

## THE CORSICANA OIL AND GAS FIELD, TEXAS.

By GEORGE C. MATSON and OLIVER B. HOPKINS.

### INTRODUCTION.

The Corsicana oil and gas field, in Navarro County, Tex., extends from Corsicana eastward to Powell and from the vicinity of Angus northward to Chatfield. Productive pools having an aggregate area of nearly 50 square miles have been developed in a field that measures 20 miles from north to south and 10 miles from east to west. Oil was first discovered here in the city of Corsicana, which marks the western limit of the productive area, and prospecting has extended the field toward the northeast, east, and southeast from that city. The field may be divided into two parts—the Corsicana district, which lies immediately east of Corsicana and includes the Corsicana, Edens, Angus, Tilton-Havener, and Chatfield pools, and the Powell district, which includes a number of small pools in the area near Powell and Mildred.

The Corsicana oil and gas field is 30 miles north of the Mexia-Groesbeck gas field, 115 miles north of the Thrall oil field, and 160 miles west of the De Soto-Red River and Caddo oil and gas fields. (See Pl. XVII.)

Although the Corsicana field has been productive for more than 20 years, little has been written concerning the geologic conditions under which oil and gas occur there, the age of the productive beds, the number and relative position of the productive sands, and the structural conditions under which these commercial pools of oil and gas have accumulated. The important references to the literature on this field are given below.

Miller, T. D., The recently developed oil field of Texas; Eng. and Min. Jour., June 18, 1898, pp. 734-735.

Oliphant, F. H., U. S. Geol. Survey Nineteenth Ann. Rept., pt. 6, continued, pp. 102-105, 1898.

Phillips, W. B., Texas petroleum: Texas Univ. Min. Survey Bull. 1, pp. 6, 36-42, 1900.

Oliphant, F. H., Petroleum: U. S. Geol. Survey Mineral Resources, 1900, pp. 573-579, 1901.

Adams, G. I., Oil and gas fields of the Upper Cretaceous and Tertiary formations of the western Gulf coast: U. S. Geol. Survey Bull. 184, pp. 54-55, 1901.

Harris, G. D., Oil and gas in Louisiana: U. S. Geol. Survey Bull. 429, pp. 31, 34, 1910.

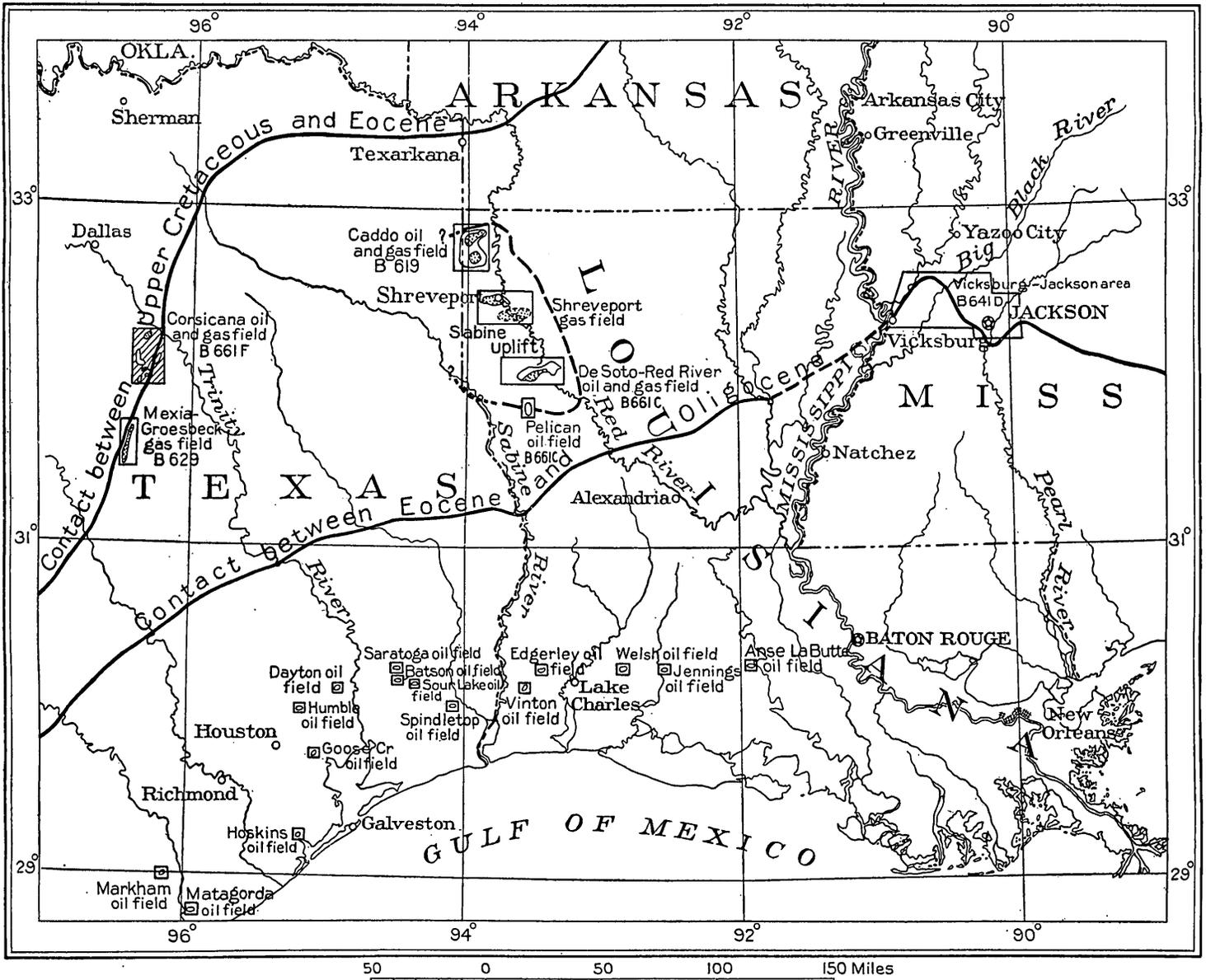
The purpose of this report is to give a more complete account of the history, production, and geology of this field than has yet been given, especially in regard to the types of structure present and the age and relations of the different sands. Although it was hoped that the study of the region might lead to the location of promising areas for prospecting, this was not the primary object of the work, for the field has been extensively drilled during the last 20 years. Information obtained from the study of this field should be applicable to other areas in the same general region where the geologic conditions are similar.

