitic sand), which constitutes the country rock, is well exposed. Casts of *Venericardia planicosta* Lamarck, indicating marine origin, may be found in this sandstone.

Beneath the red sandstone, which is referred to the Claiborne group, occurs a red clay, and beneath this a fine-grained white sand consisting almost entirely of particles of quartz, lime not being present in appreciable amount.

Similar sections can be seen in the washes of a small creek crossing the Marshall-Port Caddo road about one-half mile east of the courthouse and in the gullies along the road from the courthouse to the waterworks.

Beneath the beds described are the characteristic sandstones, clays, and lignites of the lower Wilcox.

The following section is exposed on the Marshall-Jefferson road, 3 miles north of Marshall, and about 1 mile south of the waterworks pumping station. The rocks dip 3° N. 20° E.

Section 1 mile south of waterworks pumping station at Marshall, Tex.

	Feet.
Mount Selman formation:	
Red sand with white streaks	10
Yellow and gray shale	3
Wilcox formation: White sand (Queen City sand member), exposed	5
	18

The following section is exposed in the bluff overlooking the Walnut Creek bottom on the Jefferson road, at the waterworks pumping station, about 4 miles north of Marshall.

[1] Dumble, E. T., Kennedy, William, et al., Reports on the iron ore district of east Texas: Second Ann. Rept. Geol. Survey Texas, 1891, p. 72.

Section at the waterworks pumping station, 4 miles north of Marshall, Tex.

	Feet.
Quaternary (?): Brown gravelly sand	5
Claiborne group:	
Laminated iron ore and ferruginous sand	1½
Greenish-yellow altered glauconitic sandstone with casts of *Venericardia planicosta* Lamarck	4
Wilcox formation: Laminated or thinly stratified red and white sands and sandy clays (Queen City sand member)	45

The record of a well (pp. 243–244) shows that in the foregoing section typical sands, clays, and lignites of the Wilcox formation alternate for at least 610 feet beneath the Queen City member.

At Port Caddo Landing on Caddo Lake the Wilcox formation lies beneath an indurated ferruginous sand which probably belongs to the Claiborne group. The upper member consists of the quartz sand characteristic of the upper Wilcox in this portion of the State. The lower members carry fossil leaves that indicate a lower Wilcox horizon. The beds dip slightly to the south. The details follow:

Section at Port Caddo Landing, Harrison County, Tex.[1]

	Feet.
Claiborne group (?):	
Yellow ferruginous sandy clay with streaks of limonite, passing into red sand where it has not been leached by exposure; geodes of limonite inclosing blue marl occur scattered throughout the mass	35
Blue shale with ramifications of limonite stains; grades into overlying bed when under cover, showing that it represents an unweathered phase of that bed.	
Wilcox formation:	
Reddish, nearly pure quartz sands, locally cross-bedded; limonite geodes and fossil wood are common	50
Sands containing water-worn bowlders of clay or of laminated clay and sand	10–15
Interbedded grayish sands and bluish clays; one small lignite seam	55–60
Low-grade lignite, associated with iron ore, ferruginous sandstone, and calcareous concretions. The concretions when broken show fossil leaves, among which Knowlton identified *Salix tabellaris* ? Lx.; *Magnolia laurifolia* ? Lx.; *Magnolia ovalis* Lx.; *Juglans appressa* Lx.; *Ficus schimperi* Lx.; Ficus 2 n. sp.; *Cinnamomum affine* Lx.; *Cinnamomum mississippiense* Lx.; Laurus or Litsæa n. sp.; Juglans ? n. sp.; etc	2
Thinly laminated bluish clay and sand to water line	13

Sabine River section.—Along Sabine River, between Logansport and Sabinetown, the Wilcox formation is well exposed.[2] The sec-

[1] Vaughan, T. W., Am. Geologist, vol. 16, 1895, p. 308. Partly revised by author.

[2] Veatch, A. C., The geography and geology of the Sabine River: Rept. Geol. Survey Louisiana, 1902, pp. 121-124.

tion differs from the others in exposing well-developed marine deposits carrying characteristic Wilcox fossils.

Between Logansport and Hamilton on Sabine River lignitic deposits lithologically similar to those of the Wilcox on the Brazos are exposed as follows:

At Logansport, in a small bluff near the railroad bridge, a light-colored iron-stained sandy clay lies on top of 3 to 4 feet of dark sandy clay carrying limestone concretions. At several points between Logansport and Harts Bluff lignitic clays are exposed beneath light-colored sands. At the lower end of Harts Bluff, about 15 miles below Logansport, the following section is shown:

Section at Harts Bluff.

	Feet.
Quaternary:	
White and yellow sand	28
Many-colored chert and quartz pebbles with rolled pieces of petrified wood	½
Wilcox formation:	
High-grade lignite	¾
Finely laminated drab-colored clay with lighter sand partings.	1
Sand	½
Same as drab-colored clay above, containing at base a layer of light-brown claystone concretions	3
Finely stratified fine white sand	1
Same as drab-colored clay above	11

About a mile by river below Harts Bluff, on the Louisiana side, a ledge of gray, concretionary, leaf-bearing limestone is exposed at water level. A quarter of a mile below this point a few limestone concretions outcrop on the Texas side.

A short distance below the De Soto–Sabine parish line of Louisiana, a bed of lignite 3 feet thick, dipping N. 70° W. at the rate of 1 foot in 100, is exposed close to the water level, beneath 15 feet of Quaternary material.

At Myricks Ferry, about 10 miles in a direct line north of Hamilton, the following section is exposed:

Section at Myricks Ferry.

	Feet.
Quaternary: Unstratified gray and yellow sandy clay, red above; a few pebbles at the base; clay weathers into pinnacles; material same as that capping Harts Bluff	22
Wilcox formation:	
Very dark colored clay	3
Gray sand	2
Finely laminated dark clay with large calcareous concretions	22

The lower ledges show an eastward dip of 52 feet to the mile.

About 7 miles in a direct line north of Hamilton a few feet of lignitic clay shows at the water level.

Two miles by river below the last point a bluff on the Texas side, 110 feet high, shows the following section.

Section 5 miles north of Hamilton, on Sabine River, Shelby County, Tex.

	Feet.
Unexposed to top of bluff	50
Wilcox formation: Finely laminated dark lignitic clays with scattered concretions	60

An apparent fault near the center of the bluff is due to a landslip.

Just above the town of Hamilton a bluff 60 feet high shows 30 feet of dark laminated lignitic clays.

The stratigraphic relations of the beds between Logansport and Hamilton are not entirely clear. It is possible that they represent a horizon very low in the Wilcox, but it is more probable that they represent the palustrine time equivalents of the marine beds of the upper Wilcox exposed farther downstream.

Between Hamilton and Pine Bluff on Sabine River a series of lignitic beds and sandstones with leaf-bearing concretions may be seen. The details of the sections between Hamilton and the mouth of Patroon Bayou follow (Pl. IV):

Section above Chambers Ferry, Sabine River, Sabine County, Tex.

	Feet.
Unexposed	70
Wilcox formation: Gray and light-yellow, slightly cross-bedded sand with large leaf-bearing calcareous concretions	56

About 4 miles below Chambers Ferry in a direct line a small waterfall exposes the following:

Section on Sabine River, 4 miles below Chambers Ferry, Sabine County, Tex.

	Feet.
Light-yellow sand with fine clay partings	10
Wilcox formation:	
Blue laminated sandy clay with Anomia sp., *Venericardia planicosta*	8
Covered to water level	20

One-half mile above Morans Landing, on a little point, fossiliferous clay is exposed which dip observations indicate to be the same as the blue clay of the preceding section.

About 2 miles above Carters Ferry a low pine-covered bluff shows the following section:

Section on Sabine River, about 2 miles above Carters Ferry, Sabine County, Tex.

	Feet.
Quaternary:	
Slightly stratified white and yellow sand	20
Yellow sand, with chert and quartz pebbles and rolled pieces of silicified wood	2
Wilcox formation: Dark-blue to dirty-yellow laminated sandy clay with calcareous concretions	4

At Carters Ferry a small bluff shows about 15 feet of dark-blue laminated nonfossiliferous sandy clay. A ledge of limestone bowlders extends very nearly across the river a short distance above the ferry. Below the ferry a 6-inch bed of lignite caps the clay. A second bed of calcareous concretions, stratigraphically about 30 feet above the first, appears a few hundred yards south of the ferry. The lignite bed dips S. 25° W. at the rate of 105 feet to the mile, but the second concretion bed shows a dip of only 75 feet to the mile.

Near the mouth of Patroon Bayou the following section is exposed (Pl. IV):

Section near mouth of Patroon Bayou on Sabine River, Sabine County, Tex.

	Feet.
Sands	12
Wilcox formation:	
Lignite	¾
Unexposed	15
Lignite	2
Dark-blue laminated clay	7

The apparent dip of the beds is southwest 75 feet to the mile.

All the beds exposed between Hamilton and the mouth of Patroon Bayou dip and lie below that portion of the Wilcox next to be described. They apparently correspond to the lower part of the Nanafalia formation of the Alabama section.

Between Pine Bluff, one-fourth mile below Pendleton, and Sabinetown, on Sabine River, an exposed series of marine and palustrine deposits is referred to the Wilcox formation on the basis of the contained fossils. These fossils also indicate that these beds correspond to the upper part of the Nanafalia, the Tuscahoma, and the Bashi formations of Alabama.[1] Prof. G. D. Harris was the first to make this correlation.

The beds may also represent the marine equivalents of some of the palustrine Wilcox deposits exposed on the interior.

The sections follow (Pl. IV):[2]

Section at Pine Bluff, one-fourth mile above Pendleton Ferry on Sabine River, Sabine County, Tex.

	Feet.
Wilcox formation:	
Light-gray to brownish laminated clay	7½
Ledge of impure limestone concretions	2½
Greenish-brown and light-blue clayey sand, with iron concretions and fossils	4½
Blue joint clay, fossiliferous	2½
Limestone concretions, fossiliferous, in dark-gray sand	1
Dark-gray sand	2
Stratified lignitic clay	1
Yellow and gray sand	5
Wavy alternate layers of blue sand and clay	6

The apparent dip is 1° 9′ W.

[1] Harris, G. D., and Veatch, A. C., A preliminary report on the geology of Louisiana: Rept. Geol. Survey Louisiana, 1899, pp. 299–309.

[2] Idem, pp. 65–66.

Section of Pendleton Bluff, above Pendleton Ferry on Sabine River, Sabine County, Tex.

	Feet.
Red sand	15–20
Wilcox formation:	
Light-gray and brown laminated clay	5–15
Ledge of limestone and sandstone concretions	5
Wavy alternate layers of dark sand and clay	8

The dip is slightly west. The true dip of the beds exposed in the last two sections given is found by calculation to be west of south 91 feet to the mile. The beds carry such characteristic lower Wilcox forms as *Pleurotoma silicata, Levifusus indentus,* and *Natica aperta.*

A series of palustrine strata about 125 feet thick overlying the marine deposits is exposed at High Bluff, on the river 4 miles above Sabinetown:[1]

Section at High Bluff, on the Louisiana side of Sabine River, 4 miles above Sabinetown, Sabine County, Tex.

	Feet.
Quaternary: Unexposed; shows on surface chert and quartz gravel and large masses of conglomerate	25
Wilcox formation:	
Laminated, drab to chocolate-colored clays	20
Unexposed	25
Cross-bedded yellow sand with thin layers of white clay and lines of clay pebbles, the main lines of stratification corresponding to the general dip of the strata; in places the sands form large masses of ferruginous sandstone	44
Irregularly bedded dark-colored lignitic micaceous sandy clay, containing large calcareous concretions	27

The beds dip S. 15° W. about 105 feet to the mile. So far they have yielded no fossils.

At Sabinetown sandstones and clays, which represent an horizon near the top of the Wilcox, lie immediately below the Claiborne group and stratigraphically above the beds at High Bluff. Among the fossils (which prove the marine origin of the strata) is *Kellia prima,* a form which indicates that the inclosing materials correspond to the Bashi formation of Alabama.

The details of the Sabinetown Bluff section follow:

[1] Veatch, A. C., The geography and geology of the Sabine River: Rept. Geol. Survey Louisiana, 1902, pp. 124–125.

Section exposed in Sabinetown Bluff on Sabine River, Sabine County, Tex.

	Feet.
Quaternary:	
Sands and ferruginous conglomerates	9–16
Ferruginous sandstone	1
Wilcox formation:	
Lignitic clay	15
Yellow sand	25
More or less alternating shaly lignitic clay and sand; the latter weathers to yellow color; the shaly clay is sometimes light brown or pinkish	40
More or less clayey sand, much of it greenish and fossiliferous in concretions, with hard layer above	15
Fossiliferous blue sand with concretions	6
Brittle shaly drab clay	2

The dip along the face of the bluff is slight, as the section is very nearly along the line of strike. In a little gorge leading into the bluff the beds are seen to dip south about 105 feet to the mile.

The complete section of the Wilcox formation, as exposed along Sabine River, and the stratigraphic relations of the beds in the different bluffs, is represented graphically on Plate IV (in pocket).

CLAIBORNE GROUP.

The Claiborne group of this region is divided into three formations, which, from oldest to youngest, are the Mount Selman, the Cook Mountain, and the Yegua.

Mount Selman Formation.

NAME AND CORRELATION.

The formation here described was named for Mount Selman, a town in Cherokee County, Tex., the name being first applied by Kennedy in 1892.[1]

Together with the overlying formation (Cook Mountain), it represents the time equivalent in Texas of the "Lower Claiborne"[2] or St. Maurice formation[3] of Louisiana, as described by Harris; of the Tallahatta buhrstone plus the Lisbon marl of Mississippi, as described by Crider;[4] and of the Tallahatta plus the Lisbon of Alabama, as described by Smith.[5]

[1] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 52–54.

[2] Harris, G. D., and Veatch, A. C., A preliminary report on the geology of Louisiana: Rept. Geol. Survey Louisiana, 1899, pp. 73–89.

[3] Harris, G. D., The lower Tertiaries of Louisiana: Science, new ser., vol. 31, Apr. 1, 1910, p. 502.

[4] Crider, A. F., Geology and mineral resources of Mississippi: Bull. U. S. Geol. Survey No. 283, 1906, pp. 28–33.

[5] Smith, E. A., The underground water resources of Alabama: Rept. Geol. Survey Alabama, 1907, pp. 17–18.

The deposits composing the Mount Selman formation were first described by L. C. Johnson [1] in 1888, but the first adequate account was published in 1895 by Kennedy, who described them in connection with the overlying formation under the name "Marine beds."[2]

OCCURRENCE AND CHARACTER.

The Mount Selman formation lies stratigraphically above the Wilcox and beneath the Cook Mountain. Its estimated thickness is 350 feet. The formation is composed of palustrine and marine deposits consisting of dark-green and brown sands with thin seams of iron ore, lenses of lignite and clay, and beds and concretions of limonite. As a whole it is characteristically ferruginous. Beds of iron ore of economic value are common.

In northeast Texas the Mount Selman formation is conspicuous, occupying extensive areas in Anderson, Henderson, Cherokee, Rusk, Gregg, Harrison, Marion, Morris, and Cass counties. Its sands constitute an important water-bearing stratum.

PALEONTOLOGY.

Fossils, which are not plentiful in the Mount Selman formation, occur in the form of casts, chief among which is that of *Venericardia planicosta* Lamarck.

DETAILED SECTIONS.

Brazos River section.—Along the Brazos the beds exposed between the International & Great Northern Railroad bridge near Valley Junction in Robertson County and Burleson Bluff or Collier Ferry in the northern corner of Burleson County are referred to the Mount Selman formation.

The complete section along the Brazos, with the stratigraphic relation of the different bluffs, is indicated graphically on Plate IV. The details of the sections follow:

The section exposed at the International & Great Northern Railroad bridge near Valley Junction has already been given (p. 43). In this section the black clay is tentatively considered as representing the uppermost beds of the Wilcox, and the greensand marl as representing the base of the Claiborne group or Mount Selman formation.

From this point to 2½ miles below the Burleson County line, a distance of about 12 miles by river, the bluffs expose a series of interbedded and interlaminated clays and sands with local beds of lignite and some few small gray calcareous concretions.

Trinity River section.—On Trinity River, the beds exposed between Wooters Bluff, about 12 miles south of the northern line of Houston

[1] The iron regions of northern Louisiana and eastern Texas: House Ex. Doc., 50th Cong., 1st sess., vol. 26, No. 195, 1889, pp. 19–21.

[2] The Eocene Tertiary east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, pp. 108–134.

County, and Halls Bluff, 5 miles below, are tentatively referred to the Mount Selman formation, though they may belong to the Wilcox formation. In the absence of fossils the correlation can not be definite

The beds constituting the uplands adjacent to Wooters Bluff consist of brown sandstones and altered greensands with a few casts of fossils.

At Wooters Bluff, on the Trinity, the following section is exposed:[1]

Section at Wooters Bluff, on Trinity River, Houston County, Tex.

	Ft.	in.
Mount Selman formation(?):		
Brown and yellowish-brown sand	10–15	
Clay ironstone		1–3
Dark-gray micaceous clay, weathering brown on outside	20	
Clay ironstone		1–2
Dark-blue or bluish-black micaceous clayey sand	2– 6	

Five miles below the last-mentioned locality the first undoubted outcrop of the Cook Mountain formation appears.

Cherokee County section.—Between Jacksonville and Bullard, in Cherokee County, the Mount Selman formation is typically exposed.[2]

Section exposed between Jacksonville and Bullard, Cherokee County, Tex.

	Feet.
Quaternary:	
Gray sand	10
Brown sand, ferruginous pebbles, and iron ore	15
Mottled sand	10
Brownish-yellow sand	4
Mount Selman formation:	
Brown and yellow sandstone	10
Alternate strata of iron ore in generally laminated deposits, 2 to 10 inches thick, and brown sand in layers 1 to 2 feet thick	8
Dark green sand containing casts of small bivalve shells	5
White clayey sand	1
Dark-green, nearly black sand, containing thin seams of ferruginous materials near top, and also containing small fish teeth and *Venericardia planicosta*	12
Brown sand	10
White sand	10
Alternate strata of brown sand 1 to 2 feet thick, and laminated iron ore, generally wavy and not more than 2 to 6 inches thick.	20
Pale-blue and brown clay, mottled in places and laminated in others	15
Alternate strata of altered glauconitic brown sand 6 to 24 inches thick, and iron ore, generally irregular, laminated, and siliceous, not exceeding 6 to 12 inches thick	55
Brown sand forming the surface near Bullard but passing under the alternate strata of brown sand and laminated wavy iron ore at the base of the hill; altered greensand, changing to yellow a few feet underground	40
Dark-green sand, containing fossil shells and a few shark teeth.	24

[1] Kennedy, William, Houston County: Third Ann. Rept. Geol. Survey Texas, 1892, p. 18.

[2] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, p. 53, with verbal modifications.

Wilcox formation (?):	
Lignite or "black dirt" having the appearance of drift, containing pieces of wood, leaves, etc	2
Dark lignitic clay, jointed in places; the joints are filled with glossy lignitic material and sand and are said to contain small white shells near bottom	5
Brown clay at bottom of well near Bullard, dug into	2

Near Jacksonville, in beds included in the upper portion of the foregoing section, *Cassidaria brevidentata* Ald., *Ostrea sellæformis*, and *Anomia ephippioides* were found.[1]

At a cutting on the railroad 2 miles south of Mount Selman, in the dark-green, nearly black sand of the preceding section, *Venericardia planicosta* Lam., *Sphærella anteproducta* Harris, and *Corbula aldrichi* var. *smithvillensis* Harris were found.[2]

The occurrence of these fossils at the type locality of the Mount Selman definitely fixes the formation as a lower division of the Claiborne group.

Harrison County section.—That the Mount Selman formation once covered the whole of northeast Texas is indicated by the isolated remnants which rest directly on the underlying Wilcox and now occupy the divides. (See Pl. I, in pocket.) The section at the Marshall pumping station, which shows the relation of the Mount Selman to the underlying Wilcox, has already been given (p. 46). The following section [3] at Hynsons Iron Mountain, 8 miles north of Marshall, may be considered characteristic of the formation in this region:

Section of Mount Selman formation in Hynsons Iron Mountain, 8 miles north of Marshall, Tex.

	Feet.
Mount Selman formation:	
1. Sands with a little clay, like those exposed at Rusk and Ferguson Gap, 2½ miles north of Jacksonville	1–20
2. Layer of ferruginous sandstone, either shaly or compact	$\frac{1}{12}$–6
3. Limonite, brown and buff, crumbly	$\frac{1}{12}$–1
4. Compact sand, with layer of shaly sandy rock	20–50
5. Lignitic, laminated clay, and some plastic clay	1–10
6. Great beds of sandy clay, easily eroded	100
7. Stiff laminated clay, dark brown, jointed, about	10
8. Sandy clay, like No. 6, about	20–50
9. Sands, easily eroded	80–100
10. Fossiliferous beds, with *Venericardia planicosta* on Cypress Creek	10±

Beneath these fossiliferous beds, as shown by many sections in Harrison County, lie beds characteristic of the Wilcox formation.

[1] This list of fossils is taken from a catalogue of the Tertiary fossils collected by the Geol. Survey of Texas (1889–1892). The determinations were made by Prof. G. D. Harris. The catalogue is now in the possession of the University of Texas.

[2] Idem.

[3] Johnson, L. C., The iron regions of northern Louisiana and eastern Texas: House Ex. Doc. No. 195, 1st sess. 50th Cong., vol. 26, 1889, p. 33.

Sabine River section.—Along Sabine River from about 2 miles below Sabinetown to about 4 miles below the mouth of Bayou Negreet, the Mount Selman formation is exposed, overlying the Wilcox and underlying the Cook Mountain. The details of two exposures follow (Pl. IV):[1]

Section about a mile above the mouth of Low Creek on Sabine River, Sabine County, Tex.

	Feet.
Quaternary:	
Gray sand	5
Gray and yellow unstratified clay, containing ferruginous gravel	25
Unconformity.	
Mount Selman formation:	
Dark-green limestone filled with large grains of greensand; characterized by great numbers of *Pecten cornuus* and crustacean remains	5
Fossiliferous oolitic greensand with occasional spots of green clay, weathering red	7
Ledge of green limestone containing small, rounded greensand grains; weathers red	$\frac{1}{3}$
Fossiliferous green clay with much greensand	10

The fossils are small and not well preserved. The beds dip S. 50° W., at the rate of 88 feet to the mile.

Section at mouth of Bayou Negreet, Sabine River, Sabine County, Tex.

	Feet.
Quaternary: Light-gray and yellow sandy clay with gravel at base	20
Mount Selman formation:	
Dark greenish-brown clay with greensand grains; about 4 feet from base a harder portion of the bed forms a little terrace	13
Very fossiliferous indurated green marl, weathering brown; contains among other species *Ostrea falciformis*	4
Hard limestone with many large *Venericardia planicosta*	2
Covered (mouth of Bayou Negreet)	20
Laminated chocolate-colored clay	2
Hard gray limestone with imperfect shells and bowlders of the underlying material; carries *Ostrea falciformis;* shows large masses of coral	3
Similar to the Mount Selman beds, a mile above the mouth of Low Creek on Sabine River, but contains a greater proportion of clay; more like normal greensand marl. It weathers into six distinct shelves because of difference in hardness of different portions of the bed	25

The hard gray limestone near the bottom of the section crosses the river at right angles, forming a very marked shoal. The river flows against the inclined edges of the strata, which dip 2° 18′ S. 20° W. These sections along the Sabine expose a phase of the Mount Selman formation more pronouncedly marine than that in Harrison and Cherokee counties.

[1] Veatch, A. C., The geography and geology of the Sabine River: Rept. Geol. Survey Louisiana, 1902, pp. 127–128. Verbally modified.

Cook Mountain Formation.

NAME AND CORRELATION.

The Cook Mountain formation was first so designated by Kennedy in 1892, the name being that of a hill in Houston County, Tex., where it is characteristically exposed.[1] As already stated (p. 51), it, together with the underlying Mount Selman formation, corresponds in time with the "Lower Claiborne" or the St. Maurice formation of Louisiana, and with the Tallahatta buhrstone plus the Lisbon marl in Mississippi and Alabama.

The paleontologic similarity of the Texas materials to those exposed at Claiborne in Alabama was announced as far back as 1852 by Roemer, the distinguished German geologist.[2] In 1890, Penrose described the beds in connection with his so-called "Timber Belt beds."[3] In 1892 Kennedy discriminated and described for the first time the unit which he called the Cook Mountain, which is the one here recognized and called by the same name.

OCCURRENCE AND CHARACTER.

The beds composing the Cook Mountain formation lie stratigraphically and conformably above the Mount Selman formation and beneath the Yegua formation. They consist of beds of greensand, greensand marl, iron ore, lignites, lignitic clays, and sands. The greensands, greensand marls, and iron ores are all highly fossiliferous and of marine origin; the lignites, lignitic clays, and sands are nonfossiliferous (except for fossil leaves) and are of palustrine origin. The estimated thickness of the formation is 400 feet. The outcrop of the formation appears in Robertson, Brazos, Leon, Houston, Anderson, Cherokee, Nacogdoches, San Augustine, and Sabine counties. The glauconitic sands and marls, which are the predominant members of this formation in east Texas, weather into red soils and form the so-called red lands.

PALEONTOLOGY.

The Cook Mountain formation is characterized by certain fossils, among which may be mentioned *Ostrea sellæformis* Conrad, *Ostrea divaricata* Lea, and *Anomia ephippioides* Gabb. (See Pl. V.)

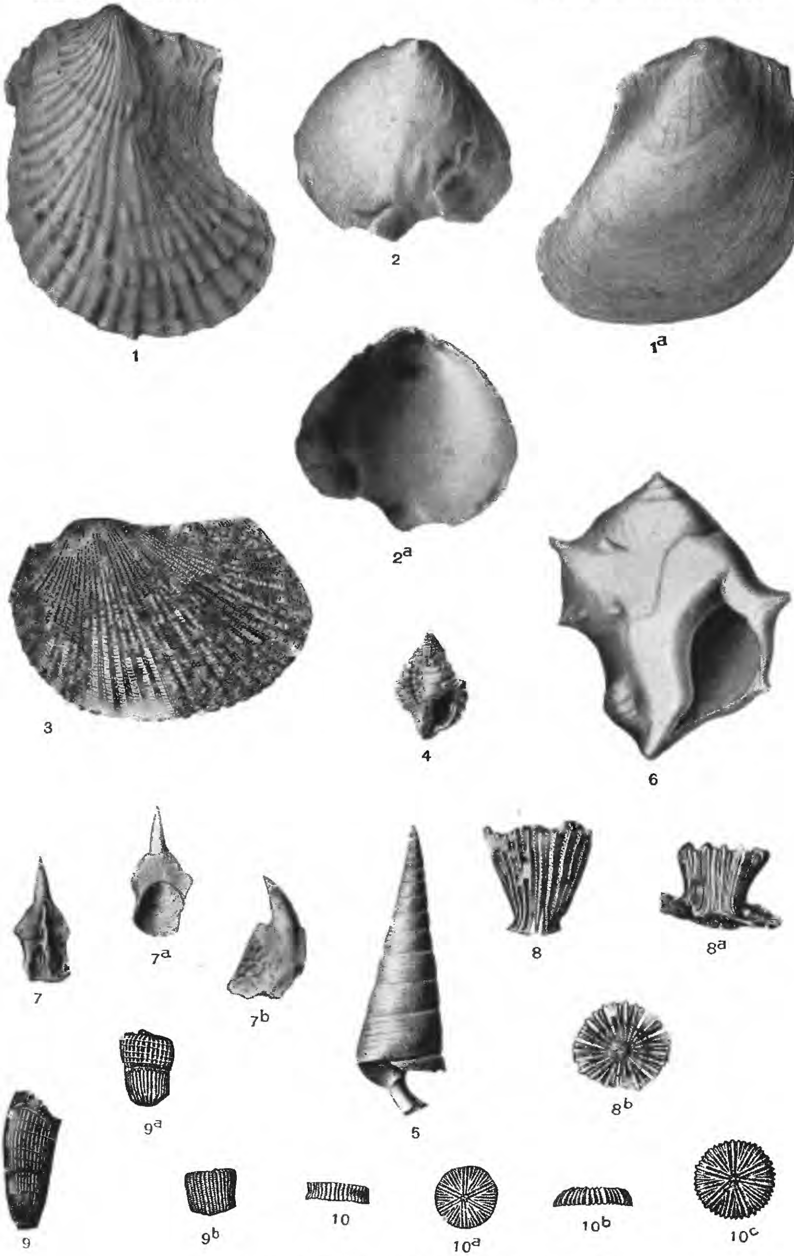
DETAILED SECTIONS.

Brazos River section.—Along the Brazos the beds exposed between Burleson Bluff at the old Collier Ferry, 2½ miles below the Burleson County line, and the Wellborn Shoals, at the mouth of the Little Brazos, belong to the Cook Mountain formation.

[1] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 54–57.

[2] Roemer, Ferdinand, Die Kreidebildungen von Texas und ihre organischen Einschlüsse, 1852, pp. 4–5.

[3] Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiaries of Texas from the Red River to the Rio Grande: First Ann. Rept. Geol. Survey Texas, 1890, pp. 22–47.



CHARACTERISTIC FOSSILS OF CLAIBORNE AGE.

1, 1a. Ostrea sellæformis Conrad.
2, 2a. Anomia ephippioides Gabb.
3. Arca vaughani Casey.
4. Distorsio sepdentata Gabb.
5. Mesalia claibornensis Conrad.
6. Cornulina armigera Conrad.
7, 7a, 7b. Belosepia ungala Gabb.
8, 8a, 8b. Paracyathus alternatus Vaughan.
9, 9a, 9b. Paracyathus bellus Vaughan.
10, 10a, 10b, 10c. Discotrochus orbignianus Milne Edwards and Haime.

The following section is exposed at Burleson Bluff:[1]

Section at Burleson Bluff, near Collier Ferry on Brazos River, Burleson County, Tex.

	Feet.
Quaternary: 1. Brown sand	10
Cook Mountain formation:	
2. Indurated brown altered greensand	$\frac{2}{3}$
3. Brownish-green altered greensand	4–6
4. Fossiliferous grayish-green sand	10–15
Formation doubtful:	
5. Dark-blue laminated clay	6–8
6. Lignite in river	4

The strata dip S. 72° E. 180 feet to the mile. Beds 3 and 4 carry the following fossils:

Turbinolia pharetra Lea.
Belosepia ungula Gabb.
Pleurotoma (Surcula) gabbi Con.
P. childreni Lea var. bitota Harris.
P. (Clathurella) fannæ Harris.
Cancellaria minuta Harris.
Olivella bombylis var. burlesonia Harris.
Plejona petrosa var. indenta (Con.)
Fusus mortoni var. mortoniopsis Gabb.
Lapparia pactilis var. mooreana (Gabb).
Clavilithes humerosa var. texana Harris.
C. penrosei Heilprin.
C. (Papillina) dumosa var. trapaquara Harris.
Latirus moorei (Gabb).
Pseudoliva vetusta (Con.) var.
Pyrula (Fusoficula) penita Con. var.
Calyptraphorus velatus Con.
Rimella texana Harris.
R. texana var. plana Harris.
Turritella sp.
Solarium scrobiculatum Con.
S. alveatum Con.
Trochita sp.
Natica semilunata var. janthinops Harris.
N. newtonensis Ald.
Sigaretus declivis Con.
Dentalium minutistriatum Gabb.
D. minutistriatum var. dumblei Harris.
Plicatula filamentosa Con.
Pinna sp.
Byssoarca cuculloides Con.
Leda opulenta (Con.).
Cytherea sp.
C. texacola Harris.
C. bastropensis Harris.
Corbula aldrichi var. smithvillensis Harris.
Ostrea sellæformis var. divaricata Lea.
Pecten deshayesii Lea.
Venericardia planicosta Lam.
V. rotunda Lea.
V. alticostata var. perantiqua Con.?

The next exposure is found at Niblitts Shoals, about 1½ miles north of Stone City or Moseleys Ferry. The section (see Pl. IV) shows:[2]

Section at Niblitts Shoals on Brazos River, 1½ miles north of Stone City, Brazos County, Tex.

	Feet.
Quaternary:	
Bluff loam or river deposits	6
Brown clay	3
Yellow sand, with gravel near bottom	10
Cook Mountain formation:	
Lignite, shaly near top, but becoming compact at base of bed	12–14
Lignitic sand.	

[1] Kennedy, William, The Eocene Tertiary of Texas east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, p. 130.

[2] Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 56.

The next outcrop is found at Moseleys Ferry at Stone City. The following section (see Pl. IV) was observed:

Section at Moseleys Ferry on Brazos River, Burleson County, Tex.

	Feet.
Quaternary:	
1. Yellow sandy clay or alluvium	15
Cook Mountain formation:	
2. Fossiliferous iron ore	½
3. Laminated blue clay, fossiliferous	3
4. Fossiliferous iron ore	2
5. Laminated blue clay, fossiliferous	6
6. Fossiliferous iron ore	2
7. Altered fossiliferous greensand	10
8. Fossiliferous iron ore	2
9. Highly fossiliferous greensand, merges into No. 7	5
10. Laminated blue clay, weathering to brown near top and into light blue near bottom; the upper portion is fossiliferous; the lower portions carry some crystals of selenite	15
11. Dark fossiliferous sandy clay	10
12. Black, clayey sand, jointed, and weathering to brown where attacked by water along the joints; no fossils exposed	1
13. Dark fossiliferous sandy clay, extending into river	8

This bluff is about 1,500 feet long and from 25 to 30 feet high. The beds dip S. 80° E. 180 feet to the mile. With the exception of No. 12 all are highly fossiliferous. In the following table column 1 includes fossils from beds 2, 3, and 4; column 2, from bed 5; column 3, from beds 6, 7, and 8; column 4, from bed 9; column 5, from beds 11 and 13.

Fossils from Cook Mountain formation at Moseleys Ferry on Brazos River, Tex.

Species.	1	2	3	4	5
Turbinolia pharetra Lea			×		
Endopachys maclurei (Lea)			×		
Belosepia ungula Gabb		×			
Conus sauridens Con.[a]	×	×	×	×	
Pleurotoma (Surcula) gabbi Con.[a]					
P. (Cochlespira) engonata Con	×	×			
P. (Drillia) nodocarinata Gabb[a]	×		×		
P. terebriformis Meyer	×				
P. (Borsonia) plenta Harris	×	×	×		
P. (Surcula) moorei Gabb var.[a]		×			
P. childreni Lea var. bitota Harris			×		
Ancilla (Olivula) staminea Con		×		×	
Plejona precursor (Dall)	×				
P. petrosa (Con.)[a]	×	×			
Levifusus trabeatoides Harris[a]	×	×	×		
Fusus mortoni var. mortoniopsis[a] Gabb	×				
Latirus moorei (Gabb)[a]	×		×		
Turricula polita (Gabb)	×				
Phos texanus Gabb var				×	
Pseudoliva vetusta (Con.) var.[a]	×	×	×	×	×
P. vetusta var. carinata (Con.)			×		
Neptunea enterogramma Gabb	×				
Pyrula (Fusoficula) texana Ald	×				
Distortio septemdentata Gabb	×	×	×	×	
Tenuiscala trapaquara Harris	×				
Turritella nasuta Gabb[a]	×	×		×	×
T. dumblei Harris	×		×		

[a] Collected by Penrose in 1889 and by Kennedy in 1891 and 1892 and determined by Harris; collected by Deussen in 1907 and determined by Vaughan.

Fossils from Cook Mountain formation at Moseleys Ferry on Brazos River, Tex.—Con.

Species.	1	2	3	4	5
Mesalia claibornensis (Con.) [a]	×	×			
Tuba antiquata [a] (Con.)	×				
Solarium acutum var. meekanum Gabb	×		×		
S. scrobiculatum Con. [b]				×	
Sigaretus declivis Con	×				
Dentalium minutistriatum Gabb [a]	×	×			
D. minutistriatum Gabb var. dumblei Harris (MS.)	×				
Ostrea sellæformis var. divaricata Lea	×				×
Anomia ephippioides Gabb [c]	×		×	×	
A. lisbonensis Ald. [b]					
Byssoarca cuculloides Con	×		×		
Leda opulenta (Con.)		×			
Yoldia claibornensis Ald			×		
Venericardia planicosta Lam	×	×	×	×	×
V. mooreana Con. [b]				×	
Cytherea bastropensis Harris			×		
C. texacola Harris	×	×		×	
C. tornadonis Harris	×				
Pteropsis conradi Dana			×		
Corbula texana Gabb	×			×	
Tellina mooreana Gabb			×		

[a] Collected by Penrose in 1889 and by Kennedy in 1891 and 1892 and determined by Harris; collected by Deussen in 1907 and determined by Vaughan.
[b] Collected by Deussen and determined by Vaughan.
[c] Collected by Penrose in 1889 and by Kennedy in 1891 and 1892 and determined by Harris.

The uppermost beds of the Cook Mountain formation are exposed on the Brazos 500 yards south of the mouth of the Little Brazos in a bluff near Wellborn Shoals. The section (see Pl. IV) shows:[1]

Section near Wellborn Shoals, Brazos River, Brazos County, Tex.

	Feet.
Quaternary:	
1. Black soil	2
2. Brown loam with limy concretions	25
3. Fine brownish-yellow sand, with some streaks or pockets of gravel	15
4. Gravel, with water-worn Cretaceous shells	2–4
Unconformity.	
Cook Mountain formation:	
5. Pale blue, nonfossiliferous clay	5
6. Dark-green sands, showing fossils in lower portions; form a portion of Wellborn Shoals	2–5
7. Dark laminated fossiliferous sandy clay, running under the river 300 yards below mouth of Little Brazos, and forming upper portion of shoals	4
8. Ferruginous sandstones	8
9. Same as No. 7.	

[1] Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 53. Verbally modified.

The fossils collected at this point in beds 6 and 7 include the following: [1]

Fossils from Cook Mountain formation in bluff on Brazos River, near Wellborn Shoals, Brazos County, Tex.

Terebra houstonia Harris.	Natica arata Gabb.
Pleurotoma (Pleurotomella) quassates Harris.	N. semilunata var. janthinops Harris.
Levifusus trabeatoides Harris.	Sigaretus inconstans Ald.
Phos texanus Gabb.	Trigonarca corbuloides (Con.).
Pseudoliva vetusta var. pica Harris.	Nucula magnifica Con.
P. vetusta var. clausa Harris.	Leda opulenta (Con.).
P. vetusta (Con.).	Cytherea bastropensis Harris.
Latirus moorei (Gabb).	Venericardia planicosta Lam.
	Corbula alabamiensis Lea.

At College station, in Brazos County, two deep wells have been drilled, one by the Houston & Texas Central Railroad; the other (1892) by the Agricultural and Mechanical College of Texas. In the railroad well, lignite was struck at 105 feet, proving that the lignitiferous formation of palustrine origin known as the Yegua occurs here. In the college well sandstone and shale were the principal materials encountered down to 900 feet; between 900 and 1,000 feet, a dark-blue fossiliferous clay was penetrated. The following fossils from this clay have been identified by Harris: [2]

Fossils from a clay of Claiborne age (either Cook Mountain or Mount Selman formation) at 900 to 1,000 feet in a well at College Station, Brazos County, Tex.

Pleurotoma (Surcula) gabbi Con.	Turritella nasuta Gabb.
P. (Drillia) nodocarinata Gabb.	T. dumblei Harris.
P. magapsis Harris.	Mesalia claibornensis (Con.).
P. (Borsonia) plenta Ald.	Natica arata Gabb.
P. (Mangilia) infans Meyer var.	Trigonarca pulchra (Gabb).
Turricula texana Harris.	Dentalium minutistriatum Gabb.
Latirus moorei (Gabb).	Venericardia planicosta Lam.
Pseudoliva vetusta var. fusiformis (Lea).	V. rotunda Lea.
Phos texanus Gabb var.	Corbula alabamiensis Lea.

This is a typical Claiborne group fauna, and indicates that the beds carrying the fossils belong either to the Cook Mountain or to the Mount Selman formation.

Trinity River section.—Along the Trinity the beds exposed between Halls Bluff and Alabama Bluff in Houston County belong to the Cook Mountain formation. The beds at Halls Bluff are probably identical with those at Burleson Bluff on the Brazos. The beds at Brookfields Bluff probably represent the lignitic beds at Niblitts Shoals on the Brazos, and the beds at Alabama Bluff doubtless

[1] Register of Tertiary fossils collected by the Geol. Survey of Texas and determined by Harris; in possession of the University of Texas.

[2] Idem.

correspond with those in the Moseley Ferry Bluff on the Brazos. Details of these sections follow:

Section at Halls Bluff on Trinity River, Houston County, Tex.[1]

	Feet.
Quaternary: Gravel and sand	25–30
Cook Mountain formation:	
Fossiliferous sandstone carrying *Cerithium vinctum* Whitf., *Ostrea sellæformis* var. *divaricata* Lea, and casts of others	4
Red sandstone	10
Yellowish-white sand	2
Brown clay with gypsum crystals	$\frac{1}{2}$
Yellowish-white sand	5
Irregular stratum of clay ironstone bowlders	$\frac{3}{8}$

Brookfields Bluff, 5 miles below Halls Bluff, shows the following section:

Section at Brookfields Bluff on Trinity River, Houston County, Tex.

	Feet.
Quaternary: Sand and gravel	20
Cook Mountain formation:	
Brown sandstone in heavy bed	10
Clay ironstone	1
Laminated dark-blue sand and light-gray clays with iron pyrites.	8
Lignite	$\frac{1}{8}$
Laminated dark-blue sand and light-gray clays with iron pyrites.	5
Thin seam of ferruginous sandstone	$\frac{1}{2}$
Laminated dark-blue sand and light-gray clays with iron pyrites; beds are darker in lower portion and covered in places with a yellow efflorescence of sulphur; water issuing from these beds is sulphurous and the springs show considerable quantities of hydrogen sulphide	51
River level.	

These beds carry no fossils.

Alabama Bluff, about 10 miles by air line below Brookfields Bluff, carries typical Cook Mountain fossils. The section is exposed as follows:[2]

Section at Alabama Bluff on Trinity River, Houston County, Tex.

	Feet.
Quaternary:	
1. Dark silty and loamy soil	4
2. Conglomerate of stained siliceous pebbles and iron ore and silicified wood, stained brown	2
Unconformity.	
Cook Mountain formation:	
3. Fossiliferous greenish-blue clay	4
4. Greensand altered to a brownish-yellow sand with thin strata of ferruginous material interstratified	5–6
5. Ferruginous sandstone with iron ore	1–2
6. Fossiliferous greensand and ferruginous material same as No. 5.	4

[1] Kennedy, William, Houston County: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 18–19.
[2] Idem, pp. 15-16.

The Cook Mountain beds dip more than 3° S. 20° E. The fossils from beds 4 and 6, listed below, indicate that these beds correspond to those at Moseleys Ferry on the Brazos and at Smithville on the Colorado.[1]

Fossils from Cook Mountain formation at Alabama Bluff, Houston County, Tex.

Species	4	6
Turbinolia pharetra Lea	×	×
Belosepia ungula Gabb	....	×
Volvula conradiana Gabb	×	×
Conus sauridens Con	×	×
Pleurotoma (Surcula) gabbii Con	×	×
P. (Cochlespira) engonata Con	×	×
P. (Surcula) moorei Gabb	×	×
P. (Drillia) nodocarinata Gabb	×	×
P. heilpriniana Harris	....	×
P. sp	×	×
Ancilla (Olivula) staminea (Con.)	×	×
Plejona petrosa (Con.)	×	×
Carricella demissa var. texana Gabb	×	×
Fusus mortoni var. mortoniopsis Gabb	×	×
Clavilithes penrosei Heilprin	×	×
C. (Pappillina) dumosa var. trapaquara Harris	....	×
Latirus moorei (Gabb)	×	×
Turricula (Conomitra) texana Harris	×	×
T. polita (Gabb)	×	×
Phos texanus (Gabb)	×	×
Pseudoliva vetusta (Con.) var	×	×
Lapparia pactilis var. mooreana (Gabb)	....	×
Distortio septemdentata Gabb	×	×
Cassidaria planotecta Meyer and Ald	×	×
Turritella nasuta var. houstonia Harris	....	×
T. nasuta Con	×	×
Mesalia claibornensis (Con.)	×	×
Solarium bellastriatum Con	×	×
Natica arata Gabb	×	×
N. limula Con	×	×
N. sp	....	×
Cadulus subcoarcuatus Gabb	×	×
Ostrea sellæformis var. divaricata Lea	....	×
Anomia ephippioides Gabb	×	×
Plicatula filamentosa Con	×	×
Pinna sp	....	×
Byssoarca cuculloides Con	....	×
Trigonarca pulchra (Gabb)	×	×
T. corbuloides (Con.)	×	×
Leda houstonia Harris	×	×
Eriphyla trapaqnara Harris	....	×
Crassatellites texana (Harris)	....	×
Cytherea texacola Harris	....	×
Corbula alabamiensis Lea	×	×
Spirorbis leptostoma Swain	×	×

Cherokee County section.—In Cherokee County, between Independence, a short distance south of Jacksonville, and Alto, the Cook Mountain formation is exposed. The details follow:[2]

Section exposed between Independence and Dial, Cherokee County, Tex.

	Feet.
Cross-bedded sand with nodules of white clay	5
Cook Mountain formation:	
Altered greensand containing white concretions, thin streaks of iron ore, and casts of fossils	80
Mottled brown and white sand	2
Thinly laminated blue sand	6
Thinly stratified or laminated red and white sand and white clay	6

[1] Kennedy, William, Proc. Acad. Nat. Sci. Philadelphia, 1895, pp. 119-120.

[2] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, p. 55.

Section of Rusk Penitentiary Hill, Cherokee County, Tex.

	Feet.
Gray sand	20
Cook Mountain formation:	
Interstratified laminated ferruginous material, iron ore and altered greensand	40
Laminated or thinly stratified, red and whitish blue sand and sandy clay	20
Mottled red and blue sandy clay, probably belonging to and forming the lower part of above	25
Red sand and ferruginous gravel	5
Brownish stratified sand, mottled in places	60
Grayish-blue stratified sand in creek	3

Section exposed at New Birmingham, Cherokee County, Tex.

	Feet.
Clay	10
Cook Mountain formation:	
Micaceous sandstone containing iron	3
Sandstone	$\frac{2}{3}$
Micaceous sand	1
Altered glauconite containing casts of fossils	6
Quicksand	1
Altered glauconite with casts of fossils and thin seams of sandstone near center	21

Section exposed in the vicinity of Alto, Cherokee County, Tex.

	Feet.
1. Gray sand	5–20
2. Ferruginous sandstone	1
3. Iron pyrites and lignite	$1\frac{1}{2}$
Cook Mountain formation:	
4. Laminated iron ore and brown sand (altered greensand)	10–15
5. Fossiliferous altered brown glauconitic sand	6
6. Yellowish-brown and grayish-brown indurated glauconitic sand; fossiliferous	20
7. Greensand containing casts of fossils	6
8. Brown sandstone, altered glauconite with casts of fossils	30
9. Greensand with gastropods and fish teeth	8

The beds exposed in the vicinity of Alto occupy the highest position stratigraphically in the Cook Mountain formation and correspond with the beds exposed at Columbus on the Sabine, at Alabama Bluff on the Trinity, at Moseleys Ferry on the Brazos, and at Smithville on the Colorado. Beds 5, 6, and 9 of the section carry the following fossils:[1]

[1] Kennedy, William, Proc. Acad. Nat. Sci. Philadelphia, 1895, pp. 113–114.

Fossils found in the Cook Mountain formation in the vicinity of Alto, Cherokee County, Tex., in beds 5, 6, and 9 of the foregoing section.

Species.	5	6	9
Scutella caput-sinensis Heilpr		×	
Terebra houstonia Harris	×		
Conus sauridens Con			×
Pleurotoma (Surcula) gabbii Con	×		
P. (Drillia) nodocarinata Gabb		×	
Cancellaria panones Harris		×	
Plejona petrosa (Con.)	×		
P. petrosa var. indenta (Con.)		×	
P. precursor (Dall)			×
Caricella subangulata var. cherokeensis Harris		×	
Clavilithes regexa Harris	×		
C. (Papillina) dumosa var. trapaquara Harris		×	
C. humerosa var. texana Harris		×	
Latirus moorei (Gabb)	×		
Phos texanus Gabb var	×		
Pseudoliva vetusta (Con.)	×		
Distortio septemdentata Gabb	×		
Cassidaria brevidentata Ald		×	
Calyptraphorus velatus Con	×		
Rimella texana var. plana Harris		×	
Turritella dutexata Harris		×	
T. nasuta Gabb	×		
Mesalia claibornensis (Con.)	×		
Terebellum sp	×		
Cerithium vinctum Whitf	×		
Solarium acutum var. meekanum Gabb	×		
Natica newtonensis Ald		×	
N. limula var. plana Harris		×	
Dentalium minutistriatum Gabb	×		
D. minutistriatum var dumblei Harris		×	
Ostrea sellæformis var. divaricata Lea	×		
Anomia ephippioides Gabb	×		
Plicatula filamentosa Con	×		
Pecten claibornensis Con	×		
P. deshayesii Lea	×		
Pinna sp	×		
Byssoarca cuculloides Con		×	
Trigonarca pulchra (Gabb)	×		
Venericardia planicosta Lam	×		
V. rotunda Lea	×		
Crassatellites texana Heilpr	×		
Protocardia nicolletti Con. var		×	
Cytherea texacola Harris	×		
Corbula texana Harris	×		
C. aldrichi var. smithvillensis Harris	×		
Martesia texana Harris		×	
Pholadomya claibornensis Ald		×	

Sabine River section.—On Sabine River the Cook Mountain formation is exposed from 4 miles below the mouth of Bayou Negreet to 3 miles below Columbus. The following sections are exposed:

Section exposed on Sabine River, 2 miles above Columbus, Sabine County, Tex.[1]

	Feet.
Quaternary:	
1. Gray and yellow sandy clay, with small ferruginous gravel; clayey portion weathers into little pinnacles	20
Cook Mountain formation:	
2. Bluish-gray laminated clay, with sand partings and some patches of sand; ledge of concretions in upper part	11
3. Dark-green shell limestone, weathering red; carries *Arca rhomboidella*	½
4. Same as No. 2, but much more fossiliferous	4

Beds 2, 3, and 4 dip southwest. Bed 4 contains a well-preserved Cook Mountain fauna.

[1] Veatch, A. C., The geography and geology of the Sabine River: Rept. Geol. Survey, Louisiana, 1902, pp. 129–130.

Section at Columbus on Sabine River.[1]

	Feet.
Quaternary:	
1. Fine gray sand, tinged with yellow	8
2. Pebble conglomerate	2
Cook Mountain formation:	
3. Drab clay, with small concretions	4
4. Ledge of fossiliferous dark-gray limestone, with *Arca rhomboidella, Glycymeris idonea, Plicatula filamentosa*	1
5. Light-green laminated fossiliferous clay	20
6. Light-green laminated fossiliferous clay, with large numbers of *Ostrea johnsoni* var. and *Ostrea falciformis*	4
7. Ledge of calcareous concretions	1
8. Same as No. 5	3

Section about 4 miles below the mouth of Bayou Negreet, on Sabine River, Sabine County, Tex.[1]

	Feet.
Gray and yellow sands and clays	15
Cook Mountain formation:	
Very dark gray fossiliferous laminated clay with lines of concretions; carries a characteristic Cook Mountain fauna; among others, *Belosepia ungula, Clavilithes penrosei, Cornulina armigera, Turritella nasuta* var. *houstonia* are found	9
Covered	3
Very fossiliferous greensand; many fossils silicified	2
Finely laminated bluish-gray sandy clay with traces of vegetable matter	6

The beds appear to dip due south.

Section exposed on Sabine River 3 miles above Columbus, Sabine County, Tex.[1]

	Feet.
Quaternary:	
Unexposed to top of bank	14
Pebble conglomerate	2
Cook Mountain formation:	
Laminated dark-brown clay and yellow sand, containing fossils irregularly distributed through the whole mass; *Anomia ephippioides* in great number	23

The Cook Mountain beds dip a little west of south.

It is difficult to determine the dip of the beds in this bluff because of the land slips, but it appears to be a little east of south.

The uppermost beds of the Cook Mountain are exposed along the river 3 miles below Columbus as a small outcrop of fossiliferous marl.

The complete section along the Sabine is indicated on Plate IV.

Yegua formation.

NAME AND CORRELATION.

In 1892 Dumble recognized the lignitiferous unit here considered as a separate formation and applied to it the name Yegua. This same lithologic unit was described in Louisiana in 1895 by Vaughan as the

[1] Veatch, A. C., op. cit., pp. 129-130.

"Cocksfield Ferry beds." Veatch[1] described the deposits in eastern Texas under the name "Cockfield" in 1906. Recent investigation has shown that the lithologic unit described by each of these investigators is the same throughout and is stratigraphically continuous from western Louisiana far into Texas, representing in eastern Texas the time equivalents of the "Upper Claiborne" deposits or the Gosport sand of Alabama. This being so, Dumble's name, which was first used for the deposits, has precedence over the others and will be used in the present report.

In his studies on the Coastal Plain of Texas, in 1888 and 1889, Penrose discriminated what he called the "Fayette beds," which included a series of lignites, clays, and sands at the base, a series of sandstones in the center, and a series of calcareous clays at the top.

Beds belonging to this formation have been described as—

<Fayette beds. Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiary of Texas from Red River to the Rio Grande: First Ann. Rept. Geol. Survey Texas, 1890, pp. 47–58.

=Yegua formation. Dumble, E. T., Report on the brown coal and lignite of Texas; character, formation, occurrence, and fuel uses: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 148–154.

≡Lufkin or Angelina County deposits (considered to be of Miocene age). Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 58–60.

<Upper Lignitic. Lerch, Otto, A preliminary report upon the hills of Louisiana: Bull. Louisiana Experiment Station, 1893, pt. 2.

=Cocksfield Ferry beds. Vaughan, T. W., The stratigraphy of northwestern Louisiana: Am. Geologist, vol. 15, 1895, pp. 209–229.

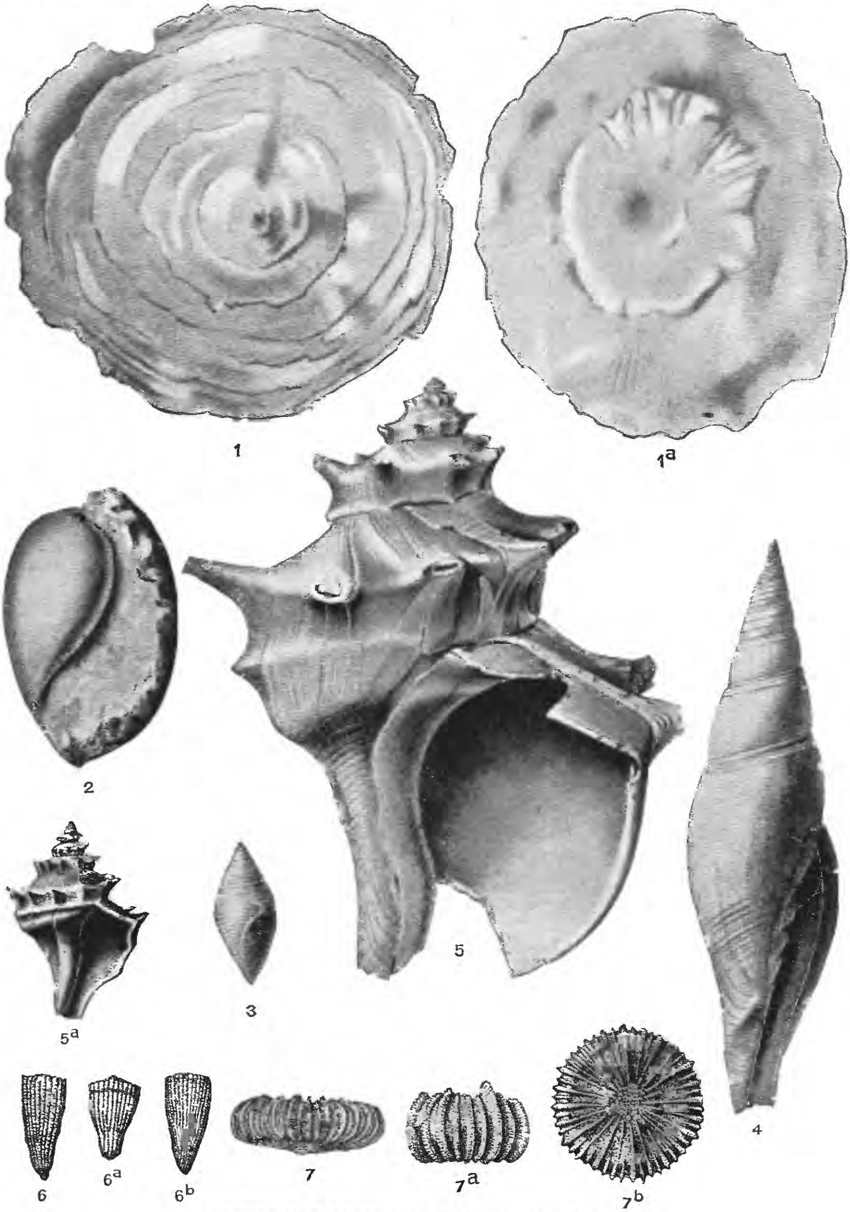
OCCURRENCE AND CHARACTER.

The Yegua formation lies stratigraphically and conformably above the Cook Mountain formation. It consists of clays, sands, and lignites of palustrine and marine origin varying from 375 to 750 feet in thickness. The clays are characterized by the fragments and concretions of selenite. The formation outcrops in Sabine, San Augustine, Angelina, Trinity, Houston, Madison, Grimes, and Brazos counties.

DETAILED SECTIONS.

Brazos River section.—On the Brazos, beds belonging to the Yegua formation are exposed from the mouth of the Little Brazos to southwest of Wellborn in Brazos County. The formation, as exposed between these two points, consists entirely, so far as known, of palustrine and lignitiferous deposits, barren of marine fossils. (See Pl. IV.)

[1] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, pp. 37, 38.



CHARACTERISTIC FOSSILS OF THE JACKSON FORMATION.

1, 1a. Umbrella planulata Conrad.
2. Haminea grandis Aldrich.
3. Conorbis alatoides Aldrich.
4. Mitra millingtoni Conrad.
5, 5a. Levifusus branneri Harris $\frac{4}{5}$.
6, 6a, 6b. Aldrichiella elegans Vaughan.
7, 7a, 7b. Trochocyathus lunulitiformis var. montgomeriensis Vaughan.

Sabine River section.—On Sabine River, beds belonging to the formation are exposed from 3 miles below Columbus to a short distance below Robertsons Ferry in Sabine County. As displayed along this river, the formation is very largely made up of typical palustrine deposits. (See Pl. IV, in pocket.)

JACKSON FORMATION.

NAME AND CORRELATION.

The formation to be described was named by Conrad in 1856 after Jackson, the capital of Mississippi, where the beds are characteristically exposed.[1] In 1869 Hopkins traced the formation across Louisiana as far westward as Red River.[2] Veatch was the first to announce the existence of the formation in Texas, which he did in 1902.[3]

The Jackson formation extends from Angelina River in Texas eastward across Louisiana into Mississippi. In Texas materials of Jackson age extend much farther west than Angelina River, and have been traced as far west as the Brazos. The materials in the region of the Brazos, however, are not lithologically similar to those of the Jackson formation, and do not belong to that formation, but form a part of the Catahoula sandstone, the lithologic unit next to be described.

Eastward from Mississippi (in Alabama) the Jackson formation is represented in time by the lower part of the St. Stephens limestone.[4]

OCCURRENCE AND CHARACTER.

The Jackson formation in eastern Texas lies stratigraphically and conformably above the Yegua and beneath the Catahoula. In Texas it appears only in the region between Trinity and Sabine rivers, in Sabine, San Augustine, and Angelina counties, as a lens of calcareous, fossiliferous clays of marine origin, containing large limestone concretions. Along the Sabine the formation is estimated to be 250 feet thick, but it thins rapidly westward and disappears between Trinity and Brazos rivers.

PALEONTOLOGY.

The Jackson formation is characterized by such fossils as *Umbrella planulata* Conrad, *Levifusus branneri* Harris, *Trochocyatus lunulitiformis* var. *montgomeriensis* Vaughan, and others. (See Pl. VI.)

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[1] Conrad, T. A., Observations on the Eocene deposits of Jackson, Mississippi, with descriptions of thirty-four new species of shells and corals: Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1856, pp. 257-268.

[2] Hopkins, F. V., First Ann. Rept. Louisiana State Geol. Survey, 1869: Ann. Rept. Board of Supervisors Louisiana State Seminary of Learning and Mil Acad. for 1869, 1870, pp. 77-109.

[3] Veatch, A. C., The geography and geology of the Sabine River: Rept. Geol. Survey Louisiana, 1902, pp. 131-132.

[4] Smith, E. A., The underground water resources of Alabama: Rept. Geol. Survey Alabama, 1907, p 5.

DETAILED SECTIONS.

Sabine River section.—On Sabine River, 1 mile below Robertsons Ferry, in Sabine County, highly fossiliferous and calcareous clays and marls, carrying large limestone concretions, outcrop, and carry characteristic Jackson fossils. The following species were determined by Harris: *Mitra millingtoni* Conrad, *Hipponyx americanus* Conrad, *Calyptrea trochiformis* Lamarck, *Ostrea trigonalis* Conrad, *Arca (Scapharca) rhomboidella* Lea, *Crassatellites flexurus* Conrad, *Cardium (Protocardia) nicolletti* Conrad, *Dione securiformis* Conrad, and *Corbula wailesiana* Harris.

OLIGOCENE SERIES.

CATAHOULA SANDSTONE (INCLUDING SOME EOCENE).

NAME AND CORRELATION.

The lithologic unit here recognized is identical with the lithologic unit first described by Dumble in 1892 under the name "Fayette division."[1] The name "Fayette" had, however, been previously applied by Penrose to a different division [2] and is not considered admissible in the present connection.

Great confusion has existed in Texas regarding the age and correlation of the unit here recognized. The nonmarine blue quartzites exposed at Grand Gulf, Miss., were first described in 1857 by Wailes, who called them "Grand Gulf sandstone."[3] These sandstones in Mississippi overlie the fossiliferous Vicksburg limestone and are there of Oligocene age.

Later Hilgard applied the name "Grand Gulf" to the group of beds exposed in southern Mississippi between the Vicksburg and the coast Pliocene ("Orange sand" or "Lafayette").[4]

In 1869 Hilgard made a geologic reconnaissance in Louisiana and incidentally visited some localities in eastern Texas. His observations disclosed the fact that the materials which he had referred to his "Grand Gulf group" in Mississippi extended across Louisiana into eastern Texas. He concluded that the age relations were the same in Texas as in Mississippi, and that the beds in Texas were also of post-Vicksburg age.[5]

Penrose, working in Texas in 1888, recognized a group of beds which he called the "Fayette."[2] This group, which he regarded as

[1] Dumble, E. T., Report on the brown coal and lignite of Texas, character, formation, occurrence, and fuel uses: Rept. Geol. Survey Texas, 1892, pp. 154-157.

[2] Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiary of Texas from Red River to the Rio Grande: First Ann. Rept. Geol. Survey Texas, 1890, pp. 47-58.

[3] Wailes, B. C. L., Agriculture and geology of Mississippi, 1857, pp. 216-219.

[4] Hilgard, E. W., Report on the geology and agriculture of the State of Mississippi, 1860, pp. 147-154.

[5] Hilgard, E. W., Summary of results of a late geological reconnaissance of Louisiana: Am. Jour. Sci., 2d ser., vol. 48, 1869, pp. 337-338.

representing the time equivalent in Texas of Hilgard's "Grand Gulf" and as being of Miocene age, included the materials here referred to the Fleming, Catahoula, and Yegua formations.

Later Dumble, working in southwestern Texas, discovered that materials lithologically similar to the "Grand Gulf sandstone" of Wailes carried fossils of Eocene age. He concluded, if his writings are here correctly interpreted, that the formation which carried these materials (called by him "Fayette") was not stratigraphically continuous with the formation which carried these materials in Louisiana and Mississippi.[1]

Kennedy, working in eastern Texas, found there the sandstone similar to the one that carried the Eocene fossils in southwestern Texas. He concluded that the materials in eastern Texas were of the same age as those in southwestern Texas.[2]

Veatch, in 1902, noted the occurrence of this group of beds in Louisiana, overlying the Vicksburg. He considered it to be of middle Oligocene age and considered that the Texas materials (with the exception of the basal portion which he assigned correctly to the Jackson epoch) were of the same age.[3]

In 1906, in order to provide a definite name for this lithologic unit to take the place of "Grand Gulf," which had been used with various meanings, Veatch proposed that it be called the Catahoula[4] (after Catahoula Parish, in Louisiana, where the formation is typically exposed), which is the name adopted in this report.

The fossiliferous Vicksburg limestone, as developed east of Louisiana, does not outcrop in Texas, nor has it been found in wells so far as known. The investigations of G. C. Matson[5] have shown that the Vicksburg limestone of Alabama grades into sandstone toward the west. Sandstone replaces the upper part of the Vicksburg in western Alabama, more of it in Mississippi, and still more in eastern Louisiana, and in western Louisiana it replaces the whole Vicksburg and even some beds of Jackson age are lithologically similar and apparently can not be separated.

As here interpreted, the Catahoula sandstone is a lithologic and stratigraphic unit which transgresses several biologic zones. Stated differently, it is conceived to be of different ages, and to have been laid down at different epochs in the respective regions of its occur-

[1] Dumble, E. T., Geology of southwestern Texas: Trans. Am. Inst. Min. Eng., vol. 33, 1903, p. 922.

[2] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol Survey No. 212, 1903, p. 21.

[3] Veatch, A. C., The Geography and Geology of the Sabine River: Rept. Geol. Survey Louisiana, 1902, pp. 131–132.

[4] Veatch, A. C., Geology and underground-water resources of northern Louisiana and southern Arkansas, Prof. Paper U. S. Geol. Survey No. 46, 1906, pp. 42–43.

[5] Unpublished notes.

rence. In central Texas, in the region of the Brazos, it is largely of Jackson age. In eastern Texas it is largely of Vicksburg age. According to Matson, the vertical transgression continues across Louisiana into Mississippi, where the formation lies above the Vicksburg limestone.[1]

OCCURRENCE AND CHARACTER.

The Catahoula sandstone lies stratigraphically and conformably above the Jackson formation in eastern Texas and above the Yegua formation in central Texas. It lies stratigraphically beneath the Fleming clay.

The formation, which ranges in thickness from 500 to 800 feet, consists of a series of gray and blue sandstones, interbedded with brown, gray, and green clays, gray sands, and some lignite. The sandstones in some places carry marine fossils and in others casts of palm leaves and reeds and great quantities of silicified and opalized wood. A characteristic feature is the occurrence locally of very hard blue quartzites, which, owing to their superior hardness, resist weathering better than the adjacent materials and form hills. These quartzites pass laterally in very short distances into soft sandstones and unconsolidated sands.

The outcrop appears as a belt of country about 15 miles wide, extending east and west across the area and including portions of Sabine, Newton, San Augustine, Jasper, Angelina, Tyler, Trinity, Polk, Walker, San Jacinto, Montgomery, Grimes, and Brazos counties.

DETAILED SECTIONS.

Sabine River section.—On the Sabine, from Anthonys Ferry to near Burrs Ferry, the Catahoula sandstone lies exposed on top of clays belonging to the Jackson formation. (See Pl. IV.) The dip varies between 1° 9′ and 1° 12′.

San Augustine County.—Near Caddel in San Augustine County the basal part of the Catahoula sandstone is exposed. It carries well-defined Jackson fossils.[2]

Tyler County.—At Rockland, Tyler County, the following section is shown:[3]

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[1] Studies made by the author since this report was written seem to indicate that the Catahoula sandstone as here described is not a stratigraphic unit but comprises two formations of similar lithologic character, the one at the base being of Jackson age, whereas the upper sandstone is of Oligocene age. The name Wellborn was applied by Kennedy to the lower of these two sandstones.

[2] Veatch, A. C., The geography and geology of the Sabine River: Rept. Geol. Survey Louisiana, 1902, p. 131.

[3] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, p. 120.

Section at Rockland, Tex.

	Feet.
Gray sand and siliceous pebbles	18
Mottled blue and brown sandy clay	20
Fleming clay:	
Green sandy clay	20
Brown sandy clay	20
Pale-blue sand and clay	15
Dark-blue clay with lime concretions	20
Dark-gray sandy clay	30
Catahoula sandstone:	
Gray sandstones, coarse-grained on top, but changing to fine-grained blue hard quartzitic stone at base	120

Polk County.—At Petersville, 4 miles north of Corrigan, Polk County, a cut on the Houston, East & West Texas Railway shows a gray sandstone, referred to the Catahoula, that carries casts of *Levifusus branneri*, *Mazzalina* var. *oweni*, *Calyptraphorus velatus* Con., *Venericardia planicosta* Lam., and *Corbula alabamiensis* Lea. The first two are reported by Harris,[1] the others by Kennedy.[2] They indicate that the materials are of Jackson age.

About one-half mile north of Corrigan, along the banks of Bear Branch, the sandstones of the Catahoula are well exposed. At this particular locality the gray sandstones are well indurated into hard stone.

Three-fourths mile northeast of Corrigan a small quarry exposes a ledge 10 feet thick, which well shows the nature of the formation. The rock is hard and firm, of uniform appearance and composition, and without bedding planes.

Brazos County.—About 2 miles northwest of Wellborn the following section was obtained:

Section exposed near head of creek on the Robert Stephenson League, about 2 miles northeast of Wellborn, Brazos County, Tex.

	Feet.
Pleistocene:	
Gravel consisting of cobbles of milky quartz, jasper, black flint, and silicified wood.	
Catahoula sandstone:	
Hard fossiliferous sandstone, carrying *Venericardia planicosta* Lamarck, *Cytherea discoidalis* Conrad, *Corbula alabamiensis* Lea, and Mactra sp.?	1¼
Yegua formation:	
Brown lignitic shale, in places sulphurous and calcareous; dips 4° S. 40° E	11
Soft, flaggy nonfossiliferous calcareous sandstone; very much jointed; exposed	7

[1] Rept. Geol. Survey Louisiana, 1902, p. 25.
[2] Proc. Acad. Nat. Sci. Philadelphia, 1895, p. 97.

Farther down the creek the hard fossiliferous sandstone of the section passes into a nonindurated sand about a foot thick that contains no fossils. This sand is underlain by a brown lignitic shale, which is apparently the same as the brown lignitic shale of the section. Above the sand lies another brown lignitic shale, which in turn is covered by a thin veneer of Pleistocene gravel.

At Wellborn, near the schoolhouse, gray nonfossiliferous sandstones showing streaks of silicified matter resembling roots and twigs are exposed. These sandstones overlie those exposed on the Stephenson League.

On the road between Wellborn and Millican a compact massive green shale is exposed at a small creek.

At Millican a hard blue semiquartzitic sandstone is quarried.

Vaughan is of the opinion that the horizon represented by the hard fossiliferous sandstone of the section on the Robert Stephenson League is probably very low in the Jackson, and if this be so, the beds between Wellborn and Millican would represent in part the time equivalents of the Jackson formation along the Sabine.

MIOCENE SERIES.[1]

FLEMING CLAY.

NAME AND CORRELATION.

The formation to be considered was named by Kennedy, by whom it was first recognized and described, after Fleming, on the Missouri, Kansas & Texas Railway in Polk County, Tex., where it is typically exposed.[2] This name will be retained in the present report.

Kennedy at that time considered that his Fleming clays belonged to the Miocene, and, as appears from the evidence afforded by fossils of brackish-water origin at Burkeville, Newton County, Tex., they are of an age not older than Miocene in that region.

After the manuscript for Mr. Deussen's report was prepared some additional collections were made from the limestones about 1 to 1½ miles southeast of Burkeville, and the fossils were submitted to W. H. Dall for study. He has prepared a paper describing the collections from this locality and comparing them with collections from well samples obtained on a farm owned by Dr. Simmons and others, about 8 miles southwest of Alexandria; from samples obtained from one of the wells of the Producers Oil Co. at Pine Prairie, La.; and from Satilla River in Georgia. A list of the fossils from these localities has been furnished by Mr. Dall and is presented here:

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[1] As paleontologic studies made after the manuscript of this report was prepared show that deposits considered a part of the Fleming clay are not older than Miocene, this formation is referred to the Miocene (see subsequent list of fossils), thus introducing a discrepancy between the text of the report and the legend of Pl. I, which had already been printed.

[2] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 62-63.

Fossils from Burkeville, Tex., Satilla River, Ga., and 8 miles southwest of Alexandria, La.

[The localities at which the fossils were found are indicated by letters: S, Satilla River; A, Alexandria; B, Burkeville.]

	New.	Pliocene.	Recent.
Rangia cuneata Gray. S			×
R. cuneata var. solida. S A	×		
Mulinia lateralis Say. S			×
M. sapotilla Dall. A (Pine Prairie)		×	
Heterodonax alexandra Dall. A	×		
Mytilopsis sp. A	?		?
Modiolaria lateralis Say? S		×	×
Gemma purpurea Lea. S		×	×
Unio sandrius Dall. A (B?)	×		
U. alixus Dall. A	×		
U. musius Dall. A	×		
Ostrea virginica Gmel. A B S		×	×
Anomia sp. B	×		
Potamides matsoni Dall. A B (Pine Prairie)	×		
P. matsoni var. gracilior Dall. A B (Pine Prairie)	×		
Cerithiopsis burkevillensis Dall. B	×		
Pachycheilus anagrammatus Dall. A B	×		
P. cancelloides Aldrich. S	×		
P. satillensis Aldrich. S B	×		
P. suavis Dall. A B (Pine Prairie)	×		
Turritella satilla Dall. A S	×		
Isapis obsoleta Dall. A	×		
Syrnola thelma Dall. A	×		
Paludestrina plana Aldrich. S	×		
P. aldrichi Dall. A	×		
P. georgiensis Aldrich. S	×		
P. satillensis Aldrich. S	×		
P. curva Dall. B	×		
P. cingulata Dall. A	×		
P. turricula Dall. A	×		
P. milium Dall. A	×		
Amnicola expansilabris Aldrich. S	×		
Pyrgulopsis satilla Dall. A	×		
Neritina sparsilineata Dall. S A B	×		
Planorbis ophis Dall. A	×		
P. antiquitus Aldrich. S	×		
Total (35 species)	29	4	5

Of the 35 species from the three localities 29 are new, and they are described by Mr. Dall in a forthcoming paper. Of the remaining species, four have previously been described from the Pliocene and five from the Recent.

At the Satilla River locality 15 species were obtained; at the locality near Alexandria, 21 species; at Burkeville 10 species. Only two species are common to all three of these localities. One of them is a new species, the other has been described from both Pliocene and Recent. In addition two species are common to the Satilla River and Alexandria localities; one species is common to the Satilla River and Burkeville localities; and four species are common to the Alexandria and Burkeville localities, with a fifth doubtfully determined from Burkeville. From Pine Prairie only four species were identified, three of them being common to the Alexandria and Burkeville localities, and a fourth known only from Alexandria.

Of the known Pliocene species in this fauna three are found on Satilla River, two are found at Alexandria, and one at Burkeville. Of the species previously described from the Recent all were obtained on Satilla River and one (*Ostrea virginica* Gmel.) was obtained from both the Alexandria and Burkeville localities. The character of this fauna led Mr. Dall to refer it to the Pliocene, and the facts are presented here for the purpose of making clear the exact status of our knowledge concerning the stratigraphy of the beds at Burkeville.—G. C. Matson.

OCCURRENCE AND CHARACTER.

The Fleming includes the series of calcareous clays which lie stratigraphically above the Catahoula sandstone.

The formation, which is 200 to 500 feet thick, consists of grayish sandy clays with small nodules of lime, thin beds of sandstone, and bluish and greenish gray sand with characteristic nodules of lime.

The outcrop appears as a belt of country, from 2 to 7 miles wide, lying south of the Catahoula outcrop east and west across Newton, Jasper, Tyler, Polk, San Jacinto, Walker, and Grimes counties. Its residual soils are black clays, approaching the type of the "black waxy" soils so common in the Cretaceous regions of Texas. These "black lands," where not mantled with materials of later age, appear as prairie or treeless areas, surrounded by forests.

DETAILED SECTIONS.

Sabine River section.—On Sabine River, the Fleming clay is exposed in the bluffs between Burrs Ferry and a point east of Burkeville. (See Pl. IV.)

Neches River section.—On Neches River, exposures of the formation occur between Smith Ferry and a point east of Colmesneil.

Grimes and Brazos counties.—In Grimes and Brazos counties, along Brazos River the Fleming clay is exposed for a short distance north of Navasota.

DEWITT FORMATION (INCLUDING SOME PLIOCENE).

NAME AND CORRELATION.

The name Dewitt is here for the first time applied to the formation below described, after Dewitt County in southwest Texas, where the beds are well exposed.

The deposits here recognized have been described by Dumble[1] as the Oakville, Lapara, and Lagarto beds. It is exceedingly difficult to discriminate these divisions in the field in such a way that their areal distribution can be satisfactorily mapped, and until adequate criteria can be evolved it is considered advisable to treat the deposits as one formation.

The extension of the formation eastward beyond the Trinity and its relation to the Miocene and Pliocene beds of this region have not been clearly determined. It is probable, however, that the Dewitt formation thins out in this direction and is replaced by Miocene and Pliocene strata laid down in brackish or marine waters.[2]

[1] Dumble, E. T., The Cenozoic deposits of Texas: Jour. Geology, vol. 2, 1894, pp. 556-560.

[2] Studies made after this report was written seem to indicate that what is here called the Dewitt formation is represented along the Sabine by the beds described as the Fleming clay.

OCCURRENCE AND CHARACTER.

The Dewitt formation lies unconformably below the Lissie gravel. It includes all materials of lacustrine and littoral origin deposited on the Coastal Plain of Texas during Miocene and early Pliocene time. It consists of gray, loosely consolidated, highly calcareous sands and sandstones, cross-bedded in places; brown, pink, green, and green-brown mottled clays; and conglomerates made up of rounded fragments of clay. In southwest Texas the clays in places carry dendrites of manganese or nodules of lime showing manganese stains. The calcareous sandstones and sands commonly lie at the base of the formation, and the clays and conglomerates predominate at higher horizons. The sandstones in places have a semblance of bedding but more commonly are without it.

The maximum thickness at one place is estimated at 1,500 feet.

The formation appears at the surface in portions of Walker, Montgomery, Grimes, Harris, and Waller counties. Its outcrop in much of the area is obscured by a veneer of Pleistocene materials. The soils derived from it are prevailingly black loams and are grass-covered or treeless.

PALEONTOLOGY.

No marine fossils occur in the formation, but fossil land vertebrates may be found at a number of places. Among the latter may be mentioned the rhinoceros Aceratherium.

DETAILED SECTIONS.

East of Brazos River.—In the region east of the Brazos the formation is almost completely hidden beneath the extensive Pleistocene materials. A cut on the Houston & Texas Central Railroad about 5 miles south of Navasota shows 8 feet of highly cross-bedded sands belonging to this formation; and a small creek about 3 miles south of Courtney, Grimes County, exposes it as a green calcareous clay weathering into a black soil, between uplands capped with Pleistocene gravel.

West of Brazos River.—West and south of the Brazos, numerous exposures of the Dewitt formation may be seen.

In Washington County immediately west of the Brazos in the vicinity of Burton, gray calcareous sandstones and clays belonging to the formation occur. A jawbone and teeth of Aceratherium, a Miocene rhinoceros, has been taken from the clays exposed in this region.

Shumard reported the occurrence of Miocene strata in the Coastal Plain as far back as 1860. In a letter dated October 2, 1860, he wrote:[1]

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[1] Trans. Acad. Sci. St. Louis, vol. 2, 1868, pp. 140-141.

Not among the least important results of the survey is the discovery in Washington and adjoining [Texas] counties of an extensive development of Miocene Tertiary strata, referable to the age of Miocene deposits of the mauvaises terres of Nebraska, which have yielded such a wonderful profusion of extinct mammalian and chelonian remains. The Texan strata consist of calcareous and siliceous sandstones, and white, pinkish, and grayish siliceous and calcareous marls. The calcareous beds are often almost wholly composed of finely comminuted and water-worn shells, chiefly derived from the destruction of the Cretaceous strata, and in places abound in fossil bones and plants, usually in a fine state of preservation. The bones have usually been found in excavations for wells, at depths varying from 20 to 60 feet below the surface, and consist of genera closely allied to or identical with Titanotherium, Rhinoceros, Equus, and Crocodilus. Among the plants are several species of palms, a fine collection of which has been made by Dr. Gideon Lincecum, of Long Point, Washington County, and by him presented to the State cabinet.

MARINE MIOCENE (PROBABLY INCLUDING SOME EARLY PLIOCENE).

GENERAL CHARACTER.

While the materials of the Dewitt formation were being deposited in lakes or deltas near the shore, extensive sands and clays were being accumulated in the adjacent sea. These deposits, preserved as an economically important group of strata beneath the present coast prairies of Texas, are characterized by marine fossils of Miocene and probably early Pliocene age. So far as known these marine beds do not outcrop in Texas, but they are found in all wells within about 60 miles of the coast and they appear to come to the surface in Louisiana and the States to the east.

Data afforded by wells show that these marine Miocene beds are not less than 813 feet thick and dip southeast 10 to 20 feet to the mile.

DETAILS OF OCCURRENCE.

At Hockley, in Harris County, in the Higgins well No. 1, a calcareous sandstone, which upon analysis showed 60.26 per cent of silica and 21.42 per cent of calcium oxide, was entered at a depth of 14 feet. Down to 730 feet the chief material penetrated was sandstone. Shark teeth, found in a bed of shale passed through at 300 feet, were submitted to Dr. L. Hussakof, of the American Museum of Natural History, New York, who reported on them as follows:

The shark teeth are identical or very close to *Oxyrhina minuta* Agassiz, a lower Miocene (Europe), and ? upper Eocene (North Carolina) species. The other teeth represent the teleoston genus Sphyræna, which ranges from Eocene to modern times.

As it is highly improbable that Eocene beds were entered at a depth of 300 feet in this well, a Miocene horizon is inferred, and this would place these beds between the surface and 300 feet in the marine Miocene.

At Galveston, in 1891–92, a well 3,070 in depth disclosed, from 2,158 to 2,920 feet, beds of Miocene age which include green clays;

indurated fine gray sands; dark-colored clays with lignitized wood and fruits, corals, fish vertebræ, and marine fossils; sandy clays, shell conglomerates, and blue clays with lime nodules. Among the numerous fossils were *Arca carolinensis*, *Turritella subgrundifera* var., Chione sp. ?, Terebra n. sp., and *Natica eminuloides*, which prove the age of the inclosing materials to be Miocene.[1] For a complete record of this well see pages 166–169.

At Batson, in Hardin County, Tex., in the Gilbert well No. 10, at a depth of 323 feet, marine Miocene beds are proved by the fossils to have been entered. The fossils, as determined by Dall, are as follows: *Olivella mutica* Say, *Nassa acuta* Say, *Utriculus canaliculatus* Say, *Pecten* fragments, *Arca transversa* Say (young), Arca fragments (*adamsi?* Smith), Solen fragments, Dosinia (very young), *Mulinia lateralis* Say (young), *Corbula galvestonensis* Harris, *Balanus* fragments, and bryozoan fragments.

At Bryan Heights, near Velasco, a sample from a depth of 649 to 688 feet contained organic remains not older than upper Miocene,[2] indicating that the marine Miocene lies more than 688 feet below the surface at this place.

At Saratoga, in Hardin County, according to information furnished by Dumble, Miocene fossils have been taken from oil-bearing sand at a depth of 1,140 to 1,154 feet.

PLIOCENE SERIES.

UVALDE FORMATION.

NAME AND CORRELATION.

The formation here recognized will be called the Uvalde, having been originally described under that name by Hill.[3] It is named after Uvalde County in southwest Texas, where it is well displayed.

So far as known the marine time equivalents of this formation have not been found beneath the Coast Prairie, and it is extremely doubtful if they exist there. To find them would probably require a search on the Gulf floor a considerable distance beyond the present shore line.

OCCURRENCE AND CHARACTER.

The formations heretofore described represent deposits laid down in the sea or in swamps and lakes close to the shore. The Uvalde and a number of the more recent formations of the Coastal Plain have, however, been formed primarily by streams and may be described as fluviatile and alluvial.

[1] Harris, G. D., Preliminary report on the organic remains obtained from the deep well at Galveston together with conclusions respecting the age of the various formations penetrated: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 118.

[2] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 14.

[3] Hill, R. T., Notes on the geology of the Southwest: Am. Geologist, vol. 7, 1891, pp. 367–368.

The Uvalde formation is the oldest and earliest of the fluviatile or alluvial formations in the Texas Coastal Plain. It was probably deposited in late Pliocene times after deposition of the Dewitt and the marine Miocene and lower Pliocene, and it represents the work of the gradational agents during the late Pliocene erosion epoch.

The formation, which ranges in thickness from a few inches to 100 feet, consists of flint and limestone gravel embedded in a limy clay matrix.

Along the Cretaceous-Tertiary boundary it lies 350 feet above the level of the present channels of the adjacent major streams. In the region west of the Tertiary area it appears as a terrace material, forming the uppermost terraces of the major streams, such as the Brazos and the Red. Downstream it passes into an interstream phase, which appears as a gravel capping the divides between the major streams and lying unconformably on the underlying Cretaceous and Eocene formations. The transition from the terrace phase to the interstream phase takes place roughly along the Cretaceous-Tertiary contact, which is in these parts largely obscured by the gravels. On the divides, a short distance south of the contact, the gravels disappear.

The Uvalde formation, therefore, appears only in the interior of the Coastal Plain; within the area covered by this report it appears only as a thin veneer mantling the interstream areas along the western margin. Between Brazos and Red rivers it is not very extensively developed, but south of the Brazos it is very conspicuous. It weathers into a fertile black gravelly clay soil. Areas of it are generally treeless and appear as prairies.

Owing to the irregular distribution and the comparative insignificance of the formation in the water-supply problems of the area covered by this report, no attempt has been made to indicate its areal extent on the map.

QUATERNARY SYSTEM.

PLEISTOCENE SERIES.

LISSIE GRAVEL.

NAME AND CORRELATION.

The lithologic unit now to be described is called the Lissie gravel after the town of Lissie, in Wharton County, Tex., where it typically occurs.

As here interpreted, the Lissie gravel represents the time equivalents of the middle and of the lower part (or gravel portion) of the lowest of the three Pleistocene terraces described on pages 82–83.

The Lissie gravel is believed to represent the coalescing alluvial fans which were spread out at the mouths of the valleys of the streams which discharged into the sea during some parts of Pleistocene time, possibly the early and middle parts. It is further believed that the gravel was later elevated and eroded, proof being found in the fact that terraces which grade laterally into the lower or interior part of this gravel lie 50 to 70 feet above the lowest of the Pleistocene terraces, whereas the lowest Pleistocene terraces grade into the upper part of the gravel and into the Beaumont clay. Furthermore, a few isolated unconformities are exposed in the southwest. Following this erosion epoch came a depression of the land and an invasion of the sea, in a later portion of Pleistocene time, submerging in part the area occupied by gravel. On the floor of this Pleistocene sea, on top of the eroded gravels, was spread unconformably another layer of gravel, similar in composition and consisting in part of reworked and eroded products of the first layer. With the gradual deepening of the sea and the lessening gradients of the streams, deposition of gravel ceased and in place of it was formed a deposit of silt, sand, and clay to which has been given the name Beaumont clay.

Lissie gravel, therefore, as used in this report, includes all the gravels, these being characterized by more or less uniform lithologic composition, albeit separated by an unconformity into lower and upper portions.

OCCURRENCE AND CHARACTER.

The Lissie gravel lies stratigraphically above the Dewitt formation; or where the Dewitt is replaced seaward by the marine Miocene beds, the Lissie rests directly on the latter. It lies stratigraphically below the Beaumont clay.

In lithologic character the Lissie gravel is variable, the variation being determined by differences in the nature of the materials composing the several drainage areas from which the débris now composing it was derived. In places it consists of gravels and conglomerates of granitic origin derived from rocks such as quartz, jasper, flint, limestone, and greenstone; in other places it consists of gravels and conglomerates of limestone origin; and in still others it consists of mottled sands and silts containing ferruginous pebbles and concretions. For example, in the southwest, where the formations crossed by the streams consist chiefly of limestone, and where, in consequence, most of the material carried by the streams is limestone débris, the formation consists chiefly of limy conglomerates and adobe. In the Colorado drainage basin, where granitic areas have been subjected to erosion, the Lissie gravel consists entirely of gravels, conglomerates, and coarse sands of granitic origin. In the eastern region, where the areas drained are largely made up of red clays and ferruginous sands and iron ores, the formation consists largely of ferruginous sands, silts, and conglomerates.

Well records indicate that the Lissie gravel does not exceed 900 feet in thickness at any point on the Coastal Plain. Along the Lissie-Beaumont boundary line it is improbable that the Lissie exceeds 600 feet in thickness, and 30 to 50 miles farther north it has thinned to a mere veneer.

The outcrop of the gravel parallels the coast, occupying portions of Newton, Jasper, Tyler, Hardin, Polk, Liberty, San Jacinto, Montgomery, Waller, Harris, and Fort Bend counties. It forms a nearly level to rolling plain, prevailingly timbered east of the Brazos, but treeless and grass-covered between the Brazos and the Colorado. The soils are largely reddish-brown or gray silts and fine sands.

The Lissie gravel constitutes one of the most important water-bearing reservoirs of the Coastal Plain, appearing in every well in the coast prairies. For example, at Spindletop it was met at 120 feet in the Higgins well No. 2 and at 245 feet in the Higgins well No. 1. In the Bryan Heights well near Velasco it was met at 735 feet.

PALEONTOLOGY.

Vertebrate fossils of Pleistocene age, among them Equus, Elephas, and Megalonyx, occur in this gravel at a number of places.

DETAILS OF OCCURRENCE.

Four miles north of Brookshire, Waller County, a well belonging to C. Wilson shows the following section:

Section of well 4 miles north of Brookshire, Tex.

	Feet.
Lissie gravel:	
Red clay (?)	52
Sand and gravel, water bearing	25
Clay	23
Sand and gravel, water bearing	37

From the sands and gravels in the bottom of this well, teeth of fossil Equus of Pleistocene age were taken.

At Kirbyville, Jasper County, in a cut on the railroad south of the depot, 6 feet of pink mottled sandy clay containing small brown pebbles or concretions is referred to this formation. Similar sections occur throughout the area of the Lissie gravel.

BEAUMONT CLAY.

NAME.

The lithologic unit described below has been called by Kennedy[1] the Beaumont clay, and this name is used in the present report.

[1] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, pp. 27-29.

OCCURRENCE AND CHARACTER.

The Beaumont clay lies stratigraphically above the Lissie gravel and below the Recent series. It consists of blue, in places reddish calcareous clay, containing numerous lime concretions about an inch in diameter, and some local lenses of sand and sandy clay. Well records indicate that it does not exceed 800 feet in thickness at any place.

The Beaumont clay outcrops in Orange, Jefferson, Hardin, Liberty, Chambers, Harris, Galveston, Fort Bend, and Brazoria counties, and it forms the substratum of the level, treeless coast prairies. (See p. 16.) The black clay soils derived from it are extremely fertile and in east Texas are well adapted to rice culture. The Beaumont clay also serves as an impervious stratum to confine the water in the porous Lissie gravel and is thus an important factor in the numerous artesian wells of the coast prairie region.

PALEONTOLOGY.

The clays of this formation carry in places fossils of Pleistocene age, among which is *Rangia cuneata*. Embedded logs are common.

PLEISTOCENE TERRACE DEPOSITS.

In Pleistocene time, in addition to the Lissie gravel and the Beaumont clay, which were deposited adjacent to the coast, there were deposited in the valleys of the major streams a series of terraces, which may be classified according to their relative topographic positions. Three terraces may be discriminated, the highest being the oldest. Each terrace grades laterally into an interstream phase, the Lissie gravel and the Beaumont clay representing the interstream phases of the middle and lowest.

HIGHEST PLEISTOCENE TERRACE.

The highest Pleistocene terrace north and west of the Yegua-Cook Mountain boundary lies 200 to 225 feet above the level of the adjacent major stream channels. It has been previously described by Hill and Vaughan[1] as the Asylum group or Asylum terraces of Colorado River in Texas.

In some drainage areas the materials consist of gravels of granitic origin; in others of ferruginous sands and conglomerates, sandy clays, and silts with fragments of iron ore; in still others of limestone débris cemented into a conglomerate by lime.

[1] Hill, R. T., and Vaughan, T. W., Geology of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Tex., with reference to the occurrence of underground waters: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1898, p. 249.

Over the area of the outcrop of the Yegua, this terrace grades laterally into an interstream or upland phase, veneering the older Tertiary formations. South and east of the Yegua outcrop the deposits thin and disappear, the country between the interstream phase and the outcrop of the Lissie not being mantled by Quaternary deposits. Thus far no marine, palustrine, or lacustrine time equivalents of this terrace have been recognized in the materials embedded beneath the Coast Prairie, and it is improbable that such will be found there, though they doubtless exist beneath the sea.

In Brazos County, on the uplands in the vicinity of Wellborn, the interstream phase of this terrace deposit is well displayed as a veneer of gravel composed of quartz, jasper, black flint, and silicified wood. In Houston County the same materials are extensively developed as a gravel covering a ridge extending southeast across the county from Brookfield Bluff on Trinity River on the west to the Trinity County line on the east.[1]

Owing to the irregular distribution and relative unimportance of this terrace deposit in water-supply problems, no attempt has been made to map it.

MIDDLE PLEISTOCENE TERRACE.

The middle Pleistocene terrace lies topographically below the highest Pleistocene terrace. North of a line extending from Sealy in Austin County, through Spring in Harris County, Kountze in Hardin County, to Buna in Jasper County and beyond, it occupies levels 100 to 140 feet above the channels of the adjacent major streams. It has been previously described under the name Capitol Terrace of Colorado River by Hill and Vaughan.[2]

The materials vary in lithologic character according to the nature of the deposits composing the drainage areas from which they have been derived. Some are gravels and conglomerates of granitic origin; others are gravels and conglomerates of limestone origin; and still others are mottled sands carrying ferruginous pebbles and concretions.

The terrace grades laterally without break into the basal portion of the Lissie gravel and is considered to be its time equivalent.

Near Hidalgo Falls, on Brazos River, the near-by hills flanking the main valley are composed of beds belonging to the Dewitt formation, capped by a pebbly deposit cemented by ferruginous matter into a coarse conglomerate. From this conglomerate, which is referred to the middle terrace, have been collected fossil bones of Mastodon, Elephas, Megalonyx, Equus, Crocodilus, and Testudo of Pleistocene age.[3]

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[1] Kennedy, William, Houston County: Third Ann. Rept. Geol. Survey Texas, 1892, p. 14.
[2] Hill, R. T., and Vaughan, T. W., op. cit., pp. 249-250.
[3] Shumard, B. F., Trans. Acad. Sci. St. Louis, vol. 2, 1868, pp. 140-141.

LOWEST PLEISTOCENE TERRACE.

The lowest of the Pleistocene terraces lies topographically below the middle Pleistocene terrace, and 40 to 70 feet above the channels of the major streams adjacent. It has been previously described by Hill as the Depot Group of terraces on Colorado River.[1]

The terrace consists of red, brown, yellow, or dark sandy, and in places calcareous clay, loam, or silt, resting on a gravel foundation. The red and brown silts and loams rest on gravel of granitic origin, in places cemented by iron into a ferruginous conglomerate. The dark or yellow calcareous silts and loams rest on limy conglomerates or gravels of limestone origin.

South and east of a line 50 to 70 miles from the coast the lowest Pleistocene terrace grades laterally into an interstream phase, represented by the upper part of the Lissie gravel and the whole of the Beaumont clay.

This terrace is more extensive than any other displayed in the valleys—fortunately so, for whereas the other gravel terraces are commonly unfit for cultivation, this lowest Pleistocene terrace is characterized by extremely fertile soils, which are widely cultivated. Much of the so-called Brazos bottom lies on this terrace. In addition, the porous gravel beneath the clays and silts constitutes an important water horizon, and renders this terrace in marked degree adapted for habitation by man.

RECENT SERIES.

Fringing the coast and constituting the bottom lands in the area (Pl. I) is a seiies of deposits that lie stratigraphically above all the formations previously described, having been laid down during the present geologic epoch—that is, since sea and land have attained practically their present relations. These deposits, even now in process of accumulation, constitute the Recent series.

Along all the larger streams this material constitutes the alluvium now occupying the flood plains. Along the Brazos it consists of red sandy clay, derived, during times of flood, from the "Red Beds" far in the interior; and along the Trinity it consists chiefly of sand derived, during high water, from Cretaceous formations.

Along the coast, east of Galveston Bay, many sluggish bayous, responsive to tidal influence, wind through marshes, in which fine silt or clay is now being deposited and in which, in places, bluffs made up of shells of a mollusk (*Rangia cuneata*) are exposed. Grigsbys Bluff on Neches River is typical.

Between the coast marshes and the Gulf a narrow, new-formed, wave-built key extends, protecting the marshes against the waters of

[1] Hill, R. T., Geography and geology of the Black and Grand prairies, Texas, etc.: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, p. 352.

the Gulf. It consists of sand, through which are scattered a great number of Recent shells.

The submerged portion of the Coastal Plain is likewise mantled with materials referable to the Recent series. Lens-shaped deposits of hard blue clay and soft mud occur, through which banks of coarse and fine gray sand and broken shells are irregularly interspersed. The Sabine Bank is made up of gray sand with black specks and broken shells. Sands appear to form the heaviest deposits at present adjacent to the shore.

STRUCTURE.

GENERAL FEATURES.

The formations of the Texas Coastal Plain have, in the area, a characteristic dip to the southeast or toward the Gulf. This dip, which ranges from practically nothing to 200 feet per mile, has been caused by the gradual elevation of the interior part of the old Cretaceous plain to a position at least 500 feet above the level occupied by it at the beginning of the Tertiary period.

The relation of one formation to another is indicated in the structure sections accompanying the geologic map. (See Pl. I, in pocket.) Toward the interior successively older rocks outcrop, the formation lowest in the geologic column having the highest topographic exposure. Such a structure is characteristic of coastal plains and is ideal for artesian water. Rain falling on the outcrop is conducted by the porous beds to great depths beneath the surface and becomes available as an uncontaminated water supply to people far coastward of the outcrop.

DOMES.

The existence of the so-called domes on the Coastal Plain has already been noted (p. 19). (See fig. 6.) Belonging to this type are Spindletop, in Jefferson County (structure section B–B′, Pl. I, in pocket); Kiser Mound, in Brazoria County; Grand Saline, in Van Zandt County; and Steen Dome, in Smith County; all of which are proved by the drill and fossils to be hills of slight deformation (quaquaversal folds) involving at least all the pre-Recent sediments. Their origin is undetermined. One theory holds that they were forced up by the intrusion of volcanic plugs; another, that they were produced by the upward pressure of artesian waters escaping from great depths along fault planes; a third, that they were caused by the crystallizing of salt nuclei, which form when hot waters from great depths ascend along fault planes and cool. Commonly these domes are associated with oil and are channels of vertical circulation, permitting salt water to rise from considerable depths. In them salt water is always encountered much nearer the surface than in the surrounding strata.

ANGELINA-CALDWELL FLEXURE.

A low monoclinal flexure (fig. 6) extending across the State of Louisiana and westward through Sabine, San Augustine, Angelina,

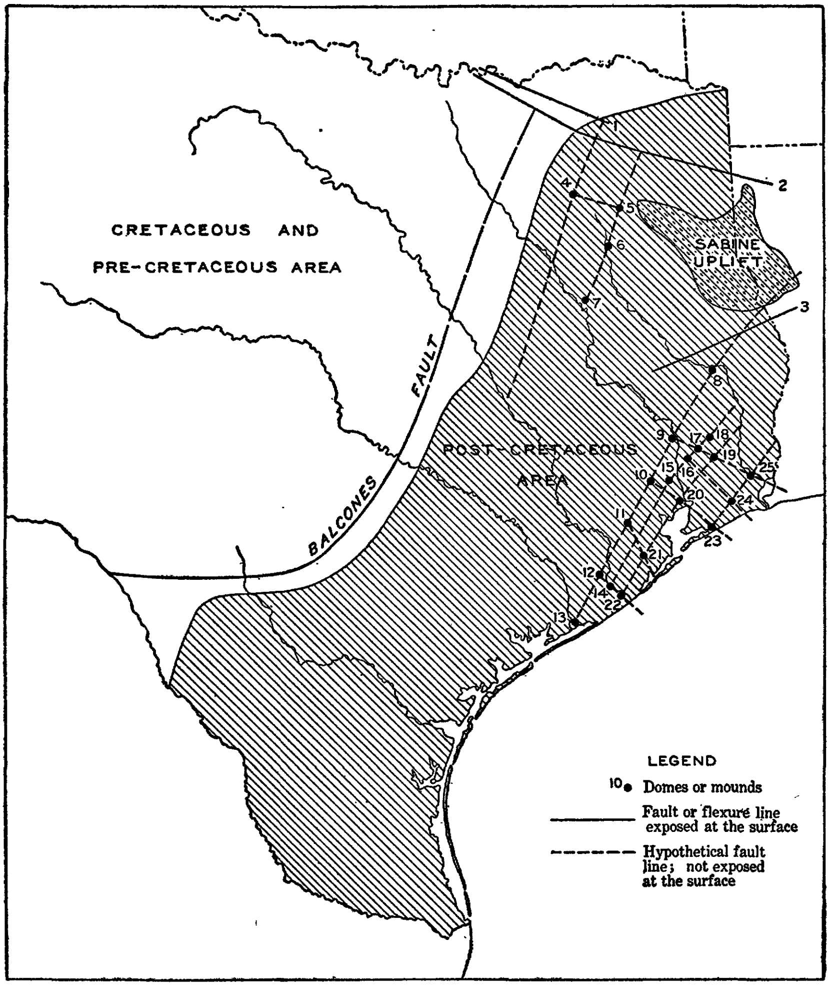

FIGURE 6.—Principal structural features of the Texas Coastal Plain.

1. Red River fault.
2. Cooks Springs-Caddo fault and flexure.
3. Angelina-Caldwell monoclinal flexure.
4. Grand Saline Mound.
5. Steen Dome.
6. Brook's Dome.
7. Anderson Dome.
8. Graham's Saline.
9. Davis Hill.
10. Humble.
11. Blue Ridge.
12. Damon Mound.
13. Big Hill.
14. Kiser Mound.
15. Dayton.
16. Big Hill.
17. Batson.
18. Saratoga.
19. Sour Lake.
20. Barber's Hill.
21. Hoskins Mound.
22. Bryan Heights.
23. High Island.
24. Big Hill.
25. Spindle top.

and Trinity counties, Tex., reduces the dip between Hattens Ferry and Burrs Ferry on Sabine River from 150 to 30 feet to the mile. (See section B–B′, Pl. I, in pocket.)

This fold began to develop in Tertiary time, and is still a line of weakness. Recent movements along its west end have produced a series of shoals on Sabine River and have literally thrown up a ridge across Angelina River, converting the land on the north side into a swamp and causing the river on the south side to flow in a channel with steep banks.[1]

This flexure, like the others described below, is possibly due to the loading of the sea bottom, causing it gradually to subside, while the plain beyond remained stationary.

COOKS SPRINGS–CADDO FAULT AND FLEXURE.

From Pottsboro and Cooks Springs in Grayson County to Savoy in Fannin County, Tex., a well-defined fault extends. At Vivian, in Caddo Parish, La., a well-defined fold is visible. The passage of the Cooks Springs–Savoy fault into the fold in Caddo Parish is inferred, and this line of faulting and flexing will be called the Cooks Springs–Caddo fault and flexure.

MINOR FLEXURES.

Additional lines of flexing and faulting in the Coastal Plain are inferred from the deposits of oil, salt, and gas, and from the evidence of fossils. At Sour Lake, for instance, Jackson fossils were taken at a depth of 1,500 feet from a well furnishing hot water, thereby showing vertical circulation. Four miles southeast a 1,900-foot well, which furnished only warm water, yielded a Miocene or Oligocene fauna, showing either a remarkable dip in this direction or a fault.[2] These flexures are, however, buried beneath deposits of later age and have no surface exposure. (See section *A–A′*, Pl. I, in pocket.) The domes above described are probably associated with these lines of structural weakness. Their approximate location is indicated on figure 6, but their existence will not be absolutely proved nor their exact location determined until accurate records and fossils from deep wells are available. Their importance in connection with artesian water lies in the possibilities for the vertical rise of salt water they may afford.

SABINE UPLIFT.

Harris regards the area adjacent to Sabine River, between Sabinetown on the south and Caddo Lake on the north, Nacogdoches on the southwest and Bistineau in Louisiana on the northeast, as a large uplifted block, which he calls the Sabine uplift.[3]

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[1] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 68.

[2] Harris, G. D., Rock salt: its origin, geological occurrences, and economic importance in the State of Louisiana, together with brief notes and references to all known salt deposits and industries of the world: Bull. Geol. Survey Louisiana No. 7, 1908, pp. 65–66.

[3] Idem, pp. 79–80.

The existence of the Angelina-Caldwell flexure on the south and of the Cooks Springs–Caddo flexure on the north; the occurrence of oil in Nacogdoches County, Tex., on the southwest and of several saline domes on the northeast; and the absence of the marine phase of the Cook Mountain formation in the area, though it is present on the southwest, southeast, and northeast, constitute the evidence supporting this theory of uplift.

HYDROLOGY.

DEFINITIONS.

In this paper the term artesian is applied to all wells whose waters are under hydrostatic pressure. Artesian wells that flow are called flowing wells, and those that do not flow are called nonflowing wells. Wells are here likewise arbitrarily divided into deep and shallow wells, the latter including all wells less than 100 feet deep.

OCCURRENCE OF GROUND WATER.

SOURCE OF GROUND WATER.

The source of all ground water (artesian water, spring water, shallow-well water, deep-well water) is rainfall. A part of the rainfall, known as run-off, enters the creeks and drainways and is carried to the sea, sometimes as a destructive flood; a second part is evaporated; and a third part, known as the ground water, sinks into the ground, where it supplies wells and springs, is taken up by plants, or enters into chemical combination with the rocks and minerals of the earth's crust.

The amount of rainfall that enters the earth is dependent (1) on the kind of rain, more water passing into the ground during a slow rain than during a cloudburst; (2) on the topography of the country, more water entering a flat area than a greatly dissected one, where drainage is rapid; (3) on the character and amount of vegetation, more water entering the ground in a forested region than in one not forested; (4) on the porosity of the surface, a sandy soil absorbing much more water than a clayey one.

In the area here considered the annual rainfall averages 50 inches and, for the most part, is equably distributed throughout the year. The region is characterized by sandy soil and by forest growth, and in consequence a large portion of the rainfall—perhaps as much as one-third—enters the ground. (See fig. 7.)

ZONE OF SATURATION.

Water that enters the ground does not sink to abnormal depths. Six miles beneath the surface the pressure of the overlying terranes is so great that the pores and crevices and caverns in the rocks are effectually sealed, and the passage of the water farther downward is prevented. There is, therefore, a certain level, known as the lower level of ground water, beneath which the waters do not sink. Practically all the water supplied by wells and of use to man comes from

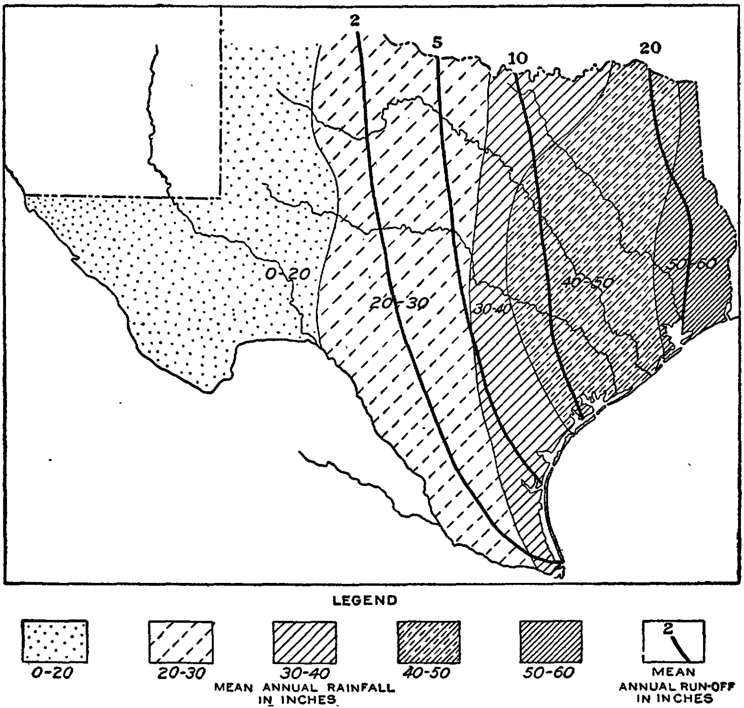

FIGURE 7.—Map showing mean annual rainfall and run-off in the State of Texas.

depths not exceeding one-half to two-thirds mile. Water that has sunk into the ground lies in a saturated zone whose surface is known

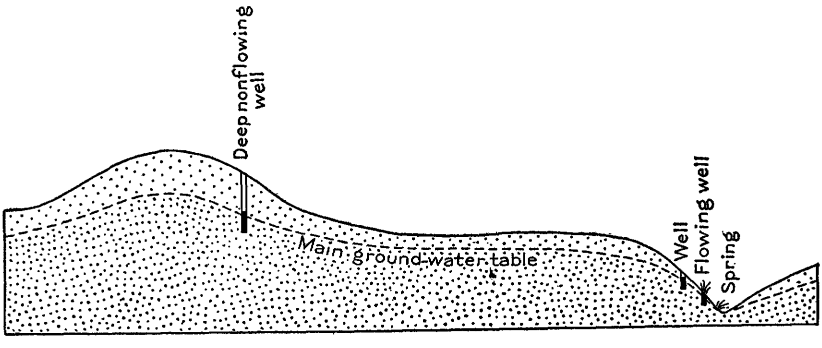

FIGURE 8.—Diagram illustrating the position of the main ground-water table in a region of undulating topography.

as the main ground-water table. This surface is constantly fluctuating, rising during rainy seasons and sinking during droughts. It is very irregular, approximately following the topography of the country (see fig. 8), and being higher (though deeper beneath the surface) under hills than under the adjacent valleys.

All the materials, whether limestones, clays, sandstones, conglomerates, or granites, within the saturated zone are thoroughly saturated. It is literally a hydrosphere or water sphere occupying the pores and crevices of a part of the lithosphere or rock sphere. The possibility of procuring water when this zone is penetrated depends on the coarseness of the materials in which the hole is bored. If a gravel or sand bed or a sandstone or a porous limestone is penetrated the water readily enters the opening with a rapidity dependent on the porosity of the terrane. If, however, a clay or a shale bed is penetrated, the

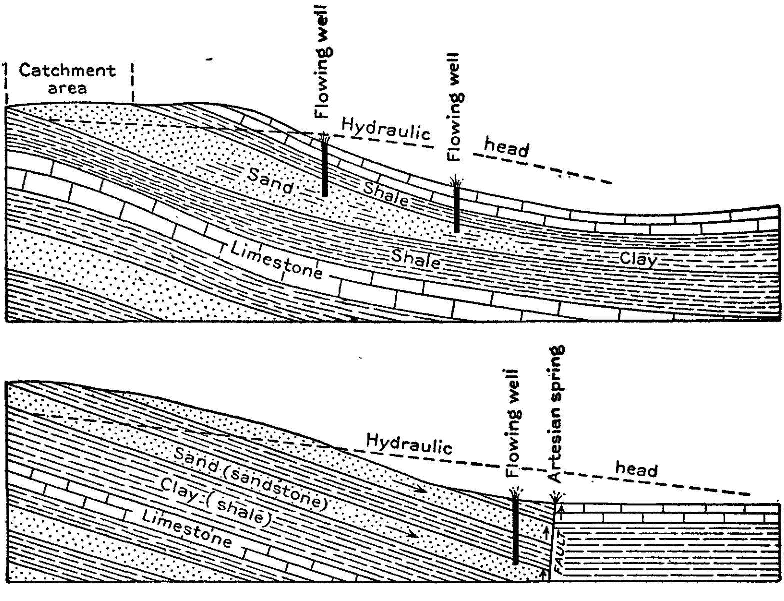

FIGURE 9.—Diagram showing common arrangement of factors producing flowing wells.

material, though saturated, yields no water owing to the fineness of the pores.

MOVEMENT OF GROUND WATER.

Certain beds, therefore, are porous or pervious, and through these the water is relatively free to move; other beds are impervious, and in these it is forced to remain stationary. Sandstones and some limestones fall in the first category, and clays and shales in the second.

Where pervious beds outcrop water soaks into them, and if they are inclined it descends under the action of gravity to the lowest possible point, where it accumulates. If a well is sunk to this porous reservoir, or if a fault plane cuts it, water will rise in the opening approximately to the level of the water in the outcrop. (See fig. 9.)

If the surface at the opening is lower than the surface of the water in the outcrop, the water will escape at the surface and produce an artesian well. The underground conditions that produce artesian wells are variable; the commoner are indicated in figures 9, 10, and 11.

PERCHED GROUND-WATER TABLES.

In some places small zones of saturation, known as perched water tables, occupy higher levels than the main water table and are separated from it by nonsaturated strata. (See fig. 12, p. 92.) Such zones are local and of no great economic importance.

ARTESIAN SYSTEMS OF THE TEXAS COASTAL PLAIN.

GENERAL FEATURES.

On the Coastal Plain of Texas the arrangement of the relatively pervious and impervious strata is such as to constitute five great artesian systems, known as the Coast Prairie, Dewitt, Catahoula, Yegua,

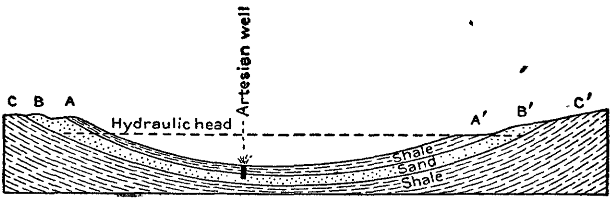

FIGURE 10.—An artesian basin. B-B′, Artesian reservoir; A-A′ and C-C′, confining impervious strata.

lower Eocene, and Nacatoch systems. (See fig. 13, p. 93.) Each system consists of two confining impervious members, between which is a porous water-logged member which constitutes an artesian reservoir. The conditions approximate closely those outlined in figure 9. Each reservoir contains a great number of water-bearing beds, but any particular bed is essentially local; different beds supply different localities.

The systems will be considered in the order of their superposition, beginning with the lowermost.

NACATOCH ARTESIAN SYSTEM.

The Nacatoch artesian system is not of great economic importance in the region considered, supplying only a small territory along the interior margin of the Tertiary area. (See Pl. VII, in pocket.) It is made up of the Nacatoch sand of the Gulf series of the Cretaceous system, underlain by the impervious Marlbrook marl and overlain by the impervious Arkadelphia clay. (See fig. 13.)

The catchment area for this system (the outcrop of the Nacatoch sand) lies slightly north and west of the Cretaceous–Tertiary boundary.

(See Pl. I, in pocket.) The available area[1] and the flowing-well area are indicated on the map (Pl. VII).

Few wells have penetrated to these sands. The most important are indicated on Plate VII. Within the area described water from these sands obtained by wells exceeding 600 to 700 feet in depth and located east of the 500-foot structure contour is likely to be salty and unfit for use.

LOWER EOCENE ARTESIAN SYSTEM.

General character.—The lower Eocene artesian system consists of the Wilcox formation, the Mount Selman formation, and the lower part of the Cook Mountain formation, the whole being underlain by the clays of the Midway formation and overlain by the clays and marls of the upper part of the Cook Mountain formation. (See Pl. VIII, in pocket.) The reservoir, which is 1,300 to 1,500 feet in vertical thickness, consists very largely of sand and sandstones but has scattered through it irregular, discontinuous beds of clay. The entire reservoir is water-logged. Seaward, the sandy beds of the system grade into impervious clays. (See fig. 9 and fig. 13.)

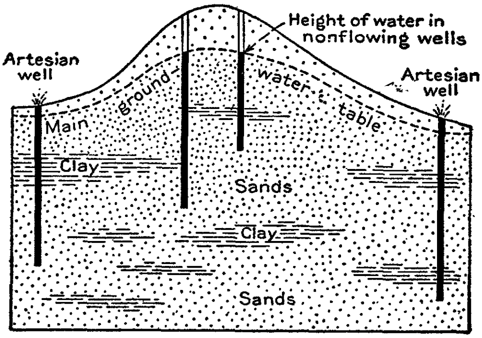

FIGURE 11.—Diagram showing water conditions in the outcrop of the Wilcox formation in Texas.

In the region where the sands of the Wilcox, Mount Selman, and Cook Mountain formations outcrop (see Pl. I, in pocket) flowing wells depend on the local topography, all of them being located in the valleys, as, for instance,[2] in the Brazos bottoms near Calvert (well No. 879, pp. 327–328), near Kilgore (No. 362, p. 178), and south of Tenaha (No. 948, p. 341). Wells at Blunt in Freestone County (well No. 215, pp. 153–154) and at other places on the divides do not flow. Throughout the greater portion of the catchment area and especially in the western half flows from this reservoir are not to be expected except in the valleys.

Where the reservoir sands are covered by the impervious upper part of the Cook Mountain formation (see Pl. I), flowing wells are more common, the area of flow increasing with the increasing depth of the reservoir and the decreasing altitude of the surface. (See Pl. VIII.)

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[1] By available area is meant the total area capable of being served from a given reservoir. It includes the catchment area, the area underlain by the reservoir, the area of flowing wells, and the area of nonflowing wells.

[2] Numbers refer to wells listed in the county descriptions, pp. 110–360.

From Stone City in Brazos County to a point 5 or 6 miles southwest of Calvert in the Brazos Valley numerous flowing wells derive their water from this system. (See wells Nos. 908, 909, 914, p. 327.) Wells at Circle (No. 163, p. 147), Nacogdoches and Oil City (Nos. 820 and 811, pp. 309–310), near Platt (No. 12, p. 115), near Ironosa (No. 942, p. 337), and near Robertsons Ferry (No. 933, p. 332) all draw from this reservoir.

On the map (Pl. VIII, in pocket) is indicated the area in which water may be obtained from these sands and the area in which flowing wells may be had.

South of the 2,000-foot structure contour this artesian reservoir is so deeply buried and the cost of reaching it is so great that it would not be economical to attempt to obtain water from it. It is also probable that the water from this great depth would not be fit for use. Water of better quality can be obtained from the overlying reservoir at much less cost, but the pressure would not be so great.

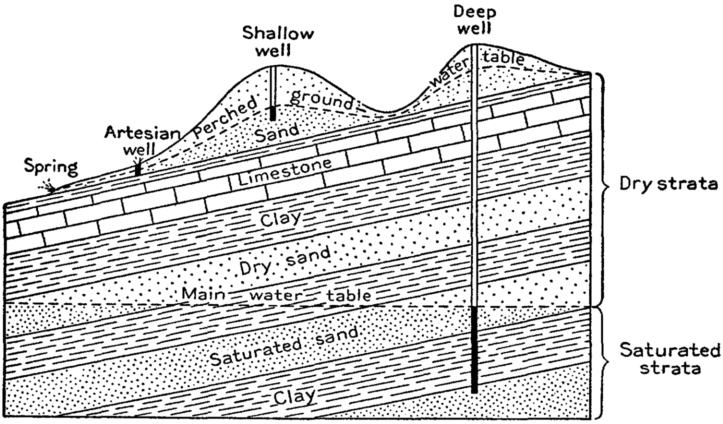

FIGURE 12.—Diagram showing the relation of a perched water table to the main water table.

Quality of water.—Where domes and faults interrupt the continuity of the sands this reservoir will commonly yield salt water. Except at such places, however, it will yield water suited for domestic and industrial use at all points north and west of the 1,500-foot structure contour. (See Pl. VIII.)

At Hearne, water from the lower Eocene is used for locomotive boilers, for domestic purposes, for irrigation, and for the manufacture of ice. At Nacogdoches it is used in boilers by the Hayward Lumber Co. For analyses, see table facing page 110.

YEGUA ARTESIAN SYSTEM.

General character.—The Yegua artesian system consists of the pervious Yegua formation, the underlying impervious clays of the upper part of the Cook Mountain formation, and the overlying impervious Jackson formation. (See fig. 13.) The Yegua contains numerous water-bearing beds, as is shown by the logs of wells at College Station (well No. 92, p. 136), at Lamb Springs and Keith (Nos. 378 and 390, pp. 183–186), and in Angelina County on the Graham Survey (No. 26, pp. 119–120).

Conditions in the catchment area are similar to those in the catchment area of the lower Eocene artesian system. (See p. 91.) If satisfactory supplies are not obtained from the Yegua, wells should be carried to the underlying lower Eocene reservoir, where supplies suitable in quantity and quality may be expected. However, where the lower reservoir lies deeper than 2,000 feet the water obtained will probably be unfit for use. (See Pl. VII, in pocket.)

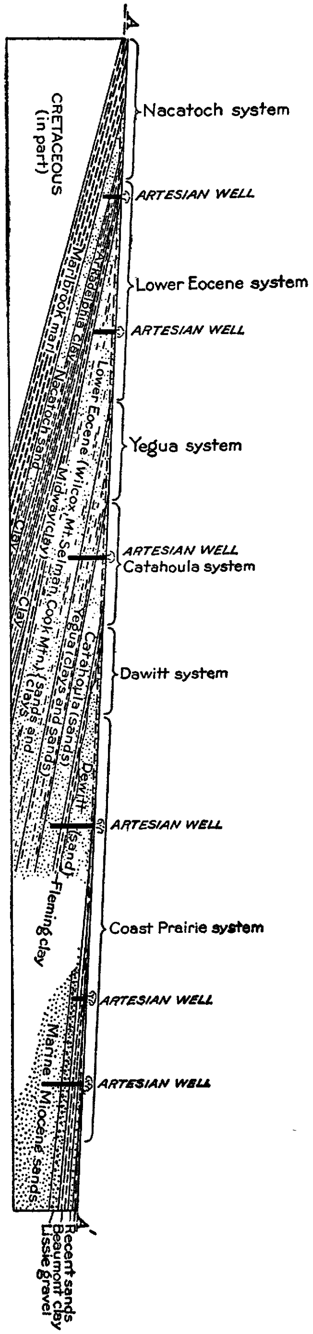

FIGURE 13.—Diagram showing the artesian systems of the Texas Coastal Plain.

Where embedded, the Yegua formation supplies the water for flowing wells, as, for instance, at Wellborn (well No. 119, p. 134), near Lovelady (No. 966, p. 344), and at Iris (No. 968, p. 344). The area of flow occupies the valleys near the Yegua-Catahoula boundary and gradually spreads out on the divides as the depth to the formation increases southward. (See Pl. VII.) The available area is indicated on Plate VII (in pocket).

Quality of water.—Water from the Yegua artesian reservoir north of the 1,000-foot structure contour (see Pl. VII) is commonly suitable for domestic use and is fairly satisfactory for use in boilers and for irrigation. South of this line the water is generally salty and unfit for use.

At Bryan a supply from a depth of 135 feet is used in boilers and is fairly satisfactory for this purpose. At Lamb Springs, Grimes County, water from a depth of 540 feet was not fit to drink. At Burke, Angelina County, salty water was obtained at a depth of 500 feet.

The analysis of the water from the well at Clay, Burleson County, indicates the general character of the water from this reservoir. (See table facing p. 110.)

CATAHOULA ARTESIAN SYSTEM.

The Catahoula sandstone, as its name implies, consists largely of sands and sandstones. Together with the impervious overlying Fleming clay and the impervious clays of the underlying Jackson and Yegua formations it constitutes an important artesian reservoir in the Coastal Plain. (See fig. 13.)

The wells at Hempstead (well No. 999, p. 354), at Kirbyville (No. 627, p. 250), and at numerous other places are supplied by this reservoir. (See Pl. VIII, in pocket.)

The available area, catchment area, area where embedded, area of flowing wells, and area of nonflowing wells for this reservoir are indicated on Plate VIII.

Water from the Catahoula sandstone is, with few exceptions, well adapted for drinking and for industrial use. The quality shown by the analysis of the water from Kirbyville (see table facing p. 110) may be regarded as typical.

DEWITT ARTESIAN SYSTEM.

The Dewitt formation contains numerous sand beds which supply water to an approximately triangular area whose apexes are at Navasota, Newton (?), and Richmond. The available area, area of flowing wells, and area of nonflowing wells for this reservoir are indicated on Plate IX (in pocket).

Water from the sands and sandstones of the Dewitt formation is, with few exceptions, well adapted for drinking and for industrial use.

COAST PRAIRIE ARTESIAN SYSTEM.

The Lissie gravel constitutes one of the most important water-bearing formations of the Coastal Plain. The overlying impervious Beaumont clay serves to confine the water to this formation. This artesian system has been previously described by Hill and has been named by him the Coast Prairie artesian system.[1]

The wells at Alta Loma, Houston, Orange, and numerous other places on the Coast Prairie are supplied by this reservoir and are used extensively for irrigation. The available area, catchment area, area where embedded, area of flowing wells, and area of nonflowing wells, are indicated on Plate VII (in pocket).

Water from the Lissie gravel from depths not exceeding 700 or 800 feet is generally satisfactory.

[1] Hill, R. T., Geography and geology of the Black and Grand prairies, Texas, etc.: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, pp. 401-408.

MINOR SOURCES OF UNDERGROUND WATER.

MARINE MIOCENE BEDS.

In the part of the Coastal Plain that lies south of a line extending nearly from Kirbyville, in Jasper County, to Richmond, in Fort Bend County, the buried marine Miocene beds supply water to wells entering them. These beds lie beneath the Lissie gravel and above the Fleming clay, where the latter has not been removed by erosion. They derive their water by infiltration from surrounding water-saturated strata, having no outcrop in Texas.

Along the coast, these marine Miocene beds lie about 1,500 feet below the surface. Along their northern limit (Kirbyville to Richmond) they lie about 700 feet below the surface. The depths of the basal beds are indicated by the structure contours on Plate IX (in pocket).

As water from these beds is, with very few exceptions, too salty for domestic or industrial use, it is of little value.

BEAUMONT CLAY.

The Beaumont clay includes a number of sand lenses and sandy zones, commonly of small extent, which serve as strainers to extract water from the surrounding water-logged clays. Wells penetrating the Beaumont commonly find two or more of these water-bearing sands. Some of these lenses or zones are exposed at the surface and collect water directly. Most of them dip at a small angle, and their water in consequence is under more or less pressure, though very rarely under sufficient pressure to flow. Commonly water from the Beaumont is more or less salty and unfit to drink. For these reasons the waters from these clays are not of very great economic importance.

SALT WATER.

In a strip of land 5 to 10 miles wide bordering the coast no potable water can be had in a well at any depth. It seems probable that the obtainable water is residual sea water that has not yet escaped from the formations. It is, however, not so highly concentrated as sea water, indicating that it has been more or less diluted by meteoric water entering at the outcrops.

Salt water is also commonly found beneath the oil domes at much less depth than in the surrounding regions. The domes are thus in a measure islands of salt water protruding through the mass of fresh water. Their water is much higher in temperature than waters from the same level in the adjacent regions, and it has probably risen from great depths through fault planes and fissures.

DEPTH TO RESERVOIRS.

If it be desired to ascertain the depth to any particular water-bearing reservoir at a given place, it is necessary (1) to determine the elevation in feet of that place above sea level; and (2) to determine, by reference to the hydrologic maps (Pls. VII, VIII, and IX in pocket), the depth, in feet, at which the particular reservoir sought lies below sea level at the point. The sum of these two numbers is the depth, in feet, to which the well will have to be drilled to reach the water-bearing reservoir sought.

USES OF GROUND WATER.

In the valley of Brazos River, between Calvert and Hempstead, each plantation has one or more artesian wells, in which the water is under sufficient pressure to carry it 5 to 10 feet above the surface, obviating the necessity for artificial lifting and distributing devices. This water is obtained at comparatively shallow depths, and it is usually cheaper to seek it in a new well than to attempt to pipe it for any great distance. As a rule each negro cabin has its own well. The water is used for drinking, washing, cooking, and stock; very little is used for irrigation.

The cities of Bryan, Navasota, Hempstead, Huntsville, Palestine, Orange, Hearne, Mineola, Marshall, Calvert, Center, Tyler, Houston, and Galveston depend on artesian wells for their public water supply. The commercial and industrial supremacy of Houston in the area largely depends on its possessing so close to the coast an adequate water supply adapted to manufacturing. In the cities and towns most of the cotton gins, sugar mills, cottonseed-oil mills, ice factories, and packing houses use artesian water for their boilers and for other purposes.

In the timbered area the chief consumers of artesian water are the sawmills, which need adequate and suitable supplies for their power plants. Some of them depend also on artesian wells to fill their log ponds.

The railroads use much artesian water in their shops and locomotive boilers. They have artesian wells at many places in the area.

In the coastal tier of counties (especially in Jefferson, Liberty, Chambers, Harris, Fort Bend, and Brazoria counties) artesian wells drawing from the Lissie gravel have come into much importance within the last 10 years for rice irrigation. In Galveston and Brazoria counties artesian wells are extensively used for irrigating truck farms and fruit orchards.

SPRINGS.

Springs occur at points where the ground water issues at the surface through natural openings. Many springs appear at the edges of perched water tables. (See fig. 12.) Ordinarily their water enters the ground not very far away and may be polluted and unfit to drink, so that they afford the least desirable kind of spring water. Springs are also formed where a stream cuts down below the level of the main ground-water table. (See fig. 8.) Springs are commonly associated with fault planes and fissures, the water being forced up along the fault planes by hydrostatic pressure. (See fig. 9.) As these springs may derive their water from great depths and are in a manner natural artesian wells, they are called artesian springs.

The northern portion of the area here considered has been greatly dissected and springs from perched water tables are common. The strata composing the hills contain a large percentage of iron and some beds of iron ore. Water percolating through these beds takes iron in solution and emerges at the surface in iron-charged, ferruginous, or chalybeate springs, some of which have reputations as local health resorts. A great number of these chalybeate springs occur in Cherokee, Rusk, and Harrison counties; Hynson's Iron Mountain Springs in Harrison County are typical.

In Nacogdoches and Angelina counties along Angelina River, in Angelina County along Neches River, and in Gregg County along Sabine River many springs have resulted from the cutting of the main water table. In circulating through the beds of lignite the water may take into solution sulphur compounds, which by reaction evolve hydrogen sulphide gas, thus producing sulphur springs, which are almost as common in the area as chalybeate springs.

So far as known, artesian springs are comparatively rare in the region, though the springs at some of the saline domes—Sour Lake and High Island, for example—may be of this type.

The important springs of the East Texas region are listed in the tables accompanying the county descriptions.

QUALITY OF WATER.

IMPURITIES IN WATER.

While water is falling as rain, or flowing over the surface of the ground, or percolating through the soil and the rocks, it takes up impurities, living and nonliving, that affect in various ways its adaptability to different uses.

LIVING MATTER IN WATER.

The living matter that may be taken up consists chiefly of bacteria (microscopic plants) and protozoa (microscopic animals). Most varieties of bacteria are not directly harmful, but others produce typhoid fever, dysentery, and cholera. Such germs are discharged with the feces or urine of persons ill with those diseases and may infect domestic water wherever sewage is emptied into drinking water or wherever drainage from privies enters stream channels or sink holes. Polluted drinking water is one of the commonest means of transferring such diseases from one person to another.

Fortunately, these deleterious agents are largely, though not entirely, confined to the surface waters as opposed to the underground waters. Wherever water has passed for some distance through a natural filtering medium in the ground the bacteria are removed and it is no longer capable of causing bacterial disease. From this standpoint, therefore, underground waters are much superior to surface waters for drinking.

It must not be understood, however, that water from all wells and springs is safe, for polluted waters drain into some wells and springs and render them just as dangerous as open streams. No surface drainage whatever should be allowed to enter domestic wells or springs, and the underground waters should enter them only after having seeped through a sufficient thickness of material not coarser than common water-bearing sand. If the presence of contamination is suspected the water and the area about the well or spring should be examined by an expert sanitarian.

NONLIVING MATTER IN WATER.

Suspended matter.—The suspended matter consists of fine particles, usually of sand or clay, gathered from soil and rock detritus, which make the water muddy or turbid. When the water becomes perfectly still, the particles settle and the water becomes clear. Suspended matter may also be filtered out either naturally or artificially. If, for example, a muddy water passes through a fairly thick bed of sand it emerges as a clear water. Suspended matter is confined largely to surface waters and occurs in ground waters only where a water-bearing formation is cavernous or is composed of extremely fine sand, or where a well flows or is pumped at a very rapid rate. Water containing much suspended matter is unsuitable for drinking, washing, or cooking, or for use in boilers, but as such material can be removed with comparative ease its presence is not a formidable objection. Water for irrigation, on the other hand, is not injured but is improved by a moderate amount of suspended matter, as such foreign material acts as a fertilizer when the water is spread on the land. As the ground waters of Texas in general contain little or no suspended matter, its quantity was not determined in the analyses for this report.

Dissolved matter.—The dissolved matter found in natural waters comprises both gases and solids; on evaporation of the water the gases go off with the water vapor and the solids remain as a residue. Solution results when a teaspoonful of salt, for example, is placed in a tumbler of water; after the salt has become invisible it is said to be in true solution, and if the water is then boiled off the teaspoonful of salt can be recovered.

The materials dissolved in water are the chemical substances which largely compose the atmosphere and the rocks of the earth's crust. Among the gases may be mentioned oxygen (O) and nitrogen (N), the principal constituents of the air; carbon dioxide (CO_2), a product of the decay of organic matter, and hydrogen sulphide (H_2S), a foul-smelling "sulphur" gas.

Among the common solids are materials which exist in water as the following so-called radicles: Iron (Fe); aluminum (Al); calcium (Ca), one of the constituents of limestone, gypsum, and plaster, magnesium (Mg), one of the constituents of Epsom salt; sodium (Na); one of the constituents of washing soda and common table salt; potassium (K), one of the constituents of lye and saltpeter; carbonate (CO_3), one of the constituents of limestone; bicarbonate (HCO_3), one of the constituents of cooking soda; sulphate (SO_4), one of the constituents of Epsom and Glauber's salts; chlorine (Cl), one of the constituents of common table salt; and nitrate (NO_3), one of the constituents of saltpeter. The first six of these are called positive or basic radicles and the other five negative or acidic radicles, and each has the power to combine, or react with, a definite amount of a radicle of the opposite sign. For example, 1 pound of the positive radicle sodium will combine with about 1.54 pounds of the negative radicle chlorine. These 11 radicles thus constitute a chemical system.

Appreciable quantities of another element, silicon, are found in natural waters, but as tests show that this element is not in true solution, though it is invisible, it is said to be in "colloidal state," and the quantities of it are conventionally expressed as silica, the oxide of silicon (SiO_2). Organic matter (matter formed through the agency of life and consisting chiefly of the element carbon) may also be present in the colloidal state and may give a brownish color to water. It is uncertain whether the iron and aluminum in some waters are in true solution or in colloidal state, but it is usual to report them as if they were in solution. Dissolved iron in some ground waters is precipitated as a rusty-looking cloud when such waters are allowed to stand open to the air. As the quantities of iron and aluminum in most waters are small, industrial chemists commonly report them together as the oxides ($Fe_2O_3+Al_2O_3$). In acid waters both are probably in true solution.

Concentration of dissolved matter.—Underground waters commonly contain in solution more mineral matter than the surface waters. Those in a humid region contain less than those in an arid region, chiefly because the greater rainfall serves to dilute the underground water, and the smaller evaporation does not so greatly concentrate the dissolved substances. Underground waters that have circulated through sandstones and jointed shales commonly contain less mineral matter than those that have circulated through limestones, rock salt, or gypsum, because the latter materials are more easily dissolved. Water that has traveled a great distance underground commonly contains more mineral matter than water that has traveled only a short distance, because it has had opportunity to come into contact with a greater quantity of soluble matter.

WATER FOR DOMESTIC USE.

WATER FOR DRINKING.

A good drinking water[1] should be cool, clear, colorless, and without odor (especially without odor of hydrogen sulphide (H_2S) or of putrescible matter); it should be agreeable to the taste, not flat, salty, or sweetish; it should be free from germs of disease and from all other substances, mineral or organic, that are injurious to the human system. Though a certain amount of mineral matter gives the water a pleasing taste, the total dissolved solids should not as a rule exceed 600 parts per million. Nominal quantities of carbon dioxide (CO_2) and air give life to the water and save it from flatness.

The character of the dissolved constituents affects the value of a water for drinking nearly as much as does the total quantity of dissolved mineral matter. Water that contains in solution less than 2 parts per million of iron and less than 600 parts of other ordinary mineral matter is not likely to be unpalatable or injurious because of the mineral substances in it. Many waters with a far greater proportion of total solids than 600 parts per million may be safely used for drinking if sodium, calcium, magnesium, chlorine, and the carbonate and bicarbonate radicles constitute the major part of the dissolved mineral ingredients. Water containing between 300 and 600 parts per million of chlorine tastes slightly brackish or salty but is nevertheless potable. Water containing as much as 800 or 900 parts of chlorine is distinctly disagreeable to the taste, and that carrying more than 2,000 parts is undrinkable. Water that contains more than 2,000 parts of the sulphate radicle (SO_4) is

[1] Smith, E. A., The underground water resources of Alabama: Geol. Survey Alabama, 1907, p. 344.

laxative, and continual drinking of it is disastrous. Waters excessively high in calcium (Ca) and magnesium (Mg) are commonly supposed to induce certain diseased conditions, such as urinary calculi, goiter, and cretinism, but no scientific data confirm such belief, and they seem more likely to cause intestinal and gastric disturbances.[1]

Waters that contain more than 8 parts per million of iron may be classed as chalybeate,[2] and though they may not be injurious to health they are unpleasant in taste and in appearance. Much less than 8 parts per million may give water a chalybeate taste and produce rusty spots on fabrics.

WATER FOR COOKING.

Waters excessively high in calcium and magnesium are not desirable for cooking, as they impair the flavor of many foods. Iron-bearing waters are also unsuitable, as they form a black compound with the tannin in tea and in many vegetables.

WATER FOR WASHING.

Soap combines with calcium and magnesium, forming an insoluble precipitate, and with waters high in these substances it is necessary to use much soap before a lather can be produced. Some waters are so high in these substances that it is necessary to "break" or "soften" them before they can be used; others, still higher, form such quantities of curd with soap that they are useless. The cost in cents per 1,000 gallons of water for the soap necessary to produce a lather may be calculated from the following formula, given by Stabler,[3] the values of Fe, Al, etc., being the number of parts per million of the respective radicles in the water:

$$\text{Soap cost} = 11 + 1.79\ \text{Fe} + 5.54\ \text{Al} + 2.5\ \text{Ca} + 4.11\ \text{Mg} + 49.6\ \text{H}$$

A very soft water would not have a soap cost greater than 40 cents per 1,000 gallons of water. Water No. 378b (table facing p. 110), which is characterized by an extremely high content of soap-consuming constituents, would have a soap cost of $13.76 per 1,000 gallons of water and may be regarded as unfit for washing purposes. Chalybeate or iron waters are also not adapted to laundry use, as precipitation of the iron produces rusty spots on fabrics, as little as 2 parts per million of iron causing stains.

[1] Turneaure, F. E., and Russell, H. L., Public water supplies; requirements, resources, and the construction of works, 1901, p. 142.

[2] Smith, E. A., op. cit., p. 325.

[3] Stabler, Herman, The industrial application of water analyses: Water-Supply Paper U. S. Geol. Survey No. 274, p. 169.

CLASSIFICATION OF DOMESTIC WATERS.

According to the classification used in the table of analyses (facing p. 110) by R. B. Dole, waters containing less than 150 parts per million of mineral matter in solution have low mineral content; waters containing from 150 to 500 parts moderate mineral content; waters containing from 500 to 2,000 parts high mineral content; and waters containing more than 2,000 parts very high mineral content. Sea water contains about 35,000 parts per million, and the waters of some salt lakes as much as 300,000 parts per million of mineral matter.

The general chemical character of waters, which is helpful in determining their availability for domestic use, has been indicated in the table of analyses.[1] Ca (calcium) indicates that calcium and magnesium are predominant, and Na (sodium) that sodium and potassium are predominant among the bases. Similarly the designation CO_3 (carbonate), SO_4 (sulphate), or Cl (chloride) shows which acid radicle is predominant. Combination of the basic and acidic designations classifies the water. For example, the designation sodium-chloride (Na–Cl) water indicates that among the bases sodium predominates and among the acids chlorine predominates. A calcium-carbonate (Ca–CO_3) water is one in which calcium is the most abundant constituent among the positive, and carbonate the most abundant among the negative radicles. A sodium-chloride water possesses different properties from a calcium-carbonate water.

WATER FOR STOCK.

Cattle and horses tolerate water of much higher mineral content than does man. Stock often drink water that contains as much as 1,700 parts per million of chlorine, and is therefore so salty that it will not be tolerated by man. It is therefore possible to use for watering stock a water that would be considered unfit for drinking by human beings. It is sometimes asserted that highly mineralized water is beneficial to cattle and helps to keep them in prime condition, but the accuracy of the assertion is extremely doubtful.

WATER FOR BOILERS.

When water is used for making steam the mineral matter in solution may produce three deleterious conditions—foaming, corrosion, and formation of scale.

FOAMING.

Foaming is the formation of bubbles (films of water inclosing steam) on and above the surface of the water. The less easily these bubbles break the higher the foam rises, and it may rise so excessively that

[1] Dole, R. B., Rapid examination of water in geologic surveys of water resources: Economic Geology, vol. 6, No. 4, June, 1911, p. 340.

the bubbles pass out with the steam. Foaming is commonly attributed to the sodium and potassium salts in the boiler feed, and therefore the estimate of the amount of these salts, given by the following formula, represents for practical purposes the foaming tendency of a water.[1]

$$\text{Foaming coefficient} = 2.7\ \text{Na} + 2\ \text{K}$$

Muddy waters of low mineral content may foam, however, so that foaming is not entirely attributable to concentration of alkali. Much depends on the type and operation of the boiler.

Priming, which should not be confused with foaming, results primarily from faulty boiler design or operation. It consists of an ebullition so violent that it drives water in the form of spray out of the boiler along with the steam. Such wet steam is not only wasteful, for it wastes heat into the engine, but it is also dangerous, for the water may so completely fill the clearances that the piston will break the cylinder head.

CORROSION.

Corrosion, which is due to solution of the metallic iron of the boiler by substances in the boiler water, may so reduce the strength of the boiler as to make its use dangerous. Corrosion of a metal occurs in the presence of water if the metal is capable of taking the place of any positive radicle in the water.

Stabler gives the following formula for calculating the corrosive tendency of a water from its analysis:

$$c = \text{H} + 0.1116\ \text{Al} + 0.0361\ \text{Fe} + 0.0828\ \text{Mg} - 0.0336\ \text{CO}_3 - 0.0165\ \text{HCO}_3$$

If the coefficient of corrosion (c) is positive, corrosion will occur. If $c + 0.0503$ Ca is negative, no corrosion will result from the mineral constituents in the water. If c is negative, but $c + 0.0503$ Ca is positive, corrosion may or may not occur, the probability of corrosive action varying directly with the value of the expression $c + 0.0503$ Ca.[2]

SCALE FORMING.

When water is evaporated to make steam much of the dissolved mineral matter is deposited as scale or sludge within the boiler. As scale is a poor conductor of heat it wastes fuel by making necessary a greater consumption of coal to evaporate a given quantity of water. The necessity of frequently cleaning the boiler and of repairing its burnt portions also increases its operating cost and shortens its effective service. A thick deposit of scale allows the boiler plates next to the furnace to become overheated and perhaps to give way, with disastrous results.

[1] Stabler, Herman, op. cit., p. 172. [2] Idem, p. 175.

In the formation of scale, calcium to the full extent of its ability to combine with the carbonate, bicarbonate, and sulphate radicles is precipitated. Silicon, iron, and aluminum in the form of oxides, magnesium (mostly as the oxide but partly as the carbonate), and suspended matter are also deposited.

Stabler's formulas for computing the total scale and the hard scale likely to result in boilers are given below with the coefficients recomputed so as to give total scale in parts per million instead of in pounds per 1,000 gallons. Sm stands for suspended matter and Cm for colloidal matter (oxides of silicon, iron, and aluminum).

$$\text{Total scale} = \text{Sm} + \text{Cm} + 1.3\ \text{Fe} + 1.9\ \text{Al} + 1.66\ \text{Mg} + 2.95\ \text{Ca}$$
$$\text{Hard scale} = \text{SiO}_2 + 1.66\ \text{Mg} + 1.92\ \text{Cl} + 1.42\ \text{SO}_4 - 2.95\ \text{Na} - 1.74\ \text{K}$$

The ratio between the amount of hard scale and of total scale indicates the probable hardness of the scale that will be deposited. If the hard scale is less than one-quarter of the total the scale may be classed as "soft"; if it is one-quarter to one-half, as "medium"; and if it is one-half or more, as hard.[a]

CLASSIFICATION OF BOILER WATERS.

The following limits of foaming and scaling ingredients proposed by Dole have been used in classifying the waters whose analyses are reported. Due allowance is made for the comparative hardness of the scale and for the corrosive tendency of the constituents. Hard and fast limits, however, can not be rigidly observed, as much depends on the nature of the water. These ratings conform to common engineering practice, though they are possibly somewhat more rigid than the local standards in Texas. Recognition of them and of the economies that may be effected by obtaining good supplies or by properly treating those capable of treatment will be beneficial to boiler-room practice throughout the State.

Approximate classification of waters for boiler use according to proportion of scale-forming and foaming ingredients.[b]

[Parts per million.]

Scale-forming ingredients.			Foaming ingredients.		
More than—	Less than—	Classification.	More than—	Less than—	Classification.
....	90	Good.	....	70	Very good.
90	200	Fair.	70	150	Good.
200	430	Poor.	150	250	Fair.
430	680	Bad.	250	400	Bad.
680	....	Very bad.	400	....	Very bad.

[a] Stabler, Herman, op. cit., pp. 176, 177.

[b] Dole, R. B., Rapid examination of water in geologic surveys of water resources: Econ. Geology vol. 6, 1911, p. 354.

A good boiler water, according to these ratings, is one which contains not more than 150 parts per million of foaming constituents, which is noncorrosive, and which contains not more than 90 parts of scale-forming constituents. A water containing more than 1,000 parts per million of foaming constituents may be called unfit for boiler use, as its use would probably result in excessive foaming. A water containing more than 700 parts per million of scale-forming ingredients also may be classed as unfit, because its use would result in excessive deposition of scale if it were used in the raw state and excessive foaming if it were softened with lime and soda ash. It is usually economical to soften waters classed as poor because of their high content of scaling ingredients, if the foaming ingredients are low enough to permit. Corrosive waters should be neutralized with soda ash or some other appropriate substance before being introduced into boilers.

WATER FOR IRRIGATION.

ALKALI COEFFICIENTS.

Waters high in sodium are injurious to vegetation and if used for irrigation a sufficient length of time the salts of sodium, commonly referred to as "alkali," poison the soil.

The alkali coefficient of a water has been defined by Stabler as the depth in inches of water which on evaporation would yield sufficient alkali to render a 4-foot depth of soil injurious to the most sensitive crops. Thus if the alkali coefficient of a water is found to be 17 that number of inches of water contains sufficient alkali to make the soil to which it is applied injurious to sensitive crops. Whether injury would actually result from the application of such a water to any particular piece of land, however, depends on methods of irrigating, the crops grown, the character of the soil, and the drainage, and it should be clearly understood that the alkali coefficient in no way takes account of such conditions. Stabler's formulas for calculating the alkali coefficient of a water are as follows:

When $Na-0.65\ Cl$ is zero or negative, the alkali coefficient $=\frac{2,040}{Cl}$

When $Na-0.65\ Cl$ is positive but not greater than $0.48\ SO_4$, the alkali coefficient $=\frac{6,620}{Na+2.6\ Cl}$

When $Na-0.65\ Cl-0.48\ SO_4$ is positive, the alkali coefficient $=\frac{662}{Na-0.32\ Cl-0.43\ SO_4}$

Waters to which the first two of the above formulas are applicable are likely to produce in the soil the so-called "white alkali," which consists of sodium chloride (common table salt) and sodium sulphate (Glauber's salt); such waters can not be improved by chemical treatment. Waters to which the last formula is applicable are likely to produce "black alkali." Many such waters can be improved by treatment with gypsum or "land plaster" and the alkali coefficient of such waters reduced to that calculated from the second formula.

CLASSIFICATION OF IRRIGATION WATERS.

The following classification of irrigation waters may be recognized:

Classification of irrigation waters.[a]

Alkali coefficient.	Class.	Remarks.
More than 18.......	Good....	Used successfully for many years without special care to prevent alkali accumulation.
18 to 6.............	Fair.....	Special care to prevent gradual alkali accumulation has generally been found necessary, except on loose soils with free drainage.
5.9 to 1.2...........	Poor....	Care in selection of soils has been found imperative and artificial drainage has frequently been found necessary.
Less than 1.2.......	Bad.....	Practically valueless for irrigation.

[a] Stabler, Herman. The industrial application of water analyses: Water-Supply Paper U. S. Geol. Survey No. 274, p. 179.

THERAPEUTIC USE OF WATER.

The conviction is widespread and popular that waters high in mineral content are valuable in the cure of certain diseases, and it is unquestionable that many so-called "mineral waters" possess curative properties. Whether these properties are always related to the mineral content is, however, open to serious doubt. For that reason the results of a chemical analysis are not absolute criteria for determining the medicinal virtue of a water. When large quantities of sulphates or other active medicinal substances are present, however, an opinion may be formed as to the constituents to which the medicinal virtue is due. Many reputed mineral waters are among the purest of potable waters, and others, even if they contain substances of active medicinal value, may be tolerated by the body and may be potable because their mineral ingredients are greatly diluted.

The following statement by Hilgard[1] regarding the constant use of strong medicinal waters can be quoted with approval:

> It can not be too strongly urged upon the inhabitants of these regions * * * that the habitual use of mineral water proper of any kind is no more rational than would be the use of any other medicine with persons in a normal state of health.

[1] Hilgard, E. W., Report on the geology and agriculture of the State of Mississippi, 1860, p. 286.

It is often said that mineral waters are "nature's own remedy," which may be true enough, provided there is something to be remedied. The Epsom salt, Glauber's salt, gypsum, etc., contained in these waters are no less purgative, debilitating, and therefore injurious to persons in good health than the same articles are when derived from the druggist's vials.

CHEMICAL CHARACTER IN RELATION TO GEOLOGIC FORMATIONS.

GENERAL QUALITY.

The analytical data are not sufficient to afford very satisfactory conclusions regarding the quality of the waters supplied by the respective formations of the Coastal Plain. The supplies of this area, like those of many other parts of the Southwest, vary widely in character and mineral content but in general may be called rather highly mineralized alkali waters, likely to foam badly in boilers and to cause trouble by alkali accumulation if used for irrigation. Though many wells furnish water too strong to be potable and some furnish water too hard to be used in cooking, most of the waters are drinkable and a large proportion of them can be used for all domestic purposes.

WATERS FROM THE LISSIE GRAVEL.

Most supplies from the Lissie gravel in east Texas are sodium carbonate ($Na\text{-}CO_3$) and calcium carbonate ($Ca\text{-}CO_3$) waters of moderate or high mineral content, as is indicated by the table on page 108. Those from the shallower wells, 300 feet or less in depth, 60 or 70 miles from the coast, are likely to be calcium carbonate waters of moderate mineral content. On the other hand, wells approximately 600 feet deep, 30 to 50 miles from the coast, yield rather highly mineralized carbonate waters in which sodium predominates, and sodium chloride waters of high mineral content are found in the area 5 to 10 miles from the coast. Apparently the proportion of salt water mixed with the limestone waters from farther inland increases toward the coast.

With the exception of the salt waters, supplies from the Lissie gravels are fair to poor for boiler use, being too high in foaming ingredients to be called good, though they are low in scaling ingredients. Most of them are potable and may be used for irrigation if proper care is taken. Nearly all the salt waters examined from this formation are too strongly mineralized to be suitable for use.

Waters from the Lissie gravel.

Well No.	Depth.	Mineral content.	Chemical character.
	Feet.		
59	1,020 ?	Very high	Na-Cl.
60	1,100 ?	do	Na-Cl.
66	(?)	do	Na-Cl.
203	406	Moderate	$Na-CO_3$.
236	813	Very high	Na-Cl.
241	856	do	Na-Cl.
244	797	do	Na-Cl.
245	1,328	do	Na-Cl.
246	810	do	Na-Cl.
249	827	do	Na-Cl.
260	756 to 796	High	
270	740 to 860	do	Na-Cl.
302	750	do	$Na-CO_3$.
306	711 to 726	do	$Na-CO_3$.
308	710	do	$Na-CO_3$.
312	690	do	$Na-CO_3$.
336	600	do	$Na-CO_3$.
348	576	do	$Na-CO_3$.
356	935 to 1,020	Very high	Na-Cl.
360	827 to 843	High	Na-Cl.
411	392 to 466	Moderate	$Ca-CO_3$.
412	286 to 339	do	$Ca-CO_3$.
429	265 to 320	do	
443	75 to 268	do	$Ca-CO_3$.
512a	661 to 683	do	$Na-CO_3$.
512b		High	$Na-CO_3$.
537	500 ?	do	$Na-CO_3$.
626	82 to 212		
638	360	Very high	Na-Cl.
661	630 to 650	High	Na-Cl.
738	240 to 290	Moderate	$Ca-CO_3$.
747	288 to 367	do	$Ca-CO_3$.
848	740 ?	High	

WATERS FROM THE DEWITT FORMATION.

The few available analyses indicate that the Dewitt formation yields waters of rather moderate mineral content, poor for boilers but capable of being improved by treatment. The waters examined are good to fair for irrigation and are potable.

Waters from the Dewitt formation.

Well No.	Depth.	Mineral content.	Chemical character.
	Feet.		
761	532 to 585	Moderate	
783	114 to 134	High	$Ca-CO_3$.
790	577 to 642 ?	Moderate	$Ca-CO_3$.

WATERS FROM THE CATAHOULA SANDSTONE.

The supplies from the Catahoula sandstone are mostly alkali waters of high mineral content. Those analyzed are so high in foaming constituents that they are bad for boilers, being capable of little improvement by treatment. They are fair to poor for irrigation, but most of them are potable.

Waters from the Catahoula sandstone.

Well No.	Depth.	Mineral content.	Chemical character.
	Feet.		
373	220 to 237	High	Na-CO_3.
381		....do	Na-CO_3.
384	520 ?	....do	Na-CO_3.
621	182 to 660	Very high	Na-Cl.
627	1,312 to 1,346	Moderate	Ca-CO_3.
1,010	339 to 484	High	Ca-CO_3.

WATERS FROM THE YEGUA FORMATION.

The analytical data are insufficient to warrant categorical statement in regard to the waters of the Yegua formation. They are apparently salt waters of mineral content and are unfit for use.

Waters from the Yegua formation.

Well No.	Depth.	Mineral content.	Chemical character.
	Feet.		
122	647 to 687	High	Na-Cl.
635	1,229 to 1,241	Very high	Na-Cl.

WATERS FROM THE MOUNT SELMAN FORMATION.

The Mount Selman formation yields sulphate waters that range widely in mineral content and in usefulness. Many of them carry large quantities of iron.

Waters from the Mount Selman formation.

Well No.	Depth.	Mineral content.	Chemical character.
	Feet.		
577	Spring.	Moderate	Ca-SO_4.
625	1,037 to 1,320	High	Ca-SO_4.
799	Spring.	Very high	Ca-SO_4.

WATERS FROM THE WILCOX FORMATION.

Waters from the Wilcox formation differ much in composition and in mineral content, ranging from supplies acceptable for all purposes to those unfit for use. Alkali waters high in mineral content are common.

Waters from the Wilcox formation.

Well No.	Depth.	Mineral content.	Chemical character.
	Feet.		
12a	430 to 456	High	Na-CO_3.
12b	1,024 to 1,070	do	Na-CO_3.
582	60	Low	Na-SO_4.
583	253	Moderate	Na-CO_3.
780	800	do	Ca-SO_4.
801	Spring.	High	Na-SO_4.
804	300	Low	Na-SO_4.
811	340 to 500	Moderate	Na-CO_3.
912a	80 to 84	Very high	Ca-SO_4.
912b	80 to 84	do	Ca-SO_4.
912c	80 to 84	do	
912d	80 to 84	do	Ca-SO_4.
935		High	
951	564 to 614	Very high	Na-CO_3.
1012	(?)	Moderate	Na-CO^3.
1013	— to 1,202	High	Na-CO_3.

ANALYSES.

Many of the analyses in the accompanying table were made especially for this report in the chemical laboratory of the University of Texas, and the rest, for the most part reported by the analysts in grains per United States gallon and in hypothetical combinations, have been recomputed into ionic form in parts per million.[1] All have been classified by R. B. Dole according to the standards outlined on pages 100–106. The analyses are grouped by counties in alphabetic order, the numbers in the first column corresponding to those in the tables of wells.

COUNTY DESCRIPTIONS.

ANDERSON COUNTY.

GEOLOGY AND HYDROLOGY.

The western half of Anderson County is characterized by the outcrop of the Wilcox formation, the eastern half by the outcrop of the Cook Mountain formation. (See Pl. I.) The Nacatoch sand and the lower Eocene comprise the water-bearing formations of this county.

Nacatoch sand.—The Nacatoch can be reached in the eastern half of the county by wells penetrating 1,000 to 1,500 below sea level, but the water would undoubtedly prove salty and therefore valueless. (See Pl. VII, in pocket.)

Lower Eocene.—The catchment or outcrop area of the lower Eocene reservoir extends over the whole of Anderson County. The base lies less than 100 feet below the sea level in the northwest corner of the county and about 550 feet below it in the southeast corner.

In the southeast half of the county the lower sands of the reservoir are covered in places by lenses of clays inclined slightly seaward.

[1] For example, a million pounds of the water represented by analysis No. 12 contains 14 pounds of calcium, 4 pounds of magnesium, and so on.

Analyses of underground waters from eastern Texas.

[Parts per million.]

Location.	Source and owner.[a]	Date of analysis.	Name of principal water-bearing formation.	Depth.	Analyst.	Silica (SiO_2).	Iron (Fe).	Aluminum (Al).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Nitrate radicle (NO_3).	Chlorine (Cl).	Volatile and organic matter.	Total dissolved solids.	Mineral content.	Chemical character.	Suitability for boilers.	Improvement by softening.	Suitability for irrigation.	Suitability for domestic use.
Angelina County:																									
Platt, 2½ miles west	A. P. Kimmey	Sept. 19, 1907	Wilcox	*Feet.* 430 to 456	B. L. Glascock	36	1.2	0.9	14	4.0	718	7.4	22	903	31	2.7	591		1,874	High	Na-CO_3	Very bad	None	Poor	Poor.
Do	do	do	do	1,024 to 1,070	do	34	.4	.5	6.8	2.2	295	3.2	38	661	73	2	17		758	do	Na-CO_3	do	do	do	Fair.
Brazoria County:																									
Perrys Landing	Guy M. Bryan		Lissie (?)	1,020?		29			87	27	1,357			264	38		2,138	56	3,891	Very high	Na-Cl	do	do	Bad	Unfit.
Velasco	E. D. Dorchester		do	1,100?	H. H. Harrington				79	28	1,331			241			2,132		3,424	do	Na-Cl	do	do	do	Do.
Velasco, 3½ miles southeast.	C. H. Alexander		(?)	(?)	Edgar Everhart	14	b 9.9		92	27	1,101			409	Tr.		1,670		3,117	do	Na-Cl	do	do	do	Do.
Burleson County:																									
Clay			Yegua	647 to 687		38			21	8.0	490		30	320	4.6		490	79	1,481	High	Na-Cl	do	do	Poor	Poor.
Chambers County:																									
Northwest part of High Island.	Smith Spring (No. 2)				James Kennedy	12	5	8.5	98	84	416	Tr.		651	76		640	8.7	2,008	Very high	Na-Cl	do	do	do	Do.
Do	Smith Spring (No. 3)				H. H. Harrington	27	18	7.9	46	6.2	52	12		.0	247		63	Tr.	479	Moderate	Na-SO_4	Fair	Yes	Good	Good.
Cherokee County:																									
Dialville, 1½ miles northeast.	Castalian Springs	Feb. 3, 1908			J. R. Bailey and A. M. McAfee.	50	8	5.5	6.2	.3	32	6.2	.0	46	50	.06	14		180	do	Na-SO_4	Good	None	do	Fair.
Fort Bend County:																									
Thompson	Eliza Jones		Lissie	406	do	21	.15	.62	42	12	55	3.5	12	231	3.3	1.4	28		283	do	Na-CO_3	Fair	Yes	Fair	Good.
Galveston County:																									
Corner post office and Twenty-sixth Sts., Galveston.	Brush Electric Light & Power Co.		do	813	C. P. Russell				20		1,422			439			1,970		(f)	Very high	Na-Cl	Very bad	None	Bad	Unfit.
Corner Twentieth St. and Avenue A, Galveston.	Texas Ice & Cold Storage Co.		do	856	S. P. Sharpless	17	2.1		33	17	1,229	22	.0	384	.3		1,793		g 3,306	do	Na-Cl	do	do	do	Do.
Shops, Galveston	Santa Fe Co		do	797	R. Voelker		2.7				1,280		.0	768			1,519	7.7	h 3,192	do	Na-Cl	do	do	do	Bad.
Corner Eighteenth St. and Avenue A, Galveston.	National Cotton Oil Co.		do	i 1,328	David Wesson				152	10							2,774		h 5,308	do	Na-Cl	do	do	do	Unfit.
Corner Thirty-eighth and Church Sts., Galveston.	Bagging factory		do	j 810	Prof. Williams		b 118										2,276	111	(k)	do	Na-Cl	do	do	do	Do.
Galveston, 10 miles southwest.	South Galveston Land Co. (No. 1).		do	l 827	H. H. Harrington m				33	18	1,152				154		1,773		h 2,996	do	Na-Cl	do	do	do	Bad.
Alta Loma	Galveston City Waterworks (No. 8).	1899	do	756 to 796	Fraser & Co.												244	21	693	High				Fair	Potable.
Do	Galveston City Waterworks (No. 13).	1899	do	740 to 860	do												1,014	31	1,974	do	Na-Cl	Very bad	None	Poor	Poor.
Hitchcock, 1½ miles west.	A. H. Tacquard	Feb. 3, 1908	do	750	J. R. Bailey and A. M. McAfee.	27	.2	1.3	8.4	9.9	188	2.8	12	311	3.9	.02	96		504	do	Na-CO_3	Poor	do	do	Good.
Hitchcock	Gulf, Colorado & Santa Fe Ry.		do	711 to 726	W. H. Melville	29	b 2.6		6.0	3.0	225	2.0	.0	419	n .0	.50	122		600	do	Na-CO_3	do	do	Bad	Do.
Hitchcock, 1½ miles northwest.	J. Tacquard		do	710	do	30	b 2.0		8.6	1.6	215	.9	.0	353	n .0	.00	146		582	do	Na-CO_3	do	do	do	Do.
Hitchcock, 1½ miles east.	R. T. Wheeler		do	690	W. D. Church	6.0	b 4.3		15	4.3	146		.0	281			100	Tr.		do	Na-CO_3	do	do	Poor	Do.
Dickinson	Nichols		do	600	W. H. Melville	20	b 2.2		4.0	2.0	260	1.2	.0	508	n .0	.00	117		660	do	Na-CO_3	do	do	do	Do.
Fairwood			Lissie(?)	576	J. E. Sieble	21	Tr.		28	5.5	198		.0	414	o Tr.		125	79	665	do	Na-CO_3	do	do	do	Do.
League City	Galveston, Houston & Henderson R. R.		Lissie	935 to 1,020	St. Louis Sampling & Testing Works.	12	b 12		21	9.2	739		.0	560	Tr.		870	142	2,021	Very high	Na-Cl	Very bad	do	do	Poor.
Lamarque, ⅝ mile northeast.	Kohfeldt & Braun	Apr. 11, 1908	do	827 to 843	J. R. Bailey and A. M. McAfee.	28	.08	.6	21	7.9	331	9.7	.0	394	5.3		354		901	High	Na-Cl	Bad	do	do	Good.
Grimes County:																									
Navasota			Catahoula	220 to 237			q 15		43	8.8	140			336	41		79	38	533	do	Na-CO_3	Poor	do	Fair	Do.
Geo. Mason headright, 16 miles north of Navasota.	Spring, on a branch of Navasota River.				Texas Geological Survey.	37	91	4.1	159	63	1,481	28		356	1,280	(r)	1,746		5,068	Very high	Na-Cl	Very bad	do	Bad	Unfit.
Do	Spring near No. 378a	1889			do	39	110	54	202	134	790	6.3			1,650		1,115		4,100	do	Na-SO_4	do	do	Poor	Bad.
Do	Shallow well	1889		10 to 12	do	9.6	22	14	206	84	149	128		350	680		248		1,768	High	Ca-SO_4	do	do	Fair	Poor.
Do	do			10 to 12	H. H. Harrington		240		95		577		.0	.0	s 1,		235	70	2,739	Very high	Na-SO_4	do	do	Bad	Unfit.
Do	do	1889		10 to 12	do		5.0	105		7.0			.0	.0	t 109	(u)		933	v 3,732	do		do	do	do	Do.
Navasota	R. B. Templeman (waterworks).	Feb. 3, 1908	Catahoula or Yegua.		J. R. Bailey and A. M. McAfee.	38	.10	1.1	24	4.9	193	26	24	401	15	.02	56		565	High	Na-CO_3	Bad	do	Poor	Good.
Isaac Jackson League, west of Navasota.	R. B. Templeman	do	Catahoula (?)	520 (?)	do	36	.20	.6	24	3.5	193	26	22	431	2.6	.02	72		592	do	Na-CO_3	do	do	do	Do.
Hardin County:																									
Silsbee	Gulf, Colorado & Santa Fe Ry.		Lissie	392 to 466		19			36	5.9	24		9.5	136	15		26	44		Moderate	Ca-CO_3	Fair	Some	Good	Do.
Olive	Olive-Sternenberg Lumber Co.	1908	do	286 to 339	J. R. Bailey and A. M. McAfee.	53	.20	.5	44	2.2	15	3.3	6.0	134	7.0	.02	14		204	do	Ca-CO_3	do	do	do	Do.
Votaw	Gulf, Colorado & Santa Fe Ry.		do	265 to 320		22	q 10		13		2.7			38	5.8			39		do					Do.
Dies	do		do	75 to 268		45	q 7.2		59		33			158	2.2		62	37		do	Ca-CO_3	Poor	Yes	Good	
Harris County:																									
Genoa	Galveston, Houston & Henderson R. R. (No. 1).		do	661 to 683	St. Louis Sampling & Testing Works.		.0		17	9	177				.0		8	3	483	do	Na-CO_3	do	do	Poor	Do.
Genoa, 9 feet north of well No. 1.	Galveston, Houston & Henderson R. R. (No. 2).		do		do	16	b 2.0		54	27	151			422	11			121	650	High	Na-CO_3	do		do	Do.
Houston, 4 miles east of post office.	C. R. Cummings Export Co.	Apr. 11, 1908	do	500 (?)	J. R. Bailey and A. M. McAfee.	10	.30	2.2	26	12	436	21	19	467	157	.01	342		1,197	do	Na-CO_3	Bad	None	do	Poor.
Harrison County:																									
Marshall, 6 miles west of.	Hynson Springs	Feb. 3, 1908	Mount Selman		do	78	40	10	9.8	16	11	5.4			239	.06	14		435	Moderate	Ca-SO_4	Fair	Yes	Good	Do.
Marshall, 3 miles northeast of.	Waterworks	Sept. 19, 1907	Wilcox (Queen City sand member).	60	B. L. Glascock	24	.31	1.3	5.4	2.0	15		.0	6.1	24	.44	7.0		86	Low	Na-SO_4	do	do	do	Good.
Do	do	do	Wilcox	253	do	26	.26	1.7	32	11	33	4.3	4.8	171	86	4.9	20		347	Moderate	Na-CO_3	do	Some	do	Do.
Marshall, 9 miles south	Roseborough Spring No. 1				J. H. Herndon	94	104	17	184	80	125	30	.0	.0	1,164		118		(z)	High	Ca-SO_4	Very bad	None	Bad	Bad.
Jasper County:																									
Horger, 2½ miles northeast of.	J. A. Bohler	Apr. 11, 1908	Catahoula	182 to 660	J. R. Bailey and A. M. McAfee.	40	.7	3.7	140	24	1,955	102	.0	531	12		3,063		5,454	Very high	Na-Cl	do	do	do	Unfit.
Remlig	Alexander Gilmer Lumber Co.		Cook Mountain, Mount Selman, and Wilcox.	1,037 to 1,320		Tr.	Tr.	Tr.	3.4	2.4	416			183	604		41	171	1,332	High	Na-SO_4	do	do	Poor	Fair.
Kirbyville			Lissie	82 to 212			q 15			9.2			21				2.5								
Do	Kirbyville Oil Co.		Catahoula	1,312 to 1,346	B. L. Glascock	36	b 3.8		85	5	22			292	12	Tr.	24	10	266	Moderate	Ca-CO_3	Poor	Yes	Good	Good.
Rockland, 4 miles east of.	Doom Spring at old salt works.	Sept. 19, 1907			do	53	.8	3.6	158	9.0	1,120	43	.0	110	12	.00	1,962		3,540	Very high	Na-Cl	Unfit	None	Bad	Unfit.
Rockland, 2 miles north of	Kountze Bros	Sept. 12, 1907	Yegua	1,229 to 1,241 (?)	do	62	.10	19	675	66	4,821	55	.0	217	9.8	.00	8,700		15,146	do	Na-Cl	do	do	Unfit	Do.
Jefferson County:																									
Spindletop	Spindletop Power Co	Nov. 15, 1907	Lissie	360	J. R. Bailey and A. M. McAfee.	26	3	.2	3.2	1.5	728	73	27	265	40		1,102		2,190	do	Na-Cl	Very bad	do	Poor	Bad.
Beaumont, 3½ miles north.	Beaumont Country Club	do	do	630 to 650	do	5.5	1.0		24	14	360	44	24	273	10		470		1,118	High	Na-Cl	do	do	do	Potable.
Liberty County:																									
Crossing on Trinity River.	Gulf, Colorado & Santa Fe Ry.		do	240 to 290		14			38	4.4	19		7.0	137	20		16	50		Moderate	Ca-CO_3	Fair	Some	Good	Good.
Cleveland	do		Lissie (?)	288 to 367	W. A. Powers	27			43	30	12		74	63	113		9	32	340	do	Ca-CO_3	do	do	do	Do.
Milvid, ½ mile southwest.	Miller & Vidor Lumber Co		Dewitt	532 to 585	G. H. Seynes														244	do		do		do	Do.
Marion County:																									
Jefferson, ½ mile north	J. M. Deware	Sept. 19, 1907	Wilcox	800	B. L. Glascock	31	18	6.4	32	14	25		.0	80	79	1.3	20		297	do	Ca-SO_4	Poor	Yes	do	Fair.
Montgomery County:																									
Bobbin	Gulf, Colorado & Santa Fe Ry.		Dewitt	114 to 134		27	q 27		110	14	90		65	358	11		167	70		High	Ca-CO_3	do	do	Fair	Poor.
Conroe	do		Dewitt (?)	577 to 642 (?)		21			73	16	41			340			48	38		Moderate	Ca-CO_3	do	do	Good	Good.
Nacogdoches County:																									
E. Chandler survey, near Stoker.	Stoker Mineral Spring		Mount Selman		Munroe, Hall & Hopkins.	145	141	116	728	866	85	5			4,128		1,434		7,484	Very high	Ca-SO_4	Unfit	None	Poor	Unfit.
Garrison	"White Spring"	Sept. 19, 1907	Wilcox		B. L. Glascock	64	11	7	126	96	273	9.0	.0	.0	bb 564	.00	443		1,624	High	Na-SO_4	do	do	Unfit	Do.
Caro	Whiteman - Decker Lumber Co.	Sept. 12, 1907	do	300	do	16	.5	1.9	4.0	2.5	8.6		.0	11	16	.09	6.2		67	Low	Na-SO_4	Fair	Yes	Good	Good.
Do	Whiteman - Decker Lumber Co. Spring.	do			do	47	.08	3.4	17	7.4	19	5.7	.0	66	50	.90	9.5		193	Moderate	Na-CO_3	do	Some	do	Do.
Nacogdoches	Nacogdoches Ice & Cold Storage Co.	Feb. 3, 1908	Wilcox	340 to 500	J. R. Bailey and A. M. McAfee.	12	1.0	.6	2.2	2.1	49	2.5	.0	107	19	1.8	8.8		150	do	Na-CO_3	Good	None	do	Do.
Do	Waterworks Spring	Sept. 19, 1907			B. L. Glascock	21	.7	.5	3.0	1.4	12		.0	16	1.5	1.8	4.5		48	Low	Na-CO_3	do	do	do	Do.
Samuel H. Hamil headright near Angelina River, south portion.	Shawnee Mineral Spring	Sept. 12, 1907			do	63	7.2	2.3	20	3.6	23	.4	.0	45	21	.00	13		179	Moderate	Na-CO_3	Fair	Some	do	Fair.
Orange County:																									
Beaumont, 8 miles north.	Park farm		Lissie (?)	740 (?)	H. H. Harrington				17	4.0							527		1,335	High		Bad	do	Poor	Potable.
Robertson County:																									
Franklin	Overall Mineral (No. 1)				Edgar Everhart	35	481	5	106	45	112				1,363		100	42	dd 2,288	Very high	Na-SO_4	Unfit	None	Unfit	Unfit.
Do	Overall Mineral (No. 2)				do		918	13	187	69	329				2,855		54	38	dd 4,465	do	Na-SO_4	do	do	do	Do.
Wootan Wells	No. 1		Wilcox	80 to 84	C. F. Chandler	56	38	11	ff 260	166					1,225		417	164	2,394	do	Ca-SO_4	Very bad	do	Poor	Bad.
Do	No. 2		do	80 to 84	W. M. Mew	48	133	14	gg 317	118	185				1,371		567		2,878	do	Ca-SO_4	do	do	do	Unfit.
Do	No. 3		do	80 to 84	do				332	180	1,628						607	210	3,194	do		do	do	Unfit	Bad.
Do	No. 4		do	80 to 84	do	70	156	31	hh 344	234	230				1,774		622		3,644	do	Ca-SO_4	do	do	Poor	Do.
Sabine County:																									
Bronson	Gulf, Colorado & Santa Fe Ry.		do			17					330			790	8.1		30	34		High		Bad	do	do	
Shelby County:																									
Center	do		do	564 to 614		24			4.1		370			860	14		57	31		Very high	Na-CO_3	Very bad	do	Bad	Bad.
Walker County:																									
Huntsville	Texas State Penitentiary	1894	Catahoula	339 to 484	H. H. Harrington	104			82	3.0	68	27		328	47		53			High	Ca-CO_3	do	Some	Fair	Good.
Wood County:																									
Mineola	Mineola Light & Ice Co	Feb. 3, 1908	Wilcox	(?)	J. R. Bailey and A. M. McAfee.	17	.30	1.9	2.6	4.2	49	2.8	2.4	102	19	1.8	7		154	Moderate	Na-CO_3	Fair	None	do	Do.
Do	Mineola	do	do	—— to 1202	do	26	.4	.4	8.0	8.6	404	33	31	485	10	.01	310		1,069	High	Na-CO_3	Very bad	do	Poor	Poor

a Well, unless otherwise stated.
b Oxides of iron and aluminum ($Fe_2O_3+Al_2O_3$).
c Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 61.
d Fenneman, N. M., Bull. U. S. Geol. Survey No. 282, 1906, p. 80.
e Singley, J. A., Fourth Ann. Rept. Geol. Survey Texas, 1893, pp. 98-101.
f Free carbon dioxide (CO_2), 143 cubic centimeters per liter.
g Apparently contains much free carbon dioxide. A local druggist charged this water with carbonic acid gas and put it on the market as a table water under the name of Natrona water. It had attained considerable sale when the business was stopped by an injunction obtained by a rival company.
h Much free carbon dioxide.
i From a sand below the sand that supplies most of the wells at Galveston; same as the sand encountered at 1,330 to 1,340 feet in the Galveston deep well.
j From the horizon that supplies most of the wells of Galveston.
k Carbonates of calcium and magnesium, 233 parts per million.
l From horizon that supplies the city wells of Galveston.
m Singley, J. A., op. cit., pp. 101-104.
n Phosphate radicle (PO_4), trace.
o Borate radicle, trace.
p Taylor, T. U., op. cit., p. 42.
q Sulphates of iron and aluminum ($FeSO_4+Al_2(SO_4)_3$).
r Free carbon dioxide, 11 cubic centimeters per liter.
s Free sulphuric acid, 94 parts per million.
t "Soda, potash, and chlorides," 1,267 parts per million.
u Manganese (Mn), trace.
v Free sulphuric acid, 394 parts per million.
w Taylor, T. U., op. cit., p. 47.
x Taylor, T. U., op. cit., p. 48.
y Dumble, E. T., Kennedy, William, et al., Reports on the iron-ore district of east Texas: Second Ann. Rept. Geol. Survey Texas (1890), 1891, pp. 158-159.
z Strongly acid. Temperature 68° F. Free carbon dioxide, 66 cubic centimeters per liter.
aa Taylor, T. U., op. cit., pp. 43-50.
bb Free sulphuric acid (H_2SO_4), 122 parts per million.
cc Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol. Survey Texas (1892), 1893, p. 84.
dd Acid water.
ee Peale, A. C., Lists and analyses of the mineral springs of the United States: Bull. U. S. Geol. Survey No. 32, 1886, p. 128.
ff Manganese (Mn), 7 parts per million.
gg Manganese (Mn), 6 parts per million.
hh Manganese (Mn), 8 parts per million.
ii Taylor, T. U., op cit., pp. 64, 65.

For this reason the waters in these parts are under more or less pressure. The pressure, however, is not sufficient to produce flows on the divides, and the area of flowing wells is confined largely to the lowlands flanking the streams. (See Pl. VIII, in pocket.) Nonflowing wells, yielding abundant supplies of potable water from depths ranging from 50 to 900 feet, may be had over the entire county. All such wells draw from the lower Eocene reservoir.

At Palestine three water sands are encountered in the Wilcox formation at depths of 200 to 250, 310 to 400, and 560 feet. No flows have been struck. The water is potable. Weak flows occur about 3½ miles south of Neches (well No. 2), at an elevation lower than that of Palestine, but the water is not adapted to domestic use.