The oil and gas in the Corsicana field are obtained from the upper part of the Upper Cretaceous, the light oil and the gas in the Corsicana oil pool and in the Chatfield and Edens gas pools probably coming from the Taylor marl and the heavy oil and the gas in the other pools from the Navarro formation. The relation of the oil and gas to the geologic structure varies from place to place but is closest where there are well-developed anticlines, such as occur in some parts of the field that yield heavy oil. The distribution of oil and gas is also influenced by variations in the porosity of the sand, though these variations are not as numerous as in the deep oil sand of northwestern Louisiana, and some pools several square miles in area have contained very few unsuccessful wells. The field reached its period of maximum production in 1906, when more than 1,000,000 barrels of oil was produced. There appears to be some possibility of extending the field by the discovery of new pools, but probably the best chance for increasing the production lies in the possibility of the discovery of deeper producing sands, especially in the heavy-oil pools of the Powell district and beneath the gas sand of the Chatfield pool.

#### ACKNOWLEDGMENTS.

In the absence of sufficient exposures of recognizable beds of rock it was necessary to rely on well logs for a determination of the structure of the field. Partial records of about 725 of the several thousand wells drilled in this field, showing principally the depths to the oil sands, were supplied by the Corsicana Petroleum Co., the Marnet Oil Co., the Houston Oil Co., Mr. C. L. Witherspoon, and Mr. W. G. Baker. Special acknowledgments are due to Superintendent Faulkner and Manager Whitehill, of the Corsicana Petroleum Co.; to Mr. C. L. Witherspoon; and to Mr. A. V. Partaine, of the Marnet Oil Co.

During the month spent in the field the junior author was assisted by Mr. R. P. McClelland, of Corsicana, of whose services he desires to express his appreciation.



INDEX MAP SHOWING THE LOCATION OF THE OIL FIELDS OF THE GULF COASTAL PLAIN.

## HISTORY.

The oil industry in Texas may be considered to date from 1895, when the first successful well was drilled in the Corsicana field. Before that year the maximum annual production of oil in Texas had not exceeded 60 barrels. The Corsicana field yielded almost the total production of the State from 1896 until the discovery of the Beaumont field in 1901.

Although the discovery of oil in the Corsicana field is credited to Maj. Alexander Beaton,<sup>1</sup> interest in the possibilities of the region was quickened by the finding of oil in a well that was being drilled by the city of Corsicana in the same year, in search of an additional municipal water supply. The oil-bearing stratum, which was reached at 1,027 feet, was cased off, and the well was deepened until a good flow of warm water was obtained at 2,470 feet. The seepage of oil, which found its way to the surface around the casing, aroused the interest of the citizens, who organized a company to test the area. The first well, drilled near the center of Corsicana in 1895, was successful and produced  $2\frac{1}{2}$  barrels a day.