WELL DATA.

A detailed list of the wells of Anderson County is given in the subjoined table:

Wells and springs in Anderson County, Tex.

No.	Location.	Owner.	Driller.	Authority.
1	Bethel, 1 mile north	J. B. Howell		J. B. Howell.
2	Neches, 3½ miles south	Anderson County Oil Co.		Postmaster.
3	Palestine	Palestine Ice Co.		Palestine Ice Co.[a]
4	do	Palestine Ice, Fuel & Gin Co.		Postmaster.
5	do	International & Great Northern Railway Co.		L. Trice, general superintendent.[a]
6	Palestine, 4½ miles from	Palestine Water & Power Co.	American Well Works.	H. L. Wright, receiver.[a]
7	Palestine, 10 miles east	Palestine Oil Co.	J. L. Mayo	J. L. Mayo.[b]
8	Palestine, 8 miles east (Ezell place, Samuel Davis League).	Ezell-Bell Co.		A. Deussen.
9	Palestine, 10 miles east (Duty tract).	M. A. Davey	T. J. Synott	Do.
10	Elkhart			R. A. F. Penrose, jr.[b]

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Pumps per minute.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*
1						
2	8	850			Small flow	
3	6	560	495	200 to 250, 560(?)	−80	100.
4	6	480		310 to 400	No flow	
5	6	650	495		−200	Small.
6	6 8–6 6 6	400 to 444	400	235 to 440		120.[c] 130.[d]
7		310		115 to 121		
8		878			Flows (?)	
9		1,040				
10		60 to 30				

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 228.
[b] Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiaries of Texas from Red River to the Rio Grande: First Ann. Rept. Geol. Survey Texas, 1890, pp. 100–101.
[c] Well No. 1.
[d] Well No. 2.

Wells and springs in Anderson County, Tex.—Continued.

No.	Source of supply.	Quality.	Remarks.
1	....	....	Spring.
2	Wilcox..........	Mineral..........	Oil test well. Mr. A. B. Hodges, Palestine, Tex., writes: "We are prospecting for oil east of Palestine, 3½ miles south of Neches. We have not found any surface artesian flow of water to amount to anything. Have a light flow in one well of a highly mineral character."
3	.....do..........	Iron..........	Casing 300 feet.
4	.....do..........	....	Completed in 1894.
5	.....do..........	....	Drilled in 1877–78; not used.
6	.....do..........	Iron, and slightly hard.	
7	Wilcox and Mount Selman...	....	Test well for oil; bored in 1887; six wells.
8	Wilcox..........	....	Show of oil at 850 feet; oil test well; completed in 1904; abandoned.
9	....	....	Oil test well; completed in 1904.
10	....	Iron, alum, and sulphur.	Local resort. A number of shallow wells.

DESCRIPTIVE NOTES.

6. *Section of well of Palestine Water & Power Co., Palestine, Tex.*

Mount Selman and Wilcox formations:	Feet.
Pipe-clay, alternating with sand..........	0– 30
Fire clay..........	30– 60
Lignite..........	60– 70
Clay and sand..........	70–130
Sandstone..........	130–
Sand and clay..........	–230
Rock..........	230–235
Water-bearing sand..........	235–280
Rock..........	280–
Water-bearing sand..........	–440
Rock..........	440–444

The second well penetrated practically the same materials. Two other wells penetrated no rock and soon caved.

7. *Section of well of Palestine Oil Co., 10 miles east of Palestine, Tex.*

Mount Selman and Wilcox formations:	Feet.
Soil..........	0– 15
Rusty sand (some oil)..........	15– 18
Chocolate-colored hardened sand..........	18– 24
Alternate strata of sand and clay..........	24– 58
Sand impregnated with oil..........	58– 72
Clay and sand..........	72–115
Quicksand and water..........	115–121
Blue lignitic clay..........	121–280
Loose sand..........	280–310

8. *Section of well on Ezell place near Neches and 10 miles east of Palestine, Tex.*

[Furnished by R. A. Brule.]

	Ft.	in.		Ft.	in.
Mount Selman and Wilcox formations:					
Mottled clay	0	0	–	14	0
"Pinched oil" sand	14	0	–	21	0
Gray shale	21	0	–	46	0
Oxide iron sand	46	0	–	50	0
Limestone	50	0	–	50	4
"Worn-out organic sand"	50	4	–	66	4
Brown shale and sand	66	4	–	89	4
"Pinched oil sand," gas indications	89	4	–	96	4
"Organic sand" and lignite	96	4	–	131	4
Brown shale	131	4	–	156	4
Limerock	156	4	–	156	6
Shale and sand	156	6	–	183	6
Gray shale	183	6	–	193	6
Brown shale	193	6	–	196	6
Limerock	196	6	–	196	9
Brown shale	196	9	–	216	9
Oil sandrock, gas indications	216	9	–	226	9
Brown shale; signs of oil	226	9	–	238	9
Organic sand; oil lignite	238	9	–	412	9
Hard sandrock	412	9	–	419	9
Packed sand; signs of oil	419	9	–	434	9
Gray shale or soapstone	434	9	–	446	9
Black-brown shale	446	9	–	458	9
Black gumbo	458	9	–	472	9
"Organic sandrock"	472	9	–	482	9
Oil sand and gas	482	9	–	498	9
Soft lignite	498	9	–	502	9
Brown shale	502	9	–	542	9
Shale and "decomposed asphalt"	542	9	–	547	9
Sandrock; traces of gas	547	9	–	548	1
Sandrock and traces of asphalt	548	1	–	552	1
Shale, lignite, and sand	552	1	–	556	1
Shale, sand, and decomposed asphalt	556	1	–	576	1
Hard sandrock	576	1	–	581	1
Shale or soapstone	581	1	–	587	1
Black shale and sand; signs of oil	587	1	–	617	1
Oil sand; gas	617	1	–	620	1
Brown shale	620	1	–	625	1
Hard rock; sand	625	1	–	629	1
Soft sandrock	629	1	–	633	1
Shale, sand, and decomposed asphalt	633	1	–	702	1
Sandrock	702	1	–	707	1
Sandrock and asphalt	707	1	–	714	1
Brown shale	714	1	–	716	1
Sandrock	716	1	–	727	1
Coarse oil sand and gas; from appearances, in paying quantities	727	7	–	755	7
Soft shale	755	7	–	795	7
Packed sand and lignite	795	7	–	807	7
Brown-black shale	807	7	–	810	7

Mount Selman and Wilcox formations—Continued.	Ft. in.	Ft. in.
Shale, sand, and lignite	810 7	- 818 7
Organic sand and asphalt	818 7	- 826 7
"Crystallized organic sandrock"	826 7	- 835 7
Oil sand; strong show of oil	835 7	- 836 5
Hard sand and asphalt	836 5	- 842 5
Brown-black shale	842 5	- 844 5
Asphalt, sandrock, and very hard	844 5	- 847 5
Oil sandrock; strong showing of oil	847 5	- 851 5
Brown shale	851 5	- 853 5
Oil sandrock and gases	853 5	- 856 5
Soft shale, sand; oil with strong indication of gas	856 5	- 860 5
Hard rock and "crystallized" limestone	860 5	- 860 7
Sandrock, full of oil	860 7	- 866 7
Hard crystallized limestone	866 7	- 867 10
"Organic oil sand;" in paying quantities	867 10	- 878
"Crystallized asphaltic limestone"	878	- 885 4
Oil sand, tapped	885 4	- 885 6

ANGELINA COUNTY.

GEOLOGY AND HYDROLOGY.

In Angelina County two important water strata, the lower Eocene and the Yegua formation, are available.

Lower Eocene.—The lower Eocene reservoir underlies the entire county, its water-bearing sands being struck at constantly increasing depths from north to south. In the northern portion wells can be completed at depths of 100 to 600 feet below sea level, and in the southern portion at depths of 1,000 to 2,000 feet below sea level. (See Pl. VIII, in pocket.) It is not advisable, however, to carry any well more than 1,500 feet below the surface, for the quality of the water will be unsatisfactory at greater depths.

Flowing wells from the lower Eocene have been obtained near Platt and 6 miles west of Lufkin. At Lufkin the water rose within 20 feet of the surface (well No. 15).[1] Flows may be expected from the lower Eocene sands over the entire county, except possibly on the divide occupied by the St. Louis Southwestern Railway. (See Pl. VIII.) It is doubtful if flowing wells, yielding potable water, will ever be encountered on the public square of Lufkin (altitude, 323 feet above sea level).

The water supplied by the lower Eocene in Angelina County is variable in quality. In wells not deeper than 700 feet it is generally potable and suitable for steaming (well No. 17), but in the immediate vicinity of Lufkin no supply suitable for the purpose has yet been developed.

Yegua formation.—The central east-west belt of Angelina County is occupied by the outcrop of the Yegua formation. (See Pl. I.) Flows are not to be expected in the outcrop area except in the lowest portions of the river bottoms (see Pl. VII), though they may be

[1] Numbers refer to wells listed in the tables accompanying the county descriptions.

obtained in the southern portion of the county where the strata lie embedded beneath the impervious clays of the Jackson formation. (See wells Nos. 19 and 26.) The well at Diboll, close to the southern line of the outcrop (depth 470 feet), failed to flow. (See Pl. VII.)

North of Diboll the water-bearing sands of the Yegua artesian system will always be encountered 100 to 200 feet below the surface, but they will not generally yield supplies that are abundant or hygienically satisfactory. At and near Diboll, wells can be completed at depths between sea level and 400 feet below. In the southern portion of the county these sands can be reached at 500 to 1,000 feet below sea level.

Water from the Yegua formation in Angelina County is not everywhere satisfactory. At Diboll it was formerly utilized for steaming purposes, but is no longer so used. On the whole, it is inclined to be slightly sulphurous. At Burke it was found to be salty at not more than 500 feet below the surface; this condition, however, is local. Salt springs rise at the Graham saline in the southern portion of the county close to Neches River. (See spring No. 14.)

Catahoula sandstone.—In the southern portion of the county (see Pl. I) the Catahoula sandstone outcrops but does not supply any flowing wells, because it is not under cover.

WELL DATA.

Detailed data on the wells of Angelina County appear in the following table:

Wells and springs in Angelina County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
11	Manton, 300 yards east of post office.	....	Angelina Orchard Co.	....	Angelina Orchard Co.
12	Platt, 2½ miles west.	Bluford Mitchell survey.	A. P. Kimmey....	M. E. Fowler.....	A. P. Kimmey.
13	Both sides of Angelina River.	Nancy Lang league	....	....	A. C. Veatch.[a]
14	Graham saline....	....	....	....	Do.[a]
15	Lufkin...........	Lot 3, block 83....	City of Lufkin.....	Gust Warnecke...	Judge E. J. Mantooth.
16	.....do...........	Center of Cotton Square.	.....do...........	....	Do.
17	Lufkin, 6 miles west.	....	Gulf Pipe Line Co.	....	A. Deussen.
18	Lufkin, 1¼ miles north.	....	City of Lufkin.....	Layne & Bowler..	Do.
19	Zavalla, 5 miles south-southeast.	Edward Miller League.	Wm. Cameron & Co.	W. Wagner.......	Do.
21	Mott, 6 miles northwest, near Angelina River.	....	Eli Gillins........	Savage Bros.......	Eli Gillins.[a]
22	Mott, 7½ miles northwest of.	....	....	....	Do.[a]
23	Burke............	....	....	....	N. H. Darton.[b]
24	Diboll...........	....	Sawmill..........	Layne & Bowler..	T. Y. Depoor.
25	Windom.........	East Texas R. R. survey.	....	....	E. T. Dumble.
26	Rockland, 2 miles north; ¼ mile northeast of well No. 635.	J. H. Graham survey.	Kountze Bros.....	....	Do.

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 228.

[b] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 142.

Wells and springs in Angelina County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
11							10
12	10	1,303	176	430 to 456 688 to 750 860 to 901 1,024 to 1,070	Flows do. do. +32.3		
13							
14							
15	4	1,200		40, and others	−20		
16	4-3	1,128			No flow		
17		530±		530	Flows		Many.
18	6	1,300+	325±				
19		1,169		69 to 175 1,165	Flows do.		
21		312			−1		
22							
23		500					
24	14	476		165 325 470	 −22 	 280	
25		1,502	170				
26		1,272		15 to 19 530 to 572 1,204 to 1,211 1,249 to 1,264	No flow Flows do. do.		

No.	Source of supply.	Quality.	Remarks.
11		Soft	Spring will be used for a water supply in the town of Manton.
12	Wilcox do. do. do.	Potable [a] do. do. Sulphur [a]	Temperature, 78° F.; drilled for oil.
13		Brine	Abandoned salt works; used during Civil War. Remains of 12 furnaces found.
14		do.	Springs. Abandoned salt works.
15	Yegua and Wilcox		Drilled in 1900; never used. Driller agreed to secure a flow of water, but failed to do so, at 1,200 feet. City refused to accept well, and driller plugged it. Doubtless an adequate supply could be pumped.
16	Wilcox		Drilled in 1898; never completed. At 40 feet a stratum of white sand carried abundant water, but had been utilized by some citizens for sewage discharge. Contractor agreed to sink 1,200 feet and get water rising within 10 feet of surface. A bit was caught in the hole, and driller abandoned it.
17	Wilcox and Mount Selman.	Good	Completed in 1907.
18	Wilcox	Hard	Water not suitable for boilers.
19	Catahoula Yegua	Good Slightly sulphur	Oil test well.
21		Salty	Oil test well; a little inflammable gas.
22		do.	Salt lick.
23		do.	Oil test well; abandoned.
24	Yegua do. do.	 Soft	Water not suitable for boilers; completed in 1908.
25			Oil test well.
26	Catahoula do. Yegua do.	Potable (?) do. do. Warm and salty	Well abandoned; oil test well.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

12. *Section of A. P. Kimmey well, 2½ miles west of Platt, Tex.*

[By M. E. Fowler, contractor.]

	Feet.
Cook Mountain, Mount Selman, and Wilcox formations:	
Soft red sand	0– 15
Fine black sand, closely packed	15– 45
Blue gumbo	45– 60
Fossil rock, composed of fossils, "silicon," and pyrites of iron	60– 170
White sand	170– 225
Gumbo	225– 246
Rock shale	246– 247
Hard sandrock (set surface casing)	247– 290
Blue and open shale	290– 300
Gumbo	300– 397
Rock	397– 399
Soft shale and sand	399– 430
White water sand; artesian flow	430– 456
Shale rock, sand and shale	456– 474
Soft rock	474– 482
Shale	482– 496
Rock	496– 499
Shale, pyrites of iron, show of gas	499– 515
Gumbo	515– 545
Hard shale, shale rock, and pyrites of iron	545– 558
Very hard rock	558– 559
Hard shale	559– 563
Rock	563– 567
Gumbo	567– 572
Soft rock	572– 603
Shale	603– 620
Gumbo	620– 635
Shale	635– 688
Soft sand; artesian flow, show of gas	688– 750
Hard sand	750– 770
Gumbo	770– 778
Shale	778– 813
Rock	813– 814
Shale	814– 844
Soft rock	844– 848
Brown clay	848– 860
Sand, artesian flow	860– 901
Shale, lignite, and pyrites of iron	901– 948
Hard rock (set 6-inch casing at 950 feet)	948– 954
Gumbo	954–1,005
Shale and sand	1,005–1,018
Very hard rock, pyrites of iron, and sulphur	1,018–1,022
Gumbo	1,022–1,023
Rock	1,023–1,024
Shale and sand; strong flow sulphur water	1,024–1,070
Rock	1,070–1,078

	Feet.
Cook Mountain, Mount Selman, and Wilcox formation—Continued.	
Shale and pyrites	1,078–1,100
Gumbo	1,100–1,110
Soft shale	1,110–1,125
Shale and pyrites of iron mixed	1,125–1,147
Hard shale	1,147–1,170
Gumbo, shale, and pyrites	1,170–1,185
Lignite	1,185–1,200
Shale and pyrites	1,200–1,213
Hard rock	1,213–1,217
Shale, pyrites, and gumbo	1,217–1,247
Rock	1,247–1,248
Shale and gumbo	1,248–1,303

The 10-inch casing extends to 305 feet; water from it flows, probably from first horizon, 430 to 456 feet. The 6-inch casing extends to 950 feet, and from this water from the horizon 1,024 to 1,070 feet rises at least 32 feet above the ground.

19. *Section of well of Wm. Cameron & Co., Edward Miller League, 5 miles south-southeast of Zavalla, Tex.*

[Furnished by William Kennedy.]

	Feet.
Catahoula, Jackson, and Yegua formations:	
Blue clay	0– 2
Yellow clay	2– 3
Red clay	3– 7
Blue and gray sand	7– 10
Gray sand	10– 16
Blue and brown sand, showing oil	16– 42
Blue and gray sand	42– 62
Sandrock	62– 69
Quicksand (artesian water)	69– 195
Gumbo	195– 245
White sand	245– 265
Dark shale and gumbo	265– 405
Rock	405– 408
Gumbo	408– 480
Rock	480– 482
Gumbo	482– 516
Soft rock	516– 518
Gumbo	518– 534
Rock	534– 535
Gumbo	535– 547
Shell	547– 551
Rock	551– 552
Gumbo	552– 564
Rock	564– 565
Gumbo	565– 593
Shell	593– 599
Rock	599– 622
Gumbo	622– 644
Rock	644– 660
Gumbo and shell	660– 689

Catahoula, Jackson, and Yegua formations—Continued.	Feet.
Rock	689– 710
Gumbo	710– 732
Packed sand	732– 735
Gumbo	735– 775
Rock bowlders	775– 776
Gumbo	776– 792
Hard packed sand	792– 796
Rock	796– 815
Red gumbo	815– 837
Rock	837– 840
Gumbo	840– 896
Rock with sand	896– 900
Gumbo	900– 960
Rock	960– 962
Gumbo	962–1,010
Rock and sand	1,010–1,016
Gumbo	1,016–1,040
White clay	1,040–1,047
Hard rock	1,047–1,051
Red gumbo	1,051–1,062
Gumbo	1,062–1,155
Rock	1,155–1,163
Water sand (sulphur water)	1,163–1,169

25. *Section of well at Windom (East Texas Railroad survey), Tex.*

[Furnished by E. T. Dumble.]

	Feet.
Catahoula sandstone:	
Green sand and clay	0– 35
Blue gumbo	35– 248
Lignite, poor quality	248– 255
Green shale	255– 335
Dark gray sandrock	335– 340
Green shale	340– 390
Hard green sandrock	390– 400
Green shale (?)	400– 460
Blue gumbo	460– 765
Dark gray sandrock	765– 791
Jackson and Yegua formations:	
Blue gumbo	791–1,000
Green marl	1,000–1,205
Green marl with hard strata	1,205–1,502

Formation names have been supplied by the author.

26. *Section of Kountze Bros. well, J. H. Graham survey, 2 miles north of Rockland, Tex.*

[Furnished by E. T. Dumble.]

	Feet.
Catahoula, Jackson, and Yegua formations:	
Red clay	0– 15
White water sand	15– 19
Green sandrock	19– 30
Dark-gray sand	30– 70
Dark soft gray rock	70– 90
Green shale	90– 265

Catahoula, Jackson, and Yegua formations—Continued.	Feet.
Blue gumbo	265- 320
Green shale	320- 522
White water sand	522- 530
Green shale	530- 557
Dark-gray sand and oil show	557- 567
Green shale and shell	567- 750
Dark-gray sand oil (blow-out)	750- 769
Green shale with shell	769- 910
Green marl	910-1,055
Green marl with shell	1,055-1,098
White sandrock	1,098-1,112
Green marl shell	1,112-1,200
Brown shale	1,200-1,204
White sand with water	1,204-1,211
Brown shale; lignite	1,211-1,230
Sand and lignite	1,230-1,239
Dark-gray shale	1,239-1,249
Dark-gray sand, warm salt water	1,249-1,264
Brown shale	1,264-1,272

BRAZORIA COUNTY.

GEOLOGY AND HYDROLOGY.

Only the half of Brazoria County east of Brazos River lies within the area included in this paper.

Lissie gravel.—The relatively impervious Recent deposits and the Beaumont clay constitute the surface and the outcropping formations. (See Pl. I.) Beneath them lies the porous and prolific water-bearing Lissie gravel, which supplies flowing wells over practically the entire county.

There is evidence that a fault crosses this county from Hoskins Mound, 4 miles south of Liverpool, to Kiser Heights, near Columbia. (See fig. 6.) The fault and the two mounds (Hoskins Mound and Kiser Heights) influence to some extent the quality of the water along this line, permitting saline supplies to rise to higher levels than in the adjacent regions.

At Pearland a water-bearing sand in the Beaumont clay is struck at 92 feet. At Alvin water-bearing sands that yield potable water adapted for irrigation, steaming, and domestic use are met between 300 and 1,000 feet below the surface. Four miles east of Liverpool potable water flows from sands at 750 and 805 to 870 feet. At Velasco salty flows are found in water-saturated sands at 450 to 1,020 feet below the surface. Four miles west of Velasco, however, a flow sufficiently fresh for domestic use is obtained at 550 feet.

In a strip at least 6 miles wide along the coast only salty flows may be expected (pp. 122–125). On the mounds salt water may be expected at shallower depths than in the surrounding regions. At

Bryan Heights water sufficiently fresh for domestic use may be had to a depth of 1,000 feet, but the shallower wells yield better supplies. At Hoskins Mound the water is comparatively fresh to 800 or 900 feet. At Amsterdam Mound the water is salty at 1,373 feet. No data are available as to the Kiser Heights supply, but water from below 700 feet will probably be salty. Except for the 6 to 8 mile strip along the coast and for the mounds along the fault line (fig. 6) good water from flowing wells can be obtained all over the county to depths ranging from 100 to 1,000 feet and perhaps to 1,500 feet. (See Pl. VII.)

Many of the wells of this county are used for rice and truck irrigation.

WELL DATA.

The details of the wells of Brazoria County appear in the following table:

Wells and springs in Brazoria County, Tex.

No.[a]	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
27	Alvin, 4 miles north.		Rice farm		J. A. Singley.[b]
28	Alvin, 12 miles south.	Sec. 1, Austin League.	W. Weyant	A. S. Smith	W. Weyant.[c]
29	Alvin				T. U. Taylor.[d]
30	do				Do.[d]
31	Alvin, 3 miles southeast.		H. L. Skeets		Do.[d]
32	Alvin, 8 miles northwest.		W. J. Moore		Do.[d]
33	Alvin		Gulf, Colorado & Santa Fe R. R.		Do.[d]
34	Alvin, 6 miles north.		J. S. Daugherty		Do.[d]
35	Alvin, 10 miles north.		do		Do.[d]
36	Alvin, 3 miles southeast.		R. Willis		Do.[d]
36a	Alvin, 3 miles south.		H. Masterson		Do.[d]
36b	Alvin, 2½ miles southeast.		E. B. Thomas		Do.[d]
36c	Alvin		W. H. Bush		Do.[d]
37	Hoskins Mound	Lot 234			Do.[e]
38	Hoskins Mound, between Chocolate and Bastrop bayous, southeast Brazoria County.				N. M. Fenneman.[f]
39	Liverpool, 4 miles east.	S. F. Austin League	D. Noble Rowan, trustee.	Ben C. Taber	D. Noble Rowan, trustee.
40	Angleton, 5 miles south.	McDermott League.	Herrick & Vineyard.		E. E. White.
41	Angleton	John W. Bland League.	W. C. Stockton		W. C. Stockton.
42	do		L. B. McMillan		T. J. McMillan, postmaster.
43	Angleton, 7 miles southeast.	J. M. Musquez survey.	F. Oberhelman Bros. & Brucker.	Homer Horton	F. Oberhelman.

[a] For additional data, see notes at end of table.
[b] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 105.
[c] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 154.
[d] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 21.
[e] Taylor, T. U., op. cit., pp. 23–24.
[f] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 86.

Wells and springs in Brazoria County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
44	Angleton		E. E. White	Homer Horton	F. Oberhelman.
45	Angleton, 6 miles southeast.		R. W. Stewart	do	Do.
46	Angleton		C. E. Phelps	do	Do.
47	Angleton, 5 miles south.		J. W. Heard		J. W. Heard.
48	Angleton, 5½ miles southeast.	S. T. Austin League	C. Radelmiller	Homer Horton	C. Radelmiller.
49	Angleton		New York & Texas Land Co.		Wm. Kennedy.[a]
50	do		Brazos Valley Oil Co.		Do.[a]
51	Angleton, 6 miles northeast.		South Texas Development Co.	M. T. Stallard	V. C. Mayes.
52	Crossing of St. Louis, Mexico & Brownsville Railway on Chocolate Bayou.				T. E. Douthit.
53	Anchor, 3 miles northeast.	T. Jamison survey.	C. Brundrett	Jef Roberts	C. Brundrett.
54	Anchor, ⅛ mile mile northwest.	George Robinson League.	William Wacker	A. B. Young	William Wacker.
55	Bryan Heights, flat on northwest side.		Reed	J. F. Frederickson.	J. F. Frederickson.
56	Bryan Heights				N. M. Fenneman.[b]
57	Bryan Heights, 10 miles from mouth of Brazos River.				Do.[b]
58	Quintana				T. U. Taylor.[c]
59	Velasco, 6 miles west.		Guy M. Bryan		Do.[c]
60	Velasco		E. D. Dorchester		Do.[c]
61	Velasco, 6 miles east.		S. H. Hudgins		Do.[c]
62	Velasco, 3 miles east.		do		Do.[c]
63	Velasco, 4 miles west.		J. P. Bryan		J. P. Bryan.
64	Velasco		Oil mill site		T. U. Taylor.[c]
65	Velasco, 3½ miles southwest.				N. H. Darton.[d]
66	Velasco, 3½ miles southeast.		C. H. Alexander	Gust Warnecke	E. P. Hoefle.
67	Surfside		E. D. Dorchester		J. A. Singley.[e]
68	Brazoria County, west of Brazos.		State farm		T. U. Taylor.[c]
69	Do		do		Do.[c]
70	Do		do		Do.[c]
71	Do		do		Do.[c]
72	Do		do		Do.[c]
73	Do		do		Do.[c]
74	Do		do		Do.[c]
75	Brazoria		Brazoria County		Do.[c]
76	Manvel		E. M. Miller		Do.[c]
77	Arcadia, 9 miles south.		A. B. Mayes	Wm. Largey	V. C. Mayes.
78	Amsterdam Mound, west side of Chocolate Bayou, 7 miles north of Hoskins Mound.				N. M. Fenneman.[f]
79	Perrys Landing, 5 miles west.		S. E. Allen	E. L. Wilson	E. L. Wilson.
80	Pearland, ¼ mile north.		W. T. Magee	C. P. Standard	W. T. Magee.

[a] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, p. 41.
[b] Fenneman, N. M., op. cit., p. 87
[c] Taylor, T. U., op. cit., p. 21.
[d] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 144.
[e] Singley, J. A., op. cit., p. 105.
[f] Fenneman, N. M., op. cit., p. 86.

Wells and springs in Brazoria County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
81	Genoa, 3 miles		A. W. Wilkerson		T. U. Taylor.[a]
82	Sandy Point				N. H. Darton.[b]
83	Sandy Point, 2 miles northwest.		Willis heirs		T. U. Taylor.[c]
84	Columbia		Arnold		Do.[d]
85	Columbia, 2 miles west (Kiser Heights).		Equitable Mining Co.		Wm. Kennedy.[e]
86	Kiser Hill				John Underwood.[f]
87	Kiser Hill, 2 miles northwest of Columbia.				Do.[g]
88	Columbia, 3 miles northwest.		J. S. Hogg estate		T. U. Taylor.[c]
89	Do		do		Do.[c]
90	Do		do		Do.[c]

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
27	2	502		502	Flows		70.
28	5	1,509		1,360 to 1,509	+40		62.5.
29		1,000					
30		1,000					
31	6	911			Flows		Few.
32		650			do		Many.
33		700					
34		300					
35		300					
36	3½	785			Flows		Few.
36a	6	603			do		Many.
36b	12	772					
36c		704					
37		825					
38		1,125±	37	1,125			
39	6	1,219	29	40 70 750 805 to 870	+2 Strong flow		305. Many.
40	2	106		90	+3.5		5.
41	2	204		20 to 100, 160 to 204.	−6		
42	4	100					
43	2	104		20, 40, 100	+5/12	12	5−.
44		100			Flows		
45		100			+1		2.
46		135			No flow		
47	1½		12 (?)	18, 100	+1½		¼.
48	2	100	8 (?)	80 to 100	+1		3.
49		600					
50		1,500					
51	14⅞	717	27½ (?)	42 370 717	+2		
52		50		50	Flows		
53	4	928	25–30 (?)	900	5+		10.
54	8	140	50 (?)	120	2−		
55		611	11	611	Flows		
56			30	450 to 500	do		
57		1,000±	11	1,000±	do		

[a] Taylor, T. U., Rice irrigation in Texas: Bull. Univ. Texas, No. 16, 1902, p. 27.
[b] Darton, N. H., op. cit., p. 143.
[c] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 21.
[d] Idem, pp. 22-23.
[e] Hayes, C. W., and Kennedy, William, op. cit., p. 40.
[f] Fenneman, N. M., op. cit., pp. 80-89.
[g] Idem, p. 88.

Wells and springs in Brazoria County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
58	4	640			Flows		60.
59	4½	1,020			do		200.
60	8	1,100			do		720.
61	2	450			do		
62	3				do		
63	8	550	30+	100 550	5+		90.
64	4	600			Flows		90.
65		745					
66					Flows		
67	4	1,070			do		180.
68	10	504					
69		365					
70		950					
71		800					
72		1,030					
73		1,040					
74		1,050					
75	4	1,100					
76		1,200					
77	14⅞	1,700	8½ (?)	67 165 390 917	3+		
78		1,373, 1,499	16		Flows		
79	3	572		300, 572	2+		
80	4	92		16 to 20 52 to 92	No flow do	50	
81	8¼	560					
82		1,500		1,000	Flows		
83		760					
84		1,214					
85		600±	34	156 to 268 600	Flows do		Many.
86		490			do		
87		680			do		
88	10	250			do		100.
89	10	500			do		100.
90	10	700			do		Few.

No.	Source of supply.	Quality.	Remarks.
27	Lissie	Good	
28	do	High in iron, magnesium, and hydrogen sulphide.	Completed, 1905. Drilled for oil.
29	do		Oil test well.
30	do		Do.
31	do		
32	do		
33	do		
34	do		
35	do		
36	do		
36a	do		
36b	do		
36c	do		
37	do		Oil test well.
38	do	Salt and sulphur	Oil test well (No. 1). Three wells; same quality water in No. 2 at 980 feet. Water comparatively fresh to 800 or 900 feet.
39	Beaumont do Lissie do	Soft do do do	Temperature 60° F. Completed April, 1906. Oil test well put down by Brazoria Development Co.; converted into water well.
40	Beaumont	Hard	Completed, 1907.
41	do	do	Completed, 1904.
42	do		
43	do	Soft	Completed, 1906.
44	do		
45	do	Hard	Do.
46	do		
47	do	Hard	Do.

Wells and springs in Brazoria County, Tex.—Continued.

No.	Source of supply.	Quality.	Remarks.
48	Beaumont	High in iron	On Bastrop Bayou. Completed, 1906.
49			
50			Drilled for oil.
51	Beaumont. Lissie	Soft	Danbury, Tex. Completed, 1907.
52	Beaumont or Recent.		Temporary well put down by railroad construction crew.
53	Lissie	Soft	Used for garden irrigation. Completed, 1906.
54	Beaumont	do	Completed, 1904.
55	Beaumont (?)	Fresh	Oil test well.
56	do. (?)	do	Several wells.
57	Lissie	Fresh enough for domestic use	Several wells; those half as deep yield better water; upper Miocene fossils at 649 to 668 feet.
58		Salty	
59	Lissie (?)	do	
60	do. (?)		
61			
62	Beaumont (?)	Slightly salty	Used for drinking. Water from 100 feet rises within 12 feet of surface. In this locality sulphur water is found at 800 feet.
63	Beaumont		
64			
65			Strong gas flow from limestone at 745 feet caused abandonment.
66			On beach.
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77	Beaumont. Lissie	Soft	Mouth of Halls Bayou; completed in 1906. Supply has increased.
78		Salty	Oil test wells; several wells have been drilled.
79	Beaumont	Soft	Completed in 1907.
80	Recent and Beaumont.	Hard	
81			Used for rice irrigation.
82	Lissie		Oil test well.
83			
84			Oil test well (No. 3).
85	Beaumont (?) Lissie		Drilled for oil. Show of gas.
86			Oil well (No. 2); flow of oil from 480 feet. Four wells have been drilled in search of oil at Kiser Hill.
87			Oil test well (No. 1).
88			
89			
90			

DESCRIPTIVE NOTES.

37. *Section of well on lot 234, Hoskins Mound (midway between Velasco and Alvin), Tex.*

	Feet.
Beaumont clay and Lissie gravel:	
Black surface clay	0 - 4
Pale-blue clay	4 - 12
Red clay	12 - 25
Yellow loamy sand, rather fine	25 - 45
Blue gumbo	45 - 85
Blue quicksand	85 -130
Blue clay filled with small white shells	130 -152
Blue quicksand	152 -172
Blue gumbo, very tough	172 -233
Blue sand, fine grained, with black specks; first indications of oil	233 -239
Sand, with some clay	239 -378
Blue sand, coarse, with black specks; some oil near bottom	378 -423
Blue clay, with some small shells	423 -465
Coarse blue sand, with black specks	465 -500
Blue sand, with some brown layers; contains iron pyrite and some small shells	500 -530
Soft blue clay, with small shells	530 -535
Blue clay, with larger shells	535 -555
Blue clay, with few shells	555 -580
Blue gumbo, very tough, shells	580 -595
Tough blue clay, with few shells	595 -628
Blue sand, with gravel and some shells	628 -632½
Blue sand, with coarse black particles	632½-642½
Blue clay, with large shells	642½-654
Blue clay, with shell fragments	654 -674
Blue sand, gravel with black particles; considerable gas	674 -684
Blue sand, with many black particles; good show of oil from 688 to 692 feet	684 -692
Bluish sand, coarse; shows oil saturation	692 -711
Tough blue clay, containing shells	711 -720
Tough blue gumbo, containing bowlders	720 -722
Blue clay and sand; show of oil	722 -728
Blue clay, with thin layers of sandstone	728 -735
Tough blue gumbo	735 -755
Blue gumbo, with thin layers of sandstone and limestone	755 -778
Blue sand, with iron pyrites; some show of oil at 778 feet	778 -783
Tough blue gumbo, with thin layers of sandstone and limestone; considerable iron pyrites	783 -786
Blue gumbo, with shells	786 -793
Sand, with iron pyrites; "oil show"	793 -794
Tough blue gumbo	794 -799
Very hard blue clay, with rock 2 to 6 feet thick, mostly limestone	799 -825

38. Three wells have been drilled here, all of which give indications of oil and gas. Samples of consolidated rock from these wells consist of sandstone cemented by carbonate of lime. Thin plates of limestone are reported. At 610 feet in well No. 2 and at 780 feet in No. 1 thick beds of marl were found. This material is sticky when wet and chalky when dry, is highly calcareous, and has little grit.

39. *Section of Brazoria Development Co.'s well on S. F. Austin League, 4 miles east of Liverpool, Tex.*

[Furnished by William Kennedy.]

	Feet.
Beaumont clay and Lissie gravel:	
Clay	0– 18
Sand	18– 45
Clay	45– 67
Sand, gas showing	67– 112
Gumbo	112– 155
Hard shale	155– 165
Gumbo	165– 240
Hard shale	240– 250
Gumbo	250– 325
Red clay, shell, sand, and gravel	325– 345
Gumbo	345– 355
Shell	355– 366
Gumbo and red clay in streaks	366– 390
Gumbo	390– 515
Blue shale	515– 545
Gumbo	545– 660
Shale and shell	660– 666
Gumbo	666– 704
Shale	704– 709
Sandrock	709– 710
Gumbo and shale	710– 720
Sand, fine and black	720– 760
Shale	760– 780
Sand	780– 795
Shale	795– 805
Water sand	805– 870
Gravel	870– 882
Gumbo	882– 896
Shale	896– 910
Gumbo	910– 915
Shale and shell	915– 920
Gumbo and shell	920– 950
Gumbo	950– 980
Shale	980– 990
Gumbo	990–1,020
Red and blue clay shale	1,020–1,060
Shale	1,060–1,070
Gumbo, shale, and shell	1,070–1,105
Shell rock	1,105–1,115
Soft gumbo	1,115–1,120
Shale	1,120–1,122
Shell rock	1,122–1,150
Shale	1,150–1,154
Soft gumbo	1,154–1,205
Shell-rock gumbo	1,205–1,207
Gumbo (?)	1,207–1,219

48. Mr. C. Radelmiller writes as follows:

"The well I describe is about as deep as any within a radius of 10 miles. In this area the water stratum is perhaps 20 feet thick, and is found over several square miles. Above this water stratum the formation is more local. In my well it was clay all the way down. Just across the bayou, 200 feet distant, the formation was sand about half way down. At other places a stratum of sand was found at about 20 feet. * * * Deep wells for irrigation have not yet been tried in this vicinity."

55. *Section of Reed well, Bryan Heights, Tex.*

[By J. F. Frederickson, driller.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel (?):	
Black surface (asphaltic specks)	0– 30
Yellow clay	30– 42
Quicksand	42– 62
Yellow clay	62– 87
Black clay	87– 92
Black clay, reddish spots of "decomposed iron"	92–162
Black clay; minute white shells	162–189
Quicksand	189–210
First sign of gas in blue quicksand	210–226
Black clay, "decomposed lime and iron"	226–244
Black clay and shale	244–247
Black shale and sand	247–275
Black shale	275–330
Black shale, some gravel; at 365 feet were 4 inches of rock, very hard	330–345
Soft black clay, "decomposed iron"	345–405
Soft blue clay, yellow clay mixed	405–467
Yellow clay, sand, and shale	467–549
Oil sand, pebbles, and shale; very coarse	549–557
Yellow clay, sand, and shale	557–587
Hard rock, probably sandstone	587–589
Oil sand, large pebbles, some oil	589–591
Gravel and flint	591–595
Black clay, with shale	595–597
"Flint," twisted off pipe here	597–598
Pipe dropped suddenly 13 feet after drilling 2 days on a very hard rock	598–611

84. *Section of Arnold well No. 3, Columbia, Tex.*

	Feet.
Surface soil, clay, and sand	0 – 85
Rock	85 – 85.5
Sand	85.5– 88
Rock	88 – 89.5
Oil sand	89.5– 118
Clay	118 – 150
Rock	150 – 158
Blue clay	158 – 192
Soft rock	192 – 196
Sand	196 – 210
Soft rock	210 – 212
Blue clay	212 – 218

	Feet.	
Soft rock	218	219
Blue clay	219	260
Soft limerock	260	261
Blue clay, very tough	261	275
Rock; hard layer at 294 feet contains some gas	275	299
Hard rock	299	315
Crystallized sand	315	328
Blue clay	328	333
Rock	333	338
Sand	338	343
Blue clay	343	346
Compact sand	346	354
Clay	354	368
Rock	368	370
Clay	370	395
Soft rock	395	397
Blue clay	397	405
Rock	405	406
Blue clay	406	428
Crystallized sand	428	462
Blue clay, very hard and oil-saturated	462	484
Soft rock	484	486
Blue clay	486	510
Sand, very compact	510	532
Rock, full of pyrites and shell	532	534
Sand, very compact	534	574
Hard rock, conglomerate, pyrites, and lime; rock sulphur and shell	574	582
Hard blue clay	582	620
Rock pyrites, sulphur, lime, "volcanic crystals," and oil saturations	620	628
Blue clay	628	632
Rock with sand	632	651
Sand	651	657
Rock	657	675
Hard rock	675	676
Sand	676	678
Very hard rock	678	680
Sand, color of oil	680	681
Rock, very hard	681	682
Sand	682	691
Blue clay	691	719
Sand	719	723
Blue clay	723	729
Oil sand	729	734
Blue clay	734	800
Sand	800	835
Shell, with some little showing of oil	835	857
Blue clay, very thin strata full of shell	857	858
Sand	858	870
Blue clay	870	906
"Crystallized" sand	906	926

	Page.
Rock	926 - 936
Blue clay	936 - 943
Sand	943 - 970
Soft sandstone	970 - 971
Hard sandstone	971 - 973
Clay	973 - 939
Sand	989 -1,002
Hard rock	1,002 -1,004
Sand, fairly firm, contains fossil wood	1,004 -1,012
Hard clay	1,012 -1,050
Sand with little gas	1,050 -1,110
Blue clay	1,110 -1,115
Sand	1,115 -1,136
Soft rock or compact sand	1,136 -1,214
Clay, blue with a greenish cast.	

Although no division of the record is possible, the Beaumont clay, Lissie gravel, and possibly the marine Miocene are indicated. Most of the "rock" reported is a sand cemented by carbonate of lime; but a little of it is limestone. The "gumbo" is a very sticky clay.

85. *Section of Equitable Mining Co.'s well at Kiser Heights, about 2 miles west of Columbia, Tex.*

	Feet.
Beaumont clay:	
White clay	0 - 2
Red clay	2 - 10
Gray sand	10 - 25
White clay	25 - 25½
Quicksand	25½ - 50
Yellow clay	50 - 60
Quicksand	60 - 61
Gray sand	61 - 84
Lignite, with logs	84 - 90
White clay	90 -105
Soapstone (clay)	105 -120
Blue shale	120 -134
Blue clay	134 -152
Rock and gas	152 -156
Blue sand and clay with thin streaks of rock; water in rock	156 -268
Rock	268 -269
Sand	269 -270
Blue clay	270 -288
Hard rock	288 -295
Blue clay	295 -314
Quicksand and gas	314 -320
Blue shale, with some oil	320 -358
Rock, with black particles	358 -359
Oil sand	359 -360
Blue sand	360 -380
Sand	380 -424
Sand	424 -500
Rock, with some oil; water	500

86. *Section of well No. 2 at Kiser Hill, 2 miles west of Columbia, Tex.*

[By John Underwood.]

	Feet.
Recent deposits, Beaumont clay, and Lissie (?) gravel:	
Soil	0– 2
White clay	2– 10
Red clay	10– 25
Sand	25– 26
White clay	26– 60
Sand, with streaks of clay	60–105
White clay	105–119
White clay, very hard	119–134
Blue clay	134–150
Sandstone	150–151
Clay and sand alternating	151–210
Sandstone	210–211
Blue clay	211–220
Sandstone, limestone, some shells, pyrite, and sulphur crystals	220–222
Blue clay	222–245
Blue limestone, very hard, containing sulphur crystals and some pyrite	245–314
Sand and shells	314–320
Blue clay	320–340
Sand showing some oil	340–346
Limestone; set 6-inch casing here	346–347
Material not given	347–354
Blue clay	354–362
Sand, with some showing of oil	362–364
Blue porous or cavernous limestone (specimen seen), blow-out of gas and oil	364–370
Clay	370–376
Oil sand	376–380
Clay	380–401
Hard limestone, mostly shells	401–402
Compact sand, small blow-out at 436 feet	402–436
Hard clay	436–458
Oil sand; good lubricating oil found at 480 feet	458–490
Rock	490

The water was lost in the porous limestone between 364 and 370 feet. This phenomenon is very common in the Coastal Plain. It indicates that the pressure of the water in the stratum is less than that of the column of water supplied artificially to the well as an aid in the drilling. The stratum absorbs the water supplied from the surface and will not yield water under sufficient pressure to rise above the surface.

This well flowed lubricating oil for 16 months from the oil sand at 476 feet.

87. *Section of well No. 1 at Kiser Hill, 2 miles northwest of Columbia, Tex.*

[By John Underwood.]

	Feet.
Similar to well No. 2; good showing of oil at 388	0–388
Alternating sand and clay	388–458
Blue shale with sand below containing good show of oil	458–478
Sand	478–498

Gray rock	498–500
Material not mentioned; it contains gas in large quantities, with some globules of oil	500–505
Rocks, shells, and wood, with showing of oil	505–510
White rock saturated with oil	510–512
Gray rock impregnated with something yellow, either oil or sulphur, and containing black particles	512–537
Blue clay	537–544
Rock, sandstone, or limestone; not determined	544–548
Black clay	548–564
Gray rock with pyrite; strong gas pressure	564–576
Blue clay; strong gas pressure	576–584
Gray limestone with sulphur and strong gas pressure	584–588
Very fine loose sand with oil alternating in thin layers with rock; strong blow-out of gas at 603 feet	588–616
Soft rock, with some sulphur	616–664
Black rock called limestone; the water was lost at this depth and the hole abandoned	664–680

Water in this well was found under strong artesian pressure, and continued to flow, accompanied by considerable gas, The formations penetrated represent the Beaumont clay and Lissie (?) gravel.

BRAZOS COUNTY.

GEOLOGY AND HYDROLOGY.

Three artesian reservoirs, the lower Eocene, the Yegua, and the Catahoula, supply the wells of Brazos County (see Pls. VII and VIII, in pocket) and yield flowing wells in the Brazos bottoms. In the northern half of the county most wells draw from the lower Eocene reservoir, and in the southern half the majority draw from the Yegua and the Catahoula.

Lower Eocene.—The lower Eocene reservoir underlies the whole county. In the Brazos bottoms, between Steeles Store and Stone City and between Little Brazos and Brazos rivers, it lies 200 to 400 feet below the surface and is therefore easily available to every householder and planter in the district. In this area about 50 flowing wells yield water for drinking, washing, stock, and steaming.

In the northern corner of the county the lower Eocene reservoir is reached by wells that penetrate from 40 feet below the surface to 600 feet below sea level, but flows probably can not be obtained. Southward the depths to the lower Eocene increase, until in the vicinity of College a well would have to go 700 feet below the surface to enter them, and 2,100 feet below to penetrate to the underlying rocks. It is doubtful if water from wells exceeding 2,000 feet in depth would be satisfactory either for steaming or for irrigation.

Yegua formation.—South of Stone City water from the lower Eocene is not at present used because equally good supplies can be obtained at less depths from the Yegua reservoir.

The central east-west belt of the county is occupied by the outcrop of the Yegua formation covered with a veneer of Quaternary gravels and alluvium. (See Pl. I.) The Yegua supplies most of the wells of Brazos County except in the Brazos bottoms between Steeles Store and Stone City. Flows from the Yegua are confined to the valleys. (See Pl. VII.)

In the northern portion of the county, in the vicinity of Bryan, the sands of the Yegua formation are generally reached at shallow depths, lying from sea level to 100 feet above. The basal sands lie deeper toward the south, reaching approximately 300 feet below sea level in the vicinity of College.

Water obtained from the Yegua is adapted for all ordinary uses. At Bryan, where an improvement in quality has been noted, it is utilized for steaming.

Catahoula sandstone.—In the southern portion of the county, the Catahoula sandstone will yield potable water in wells 200 to 1,000 feet deep.

WELL DATA.

The details of the Brazos County wells appear in the subjoined table:

Wells and springs in Brazos County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
91	College Station		Agricultural and Mechanical College.		Wm. Kennedy.[a]
92	do		do		S. E. Andrews, secretary.
93	Harvey		C. S. Jones	I. P. Nelson	I. P. Nelson.
94	Bryan		Bryan Water, Ice & Electric Light Co.		J. A. Singley.[b]
95	Bryan, 3 miles northwest.				Wm. Kennedy.[a]
96	Bryan		Bryan Press Co.		W. Wippricht, manager.
97	Bryan, 4 blocks northeast of post office.	Upper Cheapside Street, between Caldwell and Moseley.	Bryan Water, Ice, Light & Power Co.	Bigelow & McMahon.	T. J. Preston, manager.
98	Bryan, ¾ mile north.		Bryan Cotton Oil Co.		J. Webb Harrell.
99	Steeles store		Robert Adams		Robert Adams.
100	do		Henry B. Steele		Henry B. Steele.
101	do				Wm. Kennedy.[a]
102	Stone City, 25 yards southeast of post office.		Jack Doss	Peter Hill	Sam Wilson.
103	Stone City, 120 feet west of post office.		C. A. Glenn	Wm. Clark	C. A. Glenn.
104	Stone City, 1 mile northeast.		J. D. Sanders	do	J. D. Sanders.
105	Stone City, 2 miles northeast.		J. J. C. Carters		J. J. C. Carters.
106	Stone City, ¾ mile northeast.	William Mothess survey.	C. A. Harris	A. H. Eaves	C. A. Harris.

[a] Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol. Survey Texas (1892), 1893, p. 58.

[b] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 111.

Wells and springs in Brazos County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
107	Stone City				J. A. Singley.[a]
108	College Station		Houston & Texas Central R. R.		T. U. Taylor.[b]
109	Navasota, 6 miles west.		Templeton & Foster.		Do.
110	Tabor, 2 miles north.		J. S. Francis	Wm. Clark	J. S. Francis.
111	Allenfarm		John D. Rogers	Arch Eaves	T. U. Taylor.[b]
112	Allenfarm, 1 mile west.		do		Do.
113	Allenfarm		W. J. Terrell		Postmaster.
114	Allenfarm, 2 miles south.		John D. Rogers	A. H. Eaves	A. H. Eaves.
115	Wellborn, 2½ miles south.		A. B. Welch		A. B. Welch.
116	Allenfarm, 2 miles east.		W. L. Steele	A. H. Eaves	W. L. Steele.
117	Wellborn, 5 miles south.		Thos. H. Royder		Thos. H. Royder.
118	Wellborn		Thos. R. Batte	J. T. Eaves	Thos. R. Batte.
119	Wellborn, 5 miles southwest.	William McWilliams survey.	Robert F. Smith	Arch Eaves	Robert F. Smith.
120	West bank Navasota River.	J. Gray headright			Wm. Kennedy.[c]

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
91		1,400	350	700	−100		
92	6 to 4	352	350	331–352	No flow		
93	10	165		95	do		
94	6	(?) 190			−140	35	
95							
96		150		135	−80		
97	8	160	170	40 60 132	−4	60	
98	5	292		292	−80	17	
99		480		235 350 480	Flows do do		3.
100	2	400		225 (?) 375	+15 Flows		4 to 5.
101	1	330	253	230 330	do		Flows. Do.
102	2	430		430	Flows		
103	1	400			+8		
104	1	316		300	+4		
105	1	400		395	+4		
106	1	400		200, 400	+10		3½ to 4.
107	1	230		230	Flows		
108		1,005					
109					Flows		
110	2	225		200	−50		
111		900			Flows		
112		1,300			do		
113	3	800					
114	2	1,000			+30±		
115							
116	3½	289		289	+25		
117							
118	1¼	900		40 to 300 900	+15		
119	2	345		325	+5		
120							

[a] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 111.
[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 62.
[c] Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol. Survey Texas (1892), 1893, p. 58.

Wells and springs in Brazos County, Tex.—Continued.

No.	Source of supply.	Quality.	Remarks.
91	Cook Mountain	Good	Fossils from 900 to 1,000 feet determined as early Claiborne.
92	Yegua		
93	do	Hard	
94		Fair	
95		Mineral	Shallow wells; known as Manganic wells.
96	Yegua	Good	Water seems to have changed within the last 12 months from an indifferent, or rather not good, boiler water to one that keeps boiler free from excessive scale.
97	do	Iron	Completed, 1907; No. 3 well; public supply.
98	Cook Mountain	Hard	Used in boilers. Passed through three or four sandrocks; some little coal. Another well at gin flows about 5 gallons a minute.
99	Mount Selman	Soft	Lignite encountered.
100	do	do	Completed, 1886.
101	do	Good	In Brazos bottom.
102	do		
103	do	Soft	Used for irrigating garden; completed, 1892.
104	Mount Selman (?)	do	Completed, 1894.
105	do	do	Completed, 1907.
106	Cook Mountain and Mount Selman	do	Completed, 1897.
107	Cook Mountain (?)	Fairly good	
108			
109			
110	Cook Mountain (?)	Soft	Completed, 1907.
111			
112			
113		Salty	
114			
115		Soft	Minter Spring.
116	Catahoula	Strong sulphur	In Brazos bottoms.
117		Soft	Carter Springs.
118	{Yegua	do	Used for stock, etc.
	{Cook Mountain		Strong flow of gas.
119	Yegua (?)	Slighty salty	Used for drinking; flow of gas. In Brazos bottoms.
120		Sulphur	Boiling or Sulphur Springs; a local resort.

DESCRIPTIVE NOTES.

92. *Section of the new well at the Agricultural and Mechanical College, College Station, Tex.*

[Furnished by S. E. Andrews, secretary.]

	Feet.
Yegua formation:	
Yellow-brown clay shale	0– 55
Hard gumbo or blue clay	55– 75
Hard blue clay shale	75–125
Strata of hard limestone (?) and hard clay	125–132
Hard blue clay shale	132–136
Hard limestone	136–152
Hard clay shale	152–159
Hard limestone	159–165
Hard clay shale	165–178
Hard limestone (?)	178–208
Softer rock	208–213
Hard rock	213–218
Softer rock	218–223
Hard rock	223–239
Hard blue clay	239–254
Hard blue shale	254–297
Rock	297–301
Hard clay shale	301–312
Hard rock	312–315
Hard blue clay shale	315–322
Hard rock	322–331
Clay and sand	331–352

The "rock" reported in this well is chiefly sandstone.

106. Mr. C. A. Harris, of Bryan, Tex., writes: "At about 200 feet a flow of oil was found, but after passing through this a stratum of blue soapstone was found; then a kind of fine shell formation, about 10 feet or more; afterwards a yellow-colored clay until I struck water at about 400 feet. There was quicksand at about 150 feet."

The upper part of this section, including the "shell formation," represents the Cook Mountain formation. The lower part, including the water-bearing sand, represents the Mount Selman formation.

108. *Section of Houston & Texas Central Railroad well at College Station, Tex.*

	Feet.
Yegua, Cook Mountain, and Mount Selman formations:	
Surface blue clay	0– 25
Rock	25– 28
Blue clay	28– 60
Rock	60– 61
Blue marl	61– 105
Lignite	105– 106
Blue marl	106– 145
Rock	145– 147
Blue marl with some layer of rock	147–1,005

BURLESON COUNTY.

Burleson County is not included in the territory covered by this report, but the following partial list of its wells is added for the light they throw on the artesian conditions prevailing in the adjoining county of Brazos:

Wells and springs in Burleson County, Tex.

No.	Location.	Owner.	Authority.	Depth of well.
				Feet.
121	Whittaker, 5 miles north	William Koppe	J. A. Singley [a]	870
122	Clay		T. U. Taylor [b]	688
123	Clay, 3 miles east	J. W. Coulter	J. W. Coulter	

No.	Head of water above ground.	Depths of principal water-bearing strata.	Flow per minute.	Source of supply.	Quality.	Remarks.
	Feet.	*Feet.*	*Gallons.*			
121	Flows		28		Excellent	In Brazos bottom.
122		420 to 480 608 to 613 632 to 636 647-687		Yegua	Good [c]	
123	Flows				Salty	

[a] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 111.
[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 61.
[c] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

122. *Section of well at Clay, Tex.*

	Feet.
Recent:	
Soil	0- 15
Catahoula sandstone and Yegua formation:	
Clay	15- 28
Rock	28- 41
Sand	41- 67
Lignite	67- 74
Blue "granite" (probably sandstone)	74- 88
Blue sand	88-124
Gray sandrock	124-161
Lignite	161-169
Blue limestone rock	169-185
Sand	185-188
Gray sandrock	188-197
Soapstone	197-217
Rock	217-220
Soapstone	220-249
Fine blue sand	249-254
Blue "limestone" (sandstone)	254-261
Soapstone	261-271
Rock	271-282
Soapstone	282-420
Fine water sand	420-480
Soapstone	480-525
Close blue sand with lignite and soapstone	525-608
Water sand	608-613
Lignite and soapstone	613-632
Water sand	632-636
Soapstone and sand	636-647
Water sand	647-687
Rock	687-688

CHAMBERS COUNTY.

GEOLOGY AND HYDROLOGY.

The surface formation of Chambers County is the Beaumont clay, in places veneered by recent sand. (See Pl. I.) The entire county is underlain by the Lissie reservoir, which produces flowing wells practically everywhere.

At Cedar Bayou, which has a low altitude, flows are obtained at a depth of 60 feet. At Stowell a flow is obtained from a water-bearing sand in the Beaumont clay at 180 feet. Very few wells in the county are more than 500 feet deep.

Along the coast the water from nearly all depths is salty and unfit for use, though fresh water was reported in the Big Four well No. 1 at High Island at a depth of 180 feet. High Island is a typical Coastal Plain mound in which salt water has ascended from lower-lying formations. Much of the mineral originally in solution has been precipitated, forming deposits of salt and gypsum. (See wells Nos. 150 and 151.) Five miles west of High Island (well No. 146) fresh water was struck at 300 feet and water suitable for stock at 876 feet. (See Pl. VII, in pocket.)

Barring the district included in the 7 to 10 mile strip along the coast and that adjacent to Barbers Hill, which appears to be another mound, flowing wells yielding adequate and suitable domestic and industrial supplies can probably be had over the entire county at depths not exceeding 600 to 800 feet. As a general rule water from greater depths will be brackish if not salty, though the depth at which good supplies can be obtained increases toward the interior. The deeper wells yield larger supplies than the shallower ones, both by natural flow and by pumping. At 600 to 800 feet, however, sufficient quantities will always be available.

Many of the artesian wells of this county are used for irrigating rice fields.

WELL DATA.

A detailed list of the wells of Chambers County appears in the following table:

Wells and springs in Chambers County, Tex.

No.	Location.	Owner.	Driller.	Authority.
124	Stowell, near	Davidson		T. U. Taylor.[a]
125	Stowell, 1½ miles east	R. P. Carroll	Coffee Well Works Co.	R. P. Carroll.
126	Stowell	Pelham Carroll		Postmaster.
127	Cedar Bayou, 2 miles east	N. Schilling		N. Schilling.
128	do	do		Do.
129	Cedar Bayou, 1½ miles south.	E. R. Kilgore	R. J. Tompkins	John M. Kilgore.
130	Wallisville, ¼ mile west	J. W. Cook	Gust Warnecke	J. D. Clinton.
131	Wallisville, ½ mile west	C. R. Cummings Export Co.	do	R. J. Burns.
132	Barbers Hill	Higgins Oil & Fuel Co.		Patillo Higgins.[b]
133	Mount Belvieu, 4 miles south.		B. Donnelly	Sol Donnelly.
134	Mount Belvieu	E. W. Barber		T. U. Taylor.[a]
135	Mount Belvieu, 10 miles south.	Mat Fisher		Do.[a]
136	Cedar Bayou	J. C. Fisher		Do.[a]
137	Mount Belvieu, 3 miles south.	Barney Donnelly		Do.[a]
138	Mount Belvieu, 5 miles south.	Amos Lawrence		Do.[a]
139	Anahuac, 4 miles north (2 wells).	C. R. Cummings & Co.		Do.[a]
140	Anahuac, 30 yards northwest from post office.	W. D. Wilcox	Gust Warnecke	R. E. Swinney.
141	Double Bayou, 10 miles east.	J. S. & J. H. Jackson	do	John H. Jackson.
142	Double Bayou	D. L. Broussard		Postmaster at Anahuac.
143	do	Sol Brown		T. U. Taylor.[a]
144	Double Bayou, 15 miles southeast.	Hugh Jackson		Do.[a]
145	Double Bayou, 15 miles northeast.	James Jackson		Do.[a]
146	High Island, 5 miles west (R. Barrow survey).	Hugh Jackson	Gust Warnecke	Hugh Jackson.
147	High Island (7 wells)[c]			William Kennedy.[d]
148	do			Do.[d]
149	High Island, west			Do.[d]
150	High Island	Big Four		N. M. Fenneman.[e]
151	do	do		William Kennedy.[f]
152	do	Carroll Well		N. M. Fenneman.[e]
153	Turtle Bayou	R. M. White		Postmaster.
154	do	J. T. White		T. U. Taylor.[a]
155	do			N. H. Darton.[g]
156	do			Do.[g]
157	Winnie			William Kennedy.[h]
158	Winnie, 3 miles north	Dixie Oil & Pipe Line Co		Do.[i]
159	Sec. 24	Moore		A. Deussen.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 31.
[b] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, pp. 83–84.
[c] For analyses, see table facing p. 110.
[d] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, p. 122.
[e] Fenneman, N. M., op. cit., pp. 82–83.
[f] Hayes, C. W., and Kennedy, William, op. cit., p. 124.
[g] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 144.
[h] Hayes, C. W., and Kennedy, William, op. cit., p. 126.
[i] Idem, p. 61

Wells and springs in Chambers County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
124		600			Flows		100.
125	9⅝	246	38	180	2	800	60.
126	10	246					
127		727	20		Flows		
128	3	610	20	300 610	3		21.
129	2	200		10, 60	1½		3.
130	3	380		380	3		70±.
131	4½	450		250 450	47	200	
132		1,176					
133		297		207 297	20		51.
134		800			Flows		
135		550			do		
136		500(?)			do		
137		375			do		
138		500			do		
139		400			do		
140	6	850		850	20		50.
141	4	650					8.
142	6	850			Flows		100.
143		800			do		100.
144					do		100.
145		1,000			do		100.
146	4	876	7	300 876	2		2. 14.
147		260 203 142 193 170 193 165		260 203 142 193 170 193 165			
148	3						
149		Spring					
150	12–4	995					
151		610	40	180 211 to 261			
152		810					
153	4	300					
154		1,720					
155	4	900					
156	4	850			Flows		139.
157		1,600					
158		1,510	26	60 to 90 180 to 304 380 to 623			
159		838		140 to 240			

Wells and springs in Chambers County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
124	Lissie (?)	Good	
125	Beaumont	Soft	Used for irrigating rice. Completed, 1903.
126	do		
127	Lissie		Good for domestic use.
128	do	Good, soft water at 300 feet; hard salt and sulphur water at 610 feet.	Completed, 1896.
129	Recent and Beaumont	Soft	Completed, 1904.
130	Lissie		In river valley. Completed, 1900.
131	{Beaumont Lissie	 Soft	Used for irrigation and manufacturing; temperature, 75° F.
132			Oil test well. Higgins well No. 2.
133	Lissie	Sulphur	Flows 75,000 gallons per day.
134	do	Good	
135		do	
136		Salty	
137		Good	
138		do	
139	Lissie	do	
140	do	Soft	Used for boilers. Completed, 1895.
141	do	Slightly salty	Supply has decreased.
142			
143		Good	
144		do	
145			
146	{Beaumont (?) Lissie	Fresh and pure Hard	Completed, 1897.
147	Beaumont	{Strong brine Brine do do do do do	Wells drilled in search of fresh water in central and southwest parts of island. Several have strong flow of salt water; temperature, 100°+ F.
148		Sulphur water; no salt.	In northeast part of island; not so deep as the salt wells.
149		Salt	
150			Oil test well (No. 2).
151	Beaumont	{Fresh Salt	Oil test well No. 1 (abandoned).
152	do		Oil test well.
153			
154		Salty	
155			
156			
157			Oil test well. No rock to 1,600 feet. The well at Big Hill, only a few miles to the east, encountered a light-gray crystalline dolomite between 350 and 1,400 feet.
158	{Beaumont Lissie		Drilled for oil.
159			

DESCRIPTIVE NOTES.

132. *Section of Higgins well (No. 2), Barbers Hill, Tex.*

[Description of samples kept by Patillo Higgins.]

	Ft.	in.		Ft.	in.
Recent deposits, Beaumont clay, and Lissie gravel:					
Soil	0	0	–	2	0
Yellow clay, blotched with red	2	0	–	18	0
Very fine yellowish sand	18	0	–	32	5
Yellow and blue variegated stiff clay	32	5	–	51	9
Reddish-yellow very fine sand; contains enough clay to make it lumpy, slightly calcareous	51	9	–	70	9
Clear white silica sand	70	9	–	101	3
Variegated yellowish and blue clay	101	3	–	154	3
White sand	154	3	–	160	7
Light clay	160	7	–	175	7
Darker clay	175	7	–	177	7
Subangular small fragments of shale	177	7	–	179	7
Nearly white sand, medium grained	179	7	–	258	9
Blue clay	258	9	–	304	1
Fine white sand	304	1	–	314	1
Bluish limestone in small fragments	314	1	–	315	1
Fine gray sand in lumps	315	1	–	320	1
Concretionary limestone in fragments	320	1	–	327	2
Light-colored gumbo	327	2	–	337	6
White sand, medium coarse, with black grains	337	6	–	354	8
Light gumbo	354	8	–	369	1
Coarse sand, some gumbo fragments	369	1	–	371	3
Loose yellowish sand	371	3	–	372	3
Light clay	372	3	–	375	7
Fragments of limestone; some sand	375	7	–	377	5
Light clay; some fragments of limestone	377	5	–	392	6
Light clay	392	6	–	396	1
Limestone fragments	396	1	–	398	4
Light clay	398	4	–	405	6
Loose sand, few limestone fragments as if stray	405	6	–	410	3
Loose yellowish sand	410	3	–	421	8
Loose white sand, coarse	421	8	–	457	2
Gypsum, well powdered	457	2	–	556	7
Sand and limestone fragments	556	7	–	568	4
Fine white sand	568	4	–	574	10
Gypsum as above, some sand mixed	574	10	–	604	3
Coarse silica sand, many black specks making the whole dark	604	3	–	609	10
Coarse sand, white and red grains, several gypsum concretions	609	10	–	616	6
Large concretions of gypsum (egg size) embedded in sand, some powdered gypsum	616	6	–	630	0
Fragments of gypsum in sand, some very fine yellow sand, also some clear white sand with black grains	630	0	–	639	3
More gypsum fragments, as from concretions	639	3	–	657	7
Dark loose sand	657	7	–	664	1

Recent deposits, Beaumont clay, and Lissie gravel—Continued.	Ft.	in.	Ft.	in.
Some massive gypsum "bowlders" in sand..	664	1 –	688	8
Selenite flakes and round iron-like concretions larger than peas	688	8 –	695	7
Sand, loose and dark, with iron-stained gravel.	695	7 –	699	6
Loose sand and more iron-like nodules like peas	699	6 –	702	2
Sand, loose and dark, with iron-stained gravel	702	2 –	712	6
Limestone and gypsum	712	6 –	746	6
Loose gray sand	746	6 –	776	6
Gypsum flakes and sand	776	6 –	857	4
Differs little from preceding; little lime at places	857	4 –	1,108	0
Great gypsum concretions	1,108	0 –	1,115	0
Same material without the concretions; the red and yellow (as if limonite) particles more numerous	1,115	0 –	1,122	6
Concretions again	1,122	6 –	1,146	7
Clear white sand to bottom	1,146	7 –	1,176	7

146. Mr. Hugh Jackson writes that the well was drilled in 1897 and has flowed 19,000 gallons per 24 hours ever since. He had the water analyzed about three months later by Prof. H. H. Harrington, of the Agricultural and Mechanical College of Texas, who reported that it contained about 6,500 parts per million of mineral matter in solution, most of which was alkali salts.

Mr. Jackson adds: "About a year later I had it analyzed, with the same results, approximately. It makes fairly good stock water; stock do well but do not like it. Those who have inspected this well say that it is not a flow caused by artesian pressure but is caused by gas pressure . . . The accompanying gas is very inflammable and causes the water to pulsate. A few feet before getting into the water-bearing sand gumbo was encountered having the appearance slightly of asphalt. At 300 feet a fresh and pure water flow of 3,000 gallons a day was found."

150. *Section of Big Four well (No. 2) at High Island, Tex.*

	Feet.
Clay	0– 20
Sand with three layers of clay; struck a bowlder which followed the pipe 100 feet	20–226
Clay	226–237
Sand	237–282
Struck bowlder	282–300
Clay below gravel and shells at 350 feet	300–424
Hard gravel	424–426
Sand	426–432
Very hard rock; 36 hours to drill 16 inches	432–435
Sand	435–437
Hard gravel and shell	437–440
Hard rock	440–443
Gravel and shell	443–450
Rock; took 48 hours to drill 2 feet	450–452
Blue joint clay	452–472
Rock; 30 hours to drill 7 inches	472–474
Clay	474–477

	Feet.
Rock	477–483
Rock and clay	483–492
Clay	492–496
Clay and sand	496–537
Rock	537–539
Clay and sand; hard blue clay at 560	539–606
Rock	606–608
Sand	608–611
Blue gumbo	611–641
Shell and blue gumbo	641–643
Blue gumbo	643–667
Rock	667–668
Hard blue mud	668–792
Soft mud	792–808
Shell and blue gumbo	808–830
Very hard shells	830–833
Hard rock	833–837
Sand	837–897
Rock	897–899
Blue mud	899–910
Blue gumbo	910–926
Blue-gray rock, very porous	926–928
Gravel	928–944
Rock; gas pressure, oil indications	944–945
Limestone and gravel	945–963
Blue stones with mica; gas and oil signs	963–972
Mud and sand	972–993
Cavity or cave; lost water	993–995

151. *Section of Big Four well (No. 1) High Island, Tex.*

Yellow clay	0– 20
Sand	20– 40
Blue clay	40–100
Clay sand and shells, fresh water at 180 feet	100–180
Conglomerate rock	180–184
Sulphur and clay	184–207
Hard siliceous rock	207–211
Quicksand and salt water	211–261
Siliceous rock	261–266
Brown clay	266–310
Siliceous rock	310–314
Clay	314–369
Siliceous rock	369–373
Clay	373–409
Siliceous rock	409–412
Clay	412–503
Siliceous rock	503–505
Oil sand	505–509

152. The Guffey Co. has bored a well at High Island, Tex., to a depth of 2,600 feet. From 900 to 1,300 feet is in gypsum and from 1,300 to 2,600 in salt; the latter was not drilled through.

152. *Section of Carroll well at High Island, Tex.*

[Received from Mr. Carroll.]

	Feet.
Clay	0- 28
Sand	28- 36
Rock	36- 38
Sand	38- 46
Gumbo	46- 54
Sand	54- 90
Rock	90- 91
Sand	91-100
Gumbo	100-189
Rock	189-192
Sand	192-204
Rock	204-205
Gumbo	205-231
Rock	231-232
Sand	232-241
Rock	241-242
Sand	242-261
Gravel	261-264
Gumbo	264-275
Rock	275-276
Sand	276-296
Gumbo	296-316
Rock	316-322
Gumbo	322-324
Rock	324-325
Gumbo	325-331
"Rock" (examined and found to be gypsum)	331-810

High Island, as revealed by the sections above given, is one of the characteristic structural domes of the Coastal Plain, analogous to Spindletop and Damon Mound. The presence of gypsum, salt, and sulphur is characteristic. These are absent from the greater portion of the Coastal Plain. The formations involved in the structure of High Island include at least the Lissie gravel and possibly the Beaumont clay and marine Miocene.

158. *Section of Dixie Oil & Pipe Line Co.'s well, 3 miles north of Winnie, Tex.*

	Feet.
Beaumont clay:	
Soil	0- 2
Yellow clay (2-foot log, at 56 feet)	2- 60
Water sand	60- 90
Yellow clay	90- 180
Water sand	180- 304
Blue tough clay	304- 380
Lissie gravel:	
Water sand	380- 623
Tough clay	623- 835
Clay, shells	835- 856
Blue tough clay	856- 876
Blue rock	876- 897
Blue clay and shells	897-1,059
Gray sandstone	1,059-1,060
Tough clay	1,060-1,378

	Feet.
Marine Miocene (?):	
Clay with shells	1,378-1,440
Hard shale	1,440-1,460
Soft clay	1,460-1,480
Gravel	1,480-1,510

159. *Section of Moore well on sec. 24, Chambers County, Tex.*

[Furnished by William Kennedy.]

	Feet.
Beaumont clay:	
Yellow clay	0-140
Lissie gravel:	
Gray water sand	140-200
Blue clay	200-240
Sand	240-255
Gumbo and clay	255-305
Sand	305-315
Gumbo	315-375
Sand	375-385
Gumbo	385-460
Blue shale	460-485
Sand	485-493
Bowlders	493-505
Shale	505-515
Gumbo	515-600
Bowlders	600-640
Gumbo	640-710
Bowlders	710-720
Sand bowlders	720-780
Sand and bowlders	780-820
Gumbo	820-838

CHEROKEE COUNTY.

GEOLOGY AND HYDROLOGY.

Cherokee County has available only one artesian reservoir, the lower Eocene, and its area of flow is confined entirely to the valleys. Probably none of the towns along the St. Louis Southwestern Railway will ever obtain flowing wells. (See Pl. VIII, in pocket.) The only artesian well known in the county is at Circle, about 3 miles from Angelina River. At Jacksonville the lower Eocene sands are entered at 244 feet, but at Wells, in the southern part of the county, on the outcrop of the Yegua formation, a drill hole 600 feet deep failed to reach the water-bearing beds. Doubtless a deeper boring would have yielded abundant water.

In the northern portion of Cherokee County and in the vicinity of Jacksonville wells can be completed in this reservoir at depths ranging from 100 feet above sea level to 400 feet below it. The wells will deepen toward the south, reaching a maximum of 600 feet below sea level in the southern portion of the county.

Few data are available on the quality of the water in Cherokee County. Generally, most of the water in wells not deeper than 600 to 700 feet will be potable. The Circle well is said to yield "mineral water." Lower Eocene water at Jacksonville is used in locomotive boilers and for the manufacture of ice.

The numerous erosion hills capped with iron ore produce many chalybeate springs.

WELL DATA.

Additional details concerning the wells of Cherokee County are given in the following table:

Wells and springs in Cherokee County, Tex.

No.	Location.	Owner.	Driller.	Authority.
160	Lone Star, 4 miles south.	J. W. Beaird		J. J. Connor.[a]
161	Morton, 3 miles northwest of wells.	Arkansas Lumber Co.	P. M. Granberry & Co.	Arkansas Lumber Co.[a]
162	Wells			N. H. Darton.[b]
163	Circle			J. R. Mitchell, postmaster.[a]
164	....do			Do.[a]
165	Mount Selman, 1 mile southwest.	H. L. Carlton		H. L. Carlton.
166	Dialville, 1½ miles northeast.	C. H. Martin		C. H. Martin.
167	Jacksonville	Texas & New Orleans Railroad.	Layne & Bowler	Chief engineer, maintenance of way.
168	....do	Ice factory		Postmaster.[a]
169	Rusk, 3 miles northeast.			E. C. Dickinson.
170	Rusk, 10 miles east			Do.
171	Rusk, 1¼ miles east			Do.
172	Rusk, ¾ mile east	E. C. Dickinson		Do.
173	Rusk, 1 mile west	W. J. Weatherley		W. J. Weatherley.
174	Rusk	East Texas Penitentiary.		W. M. Lacy, assistant superintendent.[a]

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths of principal water-bearing strata.	Head of water above ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*		*Galls.*	*Galls.*
160		100+					
161		600					
162		600					
163		300			Flows		Large.
164		600					
167	9⅝	423	516	244 to 287 382 to 423		106	
168		386 360					
172							10.
174		620				None.	

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 230.

[b] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 144.

No.	Source of supply.	Quality.	Remarks.
160			No water.
161			Abandoned.
162			Unsuccessful.
163	Wilcox	Mineral	
164			Test for oil.
165		Soft	Spring.
166		Chalybeate [a]	Castalian Springs; local resort.
167	Wilcox		Used for locomotive boilers. Completed, 1906.
168	do		Water carries large amount of sand. Two wells.
169		Chalybeate	Spring. "For many years the resort for invalids afflicted with jaundice and kindred diseases."
170		Sulphur	Spring. Used locally for medicinal purposes.
171		do	Do.
172		Soft	Spring.
173		Sulphur	Do.
174			Bit caught and well abandoned.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

167. *Section of Texas & New Orleans Railroad Co.'s well at Jacksonville, Tex.*

Mount Selman and Wilcox formations:	Feet.
Sandrock	0– 23
Lignite	23– 26
Quicksand	26– 31
Blue clay	31– 63
Iron rock	63– 75
Black marl	75–127
Sandy clay	127–167
Sand rock	167–186
Hard sandy clay	186–244
Water-bearing white sand	244–287
Soft sandy clay	287–347
Fine packed sand	347–400
Loose sand, water	400–423

FALLS COUNTY.

Only the eastern corner of Falls County is included within the limits of the area covered by this paper, and in this corner the flowing-well prospects are very unfavorable. No Tertiary water horizon is available.[1] Flowing wells could be obtained from the underlying Cretaceous Woodbine sand, but the great depth necessary—4,000 feet—makes drilling impracticable. The Nacatoch reservoir will supply nonflowing wells. (See Pl. VII, in pocket.)

The sands of the Wilcox formation veneer the easternmost corner of the county, but being very thin and without cover they supply only shallow surface wells.

[1] For a description of the Cretaceous water horizons in this county, see Hill, R. T., Geography and geology of the Black and Grand prairies, Tex.: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901.

Additional details are given in the following table:

Wells and springs in a portion of Falls County, Tex.

No.	Location.	Owner.	Authority.	Depth of well.	Quality.	Remarks.
				Feet.		
175	Denny, 1¼ miles west.	Tom Reid	William Lyon.		Soft	Willow Springs.
176	Denny. 2½ miles south.	Kline & Kline	do		do	Gray Springs.
177	Highbank	T. W. Terry	Postmaster	800 (?)		No water reservoirs encountered.

FORT BEND COUNTY.

GEOLOGY AND HYDROLOGY.

Only the northern third of Fort Bend County is included in the region considered in this report. The surface formations are the Beaumont clay in the eastern half of this portion and the Lissie gravel in the western half. (See Pl. I, in pocket.) These areas have available the water-bearing sands of the Lissie gravel, which at least in the eastern corner are well covered by the relatively impervious Beaumont clay.

Where these sands are under cover they give rise to flowing wells, as at Arcola (wells Nos. 182, 183) and Sugarland (well No. 194). In the remainder of the county flows can probably be obtained at depths of 100 to 200 feet in the area of the outcrop of the Lissie gravel. (See Pl. VII, in pocket.)

Wells not exceeding 1,000 feet in depth may be depended on to yield supplies suitable for every use and in abundant quantity. Where large yields are sought deep wells are recommended, as these draw their water from more extensive areas than the shallow wells and are less easily exhausted.

At Almeda and Richmond this water is used for irrigation with apparently satisfactory results and at Richmond it is used in boilers. It is generally hard.

WELL DATA.

The following table gives data concerning the wells of Fort Bend County:

Wells and springs in Fort Bend County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
178	Almeda, 3 miles west-southwest.	J. Poitevent survey.	F. D. Young	P. M. Granberry.	F. D. Young.
179	Foster, ¾ mile northeast.		Mrs. J. A. Davis		Mrs. J. A. Davis.
180	Fulshear, 2 miles northwest.		Mrs. R. L. Harris.	G.W.Winsworth.	G. W. Winsworth.
181	Simonton		J. A. Robertson		Postmaster.
182	Arcola		House plantation.		J. A. Singley.[a]
183	Arcola, 2 miles southwest.		T. W. House		T. U. Taylor.[b]
184	Richmond		City Waterworks.		Do.[b]
185	do		Clem Bassett	G.W.Winsworth.	G. W. Winsworth.
186	do		John M. Moore	do	Do.
187	Richmond, 400 yards northwest of post office.	Town block 133	Richmond Cotton Co.	Payne Bros	Real F. Ransom, secretary.
188	do		Richmond Cotton Co.	do	Do.
189	Richmond, ½ mile northeast.	Wm. Morton survey.	J. A. Blasdel	G.W.Winsworth.	J. A. Blasdel.
190	Richmond, 1½ miles southeast.		do		Do.
191	Rosenberg, 4½ miles southwest.		C. Hillar	I. W. Lawson	I. W. Lawson.[c]
192	Sugarland		W. T. Eldridge	G.W.Winsworth.	G. W. Winsworth.
193	do		Cunningham farm.		T. U. Taylor.[b]
194	do				N. H. Darton.[d]
195	do				Do.[d]
196	Sugarland, ¾ mile west.		Imperial Sugar Co.	G.W.Winsworth.	G. W. Winsworth.
197	Missouri City		E. R. Robinson		Postmaster.
198	Booth		I. M. Camp		Postmaster at Thompson.
199	Booth, 800 feet northwest.	Kuykendall League.	F. I. Booth	F. I. Booth	F. I. Booth.
200	Booth, 1¼ miles north.	Henry Jones League.	Ira M. Camp	G.W.Winsworth.	Ira M. Camp.
201	Thompson, 40 yards north of post office.		Miss Eliza Jones	do	J. W. Slavin.
202	Thompson, 2½ miles northwest.			do	G. W. Winsworth.
203	Thompson, 150 feet north of post office.		Miss Eliza Jones	do	J. W. Slavin, agent.
204	Thompson		M. A. Dug		
205	Sartartia		W. I. Moody		G. W. Winsworth.
206	Stafford		Dr. W. B. Cochran.	G.W.Winsworth.	Do.

[a] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 108.

[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 24.

[c] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 160.

[d] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 147.

Wells and springs in Fort Bend County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
178	10	130		80	−6	1,200	
179	2	208		45, 86, 208	−14		
180	2	160		95, 140	−46	10	
181	6	700					
182		910			Flows		350.
183		1,000			Flows		60.
184		400			No flow		
185	2	175					
186	2	170					
187	10	400		380	−17	200	
188	10	400	87	380	−17	200	
189	3	173		30 to 35, 70	−20		
190				59½			
191	9⅝	300		200 to 260	−30	1,000	
192	2	493					
193		1,000					
194		1,760			Flows		7.
195	8–4	1,550			+9		104.
196	2	493		450	−8	12	
197	6	200					
198	2	275					
199	4	200	87	{30 to 45 110 to 130 170	−15		
200	2	279	87	{12, 46 180, 279	−12		
201	2	406		394	−2⅓		
202	2	492		463 to 469	−1		
203	2	406		{90 406	−3		
204			1,265				
205	2	233					
206	2	220					

No.	Source of supply.	Quality.	Remarks.
178	Lissie		Water is lowered 25 feet by pumping. Used for rice irrigation. Completed, 1901.
179	....do	Hard	Completed, 1899.
180	....do	Iron	
181			
182		Good	Used in sugar making.
183			
184			
185			Two other 20-inch wells, 150 and 143 feet deep, are owned by Mr. Bassett near Richmond.
186			
187	Lissie	Hard	Used for garden irrigation; water bed consists of gravel. Completed, 1905.
188	....do	....do	Used in boilers and for garden irrigation.
189	....do	Soft	Completed, 1906.
190	....do		
191	....do		Completed, 1904. Water is lowered 70 feet by pumping.
192			Two other 2-inch wells near Sugarland, 367 and 290 feet deep, are owned by Mr. Eldridge.
193			Two wells.
194			
195			
196	Lissie	Soft	In Brazos bottoms.
197			
198			
199	{Late Pleistocene Lissie	}Soft	Used in sugar mill.
200	{Late Pleistocene Lissie	}....do	
201	Lissie	Sulphur	
202	....do	Soft	Completed, 1907.
203	{Late Pleistocene Lissie	Sulphur (*a*)	}Show of gas; completed, 1905.
204			Drilled for oil.
205			
206			

a For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

191.[1] *Section of well owned by C. Hillar, 4½ miles southwest of Rosenberg, Tex.*

[By I. W. Lawson, contractor and driller.]

	Feet.
Hard black soil	0- 6
Beaumont clay:	
Soft red clay	6- 18
Quicksand; fine, but little water	18- 28
Hard red gumbo	28- 85
Lissie gravel:	
Coarse gravel; water not alkaline	85-125
Soft red clay	125-200
Fine blue gravel; water	200-260
Hard blue clay	260-300

202. *Section of well owned by Mr. Whisnand, 2½ miles northwest of Thompson, Tex.*

[Received from G. W. Winsworth.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
Soil and clay	0- 38
Fine sand	38- 50
Coarse sand and gravel	50- 63
Red clay	63- 96
Fine sand	96-118
Good sand, water	118-129
Fine sand	129-137
Clay	137-168
Fine sand	168-194
Soft clay	194-202
Fine sand	202-217
Gravel	217-218
Fine sand	218-238
Tough "putty" clay	238-246
Pack sand	246-284
Clay	284-298
Fine quicksand	298-336
Sand	336-344
Rocky clay	344-349
Quicksand	349-391
Red and blue clay	391-425
Fine sand	425-448
Clay	448-451
Soft rock	451-453
Gravel	453-463
Water sand	463-469
Fine sand	469-492

The driller says: "Every sand stratum was full of water, but sand was too fine for screen most of the time. Water is soft, good tasting."

203. J. W. Slavin writes: "Struck gas pocket at 225 feet. Did not test same. Also gas at 406 feet which came out with water. The gas is now used for illuminating, and the flow is as strong now as when first drilled. Gumbo was the principal formation encountered, with sand between the layers of gumbo."

[1] Fuller, M. L., and Sanford, Samuel, op. cit., p. 273.

FREESTONE COUNTY.

GEOLOGY AND HYDROLOGY.

The sands of the Wilcox formation outcrop over the entire area of Freestone County. (See Pl. I, in pocket.) At no point are they beneath an impervious cover, and except in a few localities they will not yield flowing wells. (See Pls. VII and VIII.) Cretaceous strata lie too deep to make attempts to reach them practicable, and their waters would probably be unfit for use. The Nacatoch reservoir underlies the entire county but would probably yield salt water.

Topographic conditions such as those shown in figure 11 (p. 91) are lacking, and flows in this district will be the exception rather than the rule. They may be had in the eastern corner of the county in the Trinity bottoms. In a well 1½ miles southeast of Butler (No. 212) water rose to the surface, and at lower levels farther southeast flowing wells can be had. (See Pl. VIII, in pocket.)

Abundant water is available from nonflowing deep wells, and some such wells are now being utilized.

In the western half of Freestone County only shallow wells 100 to 400 feet deep can be had. Toward the east the depth will increase and in the eastern corner wells can be completed from 100 feet below the surface to 200 feet below sea level.

Most of the water from the Wilcox will generally be potable and soft and suitable for steaming. At Teague water from these sands is used in locomotive boilers and for manufacturing ice.

WELL DATA.

Details of wells in Freestone County are given in the following table:

Wells and springs in Freestone County, Tex.

No.	Location.	Owner.	Driller.	Authority.
207	Teague, ½ mile west	Trinity & Brazos Valley Ry.	Layne & Bowler	Postmaster.
208	Teague, ¾ mile west	Gordon Hagins		Gordon Hagins.
209	Teague, ¾ mile southwest	Trinity & Brazos Valley Ry.	Layne & Bowler	F. W. Bobbitt, division engineer.
210	Teague, ¼ mile south	J. N. Robinson & Co.	M. H. McLeod	Postmaster.
211	Brewer			Layne & Bowler.
212	Butler, 1½ miles southeast	Grange Oil Co.		C. C. Cornwell.
213	Butler, 4 miles east	J. M. Duncan		J. W. Duncan.
214	do	do		Do.
215	Blunt, 1¾ miles southwest	F. E. Hill	A. B. Brown	J. C. Richardson, postmaster.
216	Blunt, 2 miles west	R. Y. Chancellor	W. B. Allen	Hick Lee.
217	Stewards Mill	A. T. Watson		Postmaster.
218	Bonner			N. H. Darton.[a]
219	Wortham			Do.[a]
220	Fairfield, 8 miles northwest.			Do.[a]
221	Fairfield, 10 miles northeast.			Do.[a]

[a] Darton, N. H., op. cit., p. 147.

Wells and springs in Freestone County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water below ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
207	8±	208 (?)			No flow		
208							1
209	9$\frac{5}{8}$	408		18, 140, 206, 260	80	60	
210	10	300±			No flow		
211				206			
212	8	850		62, 325; 600; 850	No flow		
213		700					
214		200					
215	10	1,400		300	30		
216	6	1,100			No flow		
217	8	500					
218							
219							
220		1,350					
221		1,200		800			

No.	Source of water.	Quality.	Remarks.
207	Wilcox	Soft (?)	At railroad shops; completed, 1906.
208		Soft	Spring water used in boilers.
209	Wilcox	Some iron	Used in locomotive boilers; completed, 1905.
210	do		Ice-plant well; completed, 1907.
211	do	Good	
212	do		Drilled for oil.
213			Do.
214			Do.
215	Wilcox	Sulphur	Drilled for oil; completed, 1907.
216			Do.
217			
219		Salty	
221	(?)	Sulphur	

GALVESTON COUNTY.

GEOLOGY AND HYDROLOGY.

Galveston County is abundantly supplied with artesian wells. The surface formations consist of Recent materials and the Beaumont clay, the latter constituting the cover above the prolific Lissie gravel. The marine Miocene sands embedded beneath the county are also water bearing and produce strong flows wherever encountered, but in Galveston County they are of no economic value, for they nearly everywhere yield water that is brackish or salty and unfit for use. (See fig. 14.)

The Lissie gravel produces flows on nearly every square mile of the county. (See Pl. VII, in pocket.) Owing, however, to the great number of wells that draw from it, the static head in the drill holes is constantly falling. At Alta Loma it has fallen in 14 years from an original height of 26 feet above the surface almost to the surface. Many wells that formerly flowed have ceased. This lowering of static head may be expected to continue. Deeper sands will yield more permanent supplies.

The Lissie gravel dips seaward at approximately 35 feet to the mile. (See fig. 14 and Pl. I.) Some of the included water sands may also have this dip, but others (see fig. 15) may vary from it considerably, and some may even show apparent reversals. Such variations, however, should not be assigned to hypothetical folds and flexures, the presence of which can be definitely determined by paleontologic criteria alone.

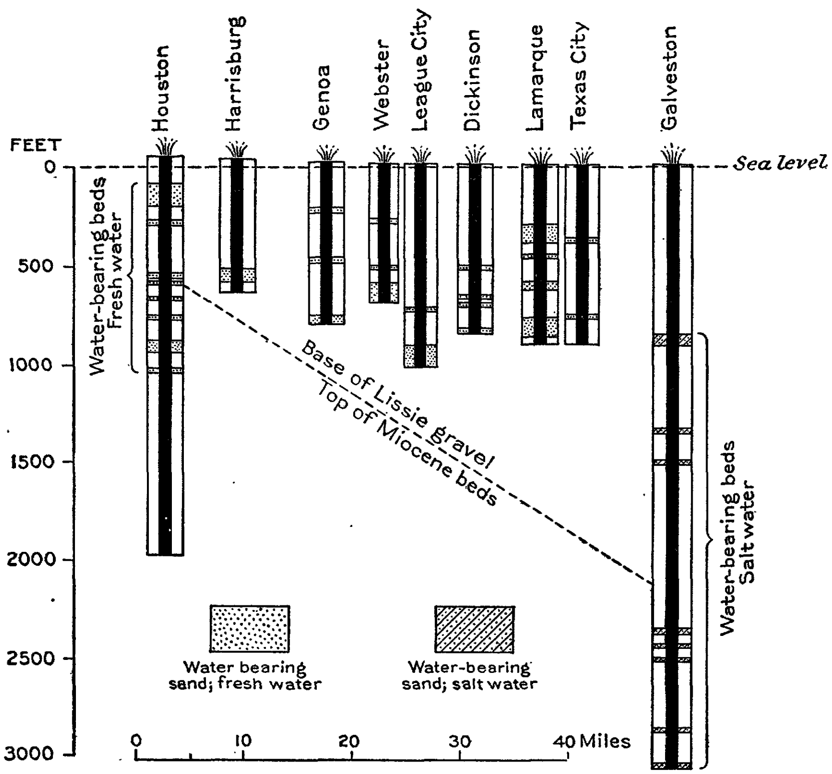

FIGURE 14.—Section between Galveston and Houston, showing the water-bearing beds of the several flowing wells and the relations of salt and fresh water.

Practically every well in the county strikes two or more water sands. In the city of Galveston the main water sand is found at a nearly uniform depth of 810 to 840 feet along the northeast-southwest strike of the beds (see fig. 14), but minor sands having a sparser distribution are met at 436 and 320 feet and many others lie lower than the sand at 810 to 840 feet. The water in all the sands beneath Galveston is brackish and unfit for use. At Texas City, the nearest point to the coast where wells supply potable water, a minor sand is encountered at 400 feet and the main sand at 700 to 800 feet. At Lamarque the main sand supplying potable water is struck at 770 to 900 feet, but four or five sands above it furnish good water. At Hitchcock a prolific sand is entered between 711 and 726 feet, but two equally important sands supply good water at 678 to 692 and at 408 to 423 feet. At Alta Loma three sands, the lower two of which have yielded flows in times past, are found 100 to 123, 489 to 494, and 740 to 868 feet below the surface. The water in all three is potable, but only the deepest has been developed. At Algoa the main sand is encountered at 700 to 750 feet and another at 500 feet. At Dickinson flows have been obtained from sands at 520 to 532 and at 700 to 783 feet. At League City sands at 525 to 550, 700 to 730, and 935 to 1,020 feet have yielded flows of potable water. (See fig. 14.)

Most of the water-bearing sands in this county belong to the Lissie gravel. Some of them persist over large areas and others are

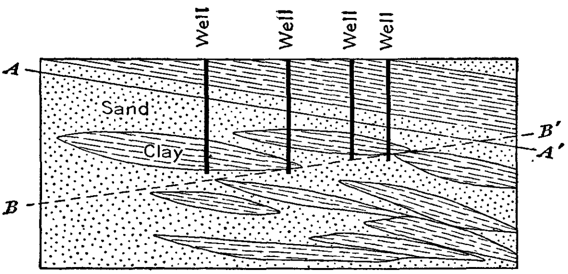

FIGURE 15.—Diagram showing effect of scattered lenticular clay masses in producing apparent water horizons with dips opposite to the true dip of the beds. A–A', True dip; B–B', apparent dip.

purely local. It is believed that the sand found at a depth of 711 to 726 feet in the Gulf, Colorado & Santa Fe Railway Co.'s well at Hitchcock (well No. 306) is continuous at least as far as Dickinson and is identical with a sand met there at a depth of 600 feet in the Nichols well (No. 336). However, the distribution of each sand lens is of little practical significance, the important fact being that any hole sunk into this reservoir is almost certain to encounter several water-bearing sands. Figure 14, which shows the water horizons in wells between Houston and Galveston along the Galveston, Houston & Henderson Railroad, indicates the difficulty of tracing the distribution of any sand.

Wells on Galveston Island and in an 8-mile strip along the coast obtain brackish water unfit for use at all known depths. Elsewhere in the county the wells yield potable supplies to depths not exceeding 1,000 feet. Many are used for truck and fruit irrigation.

WELL DATA.

Details of wells in Galveston County are given in the following table:

Wells and springs in Galveston County, Tex.

No.[a]	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
222	Galveston	Seventeenth and Winnie streets.	City of Galveston		J. A. Singley.[b]
223	do	Nineteenth and Winnie streets.	do		Do.[b]
224	do	Twenty-first and Winnie streets.	do		Do.[b]
225	do	Twenty-third and Winnie streets.	do		Do.[b]
226	do	Twenty-fifth and Winnie streets.	do		Do.[b]
227	do	Twenty-eighth and Winnie streets.	do		Do.[b]
228	do	Thirtieth and Winnie streets.	do		Do.[b]
229	do	Thirty-second and Winnie streets.	do		Do.[b]
230	do	Thirty-fifth and Winnie streets.	do		Do.[b]
231	do	Thirty-seventh and Winnie streets.	do		Do.[b]
232	do	Forty-first and Winnie streets.	do		Do.[b]
233	do	Forty-third and Winnie streets.	do		Do.[b]
234	do	Forty-fifth and Winnie streets.	do		Do.[b]
235	do		do	Galveston Artesian Well Co.	Do.[c]
236	do	Post office and Twenty-sixth streets.	Brush Electric Light & Power Co.		Do.[b]
237	do	Twentieth street and Avenue I.	Galveston City Railway Co.		Do.[b]
238	do	do	do		Do.[b]
239	do	do	do		Do.[b]
240	do	Post office and Forty-first streets.	Galveston Cotton & Woolen Mills.		Do.[b]
241	do	Twentieth street and Avenue A.	Texas Ice & Cold Storage Co.		Do.[b]
242	do	do	do		Do.[d]
243	do	do	do		Do.[d]
244	do	Santa Fe shops	Gulf, Colorado & Santa Fe Railway Co.		Do.[e]
245	do	Eighteenth street and Avenue A.	National Cotton Oil Co.		Do.[f]
246	do	Twenty-eighth and Church streets.	Bagging factory		Do.[f]
247	do	Thirty-sixth and Church streets.	Rope and twine factory.		Do.[g]
248	do		Galveston Brewing Co.		Do.[h]
249	Galveston, 10 miles southwest.		South Galveston Land Co.		Do.[g]
250	Galveston Island	Sec. 3	Atlantic & Pacific Oil Co.		A. Deussen.
251	Alta Loma, near	E. T. Mitchell survey.	City of Galveston		A. T. Dickey, city engineer.
252	do	do	do		Do.
253	do	do	do		Do.

[a] For additional data see notes at end of table.
[b] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 98.
[c] Idem, pp. 87 et seq.
[d] Idem, p. 99.
[e] Idem, pp. 99–100.
[f] Idem, p. 100.
[g] Idm, p. 101.
[h] Teylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 99.

Wells and springs in Galveston County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
254	Alta Loma, near...	E. T. Mitchell survey.	City of Galveston.	....	A. T. Dickey, city engineer.
255	.....do............	.....do............	.....do............	....	Do.
256	.....do............	Block 147, E. T. Mitchell survey.	.....do............	....	Do.
257	.....do............	Block 148, E. T. Mitchell survey, southwest corner.	.....do............	....	Do.
258	.....do............	Block 148, E. T. Mitchell survey, northwest corner.	.....do............	....	Do.
259	.....do............	Block 149, E. T. Mitchell survey.	.....do............	....	Do.
260	Alta Loma........	Block 40..........	.....do............	....	Do.
261	.....do............	Block 33, southeast corner.	.....do............	....	Do.
262	.....do............	Block 32, southeast corner.	.....do............	....	Do.
263	.....do............	Block 32, northeast corner.	.....do............	....	Do.
264	.....do............	Block 20, southeast corner.	.....do............	....	Do.
265	.....do............	Block 17, southeast corner.	.....do............	....	Do.
266	.....do............	Block 16, southeast corner.	.....do............	....	Do.
267	.....do............	Block 9, southeast corner.	.....do............	....	Do.
268	.....do............	Block 8, southeast corner.	.....do............	....	Do.
269	.....do............	Block 1, southeast corner.	.....do............	....	Do.
270	.....do............	Block 181, northeast corner.	.....do............	....	Do.
271	Alta Loma, near...	Block 179, E. T. Mitchell survey, southeast corner.	.....do............	....	Do.
272	.....do............	Block 178, east line in the E. T. Mitchell survey.	.....do............	....	Do.
273	.....do............	Block 158, E. T. Mitchell survey, northwest corner.	.....do............	....	Do.
274	.....do............	Block 160, west line of E. T. Mitchell survey.	.....do............	....	Do.
275	.....do............	Block 161, E. T. Mitchell survey, northwest corner.	.....do............	....	Do.
276	.....do............	Block 163, E. T. Mitchell survey, southwest corner.	.....do............	....	Do.
277	.....do............	Block 164, west line of E. T. Mitchell survey.	.....do............	....	Do.
278	.....do............	Block 165, E. T. Mitchell survey, northwest corner.	.....do............	....	Do.
279	.....do............	Block 167, E. T. Mitchell survey, southwest corner.	.....do............	....	Do.
280	.....do............	Block 167, E. T. Mitchell survey, northwest corner.	.....do............	....	Do.
281	Alta Loma........	....	J. A. Conklin.....	....	W. B. Kitchel, postmaster.
282	.....do............	....	Town..............	....	Do.
283	.....do............	....	H. E. Stobart.....	....	Do.
284	Alta Loma, ½ mile southwest.	....	Hoyland & Johnson.	Hoyland & Johnson.	J. E. Johnson.

Wells and springs in Galveston County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
285	Hitchcock		Jacques Tacquard.		T. U. Taylor.[a]
286	Hitchcock, 1½ miles west.		W. F. Reitmeyer.		Do.[a]
287	Hitchcock, ½ mile south.		J. A. Minot		Do.[a]
288	Hitchcock, 1½ miles east.		David Tahey		Do.[a]
289	Hitchcock, 2½ miles west.		B. F. Fast		Do.[a]
290	Hitchcock, 1 mile east.		J. H. Kempner		Do.[a]
291	Hitchcock, 4 miles northwest.		Alta Loma Co		Do.[a]
292	Hitchcock, 7 miles west.		A. H. Tacquard		Do.[a]
293	Hitchcock, 6 miles west.		do		Do.[a]
294	Hitchcock, 7 miles west.		do		Do.[a]
295	Hitchcock, 8 miles west.		do		Do.[a]
296	Hitchcock		do		Do.[a]
297	do				J. A. Singley.[b]
298	Hitchcock, 1½ miles west.		W. F. Reitmeyer.	Jacques Tacquard	W. F. Reitmeyer.
299	Hitchcock, 7 miles southwest.	P. R. Edwards survey No. 14.	A. H. Tacquard	Louis Cange	A. H. Tacquard.
300	Hitchcock, 2 miles southwest.	L. Crawford survey No. 38.	do	do	Do.
301	Hitchcock, 2¼ miles east.	Austin League	Jules Perthius	do	Jules Perthius.
302	Hitchcock, 1½ miles west.		A. H. Tacquard	do	A. H. Tacquard.
303	Hitchcock, 2 miles east.		Jules Perthius		T. U. Taylor.
304	do		do		Do.
305	League City		Galveston, Houston & Henderson R. R.		H. W. Boehm.
306	Hitchcock, 200 feet east of depot.		Gulf, Colorado & Santa Fe Ry.	J. L. Mayes	C. F. W. Felt, chief engineer.
307	Hitchcock, 1 mile east.		Mrs. J. Jensen	Louis Cange	Louis Cange.
308	Hitchcock, 1½ miles northwest.		J. Tacquard		J. A. Singley.
309	Hitchcock, 1 mile south of well No. 308.		do		Do.[c]
310	Hitchcock, 3 miles east.			J. A. Conklin	J. A. Conklin.
311	Hitchcock, ¾ mile southwest.		Fred Lemke	Louis Cange	Louis Cange.
312	Hitchcock, ½ mile east.		Mrs. R. T. Wheeler	do	R. T. Wheeler.
315	Hitchcock, ¾ mile south.		Fred D. Lemke	do	Fred D. Lemke.
316	Bayview, 60 feet south of post office.	R. Basquez survey	Wm. McClintock estate.	Gust Warnecke	W. P. Derrick.
317	Edgewater		Galveston, Houston & Henderson R. R.		T. U. Taylor.[a]
318	Dickinson, 1 mile east.		W. H. Crawford		Do.[a]
319	Dickinson, 2½ miles east.		J. D. Ward		Do.[a]
320	Dickinson, 2 miles east.		C. C. Pettit		Do.[a]
321	Dickinson, 1 mile south.		F. Fonts		Do.[a]
322	Dickinson, 2 miles north.		John Williams		Do.[a]
323	Dickinson, ½ mile northeast.		Sam Saloets		Do.[a]
324	Dickinson, ½ mile east.		Chas. Engelke		Do.[a]

[a] Taylor, T. U., op. cit., p. 29.
[b] Singley, J. A., op. cit., pp. 103–104.
[c] Singley, J. A., op. cit., pp. 102–103.

Wells and springs in Galveston County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
325	Dickinson, ¼ mile southwest.	....	Mick Weeks........	....	T. U. Taylor.[a]
326	Dickinson, 1 mile south.	....	Chas. Nolan........	....	Do.[a]
327	Dickinson, 2½ miles south.	....	.....do........	....	Do.[a]
328	Dickinson........	....	Joseph Lobit........	....	Do.[a]
329	Dickinson, ¼ mile south.	....	C. H. Collier........	....	Do.[a]
330	Dickinson, ½ mile east.	....	Joseph Lobit........	....	Joseph Collonge.
331	Dickinson, 200 yards southeast.	....	.....do........	Gust Warnecke..	J. Lobit.
332	Dickinson, ¾ mile southeast.	W. K. Wilson League.	C. C. Pettit........	L. V. Elder........	C. C. Pettit.
333	Dickinson, 1 mile east.	....	W. H. Crawford...	....	W. H. Crawford.
334	Dickinson, ½ mile northeast.	....	C. Nicolini........	....	C. Nicolini.
335	Dickinson, ¾ mile north.	....	D. Collonge........	L. Mayes........	Joseph Collonge.
336	Dickinson........	....	Nichols........	....	J. A. Singley.[b]
337	.....do........	....	Ramie farm well..	....	Do.[b]
338	Dickinson, 3 miles west.	....	Nolan........	....	Do.[b]
339	Dickinson, ¼ mile west.	....	Anderson........	....	Do.[b]
340	Dickinson, ½ mile southeast.	....	C. C. Pettit........	....	Do.[b]
341	Texas City........	Block No. 3........	Texas City Co.....	Gust Warnecke..	G. E. Whitney.
342	.....do........	....	.....do........	.....do........	Do.
343	.....do........	....	.....do........	....	Do.
344	.....do........	....	J. R. Myers........	....	T. U. Taylor.[a]
345	.....do........	....	Inman Compress Co.	....	Do.[a]
346	North Galveston..	....	North Galveston Improvement Co.	....	J. A. Singley.[c]
347	.....do........	....	.....do........	....	Do.[c]
348	Fairwood........	....	....	....	Do.[c]
349	Algoa........	International & Great Northern Railroad No. 14.	Algoa Townsite Co.	Layne & Bowler.	R. L. Jones.
350	.....do........	....	.....do........	.....do........	E. R. Cheesborough
351	Algoa, 2 miles northeast.	....	M. Marx........	....	Do.
352	Algoa........	....	St. Louis, Brownsville & Mexico Ry.	Layne & Bowler.	E. C. Burgess, engineer.
353	League City........	....	A. W. Wilkerson..	....	T. U. Taylor.[a]
354	.....do........	....	C. R. Reifel........	....	Do.[a]
355	.....do........	....	Mrs. L. Cours........	....	Do.[a]
356	.....do........	....	Galveston, Houston & Henderson R. R.	....	R. V. Brewster, resident engineer.
357	.....do........	....	J. C. League........	....	J. C. League.
358	League City, ½ mile southwest.	....	Mrs. R. A. Walker.	H. M. Biglow....	Mrs. R. A. Walker.
359	League City, ½ mile west.	....	P. I. Gill........	....	P. I. Gill.
360	Lamarque, ¾ mile northeast.	....	Kohfeldt & Braun.	Layne & Bowler..	Franz Kohfeldt.
361	Lamarque........	John D. Moore League No. 5.	Galveston, Houston & Henderson R. R.	.....do........	R. V. Brewster, resident engineer.

[a] Taylor, T. U., op. cit., p. 29. [b] Singley, J. A., op. cit., p. 104. [c] Singley, J. A., op. cit., p. 101.

Wells and springs in Galveston County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
222		1,346		840, 1,346	Flows		425.
223		840		840	do		52.
224		835		835	do		84.
225		830		830	do		35.
226		840		840	do		28.
227		835		835	do		58.
228		820		820	do		74.
229		810		810	do		59.
230		830		830	do		72.
231		826		826	do		82.
232		819		819	do		52.
233		965		965	do		241.
234		973		973	do		380.
235	22 to 26	3,070		827 to 882 1,330 to 1,340 1,493 to 1,511 2,345 to 2,377 2,432 to 2,443 2,476 to 2,552 2,883 to 2,920 3,047 to 3,070	do		Flows. Do. Do. Do. Do. Do. Strong flow. Flows.
236		813		813	do		102.
237		330		330	No flow	208	
238		320		320	0	208	
239		910		910	Flows		121.
240		1,245		1,245	do		819.
241	6	856		856	do		156.
242	6	872		872	do		208.
243	1	820		820	Flows (?)		
244		797		797	Flows		104.
245		1,328		436 836 1,328 [a]	do		347.
246		810		810	do		125.
247		1,365		1,365	do		243.
248	8	872			do		
249	3	827		827	do		37.
250		1,499					
251	9 to 7	745	22.21		+2.46		70.
252	7 to 5	733	22.12		+2.15		70.
253	7 to 5	726	22.65		+2.03		70.
254	7 to 5	775	22.78	755 to 795	+2.16		70.
255	7 to 5	790	22.74	755 to 795	+1.43		70.
256	7 to 5	838	22.37	755 to 795	+1.21		70.
257	7 to 5	800	23.00	756 to 790	−1.50		None.
258	7 to 5	788	23.46	757 to 797	−1.59		Do.
259	7 to 5	792	23.30	754 to 794	−1.97		Do.
260	7 to 5	809	23.37	756 to 796	−2.95		Do.
261	7 to 5	793	22.62	757 to 797	−1.72		Do.
262	7 to 5	868	22.93	100 to 123 489 to 494 740 to 868	No flow Flows −2.59		Do.
263	7 to 5	768	21.96	100 to 123 489 to 494 740 to 768	No flow Flows −1.62		None.
264	7 to 5	797.09	22.56	757 to 797	−2.62	500	None.
265	7 to 5	790±	22.12	740 to 790	−2.71		
266	7	790±	21.55	740 to 790	−2.43		
267	7	790±	21.08	740 to 790	−2.29		
268	7 to 5	790±	19.57	740 to 790	− .59		None.
269	7 to 5	790±	18.66	740 to 790	+ .89		70.
270	7 to 5	860±	19.34	740 to 860	+1.26		70.
271	7 to 5	790±	18.21	740 to 790	+2.71		70.
272	7 to 5	790±	18.29	740 to 790	+2.86		70.
273	7 to 5	790±	17.89	740 to 790	+3.66		70.
274	7 to 5	790±	18.78	740 to 790	+2.76		70.
275	7 to 5	790±	18.71	740 to 790	+1.94		70.
276	7 to 5	790±	20.93	740 to 790	−0.59		None.
277	7 to 5	790±	22.06	740 to 790	−0.82		Do.
278	7 to 5	790±	20.59	740 to 790	−0.56		Do.
279	9 to 7	790±	23.15	740 to 790	−2.32		Do.

[a] For analysis of water, see table facing p. 110.

Wells and springs in Galveston County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
280	9 to 7	790±	25.16	740 to 790	−4.07		Do.
281	4	100					
282	6	700					
283	6	700					
284	2½	105		100	−12		
285	2	180			Flows		15.
286	2 3	433 420			do do		10. 80.
287	2	763			do		64.
288	3	576			do		68.
289	3	702			do		120.
290	3	600			do		60.
291	3	914			do		40.
292	3	300			do		25.
293	2	306			do		30.
294	2	60			do		10.
295	2	88			do		12.
296	2	88			do		12.
297	1½	80		80	do		9.
298		800	18		+15		
299	3	750	8 to 10		+6		10 to 12.
300	4½	750	17		+3		25.
301	3	495	14	332, 495	+30		40.
302	4½	750	17	750	+10		25 to 30.
303	3	230			Flows		25.
304	3	405			do		65.
305	9⅝	1,000 (?)					
306	6	726	67	18 to 26 408 to 423 678 to 692 711 to 726 [a]	 +8		 66.
307	3	500	12	230, 500	+15		40.
308		710		710	Flows		100.
309		710		710	do		100.
310	3	220	10	220	do		10.
311	3	695	12	120 695	+30		100.
312	2	690	19	630	+30		57.
315		690 (?)		670 to 690 (?)	+4		200.
316	4	622	24 (?)	590	+14		25.
317	3	600			Flows		55.
318	8	675			+10		
319	6	700			Flows		
320	6	620			do		4.
321	6	600			do		10.
322	6	750			+8		
323		550			Flows		2.
324		700			+10		
325		675			Flows		100.
326		600					
327		650			Flows		
328		640			do		100.
329					do		
330	4½	640	25 (?)	500 to 515, 640	+8		30.
331	3	750	22 (?)	650, 750	+3		
332	6	783	14 (?)	520 to 532, 700 to 783	+10		200.
333	4	850		630, 750, 850	+8		
334	4	560	19 (?)		Flows		
335	4½	640	25 (?)	20 560, 640	+10		30.
336	3	600		600	Flows		14.
337	3	624		624	+32		40.
338	3	700		700	Flows		34.
339	1	588		300 588	do do		Large. Small.
340		1,000		625 860 1,000	−10 Flow No flow		None. 5. None.
341	5	770	11	400 770	 +4		 35.
342	8	800	11	400 800	 +8		 38.

[a] For analysis, see table facing p. 110.

Wells and springs in Galveston County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
343	6	800	11	400 800	+8		4.
344	4½	725			Flows		70.
345	4½	912			do		70.
346	3	575		575	do		62.
347	3	590		590	do		69.
348	3	576		576	do		52.
349	8	750	17½	40 500 750	−3½	70	
350		1,261		500 700			
351	2	99			Flows		
352	6	650	41	36 to 41 619 to 640	−3		
353		550, 530			Flows		40.
354		562, 410			do		25.
355		420			do		20.
356	8	1,020		700 to 730 935 to 1,020 *a*	do do		
357	4	525					
358	4	750		525, 750	Flows		
359	4½	580	12	580	+5		
360	11⅝	910		294, 363 427, 477 597, 649 827 to 843 *b*	+3	1,500	200.
361	10	900		770 to 900			

No.	Source of supply.	Quality.	Remarks.
222	Lissie	Brackish	The water from the 1,346 reservoir is inferior to that in the 840-foot reservoir.
223	do	do	
224	do	do	
225	do	do	
226	do	do	
227	do	do	
228	do	do	
229	do	do	
230	do	do	
231	do	do	
232	do	do	
233	do	do	
234	do	do	
235	do do do Marine Miocene do do do do	do	Galveston deep well; begun, Apr. 14, 1891; completed, August, 1892.
236	Lissie	Brackish *a*	Formerly used in the company's boilers.
237	Beaumont	Fair	The water from this well (No. 1) is the best on the island and has been used for steaming.
238	do	do	No. 2 well; water same as in well No. 237.
239	Lissie	Brackish	No. 3 well.
240	do	do	Used formerly for steaming.
241	do	Alkaline-saline *a*	No. 1 well; water formerly used in boilers and in manufacturing ice. Well has nearly ceased to flow.
242	do	Brackish	No. 2 well; water formerly used in boilers.
243	do	do	Three wells, not more than 100 feet apart, which interfere with each other's flow. No. 1 has nearly ceased to flow, owing probably to clogging of strainer. Water was formerly used in company's boilers and in manufacturing ice. A boiler using water from wells Nos. 1 and 2 was found to be in good condition by H. E. Stringfellow, inspector for the insurance company, after four years' use.

a For analysis, see table facing p. 110.

Wells and springs in Galveston County, Tex.—Continued.

No.	Source of supply.	Quality.	Remarks.
244	Lissie	Brackish [a]	Temperature, 83° F. Not suitable for locomotive boilers; formerly used by the Heidenheimer oil mill for steaming. From same stratum as Galveston city wells.
245	Beaumont Lissie ....do	Salty [a]	Water formerly used in boilers by mixing $\frac{1}{4}$ artesian and $\frac{3}{4}$ condensed water before being fed to the boiler.
246	....do	Brackish [a]	Temperature, 83° F. Water not well suited for boilers.
247	....do	....do	Temperature, 84° F.
249	....do	....do.[a]	Temperature, 80° F.; two wells.
250			Oil test well.
251	Lissie	Good	Well No. 26.
252	....do	....do	Well No. 24.
253	....do	....do	Well No. 22.
254	....do	....do	Well No. 20.
255	....do	....do	Well No. 18.
256	....do	....do	Well No. 16.
257	....do	....do	Well No. 14.
258	....do	....do	Well No. 12.
259	....do	....do	Well No. 10.
260	....do	Alkaline-saline [a]	Well No. 8.
261	....do	Good	Well No. 6.
262	Beaumont ....do Lissie	....do	Well No. 4.
263	Beaumont ....do Lissie	....do	Well No. 2.
264	....do	....do	Well No. 1.
265	....do	....do	Well No. 3.
266	....do	....do	Well No. 5.
267	....do	....do	Well No. 7.
268	....do	....do	Well No. 9.
269	....do	....do	Well No. 11.
270	....do	Alkaline-saline [a]	Well No. 13.
271	....do	Good	Well No. 15.
272	....do	Good	Well No. 17.
273	....do	....do	Well No. 19.
274	....do	....do	Well No. 21.
275	....do	....do	Well No. 23.
276	....do	....do	Well No. 25.
277	....do	....do	Well No. 27.
278	....do	....do	Well No. 29.
279	....do	....do	Well No. 31.
280	....do	....do	Well No. 33.
284	Beaumont	Soft	Temperature, 67° F.; completed, 1903.
285	....do	Good	
286	....do	....do	Two wells.
287	Lissie	....do	
288	Beaumont (?)	....do	
289	Lissie	....do	
290	....do	....do	
291	....do	....do	
292	Beaumont	....do	
293	....do	....do	
294	....do	....do	
295	....do	....do	
296	....do	....do	
297	....do	....do	
298	Lissie	Soft	Used for irrigation of truck.
299	....do		
300	....do	Soft	Supply has decreased.
301	Beaumont	Sulphur	Used for truck irrigation. Flow has decreased.
302	Lissie	Soft [a]	Completed, 1894; decreased by proximity of other wells.
306	Beaumont ....do Lissie ....do	....do	Completed, 1891; used for locomotive boilers; supply decreased by silt in strainer. Temperature, 77° F.
307	Beaumont	....do	Completed, 1889; used for truck irrigation. Temperature, 70° F.
308	Lissie	Good [a]	Used for drinking. Temperature, 70° F. About 1890 the pressure was 16 pounds to the square inch. At that time Mr. Tacquard had piped the water into his house, and it escaped from the faucet in the second story with considerable force.
309	....do	Good	
310	Beaumont		Completed, 1900.

[a] For analysis, see table facing p. 110.

Wells and springs of Galveston County, Tex.—Continued.

No.	Source of supply.	Quality.	Remarks.
311	Beaumont. Lissie.	Soft.	Completed, 1898; used for truck irrigation. Flow has decreased.
312	do.	do. [a]	Temperature, 70° F.
315	do.	Sulphur.	Used for truck irrigation.
316	do.	Soft.	Completed, 1903; used for truck irrigation.
317	do.	Good.	
318	do.	do.	
319	do.	do.	
320	do.	do.	
321	do.	do.	
322	do.	do.	
323	do.	do.	
324	do.	do.	
325	do.	do.	
326	do.	do	
327	do.	do.	
328	do.	do.	
329	do.	do.	
330	do.	Hard.	Completed, 1903; used for truck irrigation.
331	do.	Soft.	Flow has decreased; used for irrigating strawberries.
332	do.	Slightly alkaline.	Completed, 1898; used for truck irrigation.
333	do.	Soft.	Completed, 1894; used for truck irrigation; yield 60,000 gallons per day, natural flow.
334		do.	Completed, 1893; used for truck irrigation.
335	Recent (?). do.	Hard.	Completed, 1896; used for truck irrigation.
336	do.	Good [a].	Analysis corresponds very closely to that of water from 711 to 726 feet in the Gulf, Colorado & Santa Fe well at Hitchcock (No. 306) and to that from 710 feet in the J. Tacquard well, 1½ miles northwest of Hitchcock (No. 308), leading to inference that the same sand lens supplies the wells.
337	do.	do.	Used for irrigation.
338	do.	do.	
339	Beaumont. Lissie.	Good.	
340	do.	do.	Failure to develop a flowing well from the 1,000-foot reservoir was probably due to the mistake of the driller.
341	Beaumont. Lissie.	Slightly sulphur.	Completed, 1893; used for public supply and for boilers.
342	Beaumont. Lissie.	Sulphur.	Completed, 1895; supplies steamships and locomotives.
343	Beaumont. Lissie.	Sulphur.	Completed, 1895; used in boilers; flow interfered with by some obstruction.
344		Good.	
345		do.	
346	Lissie.	do.	Probably draws from stratum corresponding to 827 to 882 stratum in the Galveston deep well No. 1 well.
347	do.	do.	No. 2 well. This company owns five similar wells at this point.
348		do. [a]	Temperature, 78.5° F.
349	Beaumont. Lissie. do.		Completed, 1907; used for irrigation.
350	do.		Begun, June 25, 1907; completed, Aug. 24, 1907; drilled for oil; test developed 500 to 700 gallons of water per 24 hours.
351			Good, wholesome water.
352	Beaumont (?). Lissie.		Begun, Oct. 30 1906; completed, Dec. 15, 1906; used for locomotive boilers.
353		Good.	Two wells.
354		do.	Do.
355		do.	
356	Lissie.	Good. Alkaline-saline. [a]	
357			Formerly flowed.
358	Lissie.		Completed, 1897; used for truck irrigation.
359	do.	Soft.	Supply has decreased; used for irrigating oranges.
360	Beaumont. do. Lissie. do.	Soft [a].	Completed, 1907; used for rice irrigation. Natural flow varies.
361	do.		Completed, 1904; used for engine boilers.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

235.[1] *Section of Galveston deep well, Galveston, Tex.*

[By J. A. Singley.]

	Feet.
Pleistocene:	
Buff gray sand	0– 46
Reddish-brown clay, inclosing calcareous concretions, ferruginous sandstone, and quartz pebbles, nodules of dark-gray clay, and shell fragments	46– 63
Mottled red and blue clay, full of shell fragments. The last 16 feet of this clay is full of lignitic matter and has fewer shells	63– 100
Gray sandy clay	100– 110
Fine gray sand containing some fragments of lignite	110– 167
Buff-colored sandy clay	167– 279
Fine gray sand containing a few fragments of lignite	279– 305
Grayish-brown clay inclosing fragments of lignite	305– 315
Fine sand, varying in color from gray to ash gray and buff gray. Fragments of lignite were met with throughout this bed, and the last 35 feet were slightly micaceous	315– 440
Grayish-brown clay containing fragments of lignite, shells, coral, and fragments of the claw of a crustacean.	440– 458
Age doubtful:	
Gray sandy clay, slightly micaceous	458– 468
Brownish-gray sandy clay	468– 497
Fine light-gray clayey sand, micaceous	497– 575
Brownish-gray sandy clay	575– 592
Gray sand, micaceous	592– 612
Brownish sandy clay containing a few shell fragments	612– 647
Light-gray sandy clay	647– 674
Reddish-brown sandy clay containing finely comminuted shell fragments	674– 706
Buff-colored sand, slightly micaceous	706– 720
Brownish-gray clayey sand	720– 737
Light-gray clayey sand, the last 11 feet containing a few shell fragments and large pieces of lignite	737– 827
Coarse silver-gray sand composed of angular fragments of translucent and smoky quartz, not much waterworn. This is the water-bearing sand from which most of the city's water supply was derived previous to the sinking of the Alta Loma wells	827– 882
Buffy sandy clay	882– 893
Gray sand full of fragments of lignite and a few shells	893– 903
Brownish-clayey sand	903– 911
Indurated coarse gray quartz sand inclosing fragments of lignite and shells (too finely comminuted for determination), calcareous concretions, and small ferruginous sandstone pebbles	911– 914
Fine ash-gray micaceous sand	914– 930
Fine clayey sand, changing from brownish gray above through olive-buff to ash-gray below, micaceous throughout	930–1,032

[1] Hill, R. T., Geography and geology of the Black and Grand prairies, Texas: Twenty-first Ann. Rept. U. S. Geol. Survey, 1901, pt. 7, pp. 402–406.

	Feet.
Age doubtful—Continued.	
Sandy clay, varying buff, brownish, and greenish tints.	1,032–1,260
Coarse gray quartz sand (water-bearing sand)	1,260–1,288
Greenish-gray sandy clay	1,288–1,319
Buff-colored clay	1,319–1,330
Coarse gray sand, composed of rounded, waterworn fragments of quartz (water-bearing sand)	1,330–1,340
Greenish-gray sandy clay	1,340–1,357
Brownish clay	1,357–1,367
Ash-gray clay	1,367–1,384
Reddish-tinted coarse gray sand	1,384–1,393
Greenish sandy clay	1,393–1,410
Buff sandy clay	1,410–1,430
Greenish-gray sandy clay, the last 6 feet changing to buff color	1,430–1,448
Medium coarse sand of rounded fragments of translucent and smoky quartz; a ferruginous stain gives this sand a reddish tint	1,448–1,454
Greenish-gray sandy clay, the lower 9 feet shading into buff color	1,454–1,482
Brownish clay	1,482–1,493
Upper Tertiary:	
Greenish-gray sand, micaceous (water-bearing sand)	1,493–1,511
Laminated greenish clay, containing small rounded pebbles of ferruginous quartz and sandstone, jasper, flint, calcareous concretions, a few fragments of opalized wood, shells, lignitized wood and fruits, and fragments of claws of a crustacean	1,511–1,606
Brownish-gray sandy clay	1,606–1,628
Brownish-gray clayey sand	1,628–1,754
Cream-colored gritty calcareous conglomerate	1,754–1,758
Fine gray sand, micaceous	1,758–1,780
Olive-buff sandy clay	1,780–1,800
Fine greenish-gray sand, micaceous	1,800–1,832
Olive-buff sandy clay	1,832–1,845
Fine dark-gray sand	1,845–1,876
Brownish clay, containing fragments of lignite, calcareous concretions, and finely comminuted shell fragments	1,876–1,895
Dark-gray sand, micaceous	1,895–1,923
Greenish sandy clay, containing calcareous concretions and lignitized wood and fruits. A few broken shells were taken from between 1,879 and 1,990 feet	1,923–2,036
Fine gray clayey sand	2,036–2,060
Buff sandy clay	2,060–2,068
Greenish-gray clayey sand	2,068–2,097
Laminated greenish clay containing calcareous concretions, fragments of lignite, and shells too poorly preserved for identification	2,097–2,138
Upper Miocene:	
Fine dark-gray sand, micaceous	2,138–2,153
Greenish clay (the first 10 feet laminated) containing lignitized wood and well-preserved fruits and corals. The color markings are preserved on some of the shells from this stratum	2,153–2,196

	Feet.
Upper Miocene—Continued.	
Indurated fine gray sand	2,196 -2,220
Dark-colored clay, full of lignitized wood and fruits, corals, fish vertebræ, and shells	2,220 -2,249
Light buff-gray clayey sand	2,249 -2,288
Siliceous calcareous shell conglomerate, of a bluish-gray color and very hard, 40 hours having been taken to penetrate the 3½ feet	2,288 -2,291.5
Buff-gray clayey sand	2,291.5-2,310
Light-gray sand, micaceous	2,310 -2,323
Brownish sandy clay	2,323 -2,330
Greenish-gray clayey sand	2,330 -2,345
Medium coarse gray sand, composed of well-rounded translucent and smoky quartz fragments, micaceous (water-bearing sand)	2,345 -2,377
Greenish clay, inclosing a few comminuted shell fragments and particles of lignite	2,377 -2,387
Mottled blue and brownish clay containing calcareous concretions, rounded pebbles of ferruginous quartz, nodules of iron pyrites, fragments of lignitized wood, and shark teeth	2,387 -2,410
Laminated blue clay, containing calcareous concretions, iron pyrites, rounded calcareous and ferruginous sandstone pebbles, lignite, coral, shark teeth, and shells	2,410 -2,425
Red and greenish mottled clay, containing a few rounded pebbles of flint, iron pyrites in nodules, lignite, coral, and shells	2,425 -2,432
Buff-colored sand of rounded quartz fragments (water-bearing sand)	2,432 -2,443
Mottled brown and greenish clay with calcareous concretions, lignite, and fish vertebræ	2,443 -2,451
Lignite	2,451 -2,453
Mottled brown and greenish clay with calcareous concretions, rounded pebbles of bluish siliceous limestone, lignite, coral, fish spines and vertebræ, otoliths, and water-worn shells	2,453 -2,476
Light-gray sand (water-bearing sand)	2,476 -2,485
Dark-gray sand somewhat coarser than last	2,485 -2,504
Light buff-gray sand, micaceous (water)	2,504 -2,521
Dark-gray sand, micaceous (water)	2,521 -2,552
The last three beds are a continuation of the bed at 2,476 to 2,485 feet (water-bearing sand).	
Laminated greenish clay, with calcareous concretions, lignite, coral, fish vertebræ, otoliths, shark teeth, and shells	2,552 -2,567
Greenish-gray micaceous sand. A large number of shells were secured from this sample, but there is no doubt that many of them are from the clay immediately overlying the sand, as the clay was caving in while the pipe was penetrating the sand	2,567 -2,598
Mottled brown and greenish clay, containing a large number of shells, mostly fragmentary	2,598 -2,631

	Feet.
Upper Miocene—Continued.	
Fine ash-gray sand	2,631–2,637
Brownish sandy clay, hard, containing fish vertebræ and teeth, otoliths, corals, and shells	2,637–2,698
Buff clayey sand	2,698–2,717
Greenish clay, laminated after the first 16 feet, with calcareous concretions, cylindrical gray sandstone casts or concretions, waterworn limestone pebbles, lignite, coral, fish vertebræ, spines, and teeth, claws of a crustacean, and many well-preserved shells. Fragments of lignite with teredo borings and a well-preserved lignitized cone of one of the conifers were found in this bed. The last 60 feet changed to a bluish color	2,717–2,883
Gray sand, the grains of very uniform size of rounded translucent quartz. A few grains of smoky quartz were also found in this sand. A strong flow of water was encountered in this bed, forcing the sand for 200 feet up the pipe. The water was brackish	2,883–2,920
Gray clayey sand	2,920–2,985
Brownish sandy clay	2,985–3,025
Dark-gray sandy clay, micaceous, and containing a few fragments of lignite	3,025–3,047
Coarse gray sand of rounded translucent quartz fragments, slightly micaceous (water-bearing sand). The water is brackish, but apparently less so than that from any other well on the island	3,047–3,070

Résumé.

Pleistocene	46– 458
Doubtful	458–1,510
Upper Tertiary	1,510–2,158
Upper Miocene	2,158–2,920

250. *Section of the Atlantic & Pacific Oil Co.'s well on sec. 3, Galveston Island, Tex.*

[Furnished by William Kennedy.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
Sand and shell	0– 18
Clay	18– 28
Sand and soft mud	28– 48
Good showing of oil	48– 50
Red blue and brown clay	50– 223
Blue clay with streaks of shell showing oil	223– 306
Clay with sand	306– 386
Brown and blue clay	386– 445
Clay showing oil	445– 470
Blue clay	470– 480
Good showing of gas and oil	480– 500
Blue clay with streaks of shell	500– 648
Blue clay with streaks of sandstone	648– 690
Blue clay and sandstone; samples that look like coke or burnt coal	690– 759
Blue clay	759– 776

Upper Miocene—Continued.	Feet.
Sand showing gas and oil; would have been paying	776– 785
Hard clay with showing of hard brown sand	785– 818
Streaks of gumbo, hard drilling	818– 839
Gumbo	839– 860
Gumbo, very hard and black	860– 881
Gumbo	881– 901
Clay with sand	901– 922
Clay with brown sand	922– 970
Sand and shell	970–1,085
Clay and shell	1,085–1,120
Shell mixed with sand, white	1,120–1,199
Brownish sand	1,199–1,257
Brownish sand and clay	1,257–1,277
Sand and pebbles	1,277–1,297
Clay mixed with sand and shell	1,297–1,337
Clay and sand	1,337–1,357
Clay	1,357–1,377
Blue clay with sand	1,377–1,417
Not given	1,417–1,437
Sandy clay with shell	1,437–1,475
Clayey sand	1,475–1,499

251–280. Thirty wells (251 to 280) drilled in 1893 and 1894 in a north-south line at Alta Loma, Tex., furnish water for the city of Galveston. A. T. Dickey, city engineer of Galveston, writes:

"When drilled these wells furnished about 300,000 gallons each daily. Since that time the static head has fallen about 26 feet and the yield decreased to about 100,000 each daily. It is supposed that the great number of wells driven in this artesian reservoir for rice irrigation and other purposes has caused this lowering. Anticipating a further decrease in the static head, we are now making estimates and collecting data for the installation of a pumping plant sufficient to increase the total yield to 6,000,000 gallons daily. A test of well No. 1, with a small air compressor, nozzle 125 feet down, increased the yield from 70 gallons per minute, natural flow, to 500 gallons per minute while pumping. This test was continued five days and after the compressor was discontinued the natural flow of the well remained at 70 gallons per minute. While the test was being made the natural flow from well No. 3 was reduced about 15 per cent, and the natural flow from well No. 5 was reduced about 10 per cent. From the above test we know that an abundant supply can be had by pumping, and that the partial failure in supply is caused by the lowering of the static head, and not by any serious scarcity of water in this artesian area."

Three water horizons are encountered in the wells, one at 100 to 123 feet which does not flow, a second at 489 to 494 feet which flows, and a third at 740 to 868 feet, which formerly flowed about 28 feet above the surface but which now only flows in the lower places about a foot above the surface. Only the water from the lowest or deepest reservoir is used, the water from the other two reservoirs being cased off. The lowest water bed is 128 feet thick and was encountered in all the wells at 740 to 750 feet; but not all of the wells were bored through the water-bearing sand.

At present the wells discharge under their own pressure into a standpipe on the north side of the railroad track.

The original contract called for 33 wells, supplying 5,000,000 gallons of water every 24 hours. When 30 wells had been completed the yield was 9,000,000 gallons every 24 hours, or 4,000,000 gallons in excess of the guaranteed amount.

262.[1] *Section of well No. 4 of the Galveston city waterworks at Alta Loma, Tex.*

[Furnished by E. H. Stobard.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
Surface soil	0– 4
Clay	4– 12
Quicksand	12– 18
Very red clay	18– 25
Red quicksand	25– 35
Clay	35– 37
Quicksand	37– 40
Red and white clay	40–100
Sand, water-bearing; no flow	100–123
White clay	123–150
Red clay	150–173
Very hard red clay	173–190
Hard and soft clay	190–208
Soft red clay	208–218
Hard clay	218–230
Quicksand	230–385
Hard and soft white clay	385–435
Soft white clay	435–478
White sand and clay	478–488
Very hard shell rock	488–489
White water-bearing sand; first flow	489–494
Hard white clay	494–500
Soft white clay	500–514
Hard and soft white clay	514–560
Hard white clay	560–590
Quicksand	590–611
Hard clay	611–620
Soft clay	620–631
Hard and soft clay	631–703
Sand and clay	703–735
Hard white clay	735–740
Sand, water-bearing	740–868
Hard red clay	868

263. *Section of well No. 2 of the Galveston city waterworks at Alta Loma, Tex.*

[Taken by E. H. Stobard, September, 1894.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
No log kept	0– 60
Red and white clay	60–100
Water-bearing sand cased off	100–123
White clay	123–150
Red clay	150–173
Hard red clay	173–190
Red clay, hard and soft in places	190–208
Soft red clay	208–218
Hard white clay	218–230
Quicksand	230–385
Hard and soft white clay	385–435
Hard white clay	435–478

[1] Taylor, T. U., op. cit., pp. 28–29.

Recent deposits, Beaumont clay, and Lissie gravel—Contd.	Feet.
Sand and clay	478–488
Very hard shell	488–489
Water-bearing sand cased off	489–494
Hard white clay	494–500
Soft white clay	500–514
Hard and soft white clay	514–560
Hard white clay	560–590
Quicksand	590–611
Hard clay	611–620
Soft clay	620–631
Hard and soft clay	631–703
Sand and clay	703–735
Hard white clay	735–740
Water-bearing sand	740–768

302. A. H. Tacquard writes that about a year ago the water in the well became free of gas, and is now clear as glass; formerly it was milky looking when first drawn but soon cleared. "Gas now fills pipe and prevents a free flow, unless an escape is provided. I have never tested to see if it will burn, but it has no scent. The well seems to be failing. Several more act the same way. A few shallower ones distantly located seem to flow the same constantly. I think the reason is that the vein these draw from has not been tapped (that I know of)."

306. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well, 200 feet east of depot, at Hitchcock, Tex.*

[By J. L. Mayes, contractor.]

	Feet.
Recent:	
Soil	0 – 3
Clay	3 – 18
Surface water-bearing sand	18 – 26
Beaumont clay:	
Yellow clay	26 – 70
Fine blue sand (bottom of 9-inch outer casing)	70 –112
Firm blue clay	112 –185
Soft sandrock	185 –185. 5
Sand	185. 5 –207
Heavy red clay	207 –240
Firm sand	240 –284
Alternate clay and sand	284 –370
Dark clay	370 –408
Water-bearing sand	408 –423
Yellow joint clay	423 –483
Alternate sand and clay	483 –508
Tough sand and clay	508 –570
Blue "lignite" clay	570 –639
Sand and thin layers of clay	639 –658
Indurated clay	658 –678
Lissie gravel:	
Water-bearing sand (bottom of Wheeler well No. 312)	678 –692
Indurated clay	692 –708
Sand rock	708 –708. 75
Shells	708. 75–710. 35
Sand rock	710. 35–711. 1
Water-bearing sand (bottom of strainer)	711. 1 –726. 1
Indurated clay.	

315. *Section of well of Fred D. Lemke, three-fourths mile south of Hitchcock, Tex.*

	Feet.
Recent deposits and Beaumont clay:	
Clay	0– 39
Sand	39– 42
Not given, probably clay	42–120
Sand	120–130
Clay	130–400
Clay and sand mixed	400–440
Clay	440–500
Fine sand	500–
Blue clay	–520
Clay	520–667
Lissie gravel:	
Shell	667–670
Water-bearing sand	670–690

The water-bearing sand is the same that supplies the R. T. Wheeler well (No. 312) and that found at 678 to 692 feet in the Gulf, Colorado & Santa Fe Railway Co.'s well (No. 306) at Hitchcock.

350. *Section of well of the Algoa Townsite Co., at Algoa, Tex.*

[Furnished by E. R. Cheesborough.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
Clay and soil	0– 36
Sand	36– 50
Clay	50– 95
Caving sand	95– 100
Red clay	100– 192
Gumbo	192– 198
Rock (some stone)	198– 209
Sand, showing gas	209– 221
Rock	221– 227
Hard and soft clay	227– 240
Joint clay	240– 264
Hard clay	264– 276
Gumbo	276– 330
Clay	330– 405
Gumbo	405– 423
Sand rock	423– 440
Pack sand	440– 449
Hard sandrock	449– 453
Sand (water-bearing)	453– 498
Gumbo	498– 549
Sandrock	549– 555
Gumbo (lower part shows gas)	555– 617
Sand (water-bearing)	617– 677
Rock	677– 679
Sand	679– 693
Gravel	693– 736
Gumbo	736– 756
Clay and bowlders	756– 761
Gumbo	761– 778
Sandrock	778– 783
Shale	783– 787
Gumbo	787– 792

Recent deposits, Beaumont clay, and Lissie gravel—Contd.	Feet.
Sandrock	792- 796
Gumbo	796- 873
Gravel	873- 881
Gumbo	881- 883
Sandrock	883- 917
Hard clay	917- 927
Gumbo	927- 983
Sand	983- 996
Gumbo	996-1,004
Soft rock, showing little gas	1,004-1,010
Gravel	1,010-1,029
Gumbo	1,029-1,039
Coarse sand	1,039-1,072
Hard rock	1,072-1,075
Gumbo	1,075-1,079
Coarse sand	1,079-1,085
Gumbo	1,085-1,107
Sand, gravel, and shell	1,107-1,128
Gumbo	1,128-1,138
Sand	1,138-1,180
Gumbo	1,180-1,217
Sand	1,217-1,226
Gumbo	1,226-1,256
Rock	1,256-1,261

352. *Section of well of the St. Louis, Brownsville & Mexico Railway, at Algoa, Tex.*

[Furnished by E. C. Burgess, engineer.]

Recent deposits and Beaumont clay:	Feet.
Soil and clay	0- 36
Sand	36- 41
Clay	41-130
Shell and sand	130-139
Clay and gumbo	139-619
Lissie gravel:	
Sand (water-bearing)	619-640
Gumbo	640-648

356. *Section of the Galveston, Houston & Henderson Railroad well at League City, Tex.*

[Furnished by R. V. Brewster, resident engineer.]

Recent deposits and Beaumont clay:	Feet.
Soil	0- 8
Yellow clay	8- 100
Blue shale	100- 110
Fine sand	110- 114
Blue clay	114- 160
Sand	160- 165
Clay and gravel	165- 170
Hardpan	170- 180
Clay	180- 202
Sand	202- 210
Clay and gravel	210- 225
Clay	225- 262

	Feet.
Recent deposits and Beaumont clay—Continued.	
Fine sand	262– 285
Blue clay	285– 390
Blue sandy clay	390– 450
Lissie gravel:	
Sand	450– 470
Blue clay	470– 500
Blue sand	500– 508
Hard clay	508– 515
Clay	515– 523
Rock	523– 524
Clay	524– 645
Sandy clay	645– 690
Rock	690– 693
Clay	693– 700
Good water sand	700– 730
Clay	730– 760
Blue clay	760– 800
Blue sandy clay	800– 930
Clay and gravel	930– 935
Good coarse sand (water bearing)	935– 975
Sand and gravel (water bearing)	975–1,020

360. *Section of well of Kohfeldt & Braun, three-fourths mile northeast of Lamarque, Tex.*

[Furnished by Franz Kohfeldt.]

	Ft.	in.	Ft.	in.
Recent deposits and Beaumont clay:				
Gumbo	0	0 –	294	5
Sand	294	5 –	348	6
Clay	348	6 –	363	7
Sand	363	7 –	384	2
Clay	384	2 –	427	5
Sand	427	5 –	455	11
Clay	455	11 –	477	0
Sand	477	0 –	491	0
Clay	491	0 –	501	0
Sand	501	0 –	504	0
Clay	504	0 –	597	7
Sand	597	7 –	610	0
Clay	610	0 –	615	0
Sand	615	0 –	618	0
Clay	618	0 –	627	11
Sand	627	11 –	630	11
Clay	630	11 –	651	6
Mud sand	651	6 –	686	7
Lissie gravel:				
Clay and gumbo	686	7 –	819	1
Sand	819	1 –	821	1
Mixed clay	821	1 –	827	1
Fine sand (water bearing)	827	1 –	843	0
Rock (water bearing)	843	0 –	843	3
Sand (water bearing)	843	3 –	894	5
Mixed clay	894	5 –	908	7
Rock	908	7 –	909	3
Mixed clay	909	3 –	923	8

361. *Section of Galveston, Houston & Henderson Railroad well at Lamarque, Tex.*

[Furnished by William Kennedy.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
Soil	0- 10
Shell	10- 40
Clay	40- 50
Fine sand	50- 70
Sandy clay	70-130
Blue clay	130-574
Fine sand	574-612
Arenaceous clay	612-700
Sand	700-715
Arenaceous clay	715-725
Blue clay	725-770
Fine sand and gravel (water bearing)	770-840
Sand and gravel (water bearing)	840-900

GREGG COUNTY.

GEOLOGY AND HYDROLOGY.

Beneath Gregg County one artesian reservoir, the lower Eocene, is available. In places sands of the Wilcox formation are covered by remnants of the Mount Selman formation, but over a large portion of the county and especially in the Sabine River bottoms they form the surface, Sabine River having cut through and removed the former capping of the Mount Selman formation. The area of flowing wells, of which only two are known (Nos. 362 and 367), is confined almost entirely to the Sabine River bottoms. (See Pl. VIII, in pocket.)

The sands of the Wilcox formation are practically without dip in this county. Different beds are struck in wells at depths ranging from 100 feet above sea level to 500 feet below.

In Gregg County water from this horizon is inclined to be mineralized (see well No. 362 below), but is well adapted for drinking and for ordinary domestic use. At Longview water from a sand in this reservoir at 567 to 603 feet below the surface was not suitable for locomotive boilers.

WELL DATA.

Details of the wells appear in the following table:

Wells and springs in Gregg County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
362	Kilgore, 5 miles northeast.	J. L. Meredith survey.	John O. Buenz....	H. Dallmer......	John O. Buenz.
363	Gladewater, 2 miles east.	....	J. H. Simmons....	....	J. H. Simmons.[a]
364	Longview, ½ mile south.	A. R. Johnson headright.	Mrs. John Ware...	W. H. Todd.....	G. T. Reynolds.
365	Longview.........	Texas & Pacific right of way, 25 feet south.	R. G. Brown......	....	F. B. Brown.
366	.....do............	....	Longview Waterworks.	....	A. Deussen.
367	Longview, near International & Great Northern Railroad depot.	....	Texas & Pacific Ry. Co.	Texas & Pacific Ry. Co.	B. S. Wathen, chief engineer.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Pumps per minute.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*
362	10..............	1,999..........	283±..........	50 to 64..........	Flow..........	
				72 to 74..........	.....do........	
				338 to 750........	+12...........	
363	....	310............	....	....	No flow.......	Large.
364	8..............	1,900..........	322............	1,300..........	−10...........	
365	5-3............	585............	319............	450,580..........	Flows..........	
366	....	....	....	....	No flow.......	52.
367	10..............	603............	339............	567 to 603........	.....do.........	50 to 60.

No.	Source of supply.	Quality.	Remarks.
362	Wilcox.....................	....	Prospect well; abandoned. Water suitable for drinking; completed, 1904.
363	....	....	At Obyrnes switch.
364	Cretaceous (?).............	Soft..............	Oil test well; completed in 1903.
365	Wilcox.....................	Hard..............	Completed in 1890. Water formerly used by the ice factory; not suitable for boilers.
366	....	Good..............	Three shallow wells; public water supply. Water suitable for boilers.
367	Wilcox.....................	Hard..............	Drilled in 1892; leased to Longview Ice Co. for the manufacture of ice. Not good for locomotives.

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and eastern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 230.

DESCRIPTIVE NOTES.

362. *Section of John O. Buenz's well, 5 miles northeast of Kilgore, Tex.*

[Furnished by Mr. J. O. Buenz.]

	Ft.	in.		Ft.	in.
Sandstone	0	0	-	17	0
Lignite	17	0	-	21	4
Blue clay	21	4	-	35	4
Sandstone	35	4	-	35	8
Blue clay	35	8	-	50	8
Quicksand, water flow (soft water)	50	8	-	64	8
Lignite	64	8	-	65	8
Shale	65	8	-	66	8
Lignite	66	8	-	69	2
Shale	69	2	-	70	0
Lignite	70	0	-	72	6
Sand, water-bearing (good water)	72	6	-	74	0
Shale	74	0	-	91	0
Lignite	91	0	-	94	0
Black shale	94	0	-	128	0
Lignite	128	0	-	130	6
Clay and shale	130	6	-	329	0
Clay and soapstone	329	0	-	338	0
Sand, water-bearing (rose 12 feet above the surface in 10-inch casing)	338	0	-	610	0
Clay and sandstone, the sandstones carrying water; water cased off at the bottom of this stratum	610	0	-	750	0
Hard green rock (probably sandstone)	750	0	-	755	0
Sandstone and bowlders of "flint"	755(?)	0	-	1,999	7

The strata here penetrated, at least to 750 feet, are undoubtedly members of the Wilcox. It would seem from this depth that Cretaceous beds have been entered.

Mr. Buenz writes: "The well was drilled on land in a large bend of Sabine River. At low water coal can be seen outcropping along the river, and this led to the drilling in the expectation of finding coal. The well is about 2 miles from the river."

T. U. Taylor gives [1] a "Partial record of well 6 miles south of Longview, Gregg County." This well is almost certainly the same as the well above described. His section, which was copied from the driller's notes, gives the lower portion in much better detail, and is therefore herewith reproduced:

[1] Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 66.

Section of Buenz well, 6 miles southwest of Longview, Tex.

	Feet.
No record (see section above)	0- 285
Wilcox and Midway formations:	
Soapstone	285- 305
"Flint" (probably hard sandstone)	305- 307
Soapstone	307- 322
Shaly clay	322- 329
Sandy shale	329- 353
Clay	353- 356
Sandy shale	356- 437
Clay	437- 452
Sandy shale	452- 487
"Flint"	487- 489
Sandstone	489- 543
Lignite	543- 545
Clay	545- 551
Sand	551- 571
"Flint"	571- 574
Sandy shale	574- 710
Clay	710- 745
Sandstone	745- 756
Water-bearing sand	756- 780
Sandstone	780- 880
Clay	880- 892
Sandy shale	892-1,027
Clay	1,027-1,034
Sandy shale	1,034-1,199
"Flint"	1,199-1,200
Sandstone	1,200-1,246
Sandy shale	1,246-1,424
Cretaceous:	
Gumbo	1,424

365. *Section of R. G. Brown's well at Longview, Tex.*

[Furnished by Mr. F. B. Brown.]

	Feet.
Mount Selman formation:	
Sand and clay	0- 90
Wilcox formation:	
Lignite	90-100
Shale	100-102
Blue sand	102-252
Interstratified rock and clay	252-352
Gray water sand; water did not rise to surface; cased off	352-450
Clay (?)	450-
Water-bearing sand	-580

Water from the sand at 580 feet formed a slight incrustation when used for steaming. Mr. Brown states that it could be used in boilers. This well is not now used. Another well was put down 20 feet away to 60 feet, at which depth a hard rock, which could not be penetrated, was encountered, and the well was abandoned.

367. *Section of Texas & Pacific Railway Co.'s well at Longview, Tex.*

[Furnished by B. S. Wathen, chief engineer.]

	Feet.
Mount Selman formation:	
Clay	0- 35
"Limestone" (probably sandstone)	35- 45
Wilcox formation:	
Shale	45- 76
Sandrock	76-148
Black shale	148-156
Shale	156-200
Sandrock	200-220
Shale	220-245
Sandrock	245-269
Shale	269-345
Slate	345-370
Shale	370-480
Slate	480-491
Sandrock	491-510
Sand	510-522
Shale	522-567
Pack sand	567-603

Well drilled by company in 1892; 10-inch casing for 147 feet; 8-inch for 537 feet no casing for 66 feet. Water is not suitable for locomotives. Well is now leased to the Longview Ice Co. for manufacture of ice.

GRIMES COUNTY.

GEOLOGY AND HYDROLOGY.

In Grimes County the sands and clays of the Yegua formation, the Catahoula sandstone, the Fleming clay, and the sands of the Dewitt formation constitute the successively outcropping strata from north to south. (See Pl. I, in pocket.) Of these, the Yegua, the Catahoula, and the Dewitt constitute the available water horizons.

Lower Eocene.—In the northernmost portion of the county the lower Eocene sands are reached in wells 575 to 1,900 feet deep. Where wells have to be drilled to depths exceeding 2,000 feet to draw from this reservoir, the water will probably be unfit for use.

Yegua formation.—The sands in the Yegua formation will supply water to wells everywhere in the county, but yield flows only in the lowest portions of the valleys. (See Pl. VII, in pocket.) At Lamb Springs (well No. 378), close to Navasota River, flows were obtained from sands at 49 to 52 and at 540 feet. The water was sulphureted but was suitable for drinking.

Catahoula sandstone.—The Catahoula sandstone will supply the greater portion of the county with water. In the vicinity of Singleton the wells will necessarily be shallow, 50 to 200 feet, but they deepen toward the south and along the southern line can be completed at from 700 to 1,200 feet below sea level (about 1,000 to 1,500 feet below the surface).

At Navasota a sand belonging to the Catahoula (depth 225 to 250 feet) yields flows of potable water, and sands in the Catahoula probably supply the flowing wells at Courtney. In the southeastern portion of the county, on the lower levels, the Catahoula will probably supply flowing wells, but so far it has not been developed.

Dewitt formation.—South of a line extending through Navasota and Anderson water may be obtained from the Dewitt formation in wells varying in depth from 50 to 900 feet. Flows from these sands can probably not be secured within the limits of this county.

WELL DATA.

Details of wells in Grimes County are given in the following table:

Wells and springs in Grimes County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
368	Navasota		R. A. Sangster		T. U. Taylor.[a]
369	Navasota, ¼ mile south.		A. J. Sangster		Do.[a]
370	Navasota		Ice factory		Do.[a]
371	....do		August Horst		Do.[a]
372	Grimes County		Shumaker		Do.[a]
373	Navasota				Do.[a]
374	....do		W. H. Sauzelier		Postmaster.
375	Navasota, near		Mrs. L. J. Wilson		Do.
376	Navasota		Ice factory		J. A. Singley.[b]
377	....do		E. L. Bridge		F. E. Roesler.[c]
378	Navasota, 16 miles north.[d]	George Mason headright.	Mineral Springs Mining & Developing Co.	Gilliam	H. Freeman, secretary.
379	Navasota				R. B. Templeman.
380	Navasota, 4 miles west.				Do.
381	Navasota		R. B. Templeman.		Do.
382	Navasota, ½ mile south.				Do.
383	Navasota, 4 miles southwest.		O. M. Heard		O. M. Heard.
384	Navasota, west	Isaac Jackson League.	R. B. Templeman.		R. B. Templeman.
385	Navasota, northeast part.				Do.
386	Courtney, ½ mile		J. M. McCord	Gust Warnecke	J. M. McCord.
387	Courtney		....do	Sam Allen	Do.
388	Singleton, 300 feet northeast of post office.	Oak Street	Trinity & Brazos Valley Ry.	Layne & Bowler.	Postmaster.
389	Keith, 2 miles southwest.			....do	W. T. Schumacher.
390	Keith, 2 miles west.		W. T. Schumacher.	N. M. Bigelow	Do.
391	Keith, 3 miles southwest.			Tom Little	Do.
392	Erwin, 4½ miles northwest.	Moses Evans survey.	Simon Fuqua		Simon Fuqua.
393	Roans Prairie	William Fitzgibbon League, southeast quarter.	R. C. Pope		R. C. Pope.
394	Yarboro, ½ mile northwest.	Stephen F. Austin survey.	Mrs. F. H. Yarborough.		Mrs. F. H. Yarborough.
395	Ulmer, 300 yards, southwest.		Lake Creek Lumber Co.	Layne & Bowler.	J. W. Falvey, M. D.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 42.

[b] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 111.

[c] Hinton, R. J., Roesler, F. E., et al., A report on the preliminary investigation to determine the proper location of artesian wells within the area of the ninety-seventh meridian and east of the foothills of the Rocky Mountains: Senate Ex. Doc., 51st Cong., 1st sess., 1890, vol. 12, p. 265.

Wells and springs in Grimes County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Flow per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
368	2	300			Flows		60.
369		225			do		Many.
370	6	250			do		Do.
371		1,000					
372		101					
373		280		220 to 237			
374	2	400 (?)			Flows		
375	4	321			do		
376	2	224			do		
377		830	219	250 830	−11 0		
378	2	1,000	±200	49 to 52 540 999	+ 6 + 8 		15. Flow. Do.
379		500			−30		
380		500			Strong flow		
381		850			−30		
382		300			Strong flow		
383	3	485		485	+20		
384		520			Flows		
385		250			−30		
386	4	780			+20		40.
387	4	780			Flows		10–15.
388	8⅝	109		60	−40	100	
389		760					
390	8	1,042	300 (?)	283	−40		
391		760					
392		Spring					
393		do					
394		do					
395		150		150	No flow		

No.	Source of supply.	Quality.	Remarks.
368			
369			
370			
371			
372			
373	Catahoula	Good *a*	
374	do		In Brazos bottoms.
375	do		Do.
376		Good	
377	Catahoula Yegua (?)	 Potable	 Temperature, 80° F.
378	Yegua do Cook Mountain (?)	Sulphur, unfit for drinking. Salty, unfit for drinking.	At Lamb Springs; completed, 1890.
379			Within a few yards of well No. 385.
380			At edge of Brazos bottoms.
381		(*a*)	Supplies the city waterworks.
382			
383	Catahoula	Sulphur	
384	Catahoula (?)	(*a*)	In Brazos bottom.
385			Within a few yards of well No. 379.
386	Catahoula		
387		Iron and sulphur	
388	Catahoula	Hard	Completed, 1906.
389			
390	Yegua	Salt and sulphur	Drilled for oil; completed, 1906; water not used.
391			Drilled for oil; well No. 1 on Willis farm; completed, 1905.
392		Sulphur	Piedmont Springs; had large hotel and bath house before the Civil War.
393		do	Kellum Spring.
394		Soft	Spring.
395	Dewitt		Water used for boilers; completed, 1906.

a For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

373. *Section of well at Navasota, Tex.*

	Feet.
Soil	0– 2
Fleming clay and Catahoula sandstone:	
Clay	2– 18
Sand	18– 29
Blue clay	29– 94
Slate	94–114
Blue clay	114–216
Rock	216–220
Water sand	220–237
Blue shale	237–277
Rock	277–280

377. *Partial section of the E. L. Bridge well at Navasota, Tex.*

	Feet.
Black soil	0– 6
Fleming clay and Catahoula sandstone:	
Joint clay	6– 16
Sandstone	16– 32
Potter's clay	32– 41
Quicksand	41–121
Sandstone	121–131
Sand	131–139
Gravel	139–151
Gravel and clay	151–165
Sandstone	165–175
Clay	175–190
Sandstone and sand	190–310

Total depth, 830 feet.

378. *Partial section of the Mineral Springs Mining & Development Co.'s well on the George Mason headright, 16 miles north of Navasota, Tex.*

[Supplied by James H. Freeman, secretary.]

	Feet.
Yegua formation:	
Oily black muck	0 – 6
"Soapstone"	6 – 10
Lignite	10 – 12
Shale and "soapstone"	12 – 32
Lignite	32 – 34½
Potter's clay	34½– 36½
"Soapstone"	36½– 38½
Lignite	38½– 40½
Soapstone or shale	40½– 41½
Lignite	41½– 48½
Rock (probably sandstone), very hard	48½– 49
Brown, "umber"-appearing earth; struck slight flow to surface of mineral water	49 – 52
"Rich" lignite	52 – 62

Yegua formation—Continued.	Feet.
White sand	62 – 64
Very hard rock	64 – 64½
Blue sandstone	64½– 79½
White clay (potter's clay) (?)	79½–123½
Lignite	123½–125½
Blue sandrock	125½–142½
Clay	142½–150½
Hard sandstone	150½–153½
Clay	153½–165½
Rock	165½–168½
"Hardpan" (rock)	168½–176½
Sandstone	176½–179½
Clay	179½–187½
Rock	187½–191½
Clay	191½–194½
Rock	194½–197½
Clay	197½–206½
"Muck"	206½–225½
Gray sandrock	225½–227½
Clay	227½–247½
Sandrock	247½–251½
Soft sandrock	251½–277½
White clay	277½–297½
Sandrock	297½–301½
"Coal," having same appearance as cannel coal	301½–307½
Black "muck" or shale	307½–322½
"Soapstone"	322½–338½
Black clay	338½–351½
Soapstone	351½–361½
"Coal"	361½–363½
Sandrock	363½–365½
"Coal" (lignite)	365½–369½
Rock	369½–374
Sand and soft rock	374 –380
"Coal" (lignite)	380 –384
Rock	384 –394
Blue clay	394 –412
Rock	412 –416
Blue clay	416 –436
Sandrock	436 –437
Black clay	437 –452
"Coal" (lignite)	452 –458
Sandrock	458 –466
Blue clay	466 –484
Sandrock	484 –488
"Some white hard substance"	488 –508

The 100 feet below 508 consisted of "hard pan" and clay, alternating. At 756 feet "struck pure white marble, 6 inches thick; then 7 feet of coal, and 16 feet of porous rock." The remainder of the section is not available.

The section as far as given represents typical Yegua formation.

390. *Section of W. T. Schumacher well, 2 miles west of Keith, Tex.*

[Section taken by N. M. Bigelow, driller; furnished by W. T. Schumacher.]

	Feet.
Yegua formation:	
Clay and sand	0 - 22
Soapstone	22 - 43
Sandy clay	43 - 60
"Limestone" and some gas	60 - 64
Soapstone, sand, gas	64 - 131
Hard blue gumbo, gas and oil signs	131 - 142
Hard gray gumbo, gas and oil signs	142 - 180
Hard gray gumbo and some lignite	180 - 225
"Limestone," hard	225 - 228
Black clay	228 - 234
Hard "limestone"	234 - 259
Gumbo, hard	259 - 281
Very hard rock	281 - 283½
Brown clay with paraffin, oil, and strong black sulphur water	283½- 287
Hard limestone	287 - 309
Hard drab gumbo	309 - 320
Drab clay shale	320 - 326
Hard drab gumbo	326 - 356
Hard sandstone	356 - 360
Hard gumbo	360 - 375
Hard rock	375 - 376
Hard blue shale	376 - 420
Hard dark-blue gumbo	420 - 436
Soft sandrock	436 - 451
Hard drab gumbo	451 - 459
Hard "limestone"	459 - 469
Hard drab gumbo	469 - 488
Hard "limestone"	488 - 491
Soft "limestone"	491 - 504
Hard "limestone"	504 - 542
Hard blue shale	542 - 553
Hard "limestone"	553 - 555
Hard drab shale	555 - 570
Hard "limestone"	570 - 573
Hard drab shale, and oil signs, and some gas	573 - 592
Hard limestone	592 - 593½
Hard drab shale	593½- 671
Hard "limestone"	671 - 693
Lignite with paraffin, oil signs, and gas	693 - 694
Hard "limestone"	694 - 704
Hard drab gumbo	704 - 711
Hard "limestone"	711 - 721
Softer rock	721 - 736
Cook Mountain formation:	
Drab gumbo	736 - 743
Hard rock	743 - 755
Drab shale, oil signs, and some gas	755 - 767
Soft rock	767 - 789
Hard "lime" rock	789 - 824
Softer "lime" rock	824 - 852
Hard shale and gumbo, oil signs, and gas	852 - 894

Cook Mountain formation—Continued.	Feet.
Soft "limestone"	894 - 931
Hard "limestone"	931 - 934
Softer "limestone"	934 - 949
Hard rock	949 - 953
Hard shale	953 - 989
Hard rock	989 -1,015
Dark-drab gumbo with small shells, considerable gas at times	1,015 -1,042

HARDIN COUNTY.

GEOLOGY AND HYDROLOGY.

The Lissie gravel constitutes the outcropping formation in Hardin County (see Pl. I, in pocket) and furnishes the water to most wells. Beneath the Lissie gravel lie the Miocene beds. The Lissie gravel should preferably be depended on, for the chances for fresh water in the Miocene beds at depths exceeding 1,000 feet, even outside of the oil fields, are poor.

The railroads and the sawmills are the only important users of artesian waters in this district.

Miocene beds.—At Saratoga a sand in the Miocene at 670 to 723 feet yields a flow of salty water, probably derived originally from the underlying beds. (See Pl. IX, in pocket.)

In the oil fields the supplies are salty at comparatively shallow depths. This is noticeably true at Batson and at Sour Lake, where the water from depths exceeding 200 and 100 feet, respectively, is unfit for any use. At Saratoga, however, the waters are fresh to a depth of 500 feet and salty beneath this level.

At Batson all the waters beneath 200 feet are perceptibly saline, and even above this depth it has been difficult to obtain water suitable for use in boilers. At greater depths the water becomes increasingly briny. The larger number of wells which stopped between 800 and 900 feet found abundant salt water below their deepest oil stratum. The waters surrounding this oil field are fresh to much greater depths, indicating that a vertical circulation of salt water at this place has been made possible, probably by a fault or line of structural weakness.

At Batson fossils found at 323 and 333 feet indicate an uppermost Miocene horizon. At Saratoga, according to information furnished by E. T. Dumble, Miocene fossils have been taken from the oil-producing stratum at a depth of 1,140 to 1,154 feet. These beds are completely buried by the Lissie gravel. At Sour Lake Harris reports Jackson fossils from a depth of 1,500 feet.[1] Making no allowance for dip, which is negligible, these data would seem to indicate that but 346 feet of sediment, approximately, are involved in the Oligocene at this locality, represented by the Catahoula sandstone and Fleming clay. This is much less than these beds measure on the outcrop and would indicate that considerable erosion of the upper Oligocene beds

[1] Harris, G. D., Oil in Louisiana: Sp. Rept. Geol. Survey Louisiana No. 8, 1902, pp. 273–274.

had taken place before the Miocene beds were deposited on top of them. This is also in accordance with other evidence in this regard.

At Saratoga the artesian waters are fresh to a much greater depth than in the other Hardin County oil fields. The strong flow usually found at about 500 feet in the southwestern part of the field is always reported as fresh. Below the level of the clay zone which overlies the first important oil stratum the water is salty. The 1,400-foot sand, after yielding oil in large quantity for a few weeks, began to produce large quantities of salt water.

The 500-foot horizon that produces the fresh artesian water in the southwestern part of the field is found at increasing depths to the northwest and seems to dip in this direction. It may be, however, that there is here an artesian zone rather than an artesian stratum. The sands and gravels of stratigraphically different beds may be so arranged as to afford continuous passage for fluids, as illustrated by figure 15. (See page 156.)

Lissie gravel.—The Lissie reservoir is usually encountered at comparatively shallow depths—at 100 feet at Olive; 392 to 466 feet at Silsbee; 265 to 320 feet at Votaw; 75 to 104, 210 to 235, and 280 to 387 feet 4 miles north of Saratoga; 72 to 110 feet at Batson, and 303 to 313 feet at Saratoga. The artesian zone at Saratoga is very prolific, supplying flowing wells of fresh water. The depth to the zone increases to the northwest and flowing wells are found only in the valleys. The water supplied by all the sands is potable and is adapted to domestic and industrial use. The Silsbee water is used in locomotive boilers.

WELL DATA.

Details of the wells appear in the following table:

Wells and springs in Hardin County, Tex.

No.[a]	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
396	Batson	State land	J. M. Guffey Petroleum Co.		N. M. Fenneman.[b]
397	do		do		Do.[c]
398	do		do		Do.[d]
399	Batson, ½ mile north.		J. W. Ennis	Scott Clay	Bob Burton.[e]
400	Batson, 1½ miles northwest.	Milhouse farm	S. Private	E. C. Foster	Texas Drilling Co.[e]
401	do	Milholm farm	W. Weyant	Wm. Brown	W. Weyant.[e]
402	Batson	R. C. Duff tract	R. P. Allen & Co.	B. R. McBee	R. P. Allen & Co.[f]
403	Batson, 1¼ miles north-northwest.	Heywood lease	Crown Oil Co.		Crown Oil Co.
404	Batson, 1¼ miles north.	Wood & McRaven Lease, Paraffin tract.	do	W. C. Turnbow	Do.[f]
405	Batson, 1 mile northwest.		Texas Drilling Co.	Joe Drouot	G. H. Johnson.
406	Batson		Higgins Oil & Fuel Co.		N. M. Fenneman.[g]

a For additional data, see notes following table.
b Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, pp. 49–50.
c Idem, p. 51.
d Idem, p. 50.
e Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 162.
f Fuller, M. L., and Sanford, Samuel, op. cit., p. 160.
g Fenneman, N. M., op. cit. p. 49.

Wells and springs in Hardin County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
407	Batson		Higgins Oil & Fuel Co.		N. M. Fenneman.[a]
408		Turnbow League	Chappell		A. Deussen.
409		Sec. 376	Stribling		Do.
410	Silsbee, 1,000 yards east.		S. E. Fowler		John Fowler.
411	Silsbee, ½ mile west.		Gulf, Colorado & Santa Fe Ry.	W. J. Giles	C. F. W. Felt, chief engineer.
412	Olive, ⅛ mile northeast of post office.		Olive - Sternenberg Lumber Co.	Jake Giles	F. W. Sternenberg, jr.
413	Saratoga, 4 miles north.	Liberty School section.	Kountze		A. Deussen.
414	Saratoga				Do.
415	....do	Maria Ximenes League, J. F. Oliver tract.	Saratoga Oil & Pipe Line Co.		Wm. Kennedy.[b]
416	Saratoga, 3 miles west.	Joseph Blake tract	Libbie Oil Co		Do.[c]
417	Saratoga				A. Deussen.
418	....do				Do.
419	....do		Hardie-Robinson Co.		Do.
420	....do		....do		Do.
421	....do		....do		Do.
422	....do		Britton Oil Co	Joe Drouot	Joe Drouot.[d]
423	Saratoga ½ mile east.		Gulf, Colorado & Santa Fe Ry.	The company, F. A. Redmond, superintendent.	Gulf, Colorado & Santa Fe Ry.
424	Saratoga ¼ mile east.		....do	....do	Do.
425	Saratoga				A. Deussen.
426	....do	B. B. B. & C. R. R.			N. M. Fenneman.[e]
427	....do	....do			Do.[e]
428	Votaw, 3 miles south.		Miles Oil Co	James Countz	W. A. Spears, assistant postmaster.
429	Votaw		Gulf, Colorado & Santa Fe Ry.		T. U. Taylor.[f]
430	Sourlake, 2 miles northeast.		McShan Lumber Co.		T. J. Stevens.
431	Sourlake, 4 miles southeast.	Byrd Syndicate			G. D. Harris.[g]
432	Sourlake, back of post office.				Do.[h]
433	Sourlake, 1 mile northwest.		R. Chappell	A. H. Foster	R. Chappell.
434	Sourlake		Sourlake Oil Co		Wm. Kennedy.[i]
435	Sourlake, 300 feet north of well No. 434.		Great Western Co		Do.[j]
436	Sourlake, 3 miles northeast.	Isaac Bridges survey.	Empire State Oil, Coal & Iron Co.		Do.[k]
437	Sourlake, 2,000 feet north.	Stephen-Jackson League.	J. M. Guffey Petroleum Co.		Do.[l]
438	Sourlake		....do	McKallip Bros	N. M. Fenneman.[m]
439	....do		Higgins Oil & Fuel Co.		Do.[n]
440	....do	Shoestring district	....do		Do.[o]
441	....do		Atlantic & Pacific Oil Co.		G. D. Harris.[h]
442	....do		....do	N. Sinclair	Wm. Kennedy.[i]
443	Dies		Gulf, Colorado & Santa Fe Ry.		T. U. Taylor.[p]

[a] Fenneman, N. M., op. cit., p. 49.
[b] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, pp. 119-121.
[c] Idem, p. 59.
[d] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 162.
[e] Fenneman, N. M., op. cit., p. 62.
[f] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 48.
[g] Harris, G. D., Oil in Louisiana: Sp. Rept. Geol. Survey Louisiana No. 8, 1902, pp. 273-275.
[h] Idem, p. 274.
[i] Hayes, C. W., and Kennedy, William, op. cit., p. 117.
[j] Idem, p. 118.
[k] Idem, p. 60.
[l] Idem, p. 116.
[m] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 41.
[n] Op. cit., p. 47.
[o] Op. cit., p. 40.
[p] Taylor, T. U., op. cit., p. 47.

Wells and springs in Hardin County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths of principal water-bearing strata.	Head of water above (+) or below (−) the ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
396		1,150					
397		1,169		50 to 90, 120 to 180			
398		1,087					
399	6	1,103		60 to 480			
400	6 to 4	1,134		72 to 110	Flows		59.
401	4	1,165		100 to 150			
402	6 to 4	904					
403		483.5		64 to 105.5			
404	6	516					
405		885		98 to 190			
406				1,200			
407		1,159		970 to 985 1,080 to 1,130, 1,159			
408		1,029					
409		1,371		21 to 41 241 to 321 761 to 821			
410		Springs					
411	8	468	±98	392 to 466	−30	150	
412	8	387		30, 160 286 to 339	−75	120	
413		1,511		76 to 104 210 to 235 280 to 387 440 to 650	(?) Flows do do		
414	8 to 5.5	912					
415		995	100	78 to 173 475			
416		958	90	338 to 348 938 950	Flows		
417	10 to 4	1,412					
418	10 to 4	1,424		303 to 313	Flows		
419		1,495		145 to 210			
420		893		25 to 30 670 to 723	Flows		
421		1,037		185 to 195 766 to 770 841 to 866			
422		327					
423		1,432		410 to 535			
424		1,428		390 to 420			
425	10 to 4	1,429		333 to 381	Flows		
426		1,700					
427					Flows		145.
428	8 to 4	900		400	Flows (?)		
429		355		265 to 320	No flow		
430		2,500			+2		
431		1,915		1,900	Flows		Many.
432		1,500	43 (?)				
433		495		36 to 98			
434		1,500		900 to 960	Flows		
435		850±		850 to 880	do		Do.
436		1,284	95				
437		1,400+	90	822			
438		1,304					
439				985	Flowed		
440		1,612		560 to 585			
441	8	682					
442		725	100				
443		268		75 to 268	No flow		

Wells and springs in Hardin County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
396			Oil test well; Guffey well (State land) No. 14.
397	Lissie		Oil test well; no oil at 1,169 feet; well deepened later; Guffey well (Choate) No. 16.
398			Oil well; "water lost" at 1,087 feet; Guffey well (Wing) No. 21; completed, June 23, 1904.
399	Lissie and Miocene (?)		Oil well; completed 1905.
400	Lissie	Fresh	Oil test well (No. 1).
401	....do		Well No. 1; oil at 825 to 1,165 feet; completed 1905.
402			Oil test well; no oil; completed 1905.
403	Lissie		Oil well (No. 5).
404			Oil at 454 to 506 feet; completed 1904.
405	Lissie		Oil test well.
406	Marine Miocene	Briny	Temperature 125° F. Oil well (Higgins No. 1).
407	Miocene ....do	Salty ....do	Temperature 80° F. Temperature 101° F.; the 1,159-foot reservoir first yielded oil and then salt water. Higgins well No. 4; completed May, 1904.
408			Oil test well.
409	Lissie ....do Miocene		Do.
410		Soft	
411	Lissie	Hard *a*	Used for locomotive boilers; temperature, 80° F.; completed 1906.
412	Lissie	Soft *a*	Used in boilers; completed 1906.
413	...do ....do ....do Miocene	Fresh ....do (?) (?)	Oil test well (No. 2).
414			Oil well.
415	Lissie Miocene		Oil test well (Hook's No. 1).
416	Lissie Miocene ....do		Temperature 100° F. Temperature over 100° F.
417			Oil well; oil at 1,160 to 1,180 and 1,211 to 1,224 feet.
418	Lissie	Fresh	Oil well; oil at 1,252 to 1,290; 1,310 to 1,318, 1,319 to 1,341, 1,343 to 1,357 feet.
419	....do	....do	Oil well; Miocene fossils at 1,140 to 1,154 feet; oil at 1,140 to 1,154 feet (well No. 1).
420	....do Miocene	Fresh (?)	Oil well; oil at 852 to 893 feet (well No. 2).
421	Lissie Miocene ....do		Drilled for oil (No. 3).
422			Oil test well; bowlder stopped drilling; completed 1905.
423	Miocene		Oil well; completed 1905.
424	....do		Oil well.
425	Lissie	Good	Oil well; oil at 1,199 to 1,239, 1,306 to 1,335, 1,415 to 1,424 feet.
426		Hot sulphur	Oil test well; source of oil is below the 500-foot fresh water zone in this field.
427		Salty	Do.
428	Lissie		Oil test well; completed 1905.
429	....do	(*a*)	Used in locomotive boilers.
430		Salty	Completed 1902.
431	Catahoula	....do	
432			Jackson fossils at about 1,500 feet. Drilled for oil.
433	Lissie		Oil test well.
434	Miocene (?)	Hot sulphur	Oil well (No. 1).
435	Miocene	....do	Temperature 100° F. Oil test well. Abandoned.
436			Drilled for oil.
437	Miocene	Salty	Oil well (No. 1).
438			Oil well (Guffey No. 4).
439	Miocene (?)	Brine	Temperature 101° F.; oil well (Higgins No. 4).
440	Lissie		Oil test well (Higgins No. 8).
441			First "gusher" at Sourlake (No. 1).
442			Oil well (No. 2).
443	Lissie	(*a*)	Used in locomotive boilers.

a For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

396. *Section of J. M. Guffey Petroleum Co.'s well No. 14, on State land, Batson, Tex.*

Lissie gravel and marine Miocene beds:	Feet.
Clay	0– 45
Sand	45–100
Gumbo	100–190
Rock	190–205
Gumbo	205–270
Do	270–305
Blue shale	305–325
Gumbo	325–370
Blue shale	370–391
Gumbo	391–441
Rock	441–443
Blue shale	443–463
Gumbo	463–479
Do	479–482
Blue shale	482–500
Gumbo	500–518
Blue shale	518–548
Gumbo	548–561
Rock	561–562
Oil sand	562–572
Gumbo	572–598
Blue shale	598–618
Gumbo	618–641
Blue shale	641–668

397. *Section of J. M. Guffey Petroleum Co.'s well No. 16, at Batson, Tex.*

Lissie gravel and marine Miocene beds:	Feet.
Clay	0– 50
Water gravel	50– 90
Gumbo	90– 120
Water sand	120– 180
Shale, oil, and gas	180– 206
Rock	206– 210
Gumbo	210– 220
Rock	220– 223
Shale	223– 299
Sand	299– 317
Rock	317– 320
Sand	320– 330
Shale	330– 340
Rock	340– 345
Gumbo	345– 370
Shale	370– 390
Rock	390– 393
Gumbo	393– 430
Shale	430– 450
Gumbo	450– 465
Rock	465– 467
Shale	467– 500
Gumbo	500– 540

	Feet.
Lissie gravel and marine Miocene beds—Continued.	
Slate	540– 590
Rock	590– 593
Gumbo	593– 630
Shale	630– 655
Gumbo and bowlders	655– 680
Sand; slight showing of oil throughout	680– 735
Slate	735– 780
Gumbo	780– 800
Slate	800– 860
Rock	860– 863
Slate	863– 900
Gumbo	900–1,010
Shale	1,010–1,045
Do	1,045–1,078
Gumbo	1,078–1,120
Shale	1,120–1,148
Rock	1,148–1,150
Slate and shale	1,150–1,168
Rock	1,168–1,169

398. *Section of J. M. Guffey Petroleum Co.'s well No. 21, at Batson, Tex.*

	Feet.
Lissie gravel and marine Miocene beds:	
Red clay	0 – 40
Oil sand	40 – 60
Shale and gumbo	60 – 80
Oil sand	80 – 90
Water sand	90 – 140
Gumbo	140 – 160
Oil sand	160 – 170
Hardpan	170 – 180
Gumbo	180 – 200
Shale	200 – 220
Gumbo	220 – 310
Shale	310 – 368
Gumbo	368 – 390
Oil sand	390 – 415
Shale and soft rock	415 – 420
Hard rock	420 – 421
Shale	421 – 451
Gumbo	451 – 502
Shale	502 – 527
Gumbo	527 – 537
Shale	537 – 567
Gumbo	567 – 591
Shale	591 – 614
Rock	614 – 615
Shale	615 – 630
Gumbo	630 – 650
Shale	650 – 714
Shale and oil	714 – 739
Shale	739 – 760
Shale and oil	760 – 794
Shale	794 – 813

Lissie gravel and marine Miocene beds—Continued.	Feet.
Gumbo	813 - 830
Sand, soft rock, and gas	830 - 874
Oil, sand, oil rock, and gas	874 - 896
Shale and gumbo	896 - 918
Oil shale and rock	918 - 948
Oil sand and rock	948 - 961
Shale and rock	961 - 977
Hardpan	977 - 979
Shale with gas blow-out	979 - 995
Sand rock	995 - 998
Shale	998 -1,004
Hard sand and rock	1,004 -1,024
Oil rock and shale alternating and containing gas	1,024 -1,063
Same with gumbo; no gas	1,063 -1,082
Rock	1,082 -1,083
Shale	1,083 -1,085½
Rock; water lost and well stopped	1,085½-1,087

399. *Section of J. W. Ennis's well, ½ mile north of Batson, Tex.*

Lissie gravel and marine Miocene beds:	Feet.
Yellow and gray clay	0- 20
Gray clay	20- 40
Fine sand, with brownish-gray clay	40- 60
Fine to medium brownish-gray sand; may contain glauconite	60- 100
Same, with brownish clay	100- 160
Fine gray sand, with a little glauconite	160- 200
Gray sandy clay	200- 325
Fine to medium sand; a little glauconite	325- 420
Fine gray sandstone, sand, and clay	420- 450
Gray shale, sand, and clay	450- 480
Gray shale	480- 520
Do	520- 630
Gray shale, sand, and clay	630- 650
Same	650- 680
Do	680- 800
Gray clay, with sand	800- 900
Same	900-1,000
Greenish-gray clay	1,000-1,100
Gray clay, limestone, sandy limestone, pyrite, and fossil shells	1,100-

400. *Section of S. Private well (Milhouse farm well No. 1), 1½ miles northwest of Batson, Tex.*

Lissie gravel:	Ft. in.	Ft. in.
Sandy surface soil	0 0 -	5 0
Clay; blue-red stains	5 0 -	71 9
Sand and gravel; good supply of fresh water	71 9 -	110 3
White sand; medium	110 3 -	125 6
Soft rock; fossils	125 6 -	127 6
Blue sand, gray sand, and gravel	127 6 -	134 6
Hard rock	134 6 -	135 6

	Ft.	in.		Ft.	in.
Lissie gravel—Continued.					
Soft shale, sand, and gravel	135	6	–	172	6
Shale and sand	172	6	–	192	6
Coarse white (gray) sand; also clay and gravel.	192	6	–	208	7
Shale and sand	208	7	–	245	2
White sand	245	2	–	303	6
Gravel	303	6	–	323	5
Sand and gravel; calcareous green clay and pebbles	323	5	–	344	5
Marine Miocene beds:					
Soft shale	344	5	–	365	1
Soft blue shale; calcareous green clay	365	1	–	415	6
Rock	415	6	–	417	6
Hard blue gumbo	417	6	–	535	8
Hard rock; white	535	8	–	536	8
Soft blue gumbo	536	8	–	556	8
Hard blue gumbo	556	8	–	647	4
Blue shale; strata of rock	647	4	–	750	0
Hard shale	750	0	–	772	2
Soft sand shale and shell; oil and gas showing.	772	2	–	815	2
Hard shale, green	815	2	–	876	6
Soft sandy shale; oil showing	876	6	–	920	7
Gray sandy shale; best paying oil	920	7	–	1,080	0
Strata of rock and shale; rock very hard; some places showing oil	1,080	0	–	1,090	0
Blue sandy shale with oil sand and shell; good gas showing	1,090	0	–	1,134	0

401. *Section of W. Weyant well (Milholm farm well No. 1) 1½ miles northwest of Batson, Tex.*

	Feet.
Lissie gravel and marine Miocene beds:	
Gray sand and gumbo	0– 100
Clay and water sand	100– 150
Clay and gumbo	150– 500
Hard shale rock	500– 510
Gumbo	510– 820
Hard rock and gas	820– 825
Shale and oil	825–1,165
Gumbo	1,165–

402. *Section of R. P. Allen & Co.'s well at Batson, Tex.*

	Ft.	in.		Ft.	in.
Lissie gravel:					
Surface soil	0	0	–	2	0
Clay	2	0	–	14	0
Yellow clay and sand	14	0	–	273	10
Grayish brown sand, gumbo, and shale	273	10	–	311	9
Gumbo and shale, gray; rock	311	9	–	312	9
Sandstone and limestone	312	9	–	314	9
Gumbo and sand; rock	314	9	–	320	9
Marine Miocene beds:					
Gumbo and limestone and clay	320	9	–	328	9
Shale, marl, and gumbo	328	9	–	348	1
Gumbo and shale	348	1	–	402	4
Pink gumbo	402	4	–	500	5

Marine Miocene beds—Continued.	Ft.	in.	Ft.	in.
Shale and gumbo	500	5	595	9
Shale and limestone, brown	595	9	620	3
Rock	620	3	621	3
Gumbo, gray	621	3	630	3
Rock	630	3	632	9
Gray shale	632	9	657	1
Gray limestone and rock	657	1	661	10
Shale and limestone, grayish	661	10	701	4
Rock	701	4	702	4
Gray shale	702	4	726	0
Rock	726	0	727	0
Gray shale	727	0	743	0
Rock	743	0	746	0
Gray shale	746	0	749	0
Rock	749	0	752	0
Gray shale	752	0	761	0
Rock	761	0	763	3
Gray shale	763	3	765	6
Rock	765	6	766	4
Gumbo and soft limestone, brownish	766	4	796	0
Shale, gray, with fossil shells	796	0	815	0
Limy gray shale and gumbo	815	0	830	3
Shale	830	3	894	1
Gumbo	894	1	904	1

403. *Section of Crown Oil Co.'s well on Heywood League, 1¼ miles northwest of Batson, Tex.*

	Feet.
Lissie gravel:	
Soft gray gumbo	0 – 64
Yellow and brown water sand	64 –105.5
Soft gray gumbo	105.5–123.5
Bluish shale	123.5–158.5
Brownish oil sand	158.5–195
Gray gumbo	195 –217.5
Brownish oil sand	217.5–237.7
Bluish shale	237.7–290.2
Oil sand and shale	290.2–321.6
Marine Miocene beds:	
Gray gumbo	321.6–358.9
Oil sand and shale, brownish gray	358.9–404.2
Gumbo	404.2–446.9
Oil; brown hard rock	446.9–466.9
Gumbo	466.9–483.5

404. *Section of Crown Oil Co.'s well on Wood & McRaven lease, 1¼ miles north of Batson, Tex.*

	Feet.
Lissie gravel:	
Lower half mostly hard, gray	0–184
Oil sand; no water	184–219
Gray gumbo and shale	219–316
Oil sand, brown; no water	316–326
Marine Miocene beds:	
Gumbo and shale, gray; water cased off	326–454
Shale and oil sand	454–506
Gray gumbo	506–516

405. *Section of Texas Drilling Co.'s well, 1 mile northwest of Batson, Tex.*

	Feet.
Sandy, soft, dark brown soil	0– 4
Lissie gravel:	
Water sand, dark brown and hard	4– 35
Gumbo and water sand; greenish clay, mixed	35– 98
Gumbo and coarse water sand; greenish clay, mixed	98–190
Gumbo and hard and soft gray rock, mixed	190–354
Marine Miocene beds:	
Gumbo and shale, hard and gray; oil showing	354–446
Gumbo rock and shale, hard and gray, and quartz pebbles, mixed	446–489
Oil sand, shale, and gas; dark and soft	489–585
Shale, soft rock, pyrites, gray in color and "granite" pyrite mixed	585–707
Shale and soft gray rock, mixed	707–768
Sand, oil showing, gumbo, hard rock, mixed	768–807
Soft rock and shale, gray, mixed	807–863
Soft gray shale and gumbo mixed	863–885

406. In Higgins well No. 1, at Batson, the salt water at a depth of 1,200 feet had a temperature of 125° F., much above the normal for water from this depth. This is another evidence of vertical circulation, the hot water having probably come from far greater depths.