The development of that part of the field, which is known as the Corsicana pool, was relatively rapid, and the productive area was extended to the east, northeast, and southeast. In May, 1896, a well that made 22 barrels of oil in the first 24 hours demonstrated the possibilities of this field and stimulated drilling. By the end of 1899 642 wells had been drilled, of which 511 were oil wells, 13 gas wells, and 118 dry holes. The oil from this field was first marketed in 1897, and a refinery was built near Corsicana in the spring of 1898 by J. S. Cullinan. At that time there were 62 wells in the field, producing an average reported yield of 14 barrels a day. The production of this pool, which furnishes the light oil of the Corsicana field, increased until the maximum yearly output of 763,424 barrels was reached in 1901.

In the spring of 1900 oil was discovered 5 miles due east of Corsicana and also at Powell, in the area now known as the Powell district, which produces the heavy oil of the field. Oil was found here at a shallower depth than near Corsicana, and this area was soon extensively prospected. The yearly production of the Powell district increased from little more than 6,000 barrels in 1900 to the maximum of 673,221 barrels in 1906.

Not only the oil industry but the gas industry of Texas may be considered to have originated in the Corsicana field. In 1900, when the yearly production of natural gas in this State was valued at \$20,000,<sup>2</sup> all the gas was taken from the wells in the Corsicana field.

<sup>1</sup> Phillips, W. B., Texas petroleum: Texas Univ. Min. Survey Bull. 1, p. 6, 1900.

<sup>2</sup> U. S. Geol. Survey Mineral Resources, 1900, p. 650, 1901.

This field continued to yield almost the entire production of Texas until 1909, when the gas fields of Clay County were developed. Gas from the Corsicana field supplied the city of Corsicana until 1913, when the Mexia-Groesbeck field became productive and gas from it was piped to Corsicana. The pumping in the Corsicana oil field has been done for many years chiefly by gas engines, which utilize the casing-head gas obtained from the wells while they are being pumped.

The small gas field south of Chatfield was opened in 1905, and most of the wells were drilled during that and the following years. The wells yielded only a short time; by 1911 the casings had been pulled and all the wells abandoned.

### SURFACE FEATURES.

The Corsicana oil field lies along the eastern margin of the Black Prairie,<sup>1</sup> a plain that slopes gently coastward and is covered by a black calcareous clay soil, from which it derives its name. Near Corsicana the altitude of this plain is approximately 450 feet above sea level, and into it the main streams have cut broad, shallow valleys, which have an altitude of about 320 feet. Between the valleys and the plain above there are a number of terraces, which are separated from one another by low, rounded slopes. Near the eastern edge of the field the dark plastic clay gives place to sandy soil, which characterizes the area to the east. Near the western edge of the field a narrow outcrop of sandy beds gives rise to a more angular surface form than is generally present in the Black Prairie region. The soil in this sandy belt is favorable to the growth of scrubby oaks, which further distinguish it from the surrounding almost treeless country.