407. *Section of Higgins Oil & Fuel Co.'s well No. 4, at Batson, Tex.*

	Feet.
Lissie gravel:	
Mud and sand	0– 325
Marine Miocene beds:	
Oil sand and shale	325– 330
Blue shale	330– 415
Oil sand and shale	415– 430
Blue shale	430– 620
Oil sand and shale	620– 635
Shale	635– 830
Rock and sand	830– 870
Shale	870– 900
Rock	900– 901
Blue mud	901– 955
Oil sand and shale	955– 965
White mud	965– 970
Oil sand and rock; salt water, 80° F	970– 985
Blue shale	985–1,055
White rock	1,055–1,056
Blue shale	1,056–1,065
White rock	1,065–1,066
Oil sand and shale	1,066–1,081
Blue mud	1,081–1,100
Oil sand and shale	1,100–1,125
White rock	1,125–1,128
Oil sand and shale	1,128–1,130
White rock	1,130–1,132
Hard shale	1,132–1,142

Marine Miocene beds—Continued.	Feet.
White rock	1,142–1,144
Blue shale	1,144–1,146
White rock	1,146–1,147
Blue shale	1,147–1,150
White rock	1,150–1,151
Blue shale	1,151–1,158
White rock	1,158–1,159

408. *Section of Chappell well on Turnbow League, Hardin County, Tex.*

[Furnished by William Kennedy.]

Lissie gravel and marine Miocene (?) beds:	Feet.
Clay	0 – 36
Sand	36 – 98
Hard clay	98 – 112
Sand	112 – 140
Sand; brown hard clay	140 – 161
Sand	161 – 211
Gumbo	211 – 231
Coarse sand	231 – 252
Fine blue sand	252 – 271
Blue sand; gas and oil at 316	271 – 344
Gravel	344 – 349
Bowlders; gas and oil	349 – 359
Gravel	359 – 361
Sand	361 – 369
Strong gas; clay	369 – 371
Sand	371 – 399
Gumbo and shale	399 – 439
Gumbo	439 – 446
Blue shale; gas	446 – 530
Rock	530 – 536
Sand and shale	536 – 553
Flint rock	553 – 554
Shale and gumbo	554 – 570
Sand	570 – 596
Rock	596 – 596.5
Red mud	596.5– 598
Blue shale and asphalt	598 – 605
Gumbo	605 – 617
Coarse sand	617 – 643
Asphalt	643 – 644
Hard blue shale	644 – 656
Rock and shale	656 – 663
Rock	663 – 672
Rock and sand	672 – 675
Sand	675 – 704
Gravel	704 – 707
Rock	707 – 716
Soft sandstone	716 – 721
Heavy gas pressure; sand	721 – 755
Heavy gumbo	755 – 778

Lissie gravel and marine Miocene (?) beds—Continued.	Feet.
Fine blue sand	778 – 830
Soft white rock	830 – 870
Fine blue sand	870 – 889
Rock	889 – 892
Blue sand	892 – 925
Chalk	925 – 962
Rock	962 – 964
Blue shale	964 – 978
Rock gas and oil	978 –
Blue shale	–1,019
Gumbo	1,019 –1,029

409. *Section of Stribling well on sec. 376, Hardin County, Tex.*

[Furnished by William Kennedy.]

Lissie gravel and marine Miocene (?) beds:	Feet.
Sandy soil	0– 6
"Volcanic sand"	6– 8
Sandy iron clay	8– 21
Water sand	21– 41
Kaolin	41– 71
Sand	71– 111
Red clay	111– 241
Water sand	241– 321
Gumbo and red shale	321– 361
White sand	361– 381
Red shale; some gas and oil	381– 461
Brown sand	461– 621
Gumbo and brown shale	621– 761
Water sand	761– 821
Shale and gumbo	821– 861
Yellow soapstone	861– 921
Sand	921–1,121
Gravel; gas and oil (5 barrels)	1,121–1,146
Blue gumbo	1,146–1,206
White sand	1,206–1,286
Brown shale	1,286–1,336
Blue gumbo sand; show of oil	1,336–1,371

411. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Silsbee, Tex.*

Lissie gravel:	Feet.
Clay and sand	0– 88
Sand	88–288
Blue sand	288–374
Yellow clay	374–392
Water sand	392–466
Clay	466–468

The sand from 392 to 466 feet is very fine. It passes through the strainer and fills the tank. Other wells at this point have failed because the sand was pumped out, causing the well to cave. The railroad company has put down five wells. Three have failed. Consumption per month, 4,941,000 gallons.

412. *Section of Olive-Sternenberg Lumber Co.'s well at Olive, Tex.*

	Feet.
Sawdust	0– 8
Lissie gravel:	
Sand	8– 36
Yellow clay	36– 64
Sand	64–113
Blue gumbo	113–156
Sand	156–182
Blue gumbo	182–286
Water sand	286–339

413. *Section of Kountz well No. 2 on Liberty School section, 4 miles north of Saratoga, Tex.*

[Furnished by William Kennedy.]

	Feet.
Lissie gravel and marine Miocene beds:	
Yellow clay	0– 76
White water sand	76– 105
Yellow clay	105– 210
Gravel, sand (fresh artesian water)	210– 235
Dark-gray sand	235– 280
White water sand	280– 387
Sand mixed with clay	387– 440
Loose gray water sand	440– 650
White sand and gravel	650– 825
Dark sandrock and bowlders	825– 860
Dark sandrock	860– 880
Blue gumbo	880– 900
Dark-gray sand	900– 960
Dark-gray sandrock	960– 985
Sand with gumbo	985–1,147
Dark sand and gumbo	1,147–1,169
Blue gumbo and dark-gray sand	1,169–1,237
Green marl	1,237–1,265
Green marl, with strata of sandrock	1,265–1,511

414. *Section of well at Saratoga, Tex.*

[Furnished by William Kennedy.]

	Feet.
Lissie gravel and marine Miocene beds:	
Clay	0– 15
Sand	15– 25
Clay	25– 42
Clay and sand	42– 80
Sand	80– 90
Soft rock	90– 91
Hard clay	91–116
Gumbo	116–166
Rock	166–169
Gumbo	169–171
Rock	171–174
Gumbo	174–292
Soft rock	292–297

Lissie gravel and marine Miocene beds—Continued.	Feet.
Gumbo	297–308
Sand	308–402
Hard rock	402–404
Gumbo	404–408
Rock	408–409
Gumbo	409–431
Shale	431–443
Gumbo	443–454
Shale	454–475
Gumbo	475–505
Shale; oil show	505–552
Gumbo	552–563
Shale and sand; show of oil	563–572
Gumbo and shale	572–635
Gumbo soft rock	635–640
Hard gumbo	640–688
Shale	688–707
Rock	707–708
Hard gumbo	708–714
Rock	714–716
Hard gumbo	716–736
Rock	736–740
Shale	740–751
Sand; fine show of oil	751–764
Hard gumbo	764–776
Rock	776–777
Gumbo	777–784
Hard shale and rock	784–786
Hard shale and rock; oil show	786–796
Hard gumbo	796–810
Shale and sand	810–826
Hard gumbo	826–829
Shale and sand; oil show	829–833
Sand; oil show	833–838
Gumbo	838–839
Shale sand; oil show	839–851
Hard gumbo	851–854
Rock	854–859
Gumbo	859–874
Shale	874–879
Hard shale	879–903
Gumbo	903–912

415. *Section of Saratoga Oil & Pipe Line Co.'s well (Hook's well No. 1), Saratoga, Tex.*

Lissie gravel and marine Miocene beds:	Feet.
Sand	0– 78
Sand; oil and water	78–173
Hard blue and white clay	173–205
Sand and oil	205–258
White clay	258–265
Soft blue clay	265–305
Rock	305–308

Lissie gravel and marine Miocene beds—Continued.	Feet.
Sand or soft rock	308–316
Rock; with gas at 325 feet	316–325
Hard rock	325–327
Gumbo	327-335
Sandrock	335–350
Blue clay and shale	350–355
Sand cement; small stream of oil, first after 325 feet; oil shows in all formations to this depth	355–378
Gravel, becoming coarser and changing from white to black toward bottom, and gumbo	378–429
Mostly gumbo, with small layers of very hard material; but no oil	429–474
Blue clay	474–478
Sandstone, with oil of golden color; rock becomes softer and gradually turns to sand	478–484
Sand; oil flows between 478 and 488 feet	484–488
Sandstone and blue clay in thin layers	488–530
Blue clay; water from 475 and oil from 500 feet, but not in large quantities; no gas below 500 feet	530–545
Hard clay or soft rock	545–557
Hard rock	557–565
Streaks of clay and rock	565–643
Very hard rock; with some oil	643–645
Clay	645–672
Sandrock; with oil	672–680
Blue clay; with bowlders	680–781
Limerock	781–784
Blue clay	784–791
Limerock; with gas under rock	791–794
Blue clay	794–840
Hard shale; with oil	840–870
Hard shale	870–892
Shale and bowlders	892–900
Clay	900–908
Hard rock	908–915
Soft blue clay	915–920
Hard limerock	920–921
Solid rock	921–933
Soft blue shale	933–940
Limestone	940–943
Shale and loose rock	943–960
Hard rock	960–965
Oil, sand, loose rock, and shells	965–994
Rock to bottom not penetrated	994–995

416. *Section of Libby Oil Co.'s well on the Joseph Blake tract, 3 miles west of Saratoga, Tex.*

Lissie gravel:	Feet.
Brown sandy clay	0– 40
Gray sand	40– 60
Gray sand; with gas at 65 feet	60– 70
Grayish-brown sand; with gas	70– 80
Grayish-brown sand	80–135
Blue clay, with lime nodules	135–153

Lissie gravel—Continued.	Feet.
Grayish-blue sand, with lime	153–209
Grayish-white sand	209–231
Gray sand	231–270
Gray sandy clay	270–308
Gray sand	308–318
Clay	318–338
Gray rock, with artesian water and small quantities of oil immediately under the rock	338–348
Sand, with oil	348–353
Clay	353–358
Sand	358–375
Clay	375–412
Rock	412–425
Sand	425–511
Rock, in thin layers, with clay partings	511–523
Rock and sand	523–537
Sand and rock (bowlders)	537–585

417. *Section of well at Saratoga, Tex.*

[Furnished by William Kennedy.]

Lissie gravel, marine Miocene, Fleming (?) clay, and Catahoula (?) sandstone:	Feet.
Sand and clay	0– 60
Gumbo	60– 110
Shale	110– 120
Gumbo	120– 220
Shale and bowlders	220– 254
Shale and sand	254– 259
Rock	259– 261
Shale and sand	261– 325
Hard shale	325– 370
Rock	370– 372
Gumbo	372– 380
Rock	380– 382
Gumbo	382– 408
Rock	408– 409
Gumbo	409– 415
Rock	415– 417
Gumbo	417– 422
Rock	422– 424
Gumbo	424– 427
Rock	427– 428
Shale	428– 453
Rock	453– 454
Gumbo	454– 600
Shale	600– 635
Rock	635– 637
Gumbo	637– 657
Rock	657– 659
Gumbo	659– 680
Rock	680– 682
Gumbo	682– 698
Sand	698– 735

Lissie gravel, marine Miocene, Fleming clay, and Catahoula (?) sandstone—Continued.

	Feet.
Gumbo	735- 772
Shale	772- 781
Gumbo	781- 823
Rock	823- 824
Gumbo	824- 845
Sand	845- 885
Gumbo	885- 919
Shale and bowlders	919- 930
Gumbo	930- 953
Rock	953- 955
Gumbo	955- 990
Rock	990- 993
Gumbo	993-1,001
Gumbo and sand	1,001-1,025
Hard rock	1,025-1,028
Shale; oil show	1,028-1,042
Gumbo	1,042-1,090
Rock	1,090-1,091
Shale; oil show	1,091-1,106
Gumbo	1,106-1,134
Soft rock	1,134-1,140
Gumbo	1,140-1,159
Rock	1,159-1,160
Oil sand	1,160-1,180
Gumbo	1,180-1,206
Rock	1,206-1,211
Oil sand	1,211-1,224
Gumbo	1,224-1,238
Rock	1,238-1,240
Shale	1,240-1,285
Gumbo	1,285-1,300
Rock	1,300-1,303
Shale; oil show	1,303-1,348
Rock	1,348-1,353
Shale	1,353-1,368
Sandrock	1,368-1,373
Gumbo	1,373-1,383
Rock	1,383-1,392
Gumbo	1,392-1,412
Soft rock; oil show (lost mud)	1,412-

418. *Section of well at Saratoga, Tex.*

[Furnished by William Kennedy.]

Lissie gravel, marine Miocene, and Oligocene (?) beds:

	Feet.
Yellow sand and clay	0- 21
Gumbo	21- 46
Hard bowlders; blue sand	46- 63
Gumbo	63- 125
Soft shale	125- 129
Hard shale	129- 138
Rock	138- 141
Gumbo	141- 145
Rock	145- 146

Lissie gravel, marine Miocene, and Oligocene (?) beds—Con.	Feet.
Gumbo	146– 183
Shale	183– 188
Gumbo	188– 233
Shale	233– 263
Gravel	263– 266
Shell and rock	266– 271
Hard rock	271– 272
Shale	272– 279
Rock	279– 281
Sand	281– 285
Soft rock	285– 289
Sand	289– 294
Soft rock	294– 295
Gumbo	295– 295.5
Rock	295.5–296
Gumbo	296– 303
Artesian water sand	303– 313
Shale	313– 377
Hard pack sand	377– 398
Gumbo	398– 407
Rock	407– 408
Gumbo	408– 427
Rock	427– 430
Gumbo	430– 506
Rock	506– 507
Gumbo	507– 514
Rock	514– 517
Hard sand	517– 518
Rock	518– 522
Gumbo	522– 592
Sand	592– 613
Gumbo	613– 667
Shale	667– 677
Soft rock	677– 679
Gumbo	679– 700
Shale	700– 744
Rock	744– 746
Gumbo	746– 815
Hard rock	815– 818
Gumbo	818– 824
Hard rock	824– 829
Gumbo	829– 865
Shale	865– 900
Hard shale	900– 922
Gumbo	922–1,002
Rock	1,002–1,003
Oil show; sand	1,003–1,024
Rock	1,024–1,026
Gumbo	1,026–1,049
Rock	1,049–1,050
Gumbo	1,050–1,071
Rock	1,071–1,072
Gumbo	1,072–1,090

Lissie gravel, marine Miocene, and Oligocene (?) beds—Con.	Feet.
Shale, and oil show	1,090–1,108
Rock	1,108–1,111
Shale	1,111–1,129
Rock	1,129–1,131
Gumbo	1,131–1,140
Rock	1,140–1,144
Gumbo	1,144–1,160
Rock	1,160–1,161
Gumbo	1,161–1,181
Shale; good oil show	1,181–1,204
Gumbo	1,204–1,252
Shale and oil sand	1,252–1,290
Rock	1,290–1,291
Gumbo	1,291–1,301
Hard pack sand	1,301–1,308
Rock	1,308–1,310
Soft shale and oil sand	1,310–1,318
Rock	1,318–1,319
Shale and oil sand	1,319–1,341
Soft rock	1,341–1,343
Shale and oil sand	1,343–1,357
Rock	1,357–1,358
Hard shale	1,358–1,370
Hard rock	1,370–1,371
Hard shale	1,371–1,385
Gumbo	1,385–1,393
Hard rock	1,393–1,396
Hard sand	1,396–1,411
Rock	1,411–1,415
Hard sand	1,415–1,424

419. *Section of Hardie-Robinson well No. 1 at Saratoga, Tex.*

Lissie gravel, marine Miocene, and Oligocene (?) beds:	Feet.
Sand	0– 10
Gravel	10– 20
Clay	20– 30
Sand	30– 45
Clay	45– 55
Sand; slight color of oil	55– 60
Clay (?)	60– 80
Sand	80– 95
Clay	95– 145
Loose water sand	145– 210
Gumbo	210– 220
Sand	220– 258
Gumbo	258– 330
Shale	330– 339
Sand	339–
Sand and rock.	
Sand	– 373
Gumbo	373–
Rock	– 389

Lissie gravel, marine Miocene, and Oligocene (?) beds—Continued.

	Feet.
Gumbo	389 - 529
Sand; showing of oil	529 - 541
Rock	541 - 544
Gumbo	544 - 636
Rock	636 - 636.5
Gumbo	636.5- 654
Shale	654 - 670
Gumbo	670 - 742
Shale	742 - 747
Gumbo	747 - 848
Coarse white sand; some oil and gas	848 - 930
Gumbo	930 - 940
Shale; showing some oil	940 - 973
Hard gumbo	973 - 995
Hard shale	995 -1,018
Hard gumbo	1,018 -1,061
Soft shale	1,061 -1,085
Rock	1,085 -1,087
Gumbo	1,087 -1,102
Rock	1,102 -1,104
Hard gumbo	1,104 -1,140
(Miocene); sand and shell; oil and gas	1,140 -1,154
Bowlders	1,154 -1,156
Hard shale	1,156 -1,219
Soft shale	1,219 -1,224
Shale	1,224 -1,272
Soft shale and gumbo	1,272 -1,278
Hard gumbo	1,278 -1,328
Streaks of hard rock and sand; showing oil	1,328 -1,373
Gumbo	1,373 -1,433
Shale	1,433 -1,460
Gumbo	1,460 -1,495

420. *Section of Hardie-Robinson well No. 2 at Saratoga, Tex.*

Lissie gravel and marine Miocene beds:

	Feet.
Surface sand	0- 8
Yellow clay	8- 25
Fine water sand	25- 30
Gumbo	30- 92
Sand, slight oil show	92-137
Bowlders	137-143
Gumbo and bowlders	143-312
Rock	312-314
Sand	314-330
Bowlders	330-331
Soft shale	331-360
Gumbo	360-376
Rock	376-378
Gumbo	378-430
Rock	430-432
Gumbo	432-495
Rock and bowlders	495-498

Lissie gravel and marine Miocene beds—Continued.

	Feet.
Gumbo	498–500
Rock and sand; slight show of oil	500–505
Rock and bowlders	505–508
Gumbo	508–512
Rock	512–513
Hard shale	513–526
Rock	526–527
Gumbo	527–596
Rock	596–600
Hard gumbo	600–602
Fine sand	602–645
Rock	645–646
Gumbo	646–648
Fine sand	648–655
Gumbo	655–657
Fine sand	657–664
Gumbo	664–670
Coarse water sand (white)	670–723
Gumbo	723–763
Soft shale; showing gas and oil	763–800
Soft rock	800–801
Sand, showing oil	801–831
Gumbo	831–852
Rich oil-bearing sand	852–893

421. *Section of Hardie-Robinson well No. 3 at Saratoga, Tex.*

[Furnished by William Kennedy.]

Lissie gravel and Miocene beds:

	Feet.
Surface dirt	0– 15
Bowlders	15– 16
Streaks of clay sand shell	16– 40
Red clay	40– 71
Soft "limerock"	71– 75
Clay	75– 93
Soft "limerock"	93– 94
Yellow clay	94– 100
Gumbo	100– 140
Shale; showing oil	140– 165
Gumbo	165– 185
Coarse water sand	185– 195
Rock	195– 196
Gumbo	196– 325
Sand	325– 375
Gumbo	375– 400
Rock	400– 403
Gumbo	403– 411
Rock	411– 414
Gumbo	414– 458
Soft rock	458– 459
Gumbo	459– 464
Hard sandrock	464– 476
Gumbo	476– 482
Rock	482– 485

Lissie gravel and Miocene beds—Continued.	Feet.
Hard shale	485– 490
Gumbo	490– 499
"Limerock"	499– 500
Gumbo	500– 520
Soft rock	520– 528
Hard gumbo	528– 610
Soft sandrock	610– 612
Gumbo	612– 635
Soft rock	635– 638
Shale	638– 648
Gumbo	648– 680
Sand	680– 695
Red clay	695– 711
Sand; slight oil show	711– 723
Shale	723– 730
Rock	730– 731
Shale	731– 766
Water sand	766– 770
Gumbo	770– 797
Soft rock	797– 798
Shale	798– 820
Soft rock	820– 821
Soft shale	821– 824
Soft rock	824– 826
Sand	826– 840
Soft rock	840– 841
White-water sand	841– 866
Gumbo	866– 869
Rock	869– 870
Gumbo	870– 873
Soft shale	873– 882
Gumbo	882– 889
Shale	889– 906
Gumbo	906– 937
Brown shale oil	937– 951
Soft rock	951– 952
Brown shale, and streaks of sand; little oil show	952–1,037

423. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well, one-half mile east of Saratoga, Tex.*

Lissie gravel, marine Miocene, and Oligocene (?) beds:	Feet.
Surface sand	0– 10
Red clay	10– 30
Fine gray sand	30– 115
Gumbo	115– 128
Sand	128– 161
Shale	161– 184
Sand	184– 230
Gumbo	230– 270
Sand	270– 279
Gumbo	279– 338
Sand	338– 378
Soft rock	378– 380

Lissie gravel, marine Miocene and Oligocene (?) beds—Continued.

	Feet.
Gumbo	380 - 410
Sand with water	410 - 535
Gumbo	535 - 565
Sand	565 - 574
Gumbo	574 - 676
Soft gypseous gumbo	676 - 694
Gumbo with bowlders, probably concretions	694 - 701
Hard shale	701 - 717
Gumbo	717 - 856
Gravel; water worn quartz pebbles	856 - 861
Sand	861 - 863
Gumbo	863 - 874
Rock	874 - 877
Sand and gravel	877 - 883
Gravel	883 - 891
Gumbo	891 - 906
Rock; fine hard limerock	906 - 913
Gumbo, with gypsum layers	913 - 940
Gypsum rock	940 - 942
Shale	942 - 946
Rock	946 - 947
Gumbo	479 - 980
Sand	980 - 992
Gumbo	992 -1,003
Rock (hard limestone)	1,003 -1,010
Gumbo	1,010 -1,028
Gravel	1,028 -1,042
Gumbo	1,042 -1,047
Hard sandrock	1,047 -1,048
Gumbo	1,048 -1,073
Rock	1,073 -1,073.75
Rock with large quantity of selenite	1,073.75-1,078
Gravel	1,078 -1,109
Rock	1,109 -1,112
Shale	1,112 -1,122
Rock	1,122 -1,124
Shale	1,124 -1,150
Gumbo	1,150 -1,185
Gumbo and gypsum	1,185 -1,202
Gumbo and iron pyrites	1,202 -1,206
Rock	1,206 -1,209
Shale	1,209 -1,212
Soft rock	1,212 -1,216
Hard shale	1,216 -1,228
Gumbo; from 1,230 to 1,280 good showing of oil	1,228 -1,258
Shale, with two small beds of rock	1,258 -1,270
Hard rock	1,270 -1,271
Shale	1,271 -1,281
Gumbo	1,281 -1,290
Hard shale	1,290 -1,310
Very hard shale	1,310 -1,315
Shale and oil sand	1,315 -1,340

Lissie gravel, marine Miocene, and Oligocene (?) beds—Con.	Feet.
Tough gumbo	1,340–1,342
Shale and oil sand	1,342–1,350
Mixed oil sand and thin rock beds	1,350–1,387
Sand	1,387–1,430
Gumbo and rock	1,430–1,432

424. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well, one-quarter of a mile east of Saratoga, Tex.*

Lissie gravel, marine Miocene, and Oligocene (?) beds:	Feet.
Sand and clay	0– 58
Gumbo	58– 114
Sand	114– 118
Rock	118– 123
Gumbo	123– 172
Rock	172– 185
Gumbo	185– 235
Rock	235– 237
Gumbo	237– 240
Bowlders in gumbo, probably concretions of lime	240– 245
Gumbo	245– 292
Rock	292– 294
Tough gumbo	294– 390
Water sand	390– 420
Bowlders in gumbo	420– 480
Rock	480– 481
Gumbo	481– 546
Rock	546– 556
Sand	556– 561
Bowlder formation	561– 577
Gumbo	576– 584
Bowlder formation	584– 596
Rock	597– 598
Gumbo	598– 850
Hard rock	850– 855
Gumbo	855– 867
Rock and shale	867– 874
Gumbo (mistake in measurement; at this point well is 863 feet deep)	874– 888
Gumbo	863– 865
Hard gumbo	865– 867
Rock and shale	867– 874
Gumbo	874– 886
Shale	886– 900
Gumbo	900– 928
Sand; small showing of oil	928– 940
Gumbo	940– 985
Soft rock	985– 991
Tough gumbo. (Twisted bit off at this point. Fished 6 days; drilled 1 foot per day)	991–1,056
Hard rock	1,056–1,065
Gumbo	1,065–1,084
Bowlder formation	1,084–1,098
Rock	1,098–1,101
Gumbo	1,101–1,115

Lissie gravel, marine Miocene, and Oligocene (?) beds—Con.	Feet.
Blue shale	1,115–1,150
Gumbo	1,150–1,175
Blue shale	1,175–1,183
Soft rock	1,183–1,190
Rock	1,190–1,198
Shale	1,198–1,210
Rock	1,210–1,212
Shale	1,212–1,229
Gumbo	1,229–1,297
Rock, sand, and shale	1,297–1,307
Gumbo	1,307–1,318
Sand; showing of oil	1,318–1,330
Rock	1,330–1,331
Gumbo	1,331–1,342
Sand; showing of oil	1,342–1,352
Rock	1,352–1,353
Shale; showing of oil	1,353–1,356
Rock	1,356–1,358
Shale	1,358–1,368
Sand; indications of oil	1,368–1,388
Gumbo	1,388–1,392
Shale	1,392–1,423
Rock	1,423–1,428

This well came in a gusher and flowed at the rate of 70,700 barrels of oil per day. Within three days it was making a large per cent of salt water. It made a good pumping oil well.

425. *Section of well at Saratoga, Tex.*

[Furnished by William Kennedy.]

Lissie gravel, marine Miocene, and Oligocene (?) beds:	Feet.
Sandy surface soil	0– 22
Yellow clay	22– 44
Sand	44– 62
Gumbo	62– 86
Rock	86– 88
Sandrock	88– 93
Hard sand	93– 101
Gumbo	101– 162
Sand	162– 164
Soft rock	164– 170
Gumbo	170– 237
Soft rock	237– 239
Gumbo	239– 263
Sand	263– 302
Hard rock	302– 303
Sand	303– 315
Rock	315– 317
Sand	317– 321
Hard sandrock	321– 333
Water sand (artesian)	333– 381
Soft shale	381– 412
Gumbo and shell rock	412– 416
Rock	416– 419

Lissie gravel, marine Miocene, and Oligocene (?) beds—Con.	Feet.
Gumbo and shell rock	419– 425
Hard rock	425– 435
Hard shale	435– 445
Rock	445– 446
Shell rock and shale	446– 448
Soft shale	448– 456
Rock	456– 457
Soft shale	457– 466
Rock	466– 467
Soft shale	467– 483
Hard gumbo	483– 525
Gumbo and shell rock	525– 548
Rock	548– 549
Shale	549– 557
Blue gumbo	557– 632
Soft pink gumbo	632– 660
Hard blue gumbo	660– 689
Soft rock	689– 690
Blue gumbo	690– 696
Shale	696– 752
Hard gumbo	752– 770
Rock	770– 773
Gumbo	773– 777
Rock	777– 779
Gumbo	779– 791
Soft rock	791– 793
Gumbo	793– 813
Shale	813– 823
Gumbo	823– 837
Soft rock	837– 839
Shale; good oil show	839– 861
Sand; good oil show	861– 871
Shale and sand; oil show	871– 887
Gumbo	887– 898
Shale; oil show	898– 931
Soft gumbo	931– 941
Hard shale	941– 947
Hard gumbo	947– 972
Soft rock	972– 974
Shale	974– 988
Rock	988– 993
White and blue gumbo	993–1,012
Brown gumbo	1,012–1,016
Hard gumbo	1,016–1,022
Soft gumbo and rock	1,022–1,026
Hard gumbo	1,026–1,076
Rock	1,076–1,078
Gumbo	1,078–1,101
Soft sand; oil and gas show	1,101–1,137
Soft shale	1,137–1,148
Hard rock	1,148–1,149
Soft shale	1,149–1,155
Hard gumbo	1,155–1,166

Lissie gravel, marine Miocene and Oligocene (?) beds—Con.	Feet.
Hard rock	1,166–1,168
Hard gumbo	1,168–1,180
Hard gumbo and shell rock	1,180–1,199
Soft shale and sand; oil and gas	1,199–1,239
Soft shale	1,239–1,247
Hard gumbo	1,247–1,306
Hard sand; best oil show	1,306–1,335
Gumbo	1,335–1,339
Hard shale	1,339–1,355
Gumbo	1,355–1,392
Soft gumbo	1,392–1,395
Soft rock	1,395–1,397
Soft shale	1,397–1,401
Sand and shale; thin rock	1,401–1,413
Rock	1,413–1,415
Sand; oil and gas	1,415–1,422
Not given	1,422–1,424
Gumbo	1,424–1,429

429. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Votaw, Tex.*

	Feet.
Clay	0– 18
Lissie gravel:	
Sand	18–168
Coarse sand	168–203
Fine sand	203–226
Coarse sand	226–260
Clay	260–265
Open-water sand	265–320
Clay	320–354
Rock	354–355

432. G. D. Harris gives the following data concerning a deep well at Sourlake, back of the post office: "While at Sourlake, Tex., the writer found among the débris washed out from near the bottom of a 1,500-foot well a fine Jackson fauna, preserved evidently in a blue selenitic marl. The well referred to is located just back of the post office, close by one of but 900 feet in depth. Along with such fossils as *Volutilithes petrosus*, *Venericardia rotunda*, and fragments of *Pecten* and *Pinna*, we observed *Alveinus minutus*, *Eucheilodon creno-carinata*, *Corbula wailesiana*, and several undescribed Jackson species." [1]

433. *Section of R. Chappell well, 1 mile northwest of Sourlake, Tex.*

Lissie gravel:	Feet.
Clay, red and blue; medium hard	0– 36
Quartz sand, brownish to gray-white; water	36– 98
Sandy and limy clay, brown, red, and hard	98–112
Brownish white quartz sand	112–140
Sandy and limy clay, brown, red, and hard	140–161
Brownish white quartz sand	161–169
Sandy and limy clay, brown, red, and hard	169–211
Light-blue gumbo	211–231
Light-brown limy sand; hard	231–252

[1] Harris, G. D., The geology of the Mississippi embayment, with special reference to the State of Louisiana: Rept. Geol. Survey Louisiana, 1902, p. 25.

	Feet.
Lissie gravel—Continued.	
Light-brown limy sand; hard, with a little black sand and shale	252–271
Quartz and sand, light brown and blue; light gas and oil; rotten wood	271–344
Gravel and bowlders; hard; light gas and oil	344–359
Gravel	359–361
Fine quartz sand; brownish and blue	361–369
Light gumbo; gas	369–371
Fine clayey light-brown sand	371–399
Coarse sand	399–
Yellowish-brown sandy shale and soft brown limestone.	
Coarse brownish quartz sand (or fine gravel) and a little dark shale	–439
Gumbo	439–446
Brown and gray marl and sandy shale, mixed with gumbo and fine gravel	446–495

434. *Section of Sour Lake Springs Co.'s well No. 1, at Sourlake, Tex.*

	Feet.
Lissie gravel and Miocene (?) beds:	
Coarse sand	0– 90
Clay and stones	90–140
Sand	140–160
Hard clay, stone beds, and gravel	160–300
Hard clay, gumbo, strata of stones and gravel; with gas and some oil	300–556
Hard sandstone; with good show of oil and gas; 8-inch casing on hard streak, oil from which could produce about 100 barrels per day (estimated)	556–570
Blue clay and gumbo	570–614
Oil sand and conglomerate rock of all kinds from the above depth. Well flowed out all the water and commenced flowing oil through 8-inch pipe, but choked	614–630
Sand; with strong gas flow	630–680

This well is located very near the center of the Sourlake oil field and almost directly between the Guffey No. 1 (No. 437) and the Sour Lake Oil Co.'s well No. 1 (No. 434).

436. *Section of the Empire State Oil, Coal & Iron Co.'s well, 3 miles northeast of Sourlake, Isaac Bridges survey, Tex.*[1]

	Feet.
Lissie gravel and Miocene beds:	
Fine yellow sand	0– 5
Sand clay mixed	5– 15
Yellow sand	15– 65
Dark-blue clay	65– 186
Blue sand	186– 201
Green clay	201– 248
White sand	248– 330
Blue clay	330– 383
White sand	383– 409
Blue clay	409– 463
Sand and wood	463– 476
Pale-blue clay	476–1,013

[1] Hayes, C. W., and Kennedy, William, op. cit., p. 60; Fenneman, N. M., op. cit., pp. 46, 47, 120.

Lissie gravel—Continued.	Feet.
Gravel	1,013–1,020
Pale-red clay	1,020–1,036
Fragmentary rock	1,036–1,039
Blue clay	1,039–1,155
Solid rock	1,155–1,165
White sand	1,165–1,186
Blue clay	1,186–1,240
Blue clay with pyrites	1,240–1,284

At Sourlake water from wells exceeding 100 feet in depth is rarely fresh enough to drink or to use in boilers. Commonly it contains quite as much saline matter as was encountered in the Galveston deep well at 3,000 feet. At the depths where the oil wells are finished the water may be intensely briny.

Waters with temperatures much above the normal for the depths from which they come have also been encountered here.

437. *Section of Guffey well No. 1, on the Stephen Jackson League, 2,000 feet north of hotel at Sourlake, Tex.*

Lissie gravel and marine Miocene beds:	Feet.
Yellow sand	0– 40
Oil in clay	40– 50
Clay	50–150
Sand	150–275
Shale	275–279
Oil sand	279–300
Shale	300–630
Rock	630–665
Rock, shale, and gumbo	665–790
Oil sand	790–810
Gumbo	810–816
Oil sand and gas	816–822
Sand and gas	822–824
Third gas sand	824–864
Sand and oil	864–900

This section is not complete, the depth of the well being 1,400 feet.

438. *Section of J. M. Guffey Petroleum Co.'s well No. 4, at Sourlake, Tex.*

Lissie gravel:	Feet.
Surface clay	0– 20
White sand	20– 40
Gumbo	40– 60
Sand	60– 70
Gumbo	70– 109
Sand	109– 119
Gumbo	119– 133
Sand	133– 259
Gumbo	259– 302
Sand	302– 344
Shell rock	344– 345
Gumbo	345– 348
Shell rock	348– 349
Gumbo	349– 369
Sand	369– 382
Hard sand	382– 404

Marine Miocene (?) beds:	Feet.
Gumbo	404– 423
Shell rock	423– 426
Gumbo	426– 503
Shell rock	503– 504
Gumbo	504– 529
Sand	529– 546
Gumbo	546– 551
Sand	551– 574
Tough gumbo	574– 585
Shell rock. (A 6-inch pipe was remeasured and a 10-inch pipe set on the above-named shell rock, the depth being measured at 595 feet)	585– 586
Gumbo	586– 633
Sand showing oil	633– 638
Hard rock	638– 639
Gumbo	639– 657
Shell rock	657– 658
Yellow clay	658– 668
Limestone and sandrock mixed	668– 674
Red clay	674– 709
Hard shell rock	709– 710
Gumbo	710– 718
Shell rock	718– 720
Gumbo	720– 737
Limestone and iron pyrite	737– 739
Sand with small showing of oil	739– 784
Shell rock	784– 786
Gumbo	786– 795
Sand, fairly hard; small showing of oil	795– 822
Rock	822– 824
Gumbo	824– 837
Red clay	837– 856
Gumbo	856– 877
Rock with thin strata of gumbo	877– 884
Rock	884– 889
Gumbo	889– 919
Hard rock	919– 922
Gumbo with thin strata of rock	922– 947
Gumbo	947– 989
Rock	989– 990
Gumbo	990–1,007
Oil sand with good showing	1,007–1,025
Black gumbo	1,025–1,030
Blue shale with strata of rock	1,030–1,041
Blue shale	1,041–1,087
Hard blue shale	1,087–1,135
Blue shale	1,135–1,154
Gumbo	1,154–1,158
Rock	1,158–1,160
Blue shale	1,160–1,185
Lime rock	1,185–1,187
Gumbo	1,187–1,250
Iron pyrite	1,250–1,252

Marine Miocene (?) beds—Continued.	Feet.
Gumbo	1,252–1,276
Iron pyrite	1,276–1,278
Gumbo	1,278–1,304

440. *Section of Higgins well No. 8, in the Shoestring district at Sourlake, Tex.*

	Feet.
Blue and yellow mud	0– 20
White sand	20– 40
Blue mud	40– 60
White sand	60– 80
Blue mud	80– 100
White sand	100– 120
Blue mud	120– 170
Blue sand	170– 280
Blue mud	280– 310
White sand	310– 340
White rock	340– 341
Blue mud	341– 350
White sand	350– 410
Blue mud	410– 420
White rock	420– 421
White sand	421– 431
Blue mud	431– 451
White rock	451– 452
White sand	452– 465
Blue mud	465– 540
White rock	540– 542
Blue mud	542– 550
White rock	550– 552
Blue mud	552– 560
Oil and water sand	560– 585
Blue mud	585– 615
White sand	615– 655
Blue mud	655– 735
White rock	735– 737
Blue mud	737– 795
White rock	795– 796
Blue mud	796– 825
White rock	825– 826
White sand	826– 855
White rock	855– 857
Blue mud	857– 925
White rock	925– 927
Blue mud	927–1,027
White rock	1,027–1,028
Blue mud	1,028–1,035
White rock	1,035–1,036
Blue mud	1,036 1,053
White rock	1,053–1,075
Blue mud	1,075–1,078
White rock	1,078–1,079
Blue mud	1,079–1,090
White rock	1,090–1,091

	Feet.
Blue mud	1,091–1,100
White rock	1,100–1,101
Blue mud	1,101–1,105
White rock	1,105–1,106
Blue mud	1,106–1,112
White rock	1,112–1,114
Blue mud	1,114–1,117
White rock	1,117–1,118
Blue mud	1,118–1,133
White rock	1,133–1,134
Blue mud	1,134–1,160
White rock	1,160–1,161
Blue mud	1,161–1,170
White rock	1,170–1,171
Blue mud	1,171–1,174
White rock	1,174–1,175
Blue mud	1,175–1,225
White rock	1,225–1,230
Blue mud	1,230–1,255
White rock	1,255–1,260
Blue mud	1,260–1,275
Rock honeycomb?	1,275–1,290
Blue mud	1,290–1,300
White rock	1,300–1,302
Brown shale	1,302–1,360
Red gravel	1,360–1,362
Blue mud	1,362–1,378
White rock	1,378–1,379
Blue shale	1,379–1,480
Blue mud	1,480–1,525
White rock	1,525–1,526
Blue mud	1,526–1,535
White rock	1,535–1,536
Blue mud	1,536–1,558
White rock	1,558–1,559
Blue mud	1,559–1,590
White rock	1,590–1,591
Blue mud	1,591–1,604
White rock	1,604–1,605
Blue mud	1,605–1,607
White rock	1,607–1,608
Blue mud	1,608–1,612

No division of this record is possible. It includes the Lissie gravel, marine Miocene beds, the equivalents of the Fleming clay and the Catahoula sandstone, and probably also the Jackson formation.

441. *Section of Atlantic & Pacific Oil Co.'s well No. 1 at Sourlake, Hardin County, Tex.*

[Furnished by Mr. Putnam.]

	Ft.	in.	Ft.	in.
Lissie gravel and Miocene beds:				
Sand and traces of oil	0	0 –	47	0
Blue clay	47	0 –	53	0
Sand and traces of oil	53	0 –	130	0

Lissie gravel and Miocene beds—Continued.	Ft. in.	Ft. in.
Blue clay	130 0	– 186 0
Gravel, limestone, and pyrites of iron	186 0	– 188 0
Blue clay, sandstone, and pyrites of iron	188 0	– 214 10
Blue clay, hard on top, softer as drill penetrated	214 10	– 246 10
Sand	246 10	– 248 10
Blue clay and gravel; slight trace of oil	248 10	– 293 10
Mud ("gumbo")	293 10	– 337 10
Rock, apparently bowlder; showing trace of oil	337 10	– 338 10
Blue clay	338 10	– 348 10
Clay and hard shale	348 10	– 368 10
Blue clay	368 10	– 372 10
Blue clay, with 1 foot rock at 383 to 384 considerable gas, slight show of oil	372 10	– 386 0
Rock, hard limestone	386 0	– 391 0
Mud ("gumbo"); gas and oil traces	391 0	– 398 0
Blue mud	398 0	– 431 0
Clay and hard mud	431 0	– 485 0
Sandstone	485 0	– 488 0
Limestone	488 0	– 490 0
Blue clay	490 0	– 493 0
Mud ("gumbo") and gravel	493 0	– 527 0
Blue clay, resembling shale	527 0	– 562 10
Blue clay; slight gas and trace of oil	562 10	– 577 10
Blue clay, resembling soapstone; strong gas pressure and good flow of oil	577 10	– 630 0
Hard clay, resembling soapstone; very strong gas pressure and heavy flow of oil	630 0	– 635 0
Clay resembling shale; at 640 feet struck oil sand	635 0	– 640 0
Oil sand not passed through	640 0	– 682 0

This was the first well to "gush" oil at Sourlake.

442. *Condensed section of the Atlantic & Pacific Oil Co.'s well No. 2 at Sourlake, Tex.*

Lissie gravel and marine Miocene beds:	Feet.
Mostly sand with gravel and bowlders	0–170
Hard clay with beds of stones at intervals of about 6 feet; some oil in hard strata	170–450
Hard clay	450–560
Principally gumbo clay and hard limestone streaks about 5 feet thick	560–600
Blue clay and gumbo with some hard strata of limerocks and some gravel beds	600–680
Streaks of oil sand and streaks of hard clay between	680–725

443. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Dies, Tex.*

	Feet.
Soil	0– 3
Lissie gravel:	
Clay	3– 18
Dry sand	18– 66
Dark clay	66– 75
Water sand	75–268

HARRIS COUNTY.

GEOLOGY AND HYDROLOGY.

Dewitt formation.—The Dewitt formation is of great economic importance in Harris County as a source of water. (See Pl. IX.) At Houston as many as eight water-bearing sands are tapped between 137 and 1,179 feet below the surface. (See well 48 under well No. 534, p. 227.) The sands at 137 to 210, 290 to 316, 571 to 585 belong to the Lissie gravel, but the sands at 608 to 618, 687 to 705, 772 to 810, 895 to 940, and 1,137 to 1,179 belong to the Dewitt formation. (See fig. 14 and Pl. I.) All supply remarkably pure and soft water. The Dewitt formation may likewise be depended on in the northern half of the county to yield potable water at depths not exceeding 1,200 feet. In the oil fields, however, impotable water may be expected at much shallower depths. At Humble, for example, the water is fresh to 600 feet but is salt in the oil sand at 1,120 feet. At Hockley, brackish water is encountered at 750 feet. Humble and Hockley, so far as known, are the only localities in Harris County that produce brackish water at comparatively shallow depths. When occasion demands, the sands of the Dewitt formation are worthy of exploitation to depths not exceeding 1,200 feet.

Lissie gravel.—The northwestern half of Harris County is occupied by the outcrop of the Lissie gravel, which constitutes an artesian reservoir, embedded to the south beneath the relatively impervious Beaumont clay. (See Pl. I.) That the geologic conditions are ideal for artesian wells is amply demonstrated by the numerous borings that tap these sands.

In the catchment area of the reservoir the flowing wells are confined to the valleys and the lowlands. At Aldine, in the lowlands, flows are obtained at 65 feet, 240 to 280 feet, 400 feet, and greater depths. At Zimbi, near Katy, on the divide, wells 480 and 520 feet deep fail to produce flows. Where the sands are under cover the system produces flows on the uplands as well as in the valleys, as at Houston, Almeda, Harrisburg, Deepwater, Genoa, Seabrook, Laporte, and other points. (See Pl. VII.)

Most of the water derived from these sands by wells ranging in depth from 362 feet at Humble to 730 feet at Webster is potable. Much of it is very soft. (See analysis of well No. 512, table facing p. 110.) It is used in locomotive boilers at Humble, Genoa, Houston, and elsewhere; for steaming in many manufacturing plants at Houston; and for rice irrigation at Almeda, Webster, and many other places.

WELL DATA.

Details of wells in Harris County are given in the following table:

Wells and springs in Harris County, Tex.

No.[a]	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
444	Deer Park, ¾ mile south.		A. G. Howell		A. G. Howell.
445	Deer Park		P. H. West		T. U. Taylor.[b]
446	do		Galveston, Harrisburg & San Antonio Ry.		Do.[b]
447	Aldine, 3 miles north.		H. Weary	Dr. P. S. Griffith.	W. H. Drummet.
448	Aldine, ¾ mile northeast.		F. E. Markley		T. U. Taylor.[b]
449	Aldine, 4 miles southeast.		—— Kellogg		Do.[b]
450	Aldine, 5 miles northwest.		C. W. Hahl		Do.[b]
451	Aldine, 4 miles west.		do		Do.[b]
452	Barker, 1 mile south.		Irwin Boggs	Layne & Bohler	Irwin Boggs.
453	Barker, 1½ miles south.		John Wendling		Paul Wendling.
454	Barker, 2 miles south.		B. F. Smith		T. U. Taylor.[b]
455	Strong Junction				N. H. Darton.[c]
456	La Porte		Clark & Co.		T. U. Taylor.[b]
457	La Porte, Spillway Island.		Tom Jennings		Do.[b]
458	La Porte, center of town plat.				J. A. Singley.[d]
459	La Porte, shore of Galveston Bay.				Do.[d]
460	Westfield, 3 miles northeast.	Dunn farm	Turkey Creek Oil Co.	Harry A. Roberts.	Harry A. Roberts.[e]
461	Westfield		do	H. C. Roberts	Do.
462	Clodine		Meadow Brook Co.		T. U. Taylor.[f]
463	Mykawa		C. F. Smith	E. L. Wilson	E. L. Wilson.
464	Zimbi				J. A. Singley.[d]
465	do				Do.[d]
466	Strange		Galveston, Houston & Henderson R. R. (?)		T. U. Taylor.[b]
467	Hockley		Higgins Oil Co		Patillo Higgins.
468	Hockley, 1,000 feet east of well No. 467.		do		Do.
469	Hockley, 1½ miles southwest of well No. 468.		do		Do.
470	Hockley, 200 feet south of well No. 468.		do		Do.
471	Hockley, 800 feet south of well No. 468.		do		Do.
472	Hockley, 1,200 feet southeast of well No. 471.		do		Do.
473	Cypress, 1½ miles from.		D. H. Skinner		A. Deussen.
474	Cypress, near		J. A. Newton	Layne & Bowler.	Do.
475	Seabrook		Seabrook Oil Co. (?)		Do.
476	Seabrook, ¾ mile east.		Seabrook Townsite Co.	Gust Warnecke	R. H. Lanaboe.

[a] For additional data see notes following this table.
[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 25.
[c] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 148.
[d] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 107.
[e] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 162.
[f] Taylor, T. U., Rice irrigation in Texas: Bull. Univ. Texas No. 16, 1902, p. 21.

Wells and springs in Harris County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
477	Seabrook		C. H. Milby		Postmaster.
478	....do		E. A. Peden		Do.
479	....do		C. W. Ruyers		Do.
480	....do		Dr. J. M. Burrough		Do.
481	Seabrook, 3 miles northeast.		H. D. Allen		T. U. Taylor.[a]
482	Seabrook, 1¼ miles northeast.		J. G. Todd		Do.[a]
483	Seabrook, ¾ mile northeast.		Alf Palm		Do.[a]
484	Almeda		C. F. Smith		Postmaster, Almeda.
485	....do		....do		Postmaster.
486	....do		C. W. Mowery		Do.
487	....do		A. D. Yound		Do.
488	....do		J. C. Bridge		A. L. Parker, postmaster.
489	Almeda, 1½ miles north.		M. Davidson		T. U. Taylor.[a]
490	Almeda, 3½ miles east.		G. Dogg		Do.[a]
491	Almeda, 5 miles east-northeast.		John Swengel		John Swengel.
492	Erin, near		J. H. O'Donnell		T. U. Taylor.[b]
493	Katy, near		T. G. Roberts		Do.[c]
494	Deepwater		W. E. Jones		Do.[a]
495	Deepwater, 1 mile north.		....do		Do.[a]
496	Deepwater, 1¾ miles north.		....do		Do.[a]
497	Deepwater, 2 miles north.		....do		Do.[a]
498	Deepwater, 1 mile southeast.		....do		Do.[a]
499	Deepwater, 1 mile northeast.		Col. Hill		Do.[a]
500	Deepwater, 2 miles northwest.		—— Wright		Do.[a]
501	....do		L. Zlemke		Do.[a]
502	Harrisburg, ½ mile east.		C. H. Milby	Chas. Wright	C. H. Milby.
503	Harrisburg, 1 mile east.		Chas. D. Allen		T. U. Taylor.[a]
504	Harrisburg		Texas & New Orleans R. R.		Engineer maintenance of way.
505	Morgan Point		Tud Allen		T. U. Taylor.[a]
506	....do		N. A. Baker		Do.[a]
507	Wooster, 1 mile west.		Q. A. Wooster		Do.[a]
508	....do	Lynch League	Estate of T. A. Wooster.		J. Brown, postmaster.
509	Pasadena		I. L. Pitts		T. U. Taylor.[a]
510	....do		Public		Do.[a]
511	....do		H. E. Halladay		Do.[a]
511a	....do		Dr. McNyder		Do.[a]
512	Genoa		Galveston, Houston & Henderson R. R.		R. V. Brewster, resident engineer.
513	....do		City		T. U. Taylor.[a]
514	Genoa, 2 miles north.		H. Boehm		Do.[a]
515	Genoa, 2 miles south.		Sam Allen		Do.[a]
516	Genoa, 4 miles south.		....do		Do.[a]
517	Genoa		Col. Burnett		Do.[a]
518	Genoa, 1 mile south		Van Meter		Do.[a]
519	Genoa, 2½ miles southwest.			H. W. Boehm	H. W. Boehm.
520	....do	Putnam Survey	F. A. Boehm	F. A. Boehm	Do.
521	Webster		S. Saibara	Boehm	J. W. Thompson.
522	Webster, ⅛ mile east of post office.		....do	Layne & Bowler	Seito Saibara.
523	Webster 3½ miles	Thomas Choate League.	Frank Peck	....do	Frank Peck.
524	Webster, 1 mile south.		A. L. Smith		T. U. Taylor.[a]
525	Webster		H. D. T. Wilson		Do.[a]

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 25.
[b] Taylor, T. U., Rice irrigation in Texas: Bull. Univ. Texas No. 16, 1902, p. 25.
[c] Idem, p. 22.

Wells and springs in Harris County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
526	Webster, 3 miles northeast.	....	S. T. Nishimura...	....	T. U. Taylor.[a]
527	Webster, 1 mile north.	....	L. Onishi.........	....	Do.[a]
528	.....do...........	....	R. Onishi.........	....	Do.[a]
529	Webster, ¼ mile northeast.	....	J. A. Caplen.......	....	Do.[a]
530	Webster, 1 mile west.	....	R. Onishi.........	Layne & Bowler.	R. Onishi.
531	Webster, ½ mile north.	....	T. Onishi.........	.....do...........	T. Onishi.
532	Webster..........	....	Y. Konishi........	....	Postmaster.
533	Webster, 3 miles east.	....	Robert Bruce......	....	Do.
					J. A. Singley.[b]
					T. U. Taylor.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					J. A. Singley.[b]
					Do.[b]
					T. U. Taylor.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					J. A. Singley.[b]
					Do.[b]
					Do.[b]
					Do.[b]
					T. U. Taylor.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
534	Houston, 1½ miles west.	14 acres on both sides of Buffalo Bayou.	City of Houston waterworks.	....	Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					J. A. Crummy.
					T. U. Taylor.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					Do.[c]
					J. A. Singley.[b]
535	Houston, along Buffalo Bayou.	....	....	....	Do.[b]
536	Houston, 2 miles west.	....	H. E. Detering....	Carl Schulz......	Carl Schulz.
537	Houston, 4 miles east.	....	C. R. Cummings Export Co.	Gust. Warnecke..	W. C. Huff.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 25.
[b] Singley, J. A., op. cit., p. 106.
[c] Taylor, T. U., op. cit., p. 26.

Wells and springs in Harris County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
538	Houston		Magnolia Brewery Co.		T. U. Taylor.[a]
540	....do		American Brewery Co.		Do.[a]
541	....do			Gust. Warnecke	Do.[b]
542	Houston, 300 feet north of post office.	Corner Commerce and Fannin streets.	Swift & Co	....do	R. S. Womack.
543	Houston	Corner McKinney and Fannin streets.	Young Men's Christian Association.	....do	W. A. Scott, secretary.
544	....do	Corner Austin Street and Commerce Avenue.	Houston Lighting & Power Co.	....do	A. Deussen.
545	....do		Anheuser-Busch Brewing Ass'n.		J. A. Singley.[c]
546	....do		....do		Do.[c]
547	....do		....do		Do.[c]
548	....do		Houston Ice & Brewing Co.		Do.[c]
549	....do		....do		Do.[c]
550	Houston, 4 miles south.		Crystal Springs Co.		A. Deussen.
551	Houston		Aqua Pura Water Co.		
552	....do		Rice Hotel		
553	....do		First National Bank.		
554	....do		Brazos Hotel	Layne & Bowler.	Layne & Bowler.
555	Addicks	Herrera Survey	L. d'Heursel		L. d'Heursel.
556	....do		William Schulz, sr.	Carl Schulz	William Schulz, sr.
557	Addicks, 1 mile				Pat Walsh.
558	Addicks, 3 miles southwest.		Fort Smith		T. U. Taylor.[a]
559	Cedar Bayou, 1¼ miles northeast.		R. J. Tompkins	R. J. Tompkins	R. J. Tompkins.
560	Cedar Bayou		W. L. Massey	....do	W. L. Massey.
561	Cedar Bayou, 3 miles northwest.		Dr. Leon van Meldert.	Jasper Tompkins.	Dr. Leon van Meldert.
562	Cedar Bayou, 1 mile west.		M. Casey	R. J. Tompkins	M. Casey.
563	Cedar Bayou		Sol Fisher		Postmaster.
564	....do	Smith League			William Kennedy.[d]
565	Cedar Bayou, 1 mile northwest.		J. M. Brooks		J. M. Brooks.
566	Cedar Bayou, ¼ mile north.		Methodist Episcopal Church.	Collin Smith	H. W. Barkuloo.
567	Cedar Bayou, 2 miles northwest.		H. W. Barkuloo	H. W. Barkuloo	Do.
568	Humble, 2 miles northeast.		W. F. Brice & Co	Phil Audridge	T. J. Wood.[e]
569	Humble		P. M. Granberry & Co.	W. A. Young	P. M. Granberry.
570	Humble, 2 miles northeast.	Brook's farm	Coxy Oil Co	Fred Chase	T. J. Wood.[e]
571	Humble, ½ mile east of railroad station.		Westheimer Well.		N. M. Fenneman.[f]
572	Humble		Houston East & West Texas Ry.	Layne & Bowler.	I. A. Cottingham, engineer, maintenance of way.
573	Humble, 8 miles east.				William Kennedy.
574	Humble		Bender & Co.'s sawmill.		J. A. Singley.[g]
575	....do		H. F. V. Blender		T. U. Taylor.[a]
576	....do				N. H. Darton.[h]

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 25.
[b] Idem, p. 27.
[c] Singley, J. A., op. cit., p. 106.
[d] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, p. 46.
[e] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 162.
[f] Fenneman, N. M., op. cit., p. 68.
[g] Singley, J. A., op. cit., p. 107.
[h] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 148.

Wells and springs in Harris County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
444	2	325	30	325			
445		344			Flows		
446		330			do		
447	9	1,610		200 650 950	No flow (?) (?)		
448		65			Flows		
449		400			do		
450		240			do		
451		280			do		
452	9⅝	172		100–170	+4		60.
453	11⅝	155		35	Flows	800	10.
454		88			do		
455	3	450			+9		48.
456	6	440			Flows		350.
457	4	380			do		170.
458	6	440		440	do		80.
459	3	454		454	do		41.
460	8⅞ to 5⅞	831		43–62, 129–139, 151–161, 198–215, 298–312, 497–517, 520–543, 613–638, 654–684, 794–830.			
461		684					
462	10	150			−20		
463	9⅝	950	11½	600 860	(?) +2		200.
464		480			No flow	None	None.
465		520			do	do	Do.
466		450			Flows		
467		730		117	Flowed		
468		863		312 750	(?) 0		
469		545		400			
470		510					
471							
472							
473		1,800					
474		2,800			Flows		
475		1,148		40–50 382–409, 424–430, 480–488, 513–534, 542–670.	(?) Flows		
476	4	720	13 (?)	250 400, 720	+10		
477	2	400					
478	4	650					
479	4	700					
480	4	700					
481		660			Flows		
482		640			do		
483	3	670			do		70.
484	10	700					
485	9⅝	750					
486	9⅝	600					
487	9⅝	125					
488		700					
489		500			Flows		
490		450			do		
491	10	308	50 (?)	100, 300		800	
492		98+		52–98	−4		
493		130					
494		330			Flows		
495		340			do		
496		340			do		
497		340			do		
498		330			do		
499		330			do		
500		300			do		
501		300			do		
502	3	640			+15		
503		659			Flows		100.
504	6	626½		595–618			
505					Flows		

Wells and springs in Harris County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
506		440			Flows		
507		217			do		
508		217	15 (?)	100 217	+25		
509		210			Flows		
510		290			do		
511		310			do		
511a		180			do		
512	6	683.5	49.4	661–683.5			
513		600			Flows		
514		90			do		
515		250			do		
516		250			do		
517	3	700			do		
518		300			do		
519	9⅝	550			0	1,500	
520	9⅝	850	50 (?)	90 550, 820	+20		200
521	10	725		650	Flows	1,800	300
522	10	675			+18		
523	9⅝	730		300 600, 730	0		
524		570			Flows		
525		520			do		
526		475			do		
527		615			do		
528		470			do		
529		450			do		
530	10	700	45	600	+12	2,100	120
531	10	670		550	+¼	2,000	
532	10	700					
533		500			Flows		
	15	140		140	do		756
	6	140		140	do		
	6	80			do		
	15	140		140	do		
	15	140		140	do		
	15	140		140	do		
	15	140		140	do		
	6	154		154	do		175
	8	312		312	do		208
	6	328		328	do		
	6	130		130	do		
	4	328		328	do		
	8	292		292	do		
	8	292		292	do		
	8	460			do		
	6	460			do		
	8	564		564	do		140
	6	115		115	do		140
	8	493			do		126
	4	183		183	do		147
	8	314		314	do		
	8	703		703	do		
534	8	692		692	do		
	6	192		192	do		
	6	204			do		
	8	802		802	do		
	8	1,170		1,170	do		
	8	814		290–316 772–814	do		
	10	502			do		
	12	1,165		1,165	do		
	8	317		317	do		
	12	319		316	do		
	10	823			do		
	9	1,185			do		
	12	1,171		1,171	do		
	8	292		292	do		
	12	314		314	do		
	12	1,173		1,173	do		
	10	325			do		
	12	684			do		
	8	211		210	do		
	8	319			do		
	7	720			do		
	8	806		806	do		

Wells and springs in Harris County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
534	8	496			Flows		
	8	800		800	do		
	12	1,185			do		
		2,025		137–210	do		
				290–316	do		
				571–585	do		
				608–618	do		
				687–705	do		
				772–810	do		
				895–940	do		
				1,137–1,179	do		
	8	1,214			do		
	8	1,305			do		
	8	1,280			do		
	8	936		936	do		
	8	936		936	do		
	8	501			do		
	8	828			do		
	8	635			do		
	8	422			do		229.
535	6	80		80	Flows	121.	34.
536	3	124		30, 50, 85, 124	−38	40.	
537	6	500	12		+3		
538		150			Flows		35.
		300			do		209.
		200			do		104.
		500			do		249.
		500			do		250.
		500			do		490.
		800			do		
540		180			do		40.
		242			do		125.
		339			do		75.
		800			do		95.
		570			do		45.
		830			do		175.
541		2,025		154 to 161 and others.			
542	8-6	900	35	480	+2	140.	25.
543	6	500	50	500	−20	200.	
544	8	1,350		1,350	Flows		280.
545		160		160			
546		300		300			
547	5	850		850	Flows		208.
548	6	142		142	do		350.
549		158		158			
550		1,613		493–520	Flows		
				595–601			
				604–637			
				805–838			
				1,063–1,087			
				1,503–1,506			
				1,520–1,530			
551					Flows		
552		? 2,500					
553							
554		1,320	38		Flows		
555	8	300	45	40–120		1,200	
				200–250			
				300	−20		
556	3	130	85	22, 120	−6	100.	
557		85		60–85	+2		
558		180			Flows		
559	2	314	35	70	+9		22.
				314			
560	4	2,097	21	30			
				2,097	+1.75		17.
561	4	548	40	320, 545	+4		14.
562	2	516		50	+3		1.
				300, 400, 516			
563	4	300					
564		238					
565	2	345		345	+1		3.5.
566	2	285(?)	25	186	+1		42.
567	2½	320	40	80	Flowed		
				230, 287	do		
				320	do		

Wells and springs in Harris County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
568	6	1,205					
569		990		30–40			
570	4	1,140					
571		1,500		84–104, 544–545			
572		612		562½ to 586			
573				640	Flows		
574	3½	600		600	do		48.
575		500			do		
576		1,500		600–650 1,150–1,200			

No.	Source of water.	Quality.	Remarks.
444	Lissie	Iron and sulphur	Formerly flowed.
445			
446			
447	Lissie Dewitt		Drilled for oil.
448			
449			
450			
451			
452	Lissie	Hard	Used for rice irrigation; completed, 1907.
453	do	do	Used for rice irrigation; completed, 1906.
454			
455			
456			
457			
458	Lissie	Good	
459	do	do	
460	do Dewitt		Oil test well (No. 3); no oil; completed, 1905.
461			Oil test well.
462			Used for rice irrigation; 47 wells, 20 feet apart.
463	Lissie	Sulphur	Used for rice irrigation; completed, 1907.
464			At 480 feet a bed of gravel was met, and well abandoned; no water.
465			Gravel not encountered here; no water.
466			Two wells.
467	Dewitt	Sulphur	Drilled for oil (No. 1); water suitable for drinking.
468	do	Fresh Brackish	Drilled for oil (No. 2).
469	do		Drilled for oil (No. 3).
470			Drilled for oil (No. 4).
471			On Mar. 31, 1908, well was 370 feet deep (No. 5).
472			On Mar. 31, 1908, well was 630 feet deep (No. 6).
473			Oil test well.
474		Hot sulphur	Drilled for oil in 1907.
475	Recent and Beaumont Lissie	Fresh	Oil test well.
476	Beaumont Lissie	Hard sulphur	Used for public supply; completed, 1896.
477		Fresh	
478		do	
479		do	
480		do	
481		do	
482		do	
483		do	
484			
485			
486			
487			Two wells.
488			
489			
490			
491	Lissie	Hard	Used for rice irrigation.
492	do		Six wells, 50 feet apart; used for rice irrigation.
493	do		Used for rice irrigation.
494	do		
495			
496			
497			
498			
499			
500			
501			

Wells and springs in Harris County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
502		Soft	Temperature, 72° F.; completed, 1900.
503			
504	Lissie		Used in locomotive boilers.
505			
506			
507			
508	Beaumont Lissie	(?) Some sulphur	Used for garden irrigation.
509			
510			
511			
511a			
512	Lissie	See analyses Nos. 512a and 512b, table facing p. 110.	Used in boilers. Two wells.
513			
514			
515			
516			
517			
518			
519	Marine Miocene		Show of gas.
520	Beaumont Lissie	Soft	Used for rice irrigation; show of gas; completed, 1905.
521	do	do	Used for rice irrigation; completed, 1904.
522			Used for rice irrigation. Flow has decreased; completed, 1903.
523	Beaumont Lissie	 Soft	Used for rice irrigation; 18,000 gallons per day in the pump; completed, 1906.
524			
525			
526			
527			
528			
529			
530	Lissie		Used for rice irrigation; water lowered 60 feet by pumping; completed, 1907.
531	do	Soft	Used for rice irrigation; completed, 1907.
532			
533			
534	Lissie	Good	Well No. 1.
	do	do	Well No. 2.
	do	do	Well No. 3.
	do	do	Well No. 4.
	do	do	Well No. 5.
	do	do	Well No. 6.
	do	do	Well No. 7.
	do	do	Well No. 8.
	do	do	Well No. 9.
	do	do	Well No. 10.
	do	do	Well No. 11.
	do	do	Well No. 12.
	do	do	Well No. 13.
	do	do	Well No. 14.
	do	do	Well No. 15.
	do	do	Well No. 16.
	do	do	Well No. 17.
	do	do	Well No. 18.
	do	do	Well No. 19.
	do	do	Well No. 20.
	do	do	Well No. 21.
	do		Well No. 22.
	do		Well No. 23.
	do	Good	Well No. 24.
	Dewitt	do	Well No. 25.
	do	do	Well No. 26.
	do	do	Well No. 27.
	do do	do do	Well No. 28.
		do	Well No. 29.
	Dewitt	do	Well No. 30.
	Lissie	do	Well No. 31.
	do	do	Well No. 32.
		do	Well No. 33.
	Lissie	do	Well No. 34.
	Dewitt	do	Well No. 35.
	Lissie	do	Well No. 36.
	do	do	Well No. 37.
	Dewitt	do	Well No. 38.
		do	Well No. 39.
		do	Well No. 40.
	Lissie	do	Well No. 41.
		do	Well No. 42.
		do	Well No. 43.
	Dewitt	do	Well No. 44.

Wells and springs in Harris County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
534		Good	Well No. 45.
	Dewitt	do	Well No. 46.
		do	Well No. 47.
	Lissie	do	Well No. 48.
	do	do	
	do	do	
	do	do	
	do	do	
	Dewitt	do	
	do	do	
	do	do	
			Well No. 49.
			Well No. 50.
		Good	Well No. 51.
	Dewitt	do	Well No. 52.
	do	do	Well No. 53.
		do	Well No. 54.
		do	Well No. 55.
		do	Well No. 56.
		do	Well No. 57.
535	Lissie	Good	
536	do	Hard	Used for garden irrigation; completed, 1897.
537	do	Iron [a]	Completed in 1895; water used in boilers.
538			Seven wells.
540			Six wells.
541	Lissie		
542	do	Hard	Used for ice making and in boiler; temperature, 82° F. Completed, 1906.
543	do	Soft	Completed, 1907; temperature of water, 75° F.
544	Dewitt	do	Completed, 1908; water used in boilers.
545	Lissie		
546	do		
547	Dewitt	Good	The water sand consists of 12 feet of sand full of flint and quartz pebbles.
548	Lissie	do	
549	do	do	
550	Lissie	do	Oil test well.
	do	do	
	do	do	
	Marine Miocene (?)	do	
	do	do	
	Catahoula (?)	(?)	
	do	(?)	
551		Soft	
552		do	
553		do	
554		do	Completed, 1904.
555	Lissie	Soft	Used for rice irrigation.
556	do	do	Temperature, 70° F.; used for steam boilers; completed in 1906.
557	do		
558			
559	Beaumont Lissie	Soft	Used for truck irrigation; completed, 1903.
560	Recent and Beaumont Marine Miocene	do	Water hot.
561	Lissie	Sulphur	Temperature, 73° F.; used for truck irrigation; completed in 1905; saturated with hydrogen sulphide, but loses taste of gas if exposed 24 hours.
562	Beaumont Lissie	do	
563			
564			
565	Lissie	Soft	Yield 5,000 gallons per day, natural flow; completed, 1907.
566	Beaumont	do	Completed, 1907.
567	Beaumont do Lissie	 Soft	Formerly flowed 15,000 gallons in 24 hours; used for garden irrigation; completed, 1902.
568			Oil well; oil rock at 1,188-1,204 feet, pumping 500 barrels a day; completed, 1905.
569	Lissie	Sulphur, but good	Water used in boilers; oil at 950-990 feet, pumping 100 barrels per day.
570			Oil well (No. 1); gas sands at 700-800 feet; oil at 1,120 feet, flowing 250 barrels a day; completed, 1905.
571	Lissie		Oil well.
572	do		Used in boilers. Well completed, Sept. 13, 1905.
573	do	Good	
574	do	Fresh	
575			
576	Lissie Dewitt		Oil test well.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

460.[1] *Section of Turkey Creek Oil Co.'s well (well No. 3 on Dunn farm), 3 miles northeast of Westfield, Tex.*

	Feet.
Lissie gravel and Dewitt formation:	
Soft red and yellow clay and sand	0– 43
Soft white sand; water-bearing	43– 62
Soft yellow clay, solid formation	62–129
Soft white sand; water-bearing	129–139
Soft yellow clay	139–151
Soft white sand; water-bearing	151–161
Soft yellow clay	161–198
Soft white sand; water-bearing	198–215
Soft red and yellow clay, mostly red	215–296
Soft gray sandstone	296–298
Soft white sand; water-bearing	298–312
Medium-hard gray marl	312–359
Soft gray shaly sandstone	359–362
Soft gray marl	362–366
Medium-hard gray limestone	366–370
Medium-hard dark-gray marl containing much sand	370–388
Very hard dark-gray rock, called "quartzite" by driller	388–390
Medium-soft red and gray gumbo	390–410
Hard white rock	410–413
Medium-soft gray gumbo	413–422
Very hard rock	422–425
Medium-soft gray gumbo	425–440
Medium-soft gray sandstone	440–443
Medium-soft gray gumbo with intermingled sand	443–460
Medium-hard gray rock	460–462
Medium-soft gray gumbo	462–497
Soft white sand; water-bearing	497–517
Medium-hard white sandstone	517–520
Soft white sand; water-bearing	520–543
Medium-soft gray gumbo with sand	543–573
Medium-hard white sandstone	573–577
Medium-soft gray gumbo (sticky, limy clay)	577–611
Soft gray rock	611–613
Soft white to brownish sand; water-bearing	613–638
Soft white sandstone	638–641
Medium-soft gray and yellow sandy gumbo (sticky, limy clay)	641–650
Hard gray rock (fine sandstone)	650–654
Soft white limy sand; water-bearing	654–684
Medium-soft gray gumbo with sand	684–698
Soft gray limestone	698–715
Medium-soft gray gumbo or marl	715–737
Hard gray limestone	737–739
Medium-soft gray gumbo or marl	739–760
Gray limestone, top soft, bottom hard	760–772
Medium soft gray gumbo or marl with large bowlder (presumably limy concretion) from 792 to 794 feet	772–794

[1] Fuller, M. L., and Sanford, Samuel, Record for deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, pp. 276–277.

Lissie gravel and Dewitt formation—Continued.	
Soft white sand; water-bearing, with soft gray sandstone from 815 to 818 feet	Feet. 794–830
Medium-soft gray gumbo or marl	830–831

461. *Partial section of Turkey Creek Oil Co.'s well at Westfield, Tex.*

	Feet.
Lissie gravel and Dewitt formation:	
Soft red, yellow and gray, sandy limestone	577–611
Soft red, yellow and gray, clayey sandstone or clay and sand	613–638
Red, yellow and gray, limy clay with coarse sand	641–650
Gray sandstone, quartz grains fine to medium, smells of oil	650–654
Medium sand with yellow clay	654–684

464. *Section of well at Zimbi, Tex.*

	Feet.
Soil and subsoil	0– 2
Lissie gravel:	
Alternating red and yellow clays	2– 62
Sand	62–480
Gravel	480–

Another well in the same locality (No. 465) was bored to a depth of 520 feet without going through the gravel, and was abandoned. No water was found at any depth in either well.

467. In Higgins well No. 1 at Hockley a "limestone" (seen by the writer) was entered at a depth of 14 feet and continued with very little change to 730 feet, where the well was abandoned without passing through it. At 300 feet in a stratum of shale (thickness not known) shark teeth were found.

The following is an analysis of this limestone from a depth of about 14 feet by Prof. P. S. Tilson, of Houston.

Analysis of limestone from Higgins well No. 1 at Hockley, Tex.

	Feet.
Organic matter	0.04
Silica (SiO_2)	60.26
Oxides of iron and aluminum (Fe_2O_3 and Al_2O_3)	.36
Calcium oxide (CaO)	21.42
Magnesium oxide (MgO)	.55
Carbon dioxide (CO_2)	17.26
Sulphur trioxide (SO_3)	.34
Water (H_2O)	.03
	100.26

468. In the Higgins well No. 2 at Hockley a limy shale was encountered at a depth of 312 feet, and solid rock of the character found in No. 1 (No. 467) at 550 feet, which had not been penetrated at a depth of 863 feet. Brackish water from the rock between 550 to 750 feet rises just to the surface.

469. In Higgins well No. 3 at Hockley the limy shale found in well No. 2 was encountered at a depth of 312 feet and solid rock like that in Nos. 1 and 2 (Nos. 467, 468) between 438 and 545 feet. No water was found in this well beneath 400 feet. A very hard ledge, 1 foot thick, was met.

One and a half miles west of well No. 1 (No. 467) a sandstone outcrops at the surface and a few yards beyond the above-described "limestone" is found at a depth of 14 feet.

470. In Higgins well No. 4 at Hockley bowlders (perhaps concretions) were encountered at a depth of 16 feet and solid rock like in Nos. 1, 2, and 3 at 400 feet.

471. In Higgins well No. 5 at Hockley the solid rock described above was struck at 338 feet.

472. In Higgins well No. 6 bowlders in shale (probably concretions) were encountered. At the time of writing well is in progress. In none of the wells put down by the Higgins Co. at Hockley has the bottom of the solid rock described been reached.

The varying depths at which the solid rock described above is encountered in the different wells, at 14 feet in No. 1 and at 500 feet, 1,000 feet east, in No. 2, is probably not to be ascribed to abnormal dips. The solidification by cementation with lime carbonate is of secondary origin, and may affect stratigraphically different beds. The zones of solidification are the work of ground waters, perhaps ascending under artesian pressure along sandy zones or possibly also fissure or fault lines and are independent of the sand lenses, and thus appear to have dips reverse to the normal southeast dip of the beds.

475. *Section of Seabrook Oil Co.'s (?) well at Seabrook, Tex.*

[Furnished by William Kennedy.]

	Feet.
Beaumont clay:	
Red clay	0– 40
Water sand	40– 50
Red clay	50– 66
Rock	66– 74
Bluish sand	74– 86
Rocky shell	86– 98
Red clay	98– 168
Solid shell	168– 170
Red and blue clay	170– 255
Blue sand	255– 270
Red and blue clay shell	270– 310
Blue gumbo	310– 382
Lissie gravel:	
Water sand	382– 409
Gumbo	409– 424
Water sand	424– 430
Gumbo	430– 480
Water sand	480– 488
Gumbo	488– 513
Water sand	513– 534
Gumbo	534– 542
Water, sand, and gravel shell	542– 670
Blue gumbo	670– 681
Sand	681– 685
Gumbo	685– 703
Sand	703– 723
Gumbo	723– 768
Sand	768– 778
Gumbo	778– 787
Blue sand	787– 806
Gumbo	806– 826
Sand and shell	826– 848
Gumbo	848– 858

	Feet.
Lissie gravel—Continued.	
Sand and shell	858– 909
Limerock	909– 914
Gumbo	914– 929
Shell and pyrites; gas	929– 952
Gumbo	952– 976
Soft clay and shell	976–1,006
Blue sand and shell	1,006–1,058
Clay and shell	1,058–1,073
Soft rock	1,073–1,075
Clay and shell	1,075–1,110
Sand and shell with gas	1,110–1,146
Rock	1,146–1,148

491. Mr. John Swengel writes concerning the ground-water conditions at Almeda as follows:

"This vicinity is level prairie with a black, sticky soil. On the higher ridges the soil is sandy. This soil is underlain with red clay and blue clay [Beaumont clay], there being no rock or gravel. A stratum of sand is met at 50 to 60 feet, usually about 20 to 25 feet thick. This sand is water bearing, and a 10-inch well will pump about 400 gallons per minute. At about 275 feet another water-bearing sand stratum is reached, which will yield about the same amount of water as the one above. [Sand is in the Lissie reservoir.] At about 600 feet another water-bearing sand stratum is encountered [Lissie reservoir] which will yield more than twice as much water as either of the above. Near 900 feet another water-bearing sand is met [Lissie] which will yield about the same amount of water as the one at 600 feet. The water from each of these strata is used for irrigating rice. These wells cost complete about $4 per foot. All the water is warm; I do not know the exact temperature."

502. C. H. Milby, of Harrisburg writes: "Many years ago I discovered artesian water here by boring with a common wood auger. It took many months to finish the well. I had no idea of getting a flowing well; only expected plenty of water at a depth of 104 feet. The well commenced to flow a very small stream, but from that beginning all this country is supplied by artesian water * * * ."

504. *Section of the Texas & New Orleans Railroad Co.'s well at Harrisburg, Tex.*

	Feet.
Surface soil	0– 3
Beaumont clay:	
Clay	3–113
Lissie gravel:	
Sand	113–138
Clay	138–144
Sand	144–164
Clay	164–168
Sand	168–185
Clay	185–304
Sand	304–319
Clay	319–401
Sand	401–421
Clay	421–510
Sand	510–525
Clay	525–595
Sand	595–618
Clay	618–626.5

512. *Section of Galveston, Houston & Henderson Railroad Co.'s well No. 1 at Genoa, Tex.*

[Furnished by Mr. R. V. Brewster, resident engineer.]

	Feet.
Beaumont clay:	
Clay	0– 80
Sand and gravel	80– 98
Red clay	98–198
Blue clay	198–513
Lissie gravel:	
Joint clay	513–573
Quicksand	573–653
"Hardpan" and clay	653–661
Coarse water sand	661–683.5

534. *Section of the Houston Waterworks Co.'s well No. 28 at Houston, Tex.*

	Feet.
Recent deposits and Beaumont clay:	
Surface soil	0– 30
Clay	30– 44
Lissie gravel:	
Sand and rock	44– 74
Clay	74– 89
Sand and gravel	89– 93
White clay	93–137
Sand	137–210
Clay and gravel	210–290
White sand and gravel, water bearing; hard to finish	290–316
Clay and gravel	316–356
Red sand	356–393
Clay and gravel	393–456
White clay and gravel	456–496
Sand, clay, and gravel	496–514
Sand	514–526
Gravel	526–532
Clay	532–570
"Limestone"	570–571
Sand and gravel	571–585
Clay	585–600
Hard rock	600–602
Clay	602–608
Sand	608–618
Clay	618–658
Clay and gravel	658–668
Sand	668–678
Clay and sand	678–687
Sand	687–705
Clay and gravel	705–745
Dewitt formation:	
Sand	745–756
White clay	756–772
Water-bearing sand	772–814

Section of Houston Waterworks Co.'s well No. 48, 1¼ miles west of Houston, Tex.

[See fig. 14, p. 155.]

	Feet.
Recent deposits and Beaumont clay:	
Sand, reddish	1- 30
Soft, red clay	30- 44
Lissie gravel:	
Soft red sand and rock	44- 74
Hard red clay	74- 89
Sand and gravel	89- 93
White clay; hard	93- 137
Red sand; three wells on this stratum	137- 210
Red clay and gravel; hard drilling	210- 290
Whitish sand and gravel; hard drilling; 6 wells in this stratum	290- 316
Reddish clay and gravel; hard drilling	316- 356
Red sand; hard drilling	356- 393
White clay and gravel	393- 456
Whitish gray sand	456- 496
Clay and gravel	496- 514
Light-gray sand	514- 526
Gravel	526- 532
Whitish clay	532- 570
Very hard rock	570- 571
White sand and gravel; 2 wells in this stratum	571- 585
Reddish clay	585- 600
Porous rock	600- 602
White clay	602- 608
Gravel and sand; 1 well in this stratum	608- 618
Clay	618- 658
White gravel and clay	658- 668
Sand	668- 678
Whitish porous clay and rock	678- 687
White sand; five wells in this stratum	687- 705
Clay and gravel; hard drilling	705- 745
Dewitt formation:	
Whitish sand	745- 756
White clay	756- 772
Sand; 6 wells in this stratum	772- 810
Clay	810- 815
Sand	815- 835
White clay	835- 895
White sand; 4 wells in this stratum	895- 940
Reddish white clay	940-1,134
Hard rock	1,134-1,137
Whitish gray sand; 4 wells in this stratum	1,137-1,179
Clay	1,179-1,236
Whitish sand	1,236-1,314
Hard rock	1,314-1,315
Clay	1,315-1,354
Sand	1,354-1,368
Clay	1,368-1,430
White sand and gravel	1,430-1,470
Hard clay and rock	1,470-1,600

	Feet.
Fleming (?) clay:	
Rock with gas; hard	1,600–1,605
Clay	1,605–1,895
Catahoula (?) sandstone:	
Sand	1,895–1,907
Red clay	1,907–2,025

541. *Section of well at Houston, Tex.*

	Feet.
Clay and sand	0 – 154
Sand, water-bearing	154 – 161
Clay	161 – 163
Sand	163 – 210
Clay	210 – 280
Sand	280 – 312
Clay	312 – 345
Rock	345 – 345.5
Sand	345.5– 350
Clay	350 – 415
Sand	415 – 420
Clay	420 – 465
Sand	465 – 502
Clay	502 – 540
Sand	540 – 570
Clay	570 – 605
Sand and gravel	605 – 643
Clay	643 – 670
Sand and gravel	670 – 702
Clay	702 – 745
Sand	745 – 769
Clay	769 – 779
Sand	779 – 805
Clay	805 – 810
Sand	810 – 835
Clay	835 – 895
Sand	895 – 940
Clay	940 –1,134
Rock	1,134 –1,137
Sand	1,137 –1,179
Clay	1,179 –1,236
Sand	1,236 –1,314
Rock	1,314 –1,315
Clay	1,315 –1,334
Sand	1,334 –1,368
Clay	1,368 –1,430
Sand and gravel	1,430 –1,470
Clay and rock	1,470 –1,600
Rock with gas	1,600 –1,605
Clay	1,605 –1,895
Sand	1,895 –1,907
Clay	1,907 –2,025

The formations penetrated represent Beaumont clay, Lissie gravel, Dewitt formation, Fleming(?) clay, and Catahoula(?) sandstone.

550. *Section of Crystal Springs well, 4 miles south of Houston, Tex.*

[Furnished by William Kennedy.]

	Feet.
Beaumont clay:	
Red clay	0– 40
Sand	40– 60
Clay	60– 220
Lissie gravel:	
Sand; with oil showing	220– 280
Clay and gumbo	280– 394
Sand; with oil showing	394– 406
Clay and gumbo	406– 493
Water sand	493– 520
Clay and gumbo	520– 595
Water sand	595– 601
Clay	601– 604
Water sand	604– 637
White limerock; oil showing	637– 646
Sand	646– 652
Clay and gumbo	652– 739
Sand	739– 757
White limerock	757– 784
Clay and gumbo	784– 799
Shale; oil showing	799– 805
Marine Miocene beds:	
Water showing	805– 838
Clay and gumbo	838– 902
Mixed rock; with oil	902– 910
Clay and gumbo	910– 937
Sand	937– 943
Clay, gumbo, and shale	943–1,035
Porous limerock; oil sand	1,035–1,054
Clay and gumbo	1,054–1,063
Big water stratum, large crystals	1,063–1,087
Clay	1,087–1,096
White limerock	1,096–1,123
Clay	1,123–1,132
White rock; good oil showing	1,132–1,144
Fleming (?) clay:	
Clay and gumbo	1,144–1,438
Clay; oil showing	1,438–1,466
White porous limerock; oil	1,466–1,485
Hard white limerock; oil	1,485–1,503
Catahoula(?) sandstone:	
Water sand	1,503–1,506
Clay mixed with rock	1,506–1,510
Clay and gumbo	1,510–1,520
Water sand	1,520–1,530
Clay	1,530–1,560
Very porous white limerock	1,560–1,583
Loose formation	1,583–1,589
Hard blue limerock; oil, strong gas	1,589–1,613

564. *Section of well on Smith League, Cedar Bayou, Harris County, Tex.*

	Feet.
Beaumont clay:	
Red clay	0– 75

Lissie gravel:	Feet.
White sand	75–150
Bluish clay, with shells	150–190
Blue sand and pebbles	190–238

569. *Section of P. M. Granberry & Co.'s well at Humble, Tex.*

	Feet.
Lissie gravel:	
Soft gray and white sand; good water; carries sulphur, but used in boiler	30– 40
Hard gray clay	40– 60
Hard bluish sand and sandy clay; at 215 feet, oil; at 230–232 feet, wood	60–215
Hard gray sand and shale; much gas	215–310
Hard blue sand and sandy clay; much gas	310–400
Black, blue and gray coarse sand; rather hard; much gas.	400–470
Soft, fine, blue sand; much gas	470–495
Dewitt formation:	
Hard blue clay (shale); much gas	495–508
Hard blue sand and clay mixed; thin layers of rock every 4 to 6 feet, 3 inches thick	508–572
Hard blue shale; layer of sand 8 to 10 feet	572–645
Hard blue shale and sand; considerable gas; alternate layers	645–670
Hard blue shale and sand; some soft places; very little gas	670–710
Hard blue shale; some gas	710–790
Hard blue shale; little oil and much gas	790–910
Hard blue shale	910–930
Hard blue shale; little oil, much gas	930–950
Mixed rock and sand; calcareous sand; oil producing 100 barrels per day of 24 hours' pumping. Oil of 28° B. gravity	950–990

571. *Section of Westheimer well in Humble oil field, ½ mile east of railroad station, Harris County, Tex.*

	Ft.	in.		Ft.	in.
Surface soil	0	0	–	4	0
Lissie gravel:					
Joint clay	4	0	–	84	0
Water sand	84	0	–	104	0
Clay	104	0	–	127	3
Red and blue clay mixed	127	3	–	292	5
Same as above, with some gravel	292	5	–	420	1
Yellow and blue clay	420	1	–	463	8
Very sticky clay	463	8	–	507	5
Not reported	507	5	–	538	0
Hard rock	538	0	–	539	0
Blue gumbo	539	0	–	534	4
Water, sand, and gravel	534	4	–	544	4
Hard blue clay with some gravel	544	4	–	548	3
Dewitt formation:					
Blue clay and blue gumbo	548	3	–	587	7
Quicksand with black specks and heavy gas pressure	587	7	–	609	0
Not reported	609		–	630	10

	Ft. in.	Ft. in.
Dewitt formation—Continued.		
Blue and brown clay mixed, very tough	630 10	840 6
Gypsum(?)	840 6	844 10
Rock with iron pyrites and sulphur	844 10	883 1
Blue clay mixed with some yellow clay	883 1	926 7
Rock	926 7	927 7
Not reported	927 7	945 0
Sand showing carbon (?), iron, gas, and soft yellow sulphur	945 0	951 0
Mixed clay	951 0	968 7
Mixed clay and thin layers of rock	968 7	1,007 11
White sand	1,007 11	1,009 11
Brown, yellow, and red clay; some soft rock	1,009 11	1,053 7
Same clay with 5 feet of soft white shale and gas	1,053 7	1,095 11
Yellow and blue clay with sulphur; strong gas pressure	1,095 11	1,135 11
Not reported	1,135 11	1,179 10
Yellow clay mixed with white lime gravel	1,179 10	1,221 10
Soft sand rock; gas-bearing and very porous	1,221 10	1,264 1
Yellow, red, and blue clay mixed with white soft gravel	1,264 1	1,416 2
Small white gravel and gas	1,416 2	1,457 5
...	1,457 5	1,500 4

572. *Section of Houston, East & West Texas Railway Co.'s well at Humble, Tex.*

	Feet.
Soil	0 - 3
Lissie gravel:	
Yellow clay	3 - 18
Fine sand	18 - 78
Coarse sand and gravel	78 -108
Blue clay	108 -150
"Close" sand	150 -305
Blue clay	305 -455
Sand	455 -485
Blue clay	485 -563
Dewitt formation:	
Rock	563 -566
Sand	566 -571
Rock	571 -575
Sand and clay	575 -583
Blue clay	583 -612.5
Rock	612.5-

HARRISON COUNTY.

GEOLOGY AND HYDROLOGY.

The Wilcox formation underlies all of Harrison County. Remnants of the Mount Selman formation in the form of iron ore cap some of the divides, but need never be expected to yield flowing wells. (See Pl. VIII, in pocket.) The Nacatoch reservoir underlies the county, but its water would probably be too salty for use.

The sands of the Wilcox formation, which are nearly horizontal, constitute the only reservoir of potable water. Wells can be completed in them from 100 feet above to 500 feet below sea level.

A series of flowing wells in a valley 4 miles north of Marshall at the pumping station are supplied by sands lying 60 feet, 250 feet, and 347 feet below the surface. The 60-foot sand is a part of the Queen City sand member of the Wilcox and yields water remarkably free from mineral matter. (See analysis, well No. 582, table facing p. 110.) A flow has also been obtained near Woodlawn in the Cypress Bayou bottoms from a sand 210 feet below the surface.

At Marshall Wilcox water is used in boilers with satisfactory results. Most of the water from this reservoir in this county will be potable.

At present there is little demand in Harrison County for artesian water. The development of the fruit and trucking industry, however, should increase the demand, and the waters will then be available in abundance. Water from the Queen City member would be well adapted for irrigation.

WELL DATA.

Details of wells in Harrison County are given in the following table:

Wells and springs in Harrison County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
577	Marshall, 6 miles west.		C. J. Randall		C. J. Randall.
578	Marshall, 3 miles northeast.		do		Engineer of the waterworks.
579	do		do		Do.
580	do	City	do		Do.
581	do		do	City	Do.
582	do		do		Do.
583	do		do	City	Do.
584	do		do		Do.
587	Hallsville, 1 mile southwest.		J. M. Nelson		L. M. Kuykendall.
588	Hallsville, ½ mile		W. H. Shuford		W. H. Shuford.
589	Waskom, 300 yards southwest of post office.		C. M. Abney	C. M. Abney	
590	Marshall		Arkansas & Texas Ice & Coal Co.		E. L. Wells, manager.[a]
591	Marshall, 9 miles south of.	H. C. Lewis headright.	W. J. Roseborough, sr.		William Kennedy.[b]
592	do		do		W. J. Roseborough, sr.[a]
593	do		do		Do.[a]
594	Marshall, 16 miles from.		Montvale Springs		William Kennedy.[c]
595	Marshall		E. Sutphin		R. T. Hill.[d]
596	do		Marshall Car Works.		A. Deussen.
597	Marshall, 6 miles north.	L. Watkins survey, center of south line.	Hunter & McCormick.		Joe Lake.

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 230.
[b] Dumble, E. T., Kennedy, William, et al., Reports on the iron-ore district of east Texas: Second Ann. Rept. Geol. Survey Texas (1890), 1891, p. 158.
[c] Dumble, E. T., Kennedy, William, et al., op. cit., p. 159.
[d] Hill, R. T., Geography and geology of the Black and Grand prairies, Tex., with detailed descriptions of the Cretaceous formations and special reference to artesian waters: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, p. 414.

Wells and springs in Harrison County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
598	Karnack, 1 mile west.	W. R. D. Ward headright, northeast part.	Adkin Bros.		Joe Lake.
599	Karnack, 1¼ miles west.		F. M. English.		F. M. English.
600	Woodlawn, 2½ miles northwest.	T. W. Clark headright, southeast corner.	Caddo Gas & Oil Co.	E. A. Dyar.	A. Deussen.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (—) ground.	Yield per minute. Pump.	Yield per minute. Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
577							
578	10	367	±250	60 to 367	No flow		
579	10	394	±250	60 to 394	do		
580	6	236	±250	60 to 236	do		
581	6	347	±250	60 to 347			
582		60	±250	60	Flow		
583	10	610	±250	60 to 253	—8		
584	10	357	±250	60 to 357	—8		
587							2.
588							
589	2½	142		{10 to 30. {140.	—50		
590	6	208		{60 to 100. {150 to 180		150 [a] 50 [b]	
591							
592	4	200			—75		
593	6-4	450		150 (?) 350			
594							
595		1,100			No flow		
596							
597							
598		1,020					
599							
600	10			210	+5		

No.	Source of water.	Quality.	Remarks.
577	Mount Selman	Iron [c]	Local resort known as Hynson Springs; temperature of water, 56° F.
578	Wilcox		Cased 60 feet. Two wells.
579	do		Cased 60 feet; shallow water bed will flow.
580	do		Cased 60 feet.
581	do		Cased 60 feet; no flow.
582	do	([c])	21 wells.
583	do	([c])	Cased 70 feet.
584	do		Cased 60 feet.
587		Soft	Spring.
588		Sulphur	Do.
589	Mount Selman and Wilcox	Hard	Used in boilers. Completed, 1894.
590	Wilcox		3 wells; temperature of water, 68° F.
591		Iron [c]	Springs.
592	Wilcox	Slightly salty	
593	do		Test well for oil; incomplete.
594			Local resort, springs.
595			Sunk about 1890.
596			
597			Gas test well; completed, 1906.
598			Oil test well.
599		Sulphur and iron	Spring.
600	Wilcox	Soft	Cypress Bayou bottom; lignite at 120 feet; gas test well; completed, 1907.

[a] Without strainer. [b] With strainer. [c] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

582. In the wells of the Marshall waterworks, 3 miles northeast of Marshall, the casing extends only to the water-bearing sand at 60 feet. The water from the shallow sand rises above the surface but that from the deeper sand does not. This is doubtless due to the fact that the wells are cased only to 60 feet, and that water from the deeper sands is absorbed by the porous uncased strata. If the deeper wells were sufficiently cased they would probably flow more strongly than the shallow wells.

583. *Section of deep well of the Marshall waterworks, 3 miles northeast of Marshall, Tex.*

	Ft.	in.		Ft.	in.
Soil	0	0	–	1	0
Mount Selman formation:					
Sand and clay	1	0	–	12	0
Red rock; yellow rock; medium hard (ferruginous sandstone)	12	0	–	26	0
Wilcox formation:					
Lignite	26	0	–	26	8
Gray sand	26	8	–	44	0
"Pipe" or gray clay (sand)	44	0	–	67	0
Lignite	67				
Soft dark-brown clay				75	0
Lignite	75	0	–	80	0
Clay	80	0	–	84	0
Lignite	84	0	–	92	0
White clay	92	0	–	100	0
Hard rock (sandstone)	100	0	–	100	6
Gray clay	100	6	–	112	0
Gray sand	112	0	–	116	0
Lignite	116	0	–	116	6
Gray clay	116	6	–	121	0
Hard rock (sandstone)	121	0	–	124	0
Gray clay	124	0	–	130	0
Lignite	130	0	–	131	6
Gray sand	131	6	–	159	0
Hard rock	159	0	–	159	6
Sand and clay	159	6	–	172	0
Lignite	172	0	–	174	6
Sand and gray clay	174	6	–	190	0
Lignite	190	0	–	192	6
White sand	192	6	–	210	0
Lignite	210	0	–	210	6
Gray sand	210	6	–	237	0
Not given	237	0	–	238	0
Rock (sandstone)	238	0	–	239	0
Gray clay	239	0	–	242	0
Coarse sand	242	0	–	249	0
Lignite	249	0	–	253	0
White sand, water bearing	253	0	–	257	0
Lignite	257	0	–	257	6
Gray sand	257	6	–	275	0
Lignite	275	0	–	279	6
Gray clay and sand	279	6	–	290	0
Rock (sandstone)	290	0	–	290	6
Gray sand	290	6	–	310	0
Thin layer of clay and lignite	310	0	–	320	0
Gray clay	320	0	–	330	0
Lignite	330	0	–	332	0
Sand and clay	332	0	–	333	0
"Shelly rock"	333	0	–	366	0
Sharp sand	366	0	–	367	0
Soft gray sandrock	367	0	–	418	0
Hard rock (sandstone)	418	0	–	419	0

	Ft. in.		Ft. in.
Wilcox formation—Continued.			
Soft gray rock	419 0	-	505 0
Hard rock (2 inches of clay in the middle)	505 0	-	507 0
Hard rock	507 0	-	507 6
Sand rock	507 6	-	510 0
Hard rock	510 0	-	510 8
Sand and clay	510 8	-	525 0
Hard rock	525 0	-	526 0
Pipe clay	526 0	-	548 0
Hard rock	548 0	-	549 0
Gray sand	549 0	-	577 0
Pipe clay	577 0	-	583 0
Lignite	583 0	-	584 0
Gray sandrock	584 0	-	595 0
Lignite, clay, and sand	595 0	-	610 0

590. Mr. E. L. Wells, manager, reports: "The ice company has three wells about 15 feet from one another. Two are finished with 30-foot Cook well strainers with very fine slots, and one with a 20-foot strainer. A 4-inch pipe with a 7.25-inch drill was used in boring the wells. The first well was tested with a 4-inch boring pipe and air, and yielded 3 barrels per minute. The well was then cased with a 6-inch pipe, including strainer, and yield was only 1 barrel per minute. It is probable that this was due to the strainer, but may have been partly caused by the fact that the 4-inch pipe was drawing water from the water-bearing strata between 60 to 100 and 150 to 180, while the 6-inch pipe was big enough to fill the hole and case off the upper stratum."

Section of Arkansas & Texas Consolidated Ice & Coal Co.'s well at Marshall, Tex.

[By E. L. Wells.]

	Feet.
Dirt and clay	0- 60
Wilcox formation:	
Water-bearing sand	60-100
Clay	100-150
Water-bearing sand	150-180
Rock	180-181
Clay	181-208
Rock (sandstone)	208

593. *Partial section of well of W. J. Roseborough, sr., 9 miles south of Marshall, Tex.*

	Feet.
Wilcox formation:	
Lignite	20- 25
Water-bearing sand	
Lignite	200-225
Water-bearing sand	350

HENDERSON COUNTY.

GEOLOGY AND HYDROLOGY.

The western corner of Henderson County lies in the Cretaceous area and is therefore not included in the scope of this paper. To the east lies a north-south belt of marls and limestones belonging to the Midway formation, which in turn is overlain by the sands of the Wilcox formation, which occupy the greater portion of the county. The southeast corner is occupied by the Mount Selman formation. (See Pl. I, in pocket.)

Cretaceous rocks.—The prospects for flowing water in this county are highly unfavorable. In the extreme western portion it is possible to drive a deep well to the Woodbine sand of the Cretaceous and secure a flow, as has been done at Terrell and at Corsicana. Eastward, however, these sands are too deeply buried to be available. The Nacatoch sand will supply a small territory in the western end of the county. (See Pl. VII, in pocket.)

Wilcox formation.—The sands of the Wilcox formation are capable of yielding abundant supplies of good water in pumping wells but should not be expected to yield flows except in the valleys of the eastern half of the county. (See Pl. VIII, in pocket.) In the central portion and in the vicinity of Athens wells can be completed in this reservoir from 200 feet above sea level to 100 feet below. The wells will deepen toward the east and in the eastern portion can be completed between 200 feet above sea level and 200 feet below.

A well at Payner, supplied by a sand 310 feet below ground, is said to have flowed 40 feet above ground. This well is in a valley along a drainage course leading into Neches River. The great pressure reported probably finds its explanation in the elevated position of the main ground-water table under the high iron-ore-capped table-land north of Payner. (See fig. 11, p. 91.)

Most of the water supplied by the sands of the Wilcox will be potable and adapted for domestic use and for steaming.

WELL DATA.

Details on the wells of Henderson County appear in the subjoined table:

Wells and springs in Henderson County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.
				Inches.	*Feet.*
601	Eustace, ¾ mile east	Dr. L. L. Cockrell	Dr. L. L. Cockrell		
602	Trinidad, 1 mile southwest.	Johnston heirs	J. H. Johnston		
603	Brownsboro		M. D. L. Price		
604	Payner, ½ mile southeast (J. W. Burton League).	J. L. Dickersen	Quinton Morse	8	900.
605	Stockard	J. B. Ballard	Postmaster	10	100.
606	do	Wm. Hughs	C. E. Crosby, postmaster	10	100.
607	do	Y. V. Earnest	do	10	100.

No.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Flow per minute.	Source of supply.	Quality.	Remarks.
	Feet.	*Feet.*	*Galls.*			
601					Some sulphur	Davis Spring.
602			5		Hard	Spring.
603		Flows			Soft	Used partly for irrigation.
604	310 500	+40		Wilcox	do	Drilled for oil by J. P. Wintz.
605		No flow		do		
606		do		do		
607		do		do		

DESCRIPTIVE NOTES.

604. Mr. W. S. Norvell writes: "The well was put down as an oil-test well, and the water cased off with 8-inch casing. As one of the stockholders in the Caddo Oil Co. I worked on the well several weeks and took notes on the materials penetrated. Between 45 and 52 feet we struck a 7-foot stratum of lignite of good quality. Between 70 and 88 feet a stratum of "cement gravel" was met. At 310 feet we encountered an artesian flow, water soft, accompanied with gas. The water flowed out at the top of 4-inch casing, 40 feet above the surface. We had to pump mud into the hole to cut off the gas so we could continue drilling."

The company was still at work on this well in January, 1908. A rotary machine was used. The town of Payner is 45 to 50 feet above the level of the well curb.

HOUSTON COUNTY.

GEOLOGY AND HYDROLOGY.

The northern half of Houston County is occupied by the outcrop of the Cook Mountain formation, and the southern half by the outcrop of the Yegua formation. (See Pl. I.) Both the lower Eocene and the Yegua artesian reservoirs are therefore available.

Lower Eocene.—The lower Eocene reservoir should be exploited over the area occupied by the Cook Mountain formation. It will yield abundant supplies of potable water, but the area of flow will be confined to the lower levels adjacent to Neches River. (See Pl. VIII, in pocket.)

In the northern portion of the county water may be obtained from 100 feet above sea level to 500 feet below. The reservoir deepens toward the south, and in the southern corner wells must go from 700 to 1,500 feet below sea level. However, wells going over 1,200 feet below sea level will probably yield impotable water, and in the southern half of the county it would be better to depend on the overlying Yegua.

At San Pedro the water rises within 10 feet of the surface; at Kennard within 105 feet, and at Crockett within 190 feet. Any flowing wells in this region will have to be driven on ground of a lower altitude than that of the three places mentioned.

The water from the lower Eocene sands in the northern half of the county is usually potable and adapted for steaming, but at Crockett a sand 630 feet below the surface yields sulphurous water, and at Kennard "alum water" is obtained.

Yegua formation.—The Yegua reservoir will supply wells in the southern half of the county, but the area of flow is confined to the extreme southwest portion and here to the valleys only. A well (No. 966) in Trinity County close to the county line, 4 miles southeast of Lovelady, yielded potable flows from sands in this formation at 70, 304, and 550 feet.

Wells drawing from the Yegua reservoir in Houston County will be very shallow in the central portion, but will deepen toward the south.

In the southern corner, supplies generally potable can be developed at depths of from 50 to 750 feet below the surface. (See Pl. VII, in pocket.)

WELL DATA.

The subjoined table gives a detailed list of the wells and springs in Houston County:

Wells and springs in Houston County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.
				Inches.	*Feet.*
608	Lovelady, 5 miles southeast (A. Sharp survey).	J. M. Thompson Lumber Co.			
609	Lovelady, 6 miles southeast (F. Martinez League).	George C. Newhall	J. D. Freeman		
610	Percilla (I. M. Percilla League).	John Dickie	John Sewell		
611	Crockett, 10 miles east	M. A. Thomas	M. A. Thomas		
612	Crockett	Mary Allen Seminary	J. B. Smith, president [a].	5-3	630
613	Kennard	Louisiana & Texas Lumber Co.	J. M. Martin, superintendent.[a]	3	1,065
614	Kennard, ¼ mile southeast.	4. C. Lumber Co	H. C. Christian		
615	Kennard, ¾ mile west		do		
616	Arbor, 1 mile west	Mary Lynch	Mary Lynch		
617	Creek, ½ mile northeast	A. P. Hester	A. P. Hester		
618	Creek, 4 miles northeast	J. W. Yarbrough	J. W. Yarbrough		
619	San Pedro, a few yards from well No. 620.	East Texas Oil Co	Z. D. Driskill		1,200
620	San Pedro, 300 to 400 yards east of post office.	do	Dr. T. F. Driskill	6	1,500

No.	Approximate elevation of surface.	Depth to principal water-bearing strata.	Head of water below ground.	Pumps per minute.	Source of supply.	Quality.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Gallons.*			
608						Salt	Spring.
609						Some salt; sulphur.	"Boiling Spring."
610							Spring.
611						Soft	Do.
612	350	350, 630	190	Large	Wilcox and Mount Selman.	Sulphur	The 350-foot reservoir is not used.
613			105	80	Wilcox	Alum	Fossils at 800 feet. Well no longer used. Several water-bearing layers are said to have been cased off.
614						Soft	Spring; water used for public water supply.
615						Salty	Spring.
616						Sulphur	Spring; water locally used medicinally.
617						Hard	Mineral springs; said to have an alum taste. Stock will not drink water.
618							Spring.
619			12 to 14				Drilled for oil by Joe Lee. Well No. 2 on Z. D. Driskill farm; completed, 1904.
620		187-208, 821-964.	10 to 12		Mount Selman and Wilcox.	Soft	Drilled for oil by Joe Lee. Well No. 1 on Z. D. Driskill farm; completed, 1904.

[a] Veatch, A. C., op. cit., p. 232.

DESCRIPTIVE NOTES.

620. *Section of East Texas Oil Co.'s well (No. 1 on Z. D. Driskill farm) at San Pedro, Tex.*

[Furnished by Dr. T. F. Driskill.]

	Feet.
Cook Mountain formation:	
Brownish-gray clay	0 - 2
Dark-greenish gray marl with fossil shells	2 - 12
Brown sandy shale and sand	12 - 120
Brown shale, sandy in places; fossiliferous	120 - 187
Water-bearing sand	187 - 208
Not given	208 - 218
Brown clay and shale	218 - 260
Dark-brown shale, gritty and limy	260 - 300
Greenish-brown sand and sandstone; contains rounded grains of quartz and glauconite	300 - 310
Mount Selman formation:	
Hard brownish-gray sandstone	310 - 350
Brownish sand (greensand?) and brown sandy shale	350 - 433¾
Lignite	433¾- 434¼
Brown sandy shale (?)	434¼- 486
Brown shale	486 - 492
Greenish-brown quartz sand (greensand?) and brown fossiliferous shale	492 - 575
White sand; dark-gray shale; nodules of limonite	575 - 585
Grayish sand; a little gray shale and some glauconite?	585 - 709
Stratum much like that next above	709 - 729
Wilcox formation:	
White quartz sand; a little glauconite (?)	729 - 775
Brownish sandstone; some brown shale; and a little glauconite ?	775 - 780
Brownish quartz sand; some grains of glauconite (?); grayish brown shale	780 - 805
Brownish and greenish-gray quartzose sand (water-bearing)	805 - 965
White quartz sand; a little glauconite (?)	965 - 995
Sand; more glauconite (?)	995 -1,041
Greenish-gray gritty shale or clay; nodules of limonite	1,041 -1,054
Light-gray quartz sand; some glauconite	1,054 -1,085
Strata much like next above	1,085 -1,105
Strata much like greenish-gray clay above	1,105 -1,110
Strata much like greenish-gray clay above, but with more "glauconite"	1,110 -1,150
Greenish and brown sandy shale, nodules of limonite, casts of shells	1,189 -1,194
Brownish-gray quartz sand; a little "glauconite"	1,194 -1,198½
Brown sandstone, plates of limonite, fragments of shells	1,198½-1,199
Brownish-gray quartz sand; a little glauconite	1,199 -1,225
Brown sandstone	1,225 -1,245
Dark greenish-brown sand; much glauconite	1,245 -1,256
Black sandy shale and lignite	1,256 -1,262
Slightly limy brown sandy shale	1,262 -1,270

Wilcox formation—Continued.	Feet.
Gray limestone	1,330 -1,332
Gray quartz sand; a little glauconite	1,360 -1,375
Sandy brown shale, slightly limy	1,375 -1,438
Brown and gray sandstone and shells	1,438 -1,450
Gray sand; streaks of gray sandy shale	1,495 -1,504

Two logs of this well, one by E. L. Holloway and the other presumably by the driller, show marked discrepancy. The section above harmonizes the two as much as possible.

JASPER COUNTY.

GEOLOGY AND HYDROLOGY.

The northern part of Jasper County is occupied by the outcrop of the Catahoula sandstone. This is embedded to the south beneath the outcrop of the impervious Fleming clay, which in turn disappears beneath the Lissie gravel. (See Pl. I, in pocket.) The geologic structure is favorable for flowing wells and they are scattered over the county.

Two artesian reservoirs are available in the county—the Catahoula (see Pl. VIII) in at least the northern half and the Lissie reservoir (see Pl. IX, in pocket) in the southern half, where the Catahoula is too deeply buried.

Yegua formation.—On the Graham survey, in the northern portion of Jasper County, a well near the Graham saline produced a flow of salty water from a sand at 1,229 to 1,241 feet in the Yegua formation. The salinity of the water of this well may be due to the saline, which probably brings salt water from great depths, whereas the Yegua reservoir near by may yield fresh water. But as abundant good water may be obtained at less depths in the Catahoula sandstone, it is not expedient to try for fresh supplies in the Yegua to depths exceeding 1,000 feet. Deep wells are more apt to yield flows and to yield much more water than shallower wells, and from the sanitary standpoint they are superior; but they are costly and are more apt to yield saline supplies, unsuitable for steaming and for irrigation. The choice of reservoirs, therefore, must depend on local conditions. The Yegua reservoir is available only in the extreme northern limits of the county. (See Pl. VII, in pocket.)

Catahoula sandstone.—That the Catahoula sandstone will yield abundant potable water over nearly the entire northern half of the county is shown by experiments on the Conn League, 4 miles east of Rockland (see fig. 17, p. 347), where a flow was obtained from a sand at 76 feet (well No. 634); at Lewis Ferry (well No. 637); at Horger, where a flow (reported as slightly salty) was obtained from sands at 189 to 192 and 219 to 220 feet; at a point 3 miles south of Jasper, where a flow was obtained at 275 feet; and at Kirbyville, where a strong flow of potable water was obtained at 1,312 to 1,346 feet. The area of flow in the northern part of the county is confined to the valleys, but widens to the south.

Marine Miocene.—The marine Miocene beds, which derive their water from the overlying water-logged sands of the Lissie gravel, doubtless supply the flowing wells in the southern half of Jasper County. The sands that supply the flowing wells near Wiess Bluff (Nos. 622 to 624), depths 1,060 and 1,100 feet, are probably Miocene. In this area the marine Miocene sands present favorable probabilities to depths not exceeding 1,200 feet. They thin rapidly toward the north (see section B–B′, Pl. I), and the depths to which they may be exploited decrease in the same direction. North of Call Junction they are absent.

Lissie gravel.—In the southern half of the county the Lissie gravel will probably yield flows in the Neches River bottoms. At best, however, these sands are not over 500 or 600 feet thick on the southern county line, and they decrease in thickness toward the north. Wells over 600 feet deep in this region will not draw from them.

WELL DATA.

Data on the wells of Jasper County appear in the following table:

Wells and springs in Jasper County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
621	Horger, 2½ miles northeast.	J. A. Bohler survey.	J. A. Bohler	Henderson & Cross.	J. A. Bohler.
622	Wiess Bluff, 2 miles north.		Wiess & Sanders	L. B. Jenson	J. W. Sanders.
623	Wiess Bluff, located near well No. 622.		do		Do.
624	Wiess Bluff, 4 miles northeast.		do		Do.
625	Remlig, 200 yards east of post office.		Alexander Gilmer Lumber Co.	Jake Giles	Max D. Almond.
626	Kirbyville				T. U. Taylor.[a]
627	Kirbyville, 1½ miles east.	Houston & Texas Central R. R. survey No. 6.	Kirbyville Oil Co.	W. T. Arnett	W. T. Arnett.
628	Browndel, 2 miles northeast.		H. B. Falls		Ben Powell.
629	Jasper, 3 miles south.		Seale farm		Prof. F. C. Thiele.[b]
630	Jasper, 14 miles northwest.		Radium Oil Co.	Andrew Williams	Radium Oil Co.[c]
631	Rockland, 8 miles east-northeast.	Joseph Conn League			J. P. Mettauer.
632	Rockland, 4 miles east.	do			A. Deussen.
633	do	do			Do.
634	do	do			J. P. Mettauer.
635	Rockland, 2 miles north.	J. H. Graham survey, near south line.	Kountze Bros		E. T. Dumble.
636	do	J. B. Pate survey, near northwest corner.	do		Do.
637	Lewis Ferry, 2 miles west.	M. Walker survey.	H. Ralph	Guffey Oil Co	H. Ralph.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, pp. 49–50.

[b] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 73.

[c] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 162.

Wells and springs in Jasper County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
621	6	1,400		15 to 20 182 to 192 219 to 220 462 to 473 560±	No flow −15 Flowed do +30	 Many.	 Many.
622	8	1,211		1,048 to 1,062 1,114 to 1,211	+10 (?) +12		 165.
623		1,070		1,060			80.
624	6	1,084		990 to 1,012	+10		85.
625	8	1,320	±350	1,037 to 1,077 1,193 to 1,223 1,251 to 1,262 1,268 to 1,285 1,290 to 1,320	−22		
626		227		82 to 212	No flow		
627	4	1,495		300 to 332 538 to 678 1,312 to 1,346[a]	do Flows +25		 200.
628							6.
629		1,471		40 to 60 275	No flow Flow		
630	12 to 4	1,520		720 to 730			
631	8	1,200			Flows		
632							
633							
634	8	76		76	Flows		Small.
635		1,243		65 to 85 1,229 to 1,241[a]	Flowed		
636		2,007		55 to 60 107 to 140	No flow		
637	10	2,300	±150	60 to 80 650 to 800 2,230 to 2,277	+22		

No.	Source of supply.	Quality.	Remarks.
621	Catahoula do do do do	Fresh ?[a] Brackish do ?	Cattle drink this water; well drilled for oil; temperature 65° F.; completed, 1903.
622	Marine Miocene (?)	Sulphur	Used for stock and for truck irrigation; completed, 1905 (No. 1).
623	do. (?)	do	Well No. 3.
624	do. (?)	do	Used partly for truck irrigation; completed, 1904 (No. 2).
625	Cook Mountain, Mount Selman, and Wilcox.	([a])	Used in boilers; combined yield from first and last sands pumps 60 gallons a minute.
626	Lissie	Good	
627	do do Catahoula	Potable[a]	Drilled for oil; two wells; completed, Jan. 12, 1907.
628		Iron and sulphur	Spring.
629	Lissie Catahoula (?)		Oil test well.
630	do. (?)		Oil test well; completed, 1905.
631		Soft	Oil test well (near Tar well); completed, 1903.
632		Salty[a]	Spring at old salt works.
633		Brine	Old salt works; known as Doom's saline.
634	Catahoula	Soft	Tar well; drilled in 1866; not in use.
635	do Yegua	Salty[a]	Drilled for oil near the Graham saline; abandoned. (Well No. 6 on fig. 17, p. 347.)
636	Catahoula	Potable	On a hill. (Well No. 5 on fig. 17, p. 347.)
637	do do Wilcox	(?) (?) Slightly salty	Drilled for oil; abandoned; completed, 1904 (?).

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

621. *Section of well on the J. A. Bohler survey, 2½ miles northeast of Horger, Tex.*

[Supplied by R. W. Henderson, of Cleveland, Ohio.]

	Feet.
Catahoula sandstone:	
Red clay	0- 15
Fine white sand (water bearing; fresh)	15- 20
Soft white "limestone" ("gypsum or chalk")	20- 62
Green shale	62- 65
Mixed streaks of sandstone and "limestone"	65- 86
Shale	86- 88
Hard sandstone	88- 92
Soft sandstone	92- 104
Greenish shale	104- 128
White sand	128- 131
"Limestone"	131- 140
Green shale	140- 144
Green shale with "limestone" interbedded	144- 176
Tough blue clay	176- 182
"Limestone;" water-bearing; (cased and baled, but could not lower water over 40 feet; water rose to 15 feet of surface; baled before casing was set)	182- 192
Fine-grained rock (quartzitic sandstone; of great grinding power; could not penetrate with rotary)	192- 195
Green shale	195- 219
White sand (artesian flow and some gas; water brackish).	219- 220
Green and blue shale with streaks of "limestone"	220- 306
Fine gray sand	306- 312
Blue clay	312- 321
Blue shale	321- 326
Shale and sand in streaks	326- 335
Gray sand (bad odor)	335- 345
Blue shale	345- 348
Fine gray sand	348- 360
Sand and shale	360- 365
"Limestone;" soft	365- 380
Blue clay and shale	380- 389
White sand, fine grained	389- 415
Blue clay and shale	415- 425
"Limestone"	425- 435
Blue shale	435- 450
"Limestone"	450- 462
Fine white sand with good artesian flow; water brackish.	462- 473
Blue shale	473- 483
Limestone with sheets of sand	483- 509
Fine white sand	509- 524
Soft sandstone	524- 529
Catahoula sandstone and Jackson formation:	
Sand and soft shales; strong artesian flow at about 660 feet; water rose 30 feet above surface as casing was pulled	529- 991
Soft rock	991- 992
Sand	992- 993?
Jackson and Yegua formations:	
Soft bluish shale; caved considerably	993?-1,400

"Set 8-inch casing at 365 feet; always had fair artesian flow of brackish water."

J. S. Bean, postmaster at Horger, writes: "This well was bored for oil by the Cleveland & East Texas Oil Co., of Cleveland, Ohio, They found very little oil. The well is out in the piney woods where it is useless, save to water range stock. They are very fond of the water * * *. There is a strong flow of gas from this well, enough to ignite and burn over the well."

622. *Section of Wiess & Sanders well No. 1, 2 miles north of Wiess Bluff, Tex.*

[Supplied by J. W. Sanders.]

	Feet.
Fine sandy loam	0- 2
Red clay	2- 25
Lissie gravel and marine Miocene beds:	
White sand	25- 75
Yellow clay	75- 96
Fine blue sand	96- 129
Yellow clay	129- 156
White sand	156- 173
Yellow clay	173- 225
Fine blue sand	225- 252
Hard yellow clay	252- 386
White sand	386- 476
Blue clay	476- 557
Blue sand	557- 579
Hard blue clay	579- 589
Coarse white sand	589- 638
Blue clay	638- 656
Fine blue clay	656- 686
Hard blue clay	686- 705
Coarse white sand	705- 760
Hard blue clay	760- 769
Soft blue clay	769- 794
White sand	794- 804
Hard blue clay	804- 824
Fragmentary sandstone	824- 828
Hard blue clay	828- 910
Rotten sandstone	910- 916
Blue clay	916- 923
White sand	923- 945
Hard blue clay	945-1,012
Coarse white sand	1,012-1,031
Fine gravel	1,031-1,048
Coarse gravel (water bearing)	1,048-1,062
White sand	1,062-1,096
Blue clay	1,096-1,114
White sand (water bearing)	1,114-1,211

624. *Section of Wiess & Sanders well No. 2, 4 miles northeast of Wiess Bluff, Tex.*

	Feet.
Fine sandy loam	0- 2
Yellow clay	2- 6
Yellow sand	6- 18
Gray clay	18- 27

	Feet.
Lissie gravel and marine Miocene beds:	
White sand	27– 50
Yellow clay	50– 83
Fine blue sand	83– 117
Blue clay	117– 152
White sand	152– 173
Blue clay	173– 234
Fine blue sand	234– 264
Blue clay	264– 295
Fine blue sand	295– 356
Gray clay	356– 426
White sand	426– 520
Blue clay	520– 583
Fine blue sand	583– 620
Blue hard clay	620– 631
Coarse white sand	631– 684
Blue clay	684– 697
Fine blue sand	697– 718
Soft stone	718– 756
Hard blue clay	756– 768
Coarse white sand, loses water rapidly	768– 799
Hard blue clay	799– 853
Unable to tell the strata, drills like oil strata	853– 868
Hard blue clay	868– 936
Fine blue clay	936– 949
Hard blue clay	949– 990
White sand, water bearing	990–1,012
Blue and green clay	1,012–1,039
Hard blue clay	1,039–

625. *Section of Alexander Gilmer Lumber Co.'s well at Remlig, Tex.*

[Furnished by the company.]

	Feet.
Soil	0– 4
Clay	4– 18
Sand	18– 20
Blue gumbo and shale	20– 382
Rock	382– 384
Blue gumbo and shale	384– 460
Rock	460– 461
Blue gumbo and shale	461– 511
Rock	511– 513
Blue gumbo and shale	513– 565
Sand	565– 573
Blue gumbo and shale	573– 603
Rock	603– 604
Blue gumbo and shale	604– 610
Rock	610– 613
Blue gumbo and shale	613– 885
Close blue sand	885– 925
Blue gumbo and shale	925–1,037
Blue water sand (strainer)	1,037–1,077
Gumbo and shale	1,077–1,087
Rock	1,087–1,089

	Feet.
Brown shale and gumbo	1,089–1,123
Rock	1,123–1,125
Brown shale and gumbo	1,125–1,182
Rock	1,182–1,183
"Coal" (lignite)	1,183–1,187
Brown shale and gumbo	1,187–1,193
Blue water sand	1,193–1,223
Brown shale and gumbo	1,223–1,251
Blue water sand	1,251–1,262
"Coal" (lignite)	1,262–1,265
Rock	1,265–1,268
Blue water sand	1,268–1,285
Brown shale and gumbo	1,285–1,290
Blue water sand (strainer)	1,290–1,320

Casing used, 1,087 feet of 8-inch and 233 feet of 6-inch; strainers at 1,037 to 1,077 and 1,290 to 1,320 feet.

The formations penetrated represent the Catahoula, Jackson, Yegua, Cook Mountain, and probably Mount Selman and Wilcox.

626. *Section of well at Kirbyville, Tex.*

	Feet.
Lissie gravel:	
Yellow clay	0– 17
Yellow sand	17– 34
Coarse white sand	34– 54
Sand and gravel	54– 82
Water sand	82–212
Blue clay	212–227

627. *Section of Kirbyville Oil Co.'s well No. 1, on the Houston & Texas Central Railroad survey No. 6, 1½ miles east of Kirbyville, Tex.*

[Furnished by Mr. W. T. Arnett, driller.]

	Feet.
Red and white joint clay	1– 47
Blue sand	47– 199
Sulphur and shale	199– 247
Soapstone rock	247– 248
Gray sand	248– 277
Sand and shale; oil seepage	277– 299
Soapstone rock	299– 300
Water sand	300– 332
Gumbo	332– 337
Blue hard rock	337– 338
Blue and brown shale	338– 445
Blue sand	445– 495
Soapstone rock	495– 497
Hard blue shale	497– 535
Blue marl	535– 538
Water sand; artesian flow	538– 678
Gumbo	678– 696
Hard blue rock (sandstone)	696– 697
Blue and brown shale; oil signs	697– 770
Blue marl; set 6-inch casing at 786 feet	770– 786
Blue marl	786– 788

	Feet.
Hard, blue rock (sandstone)	788– 790
Sand; oil seepage	790– 799
Blue soapstone rock	799– 802
Blue and yellow shale	802–1,269
Gumbo; set 4-inch casing at 1,303 feet	1,269–1,303
Gumbo	1,303–1,312
Mineral water sand; artesian flow	1,312–1,346
Gumbo	1,346–1,352
Blue shale	1,352–1,363
Blue gumbo	1,363–1,382
Blue and purple shale	1,382–1,495

The formations penetrated represent the Lissie, Dewitt?, Fleming, and Catahoula.

629. *Section of Seale farm well, 3 miles south of Jasper, Tex.*

[Taken by Prof. F. C. Thiele, of Beaumont.]

	Feet.
Sand	0– 40
Water sand	40– 60
Sand and sandrock	60– 150
Blue clay and sand; at 275 feet, artesian water and gas; at 250 feet, oil showing	150– 410
Limerock	410– 420
Blue clay	420– 520
Limerock	520– 525
Gumbo and sand	525– 675
Limerock	675– 681
Gumbo	681– 704
Sand; oil showing	704– 727
Limerock	727– 730
Gumbo and shale	730– 758
Dolomitic rock, pyrites, quartz, sand; oil showing	758– 767
Dolomitic rock, pyrites, quartz, sand, yellow clay; oil showing	767– 786
Quicksand, dolomitic rock, gumbo	786– 808
Gumbo, shale, gravel, dolomitic rock, quicksand, iron pyrites; oil showing	808– 832
Dolomitic rock, quicksand, yellow clay, lignite (?); slight oil showing	832– 853
Hard gray clay, calcareous concretions, limerock, pyrites	853– 930
Fine quicksand, concretions, much fine pyrites; splendid oil showing	930– 941
Shale, fine quartz sand, dolomitic rock, iron oxide, calcite	941–1,020
Fine white sand, pyrites, shale, large amount of limerock	1,020–1,060
Fine white sand, pyrites, shale, some limerock	1,060–1,070
Shale, variegated pebbles, chips of flint rock, limerock, and plenty of pyrites	1,070–1,072
Extremely fine gray sand, shell fragments, very fine white quartz, black carbonaceous matter, some clay and limestone; oil showing very good	1,072–1,095
Fine gray sand, lime concretions, some white quartz, black carbonaceous particles, considerable iron oxide	1,095–1,116
Fine gray sand, lime concretions, white quartz, black carbonaceous matter, magnetic iron oxide in abundance; oil showing good	1,116–1,128

	Feet.
Sandrock; white quartz	1,128–1,170
Sandrock; gas and oil showing	1,170–1,190
Fine gray sand, carbonaceous particles, magnetic iron oxide.	1,190–1,270
Bluish-gray clay, very fine sand, black particles, magnetic iron, quartz	1,270–1,320
Very hard blue shale	1,320–1,471

The formations penetrated represent the Lissie, Fleming, Catahoula, and Jackson.

630.[1] *Section of Radium Oil Co. well, 14 miles northwest of Jasper, Tex.*

	Feet.
Soft blue (or dark gray) shale and limestone	100– 200
Hard blue shale with sandstone to 250 feet, containing pyrites below	200– 300
Soft blue shale with limestone	300– 720
Sand; water-bearing	720– 730
Soft blue gumbo	730– 935
Soft blue gumbo (dark sandy clay) containing lignite	935– 945
Soft, very sticky gumbo	945–1,250
Soft blue shale	1,250–1,300
Hard blue rock, described as a kind of sandstone with sea shells	1,300–1,375
Soft blue shale	1,375–1,520

Rig used, rotary. Casing used, 63 feet of 12-inch, 683 feet of 8-inch. Not a show of oil.

The formations penetrated represent the Catahoula, Jackson, Yegua, and Cook Mountain.

635. *Section of Kountze Bros. well No. 6, near the south line of the J. H. Graham survey, near Rockland, Tex.*

[Furnished by E. T. Dumble.]

	Feet.
Red clay sand	0– 65
Catahoula sandstone:	
Dark-gray loose sand, artesian flow, salt	65– 85
Dark-gray sandrock	85– 105
Blue gumbo and shale	105– 175
Blue gumbo	175– 263
Green shale	263– 275
Blue gumbo	275– 300
Green shale	300– 490
Green marl (bowlder)	490– 535
Green marl	535– 615
Dark-blue sand	615– 630
Dark-gray sand	630– 655
Jackson formation:	
Dark-gray shale	655– 672
Green shale	672– 692
Green shale with shell	692– 765
Yegua formation:	
Dark-gray sand; good oil show	765– 784
Green marl	784– 800

[1] Fuller, M. L., and Sanford, Samuel, Bull. U. S. Geol. Survey No. 298, 1906, p. 278.

	Feet.
Yegua formation—Continued.	
Green shale with hard streaks	800– 835
Green marl with shell	835– 980
Green marl with rock	980–1, 118
Sandrock	1, 118–1, 120
Green marl	1, 120–1, 200
Dark-brown shale	1, 200–1, 208
Green marl	1, 208–1, 229
Loose and gray sand; oil; artesian flow salt water	1, 229–1, 241
Green shale	1, 241–1, 245

636. *Section of Kountze Bros. well No. 5, on the J. B. Pate survey, near Rockland, Tex.*

[Furnished by E. T. Dumble.]

	Feet.
Surface clay	0– 15
Green shale	15– 55
Catahoula, Jackson, Yegua, Cook Mountain, and Mount Selman (?) formations:	
White water sand	55– 60
Hard dark-gray sand	60– 86
Green shale	86– 107
Dark-gray water sand	107– 140
Green shale	140– 405
Blue gumbo	405– 485
Green shale	485– 570
Dark green sandstone	570– 573
Green shale	573– 660
Green shale with shells	660– 817
Dark-gray rock	817– 820
Green shale	820–1, 115
Green shale with shell	1, 115–1, 143
White sandrock	1, 143–1, 165
Green shale	1, 165–1, 502
Dark-gray sand	1, 502–1, 505
Green shale and shells	1, 505–1, 620
Dark-green shale and sand	1, 620–1, 635
Green shale	1, 635–2, 007

637. *Section of Ralph well No. 1, on the M. Walker headright, 2 miles west of Lewis Ferry, Jasper County, Tex.*

[Furnished by the J. M. Guffey Petroleum Co.]

	Feet.
Clay	0– 20
Catahoula, Jackson, Yegua, Cook Mountain, Mount Selman, and Wilcox formations:	
Sand	20– 45
Gravel	45– 60
Sand and water flow	60– 80
Soapstone	80– 140
Sand	140– 160
Rock	160– 180
Gumbo	180– 200
Sand	200– 220
Gumbo	220– 240
Sand	240– 350

Catahoula, Jackson, Yegua, Cook Mountain, Mount Selman, and Wilcox formations—Continued.

	Feet.
Gumbo and gravel	350– 400
Shale	400– 420
Sand and gravel	420– 460
Gumbo	460– 540
Shale	540– 650
Sand, gravel, water flow; little gas	650– 800
Soapstone	800– 850
Sand	850– 940
Gumbo	940–1,000
Loose shale	1,000–1,150
Gumbo	1,150–1,500
Sand and gravel	1,500–1,550
Gumbo, gravel, and bowlders	1,550–1,715
Rock	1,715–1,720
Gumbo	1,720–1,760
Rock	1,760–1,770
Gumbo	1,770–2,000
Sand	2,000–2,040
Coarse gravel and shale	2,040–2,100
Soft rock and gravel	2,100–2,230
Hard gravel and water sand	2,230–2,277

The reported presence of numerous gravel beds in this section is in marked contrast with their absence in other wells in the immediate vicinity, and the accuracy of the section is questionable.

JEFFERSON COUNTY.

GEOLOGY AND HYDROLOGY.

The Beaumont clay outcrops in the greater part of Jefferson County, but toward the coast is overlain by sands and clays of Recent origin. Beneath the Beaumont clay lies the Lissie gravel which dips about 35 feet to the mile. (See Pl. I, in pocket.)

Marine Miocene.—The marine Miocene beds will produce flows in Jefferson County wherever tapped, but the water will nearly always be salty.

Lissie gravel.—The sand and gravels of the Lissie supply most of the wells of Jefferson County. They will yield flows over all the area, and if not entered at too great depth or too near the coast or in too close proximity to a dome they will supply water suitable for domestic use, steaming, and irrigation. (See Pl. VII, in pocket.)

At Hampshire a sand at 207 to 250 feet below the surface (well No. 673) supplies a flowing well used for rice irrigation. At Fannett sands at 600 feet (well No. 680a) yield water described as slightly sulphurous. At Stowell, near the coast, the water is potable in sands at 120, 210, and 260 feet, but nonpotable and unfit for use at 580 feet. At Nome water suitable for use in locomotive boilers comes from 642 to 692 feet. At Beaumont water suitable for drinking can be found as far down as 630 to 650 feet, but salt water is found in a sand at 1,150 feet (well No. 661). At Spindletop and in the surrounding regions artesian flows are encountered at various depths. Within the limits of the producing oil field a zone of fresh water is encountered at depths varying from 140 to 360 feet. (See fig. 16.) Beneath this fresh-water zone all the water is too salty for use. The salt water is sealed off from the upper fresh-water zone by impervious clay.

In the regions surrounding the oil field, the waters are fresh to much greater depths. Thus in the Allyne well (No. 651) a fresh flow was

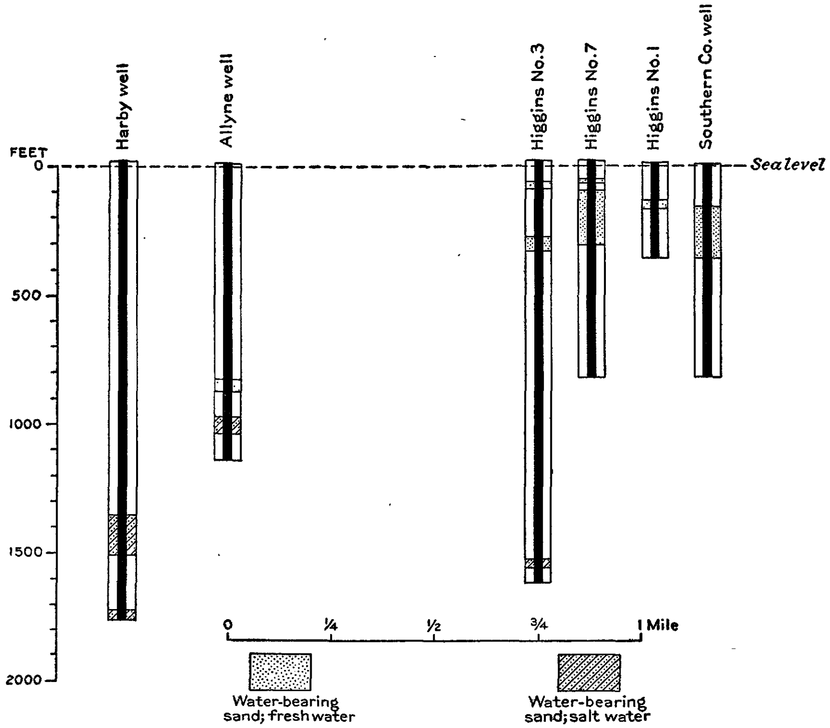

FIGURE 16.—Section showing the water-bearing sands in the Spindletop wells.

struck at a depth of 850 to 882 feet. Doubtless the Spindletop water has risen from lower levels.

At Sabine, on the coast, the water is salty in all sands encountered. Sands occur at 60 to 175 feet, at 452 to 498, and at 1,035 to 1,065 feet.

Flows from the Lissie gravel and Beaumont clay may therefore be expected over all Jefferson County. In a strip along the coast 8 or 10 miles wide salt water may be expected at all depths. Under the mounds (Spindletop and Big Hill are the only mounds in the county thus far known) (see fig. 6, p. 85), salty and impotable waters may be looked for at 100 to 300 feet. In the remainder of the county the sands can be safely exploited to depths not exceeding 600 feet south of Beaumont and not exceeding 1,100 feet north of Beaumont, the depth to salt water always decreasing coastward. At Beaumont potable supplies will be available at depths not exceeding 500 to 600 feet.

WELL DATA.

Details of the wells of Jefferson County appear in the following table:

Wells and springs in Jefferson County, Tex.

No.[a]	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
638	Spindletop		Spindletop Power Co.	Johnson Bros.	J. W. McCarley.
639	Spindletop, north.	East side of J. W. Bullock League.	Bayou City		Wm. Kennedy.[b]
640	Spindletop, northwest.	J. W. Bullock League.	Harby		Do.[c]
641	Spindletop, northeast, on Smith Island in Neches River.	Plomand survey			Do.[d]
642	Spindletop	Hog-Swayne tract.	Ira O. Wyse, Beaumont Oil Co.		Do.[e]
643	do	do	Texas Oil & Pipe Line Co.		Do.[e]
644	Spindletop, near	Lot 2, Veatch survey.	Slaughter-Masterson.		Do.[f]
645	do	Lot 36, Gladys City.	Treadway		Do.[g]
646	Spindletop		Denver-Beaumont Oil, Tank & Pipe Line Co.		N. M. Fenneman.[h]
647	do		Southern Co		Do.[h]
648	do	Block 23	Geyser - Kaltenbach.		Wm. Kennedy.[i]
649	Spindletop, southwest.	J. Pivitot survey	Federal Crude Co.		Do.[j]
650	Spindletop, east end.	Bullock League	United States Co.		Do.[j]
651	Spindletop, near	Block 28, Bullock League.	Allyne		Do.[k]
652	Spindletop		Higgins Oil & Fuel Co.		W. B. Phillips.[l]
653	Spindletop, near southern margin of pool.		do		Wm. Kennedy.[m]
654	Spindletop		do		N. M. Fenneman.[n]
655	do		do		Do.[o]
656	do	P. Humphrey survey.	J. M. Guffey Petroleum Co.	Hamill Bros.	W. B. Phillips.[p]
657	do		Heywood Oil Co.		Do.[q]
658	do		do		Do.[r]
659	Beaumont, southeast.	Chaison Place		J. W. McCarley.	J. W. McCarley.
660	Beaumont, 3½ miles north.	H. R. Williams survey.	Beaumont Country Club.	George F. Rainey	J. Edgar Pew.
661	do	do	do	do	Do.
662	Beaumont, 1 mile west.	2210 Calder Avenue.	J. F. Keith	Jake Giles	J. F. Keith.

[a] For additional data, see notes following this table.
[b] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1913, pp. 93-95.
[c] Idem, pp. 95-97.
[d] Idem, p. 25, 104.
[e] Idem, p. 25, 79.
[f] Idem, pp. 97-99.
[g] Idem, pp. 99-100.
[h] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, pp. 22, 23.
[i] Hayes, C. W., and Kennedy, William, op. cit., pp. 74-75.
[j] Idem, pp. 101-102.
[k] Hayes, C. W., and Kennedy, William, op. cit., pp. 100-101.
[l] Phillips, W. B., Texas petroleum: Bull. Univ. Texas No. 5, 1901, p. 73.
[m] Hayes, C. W., and Kennedy, William, op. cit., pp. 76-77.
[n] Fenneman, N. M., op. cit., pp. 20-21.
[o] Idem, pp. 21-22.
[p] Phillips, W. B., op. cit., p. 70.
[q] Idem, p. 74.
[r] Idem, p. 75.

Wells and springs in Jefferson County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
663	Beaumont, 17½ miles southwest.				N. H. Darton.[a]
663a	Beaumont, at courthouse.		Jefferson Co.		T. U. Taylor.[b]
664	Beaumont		Texas Dynamite Co.		A. Deussen.
665	Beaumont, Gulf, Colorado & Santa Fe Ry. station.		Gulf, Colorado & Santa Fe Ry.		Wm. Kennedy.[c]
666	Beaumont, southwest.	Bullock League, southwest corner.	Almaden		Do.[d]
667	Beaumont, near	David Brown survey.	Caswell		Do.[e]
668	do	International & Great Northern R. R. lands, sec. 11.	Gulf Coast Oil & Land Co.		Do.[f]
669	Beaumont, 5 miles west.	Texas & New Orleans R. R. lands, sec. 101.	American Oil Co.		Do.[g]
670	Beaumont, 22 miles southwest.	Texas & New Orleans R. R. lands, sec. 56.			Do.[h]
671	Beaumont, 9 miles north, near Pine Island Bayou.	D. Easley survey	Sanger		Do.[i]
672	Hampshire, 1½ miles south.		H. C. Wheeler		T. U. Taylor.[b]
673	Hampshire, near		do		Do.[j]
674	do		J. McManus		Do.[b] Do.[b] Do.[j] Do.[b]
675	Hampshire, 6 miles east.	Carr labor			J. G. Garland.
676	Hampshire, 1½ miles north.		A. J. Snouffer		T. U. Taylor.[b]
677	Hampshire				N. M. Fenneman.[k]
678	Nederland, 1 mile northeast.	Carroll survey	Sun Oil Co.	James Clark	J. Edgar Pew.
679	Fannett, 5 miles south of post office.	Burrell League	Y. Mayumi	W. J. Giles	Y. Mayumi.
680	Fannett, 5 miles east.		Bigham Bros.		Postmaster.
680a	Fannett		H. Monvert	F. A. Schauman	Do.
681	Fannett, 3 miles west.		J. P. Landrum		N. M. Fenneman.[k]
682	Fannett, 1¾ miles northeast.		H. de Mandrat	F. A. Schauman	O. D. Baker, postmaster.
683	Big Hill				Wm. Kennedy.[l]
684	do				N. M. Fenneman.[k]
685	Hildebrands Bayou, Jefferson County.	Grange League			Do.[m]
686	Stowell, 2 miles east.	Texas & New Or. R. R. No. 159.	Texas Land & Irrigation Co.		Chas. M. Lowe.
687	do	do	do		Do.
688	do	do	do		Do.
689	do		J. McManus		T. U. Taylor.[b]
690	Port Arthur, 2½ miles west.		Port Arthur Oil Co.		William Kennedy.[n]

[a] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey, No. 149, 1905, p. 149.
[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper No. 190, 1907, p. 31.
[c] Hayes, C. W., and Kennedy, William, op. cit., p. 61.
[d] Idem, p. 91.
[e] Idem, p. 93.
[f] Idem, p. 92.
[g] Idem, pp. 88–90.
[h] Idem, p. 61.
[i] Idem, pp. 87–88.
[j] Taylor, T. U., Rice irrigation in Texas: Bull. Univ. Texas No. 16, 1902, p. 17.
[k] Fenneman, N. M., op. cit., p. 79.
[l] Hayes, C. W., and Kennedy, William, op. cit., p. 126.
[m] Fenneman, N. M., op. cit., p. 78.
[n] Hayes, C. W., and Kennedy, William, op. cit., p. 112.

Wells and springs in Jefferson County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
691	Port Arthur, 3 miles north.		Port Arthur Mineral Water Co.		Postmaster.
692	Port Arthur		Natatorium		T. U. Taylor.[a]
693	Port Neches, 1 mile northeast.		Nederland Oil Co.	W. H. Derr	R. G. Fisher, assistant postmaster.
694	Sabine	Block 34, Division H.	Windsor Hotel	Gust Warnecke	Postmaster.
695	Voth		Gulf States Brick Co.		Do.
696	do		J. F. Keith		Do.
697	China, 1¼ miles northeast.		J. E. Harrison		A. R. Sproey.
698	China		John Norton		Postmaster.
699	Nome		A. C. Zierath		Do.
700	Nome, 3 miles west.		Chas. S. Edgar	M. F. Stollard	W. R. Ozment.[b]
701	Nome		Texas & New Orleans R. R.	Gust Warnecke	Engineer of maintenance of way.
702	Nome, 1¾ miles south.	John Blair League.	J. E. Burrows		J. E. Burrows.
703	Pine Island, 2 miles south.		J. R. Blanch	George Rainey	J. R. Blanch.
703a	Pine Island, 1 mile northwest.		A. Deloune		A. H. Boyt, postmaster.
704	Pine Island, 3 miles south.		G. H. Nicholls	Chicago Well Boring Co.	G. H. Nicholls.
705	Sabine Pass		Stribling		T. U. Taylor.[c]
706	Sabine Pass, 3 miles west.	B. F. Howard League.	Texas Oil Co.		William Kennedy.[d]
707	do		Tom Robinson		Thomas Wilson, postmaster.
708	Sabine Pass, 6 miles southwest.				Do.
709	Sabine Pass, 7 miles west.				Do.
710			W. C. Tyrrell		T. U. Taylor.[e]
711	Port Arthur				Do.[e]
712			C. T. Heisig		Do.[e]
713			Dr. Price		Do.[e]
714			H. Aldridge		Do.[e]
715			——— McKinney		Do.[e]
716			Jefferson Rice Co.		Do.[e]
718			Jes Garland		Do.[e]
719			J. W. Denny		Do.[e]
720			D. N. Coffol		Do.[e]
721	Near mouth of Neches River.	Joseph Grigsby League, southeast corner.	Stillwell Co.		N. M. Fenneman.[f]
722			R. P. Carroll		T. U. Taylor.[e]

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper No. 190, 1907, p. 31.
[b] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 164.
[c] Taylor, T. U., op. cit., p. 32.
[d] Hayes, C. W., and Kennedy, William, op. cit., p. 113.
[e] Taylor, T. U., op. cit., p. 31.
[f] Fenneman, N. M., op. cit., pp. 77–78.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
638				360	Flows		
639		2,009	25	1,367½ to 1,460 1,757 to 1,766			
640		1,840+	20	1,840	Flows		Many.
641		1,500					
642	6		22½				
643	8	1,036	25+				
644		2,250	25				
645		2,250	25				
646		1,110	20−				
647		982	20−	169 to 355			

Wells and springs in Jefferson County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
648	6.	930.	25.				
649		2,350.					
650		2,075.	24.				
651		2,015.	22.	850 to 882. 1,050.	Flows.		Flow. (?).
652	4.	1,040.	20+.	140 to 160.	Flows.		
653	6.	1,006.	25.				
654		1,956.	27½.	83 to 98. 318 to 353. 1,527 to 1,567.			
655		772.	27.5+.	85 to 94. 114 to 324.			
656	6 to 4.	1,139.	22.5−.				
657	6.	967.	25+.				
658	6.	936.	27½+.				
659		1,284.		45 to 82. 368 to 458. 1,269 to 1,284.	(?). Flows. do.		
660		1,150.	±24.	630 to 650. 1,150.	Flowed. do.		
661	4.	650.	±24.	630 to 650.	+40.		
662	6.	1,034.	25.	1,000.	+2.		8.
663	6–4.	1,515.		220, 260.			
663a	3.	745.			Flows.		30.
664					do.		5.
665		175.		120 to 175.			
666		1,400.	25.				
667		1,518.	30.	930.			
668		1,516.	25.				
669		1,559.	50.				
670		104.		100 to 104.			
671		1,419.	25.	6 to 156, 162 to 600			
672		230.			Flows.		Few.
673		250.		207 to 250.			
674		178.			Flows.		20.
		267.			do.		20.
	8.	180.		108 to 180.	do.		20.
		653.			do.		45.
675	8.	230.	5 (?).	90. 200.	 +7.		
676		180.			Flows.		25.
		200.			do.		25.
677		2,506.					
678	4.	620.	25 (?).	600 to 620.	Flows.		100.
679		300.		300.	do.		
680	8 to 6.	536.			+2.		
680a	6.	600.		600.	+1.		Few.
681		1,191.					
682	6 to 4.5.	900.		640.	+4.		
683		1,400.					
684		2,496.					
685							
686	8.	180.	30.	28 to 32. 120.	No flow. Flows.	 500.	 5.
687	8.	260.	30.	28 to 32. 120. 260.	No flow. Flows. do.		
688	8.	650.	30.	28 to 32. 120. 210. 580.	No flow. Flows. do. +8.	 800.	 25.
689		180.			Flows.		20.
690		1,260.	25(?).				
691	12–6.	1,400±.			Flows.		
692	4½.	796.			do.		150.
693	4.	1,200 (?).	30 (?).				
694		1,065.	6.	60 to 175. 452 to 498. 1,035 to 1,065.	No flow. Flow. do.		0. 7. Many.
695	8.	275.					
696	6.			600 to 700.	Flows.		
697	6.	300.	44(?).	20. 300.	 −10.		
698		1,000.					
699	2.	500.			Flows.		
700	8–7.5.	2,000.					
701	8.	692$\frac{5}{12}$.		642 to 692$\frac{5}{12}$.	2.		7.

Wells and springs in Jefferson County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depth of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
702	8	132	35	16 to 34 90 to 140	+10 inches	600	5.
703	8	100	34	80	−4		
703a	8	1,200			0		
704	8	1,500	30				
705		1,500					
706		1,486	15(?)				
707		1,050	6(?)		Flows		
708		1,800					
709		2,000(?)					
710		180			Flows		Few.
711		450			do		40.
712		230			do		Few.
		180			No flow		None.
		150			do		Do.
713		190			Flows		Few.
714		135			do		Do.
715		620			do		Do.
716		530			do		Do.
718		450			do		65.
719		260			do		Few.
720		306			do		25.
721		1,475	20				
722		280			Flows		25.

No.	Source of water.	Quality.	Remarks.
638	Lissie	Some sulphur [a]	Suitable for drinking; used in boilers.
639	Marine Miocene	Salty	Drilled for oil; none found and well abandoned. Miocene fossils at 1,910 feet.
640	do do	do do	Drilled for oil; none found; completed, 1902. Post-Pliocene fossils at 45 feet.
641			Island well; drilled for oil; abandoned. Miocene fossils at 800 feet.
642			Drilled for oil. Miocene fossils at 1,000 feet.
643			Formerly a producing oil well. Miocene fossils at 1,036 feet. No. 1 well; known as Plunger well.
644			Oil test well.
645			Oil test well; abandoned.
646			Oil well (No. 1).
647	Beaumont and Lissie		Oil well (No. 4).
648			Formerly a producing oil well.
649			Oil test well; between 2,200 and 2,350 feet gray sandstone with shells and pyrites (probably belonging to the Catahoula sandstone) was passed through.
650			
651	Lissie (?) Marine Miocene	Good Salty	Oil test well.
652	Beaumont	Brackish	Oil well (No. 1); completed Mar. 25, 1901. Oil at 556 feet; flow of oil at 1,020 to 1,030 feet.
653			Producing oil well (No. 2).
654	Beaumont Lissie Marine Miocene	 Salty	Oil well (No. 3).
655	Beaumont	Sulphur (?)	Oil well (No. 7).
656			McFadden Well No. 1; this is the original Lucas "gusher." Flow of oil from depths 1,120 to 1,139 feet; salt water appeared at this depth after oil was exhausted.
657			Oil well (No. 2); completed May 25, 1901. Flow of oil from 950 to 967 feet; salt water at this depth after oil was exhausted.
658			Oil well (Heywood No. 3); completed June 24, 1901. Flow of oil from 927 to 935 feet.
659	Beaumont Lissie Marine Miocene	(?) (?) Salty	Drilled, 1904.
660	Lissie Marine Miocene	 Salty	Flow about 300 barrels a day. Within a few feet of well No. 661.
661	Lissie	(*a*)	Completed, 1907; water used for drinking.
662	do. (?)	Salty	Completed, 1904; temperature of water, 74°F.
663	Beaumont		Oil test well; gas at 240 and 400 feet.
663a			

[a] For analysis, see table facing p. 110.

Wells and springs in Jefferson County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
664		Soft	Completed, 1907.
665	Beaumont (?)		
666			Drilled for oil.
667	Lissie (?)	Salt	Oil test well; abandoned.
668			Oil test well.
669			Drilled for oil; abandoned.
670	Beaumont		Section shows 100 feet of mottled clay above 4 feet of white sand.
671	Lissie		Drilled for oil.
672			Four wells.
673	Beaumont (?)	Good	Used for rice irrigation.
674	Beaumont ....do ....do ....do		Four wells; used for rice irrigation.
675	....do	Hard	Used for rice irrigation; completed, 1902.
676			Two wells.
677			Oil test well; abandoned.
678	Lissie		Used for drinking and in boilers; completed, 1903.
679	....do. (?)	Salty	Used for drinking and for irrigation.
680		Sulphur	Used for rice irrigation.
680a	Lissie	Some sulphur	Completed, 1902; well now owned by F. Goulding, Fannett, Tex.
681			Oil test well.
682	Lissie	Good	Completed, 1902; drilled for oil; well ruined in attempt to cut casing.
683			Oil test well; abandoned.
684			Do.
685			Oil test well; two wells.
686	Recent Beaumont	Hard	Used for rice irrigation; two wells; completed, 1903.
667	....do	....do	Two wells; used for rice irrigation.
688	....do Lissie (?)	Salty	Used for rice irrigation; completed, 1904.
689			
690			Oil test well.
691		Mineral	Temperature 80° F.; well drilled for oil and flow of mineral water discovered in attempting to draw casing.
692			
693			Drilled for oil.
694	Beaumont ....do Lissie	Salty ....do ....do	Used for toilet. Bored in June and July, 1897; strainer at 1,035 to 1,065 feet.
695	....do		Drilled for oil.
696	Beaumont		Surface water; not used.
697	Lissie	Soft	Used for rice irrigation; completed, 1902.
698			Drilled for oil.
699			
700			Oil test well; completed, 1904.
701	Lissie		Used for locomotive boilers; completed, September, 1906.
702	Beaumont Lissie	Brackish	Water lowered 26 feet by pumping; formerly used for rice irrigation, but now discontinued; completed, 1902.
703	Beaumont		Water not suitable for drinking.
703a			Drilled for oil.
704			Drilled for oil. Flowed for a short time a few gallons per day; water not suited for drinking; completed, 1902.
705			Oil test well.
706			Do.
707		Salty	Unfit for drinking; completed, 1900.
708			Drilled for oil; abandoned.
709			Do.
710			
711			
712			Three wells.
713			
714			Two wells.
715			
716			
718			
719			
720			
721			Oil test well. Two other wells are not so deep as that listed.
722			

DESCRIPTIVE NOTES.

639. *Section of Bayou City well on the east side of Bullock League, near Spindletop, Tex.*

	Feet.
Recent:	
Red clay	0 – 18
Red sand	18 – 41
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay	41 – 58
Sand	58 – 78
Clay	78 – 91
Red sand	91 – 93
Blue clay	93 – 101
Sand	101 – 102
Blue clay with hard shaly streaks	102 – 230
Blue sand	230 – 245
White sand	245 – 256
Blue clay	256 – 267
Greasy blue clay (called soapstone)	267 – 306
Hard sand	306 – 321
Blue clay, same as No. 13	321 – 330
Gray indurated sand	330 – 346
Blue clay	346 – 356
White sandstone	356 – 366
Indurated sand	366 – 371
Tough red clay	371 – 375
Indurated sand	375 – 392
Broken shells	392 – 393
Blue clay	393 – 420
Sand and clay mixed	420 – 433
Fine white sand	433 – 458
Blue clay	458 – 524
Blue sand and small gravel	524 – 579
Shale	579 – 610
Brown oily clay	610 – 611
Quicksand	611 – 615
Coarse crystalline sand	615 – 639
Blue clay	639 – 680
Clay and sand	680 – 735
Gravel	735 – 770
White sand	770 – 958
Blue clay	958 –1,367
Rock	1,367 –1,367.5
Sand with salt water	1,367.5–1,460
Blue clay	1,460 –1,511
White sand	1,511 –1,691
Sandstone showing clay	1,691 –1,731
Red clay	1,731 –1,757
Coarse sand, with salt water	1,757 –1,766
Very fine white sand	1,766 –1,780
White clay and blue sand	1,780 –1,783
Sand, with broken shells	1,783 –1,811
Compact white sand	1,811 –1,825
Sand and clay	1,825 –1,852

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	
Coarse white sand, with wood, shells, *Mulinea balanus* sp., and fish bones	1,852 –1,870
Coarse sand, shells, and wood	1,870 –1,900
Fine gravel, with wood and shells (*Mulinea balanus*) (Miocene fossils)	1,900 –1,910
Dark-blue shale	1,910 –1,917
Blue clay	1,917 –1,935
Red clay	1,935 –1,951
Blue clay, with pockets of soft white sand	1,951 –2,009

640. *Section of Harby well on the Jeff Chaison tract, on the J. W. Bullock League, near Spindletop, Tex.*

	Feet.
Recent:	
Clay	0 – 34
Sand	34 – 38
Beaumont clay:	
Clay	38 – 45
Sand, with shells and wood (post-Pliocene fossils)	45 – 50
Clay	50 – 70
Clean white sand	70 – 75
Clay	75 – 100
Sand	100 – 168
Shale	168 – 182
Blue clay	182 – 228
Rock	228 – 230
Blue clay	230 – 256
Rock	256 – 260
Soft blue clay with log at 290 feet; yellow streaks and some shells	260 – 290
Yellow clay, with log at 340 feet	290 – 340
Lissie gravel and marine Miocene beds:	
Sand	340 – 405
Blue clay	405 – 482
Hard rock	482 – 483
Soft blue clay	483 – 492
Sand	492 – 508
Blue clay	508 – 550
Sand	550 – 555
Yellow clay	555 – 570
Lignite	570 – 571
Sand	571 – 575
Clay	575 – 604
Hard rock	604 – 612
Soft blue clay	612 – 624
Shale rock	624 – 648
Blue clay and shale, very hard in streaks	648 – 698
Fine white sand	698 – 716
Hard blue shale, with thin layers of sand	716 – 735
Shale mixed with coarse sand; sand sharp, with black and yellow specks	735 – 764
White sand; upper 30 feet hard in streaks, last 30 feet showing black specks	764 – 874

Lissie gravel and marine Miocene beds—Continued.	Feet.
Blue clay	874 - 876
Coarse sand	876 - 886
Blue clay with some shale	886 - 942
Sand	942 - 950
Blue shale with shells	950 - 960
Sand, with indications of oil	960 - 964
Blue shale	964 - 967
Hard white rock	967 - 967¼
Soft-blue clay and shells	967¼-1,003
Sand	1,003 -1,013
Soft blue clay, with yellowish sand and lignite and shells; indications of oil at 1,065 to 1,071 feet	1,013 -1,212
Rock	1,212 -1,212¼
Fine white sand	1,212¼-1,218
Blue clay	1,218 -1,264
Fine white sand	1,264 -1,267
Hard blue clay with some shells	1,267 -1,280
Red clay	1,280 -1,317
Fine gray sand	1,317 -1,357
Red and blue clay	1,357 -1,380
Fine white sand	1,380 -1,390
Blue, red, and brownish clay	1,390 -1,394
Blue and red hard clay, with streaks of rock from a few inches to 2 feet, mostly limestone; strong indications of oil between 1,450 and 1,460 feet	1,394 -1,599
Blue clay with streaks of limestone from 2 inches to 2 feet	1,599 -1,614
Red, blue, and brown clay with limestone rock; mostly rock	1,614 -1,623
Light-blue clay	1,623 -1,625
Limestones in this layer with a few inches of mud between	1,625 -1,649
Fine white sand with blue clay and limestone	1,649 -1,661
Blue clay mixed with some limestone and sandstone	1,661 -1,669
Sandstone with thin deposits of clay	1,669 -1,700
Blue clay with streaks of limestone and pyrites	1,700 -1,705
Sandstone, with small quartz crystals and black specks and indications of oil at 1,735 feet	1,705 -1,743
Fine white sand; with indications of oil at 1,761 feet	1,743 -1,763
Blue and red clay and shale and mud	1,763 -1,794
Limestone, with some very dark-red and blue clay	1,794 -1,835
Limestone	1,835 -1,837
Limestone and clay	1,837 -1,840

644. *Section of Slaughter-Masterson well on lot 2 of the Veatch survey, near Spindletop, Tex.*

	Feet.
From surface to 360 feet, record lost	0- 360
Tough blue clay	360- 400
Lissie gravel and marine Miocene beds:	
Alternate layers of gray clay and sandstone	400- 420
Gray clay	420- 551

Lissie gravel and marine Miocene beds—Continued.	Feet.
Shelly rock	551- 598
Bowlders	598- 603
Gray clay and sand	603- 605
Hard gray sand	605- 637
Gray clay	637- 670
Limestone	670- 671
Gray clay with sandstone	671- 698
Hard sand; show of oil	698- 701
Gray clay	701- 731
Gray sand; with show of oil and gas	731- 790
Clay and sand	790- 801
Coarse pebbly sand, with sandstone and some gas	801- 846
Hard sandstone	846- 848
Soft gray clay	848- 864
Hard gray sandstone with marl	864- 873
Gumbo (blue clay)	873- 887
Soft gray sand	887- 900
Soft blue clay; showing oil	900- 922
White sand; showing gas	922- 930
Blue clay, with shells	930- 941
Hard gray sandstone	941- 953
Soft fine sand	953- 994
Shells	994-1,001
Clay with shells	1,001-1,020
Shells, with a little limestone	1,020-1,048
Hard gray sand	1,048-1,061
Blue clay, with hard streaks and shells	1,061-1,169
Hard sand	1,169-1,173
Soft gray clay	1,173-1,180
Hard blue clay	1,180-1,194
Limestone, with thin layers of clay	1,194-1,223
Clay	1,223-1,270
Thin layers of limestone, with some gas; hard in lower division	1,270-1,328
Gray sand; showing oil and gas	1,328-1,385
Hard limestone	1,385-1,387
Hard clay	1,387-1,397
Hard blue limestone	1,397-1,398
Pebbly concrete	1,398-1,400
Soft white lime, with iron "pellets"	1,400-1,412
Coarse gray sand	1,412-1,417
Limestones interstratified with blue and red clays and sand with pyrites	1,417-1,552
Conglomerate	1,552-1,570
Clay, with thin layers of limestone	1,570-1,600
Very hard bed of limestone	1,600-1,608
Yellow sand	1,608-1,618
Soft limestone	1,618-1,635
Clay, with wood and iron pyrites	1,635-1,665
Soft reddish clay	1,665-1,680
Blue limestone, with sand and pebbles	1,680-1,701
Soft red clay	1,701-1,756
White sandstone	1,756-1,767

	Feet.
Lissie gravel and marine Miocene beds—Continued.	
Limestone, with pink pebbles	1,767–1,775
Coarse gray sandstone, with some lime in lower division	1,775–1,844
Gray clay	1,844–1,868
Sandstone, with lime	1,868–1,895
Tough red clay	1,895–1,909
Gray and pink limestone	1,909–1,914
Blue clay and red clay	1,914–1,934
Sandstone	1,934–1,945
White limestone, with iron pyrites	1,945–1,997
Limestone	1,997–2,032

645. *Section of Treadway well on lot 36, Gladys City, near Spindletop, Tex.*

	Feet.
Recent deposits and Beaumont clay:	
Blue and yellow clay and sand	0– 269
Lissie gravel and marine Miocene beds:	
Sandrock and shells	269– 291
Blue clay, with shells and some thin layers of sandstone	291– 393
Sandstone	393– 407
Blue clay; with indications of oil at 413 feet	407– 432
Coarse gray sand, with gravel in last 18 feet	432– 472
Blue sand and shells	472– 493
Gray sandstone	493– 515
Blue clay	515– 525
Blue sand	525– 589
Sandstones, gray; with brown gravel	589– 619
Sand	619– 640
Blue shale and clay	640– 682
Soft white rock	682– 703
Gray quicksand	703– 854
Brown sandstone, with gray and white sand	854– 924
Blue clay	924–
Strata of limestones, sands, and clays	1,500–1,800

646. *Section of Denver-Beaumont Oil Tank & Pipe Line Co.'s well No. 1 at Spindletop, Tex.*

	Feet.
Yellow clay	0 – 42
Quicksand	42 – 60
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Yellow sand	60 – 82
Blue sand	82 – 103
Gumbo	103 – 145
Hard shale	145 – 146
Gumbo	146 – 230
Hard shale	230 – 252
Gumbo	252 – 296
Hard shale	296 – 372
Gumbo	372 – 416
Hard shale, with shells	416 – 451
Heavy gumbo	451 – 496
Hard shale, with shells	496 – 514

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	
Sandrock, with some oil	514 - 516
Hard shale, with shells	516 - 597
Quicksand	597 - 607
Hard shale, with shells	607 - 618
Hard limerock, with some shells	618 - 651
Quicksand	651 - 654
Crystallized limestone, with sharp sand	654 - 681
Quicksand	681 - 693
Gumbo	693 - 707
Hard limerock	707 - 708
Hard shale, with shells	708 - 717
Soft shale	717 - 746
Hard limerock	746 - 750
Gumbo	750 - 758
Crystallized limerock	758 - 760
Gumbo	760 - 771
Hard limerock	771 - 782
Gumbo	782 - 787
Limerock, with some oil in the seams	787 - 826
Gumbo	826 - 832
Hard limerock	832 - 835
Gumbo	835 - 896
Hard shale	896 - 922
Gumbo	922 - 989
Hard limerock	989 - 990
Gumbo	990 -1, 042
Hard shale, with stratum of limerock	1, 042 -1, 053
Gumbo	1, 053 -1, 095
First cap rock, oil sand, shells; some oil	1, 095 -1, 095. 5
Hard shale with small limestone strata	1, 095. 5-1, 097
Second cap rock, like first, with considerable oil	1, 097 -1, 098
Hard shale, with crystallized limerock	1, 098 -1, 101
Third cap rock, like first	1, 101 -1, 103
Oil sand	1, 103 -1, 110

647. *Section of Southern Co.'s well No. 4 at Spindletop, Tex.*

	Feet.
Soil	0- 35
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Quicksand	35-165
Shells	165-169
Water sand	169-355
Gravel	355-423
Sand and shells	423-502
Rock, with pyrite	502-506
Gumbo	506-648
Sand, with shells	648-672
Shells	672-720
Gumbo	720-784
Wet sand	784-823
Rock and gumbo	823-845
Sulphur	845-848
Flint rock (?)	848-851

Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	Feet.
Sand and shells	851–883
Gumbo	883–892
Sandrock	892–893
Gumbo	893–901
Flint rock (?)	901–905
Gumbo	905–965
Sand with shells	965–981
Sulphur	981–982
Cap rock	982–

648. *Section of Geyser-Kaltenbach well on block 23 at Spindletop, Tex.*

	Feet.
Yellow clay	0– 20
Quicksand	20– 56
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay	56–190
Quicksand	190–295
Coarse gravel	295–315
Blue clay	315–325
Hard blue shale	325–329
Blue clay	329–380
Coarse gravel	380–397
Blue clay	397–410
Coarse gravel	410–428
Coarse sand, with gas	428–465
Blue clay	465–480
Blue clay mixed, with small bowlders	480–495
Quicksand	495–507
Blue clay	507–590
White limerock	590–600
Sulphur and oil sand	600–602
Blue sandrock	602–620
Hard white limerock	620–625
Blue clay	625–632
Soft sandrock	632–643
Hard white limerock	643–644
Blue clay	644–652
Soft sandrock	652–657
Blue clay	657–680
Shell formation	680–717
White limerock	717–737
Gray clay	737–748
White limerock	748–749
Gray clay, with shells	749–780
Shells	780–787
Blue clay	787–794
Gray clay	794–810
Shells	810–812
Oil sand	812–815
Blue clay	815–820
Hard limerock	820–824
Black sand	824–830

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	
White limerock	830–832
Soft dark shale	832–845
Soft white limerock	845–852
Soft dark shale	852–865
Blue sand rock	865–870
Quicksand	870–882
White limerock	882–885
Sand showing oil	885–897
Blue clay	897–907
Iron pyrites	907–909
Dark clay	909–912
Oil sand	912–930

650. *Section of United States well on Bullock League, east of Spindletop, Jefferson County, Tex.*

	Feet.
Clay and sand	0– 180
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Sandstone	180– 246
Clay	246– 250
Sandstone	250– 260
Hard blue clay	260– 374
Rock, with thin stratum of sand	374– 481
Sand; slight traces of oil at 500 feet	481– 530
Hard rock	530– 560
Record wanting	560– 610
Blue clay	610– 680
Sand and gravel with gas at 724 feet	680– 841
Blue clay	841– 850
Blue sand; traces of oil at 860 feet	850– 880
Blue clay; traces of oil	880– 900
Sand	900– 921
Blue clay, with loose rock; traces of oil	921–1,037
Gray sand; indications of oil at 1,155 feet	1,037–1,236
Blue clay	1,236–1,240
Sand with shells	1,240–1,348
Hard rock	1,348–1,352
Sand with shells	1,352–1,375
Blue and red clays	1,375–1,410
Sandstone; oil indications below	1,410–1,500
Sand; strong indications of oil	1,500–1,530
Soft mud	1,530–1,583
Sand, with shells; indications of oil	1,583–1,690
Soft sand; indications of oil	1,690–1,720
Sandstone and sand; oil in sand	1,720–1,800
Red and blue clay; slight indications of oil	1,800–1,815
Soft mud	1,815–1,835
Sand	1,835–1,900
Soft mud	1,900–1,950
Sand	1,950–2,000
Blue clay	2,000–2,050
Coarse sand and shells	1,050–2,075

651. *Section of Allyne well, on lot 28, Iowa Colony lands, Bullock League, near Spindletop, Tex.*

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Sands and clays	0– 800
Clear fine gravel or coarse sand with strata of limestone	800– 850
Very fine quicksand; artesian water	850– 882
Wanting	882–1,000
Sand, sandstone with gravel and shells; salt water at 1,050 feet	1,000–1,075
Blue clay, with occasional beds of gravel and sand	1,075–1,545
Pinkish-colored limestone, with clays interstratified	1,545–1,725
Gravel, with a thin bed of blue clay	1,725–1,755
Thin limestone beds, with gravel, sand, and some clay	1,755–1,900
Sand	1,900–1,955
Blue, red, and chocolate-colored clay, with thin streaks of rock	1,955–2,015

652. *Section of Higgins Oil & Fuel Co.'s well No. 1, at Spindletop, Tex.*

	Feet.
Black loam	0– 3
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay	3– 30
Quicksand and very fine sand	30– 51
Fine sand, mixed with clay	51– 80
Fine sand, mixed with very fine clay	80– 100
Sand as fine as flour	100– 110
Fine sand	110– 120
Clay, sand, and stone	120– 140
Fine sand and brackish water	140– 160
Blue clay	160– 170
Coarse sand	170– 180
Coarser sand	180– 200
Medium fine sand	200– 225
A little finer sand	225– 245
Coarser sand, with black pebbles	245– 260
Still coarser sand	260– 280
Coarse sand, mixed with clay	280– 360
Coarse sand; no clay	360– 365
Coarser sand	365– 380
Very coarse sand	380– 395
Coarse sand, with black pebbles and shells	395– 418
Sharp finer sand and shells	418– 425
Blue sand; still finer	425– 445
Coarse sand	445– 460
Sharp sand; coarse shells	460– 490
Sharp sand; coarser shells	490– 515
First sign of oil	515– 536
No oil; coarse sand and shells	536– 556
Coarse sand, with black pebbles; more oil than at 536	556– 575
Very fine blue sand; no oil	575– 995
Coarser sand; some shells	995– 615
Coarser sand and siliceous pebbles	615– 700

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	
Very coarse blue shells	700– 785
Finer shells; some blue clay	785– 805
Clayey sand; numerous shells	805– 825
Sand; some shells	825– 845
Blue sand; some shells	845– 875
Little finer sand; some shells	875– 900
Yellow sand; fairly good signs of oil which settled on water	900– 920
No oil; medium fine sand	920– 940
Blue shale; some shells	940– 945
Blue shale; no shells	945– 960
Darker sand; trace of oil	960– 980
Lighter colored sand; blue shale; trace of oil	980–1,000
Blue shale; trace of oil (a barrel bailed in two days)	1,000–1,020
Oil-bearing rock	1,020–1,030
Sulphur and rock	1,030–1,040

653. *Section of Higgins Oil & Fuel Co.'s well No. 2, near southern margin of Spindletop oil pool, Jefferson County, Tex.*

	Feet.
Soil, black sandy loam	0 – 0.66
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Yellow clay, with red streaks	0.66– 14
Blue clay, with limy concretions	4 – 16
Bluish-gray sand	16 – 22
Yellowish-colored clay, with lime	22 – 30
Dark-blue clay, with some lime and shells	30 – 40
Gray sand	40 – 56
Blue sand	56 – 69
Blue clay, with pyrites	69 – 120
Blue sand, with some clay and small pebbles	120 – 146
Fine bluish-gray sand	146 – 156
Fine gray sand	156 – 187
Fine gray sand, with black specks	187 – 197
Bluish-tinted gray sand	197 – 262
Dark-gray sand, with black specks	262 – 271
Fine drak-gray sand	271 – 315
Fine grayish-tinted sand	315 – 350
Fine grayish-green sand	350 – 400
Fine brownish-gray sand	400 – 440
Fine brown sand, with shells	440 – 470
Fine brown sand, with broken shells	470 – 491
Coarse blue sand, with broken shells	491 – 500
Very fine muddy sand	500 – 547
Very fine bluish-gray sand	547 – 564
Very fine gray sand, with bluish tint	564 – 612
Fine gray sand, with bluish tint	612 – 624
Fine sandy clay (fish bones, at 628 feet)	624 – 666
Fine blue sandy clay	666 – 672
Very fine light-blue sand	672 – 685
Light-blue rock	685 – 728
Bluish-gray sand	728 – 736

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	
Light-gray sand, with shells	736– 750
Marl, with small shells	750– 756
Light bluish-gray sand and shells	756– 761
Fine sand and shells	761– 825
Very fine dark brownish-gray sand	825– 874
Hard grayish-blue sandy clay, with shells; heavy indications of oil	874– 900
Dark rock 2 feet, shells 1 foot	900– 903
Dark grayish-blue sand, with some clay	903– 915
Lignite	915– 920
Bluish-gray sand, with shells	920– 954
Bluish-gray rock	954– 958
Very fine grayish-brown sand, with shells	958– 982
Very fine sand, with shells	982– 995
Dark gray rock, "cap rock"	995–1,000
Coarse dark-gray sand, with oil	1,000–1,006

654. *Section of Higgins Oil & Fuel Co.'s well No. 3, at Spindletop, Tex.*

	Feet.
Soil and clay	0– 17
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Sand	17– 23
Clay	23– 43
Quicksand with clay	43– 83
Water sand	83– 98
Blue marl	98– 178
Quicksand	178– 308
Blue clay	308– 318
Water sand	318– 353
Blue marl	353– 383
Quicksand	383– 425
Rock	425– 426
Quicksand	426– 467
Sandrock	467– 471
Blue marl	471– 521
Shell rock	521– 524
Blue marl	524– 584
Quicksand	584– 614
Rock	614– 620
Blue clay	620– 623
Rock	623– 625
Blue clay	625– 632
Rock clay	632– 636
Blue marl with sand	636– 666
Rock	666– 667
Blue sand	667– 747
Blue clay	747– 759
Shell rock	759– 773
Blue marl	773– 833
Rock	833– 838
Blue clay	838– 848
Rock	848– 854

Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.

	Feet.
Blue clay	854– 866
Oil sand	866– 886
White limerock	886– 989
Sulphur and oil sand	989–1,008
White limerock	1,008–1,081
White limerock with sand	1,081–1,306
Sand with a little gas	1,306–1,307
White lime with sand	1,307–1,480
Sand with very little gas	1,480–1,481
White lime with more sand than heretofore	1,481–1,527
Salt-water sand	1,527–1,567
White lime and sandrock	1,567–1,620
Same, with gas	1,620–1,625
Rock	1,625–1,647
Rock salt	1,647–1,956
Quit in rock salt	1,956–

655. *Section of Higgins Oil & Fuel Co.'s well No. 7, Spindletop, Tex.*

	Feet.
Yellow and red clay	0– 21
Very fine sand	21– 29
Beaumont clay and Lissie gravel:	
Blue clay with some shells	29– 85
Coarse sand and sulphur water	85– 94
White clay with fine shells	94– 114
Very coarse sand; much water	114– 324
Red and gray clay, very sticky	324– 334
Fine sand, with shells and gravel	334– 413
Gumbo, very sticky	413– 476
Sand; showing of oil	476– 480
Blue clay	480– 505
Sandwith rotten wood	505– 506
Sandrock	506– 508
Sticky clay, very dark	508– 550
"Cement rock," shells, and sand	550– 552
Very fine loose sand	552– 557
Very hard sandstone	557– 558
White sticky clay, very hard	558– 565
Limerock (cemented shells)	565– 567
Clay, very gummy	567– 575
Soft white limestone	575– 577
White clay	577– 629
Very hard blue flint rock	629– 630
Rock, shells, and clay	630– 667
Hard sandstone	667– 669
White clay, very gummy	669– 704
Very hard white limestone	704– 709
Sand with strong gas pressure	709– 722
Sulphur and white rock mixed	722– 746
Very porous oil rock	746– 770
Very hard clay	770– 772

656. *Section of the J. M. Guffey Petroleum Co.'s well (McFaddin No. 1, original Lucas "gusher") on the P. Humphrey survey, Spindletop, Tex.*

	Feet.
Yellow clay	0 – 36
Coarse gray sand	36 – 56
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay, pretty hard	56 – 170
Fine gray sand	170 – 245
Variously colored gravel, from bean to goose-egg size	245 – 265
Coarse gray sand	265 – 317
Blue clay	317 – 352
Coarse gray sand, with pyrite concretions	352 – 376
Blue clay	376 – 395
Fine gray sand, with lignite	395 – 440
Marl	440 – 448
Gray sand with concretions and much lignite	448 – 508
Soft limestone	508 – 508.75
Gray clay and sulphureted hydrogen gas	508.75 – 528.25
Hard sandstone, with calcite depositions	528.25 – 529
Gray sand	529 – 563
Compact hard sand with pyrite	563 – 588
Hard sandstone and calcareous concretions	588 – 588.5
Gray clay	588.5 – 601.75
Hard sand	601.75 – 602
Gray clay with calcareous concretions	602 – 659
White calcareous shells	659 – 665
Gray clay	665 – 679
Gray sandstone; oil	679 – 685
Gray clay, with calcareous concretions	685 – 692
Gray clay, getting harder	692 – 715
Calcareous concretions, with calcite	715 – 717
Hard gray clay, with calcareous concretions; much fine pyrite	717 – 853
Sandstone and pyrite; hard	853 – 873
Hard rock, apparently limestone	873 – 875
Fine oil sand, with large layer toward the bottom and heavy pressure under it, filling casing for 100 feet above point of drilling	875 – 899
Hard clay	899 – 979
Calcareous concretions, with layers of hard sandstone	979 – 1,029
Struck heavy gas pressure and oil, which lasted about one hour and then subsided	1,029 – 1,069
Sand mixed with calcareous concretions and fossils	1,069 – 1,139

657. *Section of Heywood Oil Co.'s well No. 2, Spindletop, Tex.*

	Feet.
Red clay	0– 15
Fine sand	15– 25
Blue clay	25– 60

	Feet.
Beaumont clay and Lissie gravel:	
Sand	60- 75
Blue clay	75-120
Sand	120-130
Clay	130-180
Sand	180-480
Clay	480-510
Sand	510-526
Rock	526-527
Sand	527-595
Rock in small layers, clay between	595-620
Clay	620-633
Rock	633-638
Clay	638-660
Rock	660-663
Clay	663-680
Sand	680-690
Rock	690-694
Clay	694-735
Rock	735-740
Clay	740-780
Rock	780-786
Sand	786-830
Rock	830-832
Clay	832-872
Rock	872-873
Sand	873-893
Clay	893-917
Sulphur rock	917-950
Oil sand	950-967

658. *Section of Heywood Oil Co.'s well No. 3, at Spindletop, Tex.*

	Feet.
Yellow clay	0- 18
Sand	18- 28
Blue clay	28- 60
Beaumont clay and Lissie gravels:	
Sand	60- 78
Blue clay	78-180
Sand	180-350
Clay and sand	350-480
Rock	480-530
Clay	530-560
Sand	560-595
Clay	595-740
Sand	740-780
Clay	780-812
Sand	812-822
Clay	822-842
Sulphur rock, with oil signs	842-852
Sand	852-872
Sulphur rock	872-887
Sand	887-897
Sulphur rock	897-905

Beaumont clay and Lissie gravels—Continued.

	Feet.
Sand	905–907
Sulphur rock	907–927
Loose oil sand	927–935

659. *Section of well on Chaison Place in southeast Beaumont, Tex.*

[Furnished by J. W. McCarley, driller.]

	Feet.
Red clay	1– 45
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Water sand (surface water)	45– 82
Clay, reddish hue	82– 103
White sand	103– 168
Blue gumbo	168– 231
Hard gray sand	231– 290
Soft blue sand	290– 359
Blue gumbo	359– 368
Sand, bluish, with black specks; artesian flow	368– 458
Gumbo	458– 480
Soft blue shale	480– 530
Gumbo	530– 612
Blue sand	612– 635
Brown shale; sour taste; 18 inches rock	635– 771
Soft brown shale	771– 997
Porous brown rock; very hard	997– 999
"Oil sand"	999–1,026
Gumbo	1,026–1,269
Sand and salt water	1,269–1,284

665. *Section of well at Gulf, Colorado & Santa Fe Railway station at Beaumont, Tex.*

	Feet.
Beaumont clay:	
Clay	0– 6
Sand	6– 8
Blue clay	8– 45
Sand, with shells	45– 49
Blue clay, with thin streaks of sand	49–120
Lissie gravel:	
Sand, with water	120–175

666. *Section of Almaden well, southwest corner of Bullock League, southwest of Beaumont, Tex.*

	Feet.
Recent:	
Surface clay	0– 10
Orange sand	10– 75
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay	75– 175
Dark-gray sand	175– 200
Blue clay	200– 300
Clay and bark	300– 353
Heavy dark-blue clay	353– 400
Fine sand, with wood	400– 552
Clay	552– 557
Fine gray sand	557– 605
Clay	605– 623
Sand, with slight showing of oil	623– 643

Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.

	Feet.
Sandy clay	643- 725
Fine gray sand	725- 865
Sandy clay, with broken shells	865- 995
Fine dark sand	995-1,070
Blue sandy clay, with broken shells	1,070-1,135
Fine gray sand	1,135-1,155
Blue clay and sand	1,155-1,170
Clay	1,170-1,260
Sand	1,260-1,400

667. *Section of Caswell well on the David Brown survey, near Beaumont, Tex.*

	Feet.
Clay	0 - 45
White sand	45 - 110
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay	110 - 325
Sand	325 - 490
Clay	490 - 675.5
Rock, showing oil	675.5- 676
Clay	676 - 681
Rock, showing oil	681 - 682
White quicksand, with black specks	682 - 810
Blue clay	810 - 830
Sand	830 - 870
Blue clay	870 - 890
Sand; salt water at 930 feet	890 - 950
Clay and coarse brown sand, showing oil	950 - 970
Hard blue clay	970 -1,000
Sand	1,000 -1,050
Clay and shells	1,050 -1,184
Hard white clay	1,184 -1,197
Sand, showing oil	1,197 -1,203
Three beds of limestone, with 1 foot of oil and asphalt (?)	1,203 -1,240
Oil sand	1,240 -1,243
Clay	1,243 -1,275
Sand	1,275 -1,282
Clay	1,282 -1,386
Sandstone	1,386 -1,388
Clay	1,388 -1,389
Sand	1,389 -1,406
Hard red clay, drying to light pink	1,406 -1,518

668. *Section of Gulf Coast Oil & Land Co.'s well, in sec. 11, International & Great Northern Railroad Co.'s lands, Jefferson County, Tex.*

	Feet.
Red clay	0- 20
Quicksand	20- 50
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Alternate strata of sand and clay	50- 120
Hard blue clay	120- 170
Sand and clay	170- 280

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.	
Shale	280– 310
Blue clay	310– 360
"Hardpan," traces of oil	360– 400
Sand and shale	400– 440
Sandrock	440– 441
Red marl shale	441– 471
Sandrock	471– 472
Sand and shale	472– 540
Blue clay, with cypress logs (Beaumont clay)	540– 580
Rock in thin layers, with gravel	580– 700
Limestone and sandstone, with traces of sulphur	700– 780
Hard blue clay	780– 830
Rock in thin layers, with sand and clay	830– 900
Shells and gravel	900– 910
Blue clay, with small lumps of limestone	910– 990
Hard blue clay and shells	990–1,000
Blue and red clay, mixed with shells and gravel	1,000–1,060
Thin rock, blue and red clay, in layers	1,060–1,130
Shells and clay	1,130–1,190
Clay and shells	1,190–1,200
Thin rock and gravel	1,200–1,250
Black shale, traces of oil	1,250–1,280
Yellow sand	1,280–1,300
Red and blue clay and shells	1,300–1,340
Sharp, coarse sand	1,340–1,360
Hard blue clay, with limestone in hard lumps	1,360–1,410
Soft blue clay	1,410–1,430
Sand and clay	1,430–1,450
Thin rock and gravel	1,450–1,470
Sharp sand	1,470–1,480
Hard blue clay	1,480–1,500
Gravel and limestone	1,500–1,516

669. *Section of American Oil Co.'s well, Texas & New Orleans Railroad Co.'s lands, sec. 101, 5 miles west of Beaumont, Tex.*

	Feet.
Sand	0– 3
Yellow clay	3– 8
Quicksand	8– 18
Yellow clay	18– 29
Fine sand and shells	29– 32
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Blue clay	32– 48
Sand	48– 66
Blue clay	66– 78
Sand	78– 88
Blue clay	88– 120
Fine sand and shells	120– 126
Blue clay	126– 146
Sand	146– 174
Blue clay	174– 209
Sand	209– 230
Blue clay	230– 264

Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.

	Feet.
Sand	264– 272
Blue clay	272– 294
Sand	294– 320
Blue clay	320– 339
Sand	339– 403
Blue clay	403– 440
Sand	440– 453
Blue clay	453– 484
Sand	484– 490
Blue clay	490– 536
Sand	536– 560
Blue clay	560– 577
Sand with hard streaks	577– 590
Red clay	590– 605
Soft sandstone	605– 607
Sand	607– 637
Sand with hard streaks	637– 640
Blue clay	640– 655
Sand	655– 675
Blue clay	675– 700
Sand	700– 765
Fine quartz gravel from pea to marble sizes, smooth, and various colors	765– 775
Sand	775– 840
Blue clay	840– 853
Sand	853– 864
Red clay	864– 870
Sand	870– 892
Bark and logs	892– 900
Blue clay	900– 916
Sand and shells	916– 926
Blue clay	926– 934
Sand	934– 990
Hard sand	990– 994
Bark and logs	994–1,010
Blue clay	1,010–1,021
Sand	1,021–1,046
Red clay	1,046–1,055
Sand, clay, and bark	1,055–1,070
Blue clay	1,070–1,082
Sand	1,082–1,105
Blue clay	1,105–1,132
Sand	1,132–1,153
Sand and gravel	1,153–1,164
Blue clay	1,164–1,203
Sand	1,203–1,233
Sand and fine gravel	1,233–1,249
Sand	1,249–1,304
Sand and shells	1,304–1,316
Blue clay	1,316–1,323
Soft limestone	1,323–1,325
Yellow clay	1,325–1,329
Sand	1,329–1,359

Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.

	Feet.
Red clay	1,359–1,371
Sand and shells	1,371–1,376
Blue clay	1,376–1,417
Sand	1,417–1,454
Blue clay	1,454–1,531
Sand	1,531–1,537
Blue clay	1,537–1,549
Sand	1,549–1,559

671. *Section of Sanger well, near Pine Island Bayou, D. Easley survey, 9 miles north of Beaumont, Tex.*

	Feet.
Clay	0 – 6
Lissie gravel and marine Miocene beds:	
Coarse water sand	6 – 156
Blue clay	156 – 162
Alternate layers of clay and coarse white sand; clay, blue; sand, water-bearing	162 – 600
Shell rock	600 – 600.5
Sand	600.5– 641
Blue clay and sand, more clay than sand	641 – 901
Shell rock	901 – 902
Sand	902 – 932
Blue and red clay	932 – 992
Sand and clay	992 –1,231
Shells	1,231 –1,232
Sand and clay	1,232 –1,259
Sand	1,259 –1,289
Clay	1,289 –1,309
Sand and shells	1,309 –1,334
Clay	1,334 –1,419

683. Kennedy says: "* * * At a depth of 350 feet rock was encountered, which continued to a depth of 1,400, where drilling was discontinued. This rock, which is remarkably uniform throughout its 1,050 feet, is a light-gray crystalline dolomite. The rock is massive, but contains parallel seams which may represent bedding planes. These have an inclination of about 7°, indicating a decided dip in the beds. Since the angle of dip is obtained from cores, its direction can not be determined, but it is assumed to be toward the east, with the surface slope on which the well is located. The dolomite contains much gypsum, and in places is cavernous. * * *

"While it can not be stated definitely from data at present available, it appears probable that this locality is upon a dome similar to those at Spindletop and High Island. A well at Winnie, only a few miles to the west, found no rock whatever to a depth of 1,600 feet."

684. This well went 2,496 feet before encountering any formation characteristic of the mounds. At that depth it entered "solid gray limestone, with gypsum and some pyrite." After drilling in this rock 34 feet, the well was abandoned.

687. C. M. Lowe says: "The distance between the first (120 feet) and second (260 feet) sands in these wells is about the same. These two wells yield the same character of water and in about the same quantity. These two water-bearing sands are connected, as pumping one well in either sand lowers water level in other sands 50 to 400 feet distant."

688. C. M. Lowe says: "This water (at 580 feet) is perceptibly salty, but on analysis State chemist stated was safe for use for irrigating rice with 25 per cent admixture of fresh water. No bad effects are visible."

690. *Section of Port Arthur Oil Co.'s well, 2½ miles west of Port Arthur, Tex.*

	Feet.
Beaumont clay and Lissie gravel:	
Blue surface clay	0 - 87
Wet blue sand	87 - 109
Dry white sand	109 - 291
Blue clay	291 - 331
Dry sand	331 - 401
Blue clay	401 - 441
Whitish-yellow wet sand	441 - 466
Dry sand	466 - 496
Hard blue clay	496 - 723
Sand, with a little oil	723 - 724.5
Hard blue clay	724.5- 778
Bluish wet sand	778 - 926
Blue clay	926 - 971
Wet sand	971 -1,001
Sand and clay	1,001 -1,120
Conglomerate of sand, mud, and clay	1,120 -1,260

694. *Section of artesian well at Windsor Hotel, Sabine, Tex.*

[Furnished by J. G. Reeve, hotel manager.]

	Feet.
Recent deposits, Beaumont clay, and Lissie gravel:	
Black mud and sand	0- 60
Sand; salt water; no flow	60- 175
Clay (Beaumont ?)	175- 452
Sand; flows 7 gallons per minute of salt water	452- 498
Clay and shell mixed	498-1,031
Shell	1,031-1,035
Sand; flows salt water	1,035-1,065

1,031 feet of 4½-inch casing used; 30-foot strainer between 1,031 and 1,061 feet.

700. *Section of well owned by C. S. Edgar, 3 miles west of Nome, Tex.*

	Feet.
Beaumont clay, Lissie gravel, and marine Miocene beds:	
Greenish, soft gumbo; slight showing of oil	0- 135
Sand and gumbo; tested here for oil; none to amount to paying venture	135- 560
Sand	560- 570
Gumbo	570- 609
Coarse sand	609- 629
Gumbo	629- 850
Clam shells	850- 890
Gumbo	890-1,215
Red clay	1,215-1,225
Gumbo	1,225-1,260
Sand; slight showing of oil	1,260-1,287
Gumbo	1,287-1,290
Rock	1,290-1,291
Gumbo	1,291-1,300

Beaumont clay, Lissie gravel, and marine Miocene beds—Continued.

	Feet.
Blue gumbo	1,300–1,310
Sand	1,310–1,325
Gumbo	1,325–1,334
Sand; slight showing of oil	1,334–1,450
Rock	1,450–1,510
Gumbo and rock sand, very hard at 1,810 feet	1,510–1,810
Gumbo	1,810–1,985
Rock	1,985–1,990
Gumbo	1,990–2,000

701. *Section of Texas & New Orleans Railroad Co.'s well at Nome, Tex.*

Beaumont clay and Lissie gravel:

	Feet.
Clay	0– 19
Sand	19–103
Clay	103–107
Sand	107–123
Clay	123–169
Sand	169–181
Clay	181–230
Sandy loam	230–359
Sand	359–380
Clay	380–420
Sand	420–460
Soft shale	460–642
Sand, water bearing	642–692$\frac{5}{12}$

655 feet and 7 inches of 8-inch casing used; 36 feet 10-inch strainer between 655 feet 7 inches and 692 feet 5 inches.

704. G. H. Nicholls, of Galveston, writes: "The boring to 800 feet took about three months. One gas blow-out occurred, and water used in boring was lost for 24 hours (absorbed in a porous nonsaturated stratum) between 750 and 800 feet. The 8-inch pipe was pulled to 400 feet, and the well caved in; it was then pumped full of clay, and boring resumed under 100 pounds pressure on force pump. The 6-inch pipe was driven down to 1,500 feet. The driller failed to bail the well. After some weeks water rose to top of casing, and I have several times brought oil to the top by dropping pieces of iron down. Some months since I had it dynamited. It has now caved in around the casing. * * * The well * * * did flow for a short time, but only a few gallons per diem."

705. *Section of Stribling well at Sabine Pass, Tex.*

Recent deposits, Beaumont clay, and Lissie gravel:

	Feet.
Red clay	0 – 16
Red sand	16 – 20
Red clay	20 – 60
White sand	60 – 80
Red clay	80 – 140
Coarse sand	140 – 170
Blue clay	170 – 185
White sand	185 – 220
Soft blue clay	220 – 236
Fine white sand	236 – 250
Hard blue clay	250 – 260

Recent deposits, Beaumont clay, and Lissie gravel—Continued.

	Feet.
White sand	260 - 270
Blue clay	270 - 355
White sand	355 - 426
Blue clay	426 - 442
Interbedded sand and clay	442 - 500
White sand	500 - 600
White sand with gravel at bottom	600 - 636
Blue clay with streaks of sand	636 - 740
Sand	740 - 764
Sand and coarse gravel, all colors	764 - 795
Hard sandstone	795 - 796
Blue shale	796 - 854
Hard sandstone	854 - 855.5
Blue shale	855.5- 892
Sandstone	892 - 893
Fine white sand	893 - 960
Soft blue clay	960 -1,000
Fine white sand	1,000 -1,260
Blue and white shale	1,260 -1,270
Fine white sand	1,270 -1,360
White and blue clays	1,360 -1,450
White sand	1,450 -1,490
Solid white and blue shale	1,490 -1,500

706. *Section of Texas Oil Co.'s well on the B. F. Howard League, Tex., 3 miles west of Sabine Pass.*

Recent deposits, Beaumont clay, and Lissie gravel:

	Feet.
Blue and yellow clay	0- 170
Dark quicksand	170- 300
Blue clay	300- 730
Blue clay with asphalt	730- 763
Blue and yellow clay with oil at bottom	763- 999
Sand	999-1,001
Blue clay	1,001-1,039
Bluish-black sand	1,039-1,056
Blue clay	1,056-1,058
Coarse white sand	1,058-1,135
Blue clay and sand	1,135-1,390
Sand, clay, and shells	1,390-1,486

707. Thomas Wilson, postmaster at Sabine Pass, writes: "The well was bored in 1896 or 1897 as an artesian well, but the water had so much iron and other minerals in it that it burned everything it flowed over. It could not be used for irrigation purposes; hence was conducted into a ditch where it could do no harm. When the oil boom at Spindletop broke out in 1900 and the prospects for oil became good the land was leased * * * with the hopes that a gusher would be brought in equal to any that had come in at Spindletop * * * ." The well was deepened, but failed to find any oil.

KAUFMAN COUNTY.

GEOLOGY AND HYDROLOGY.

In that portion of Kaufman County lying within the Tertiary area (see Pl. I, in pocket) the artesian conditions are highly unfavorable. The barren marls of the Midway formation constitute the surface. No Tertiary water horizons are available, and the only possible sources of artesian water are those of the Cretaceous, the best of which are too deeply buried to be available. Likewise the quality of their water is questionable.

At Mabank, in the extreme southeast corner, where the sands of the Wilcox formation, here extremely thin, outcrop, a flow suitable for stock was supplied at a depth of 950 feet by a sand in the Upper Cretaceous or Nacatoch reservoir. This reservoir, however, will not produce flows except in a very small portion of this county. (See Pl. VII, in pocket.)

WELL DATA.

Details of the wells in the county appear in the following table:

Wells and springs in Kaufman County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.
				Inches.	*Feet.*
723	Kemp, 8 miles south	R. W. Burns	R. W. Burns		
724	Mabank, 400 feet southeast of post office.	Mabank Land Co	E. O. Jones	8	1,500.

No.	Approximate elevation of surface.	Head of water above ground.	Depths to principal water-bearing strata.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Feet.*			
723						Spring.
724	(?) 383	20	950	Nacatoch	Salty	Drilled by C. L. Witherspoon. Stock drink this water. Completed 1905.

LEON COUNTY.

GEOLOGY AND HYDROLOGY.

In the northwestern half of Leon County the sands of the Wilcox formation form the surface; in the southeastern half they are embedded beneath the Mount Selman and Cook Mountain formations. (See Pl. I.) The lower Eocene sands constitute, therefore, the available sources of artesian supplies. They will develop flows in the valleys but not on the divides. Their depth is indicated on the map (Pl. VIII, in pocket). Along the north line of the county they supply wells extending to depths from 200 feet above to 200 feet below sea level; toward the south they lie deeper and along the southern line can be reached from sea level to 600 feet below.

The only artesian well in Leon County is half a mile northwest of Buffalo. It is 1,100 feet deep and yields a flow of soft water from a sand in the lower Eocene.

WELL DATA.

Details of the county wells appear in the following table:

Wells and springs in Leon County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.
				Inches.	*Feet.*
725	Jewett, 4 miles east	B. D. Dashiells	J. H. Brown		
726	Buffalo, 2 miles southwest	Beecher Jones	Beecher Jones		
727	Buffalo, ½ mile northwest	M. Oliver	S. W. Bighorn	6	1,100.
728	Snow, 1 mile east	I. L. Hillhouse	I. L. Hillhouse		
729	Rogers Prairie	J. A. Heath	Postmaster	7	103.
730	do	Palmer & Hunter	do	7	108.

No.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (—) ground.	Quality.	Remarks.
	Feet.	*Feet.*	*Feet.*		
725				Iron	Spring; local resort. Flows 8 to 10 gallons a minute.
726				Soft	Spring. Flows 2 to 3 gallons a minute.
727	347		+4	do	Draws from the Wilcox; completed 1901. Flows 50 gallons a minute.
728				do	Spring. Plenty of similar springs in this vicinity are used for stock and for drinking. Flows 10 gallons a minute.
729	363 (?)	103	—50	Hard	Drilled by W. A. Cobb.
730		40, 60, 108	—58	do	Do.

LIBERTY COUNTY.

GEOLOGY AND HYDROLOGY.

Marine Miocene.—The marine Miocene beds can be struck south of the Texas & New Orleans Railroad at depths ranging from 600 to 1,500 feet. These beds will produce flows in the prairie region. Their water, however, may not be of desirable quality and should not be sought at depths exceeding 1,000 feet. It is indeed doubtful if they would yield any water of merit, for it is believed that all the water in the county from depths exceeding 600 to 700 feet will be more or less unsuited for domestic use, steaming, and irrigation; and these depths would hardly reach the marine Miocene sands.

Lissie gravel.—The portion of Liberty County lying north of the Texas & New Orleans Railroad is occupied by the outcrop of sands belonging to the Lissie gravel. To the south these sands are embedded beneath the Beaumont clay, and they constitute the reservoir which supplies the numerous artesian wells on the coast prairie. At Liberty they come to within 25 to 60 feet of the surface, but near Lake Charlotte it requires a boring 200 to 300 feet deep to reach them.

In the catchment area flows from these sands are confined chiefly to the valleys and the bottoms. In the embedded area they produce flows on the divides as well as in the bottoms. (See Pl. VII, in pocket.) Four miles west of Stilson (well No. 740) water from a sand at 300 feet rises within 17 feet of the surface. At Stilson (well No. 739) a sand at 380 feet yields a flow.

With perhaps the exception of a region 4 miles southwest of Dayton, where salt water has been encountered at 360 feet, and possibly of a few other undiscovered mounds, these sands may be expected to yield potable supplies over the entire county.

On the prairie many artesian wells are used for rice irrigation. In the timber belt there is less demand for artesian water, the railroads and the sawmills being the chief consumers.

WELL DATA.

Details of wells in Liberty County are given in the following table:

Wells and springs in Liberty County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
731	Liberty, 1 mile west.		C. W. Fisher	C. W. Fisher	C. W. Fisher.
732	Liberty, ½ mile south.		J. T. Russell		T. U. Taylor.[a]
733	Liberty, ¾ mile southeast.		do		Do.[a]
734	Liberty, ½ mile south.		Melon Farm		Do.[a]
735	Liberty		Texas & New Orleans R. R.		Do.[a]
736	Liberty, 300 yards southeast.		do		Do.[a]
737	Liberty		Judge Nyland		William Stocy.
738	Gulf, Colorado & Santa Fe Ry. crossing, at Trinity River.		Gulf, Colorado & Santa Fe Ry.		T. U. Taylor.[a]
739	Stilson		N. B. Sapp		Do.[b]
740	Stilson, 4 miles west.	Sec. 29, Houston & Texas Central R. R.	C. Newman	C. A. Brown	C. S. Brown, assistant postmaster.
741	Stilson, 1 mile southwest.	Sec. 37, Houston & Texas Central R. R.	Charles Seaburgh	do	Do.
742	Stilson, 4 miles southwest.		W. A. Noble	do	W. A. Noble.
743	Stilson	Sec. 138, Gulf, Colorado & Santa Fe R. R. Co.	Hill-Brown Rice Land & Irrigation Co.		Wm. Kennedy.[c]
744	Stilson, 1 mile		C. S. Brown	C. S. Brown	C. S. Brown.
745	Stilson, 5 miles west.			C. A. Brown	C. A. Brown.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 43.
[b] Taylor, T. U., Rice irrigation in Texas: Bull. Univ. Texas, No. 16, 1902, p. 20.
[c] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, pp. 46-47.

Wells and springs in Liberty County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
746	Pelican, $\frac{3}{4}$ mile northeast.	....	Pelican Oil Co.......	....	
747	Cleveland..........	....	Gulf, Colorado & Santa Fe Ry.	....	T. U. Taylor.[a]
748	.....do............	....	W. C. McBride....	....	Postmaster.
749	.....do............	....	Dallas Oil & Development Co.	....	Do.
750	.....do............	....	C. C. Cherry.......	....	Do.
751	Dayton, 4 miles southeast, near Trinity River.	....	Bullard & Wilson.	....	N. M. Fenneman.[b]
752	Dayton..........	NW. $\frac{1}{4}$ S. $\frac{1}{2}$ sec. 125, Houston & Texas Central R. R.	Sun Co...........	....	Sun Co.
753	.....do............	J. B. Harrison tract, NW. $\frac{1}{4}$ S. $\frac{1}{2}$ sec. 125, Houston & Texas Central R. R.	.....do............	....	Do.[c]
754	.....do............	....	....	....	A. Deussen.
755	.....do............	Sec. 124, Houston & Texas Central R. R.	Taylor-Dayton Co.	....	Wm. Kennedy.[d]
756	.....do............	....	J. M. Guffey Petroleum Co.	....	Do.[e]
757	Dayton, 2 miles southeast.	....	Ed Pruitt..........	J. A. Conklin.....	J. A. Conklin.
758	Clark, 3 miles north.	....	Liberty County school.	....	H. H. Daniels.
759	Rye, 2 to 3 miles north.	....	D. R. Emanuel...	....	D. R. Emanuel.
760	Milvid, 300 feet southeast of post office.	....	T. B. Allen & Co..	R. B. Melat......	C. S. Vidor.
761	Milvid, $\frac{1}{4}$ mile southwest.	....	Miller & Vidor Lumber Co.	.....do............	Do.
762	Big Creek, 2,000 feet northwest.	....	Liberty Hardwood Lumber Co.	W. J. Giles.......	W. J. Giles.
763	Big Creek, 8 miles southeast.	....	A. G. Lesterjette..	....	Postmaster, Big Creek, Tex.
764	Keno............	....	....	....	J. A. Singley.[f]
765	Walter, 1 mile southeast.	....	Frank Abshier....	L. D. McAlister..	Frank Abshier.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 44.
[b] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 85.
[c] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 166.
[d] Hayes, C. W., and Kennedy, William, op. cit., pp. 46–47.
[e] Idem, pp. 126–127.
[f] Singley, J. A., Preliminary report on the artesian wells of the Gulf coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 107.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
731	2............	232............	28(?)..........	232............	+34..........	....	17.
732	....	290............	....	....	Flows..........	....	
733	....	300............	....	....	.....do..........	....	
734	....	240............	....	....	.....do..........	....	
	....	245............	....	....	.....do..........	....	
735	6............	576............	....	....	.....do..........	....	
736	....	800............	....	....	.....do..........	....	
737	6............	365............	....	360............	.....do..........	....	
738	....	300............	....	240 to 290..........	No flow..........	....	
739	8............	380............	....	....	Flows..........	....	
740	10 to 7..........	400............	....	300............	−17..........	800....	
741	11 to 8..........	415............	....	100............	−17..........	800....	
742	9 to $\frac{5}{8}$..........	400............	67............	320............	−8..........	....	
743	8............	487............	85............	447 to 487..........	−10..........	....	
744	....	400............	±72............	300............	−16..........	700....	
745	9 to $\frac{5}{8}$..........	400............	(?) 60..........	300............	−18..........	700....	

Wells and springs in Liberty County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
746	8	1,200					
747		368			Flows (?)		
748		1,200					
749		1,300					
750		1,300					
751		670+					
752		775		420 to 440			
753		1,763					
754		1,508					
755		1,200	100	28 to 36, 320 to 326.			
756		1,900					
757	8	1,014		{60 to 300 {738	+50		Large.
758		Spring					
759		do					2.
760	4	659		550 to 659	+30		
761	4	585		532 to 585	+40		300.
762	4	608		485 to 508	+55		
763		662		{200 (?) {640 to 662	}Strong flow		
764		700		90	−50	21	
765	10	1,225	±40	1,000	−10		

No.	Source of water.	Quality.	Remarks.
731		Hard	Completed, 1895.
732			
733			
734			Two wells.
735			Used in locomotive boilers.
736			
737	Lissie	Soft	Used for rice irrigation; completed, May, 1895.
738	do		Used in locomotive boilers.
739			Cypress log struck at a depth of 360; water used for rice irrigation.
740	Lissie	Soft	Used for rice irrigation.
741	do	Some sulphur	Used for rice irrigation; completed, 1902.
742	do	Soft	Used for rice irrigation; completed, 1904.
743	do		Two wells.
744	do		Formerly used for rice irrigation; abandoned; water vein 100 feet thick; supply abundant; completed, 1902.
745	do		Used for rice irrigation; completed, 1907.
746			
747		(a)	
748			Drilled for oil.
749			Do.
750			Do.
751		Strong salt water charged with hydrogen sulphide found below 360 feet.	Oil test well; Bullard & Wilson well No. 5; 6 wells have been put down in this locality in search of oil.
752	Lissie		West Liberty well No. 2, producing oil at 775 feet; completed, 1905.
753			Oil test well; no oil. Known as Sun Co.'s Quintette No. 1 well. Completed, 1905.
754			Oil test well.
755	Lissie		Drilled for oil; rock salt at bottom. Well No. 1.(?)
756			Drilled for oil.
757	Lissie	Soft	Drilled for oil. In river bottom. Completed, 1904.
758		do	Concord Spring; temperature, 60° F.
759		Sulphur and iron	Spring. "We have 15 to 20 springs 2 or 3 miles south of Rye; many are impregnated with mineral matter."
760	Dewitt		Completed, 1907.
761	do	(a)	Completed, 1907; water used in boilers.
762	do	Soft	Completed, 1907; used in boilers.
763	{Lissie {Dewitt (?)	Good Sulphur	{At Davis Hill. Drilled for oil. Reservoir 640 to 662 carries salt water.
764	Lissie		Abandoned; no water below 90 feet.
765	Marine Miocene	Sulphur	Drilled for oil; completed, 1904.

a For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

731. *Section of well owned by C. W. Fisher, 1 mile west of Liberty, Tex.*

[Furnished by C. W. Fisher.]

	Feet.
Clay with layers of sand; supplies surface wells	0– 40
Lissie gravel:	
Sand and gravel	40–200
Blue clay	200–230
Water-bearing sand	230–

Thickness of water-bearing sand not known; well was drilled 8 feet into it without going through; casing reaches into it only 2 feet.

738. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well, at crossing of Trinity River, Tex.*

	Feet.
Red clay	0– 8
Sand	8– 38
Lissie gravel:	
Clay	38– 60
Rock and clay	60–104
Quicksand	104–117
Rock	117–119
Clay	119–121
Rock	121–133
Clay	133–145
Rock	145–151
Coarse sand	151–163
Soapstone	163–194
Rock	194–196
Sand	196–203
Rock	203–210
Clay	210–220
Rock	220–240
Water sand	240–290
Clay	290–300

743. *Section of Hill-Brown Rice Land & Irrigation Co.'s well on sec. 138, Gulf Coast & Santa Fe Railway Co.'s lands, at Stilson, Tex.*

	Feet.
Yellow clay	0–104
Lissie gravel:	
Quicksand	104–123
Hard clay	123–129
Sand	129–132
Hard clay and lime pebbles	132–174
Soft clay	174–184
Sand	184–194
Hard blue clay	194–238
Soft blue clay	238–244
Soft blue clay with lime	244–263
Hard blue clay	263–276
Soft blue clay	276–292
Hard blue clay	292–297
Soft blue clay	297–314
Hard blue clay	314–334

	Feet.
Lissie gravel—Continued.	
Fine gray sand	334–349
Hard blue clay	349–358
Yellow clay and sand	358–407
Very hard yellow clay	407–412
Yellow sand and clay	412–447
Coarse gravelly sand to bottom (water)	447–487

745. *Section of well 5 miles west of Stilson, Tex.*

[Furnished by C. A. Brown.]

	Feet.
Clay	0–250
Lissie gravel:	
Quicksand	250–300
Fine sharp water sand	300–400
Blue clay	400–

747. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well, at Cleveland, Tex.*

	Feet.
Soil	0– 4
Lissie gravel:	
Yellow clay	4– 24
Yellow sand	24–100
Clay	100–108
Sand	108–131
Rock	131–132
Clay and coarse sand	132–140
White sandrock	140–142
Yellow clay	142–160
White sandrock	160–161
Yellow sand	161–165
White sandrock	165–166
Yellow clay	166–236
Sand	236–246
Clay	246–288
Open water sand	288–367
Rock	367–368

753.[1] *Section of Sun Co.'s Quintette well No. 1, J. B. Harrison tract, NW. ¼ S. ½ sec. 125, Houston & Texas Central Railroad survey, at Dayton, Tex.*

[Authority, Sun Co.]

	Feet.
Yellow surface clay	0– 20
Blue shale	20– 33
Lissie gravel, marine Miocene (?), Fleming (?) clay, and Catahoula (?) sandstone:	
White sand	33– 53
Sand and clay	53– 158
White quicksand	158– 171
Blue shale	171– 180
White sand	180– 186
Blue shale	186– 193
Gumbo	193– 240
Sand and gravel	240– 325
Gumbo	325– 347

[1] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, pp. 280-281.

Lissie gravel, marine Miocene (?), Fleming (?) clay, and Catahoula (?) sandstone—Continued.

	Feet.
Sand, putty sand	347- 358
Sand and gravel	358- 437
Shale	437- 443
Sand	443- 465
Gumbo	465- 481
Sand	481- 496
Gumbo	496- 513
Sand, putty sand	513- 527
Gumbo	527- 565
Sand, putty sand	565- 597
Shale	597- 601
Sand	601- 613
Gumbo	613- 621
Shale, rock, and clay	621- 660
Shale	660- 672
Hard rock	672- 673
Gumbo	673- 679
Sand	679- 705
Shale	705- 730
Gumbo	730- 795
Rock	795- 799
Gumbo	799- 806
Shale	806- 818
Gumbo	818- 845
Yellow clay	845- 855
Gumbo	855- 875
Clay	875- 884
Gumbo	884- 890
Sand, putty sand	890- 895
Limestone	895- 896
Sand, putty sand	896- 904
Coarse sand	904- 910
Gumbo	910- 933
Sand, putty sand	933- 942
Shale	942- 958
Rock	958- 961
Gumbo and shale	961-1,025
Shale, rock, and shale	1,025-1,036
Rock	1,036-1,038
Shale	1,038-1,060
Rock	1,060-1,065
Gumbo and shale	1,065-1,112
Shale and rock	1,112-1,124
Limestone	1,124-1,126
Sand, putty sand	1,126-1,133
Limestone	1,133-1,134
Brown and blue shale	1,134-1,167
(No entry)	1,167-1,245
Bowlders (concretions) and rock	1,245-1,249
Gumbo	1,249-1,290
Shale	1,290-1,295
Rock and clay	1,295-1,299
Gumbo	1,299-1,306

Lissie gravel, marine Miocene (?), Fleming (?) clay, and Catahoula (?) sandstone—Continued.	Feet.
Shale	1,306–1,392
Hard sand	1,392–1,398
Shale	1,398–1,406
Gumbo	1,406–1,420
Shale	1,420–1,454
Very tough gumbo	1,454–1,525
Hard shale	1,525–1,552
Shale and gumbo	1,552–1,591
White shell and rock	1,591–1,598
Blue shale	1,598–1,630
Soft rock	1,630–1,632
Gumbo	1,632–1,640
Hard blue sand with strata of rock	1,640–1,650
Blue gumbo	1,650–1,680
Rock	1,680–1,683
Shale	1,683–1,691
Hard sandstone	1,691–1,693
Blue shale and blue sand, very slight show of oil	1,693–1,705
Blue shale and thin strata of rock	1,705–1,718
Blue shale	1,718–1,763
"Dry" hole.	

754. *Section of well at Dayton, Tex.*

[Furnished by William Kennedy.]

	Feet.
Yellow clay	0– 170
Sand	170– 180
Blue clay	180– 192
Blue shale	192– 205
Blue clay	205– 220
Coarse sand	220– 248
Blue shale	248– 256
Sand	256– 370
Joint clay	370– 381
Sand	381– 389
Gravel	389– 393
Gumbo	393– 416
Brown shale	416– 424
Blue gumbo	424– 452
Sand	452– 518
Gumbo	518– 530
Sand and gravel	530– 545
Rock	545– 546
Sand	546– 576
Gravel and rock	576– 590
Sand	590– 628
Rock	628– 633
Gumbo	633– 649
Rock	649– 656
Gumbo	656– 674
Brown shale (oil)	674– 676
Gumbo	676– 690
White pipe clay	690– 708

	Feet.
Gumbo	708– 721
Rock	721– 729
Gumbo	729– 784
Shale	784– 791
Rock	791– 793
Gumbo	793– 799
Sand	799– 805
Gumbo	805– 895
White limerock	895– 903
Sandrock	903– 904
Hard shale	904– 906
Limerock	906– 908
Hard sandrock	908– 916
Gypsum and sandrock	916– 922
Gypsum	922– 947
Blue shale, sandrock, gypsum	947– 968
Sandrock and gypsum	968– 972
Sandrock, show of oil	972– 982
Sandrock	982– 995
Sandrock and gypsum	995–1,012
Sandrock	1,012–1,019
Sandrock and gypsum	1,019–1,031
Lignite (?)	1,031–1,037
Sandrock, gypsum, and sulphur	1,037–1,058
Sandrock	1,058–1,080
Gypsum	1,080–1,084
Rock, gypsum, and sulphur	1,084–1,088
Hard sandrock	1,088–1,095
Gypsum and sulphur	1,095–1,100
Sandrock and gypsum	1,100–1,114
Sandrock, gypsum, and sulphur	1,114–1,138
Gypsum and sand	1,138–1,158
Gypsum, rock, and sulphur	1,158–1,163
Sandrock and gypsum	1,163–1,228
Gypsum and sulphur	1,228–1,240
Gypsum and salt	1,240–1,420
Salt (pure)	1,420–1,508

The formations penetrated represent the Lissie, marine Miocene, and possibly the Fleming and Catahoula.

755. *Section of Taylor-Dayton Co.'s well on sec. 124, at Dayton, Tex.*

	Feet.
Black dirt	0– 6
Blue clay	6– 28
Water sand	28– 36
Blue marl	36– 73
Quicksand	73– 85
Blue clay	85– 100
Bowlders (sandstone)	100– 102
Quicksand	102– 141
Blue marl	141– 207
Bowlders	207– 209

	Feet.
Coarse quicksand	209– 229
Blue marl and bowlders	229– 232
Blue marl	232– 238
Bowlders	238– 241
Blue marl; gas at 244 feet	241– 273
Quicksand	273– 320
Water sand	320– 326
Quicksand	326– 329
Blue marl	329–
Record wanting	– 600
Limestone	600– 800
Rock salt	800–1,200

The upper 600 feet represents the Lissie gravel. The lower 400 feet comprises materials of secondary origin formed along a fault plane.

757. Mr. J. A. Conklin, driller, of Alta Loma, Tex., says: "This well was bored as a prospect hole for oil. The water strata were so numerous and thick that it was impossible to pass through them. The water is not used for anything except to water stock. It is nice pleasant drinking water."

760. *Section of T. B. Allen & Co.'s well at Milvid, Tex.*

[Furnished by Mr. C. S. Vidor.]

	Feet.
Lissie gravel and Dewitt formation:	
Clay	0– 10
Sand	10– 80
Clay and gravel	80–100
Sand	100–140
Clay and gravel	140–160
Sand	160–180
Rock	180–182
Clay and gravel	182–188
Rock	188–191
Gravel	191–210
Rock and sand	210–240
Clay and gravel	240–400
Sand	400–420
Clay and gravel	420–470
Thin layers "rocksand"	470–482
Shale	482–520
Clay and gravel	520–550
Water sand	550–659

761. *Section of Miller & Vidor Lumber Co.'s well, ¼ mile southwest of Milvid, Tex.*

	Feet.
Lissie gravel and Dewitt formation:	
Sand	0–140
Red clay and gravel	140–280
Rock	280–282
Red clay and gravel	282–430
Rock	430–432
Very hard clay	432–532
Water sand	532–585
Rock	585–

42 feet of screen.

762. *Section of Liberty Hardwood Lumber Co.'s well, at Big Creek, Tex.*

[Furnished by W. J. Giles, driller.]

	Ft.	in.		Ft.	in.
Lissie gravel and Dewitt formation:					
Surface sand	0	0	–	107	9
Yellow clay	107	9	–	138	9
White sand	138	9	–	156	9
Hard rock	156	9	–	160	11
Blue gumbo	160	11	–	206	11
White sand	206	11	–	218	11
Blue gumbo	218	11	–	338	9
Rock	338	9	–	341	9
Blue gumbo	341	9	–	354	2
Bowlders	354	2	–	372	2
Blue gumbo	372	2	–	424	9
Rock	424	9	–	425	9
Blue gumbo	425	9	–	427	1
Rock	427	1	–	429	1
Blue gumbo	429	1	–	437	1
Rock	437	1	–	438	1
Blue gumbo	438	1	–	478	1
Rock	478	1	–	480	6
Blue gumbo	480	6	–	485	6
Water sand (flowing fine)	485	6	–	508	2
Rock	508	2	–	588	2
Blue gumbo	588	2	–	608	2

763. *Section of Lesterjette well No. 1, at Davis Hill, 8 miles southeast of Big Creek, Tex.*

[Furnished by William Kennedy.]

	Feet.
Top soil	0– 12
Lissie gravel:	
Showing of dead oil; shale and sand	12–185
Blue gumbo	185–285
Shale and packed sand	285–380
Gumbo; showing oil	380–420
Sand and shale	420–570
Gumbo	570–575
Oil sand (blow-out)	575–593
Gumbo	593–640
Sand with salt water	640–662

LIMESTONE COUNTY.

GEOLOGY AND HYDROLOGY.

Only the eastern half of Limestone County comes properly within the purview of this paper, the western half lying in the Cretaceous area. The clays and limestones of the Midway formation outcrop in a north-south belt about 10 miles wide through the central portion of the county and are embedded to the east beneath the sands of the Wilcox formation. (See Pl. I, in pocket.)

Cretaceous rocks.—In the northwest corner it is possible to tap the Woodbine sand of the Cretaceous, but in the eastern half of the county this sand, if present, would lie too deep to be available.

The Nacatoch reservoir supplies the central portion of the county. (See Pl. VII, in pocket.) Water-bearing sands in it have been entered 5 miles northwest of Groesbeck (well No. 772) and at 512 feet at Mexia (well No. 766).

Wilcox formation.—Five to ten miles east of the eastern line of the Midway outcrop the sands of the Wilcox formation will supply water to pumping wells, but it is improbable that they will anywhere yield flows, though they may do so in a few spots where the main ground-water table is considerably higher than the well curbs. Such is doubtless the origin of the flows reported in the very shallow wells (No. 774) near Groesbeck. Such occurrences will not be common and most of them will be confined to the extreme eastern corner of the county.

Where the Wilcox is 300 to 400 feet thick (see Pl. VII, in pocket) it will yield abundant supplies to pumping wells.

Most Wilcox water will be potable and adapted for steaming. In places, however, sulphur water may be expected.

A fault of small throw crosses the county in a northeast-southwest direction. (See fig. 6, p. 85.) This fault has broken the continuity of some of the sand lenses that occur in the Navarro formation of the Cretaceous, and it is probable that the gas in the Mexia district is struck in these discontinuous and locally warped sands on the east side of the fault.

WELL DATA.

Details of wells in Limestone County are given in the following table:

Wells and springs in Limestone County, Tex.

No.	Location.	Owner.	Driller.	Authority.
766	Mexia			N. H. Darton.[a]
767	Mexia, 8 miles southwest	Mexia Light & Water Co.		Mexia Light & Water Co.
768	Tehuacana, 2 miles west	W. T. Mayes.	Will G. Reynolds.	Will G. Reynolds.
769	Tehuacana, ½ mile northeast.	A. A. Davis		A. A. Davis.
770	Tehuacana	Mrs. R. M. Love		Mrs. R. M. Love.
771	Groesbeck, 4 miles north	Sulphur Springs Oil Co.		A. Deussen.
772	Groesbeck, 5 miles northwest	A. W. Kennedy	J. D. Dillard	S. P. Hurley.
773	do	Mrs. L. A. Kennedy		A. W. Kennedy.
774	Groesbeck, ½ mile southwest.	W. H. Wilson	C. P. Wilson	W. H. Wilson.
775	Cooledge	W. T. Mayes		Postmaster.

No.	Diameter of well.	Depth of well.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Flow per minute.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Galls.*
766	4½	1,333	512		
767		Spring			500.
768	8	300	300	−30	
769		Spring			2½.
770		do			
771		1,100+			
772		1,412	99 to 144	No flow	None.
773		Spring			
774	2	80		Flows	¾.
775		400			

[a] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 150.

Wells and springs in Limestone County, Tex.—Continued.

No.	Source of supply.	Quality.	Remarks.
766	Nacatoch		Oil and gas test well; abandoned.
767		Hard	Springfield Spring; water supply for Mexia.
768	Nacatoch		Completed, 1907.
769		Hard	John Boyd Springs; 5 springs.
770		do	Love Spring.
771			Oil test well; completed, 1907.
772	Nacatoch	Potable	Drilled for oil; abandoned.
773		Sulphur	Kennedy Spring.
774	Wilcox	do	Completed, 1907. Another flowing well 200 feet away is 2 inches in diameter, 41 feet in depth; completed, 1906. Both wells are in a valley.
775	Cretaceous		

DESCRIPTIVE NOTES.

772. *Section of well owned by A. W. Kennedy, 5 miles northwest of Groesbeck, Tex.*

[Supplied by S. P. Hurley.]

	Feet.
Soil	0– 15
Midway formation:	
Limestone	15– 99
Nacatoch sand:	
Water sand	99–144
Navarro formation and Taylor marl:	
Shale	144–1, 412

MADISON COUNTY.

GEOLOGY AND HYDROLOGY.

The Yegua formation outcrops over all of Madison County except a narrow belt along the northwestern line, where the Cook Mountain formation comes to the surface. (See Pl. I, in pocket.)

Lower Eocene.—The lower Eocene reservoir is embedded beneath the entire county and will probably yield flows in the lowlands adjacent to Trinity River. (See Pl. VIII, in pocket.) Along the northern line wells to develop water in these sands would have to reach from sea level to 600 feet below. They will have to go deeper toward the south, and along the Grimes County line will have to go 200 to 1,500 feet below sea level. The quality of the water obtainable is problematical. Wells not over 1,000 feet deep may give potable water sufficiently free from mineral matter to be useful for steaming. Up to 1908 the reservoir had not been exploited.

Yegua formation.—In Madison County the Yegua formation is nowhere under cover. The basal sands would probably produce flows in the Trinity bottoms (see Pl. VII) but in the northern half would supply wells only 25 to 100 feet deep. Along the southern line wells ranging in depth from the surface to 500 feet below sea level will draw from these sands. Most of the Yegua water in Madison County will be potable.

WELL DATA.

Details of wells in Madison County are given in the following table:

Wells and springs in Madison County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
776	Hennessey, 1 mile southwest.	T. M. B. Greene survey.	J. I. Darter......	......	J. I. Darter.
777	Normangee........	William Walker League.	John Windsor...	William Williams.	S. T. Windsor.
778	High Prairie.......	......	W. H. May......	......	Postmaster.
779	High Prairie, 600 yards north of post office.	......	Dave H. Shapira.	Frank Steele......	W. H. May.

No.	Diameter of well.	Depth of well.	Depths to principal water-bearing strata.	Head of water below ground.	Pumps per minute.	Source of water.	Quality.	Remarks.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Galls.*			
776	......	......	......	......	......	......	Soft.......	Buck Horn Spring.
777	10.......	105......	47, 102...	45.......	4½.....	Cook Mountain..	Hard......	Used for boiler purposes; completed 1907.
778	12.......	112......	......	......	......	......	......	
779	12.......	112......	55, 80....	30.......	......	Yegua..........	Sulphur...	Completed, 1905.

MARION COUNTY.

GEOLOGY AND HYDROLOGY.

In Marion County the Wilcox formation outcrops in the lowlands and in the valleys. The divides, many of which are iron-ore-capped hills and plateaus, are occupied largely by the Mount Selman formation, which probably at one time mantled the entire county, but which has been largely removed by erosion.

Cretaceous rocks.—The Nacatoch reservoir can be reached in wells going down 1,200 to 1,500 feet below sea level but would probably yield water salty and unfit for use.

Lower Eocene.—The lower Eocene reservoir constitutes the only available source of potable water. The sands dip gently to the south. Wells can be developed south of Jefferson at depths from 100 feet above sea level to 500 feet below. The area of flow, however, is confined to the bottoms and the lowlands. (See Pl. VIII, in pocket.)

The only flowing well in this county is at Jefferson (No. 780). It probably draws from a sand in the Wilcox formation. The water (see analysis, table facing p. 110) is good for drinking and for irrigation but is not good for boilers.

WELL DATA.

The following table gives data on the wells of Marion County:

Wells in Marion County, Tex.

No.	Location.	Owner.	Diameter of well.	Depth of of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.
			Inches.	*Feet.*	*Feet.*	*Feet.*
780	Jefferson, ½ mile north.....	J. M. Deware.........	4.........	800......	190........	300, 500, 800...

No.	Head of water above (+) or below (−) ground.	Source of water.	Quality.	Remarks.
	Feet.			
780	+2........	Wilcox............	Soft [a].........	Cannel coal at bottom; completed, 1887. Authority, J. M. Deware; drilled by Diamond Drill Co.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

780. W. T. Adkins reports that the well shows strong indications of gas. He adds: "The sample of coal which came up last was of good quality. Unfortunately, it had no roofing. No solid rock was gone through, as I now remember the different cores taken out."

Kennedy [1] gives the following data: "The drill passed through alternate strata of sands, clays, and lignites to a depth of 802 feet. Three heavy beds of lignite and a number of smaller ones are said to have been passed."

MONTGOMERY COUNTY.

GEOLOGY AND HYDROLOGY.

In Montgomery County the geologic conditions are favorable for the occurrence of artesian wells.

The Fleming clay outcrops in the extreme northwest corner, but is buried to the south beneath the Dewitt formation, and this in turn is buried beneath the Lissie gravel, which constitutes the surface formation in the remainder of the county. (See Pl. I, in pocket.)

The Catahoula sandstone does not come to the surface anywhere within the limits of this county, but it is embedded beneath the whole of it at depths varying from 100 to 2,300 feet below the surface. (See Pl. VIII, in pocket.)

The water-bearing formations available are the Catahoula, Dewitt, and Lissie.

Catahoula sandstone.—Flows, mostly potable, can probably be obtained from the Catahoula over the entire southern half of the

[1] Kennedy, William, The Eocene Tertiary east of the Brazos River: Proc. Acad. Nat. Sci. Philadelphia, 1895, pp. 136–137.

county and in the lowlands of the northern half. In the northwest corner wells 150 to 300 feet deep will reach these sands, but along the Harris County line borings of 800 to 1,200 feet will be required. The well at Bobbin (No. 784) probably derives its water from these sands. The supply is potable.

Dewitt formation.—Water from the Dewitt formation may be had over practically the entire county, at depths ranging from 20 to 50 feet in the northwestern corner to 800 to 1,700 feet along the Harris County line. Flows from these sands may be had south of the latitude of Tamina. The water in most wells will be potable. (See Pl. IX, in pocket.)

Lissie gravel.—The sands of the Lissie gravel supply the portion of the county lying east of a line through Elmina and Waller. Along this line wells may be completed in these sands at 20 to 30 feet and along the Harris County line at 20 to 600 feet. Flows from this formation can not be expected except in wells 500 or 600 feet deep in the lowlands along the Harris County line. (See Pl. VII, in pocket.) Most of the wells will yield potable water suitable for use in boilers.

WELL DATA.

Details of wells in Montgomery County are given in the following table:

Wells and springs in Montgomery County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
781	Fostoria, 400 yards northeast of post office.	....	Foster Lumber Co.	W. J. Giles.......	Foster Lumber Co.
782	Bobbin, 1 mile south.	....	H. B. Beckworth.	....	H. B. Beckworth.
783	Bobbin..........	....	Gulf, Colorado & Santa Fe Ry.	....	T. U. Taylor.[a]
784	.....do..........	....	Texas Oil Co......	....	E. J. Minnock.
785	Willis, ½ mile north.	G. W. Louis survey.	M. C. Leslie.......	....	Clinton Bybee.
786	Timber, 350 yards northeast of post-office.	M. Hinch survey, northeast corner.	Peach River Lumber Co.	Gust Warnecke..	G. Otis Battle, superintendent.
787	Wilburton, 1 mile northeast.	....	....	....	Dr. O. E. Robertson.
788	Esperanza, ½ mile west.	....	W. T. Spiller.....	....	W. T. Spiller.
789	Waukegan	....	Keystone Mills Co.	....	Postmaster at Waukegan.
790	Conroe..........	....	Gulf, Colorado & Santa Fe Ry.	....	T. U. Taylor.[b]
791	Tamina..........	....	Dick Naylor Oil Co.	J. H. Lee........	J. H. Lee.[c]
792	Dacus, 1 mile west.	....	Trinity & Brazos Valley Ry.	Layne & Bowler.	Walter T. Taylor, postmaster.
793	Splendora........	....	Producers Oil Co..	....	Oil Investors Journal.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, pp. 44-45.
[b] Idem, pp. 45-46.
[c] Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: Bull. U. S. Geol. Survey No. 298, 1906, p. 166.

Wells and springs in Montgomery County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute. Pump.	Yield per minute. Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
781	9	806		766 to 806	+10	260	
782							
783		480		114 to 134	No flow		
784		447			Flows		300.
785							
786	10	185	210 (?)	145	−22	240	
787	4	1,200			+20		
788	7	610		76, 140, etc	−10		
789	8	190			No flow		
790	8	1,236		{182 to 193 / 577 to 642	Flows		
791	10	1,288					
792		200	300		No flow	70	
793		1,242+					

No.	Source of supply.	Quality.	Remarks.
781	Dewitt		Used in steam boilers. Completed in 1907.
782		Sulphur	Spring.
783	Dewitt	(a)	Used in locomotive boilers.
784	Catahoula		Oil test well; water suitable for drinking.
785		Soft	Spring; water used for locomotive boilers.
786	Lissie		Water is lowered in well when north wind blows; pumping lowers well 10 feet; used for boiler purposes; completed, 1904.
787		Soft	Drilled for oil.
788	Lissie and Dewitt		Completed, 1901.
789		Soft	}Used in boilers. Completed, 1907.
790	{Lissie (?) / Dewitt (?)	(a)	Used in locomotive boilers.
791			Oil test well; completed, 1905.
792		Soft	Used in locomotive boilers.
793			Oil test well; completed, 1907; abandoned.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

781. *Section of Foster Lumber Co.'s well at Fostoria, Tex.*

[By Harry Bell.]

	Feet.
Lissie gravel and Dewitt formation:	
Sand and gravel	0– 60
Red clay	60–100
Gravel and gumbo	100–150
Packed sand	150–175
Gray rock	175–195
Gumbo	195–220
Packed sand	220–247
Gumbo	247–382
Sand	382–392
Gumbo	392–419
Gravel	419–440
Gravel gumbo	440–458
Gumbo	458–534
Gravel	534–564
Gumbo	564–586
Rock	586–588
Bowlders	588–596

Lissie gravel and Dewitt formation—Continued.	Feet.
Gumbo	596–606
Shale gumbo	606–766
Sand gravel, water-bearing	766–806
Rock	806–

783. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Bobbin, Tex.*

	Feet.
Soil	0– 2
Dewitt formation, Fleming clay, and Catahoula (?) sandstone:	
Clay	2– 12
Sand	12– 28
Clay	28– 78
Quicksand	78– 90
Sandstone	90–101
Clay	101–114
Water sand	114–134
Clay	134–234
Sand	234–264
Rock	264–309
Clay	309–343
Rock	343–347
Slate	347–383
Rock	383–390
Slate	390–454
Rock	454–457
Slate	457–480

790. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Conroe, Tex.*

Lissie gravel:	Feet.
Red clay	0– 12
Rock	12– 13
Red clay	13– 69
Sand	69– 89
Red clay	89–133
Hard yellow clay	133–153
Joint clay	153–182
Water sand	182–193
Soft clay	193–248
Dewitt formation and Fleming clay:	
Hard clay	248–265
Rock	265–267
Hard clay	267–280
Rock	280–285
Dry sand bed	285–297
Clay	297–340
Rock	340–343
Clay	343–363
Rock	363–365
Blue clay	365–489
Light clay	489–500
Soft clay	500–575
Rock	575–577
Water sand	577–642
Blue clay	642–680

	Feet.
Dewitt formation and Fleming clay—Continued.	
Water sand	680– 740
Clay	740– 790
Soapstone	790– 831
Red clay	831– 888
Soapstone	888– 924
Clay	924– 976
Rock	976– 978
Clay	978–1,003
Rock	1,003–1,004
Sand	1,004–1,008
Red clay	1,008–1,033
Soapstone	1,033–1,073
Rock	1,073–1,075
Sand	1,075–1,125
Soapstone	1,125–1,169
Rock	1,169–1,170
Clay	1,170–1,190
Rock	1,190–1,192
Clay	1,192–1,212
Sand	1,212–1,234
Rock	1,234–1,236

791. *Section of Dick Naylor Oil Co.'s well at Tamina, Tex.*

[By J. H. Lee, driller.]

	Feet.
Lissie gravel, Dewitt formation, and (?) Fleming clay:	
Fine pinkish sand	1– 3
Fine red sand	3– 30
White sand	30– 50
Yellowish sand and gravel	50– 73
Yellowish clay	73– 219
Yellowish sand	219– 248
Yellowish clay	248–1,205
Yellowish and pinkish clay	1,205–1,246
Yellowish sand and clay	1,246–1,288

MILAM COUNTY.

Milam County is not included in the territory covered in this report, but the following partial list of wells is appended for the light they throw on the artesian conditions in the neighboring county of Robertson:

Partial list of wells in Milam County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Depths to principal water-bearing strata.	Height of water above (+) or below (—) ground.	Source of water.	Quality.
				In.	Feet.	Feet.	Feet.		
794	Baileyville, 3½ miles west.	T. J. Estes	R. T. Hill [a]	......	831	500 600	No flow	Nacatoch	Salty.
795	Branchville	A. J. Raymond	do.[a]	......	700	250	—6	Wilcox	Soft.
796	Branchville, 4 miles east.	J. A. Peele	do.[a]	......	530	200 320	No flow	do	Do.
797	Maysfield	A. E. Brady	do.[a]	......	1,356	850 1,150	do —34	Nacatoch	Salty.

[a] Hill, R. T., Geography and geology of the Black and Grand prairies, Tex.: Twenty-second Ann. Rept. U. S. Geol. Survey, p. 7, 1901, pt. 646.

NACOGDOCHES COUNTY.

GEOLOGY AND HYDROLOGY.

The greater portion of Nacogdoches County is occupied by the outcrop of the Cook Mountain formation, but in the region adjacent to Attoyac Bayou the sands of the underlying Wilcox formation come to the surface. The Yegua outcrops in the extreme southern portion of the county. (See Pl. I, in pocket.)

Lower Eocene.—The lower Eocene sands will supply potable water over the entire county and will yield flows over most of it. (See Pl. VIII, in pocket.)

In the northern portion wells can be developed at depths from 100 feet above sea level to 500 feet below. The reservoir deepens toward the south and wells must go 400 to 1,000 feet below sea level. At Nacogdoches sands in the lower Eocene are met at 155, 214, 297, and 340 to 500 feet below the surface, the lowest stratum yielding soft water. Some of the sands in the county, however, supply sulphur water.

Yegua formation.—In the southern portion of the county the sands of the Yegua formation outcrop, but they are not under cover and therefore will not produce flows. (See Pl. VII, in pocket.)

WELL DATA.

A detailed list of wells appears in the following table:

Wells and springs in Nacogdoches County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
798	Attoyac, 1¼ miles from.	J. I. Y. Barbo grant.	H. B. Fall		E. M. Weeks.
799	Stoker, near	E. Chandler survey.	M. D. Stoker		A. Deussen.
800	Etoile		Long Bell Lumber Co.		S. W. Flurnoy.
801	Garrison		Garrison		A. Deussen.
802	....do		Dotson Bros		Do.
803	Melrose, 1 mile south of E. A. Day place.		Lubricating Oil Co.		Joseph B. Walker.[a]
804	Caro, ½ mile southeast of post office.	J. A. Caro survey.	Whiteman-Decker Lumber Co.[b]	Layne & Bowler.	E. M. Decker, secretary.
805	Toliver				B. W. Pye, postmaster.[c]
806	Appleby, 9 miles east.	Richard Nelson survey, west line.	Producers Oil Co.	C. E. Morgan	June Harris.
807	Cushing, 2 miles northeast.		O. V. Pirtle		O. V. Pirtle.
808	Woden, 5 miles southeast, near oil spring.		Higgins Oil & Fuel Co.	F. W. Michaux.	F. W. Michaux.
809	Woden, 6 miles southeast.	Nacogdoches-Browns Ferry road.		G. A. Watkins	W. C. Alders.
810	Nacogdoches, ½ mile southwest of post office.		Nacogdoches Ice & Cold Storage Co.		Arthur Marshall, superintendent.
811	Nacogdoches		....do	Frank Michaux.	Do.

[a] Dumble, E. T., Kennedy, William, et al., Reports on the iron ore district of east Texas: Second Ann. Rept. Geol. Survey Texas, 1891, p. 286.
[b] For analysis of water from a spring at Caro, see analysis No. 804b, in table facing p. 110.
[c] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 232.

Wells and springs in Nacogdoches County, Tex.—Continued.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
812	Nacogdoches, 1 mile southwest.		Hayward Lumber Co.	W. P. Lloyd	F. H. Wilcox.
813	Nacogdoches		City		A. Deussen.
814	Nacogdoches, 1 mile southwest.		Hayward Lumber Co.	Thompson Bros.	F. H. Wilcox.
815	Oil City		Petroleum Prospecting Co.		A. Deussen.
816	do		do		J. B. Walker.[a]
817	Oil City, near		Williams Bros.	J. M. Thrasher	J. M. Thrasher.
818	Oil City, 3 miles west.		J. M. Thrasher		N. M. Fenneman.[b]
819	Oil City, near	J. S. Skillern homestead, between Mast and Rector creeks.	Nip Oil Co. (?)		Do.[b]
820	Oil City, near No. 815.		Higgins Oil & Fuel Co.	F. W. Michaux	F. W. Michaux.
821	Chireno, 1 mile south-southwest.	J. C. Buckner headright.	W. D. Lambert		W. D. Lambert.
822	Chireno, near	do			Do.
823	Chireno, southwest	do	W. A. Thompson.		Do.
824	Chireno, 4 miles southwest.	Mayfield & White survey, near northeast corner.			S. W. Flurnoy.
825	Chireno, 2 miles southwest.	W. L. Wilson survey (?)	E. M. Weeks	Andy Thompson.	E. M. Weeks.
826	Chireno		Mammoth Oil, Mineral & Land Co.		Mammoth Oil, Mineral & Land Co.[c]
827	do	Y Barbo grant, on Anoladeras Creek.	J. A. Richardson	Thompson Bros.	J. A. Richardson.

[a] Dumble, E. T., Kennedy, William, et al., op. cit., pp. 273 et seq.
[b] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 71.
[c] Veatch, A. C., op. cit., p. 232.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
798	6	316 (?)			Flows		
799							2.5.
800	6	350 (?)			Flows		
801							
802							
803		255				None.	
804	8	300	460	300	0	350	
805		375			Flows		
806	10 to $5\frac{5}{8}$	2,000		220 972 to 996 1,098 to 1,132 1,155 to 1,263	No flow do do Flows		
807							
808	10	1,956		370 to 467, 476 to 478.	Flows strongly.		150.
809	10 to 4	1,600		1,500	Flows		
810	6	300	314.6	155, 214, 297	+3		
811	6	500	314.6	340 to 500	+40	500	225.
812	8	290		276	−30	Many.	
813							200.
814	8	820	317	470 to 500	+4	35	21.
815							
816	8	70					
817	10 to 4	1,304			+4		
818		400+					
819		684		387 to 405	Flows		
820		240		240	do		
821	4	300		300	+16		
822	4	198			No flow		
823	4	300		300	Flows		
824	6	800 (?)			+10		
825	6	386		386	−100		
826		877		382 to 462	Flows		50.
827	8	228		220	+1		

Wells and springs in Nacogdoches County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
798	Wilcox	Sulphur	Completed, 1906.
799	Mount Selman	Mineral [a]	Spring; local resort; temperature of water, 66° F.
800		Sulphur	Completed, 1899.
801	Wilcox	([a])	"White Spring"; local resort.
802		Iron	"Red Spring."
803			Oil-test well; abandoned; 40 wells on property.
804	Wilcox	Iron and sulphur [a]	Water used in boilers; not lowered by pumping; well completed, 1904.
805	do		
806	do	Some sulphur	Oil-test well; completed, 1907; abandoned.
807		Soft	Spring.
808	Wilcox	Some sulphur	Drilled for oil; at Oil City; completed, 1907.
809	do	Salty and sulphur.	Stock drink water; gas at 1,000 feet; completed, 1904.
810	Mount Selman and Wilcox	Some sulphur	Old well.
811	Wilcox	Soft [a]	Completed, 1907; new well (No. 2); cost, $2,000; temperature, 74° F.
812	Mount Selman and Wilcox	Some sulphur	Completed, 1903; about 100 feet east by a little north of, and 4 feet higher than well No. 814.
813		Potable [a]	Springs; water supply for the city.
814	Wilcox	Soft	Used in boilers; completed, 1904.
815		Sulphureted; oil bearing.	Oil spring.
816			Oil well; about 40 shallow oil wells drilled in vicinity.
817			Oil-test well; completed, 1905.
818			Oil-test well.
819	Wilcox and Mount Selman	Good	Do.
820	do	do	Oil-test well; abandoned.
821	do	Soft	Completed, 1905.
822			Oil stands in well; completed, 1905.
823	do	Sulphur	Oil comes to surface with water; completed in 1905.
824		Potable	
825	Wilcox		Oil-test well; completed, 1905. At "Highland Pond."
826	do	Sulphur	
827	do	do	Completed, 1905.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

801.[1] The water is believed to be beneficial. The property has been recently improved. The water is from the main water-bearing sand which overlies the lignite.

803. *Section of Lubricating Oil Co.'s well, 1 mile south of Melrose, on the E. A. Day place, Nacogdoches County, Tex.*

	Feet.
Cook Mountain and Mount Selman formations:	
Red clay earth	0 – 9
Bluish-green calcareous shell marl	9 – 70
Dark-green calcareous shell marl	70 –119
Dark-drab clay	119 –139
Light-drab clay, with iron pyrites	139 –255. 5
Sand with iron pyrites, containing "slush oil"	255. 5–258
Dark-drab clay	258 –293
Calcareous marl, with sand "streakings"	293 –299
Sandstone	299 –302
Clay with sand "streakings" and iron pyrites	302 –309
Dark bluish-green shell marl	309 –338
Dark-drab clay	338 –349
Marl	349 –352

[1] Dumble, E. T., Kennedy, William, et al., Reports on the iron ore district of east Texas: Second Ann. Rept. Geol. Survey Texas, 1891.

804. E. M. Decker writes: "Well was drilled for boiler supply and for domestic use. It was drilled in 1904, and has been in daily use since, furnishing from 300,000 to 500,000 gallons daily. * * * Rock was struck about 30 feet below surface, and was a hard blue stone, some 12 feet thick. Under this was a black dirt, and then sand and sandstone. At about 225 feet there was encountered a very hard rock through which the drill made barely 9 to 12 inches per day. This rock lasted until about 270 feet. After passing through this, a water-bearing gravel was found in which we stopped. This water cleared immediately, and was found to be heavily impregnated with iron, sulphur, and magnesia. We are not using this water very much in boilers, as we have a large pool from which we draw a supply. The water, however, is not injurious to boilers. We think it very probable that had we gone a little deeper, artesian water would have been encountered. But we were afraid to go deeper on account of encountering oily water, which was not wanted at this time."

Like the shallow wells at Marshall, this water seems likewise to be supplied by the Queen City sand member of the Wilcox formation. Both at Marshall and at this point water from these beds is remarkably pure. This horizon in the Wilcox is worth exploitation over this entire portion of the State, especially where boiler, drinking, and irrigation waters are sought.

806. *Section of Producers Oil Co.'s well, 9 miles east of Appleby, on the west line of the Richard Nelson survey, Tex.*

	Ft.	in.		Ft.	in.
Mount Selman formation:					
Sand	0	0	–	23	8
Gumbo (greensand marl)	23	8	–	112	4
Gumbo(?); rock (sandstone) 2 feet	112	4	–	158	4
Gumbo(?); 2 feet hard rock	158	4	–	208	1
Wilcox, Midway, and Cretaceous formations:					
Not given; 5 feet of water sand	208	1	–	252	6
No record in part; rock 5 feet	252	6	–	294	10
No record in part; rock (sandstone) 5 feet	294	10	–	340	6
Partial record; 5 feet rock	340	6	–	385	8
Partial record; 5 feet sandstone	385	8	–	432	4
Do	432	4	–	475	2
Do	475	2	–	520	11
Do	520	11	–	566	7
Do	566	7	–	612	11
Rock 5 feet; partial record	612	11	–	658	5
Hard sand	658	5	–	727	1
Partial record; very little shale	727	1	–	839	1
Sand	839	1	–	849	1
Gumbo	849	1	–	859	1
Partial record; 1 foot rock	859	1	–	883	0
Gumbo	883	0	–	905	0
Hard sand	905	0	–	927	0
Sand; 2 feet rock	927	0	–	948	8
Sand	948	8	–	972	4
Water sand	972	4	–	996	1
Partial record; 2 feet rock	996	1	–	1,017	2
Sand	1,017	2	–	1,063	5
Partial record; 8 feet porous rock, containing no water	1,063	5	–	1,087	5
Porous rock; reduced casing from 7⅝ to 5⅝ inches	1,087	5	–	1,098	10
Water sand	1,098	10	–	1,132	4

Wilcox, Midway, and Cretaceous formations—Continued.	Ft.	in.	Ft.	in.
Hard sand	1,132	4	1,155	7
Sand; water flow	1,155	7	1,263	7
Sand with black, "flaky" dirt	1,263	7	1,578	0
Rock; gas	1,578	0	1,580	0
Black "flaky" dirt	1,580	0	1,624	11
Rock	1,624	11	1,715	5
Lignite	1,715	5	1,720	5
Gumbo	1,720	5	1,762	6
Gumbo, with 4 feet rock	1,762	6	1,786	2
Rock	1,786	2	1,805	9
"Salt"(?)	1,805	9	1,826	5
Rock and hard sand and a little lignite	1,826	5	2,000	0

808. *Section of Higgins Oil & Fuel Co.'s well at Oil City, 5 miles southeast of Woden, Tex.*

[Furnished by F. W. Michaux, driller.]

	Feet.
Cook Mountain and Mount Selman formations:	
Surface yellow sand	0 - 20
Blue sand	20 - 56
Black gumbo (greensand marl)	56 - 66
Black shale, shells, and oil (greensand marl)	66 - 75
Black shale (greensand marl)	75 - 83
Black shale shells (greensand marl)	83 - 136
Soft sandy rock	136 - 142
Black shale, shells; oil	142 - 184
Hard shale, shells, rock; oil	184 - 260
Blue "limerock"	260 - 270
Lighter color shale; more oil	270 - 320
Hard blue limerock; shells	320 - 328
Hard marl; oil showing	328 - 336
Very hard rock, worked on same one week (indurated greensand)	336 - 366
Blue gumbo	366 - 370
Wilcox formation:	
Soft rocks, hard streaks; blue water sand; artesian flow	370 - 410
Soft marl, oil showing; blue water sand	410 - 467
Top showed oil, very hard rock	467 - 476
Artesian sand; main flow	476 - 478
Hard sandrock; petrified wood (white)	478 - 482¾
Soft sand	482¾ - 484
Hard sandrock	484 - 489
Soft blue marl	489 - 521
Hard marl	521 - 523
Soft marl	523 - 534
Hard marl	534 - 538
Marl with thin "shells" of rock 3 to 12 feet	538 - 556
Dark sand	556 - 569
Rock, black marl	569 - 570
Blue gumbo	570 - 583
Hard rock	583 - 584
Blue gumbo	584 - 594

Wilcox formation—Continued.	Feet.
Rock	594 - 595
Gumbo; changed to 5⅝ inch bit	595 - 608
Rock	608 - 609
Gumbo	609 - 617
Marl	617 - 632
Rock	632 - 633
Green marl	633 - 639
White sand	639 - 641
Marl and sand	641 - 650
Green marl	650 - 652
White sand	652 - 654
Gummy marl	664 - 668
White sand	704 - 715
Gumbo	715 - 717
Black rock	717 - 718
Gumbo	718 - 722
White sand	722 - 738
Shale and sand	738 - 753
Rock, medium hard	753 - 755
Tough gumbo	755 - 770
Black shale	770 - 811
Hard shale	811 - 815
Sand shale	815 - 836
Soft gumbo	836 - 840
Sandy shale	840 - 869
Blue gumbo	869 - 876
White sand	876 - 887
Brittle shale	887 - 895
Tough black gumbo, some "coal"	895 - 919
Brittle shale	919 - 933
Gumbo	933 - 937½
Blue limerock	937½- 943
Gumbo	943 - 945
Hard marl	945 - 950
Hard blue rock	950 - 953
Conglomerate; artesian flow; water warm	953 - 990
Rock	990 - 993
Shale and conglomerate	993 -1,051
Blue rock, very hard	1,051 -1,052
Sandy shale	1,052 -1,065
Black gumbo	1,065 -1,073
Brittle shale, blue and white	1,073 -1,106
Sandy shale	1,106 -1,137
White gumbo	1,137 -1,163
Blue limerock	1,163 -1,163½
Black shale, hard	1,163½-1,166
Soft rock	1,166 -1,169
Soft white mud	1,169 -1,174
Blue shale	1,174 -1,185
Lignite showing	1,185 -1,194
Brown shale	1,194 -1,206
Gumbo	1,206 -1,211
Soft gumbo, light color	1,211 -1,225
"Shell" of rock	1,225 -1,225½

	Feet.
Wilcox formation—Continued.	
Brittle brown shale	1,225½–1,231
Brown shale	1,231 –1,273
Blue gumbo	1,273 –1,279
Hard black shale	1,279 –1,309½
Hard gray sandrock	1,309½–1,311
Hard shale with flakes of soft sandrock	1,311 –1,339
Shale and "shells" of rock; showing "oil crystals"	1,339 –1,372
"Shell of rock" and "oil crystals"	1,372 –1,373
Shale; easy drilling	1,373 –1,380
Gumbo	1,380 –1,395
Lignite	1,395 –1,406
Midway formation and Arkadelphia clay:	
Brittle shale	1,406 –1,420
Sand shale	1,420 –1,490
Soft limerock	1,490 –1,491
Sand, soft drilling	1,491 –1,495
Sandy shale, hard, with thin "shells of rock"	1,495 –1,518
Gray rock, not very hard	1,518 –1,519
Hard shale with thin "shells of rock"	1,519 –1,540
Hard sandy shale, with "shells of rock"	1,540 –1,573
Soft shale; easy drilling	1,573 –1,594
Very hard rock; yellow lime	1,594 –1,597
Sandy shale	1,597 –1,614
Blue hard sandrock	1,614 –1,617
Blue sandy shale	1,617 –1,622
Soft limerock	1,622 –1,623
Shale with "shells of rock," soft	1,623 –1,634
Sandy shale	1,634 –1,673
Shale and "shells of rock	1,673 –1,696
Hard rock; yellow lime	1,696 –1,697
Hard shale with "shells of rock"	1,697 –1,706
Hard sandy shale	1,706 –1,730
Soft rock; rough peculiar yellow particles	1,730 –1,735
Very hard sandy shale	1,735 –1,740
Hard shale, sandy	1,740 –1,760
Rough rock	1,760 –1,762
Hard sandy shale with shells of rock	1,762 –1,789
Hard sand, with "shells of rock"	1,789 –1,816
Hard rock; yellow lime	1,816 –1,817
Hard sandy shale; "shells of rock"	1,817 –1,832
Hard sandy shale	1,832 –1,887
Rough limerock, soft	1,887 –1,889
Brittle brown shale with sand	1,889 –1,915
Sand, shale, "shells of rock"	1,915 –1,939
Hard sand with shells of rock	1,939 –1,950
Soft limerock	1,950 –1,955

No samples were preserved from this well, and it is to be regretted that the important data that they might have revealed are not available. The upper portion of the section is clearly Cook Mountain and Mount Selman, this being definitely shown by the outcrops of fossiliferous Cook Mountain strata in the vicinity, notably near Melrose and Chireno. The sandy beds and lignitic deposits below 370 feet and above 1,406 feet are clearly Wilcox, at least 1,036 feet in thickness. From the depth to which this well penetrated, it is probable that the Midway and Upper Cretaceous marls were struck, and the nature of the beds reported strongly suggests this.

811. *Section of Nacogdoches Ice & Cold Storage Co.'s well No. 2 at Nacogdoches, Tex.*

	Feet.
Cook Mountain and Mount Selman formations:	
Black loam	0– 12
Brown stone and gravel	12– 22
Blue and fine sand and blue soapstone	22– 92
Clay or soapstone with sand and bowlders	92–293
Wilcox formation:	
Hard shale and streaks of sand	293–300
Sand	300–330
Shale	330–340
White sand, varying in fineness, with some streaks of shale 6 inches thick	340–500
Rock	500

817. *Section of Williams Bros.' well, near Oil City, Tex.*

	Feet.
Cook Mountain and Mount Selman formations:	
Soft dark-brown to black shale with bits of shells	160– 165
Dark clay with bits of shells and black nodules	165– 170
Dark-greenish sand and shale with bits of shells	170– 180
Brownish and dark-greenish sandstone, shale and limestone with bits of shells	180– 186
Dark-greenish and brown sandy clay or soft shale	186– 326
Brown ferruginous sandstone	326– 330
Light-brown shale and dark-greenish sand; a greensand	330– 340
Sand with greenish "granulars"; a greensand	340– 410
Same; finer sand	410– 485
A greensand, also contains bits of sandstone	420– 424
Wilcox formation:	
Brown shale and dark-gray sandy clay	424– 591
Dark-gray and brown sandstone	591– 632
Dark-gray and brown sandstone	1,059–1,243
Gray sandy shale and lignite	1,244–1,265
Coarse gray sand or soft sandstone and gray sandy shale	1,265–1,297
Brown rock; not a sandstone, may contain sulphur	1,297–1,304

819. *Section of Nip Oil Co.'s (?) well on the J. S. Skillern tract, near Oil City, Tex.*

	Feet.
Cook Mountain and Mount Selman formations:	
Clay	0– 47
Rock, with shells	47– 54
Blue marl	54– 80
Sand with slight show of oil	80– 88
Blue clay	88–144
Hard rock	144–151
Blue clay	151–188
Sand, with oil signs	188–194
Hard, dark-blue clay	194–238
Sand	238–276
Rock, with streaks of sand from 8 to 10 feet	276–294
Coarse sand, good showing of oil	294–299
Blue clay (set 10-inch pipe in rock)	299–340
Hard rock	340–349
Stiff blue clay	349–387

Wilcox formation:	Feet.
White sand; artesian water	387–405
Hard blue clay and some rock	405–458
Thin rock with sand	458–489
Porous rock; sulphur	489–497
Coarse sand; some gas	497–514
Hard rock	514–518
Bed of shells; some gas	518–525
Stiff blue clay (gumbo)	525–559
Porous soft rock	559–563
Sand, slight sign of oil	563–572
Black formation of asphalt, dry	572–581
Gumbo or blue clay	581–612
Hard rock	612–616
Shells, with gravel	616–624
Gumbo	624–651
Thin rocks, with sands between	651–664
Hard, flinty rock	664–667
Dark, coarse sand, or oil sand; good show of oil	667–673
Porous rock, soft	673–678
Sand, dark with asphalt	678–681
Hard rock	681–684

826.[1] *Section of well of Mammoth Oil, Mineral & Land Co., near Chireno, Tex.*

	Feet.
Cook Mountain and Mount Selman formations:	
Red fossiliferous marl containing *Ostrea sellæformis* and *Anomia ephippioides* in upper portions; below changes to blue-gray marl	0–110
"Oil sand"; this outcrops to the north at the base of the Claiborne group	110–112
Blue to gray fossiliferous marl	112–382
Wilcox formation:	
White quicksand; strong flow of artesian water	382–462
Dark-gray lignitic clay	462–468
Lignite	468–477
White quicksand	477–515
Lignite	515–522
Gray-blue sand, with very small shell fragments; layer of pyrites 3 inches thick at base	522–562
Blue micaceous sand; fragments of shells reported, but sample shows only glittering particles of mica	562–632
Hard fossiliferous green sand	632–636
Dark-green sand	636–676
Soft dark-gray lignitic clay	676–736
Chocolate to yellow laminated clay	736–826
Indurated gray sand	826–836
White clay	836–840
Gray sand with a little oil	840–865
Hard sand	865–873
Hard rock, not passed through	873–877

[1] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 322.

NAVARRO COUNTY.

GEOLOGY AND HYDROLOGY.

Only the eastern portion of Navarro County comes within the purview of this paper,[1] and in this portion no important Tertiary water horizons are available. Likewise, the better Cretaceous horizons are embedded so deeply as to be practically unavailable. The Nacatoch reservoir is also of doubtful value owing to the saltiness of its water. (See Pl. VII, in pocket.) The chances for finding artesian supplies are therefore not favorable and search for them should be undertaken with caution.

The clays and limestones of the Midway formation occupy a north-south belt in the eastern half of the county. To the east they dip beneath the sands of the Wilcox formation. These last are not under cover and are comparatively thin. Hence, though capable of supplying abundant shallow surface wells, they are not to be depended on for artesian supplies.

WELL DATA.

The following table gives data on wells in Navarro County:

Partial list of wells in Navarro County, Tex.

No.	Location.	Owner.	Driller and authority.
828	Birdston (?), 2 miles south		J. W. Folk.
829	Roane, 2 miles north	J. P. Lindsay	J. P. Lindsay.

No.	Diameter of well.	Depth of well.	Depths to principal water-bearing strata.	Head of water below (−) ground.	Source of water.	Quality.
	Inches.	*Feet.*	*Feet.*	*Feet.*		
828	12	100	80, 90	−70	Midway (?)	Hard.
829	8	150	145	−50	Nacatoch (?)	Soft.

NEWTON COUNTY.

GEOLOGY AND HYDROLOGY.

The northern portion of Newton County is occupied by the outcrop of the Catahoula sandstone, which dips beneath the impervious Fleming clay to the south. The Lissie gravel forms the surface of the remainder of the county. (See Pl. I.) The water-bearing formations available are the Yegua in the extreme north, the Catahoula in the center, and the marine Miocene beds and Lissie gravel in the south.

Yegua formation.—In the northern part drill holes 600 to 1,000 feet deep will reach the Yegua. (See Pl. VII, in pocket.) Where

[1] For discussion of the Cretaceous water horizons, see Hill, R. T., Geography and geology of the Black and Grand prairies, Tex.: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901.

these sands lie deeper than 1,000 feet they will probably not yield potable water. This formation will therefore be available only in the extreme north.

Catahoula sandstone.—Experiments at Call (wells Nos. 830 and 831) indicate that the Catahoula sandstone can supply the central half of this county with artesian water where needed. The area of flow is indicated on the map (Pl. VII, in pocket). The supply from depths not exceeding 1,500 feet will generally be potable.

Marine Miocene.—The marine Miocene beds likewise carry water in these regions and should be sought at depths not exceeding 1,000 feet, where satisfactory supplies can not be found at shallower depths. (See Pl. IX, in pocket.) The marine Miocene beds will not be found north of Call.

Lissie gravel.—In the southern portion of the county, where the Catahoula sandstone is embedded too deeply, the Lissie gravel will yield abundant supplies, but the area of flow is confined to the bottoms and the lowlands. Along the south line of the county drill holes 600 feet deep will draw from this source. The well at Bon Wier (No. 834) was probably supplied by these sands. (See Pl. VII.)

WELL DATA.

Details of wells in Newton County are given in the following table:

Wells in Newton County, Tex.

No.	Location.	Owner.	Driller.	Authority.	Diameter of well.	Depth of well.
					Inches.	*Feet.*
830	Call, ½ mile south	Kirby Lumber Co.		J. G. Stanton, jr.	8	797.
831	do	do	Gust Warnecke	do	8	852.
832	Ruliff, 200 feet east of post office.	Kansas City Southern Ry.		A. F. Rust, resident engineer.	4	70.
833	Deweyville	Sabine Tram Co.		Postmaster	6-4	120.
834	Bon Wier, 2 miles southeast (A. L. Stark tract).	Bon Wier Oil & Mineral Co.	W. T. Arnett	do	8-2	1,017.

No.	Depths to principal water-bearing strata.	Head of water above (+) or below (—) ground.	Yield per minute.		Source of water.	Quality.	Remarks.
			Pump.	Flow.			
	Feet.	*Feet.*	*Galls.*	*Galls.*			
830	790	Flows	90	5	Catahoula	Hard	Used in boilers.
831	840	do	115	8	do	do	Completed, 1906; water used in boilers.
832	70	do			Lissie	Soft	Completed, 1904; water used in locomotive boilers.
833	90	—6	30	None	do	Iron and sulphur.	Completed, 1903; water used in boilers.
834		Flowed			Lissie (?)		Oil test well; in progress, 1908.

832. A. F. Rust writes: "We have an open well consisting of old bridge cylinders about 7 feet in diameter and 20 feet deep, in the bottom of which points have been sunk to the depth of 40 or 50 feet more. The water rises to the surface of the ground, and is pumped into our tank. The points seem to be in a bed of gravel."

834. J. S. Meadows says: "This well was abandoned at 1,017 feet. We struck a cavity at about 123 feet and also rock (21 feet through). At about 123 feet below the surface we set 4-inch casing through a shale, with 4 feet of blue gumbo about the middle of the shale. After the 2-inch pipe was pulled flowing water filled up the ditch with white water sand during the night. * * * "

ORANGE COUNTY.

GEOLOGY AND HYDROLOGY.

In Orange County artesian wells are coming to be largely used for rice and truck irrigation. A large development along these lines may be looked for during the next decade.

The Lissie gravel has a small exposure in the northern portion of the county. Its beds dip beneath the impervious Beaumont clay, which succeeds them on the south, and which in turn disappears beneath the recent clays and silts. (See Pl. I, in pocket.)

The geologic structure is ideal for artesian water. The sands and gravels of the Lissie will yield flows over almost the entire county. (See Pl. VII, in pocket.) They must, however, not be penetrated too deeply, for at depths exceeding 600 to 700 feet, in the neighborhood of Orange, they yield salt water. The depth to salt water decreases toward the coast and deepens toward the interior.

In Orange a number of artesian wells draw from sands in the Lissie reservoir at depths of 462 feet (well No. 840), 578 feet (well No. 841), and 600 feet (well No. 842). The water is potable, and is used for irrigation, steaming, and domestic supplies.

WELL DATA.

A detailed list of the wells in Orange County appears in the subjoined table:

Wells in Orange County, Tex.

No.	Location.	Owner.	Driller.	Authority.	Diameter of well.	Depth of well.
					Inches.	*Feet.*
835	Terry, 3 miles west	Anderson Bros.	J. W. Giles	A. Anderson	6	120.
836	Terry, 4 miles east.	Lon Garison		Lon Garison	4	800.
837	Texla	R. W. Wier Lumber Co.		Postmaster	4	75.
838	Echo	Texas & New Orleans R. R.		do	8¾	396.
839	Echo, 1 mile from Sabine River.	do		The company	8¼	435.
840	Orange, 3 miles southwest, near well No. 841.	Orange County Demonstration Farm.	Chris Geyer	L. H. Shelfer	6	462.
841	Orange, 3 miles southwest.	do	do	do	4	578.
842	Orange	J. W. Link		Postmaster	4	600.
843	do	do		T. U. Taylor[a]	4	467.
844	do	High School		do.[a]	{3 / ..	467. / 500.
845	do	Electric Light Co.		do.[a]		650.
846	do	Ice Co.		do.[a]	6	480.
847	Orange, 9 miles northwest.	Sam Wilson		do.[a]		800.
848	Beaumont, 8 miles north.	W. A. Fletcher		A. Deussen	6	740.

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 33.

Wells in Orange County, Tex.—Continued.

No.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Flow per minute.	Source of supply.	Quality.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Galls.*			
835	(?) 15	120	−12		Lissie	Hard	Completed, 1905; water used in boilers.
836		470, 650, 710.	Flows		do	Salty	Drilled for oil; water beds of gravel.
837	12		No flow			Iron	Completed, 1905; water used in boilers.
838							
839		390 to 435	Flows	35	Lissie		Completed, 1905; water used in locomotive boilers.
840			do	22		Some sulphur.	Completed, 1907.
841	20		+20	80		Soft	Completed, 1907; water used for irrigation of tobacco and vegetables.
842			Flows	15			
843			+4	21			
844			Flows	22			Two wells.
			do	10			
845			do				
846			do	52			
847			do	Few			
848			+14	70	Lissie (?)	Saline [a]	Park farm well.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

836. Lon Garison says: "Between 710 and 800 feet we passed through beds of gravel. Water sand was found at 470 feet. All wells around here strike gravel which produces a good flow of water at 700 feet. This bed of gravel is about 80 to 90 feet thick. In my well I had the water cased off, because we were looking for oil. It is a failure, because the strainer was not placed right."

839. *Section of Texas & New Orleans Railroad Co.'s well, at Echo, 1 mile from Sabine River, Tex.*

	Feet.
Red clay	0–76
Lissie gravel:	
Sand	76–110
Blue clay	110–250
White sand	250–276
Sandy clay	276–292
Blue sand	292–382
Blue clay	382–390
Water-bearing sand	390–435

842. *Section of well owned by J. W. Link at Orange, Tex.*

	Feet.
Beaumont clay:	
Soil and yellow clay	0–10
Yellow sand	10–20
Partly blue clay	20–80
Lissie gravel:	
Gray sand, filled with water	80–220
Hard clay	220–426
Water sand, producing flowing well	426–467

Forty-foot strainer between 467 and 427 feet.

Mr. Link says that the water from the sand at 426 to 467 feet is "exceedingly healthful and nice to drink and is used by a great number of people."

PANOLA COUNTY.

GEOLOGY AND HYDROLOGY.

The Wilcox forms the outcropping formation over the major portion of Panola County, but isolated exposures of the Mount Selman formation probably occur in some of the iron-capped hills. (See Pl. I, in pocket.)

Owing to the absence of cover the Wilcox will not yield flows except in the bottoms along Sabine River. Thus far no flowing wells have been obtained, but abundant supplies of good water are everywhere available to pumps. Supplies can be developed in the sands of the Wilcox formation at depths ranging from 100 feet above sea level to 500 feet below. There is at present little demand for artesian water.

WELL DATA.

Data on the wells of the county are given in the following table:

Wells and springs in Panola County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.
				Inches.	*Feet.*
850	Clayton, 1½ miles west	A. W. Davis, jr	A. W. Davis, jr		
851	Gary	William Bros	Postmaster	4	200.
852	Gary, 5 miles southeast	R. E. Trabue	M. L. O'Neal	10	235.
853	Cozart	Brown Springs	Joseph B. Walker [a]		

No.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water below (—) ground.	Yield per minute.		Source of supply.	Quality.	Remarks.
				Pump.	Flow.			
	Feet.	*Feet.*	*Feet.*	*Galls.*	*Galls.*			
850					20		Iron and sulphur.	Spring.
852	400±	80 200	—80	? Many.		? Wilcox.	do	Drilled by M. L. O'Neal in 1906; water used in boilers.
853								Spring; local resort.

[a] Dumble, E. T., Kennedy, William, et al., Reports on the iron ore district of east Texas: Second Ann. Rept. Geol. Survey Texas, 1891, pp. 270–286.

DESCRIPTIVE NOTES.

852. *Section of well owned by R. E. Trabue, 5 miles southeast of Gary, Tex.*

[By M. L. O'Neal, driller.]

	Feet.
Wilcox formation:	
Red clay	0– 50
Bluish clay	50– 80
Lignite	80– 84
Blue or black gumbo	84–194
Black and white water-bearing sand; no flow	194–235

The water is cool and pleasant to drink. It forms a very heavy and hard incrustation when used in boilers.

853. The water is described as having a deep amber color, not unlike whisky; "is not styptic in taste, makes no rusty deposit, and therefore has little if any iron in solution, and there is no indication of any other metallic salt * * *. The place has been noted as a neighborhood resort for about 35 years, and recently a few temporary cabins have been erected for the accommodation of visitors."[1]

POLK COUNTY.

GEOLOGY AND HYDROLOGY.

The Catahoula sandstone occupies the northern portion of Polk County but is overlain and succeeded on the south by the impervious Fleming clay (see Pl. I), which in turn is overlain by the Lissie gravel. South of the approximate latitude of Livingston the Dewitt formation probably lies between the Fleming clay and the Lissie gravel, the basal beds being approximately at sea level at this latitude and 1,000 feet below sea level on the Liberty County line. North of the latitude of Corrigan, the Yegua formation can be reached in wells ranging in depth from 700 to 2,000 feet. The water-bearing formations available are therefore the Yegua, Catahoula, Dewitt, and Lissie.

Yegua formation.—Flowing wells from the Yegua can be had only in the lower levels in the available area. (See Pl. VII, in pocket.) In the northern part of Polk County wells should not be drilled deeper than 1,000 feet, if potable water is desired.

Catahoula sandstone.—Water from the Catahoula sandstone may be had anywhere in the county. North of the latitude of Moscow wells ranging in depth from 50 to 800 feet will draw from these sands. South of this latitude the formation is embedded, the depth to it increasing toward the south. Along the Liberty County line, to secure a supply from the Catahoula a well will have to be from 1,400 to 2,200 feet deep. The area of flowing wells for this reservoir is indicated on the map (Pl. VIII). As a general rule water from the Catahoula will be potable. The wells at Bering (well No. 856) and at Onalaska (well No. 862) draw from these sands.

Dewitt formation.—Where water in sufficient quantity or under sufficient pressure can not be obtained from the overlying Lissie gravel it may be desirable to try the Dewitt, but it is improbable that the water will be so well adapted to boilers or to irrigation as the water from the overlying Lissie.

To reach these sands will require a well about 300 feet deep in the vicinity of Livingston. The required depths will increase toward the south, reaching 400 to 1,200 feet along the Liberty County line.

Lissie gravel.—The Lissie gravel will supply the entire southern half of the county with water, the wells ranging in depth from 30 feet near Livingston to approximately 400 feet on the southern

[1] Dumble, E. T., Kennedy, William, et al., Reports on the iron ore district of east Texas: Second Ann. Rept. Geol. Survey Texas, 1891, p. 251.

boundary line. The water is nearly everywhere potable and suitable for use in boilers, but the quantity available is not large in wells shallower than 300 feet.

WELL DATA.

Details of wells in Polk County are given in the following table:

Wells and springs in Polk County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
854	Bering				A. B. Garvey, county surveyor.[a]
855	Bering, 5 miles west.		—— Dean		William Kennedy.[b]
856	Bering		Mrs. George Ely		Bering Manufacturing Co.
857	Barnum, 6 miles north.				W. T. Carter & Bros.
858	Barnum, 3 miles northwest.		W. R. Harris		W. R. Harris.
859	Livingston, 1½ miles northeast.	M. L. Choate League.	Livingston Lumber Co., lessees.		James E. Hill.
860	Soda, 2 miles northeast.		T. W. Wilson	A. J. Leggett	T. W. Wilson.
861	Moscow, 4 miles		T. L. Hackney		J. A. Singley.[c]
862	Onalaska, 200 yards southeast of post office.	John Johnson survey, Reuben Lynch League.	Wm. Carlisle & Co.	Gust. Warnecke	Postmaster.

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 232.
[b] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, p. 54.
[c] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 107.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	Feet.	Feet.	Feet.	Feet.	Galls.	Galls.
854		1,000 (?)			Flows		
855		543	225	36 to 95; 195; 530 to 540			
856					Flows		
857							
858							
859		800			+3 to 4		
860	8	118		102	No flow		
861	4	420			Flows	Large.	45.
862	6 to 4	285; 285; 350		150 to 285	+3		

No.	Source of water.	Quality.	Remarks.
854			Abandoned.
855	Catahoula		
856			
857		Sulphur	Spring.
858		Iron and sulphur	Mineral spring.
859			Not good for boilers until water has remained for some time in the pond. Flow of gas.
860	Lissie	Soft	
861		Good	Well for sawmill.
862	Catahoula	Hard and iron	Used in boilers and to fill log pond; three wells; completed, 1906 and 1907. Show of gas.

DESCRIPTIVE NOTES.

855. *Section of Dean well, 5 miles west of Bering, Tex.*

	Feet.
Surface sands and gravels	0- 22
Fleming clay:	
White sand	22- 36
Strong water sand	36- 95
Clay with lime	95-140
Blue clay	140-160
Greenish clay, with water at 195 feet	160-195
Green shale	195-230
Green shale, with gravel	230-240
Catahoula sandstone:	
Quicksand	240-251
Quicksand, with lime and shells	251-284
Blue clay	284-292
Green shale	292-296
Shale	296-321
Soft green shale	321-325
Green clay	325-350
Greensand, with pyrites	350-384
Quicksand	384-400
Greensand	400-403
Blue clay	403-424
Green shale	424-430
Blue clay	430-460
Shale rich in iron pyrites	460-496
Dark shale	496-507
Light shale	507-520
Shale	520-530
Water sand	530-540
Gray sand	540-543

ROBERTSON COUNTY.

GEOLOGY AND HYDROLOGY.

In the northern half of Robertson County the Wilcox formation outcrops. To the southeast this dips under the Mount Selman, which in turn dips under the Cook Mountain. (See Pl. I.) The artesian reservoirs are therefore the Nacatoch (Cretaceous) and the lower Eocene.

Cretaceous rocks.—Between the western corner and a line extending northeast and southwest through Hearne, the Nacatoch reservoir can be reached in wells which will gradually deepen from 700 to 1,700 feet. (See Pl. VII, in pocket.) Probably, however, all the water from this formation is too salty for use.

Lower Eocene.—The lower Eocene reservoir can be reached anywhere in the county. West of the line passing through Hearne, as above described, wells from 20 to 800 feet in depth will draw from this reservoir. In the remainder of the county wells ranging in depth from 200 to 1,350 feet will be served by the lower Eocene sands.

Along the northern margin of the catchment area of the lower Eocene artesian system no flowing wells are obtainable. In the Brazos Valley, north of a line between Calvert and Calvert Bluff, the wells are generally very deep, and the water rises within 100 to 120 feet of the surface. South of this line and at low altitudes (see Pl. VIII) flowing wells are numerous. Experiments at Franklin (well No. 905) indicate that the water will not rise to the surface on the divides.

There are a great many flowing wells in the Brazos bottoms south of a line extending westward from Calvert. Nearly every plantation has two or more, which supply water for drinking and washing, for watering stock, and for the boilers of cotton gins, locomotives, and industrial establishments. One or more sands supply the wells. At Hearne there are 23 flowing wells, nearly all of which draw from a sand 700 feet below the surface.

Mr. H. Field, of Calvert, gives the following data concerning artesian wells in his section:

Artesian water is plentiful anywhere west of Houston & Texas Central Railroad, and south of the lignite beds on the Brown place (Calvert Bluff), about 6 miles northwest of Calvert. No artesian water can be had north of the lignite beds. Between the railroad above mentioned and the Brazos River there is no trouble in getting water at from 300 to 400 feet. Each farm in the Brazos bottom has from two to a half dozen wells. The water is fine for all purposes; it is cool and pleasant to drink, washes well, good for cooking, and fine for stock.

WELL DATA.

Details of wells in Robertson County are given in the following table:

Wells and springs in Robertson County, Tex.[a]

No.[e]	Location.	Owner.	Driller.	Authority.
863	Calvert, 5 miles west.	Brown		J. A. Singley.[b]
864	Calvert, 6 miles southwest, J. D. Smith, headright.	W. C. Anderson	A. Gilliam	W. C. Anderson.
865	Calvert, 4 miles south.	J. H. Drennon	do	J. H. Drennon.
866	Calvert			J. A. Singley.[c]
867	do			Do.[c]
868	do	Water, Ice & Electric Light Co.		Do.[c]
869	do	Market house		Do.[d]
870	do	Gibson		Do.[d]
871	Calvert, 5 miles southwest.	Garrett		Do.[d]
872	Calvert, 5 miles southwest and 600 yards east of well No. 871.	do		Do.[d]
873	Calvert, 5 miles southwest.	do		Do.[d]
874	Calvert, near; ½ mile east of well No. 872.	Field		Do.[d]

[a] For additional data, see notes following this table.
[b] Singley, J. A., Preliminary report on the artesian wells of the Gulf Coastal slope: Fourth Ann. Rept. Geol. Survey Texas, 1893, p. 111.
[c] Idem, p. 108.
[d] Idem, p. 109.

Wells and springs in Robertson County, Tex.—Continued.

No.	Location.	Owner.	Driller.	Authority.
875	Calvert, near; 600 yards south of well No. 872.	E. S. Peters		J. A. Singley.[a]
876	Calvert, 5 miles west.	Burnet		Do.[a]
877	Calvert, near	Astin		Do.[a]
878	Calvert, 2½ miles southwest.	J. A. Foster	A. Gilliam	J. A. Foster.
879	Calvert, west	H. Field		H. Field.
880	Hearne, 5 miles west.	Westbrook		J. A. Singley.[a]
881	Hearne	Joseph Hearne		Do.[a]
882	do	Mrs. E. F. Armstrong		Mrs. E. F. Armstrong.
883	Hearne, Magnolia Street.	J. H. Hartzog	Wm. Clark	J. H. Hartzog.
884	Hearne	Compress		J. A. Singley.[a]
885	do	R. C. Allen		Postmaster.
886	do	Planters Oil Co		Do.
887	do	Industrial Cotton Oil Co		Do.
888	Hearne, Magnolia Street, 700 feet northwest of post office.	Hearne Light & Power Co	Gust Warnecke	P. L. Brady, jr.
889	Hearne, 4 miles west.	J. B. Dunn	Wm. Clark	J. B. Dunn.
890	Hearne	L. W. Carr		Postmaster.
891	do	J. H. Hartzog		Do.
892	do	W. A. Scott		Do.
893	do	Mrs. H. K. Davis		Do.
894	do	W. Crenan		T. U. Taylor.[b]
895	do	Houston & Texas Central R. R.		Do.[b]
896	do	Gin & Light Co		Do.[b]
897	do	National Oil Co		Do.[b]
898	Hearne, 1 mile northwest.	Stock yards		Do.[b]
899	do	W. Kerlicks		Do.[b]
900	do	C. J. Hostrasses		Do.[b]
901	do	Charles Wood		Do.[b]
902	do	W. P. Ferguson		Do.[b]
903	Hearne, 3 miles southwest.	C. L. Glass		Do.[b]
904	Hearne	City		Do.[b]
905	Franklin			J. A. Singley.[a]
906	Franklin, 700 yards northeast of post office.	M. D. Sharp	Clark	M. D. Sharp.
907	Franklin			Wm. Kennedy.[c]
908	Mumford, 3 miles from, near the Little Brazos River.	Dr. Cernals		Dr. Cernals.
909	Mumford			J. A. Singley.[d]
910	Petteway (Thompson League).	M. Petteway	Ed. H. Phillips	M. Petteway.
911	Bremond			J. A. Singley[d].
912	Wootan wells, 200 yards southwest.	Ralph Wade		Ralph Wade.
913		Judge Terrell		J. A. Singley.[a]
914	Valley Junction			Do.[a]
915	Wheelock, 300 yards east of post office	W. G. Curry	William Clark	W. G. Curry.
916	Wheelock	Mitchell Bros		Mitchell Bros.
917	do	do		Postmaster at Wheelock.
918	do	Roger Killough		Do.
919	do	W. S. Hanover		Do.
920	do	Leonard McDonald		Do.
921	do	J. B. Dunn	William Clark	Do.
922	do	G. R. Dunn	do	Do.
923	do	S. E. Cavitt	do	Do.

[a] Singley, J. A., op. cit., p. 110.
[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 59.
[c] Kennedy, William, Report on Grimes, Brazos, and Robertson counties: Fourth Ann. Rept. Geol. Survey Texas, 1893, pp. 83-84.
[d] Singley, J. A., op. cit., p. 109.

Wells and springs in Robertson County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute.	
						Pump.	Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
863		800			−100		
864	2, 1	700		400	+30		
865	2	677			+32		10.
866	4	587			Flows		104.
867	4	620		560	do		104.
868		288			−30	700	
869	2	430			Flows		
870		585		585	do		
871	1	510			do		
872	1	266			do		
873	1	900			−20		
874	1	430			Flows		
875	1	288		288	do		
876		400			−20		
877		700			Flows		
878	3	710		585	+25		40.
879	2			270, 320, 400, 500	+25		1.
880	1	400			Flows		
881		700			do		
882		75			do		
883	2	715		715	+10		
884	2	725			Flows		70.
885	1	666			do		
886	2	600			do		
887	2	700			do		
888	6	720	300	23	Flowed		
				720	Flows	600	
889	4	850		800	+8		
890	1	700			Flows		
891	1	720			do		
892	1	700			do		
893	1	710			do		
894	1	740		480, 740	Flows		
		680			do		
895		720		700	do		
896		700+		700	do		
		700		700	do		
897		715		700	do		
898		1,020			do		
		750			do		
899		700		700	do		
900		690			do		
901		400			do		
902		720		700	do		
903		690					
		700			do		
		710					
904		720		700	do		
905		1,200			−100		
906	6	173		173	−80		
907							
908		280		220, 280	Flows		5.
909	1	580		580	do		
910	8	115		100	No flow		
911		1,500	467		do		
912	6 feet	84	±500	80 to 84	−70		
913	1	400			Flows		
914	1	300			do		
915	3	300		45, 300	−90	15	
916		200			−50	15	
917	3	200					
918	3	200					
919	3	200					
920	3	200					
921	3	200					
922	3	200					
923	3	200					

Wells and springs in Robertson County, Tex.—Continued.

No.	Source of water.	Quality.	Remarks.
863	Wilcox		In Brazos bottom.
864	do	Soft	Completed, 1888.
865		do	In Little Brazos bottom; completed, 1885.
866	Wilcox		
867	do	Good	
868	do		
869	do	Good	
870	do	do	
871	do	do	No. 1 well.
872	do	Excellent	No. 2 well.
873	do		No. 3 well.
874	do	Good	
875	do	Sulphur	
876	do		
877	do	Sulphur	
878	do		Located on post-oak plain, about 25 feet above the level of Brazos Valley; completed, 1902.
879	do		
880	do	Poor	In Brazos bottom.
881	do	Good	
882		Soft	In Brazos bottom.
883	Wilcox	do	Used for family purposes and garden irrigation; completed, 1900.
884	do		Compress well.
885	do		
886	do		
887	do		
888	{(?) Wilcox		Excellent boiler water; well completed, 1907.
889	do	Soft	Completed, 1894.
890	do		
891	do		
892	do		
893	do		
894	do	Good	Two wells.
895	do	do	Used in locomotive boilers; two wells.
896	do	do	Two wells.
897	do	do	
898	do		Do.
899	do	Good	
900	do	do	
901	do	do	
902	do	do	
903	do	do	Three wells.
904	do	do	
905	do	do	
906	do	Iron	Used for the irrigation of strawberries; completed, 1898.
907		(a)	Shallow well; known as Overall Mineral well; two wells.
908	Mount Selman		
909	Wilcox (?)	Good	
910	do	Sulphur	Completed, 1890; 3-foot seam of lignite encountered.
911	Nacatoch		This well began in strata lower than the productive beds of the Wilcox formation and penetrated the barren beds of the Upper Cretaceous. Some water struck.
912	Wilcox	(a)	Water used for medicinal purposes and in the manufacture of soda water. Health resort. There are four dug wells of this character. First well completed in 1881.
913		Good	In Brazos bottom.
914	Wilcox	do	Do.
915		Iron	Completed, 1906.
916	Mount Selman	Soft	Used in boilers.
917	do		
918	do		
919	do		
920	do		
921	do		
922	do		
923	do		

a For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

870. *Section of well at Gibson's gin, near Calvert, Tex.*

[Taken by J. L. Jones.]

	Feet.
Soil, subsoil, and gray sand	0 - 25
Red sand and gravel	25 - 30
Wilcox formation:	
Blue clay, with lime nodules	30 - 48
Limestone	48 - 52
Blue clay	52 - 67
Lignite	67 - 69
Blue clayey sand	69 - 77
Limestone	77 - 81
Blue clayey sand	81 -115
Lignite	115 -116. 5
Blue clayey sand	116. 5-140
Lignite	140 -145
Blue clayey sand	145 -161
Soft sandstone	161 -167
Blue clay	167 -168
Rock, hard	168 -172
Blue clay	172 -200
Lignite	200 -202
Red clay	202 -210
Limestone	210 -216
Blue clay	216 -232
Lignite	232 -234
Blue clayey sand	234 -310
Lignite	310 -320
Blue clayey sand, water bearing	320 -585

Three "hard rock" strata, 3, 6, and 10 inches thick, were met at 450, 492, and 504 feet, respectively.

875. *Section of well on E. S. Peters's plantation, near Calvert, Tex.*

[Taken by J. L. Jones.]

	Feet.
Soil and gray sand	0 - 10
Red sand	10 - 20
Gravel	20 - 42
Wilcox formation:	
Clay	42 - 46
Lignite	46 - 51
Clay	51 - 71
Limestone	71 - 72
Lignite	72 - 76
Clay	76 -100
Sandstone	100 -106. 5
Clay	106. 5-150
Rock	150 -151
Clay	151 -160
Rock	160 -161
Clay	161 -175
Lignite	175 -179
Clay	179 -240
Lignite	240 -258
Clay	258 -277
Water-bearing sand	277 -288

RUSK COUNTY.

GEOLOGY AND HYDROLOGY.

At one time the Mount Selman formation covered all of Rusk County, but it has been largely removed by erosion, exposing the sandy Wilcox formation in many places, especially in the lowlands. The Mount Selman remains chiefly on the divides and the iron-capped plateaus.

Owing to the absence of cover over the larger portion of the Wilcox, the conditions are not favorable for flowing wells except in the valleys. Thus far one artesian well (No. 928) has been sunk in this county, but it did not flow. Flows can probably be developed in the Sabine River bottoms (see Pl. VIII, in pocket), but there would be little demand for them there, except perhaps for sawmills. The chances are against flowing wells in other portions of the county, except in small areas where the ground-water table is locally elevated.

Owing to the fact that the strata are very nearly horizontal, abundant supplies of potable water may be had by pumping over the entire county in all wells ranging in depth from 100 feet above to 600 feet below sea level. These will come into larger use with the development of the orchard and trucking industries.

WELL DATA.

Well data are given in the table below:

Wells and springs in Rusk County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.
				Inches.	*Feet.*
924	Eulalie, ¾ mile east of	W. M. Britton	W. M. Britton		
925	Wherry, 2½ miles north (John Hallan survey).	J. T. Hall	J. T. Hall		
926	Tatum	J. R. Parish	J. R. Parish		
927	Tatum, 400 yards southeast of post office.	W. T. Hemby	W. T. Hemby		
928	Flanagan, 100 yards southeast of post office.	New South Lumber Co.	Assistant postmaster	8	300.
929	Mount Enterprise	D. W. March	(a)		
930	Stevens	Martin Baysinger			

No.	Depths to principal water-bearing strata.	Flow per minute.	Source of water.	Quality.	Remarks.
	Feet.	*Gallons.*			
924					Spring; local resort.
925				Soft	Spring.
926		6		do	Spring; used in boilers.
927		30		Iron and sulphur.	White Oak Spring; temperature, 70° F. used medicinally.
928	25, 150		Wilcox		Formerly used in boilers; well is not now in use; drilled by M. L. O'Neal in 1907 Does not flow.
929		Large		Iron	Stockmans Spring.
930		do		do	Sulphur spring.

a Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 234.

SABINE COUNTY.

GEOLOGY AND HYDROLOGY.

The northern portion of Sabine County is occupied by the outcrop of the Wilcox formation. To the south this is overlain by the Mount Selman and Cook Mountain formations, which outcrop in the central east-west belt. South of the Cook Mountain formation the Yegua formation is exposed, and this in turn is overlain by the Jackson formation. The extreme southern portion of the county is occupied by the outcrop of the Catahoula sandstone. The water-bearing formations available are the lower Eocene, Yegua, and Catahoula.

Lower Eocene.—In the well of the East Texas Timber & Oil Co., near Roberstons Ferry, a sand belonging to the Wilcox yielded a flow at a depth of 1,800 feet (well No. 933). At Sabinetown (well No. 934) water-bearing sands belonging to the Wilcox formation yielded flows at 241 to 290 and 638 to 690 feet. (See Pl. VIII, in pocket.) Water from depths exceeding 1,000 feet is inclined to be brackish, and it is not advisable to carry borings deeper.

Yegua formation.—The sands of the Yegua formation supply the well at Pineland from a depth of 350 feet (well No. 932). These sands constitute the available source of artesian water for the southern half of this county. The area of flow is confined to the lowlands along Sabine River. (See Pl. VII, in pocket.) The water is usually satisfactory in quality.

Catahoula sandstone.—The Catahoula sandstone is not under cover in this area and is capable of supplying shallow surface wells only.

WELL DATA.

The only important consumers of artesian water in Sabine County are the sawmills and railroads. Details of wells are given in the following table:

Wells in Sabine County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Driller.	Authority.
931	Milam, 4 miles east.	Moses Hill League.	G. B. McLanahan.	....	G. B. McLanahan.
932	Pineland..........	....	Garrison & Norton Lumber Co.	P. Leukey.......	J. A. Hargrave, postmaster.
933	Robertsons Ferry, 15 miles east-southeast of Hemphill.	H. C. Maund tract.	East Texas Timber & Oil Co.	W. A. Turner.....	W. A. Turner.[a]
934	Sabinetown, 1 mile west.	....	Sabine Oil & Mineral Co.	Will Spurm......	
935	Bronson..........	....	Gulf, Colorado & Santa Fe Ry.	....	T. U. Taylor.[b]

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 234.

[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, pp. 63–64.

Wells in Sabine County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Flow per minute.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*
931						20.
932	10	720		350	−7	
933		1,975	120	1,010 to 1,030 1,800	Flows do	Large. Do.
934		1,501		241 to 290 638.5 to 690 1,391 to 1,414	Flowed	
935		1,070		674 to 729 1,018 to 1,068		

No.	Source of water.	Quality.	Remarks.
931		Sulphur	Boiling spring.
932	Yegua		Used in boilers; completed, 1906.
933	Cook Mountain Wilcox	Pleasant tasting Brine	
934	do do Cretaceous(?)	Good (?) Salty	Completed, 1903; drilled for oil; first water is soft; second and third are salt water; abandoned.
935	Wilcox	Good [a]	Used in locomotive boilers.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

933. *Section of East Texas Timber & Oil Co.'s well, 1 mile below Robertsons Ferry, Sabine County, Tex.*

	Feet.
Soil	0 – 2
Yellow sand	2 – 35
Blue clay	35 – 55
Hard blue clay	55 – 95
Rock, with fossil shells	95 – 98
Blue shale	98 – 120
Hard blue clay	120 – 180
Rock, with fossil shells	180 – 185
Stiff blue clay ("gumbo")	185 – 230
Sand	230 – 238
Gumbo (stiff blue clay)	238 – 286
Soft sand	286 – 290
Gumbo	290 – 321
Sand	321 – 327
Rock	327 – 331
Lignite	331 – 335
Sand	335 – 360
Dark-brown clay	360 – 375
"Coal" (lignite)	375 – 380
Blue gumbo	380 – 442
Sandstone	442 – 460
Limestone	460 – 468
Blue gumbo	468 – 498
Sandstone	498 – 516

	Feet.
Very dark gumbo	516 - 550
Soft clay	550 - 580
Hard clay	580 - 640
Fossiliferous marl	640 - 649
Hard clay	649 - 650.5
Fossiliferous sandstone	650.5- 665
Rock	665 - 666.5
Hard clay	666.5- 684
Flint rock, very hard	684 - 685.5
Dark-colored shale	685.5- 726
Soft sandstone	726 - 741
Gumbo	741 - 767
Soft sandstone	767 - 779
Shale	779 - 784
Soft sandstone, with shells	784 - 800
No record	800 -1,010
Sand, with pleasant-tasting artesian water	1,010 -1,030
Clays, mostly dark colored, containing fossil shells of the Claiborne group (Eocene) below 1,215 feet	1,030 -1,350
Hard rock	1,350 -1,425
Artesian salt water	1,425 -1,800
Total depth, Mar. 2, 1903	1,975

Veatch[1] says:

On November 30, 1902, Mr. Turner wrote: "At about 1,020 feet we got some 15 to 20 feet of sand, and when we bailed the well we got a good flow of pleasant-tasting water. It boiled about 1 foot above the top of the 6-inch casing, but would soon choke with sand. When the flow weakened, some gas would be noticed with the water. Below 1,030 feet the formation was different clays, etc., mostly dark colored, but there was nothing that could be called sand until 1,350 feet was reached. We put in 1,215 feet of 6-inch casing and bailed again. Result, considerable gas and the hole filled to within 300 feet of the surface with clay shale and thick mud; no sand; the mud might be called greasy. The shells which I send you came from the hole after putting in the 6-inch casing and washing and bailing. They certainly came from below 1,215 feet."

These shells were referred to Dr. W. H. Dall, who reported: "They are of the horizon of the Claiborne sands, or mid-Eocene, and the specimens contain fragments of half a dozen characteristic Clairbornian species."

Just north of this well there is a good exposure of fossiliferous Jackson marl in the river bank which definitely determines the fossiliferous beds encountered in the upper part of this well to be of Jackson age. The lignitiferous clays below are clearly Cockfield (Yegua). The lignite beds suggest the impure lignite found in Lawhorn Bluff, and if in exactly the same stratigraphic position, indicate a dip of 82 feet per mile.

934. *Section of Sabine Oil & Mineral Co.'s well, 1 mile west of Sabinetown, Tex.*

	Feet.
Red and blue clay	0 - 30
White sand	30 - 40
Soft red rock	40 - 50
Shell rock	50 - 52
Sandrock with 1 foot hard pyrites at bottom	52 - 59
Blue marl and shell	59 - 80

[1] Veatch, A. C., op. cit., pp. 324-325.

	Feet.
Wilcox formation:	
Lignite (first gas)	80 – 95
Soft green sandrock with 1 foot hard pyrites at bottom	95 – 241
Soft shale (?) with flow of water	241 – 300
Blue shale and sand	300 – 379
Caving blue sand capped by 1½ feet hard pyrites	379 – 528
Blue sand capped by hard rock	528 – 534.5
13½ feet sand underlain by ½ foot of shell rock	534.5– 548
Sand	548 – 600
Shell rock	600 – 604
Sandrock; 1 foot very hard rock at bottom	604 – 645
Shales and sandrock	645 – 674
Very hard rock	674 – 680
Gumbo	680 – 690
Soft sandrock	690 – 728
Soft gray sandrock	728 – 800
Gravel and pyrites	800 – 804
Soft sandrock	804 – 860
Shale and sand mixed	860 – 875
Soft sandrock and 1 foot very hard rock at bottom	875 – 907
Soft sandrock and 2 feet hard rock at bottom	907 – 996
Medium hard sandrock underlain by 2 feet hard pyrites	996 –1,035
First showing strong sulphur gas	1,035 –1,037
Soft sandrock	1,037 –1,065
Midway formation:	
Mixed streaks shale, sand, and gumbo	1,065 –1,265
Brown shale	1,265 –1,293
Very hard rock with pyrites	1,293 –1,299
Hard rock, showing oil and gas	1,299 –1,306
Cretaceous (?):	
Soft sandrock (salt water)	1,306 –1,329
Soft sandrock capped by shell rock	1,329 –1,341
Soft sandrock; and gas underneath	1,341 –1,344
Hard rock	1,344 –1,347
Soft sandrock with 1 foot hard rock, 1,383–1,384, and 2 feet hard shell at bottom	1,347 –1,406
Soft sandrock or hard packed sand	1,406 –1,489
Clay and sand mixed	1,489 –1,499

935. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Bronson, Tex.*

	Feet.
Yellow clay	0– 30
Cook Mountain and Mount Selman formations:	
Blue clay	30– 60
Brown shale	60– 103
Sand	103– 115
Brown shale	115– 145
Sand	145– 155
Blue clay	155– 163
Limestone rock	163– 164
Blue clay	164– 258
Sand	258– 272
Blue clay	272– 322

	Feet.
Cook Mountain and Mount Selman formations—Continued.	
Brown shale	322- 352
Blue clay	352- 374
Blue clay and "shell"	374- 380
Blue clay	380- 486
Sandrock	486- 489
Blue clay	489- 578
Blue clay and bowlders (concretions)	578- 586
Blue clay	586- 674
Wilcox formation:	
Water sand	674- 729
Blue clay	729- 810
Dark sand	810- 818
Blue clay	818- 892
Blue shale and "shell"	892- 928
Dark shale	928-1,018
Water sand	1,018-1,068
Dark clay	1,068-1,070

SAN AUGUSTINE COUNTY.

GEOLOGY AND HYDROLOGY.

The Wilcox formation outcrops in the extreme northern portion of San Augustine County, but is overlain to the south by the Mount Selman and Cook Mountain formations. The sands of the Yegua formation are exposed along the central belt of the county and are overlain to the south by marls of the Jackson formation. In the extreme south the Catahoula sandstone has a small exposure. (See Pl. I.) The important water-bearing formations of the county are the Wilcox, Yegua, and Catahoula.

Wilcox formation.—In the northern portion wells can be completed in the Wilcox reservoir at depths ranging from sea level to 600 feet below. The depths increase toward the south and in the southern portion it would require wells reaching 1,400 to 2,000 feet below sea level to develop supplies. The area of flow (see Pl. VIII, in pocket) is confined largely to the lowlands.

Wilcox water from wells that do not reach over 1,200 feet below sea level will generally be potable and adapted to boilers. In places sulphur and chalybeate water may be expected.

Six miles south of San Augustine these sands supply very soft water from a depth of 395 to 415 feet. Two and one-half miles southwest of Denning a sand 98 feet below the surface yields a flow of sulphurous and chalybeate water. Six miles northwest of San Augustine flows of unknown quality were developed in sands at 139 to 173, 198 to 208, and 240 to 250 feet below the surface.

Yegua formation.—In the southern portion of the county, where the Wilcox is so deeply embedded that the quality of its water is questionable and the expense of reaching it great, the Yegua artesian system may be drawn on. The Yegua dips at a high angle to the south and to reach it wells must go down to sea level close to Warsaw and to depths between 400 and 800 feet below sea level in the extreme southern corner. Wells reaching over 900 feet below sea level are not to be recommended. The flows will be confined to the lowlands adjacent to Attoyac Bayou and to the southern portion of the county. (See Pl. VII, in pocket.)

The sands of the Yegua formation, so far as known, have not been exploited in other than shallow surface wells, and no data as to the quality of their water are available. In most wells not exceeding 700 feet in depth the water will probably be potable and doubtless some of the sands penetrated will supply good boiler water. In many, however, sulphur water may be looked for.

Catahoula sandstone.—The Catahoula sandstone is not sufficiently embedded to make it important except in relatively shallow non-flowing wells.

WELL DATA.

Details of wells in San Augustine County are given in the following table:

Wells and springs in San Augustine County, Tex.

No.	Location.	Owner.	Driller.	Authority.	Diameter of well.	Depth of well.
					Inches.	*Feet.*
936	Denning, 2½ miles southwest.	W. K. Freeman	E. F. Graham	W. K. Freeman	10	800.
937	Altonia, ½ mile west.	Z. S. Moss		Z. S. Moss		
938	Swannville, 300 yards east of post office.	Lufkin Land & Lumber Co.		J. R. Phelps		
939	San Augustine, 6 miles south.	Andrew Phillips	Savage Bros	W. W. Lawrence	6	415.
940	San Augustine, 3 miles northwest.	Dr. J. E. Harrison.		L. Sharp, postmaster.		1,400 (?).
941	San Augustine, 6 miles northwest.			do.		400.
942	do.	Santa Fe Ry. Co.		N. M. Fenneman [a].		595.
943	San Augustine, 2 miles west.			N. H. Darton [b]		700.

No.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above ground.	Flow per minute.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Galls.*			
936		98	5		Wilcox and Mount Selman.	Iron and sulphur.	Drilled for oil; Sun Oil Co. well (?); completed, 1904.
937						Soft	Bullock Spring, temperature of water, 65° F.
938						Sulphur	Spring.
939	200	395 to 415	30		Wilcox		Completed, 1900; drilled for oil.
940							Drilled for oil.
941							Do.
942		139 to 173 198 to 208 240 to 250	Flows		Wilcox		Oil test well (No. 1); two other similar wells belong to same company.
943			Flows	Many.	do		Oil test well.

[a] Fenneman, N. M., Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 282, 1906, p. 72.
[b] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 153.

DESCRIPTIVE NOTES.

936. W. K. Freeman writes: "The well was drilled for oil. At 98 feet there came in the flow of water that rose in the 10-inch casing 5 feet above the mouth of the casing. They tried to case off this water with 10-inch pipe, and went on down with 6-inch casing, and then 4-inch, but they never succeeded in casing out the water, and there is now a fine 10-inch flow."

942. *Section of Santa Fe Railway Co.'s well No. 1, 6 miles northwest of San Augustine, Tex.*

	Feet.
Cook Mountain and Mount Selman (?) formations:	
Red clay	0 - 15
Yellow clay and marl	15 - 20
Blue marl	20 - 34
Blue marl, black as coal when wet	34 - 44
Blue marl, streaks of harder marl	44 - 52
Blue marl	52 - 57
Blue clay	57 - 69
Brown shale	69 - 72.5
Brown soapy shale, with bowlder (concretion) of hematite at 75 and 78 feet	72.5- 82
Brown soapy shale	82 - 89
Brown soapstone and thin layers of limestone	89 - 96
Blue marl	96 -114.5
Blue clay	114.5-115.5
Blue and brown shale, with hard streaks	115.5-132.5
Blue limestone and marl, with pyrite; very hard	132.5-139
Wilcox formation:	
Gray water sand, hard	139 -141
Gray water sand, a little pyrite, and very small trace of oil and gas	141 -167
Blue-gray water sand	167 -173
Brown clay, with sand	173 -187
Brown sand, with streaks of clay	187 -198
Brown water sand	198 -208
White clay	208 -209
Brown gumbo and clay	209 -238
Pyrite	238 -240
Water sand	240 -250
Water clay	250 -260
Black rock and pyrite	260 -261
Brown clay	261 -267
Bowlder (concretion) of lime, with little oil	267 -268
Brown clay	268 -270
Brown clay, with layers of sand	270 -274
Fine sand	274 -275
Brown clay	275 -277
Fine sand	277 -278
Brown clay	278 -283
Bowlder of lime	283 -285
Brown clay	285 -290
Brown sand	290 -294
Brown clay with layers of sand	294 -304
Not reported	304 -328

Wilcox formation—Continued.	Feet.
Brown clay; little oil	328 –342
Fine sand	342 –360
Fine sand or clay	360 –368
Not reported	368 –404
Clay and shells	404 –423
Clay or fine sand	423 –434
Shale with layers of lignite	434 –460
Clay or fine sand	460 –483
Fine sand	483 –485
Clay and little lignite	485 –488
Clay	488 –503
Shale	503 –508
Shale with little lignite	508 –514
Shale and few shells	514 –518
Shale	518 –530
Lignite	530 –530.5
Shale; thin lignite layers	530.5–588
Lignite	588 –590
Shale	590 –591
Lignite	591 –595

SAN JACINTO COUNTY.

GEOLOGY AND HYDROLOGY.

In the extreme north corner of San Jacinto County the Catahoula sandstone outcrops. These sandstones are covered to the south by the Fleming clay, which in turn is succeeded by the Lissie gravel. The latter covers the greater portion of the county. The artesian beds have not yet been developed.

Catahoula sandstone.—The Catahoula sandstone constitutes an important water horizon which is everywhere available. In the north it will be met in drill holes a few hundred feet deep, but the depth increases southward, reaching about 1,000 feet along the Liberty County line. The area of flow (see Pl. VIII) is confined to the valleys in the north but widens toward the south.

Dewitt formation.—Sandstones of the Dewitt formation underlie the county but have no surface outcrop, being embedded. They lie between the Lissie gravel and the Fleming clay and will supply water of potable character. They may be reached by wells about 300 feet deep in the vicinity of Oakhurst and about 400 to 1,200 feet deep along the Liberty County line. The area in which flows may be expected is indicated on Plate IX. Although the water from these Dewitt strata will not be as well adapted for boilers and irrigation as that from the overlying Lissie, it will probably be more abundant.

Lissie gravel.—The Lissie gravel is not under cover and need not be expected to yield flows except in the bottoms in the southern part of the county. The water will be better than that supplied by the deeper wells dependent on the other artesian beds.

WELL DATA.

Details of wells in San Jacinto County are given in the following table:

Wells and springs in San Jacinto County, Tex.

No.	Location.	Owner.	Authority.	Depth of well.
				Feet.
944	Evergreen, 2½ miles west	A. G. Hoot	A. G. Hoot	
945	Shepherd	Dr. W. H. Beazley	Postmaster	
946	Oakhurst		T. U. Taylor [a]	1,052.

No.	Height of water above (+) or below (−) ground.	Source of water.	Quality.	Remarks.
944			Sulphur	Spring. "It would be impossible to mention the number of springs in this vicinity, there are so many."
945	Strong flow			Drilled for oil; abandoned.
946	No flow	Catahoula		

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 46.

SHELBY COUNTY.

GEOLOGY AND HYDROLOGY.

In Shelby County the Wilcox formation predominates, the former cover of the Mount Selman formation persisting in only a few scattered hills. (See Pl. I.)

Artesian wells draw from the water-bearing sands of the Wilcox formation. That flows are restricted to the valleys and the bottoms (see Pl. VIII) is shown by wells near Tenaha and at Timpson. Near Tenaha, in the Flat Fork bottoms (well No. 948), the sands yielded a copious flow, but at Timpson at a higher altitude (well No. 950) the water rose only within 80 feet of the surface. The area of flow is delimited on the map (Pl. VIII, in pocket).

Wells can be developed at depths ranging from 100 feet above sea level to 600 feet below. The sands dip gently, almost imperceptibly, and the depth of wells need vary little.

Four miles southeast of Tenaha a sand 490 feet below the surface yields a flow described as "slightly sulphur." At Center sands at 564 to 614 feet below the surface yield water satisfactory for locomotive boilers. Over the entire county water suited for drinking and for boilers may be expected, though in a few wells sulphur water may be obtained. Where sulphur water appears in the upper portion of the reservoir it is always advisable to carry wells to the basal sands, if a good boiler water is desired, though it does not follow that such water will always be obtained.

WELL DATA.

Details of wells in Shelby County are given in the following table:

Wells and springs in Shelby County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Approximate elevation of surface.
				Inches.	*Feet.*	*Feet.*
947	Shelbyville, 16 miles east, near Myrick Ferry.	W. T. Beck	William Harrawood.			
948	Tenaha, 4 miles southeast.	The Flat Fork Oil Co.	J. B. Burus	13	1,200	311.
949	Timpson, ½ mile south of post office.	T. C. Whiteside	T. C. Whiteside			
950	Timpson	T. C. Whiteside et al.	do.[a]		900	392.
951	Center	Gulf, Colorado & Santa Fe Ry.	T. U. Taylor [b]		623	
952	Center, 600 feet southwest of post office.	City	Henry Lien, postmaster.	8	368	

No.	Depths to principal water-bearing strata. (?)	Head of water above (+) or below (−) ground.	Flow per minute.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Gallons.*			
947			2		Soft	Spring on James Smith survey.
948	490	+6		Wilcox	Some sulphur.	No other water beds encountered; drilled for oil by J. B. Burus in 1907.
949			15			Mineral spring.
950	700	−80		Wilcox		Test well for oil.
951	564 to 614.			do	Good [c]	Used for locomotive boilers.
952	368	−40		do	Soft	Water supply for Center. Drilled by C. A. Lewis.

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 234.
[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 65.
[c] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

951. *Section of Gulf, Colorado & Santa Fe Railway Co.'s well at Center, Tex.*

	Feet.
Yellow clay	0–10
Wilcox formation:	
Brown shale	10–106
Lignite	106–108
Brown shale	108–240
Sand	240–250
Brown shale	250–320
White sandstone	320–330
Brown shale	330–356
Lignite	356–358
Brown shale	358–372
White sandstone	372–374

Wilcox formation—Continued.	Feet.
Brown shale	374–416
"Stone coal"	416–417
Brown shale	417–443
Sandstone	443–445
Brown shale	445–517
"Gray granite" (sandstone)	517–520
Brown shale	520–556
Sandstone	556–557
Brown shale	557–562
"Gray granite" (sandstone (?))	562–564
White sand, water-bearing	564–614
Brown shale	614–623

SMITH COUNTY.

GEOLOGY AND HYDROLOGY.

The Wilcox constitutes the outcropping formation over the major portion of Smith County, but in the extreme southern portion and in some scattering localities it is overlain by the Mount Selman formation.

The sands of the Wilcox formation, which constitute the important available source of water, may be exploited at depths of 100 to 1,000 feet. The area of flowing wells is confined to the valleys and the bottoms. (See Pl. VIII.) Two flowing wells (Nos. 954 and 960) have been sunk, and their success should encourage further development.

Wilcox water in Smith County is potable except in the vicinity of the salines, of which there are two. Near these salines prospects for fresh water are not favorable.

WELL DATA.

Data on wells of Smith County are given in the following table:

Wells in Smith County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Approximate elevation of surface.
				Inches.	*Feet.*	*Feet.*
953	Lindale, 5½ miles north.	H. L. Tate	H. L. Tate	6	400	±450.
954	Lindale, 4 miles north.	Mrs. J. A. Dickert.	Mrs. J. A. Dickert	15	500	±559.
955	Tyler	Tyler Ice Co	(a)	6 to 4	60	
956	do	do	County clerk [a]		500 to 600.	
957	do	Col. W. S. Herndon.	Col. W. S. Herndon [a]	6	1,207	
958	Tyler, 17 miles southwest.		J. H. Herndon [a]			
959	Tyler, 14 miles north.					
960		County poor farm.	T. U. Taylor [b]		460	

[a] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: Prof. Paper U. S. Geol. Survey No. 46, 1906, p. 234.

[b] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 66.

Wells in Smith County, Tex.—Continued.

No.	Depths of principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute. Pump.	Yield per minute. Flow.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Galls.*	*Galls.*			
953	200	−14			Wilcox		Completed, 1900.
954	150	+18		3	do	Soft	Completed, 1898.
955		−60	100				Temperature, 63° F.
956			Large		Wilcox		
957	400	−100	3		do	Soft	Abandoned.
958						Brine	Abandoned salt works. Brooks saline.
959						do	Abandoned salt works. Steen saline.
960		Strong flow.			Wilcox		Drilled for oil.

DESCRIPTIVE NOTES.

957. *Partial section of well owned by Col. W. S. Herndon, at Tyler, Tex.*

	Feet.
Blue clay	0–300
Wilcox formation:	
Sandstone, very hard	300–302
Sand	302–
Clay.	
Sand, not water-bearing.	
Clay.	
Sand.	

TRINITY COUNTY.

GEOLOGY AND HYDROLOGY.

The northern half of Trinity County is occupied by the outcrop of the Yegua formation. These beds dip beneath the Catahoula sandstone, which constitutes the surface formation in the southern half of the county. In the extreme southern corner the Fleming clay covers the Catahoula sandstone. (See Pl. I.)

Yegua formation.—The Yegua formation supplies water over the entire county. The area of flowing wells is limited to the lowlands. (See Pl. VII, in pocket.) Thus far flows have been obtained at Groveton (well No. 964), 5 miles southeast of Lovelady (well No. 966), near Iris (well No. 968), and at Trinity. The waters of the first three were potable; that from a sand at a depth of 900 feet in the Trinity well is reported to have been salty. Artesian wells in this county should not be drilled to depths exceeding 1,000 feet.

Catahoula sandstone.—In the southern half of Trinity County the Catahoula sandstone is available. Wells along the line extending from Trinity through Groveton to Potomac in order to draw water from these sands, will have to be from 30 to 150 feet in depth; in the south corner they will have to be 200 to 700 feet in depth. Between these limits the upper sands can be reached between 30 and 200 feet and the basal sands between 150 and 700 feet. Catahoula water will be potable, but its value in boilers is doubtful.

WELL DATA.

Details of wells in Trinity County are given in the following table:

Wells in Trinity County, Tex.

No.	Location.	Owner.	Driller.	Authority.	Diameter of well.	Depth of well.
					Inches.	*Feet.*
961	Groveton, ½ mile southeast.	Groveton Light & Ice Co.	Layne & Bowler.	John R. Collins ...	6........	380.
962	Groveton, 2,200 feet southwest.	Trinity County Lumber Co.	.....do..........	P. A. McCarthy, chief engineer.	6........	343.
963	Groveton, 2,000 feet southwest.	.....do..........	.....do..........	.....do..........	8¼........	473.
964	Groveton..........	.....do..........	....	John R. Collins...	6........	495.
965	Westville, 200 yards northwest of post office.	West Lumber Co..	....	Luther L. Werner, postmaster.	6........	500.
966	Lovelady, 5 miles southeast.	J. M. Thompson Lumber Co.	....	W. B. Collins......	6........	1,200.
967	Trinity............	....	....	N. H. Darton [a]....	....	900+.
968	Iris, 4 miles east, near Neches River, on Burrs Ferry.	Douglas & Crawford.	E. L. McCloud...	A. P. Kimmey and others.	....	1,000±.
969	Iris, 500 yards east of post office.	J. B. Roach.......	....	J. B. Roach.......	....	

No.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Flow per minute.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Galls.*			
961	....	194 to 307..	−60........	....	Yegua....	Soft.......	Completed, 1906; water used for the manufacture of ice.
962	288......	303 to 324..	No flow...	....	...do......	...do......	Completed, 1907 (well No. 2).
963	288......	458 to 478..	...do......	....	...do......	....	Completed, 1907; well No. 1; used in boilers.
964	....	....	Flows......	....	...do......	....	Well No. 3.
965	....	300 to 500..	No flow...	....	...do......	Soft.......	Completed, 1905; used in boilers.
966	....	70........ 304........ 550 (?)....	Flow...... +40........ Flow......	Many... ...do.... ...do....	...do...... ...do...... ...do (?)...	..do......	In a valley. Completed, 1903. Put down by the Houston County Development Co. in search of oil. Two wells were put down; the first struck a flow of water at 70 feet and was abandoned.
967	....	....	Flows.....	Few....	...do......	Salty; sulphur.	
968	....	197 to 234..	Flowed....	....	...do......	....	Oil test well; completed, 1904; abandoned.
969	....	....	....	....	....	Soft.......	Spring.

[a] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 154.

DESCRIPTIVE NOTES.

961. *Section of Groveton Light & Ice Co.'s well, ½ mile southeast of post office at Groveton, Tex.*

[Supplied by John R. Collins.]

	Feet.
Catahoula sandstone and Yegua formation:	
Sand and clay	0– 24
Soft shale	24– 73
Lignite	73– 75
Muddy sand	75– 98
Shale and lignite	98–120
Lignite	120–130
Shale	130–140
Sand	140–142
Shale	142–186
Sandstone	186–194
Mud and sand; water-bearing	194–215
Clay and sand	215–236
Shale rock	236–242
Gumbo	242–267
Sandstone	267–270
Gumbo	270–276
Rock	276–282
Gumbo	282–289
Sand	289–291
Gumbo	291–306
Sand; water-bearing	306–310
Gumbo and layers of rock	310–360
Sandrock	360–379
Gumbo	379–380

962. *Section of Trinity County Lumber Co.'s well No. 2, 2,200 feet southwest of post office at Groveton, Tex.*

[Furnished by P. A. McCarthy, chief engineer.

	Feet.
Catahoula sandstone:	
Sandy clay	0– 57
Chalk rock	57– 72
Sand	72– 79
Hard sandstone	79– 81
Yegua formation:	
Lignite	81– 88
Chalk rock	88–101
Lignite	101–105
Sandy shale	105–188
Shale	188–209
Sandstone	209–219
Shale	219–235
Gumbo	235–257
Soapstone	257–278
Gumbo	278–296
Sharp sand, water-bearing	296–324
Gumbo and soapstone	324–327
Lignite	327–343

6-inch casing to 306 feet; 6-inch strainer from 306 to 327 feet; 6-inch casing from 327 to 346 feet.

963. *Section of Trinity County Lumber Co.'s well No. 1, 2,000 feet southwest of post office, at Groveton, Tex.*

[Furnished by P. A. McCarthy, chief engineer.]

	Feet.
Sand	0– 12
Catahoula sandstone and Yegua formation:	
Hard layers	12– 52
Lignite	52– 61
Rock	61– 70
Sand	70– 76
Shale	76– 85
Sandy shale	85–199
Sandrock	199–207
Shale	207–214
Rock	214–222
Shale	222–227
White rock	227–232
Soapstone and gumbo	232–303
Sandy shale	303–315
Soapstone	315–337
Hard lignite	337–354
Hard shale	354–376
Soapstone	376–388
Rock	388–395
Gumbo	395–409
Soapstone and gumbo	409–434
Sandy clay	434–436
Sandrock	436–440
Sandy clay	440–446
Sandrock, water-bearing	446–449
Sharp fine sand, water-bearing	449–464
Sandrock	464–467
Sand	467–469
Soapstone and gumbo	469–478

8¼-inch casing to 446 feet 6 inches; 8¼-inch strainer from 446 feet 6 inches to 466 feet 6 inches; 8¼-inch casing from 466 feet 6 inches to 478 feet.

968. *Partial section of well 4 miles east of Iris, near Neches River, Tex.*

	Ft.	in.	Ft.	in.
Yegua formation:				
Black sand and clay; oil at 7 feet; one-half foot rock at 20 feet	0	0–	160	2
Black sand	160	2–	178	2
Hard sand	178	2–	197	6
Sand; artesian flow; oil on water	197	6–	234	11
Partial record; 3 feet rock	234	11–	253	11
Partial record; 2 feet shale	253	11–	274	11
Shale	274	11–	296	11
Partial record; sand 10 feet	296	11–	313	11
Shale	313	11–	356	1
Partial record; 1 foot rock; gas	356	1–	375	10
No record; oil	375	10–	395	4
Rock	395	4–	414	1

Cook Mountain and Mount Selman formations:	Ft.	in.	Ft.	in.
"Shell"	414	1–	433	10
No record; oil	433	10–	475	8
Shale and oil	475	8–	494	8
Record wanting	494	8–	1,000±	

TYLER COUNTY.

GEOLOGY AND HYDROLOGY.

The northern east-west belt of Tyler County is occupied by the outcrop of the Catahoula sandstone. These beds dip beneath the

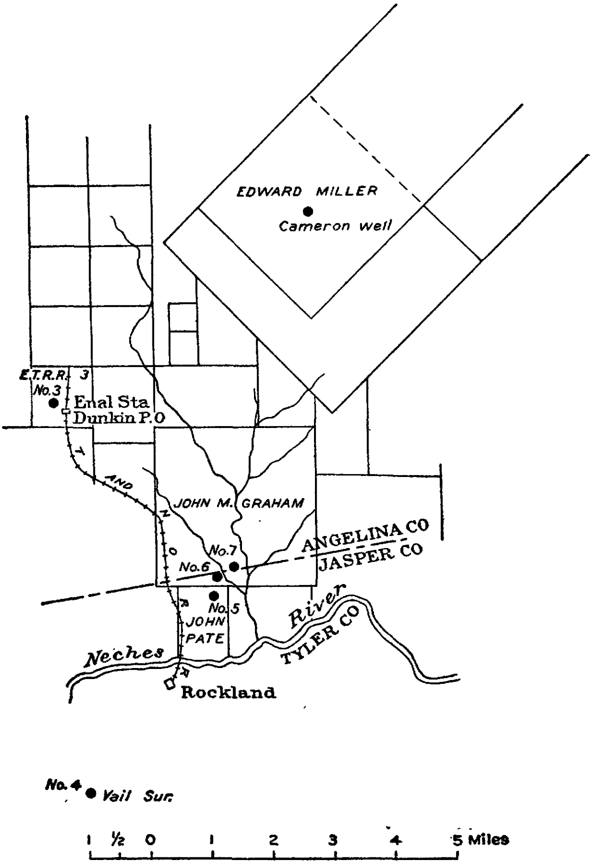

FIGURE 17.—Wells in the vicinity of Rockland.

Fleming clay, which occupies the central belt and which in turn dips beneath the Lissie gravel. (See Pl. I.)

Yegua formation.—In the north the sands of the Yegua formation will yield flowing wells (well No. 980). The sands lie about 1,200 feet below sea level and their water is not suitable for use. Shallower, nonflowing wells from the overlying horizons are recommended.

Catahoula sandstone.—In the north, along the Missouri, Kansas & Texas Railway, wells in the Catahoula reservoir can be developed at depths ranging from sea level to 500 feet below. The reservoir deepens toward the south until in the vicinity of Warren wells will have to go from 800 to 1,500 feet below sea level. It will generally not be advisable to go deeper than 1,200 feet below sea level, especially as satisfactory supplies will generally be obtainable at shallower depths. The region of flowing wells is limited to the lowlands adjacent to Neches River. (See Pl. VIII, in pocket.) Catahoula water will in most wells prove potable and fairly well adapted for boilers. Figure 17 shows wells in the Catahoula sandstone near Rockland.

Dewitt formation.—The Dewitt formation presents possibilities in the southern part of the county, where flows are particularly desired, but wells to it should not be deeper than 1,000 feet. (See Pl. IX, in pocket.)

Lissie gravel.—The Lissie gravel in the southern part of the county is not under cover. It may, therefore, not be expected to produce flowing wells except in the Neches bottoms close to the Hardin County line.

In the northern part of the county this formation is very thin and can supply only shallow surface wells. It thickens toward the south, and here may be expected to yield abundant water adapted to every use in wells 100 to 200 feet deep.

WELL DATA.

Details of wells in Tyler County are given in the following table:

Wells and springs in Tyler County, Tex.

No.	Location.	Survey, headright, or street.	Owner.	Authority.
970	Pedigo, 1½ miles northeast.			William Kennedy.[a]
971	Pedigo, 2 miles northwest.		J. T. Crumpler	J. T. Crumpler.
972	Mobile, ½ mile north			J. F. Walker.
973	Woodville, 9 miles west.		F. A. Rodgers	Postmaster.
974	Doucette		Thompson Bros. Lumber Co.	Do.
975	Chester, 7 miles northeast.	Whitehead Hill, S. ½ sec. 8, B. B. & C. R. R. survey.	Dr. Guilder heirs	D. S. Whitehead.
976	Hyatt		Rice Bros	W. C. McBride.
978	Colmesneil, 3 miles northwest.	John Schillings survey	Oklahoma-Texas Oil Co.	J. C. Harelson.
979	Townbluff	W. W. Hanks survey		Tom Mann.
980	Rockland, ¾ miles south.	D. H. Vail League	Kountze Bros.	E. T. Dumble and others.

[a] Hayes, C. W., and Kennedy, William, Oil fields of the Texas-Louisiana Gulf Coastal Plain: Bull. U. S. Geol. Survey No. 212, 1903, p. 57.

Wells and springs in Tyler County, Tex.—Continued.

No.	Diameter of well.	Depth of well.	Approximate elevation of surface.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute. Pump.	Yield per minute. Flow.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Galls.*	*Galls.*
970		824			Flowed(?)		
971							25.
972							
973		933(?)			No flow(?)		
974	8	344			−50	66	
975	8	1,000+		200	No flow		
976		500(?)					
978		2,103			−200		
979		1,000±			Flows(?)		
980		1,550	230	1,070 to 1,130	Flows		

No.	Source of water.	Quality.	Remarks.
970			Drilled for oil.
971		Iron and sulphur	Spring.
972		Sulphur	Do.
973			Drilled for oil.
974	Catahoula(?)		Completed, 1903; used for boiler purposes.
975	do		Oil test well; drilled by J. F. Wagnon, in 1905.
976		Good	Oil test well.
978			Oil test well; completed, 1905; abandoned.
979			Oil test well; abandoned.
980	Yegua	Salty	Drilled for oil; abandoned. Completed, 1905. (Well No. 4, fig. 17, p. 347.)

DESCRIPTIVE NOTES.

970. *Section of well, 1½ miles northeast of Pedigo, between Rush and Wolf creeks and 2 miles from Neches River, Tyler County, Tex.*

	Feet.
Clay	0– 8
Sand and gravel	8–168
Clay	168–172
Coarse sand with some gravel	172–600
Blue shale; slight indications of oil and gas	600–660
Blue sand	660–824

No division of this record is possible, but from the depth it must have been drilled into the Catahoula sandstone, the last 224 feet at least apparently belonging to that formation.

975. D. S. Whitehead writes: "Sulphur water was found at 200 feet. Then the drill entered into what was called a blue sulphur shale * * *. They found many species of shells * * *. This blue shale * * * continued down to 1,000 feet."

The sulphur water probably came from a bed in the Catahoula sandstone, of which about 600 feet must have been penetrated. The fossiliferous marls beneath were probably the Jackson formation.

980. *Section of Kountze Bros.' well No. 4, on the D. H. Vail League, three-fourths mile southeast of Rockland, Tex.*

[Furnished by E. T. Dumble. See fig. 17, p. 347.]

	Feet.
Catahoula sandstone:	
Gray sand	0– 32
Green sandstone	32– 50
Shaly rock	50– 60
Quicksand	60– 70

	Feet.
Catahoula sandstone—Continued.	
Gray sandrock	70– 85
Gravel and sand	85– 90
Greensand	90– 100
Blue shale	100– 105
Record missing	105– 109
Gravel and bowlders	109– 120
Hard sandrock	120– 140
Blue gumbo	140– 150
Green shale	150– 200
Loose gray sand	200– 235
Sandstone	235– 240
Sandrock with strata of green clay	240– 286
Green shale with layers of sandrock	286– 322
Gray sand	322– 326
Blue gumbo	326– 330
Green shale with sand and gravel	330– 370
Hard limestone	370– 375
Hard gray sand; some gas and oil	375– 380
Blue gumbo	380– 420
Green shale	420– 555
Dark gray sand with hard strata	555– 585
Hard strata; dark-gray sand	585– 635
Hard dark-gray sandrock	635– 651
Gumbo and sand	651– 670
Dark-gray sand with gumbo	670– 775
Dark-gray sandrock	775– 780
Jackson and Yegua formations:	
Blue gumbo	780– 852
Green shale with shell	852–1,015
Sand, gravel, stone; some gas	1,015–1,035
Blue gumbo	1,035–1,070
Dark-gray sand beds, spiral shell	1,070–1,130
Green marl	1,130–1,162
Green marl with shells	1,162–1,300
Green marl	1,300–1,378
Green marl mixed with shell	1,378–1,550

UPSHUR COUNTY.

The Wilcox constitutes the outcropping formation over the major portion of Upshur County. In a few isolated localities remnants of the former much more extensive cover of the Mount Selnan formation persist.

The Wilcox formation constitutes the available source of water. The area of flows is limited to the lowlands adjacent to the Sabine. (See Pl. VIII, in pocket.)

In the western portion of the county these sands will be encountered in wells ranging from 200 feet above sea level to 200 feet below. In the eastern portion they can be reached at depths ranging from 200 feet above sea level to 500 feet below. So far as known no artesian wells have ever been attempted in the county. Potable water and good boiler water are probably obtainable over the entire county.

VAN ZANDT COUNTY.

GEOLOGY AND HYDROLOGY.

The northwestern portion of Van Zandt County is occupied by the outcrop of the clays and limestones of the Midway formation, and the remainder by sands of the Wilcox formation. Geologic conditions are not favorable for the occurrence of flowing wells in this county. The Woodbine sand of the Cretaceous is buried too deeply to be available; the Nacatoch sand is embedded beneath the entire county but would probably yield salt water; and the Wilcox formation, not being under cover, can supply only nonflowing wells.

It may be possible to obtain local flows from the Wilcox in the Sabine River bottoms, in the extreme northeast corner of the county, but this is uncertain. (See Pl. VIII, in pocket.) In the central third of the county the Wilcox is very thin and will supply only shallow surface wells. It thickens and the beds dip toward the east. Along the eastern line the sands of the Wilcox formation will supply wells that go down to depths from 300 feet above to 150 feet below sea level.

A fault crosses this county southward from Grand Saline, and along it the water is probably salty. (See fig. 6, p. 85.) At Wills Point salt water is found from 178 to 1,130 feet below the surface.

In other portions of the county away from the fault lines the chances are favorable for potable and good boiler waters in the sands of the Wilcox. The beds have thus far not been much exploited for artesian waters.

WELL DATA.

Details of wells in Van Zandt County are given in the following table:

Wells and springs in Van Zandt County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Approximate elevation of surface.
				Inches.	*Feet.*	*Feet.*
981	Grand Saline	Lone Star Co	William Kennedy[a]		359	408.
982	Grand Saline, ½ mile west(?) of well No. 98.	Richardson	do.[b]		520	378.
983	Grand Saline, 1 mile southwest.	A. Wilderspin	A. Wilderspin, president.	9	875	467.
984	do	Southern Salt Co	do		315	
985	Grand Saline	Grand Saline Salt Co	Postmaster		285	
986	do	Fielder Salt Co	do		280	
987	do	B. W. Carrington Salt Co.	do		285	
989	Fruitvale	J. A. Lewis	do	8	100	
990	do	J. H. Creagle	do	8	103	
991	Fruitvale, 1 mile northwest.	G. C. Rochell	C. A. Cowy			
992	Wills Point, 6 miles southeast.	W. D. Childs	N. E. Farrell	12	75	800 (?).
993	Wills Point, 1,200 feet northeast of post office.	Johnson Gin Co	Gibbard & Gibbard	6	1,200	434 (?).
994	Wills Point		N. H. Darton [c]	6	1,100	
995	Myrtle Springs		do.[c]		650	
996	Primrose, 3 miles east	R. J. Coleman	R. J. Coleman			

[a] Kennedy, William, A section from Terrell, Kaufman County, to Sabine Pass, on the Gulf of Mexico: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 76–77.
[b] Idem, p. 77.
[c] Darton, N. H., Preliminary list of deep borings in the United States: Water-Supply Paper U. S. Geol. Survey No. 149, 1905, p. 154.

Wells and springs in Van Zandt County, Tex.—Continued.

No.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*			
981	80 to 85		Wilcox		Sunk for salt.
	150 to 164		(?)		
	178		(?)	Salty	
982	20 to 26, 28 to 30.		Wilcox		Bored for salt.
	514 to 520		(?)		
983		−40			Show of oil; well abandoned because of breaking of bit; considerable oil at bottom; drilled in 1900 by T. J. Marsden.
984	34 to 37, 80 to 85.		Wilcox		
	140 to 168			Salty	
985					
986					
987					
989					
990					
991				Soft	Spring.
992	53	−48		Iron	Sold for medicinal purposes; temperature 65° F.; completed 1900.
993	180	(?)	Midway (?)	(?)	Drilled by W. M. Morgan in 1907; not used; water lowered 400 feet by pumping.
	1,130	−65	Nacatoch	Salty	
994					
995					Unsuccessful.
996				Soft	Buford Springs.

DESCRIPTIVE NOTES.

981. *Section of Lone Star Co.'s well near Grand Saline station, Tex.*

	Feet.
Brownish-gray sandy clay	0– 26
Brown sand	26– 34
Sand and gravel	34– 37
Black shaly clay	37– 57
Lignite	57– 60
Sandy shaly clay	60– 80
Sand and water	80– 85
Sandy clay shale	85–150
Sand and water	150–164
Hard white sand with vein of salt water; 5 per cent salt	164–178
Hard sandrock	178–184
Shale containing pyrites	184–188
Blue limestone mixed with streaks of sand and gray limestone, but blue forming chief deposit	188–230
Gypsum	230–235
Rock salt	235–359

982. *Section of Richardson's well at Grand Saline, Tex.*

	Feet.
Soil, brownish-black sand	0 – 3
Sandy clay	3 – 15
Gravel and clay	15 – 20
Yellow sand and water	20 – 26
Fine blue clay and gravel	26 – 28
Quicksand with water	28 – 30
Coarse white sand	30 – 35
Blue-gray merging into bluish black dirt with iron pyrites and broken limestone	35 – 83

	Feet.
Hard gray limestone	83 – 86
Sandy shaly clay (slate?)	86 –103
Blue clay with iron pyrites	103 –123
Shales?	123 –132
Shale with iron pyrites	132 –137
Sandy shale with pyrites	137 –149
Sandstone with pyrites	149 –163
Hard blue limestone	163 –188
Hard gray limestone	188 –191.5
Quicksand	191.5 –194
Alternate strata of salt and limestone	194 –212
Rock salt	212 –512
Bluish-gray sand	512 –514
Black sand with water, in bottom of well, not bored through.	514 –520

984. *Section of Southern Salt Co.'s well, 1 mile southwest of Grand Saline, Tex.*

[Furnished by A. Wilderspin, president.]

	Feet.
Red clay	0– 26
Sandy clay	26– 34
Sand and gravel, water bearing	34– 37
Wilcox formation:	
Black shale	37– 57
Lignite	57– 60
Sandy clay	60– 80
Sand and water	80– 85
Sandy shale	85–150
Sand and water; oil, yellow in color	150–164
Formation doubtful:	
Hard white sand; salt water	164–178
Hard sandrock	178–184
Shale containing pyrites	184–188
Blue limestone mixed with streaks of sand and gray limestone	188–230
Gypsum	230–235
Rock salt, not penetrated	235–315

In January, 1908, Mr. Wilderspin states that oil appeared in this well, flooding the brine tanks supplied by the salt water (well is being used in the manufacture of salt.) The oil is stated to have been accompanied by considerable gas.

WALLER COUNTY.

GEOLOGY AND HYDROLOGY.

The northern half of Waller County is occupied by the outcrop of the Dewitt formation, the southern half by that of the Lissie gravel. The Catahoula sandstone is embedded beneath the entire county.

Catahoula sandstone.—The Catahoula constitutes an important water-bearing formation. The area of flowing wells, however, is limited to the Brazos bottoms. The 1,110-foot sand in the Hempstead well (No. 1000) belongs probably to the Catahoula. The water is reported as being soft and well adapted to use in boilers.

The depth to the Catahoula is an obstacle to its more general development. (See Pl. VIII, in pocket.) Along the north line wells must go from 1,000 to 1,500 feet, and toward the south from 2,000 to 2,500 feet, below sea level. Wells going more than 1,200 feet below sea level are not to be recommended because of the doubtful quality of the water.

Dewitt formation.—The Dewitt formation will furnish water anywhere in the county. West of a line passing through Waller and Sealy wells will have to be from 50 to 700 feet in depth, and east of this line from 50 to 2,000 feet. The depth to the basal members of this formation varies from 500 feet along the north line to approximately 2,000 feet along the south line. These basal sands may be expected to yield flows in the Brazos bottoms south of Hempstead, but will probably, though not certainly, fail to do so on the divides.

Water from the Dewitt will commonly be potable and fairly good for use in boilers. For the latter, however, it is not so well adapted as the water from the Lissie gravel.

Lissie gravel.—The Lissie gravel is not under cover and will therefore probably not yield flowing wells, even at the lowest altitudes in the county. It yields adequate supplies to nonflowing wells and is largely utilized for this purpose. (See Pl. VII, in pocket.)

From Waller south the Lissie gravel mantles the entire county. Near Waller it is not over 25 to 30 feet thick, but along the south line it measures possibly 300 feet, and is capable of supplying abundant water.

The Lissie water is potable and most of it is adapted to boilers. In places it is used for rice irrigation with favorable results.

WELL DATA.

Details of wells in Waller County are given in the following table:

Wells and springs in Waller County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Approximate elevation of surface.
				Inches.	*Feet.*	*Feet.*
997	Brookshire, 4 miles north.	L. Gassner	L. Gassner	9⅝	127	
998	....do	C. Wilson	C. Wilson	9⅝	137	115(?).
999	Hempstead, near well No. 1000.		John C. Amsler		1,800	
1000	Hempstead, Main and Thirteenth St., 300 yards south of post office.	Citizen's Water Co	....do	4½	1,131	251(?).
1001	Hempstead	A. F. Buchanan	Postmaster	4½	400	
1002	Hempstead, 6 miles south.	Rufus Hardy	T. U. Taylor [a]	1	850	
1003	Hempstead, 5 miles northwest.	Heber Stone	....do [a]	1	485	
1004	Katy, near	C. J. Nelson	....do [b]		100	
1005	....do	Wm. Eule	....do [c]		102	
1006	Waller, 5 miles south (Polly Percy League).	J. C. Ralston	J. C. Ralston	6	1,750	

[a] Taylor, T. U., Underground waters of the Coastal Plain of Texas: Water-Supply Paper U. S. Geol. Survey No. 190, 1907, p. 41.
[b] Taylor, T. U., Rice irrigation in Texas: Bull. Univ. Texas No. 16, 1902, p. 23.
[c] Idem, pp. 23-24.

Wells and springs in Waller County, Tex.—Continued.

No.	Depths of principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute. Pump.	Yield per minute. Flow.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Galls.*	*Galls.*			
997	43, 65	−51	800		Lissie		Used for rice irrigation; completed 1903.
998	100	−52	450		do		Used for rice irrigation; completed 1904.
999	1,130–1,150				Catahoula		Drilled for oil.
1000	60	No flow			Dewitt (?)		Temperature 80° F. used for boilers and public supply; drilled by Gust. Warnecke in 1897.
	400	do			Dewitt		
	1,110	+10		100	Catahoula	Soft	
1002		Flows		15			
1003		do		40			
1004	70 to 100				Lissie		Used for rice irrigation.
1005	72 to 102				do		Do.
1006	47	No flow			do		Drilled by Bell & Maxwell for oil in 1905.
	780	do			Dewitt		
	1,210	−47			do		

DESCRIPTIVE NOTES.

998. *Section of well owned by C. Wilson, 4 miles north of Brookshire, Tex.*

	Feet.
Lissie gravel:	
Red clay	0– 52
Sand and gravel; water bearing	52– 77
Clay	77–100
Sand and gravel; water bearing	100–137

Forty-foot screen from 97 to 137 feet; no strainer at the upper water-bearing bed.

1006. J. C. Ralston writes: "This well was dug for oil, and no effort was made to develop a water supply. A stratum of coarse sand and gravel 20 feet thick at 47 feet carried water. At about 740 feet a stratum of white sand 40 feet thick carried water. At 1,210 feet a stratum of water sand 35 feet thick was struck. At this point, I think, a flowing well could have been developed, but, oil being the object sought, little attention was paid to water. Drilling continued to 1,750 feet. At 1,740 feet we struck rock; we drilled into this rock 10 feet and then suspended work."

WALKER COUNTY.

GEOLOGY AND HYDROLOGY.

The extreme northern portion of Walker County is occupied by the outcrop of the Yegua formation. This is succeeded on the south by the Catahoula sandstone, which occupies the greater part of the northern half of the county. The Fleming clay lies south of the Catahoula. The Dewitt formation lies stratigraphically above the Fleming, outcropping in the western portion of the southern half of the county. The southeastern part of the county is characterized by the outcrop of the Lissie gravel, which lies geologically above the Dewitt.

The important water-bearing formations available in the county are the Catahoula and the Dewitt. The Yegua and the Lissie are also available, but are less important.

Yegua formation.—The Yegua reservoir will supply water in the northern two-thirds of the county to wells ranging from 50 to 600 feet in depth along the northern line to 1,300 to 1,900 feet in the vicinity of Elmina. Water from 1,500 feet will generally not be adapted for use. Where it is necessary to go down 1,500 feet to develop a supply from the Yegua, it is preferable to depend on the Catahoula or the Dewitt. (See Pl. VII, in pocket.)

Catahoula sandstone.—The Catahoula reservoir will supply the major portion of the county with water. In the north corner the beds are thin and can only supply wells 100 to 200 feet deep. In the vicinity of Huntsville they attain a thickness of 500 feet, and in the southern portion of the county they will supply wells 700 to 1,300 feet deep. Available data indicate that the water is hard, though it is used in boilers. In places good boiler waters may be developed. (See Pl. VIII, in pocket.)

Dewitt formation.—The sandstones of the Dewitt formation will supply the southern half of the county. Any well 50 to 100 feet deep along a line extending from Oakhurst to Anderson, or 200 to 600 feet deep in the southeast corner of the county, may expect a supply from these sands. Flows need not be looked for. Such water will generally be potable, but for boilers it will be only fairly satisfactory. (See Pl. IX, in pocket.)

Lissie gravel.—The Lissie gravel in the southern portion of the county is only 20 to 150 feet thick, and therefore can supply only shallow surface wells. Flowing wells of potable water in this county can probably be obtained only in Trinity River bottoms.

WELL DATA.

Details of wells in Walker County are given in the following table:

Wells in Walker County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Approximate elevation of surface.
				Inches.	*Feet.*	*Feet.*
1007	Elmina, ½ mile northeast of post office.	Walker County Lumber Co.	C. H. Pilmey	8	500	58(?).
1008	Huntsville	Huntsville Electric Light & Ice Co.	Postmaster	6	335	
1009	do	Huntsville Waterworks.	do	9⅝	360	
1010	do	Texas State Penitentiary.	Fred B. Smith	9	2,203	

Wells in Walker County, Tex.—Continued.

No.	Depths of principal water-bearing strata.	Height of water above (+) or below (−) ground.	Pumps per minute.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Galls.*			
1007	450	−200	150	Dewitt (?)	Hard	Used for boiler purposes; completed 1906.
1008						
1009						
1010	339, 417–484	No flow.		Catahoula	(a)	Used for boiler purposes; drilled by C. H. Robinson in 1892.

a For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

1010. *Section of Texas State Penitentiary well at Huntsville, Tex.*

	Feet.
Clays and sandy clay, with water bed at 339 feet	0– 417
Water-bearing sand	417– 494
Clays, etc	494–1,000
Sand	1,000–1,159
Clays	1,159–1,576
Sands	1,576–2,203

The record is evidently very generalized. It would seem from the depth reached by this well that it penetrated the Fleming, Catahoula, Yegua, Cook Mountain, and probably the Mount Selman formations.

WOOD COUNTY.

GEOLOGY AND HYDROLOGY.

The Wilcox, which constitutes the outcropping formation over the entire area of Wood County (see Pl. I), likewise constitutes the only available source of artesian water, the Cretaceous horizons being too deeply embedded for practical development.

The Wilcox will yield copious supplies in nonflowing wells (well No. 1013), but not being under cover it will yield flows only in the Sabine River bottoms. (See Pl. VIII, in pocket.) The only flowing well thus far drilled in the county is near Hawkins, close to Sabine River.

In the western portion of Wood County the Wilcox is perhaps 200 feet thick. The beds dip slightly east. Along the eastern line wells may be finished in them at 200 feet below sea level. Over the entire county they will produce abundant water.

All of the Wilcox water in Wood County is good, though certain beds may yield sulphurous supplies. At Mineola and Quitman the water is used in boilers, and at Mineola it is reputed to have medicinal value.

WELL DATA.

Details of wells in Wood County are given in the following table:

Wells and springs in Wood County, Tex.

No.	Location.	Owner.	Authority.	Diameter of well.	Depth of well.	Approximate elevation of surface.
				Inches.	*Feet.*	*Feet.*
1011	Mineola	Mrs. M. A. Ferguson	Mrs. E. E. Ford	4	350	
1012	Mineola, 1,200 feet south of post office.	Mineola Light & Ice Co.	A. Patten	6	310	
1013	Mineola, corner Johnson and Broad streets, 300 feet southeast of post office.	City	do	6	1,202	400±.
1014	Mineola	Mrs. E. J. Henry	Postmaster	4	300	
1015	Alba, 100 yards southwest of post office.	F. N. Hopkins	do		479	
1016	Quitman	Wright & Bros.	do	6	500	
1017	do	Wood County	do	6	500	
1018	Quitman, 300 feet south of post office.	Sam Benton	Dr. J. B. Goldsmith.	6	450	
1019	Hawkins, 1½ miles west.	A. W. Campbell (?)	John Gillis	3	271	380±

No.	Depths to principal water-bearing strata.	Head of water above (+) or below (−) ground.	Yield per minute. Pump.	Yield per minute. Flow.	Source of water.	Quality.	Remarks.
	Feet.	*Feet.*	*Galls.*	*Galls.*			
1011	350	40			Wilcox	Soft	
1012	70–71 75–80 110–115 115.5–125 229–235 310	−48			do	do.[a]	Temperature, 68° F. Used in boilers. Drilled by C. Witherspoon in 1900; a second well 300 feet deep is near this one.
1013	12–20 75–80 110–125	No flow					Used for medicinal purposes; completed 1890(?). Temperature, 70° F.
	229–239	−40			Wilcox	do.[a]	
	270–280 281–300 310–320 380–406 406–408 480–490 495–505 510–530	No flow			do		
1015	439	No flow	60		do	do	Used for public supply; completed, 1903.
1018	400	−30	50			Sulphur	Water supply for Quitman; temperature, 60° F.; completed, 1901.
1019	160	+16		4	Wilcox	Good	Completed, 1886.

[a] For analysis, see table facing p. 110.

DESCRIPTIVE NOTES.

1012. *Section of Mineola Light & Ice Co.'s well at Mineola, Tex.*

	Feet.
Soil	0 – 1
Wilcox formation:	
Red clay	1 – 12
Gray sand	12 – 20
Black clay	20 – 25
Brown clay	25 – 35
Blue clay	35 – 50

	Feet.
Wilcox formation—Continued.	
Brown clay, mica, and sand	50 – 66
Lignite, sand, and iron pyrites	66 – 70
Sandstone, water bearing	70 – 71
Blue clay	71 – 75
Gray sand and water	75 – 80
Blue clay	80 –100
Black clay	100 –110
Sandstone, water bearing	110 –115
Blue clay	115 –115.5
Sandstone, water bearing	115.5–125
Gray clay and pyrites	125 –170
Gray clay	170 –180
Gray-blue clay and limestone	180 –200
Gray sandrock	200 –215
Black clay limestone	215 –221
Dark limestone	221 –223
Gray sand and mica	223 –228
Blue clay, mica, and pyrites	228 –229
Gray micaceous sand, water bearing	229 –235
Sandstone	235 –239
Black clay	239 –265
White joint clay	265 –270
Gray clay and sand	270 –280
Lignite	280 –281
White clay	281 –300
Potter's clay	300 –310
White sand and water	310 –320

Samples preserved of each stratum.

1013. *Partial section of well at Mineola, Tex.*[1]

Top soil	0 – 1
Wilcox formation:	
Red clay	1 – 12
Gray or white sand, with water	12 – 20
Brownish-black clay	20 – 25
Brown clay	25 – 35
Blue clay	35 – 50
Brown clay, sand, and mica	50 – 66
Lignite, sand, and iron pyrites	66 – 70
Sandstone, with water	70 – 71
Blue clay or mud	71 – 75
Gray sandstone, with water	75 – 80
Blue clay	80 –100
Potter's clay	100 –110
Sandstone, with water	110 –115
Gray or blue clay	115 –115.5
Sandstone, with water	115.5–125
Bluish-gray clay and pyrites	125 –170
Bluish-gray clay, with some sand	170 –180
Blue clay, with limestone bowlders	180 –200
Gray sand	200 –215

[1] Dumble, E. T., Report on the brown coal and lignite of Texas: Geol. Survey Texas, 1892, pp. 132–135.

	Feet.	
Wilcox formation—Continued.		
Black clay, with limestone, pyrites, etc.	215	-221
Dark limestone	221	-223
Gray sand and mica	223	-228
Black and blue clay, mica, and pyrites	228	-229
Gray sand, mica, brown clay, and water	229	-235
Sandstone, with water	235	-239
Brown-black clay	239	-265
White clay	265	-270
White or gray sand, mica, and pyrites, with water	270	-280
Lignite	280	-281
White clay, with thin strata or sand, with water	281	-300
Brown clay and white sand	300	-310
White sand, with water	310	-320
Brown clay and lignite	320	-340
Brown joint clay	340	-342
Gray sand	342	-350
Gray sand and lignite	350	-360
Gray sand and pyrites	360	-370
White sand	370	-375
Grayish-white sand and black mud	375	-380
Coarse white sand, with grains of lignite and water	380	-400
Brown clay	400	-405
Lignite	405	-406
White sand, very coarse, with water	406	-408
Lignite	408	-411
Gray clay	411	-413
Grayish-white clay	413	-416
Brown clay	416	-421
Dark-brown clay	421	-422
Black mud	422	-424
Black mud, sand, and lignite	424	-426
Iron pyrites and black mud	426	-430
Black-brown clay and pyrites	430	-460
Lignite	460	-475
Black-brown clay	475	-480
Gray sand, with water	480	-490
Lignite	490	-495
White sand, with water	495	-505
Dark-brown joint clay	505	-515
Gray sand, mica, and water	515	-530
Midway (?) formation:		
Dark-brown clay	530	-550
Grayish-blue clay	550	-575
Dark-brown clay	575	-595
Joint clay and sand at bottom of boring	595	-600

The record below 600 to 1,200 feet was not well kept and is not available.

1019. Mr. John Gillis writes that he drilled the well while prospecting for lignite. He adds: "This well is 1¼ miles from the outcrop of the lignite on Sabine River. It was 85 feet 4 inches to the lignite. This is overlaid by a stratum of soft slate or soapstone, and is underlaid by a stratum of soft gray sandstone. At 241 feet another stratum of lignite was met. The well was continued to a depth of 271 feet. The artesian flow came from a sand bed at 160 feet."

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