### GEOLOGY.

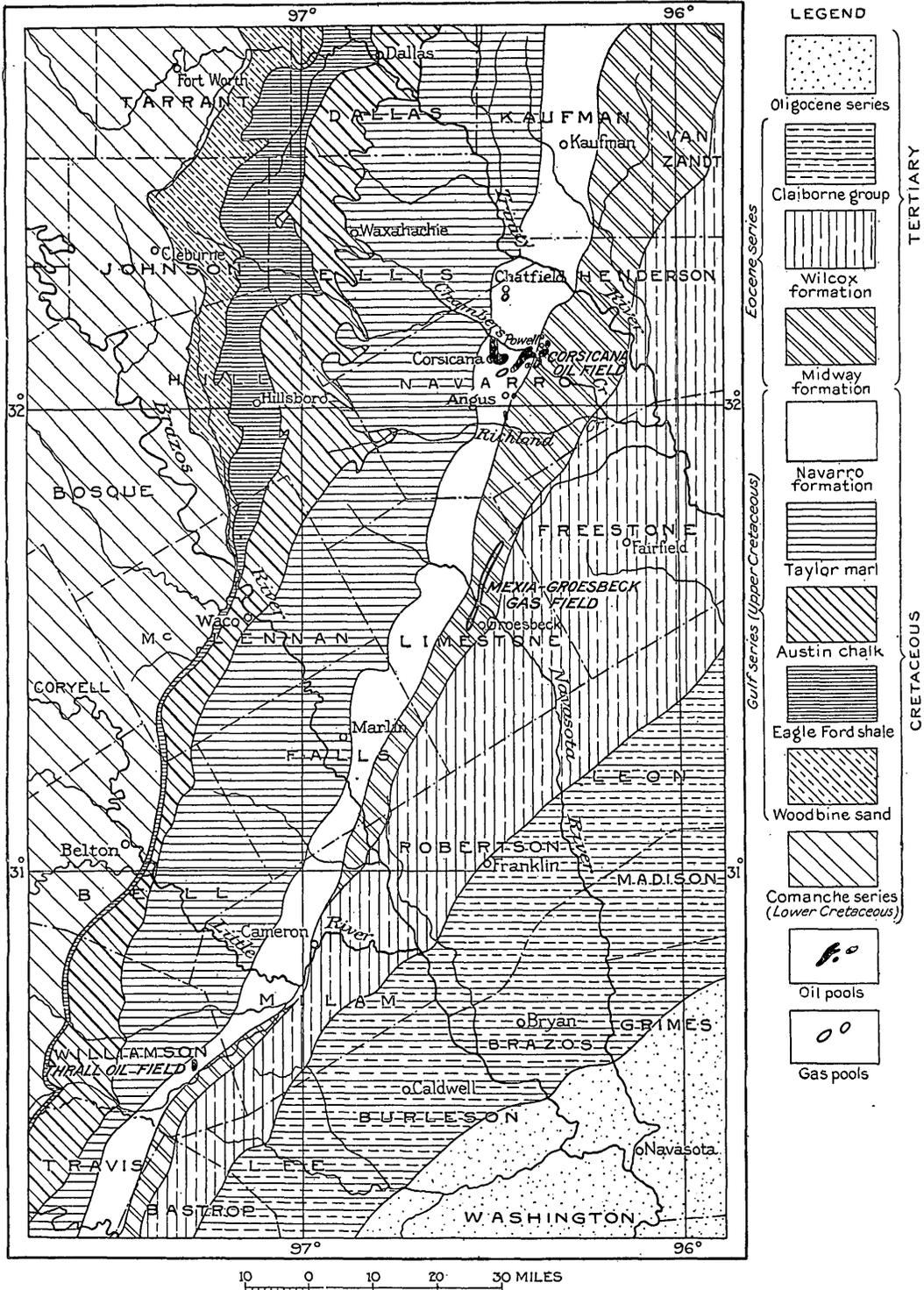
#### STRATIGRAPHY.

#### GENERALIZED SECTION.

The accompanying table (p. 215) contains a list of the formations into which the strata that crop out in the Corsicana field and underlie it at moderate depths have been divided. The table and the diagram in Plate XIX show the order in which the formations are encountered in well drilling and the character and approximate thickness of the beds that compose the formations.

The Navarro and Midway formations crop out in the Corsicana field; the underlying formations are exposed farther west and dip

<sup>1</sup> Hill, R. T., Geography and geology of the Black and Grand prairies, Tex.: U. S. Geol. Survey, Twenty-first Ann. Rept., pt. 7, pp. 65-69, 1901.



SKETCH MAP SHOWING THE LOCATION OF THE CORSICANA OIL AND GAS FIELD, TEX., AND OTHER PRODUCTIVE FIELDS IN THE VICINITY, TOGETHER WITH AN OUTLINE OF THE AREAL GEOLOGY OF THE REGION.

under this area. Within this field the deep wells drilled for water have reached the Woodbine sand. Oil and gas occur in the Taylor and Navarro formations, and warm, slightly saline water occurs in the Woodbine.

*Generalized section of formations in the Corsicana oil and gas field, Texas.<sup>a</sup>*

System.	Series.	Group.	Formation.	Thickness (feet).	Character.
Quaternary:	Recent.				Alluvial deposits along streams.
	Pleistocene.				Terrace deposits.
Tertiary.	Eocene.		Midway formation.	250-500	Micaceous sandy clays, fine argillaceous sands, and limestone concretions.
Cretaceous.	Gulf (Upper Cretaceous).		Navarro formation.	1,800-2,000	Light to dark gray calcareous clay, sandy clay, and fine lenticular beds of sand.
			Taylor marl.		Massive calcareous clay marl, little or no sand, and glauconite.
			Austin chalk.	400-500	Gray to white chalky limestone containing some hard beds.
			Eagle Ford shale.	300-400	Light to dark colored shale or clay and thinly laminated impure limestone.
			Woodbine sand.	400-450	Sand, sandy lignitic clay, sandstone, ferruginous sand, and clay.
	Comanche (Lower Cretaceous).	Washita.	Denison formation.	150-200	Clay and limestone.
			Fort Worth limestone.	25-75	Alternating beds of limestone and marl.
			Preston formation.	50-100	Calcareous laminated clays and impure limestone.
		Fredericksburg.	Edwards limestone.	300-400	White chalky limestones, variously indurated, and in places fine arenaceous beds.
			Comanche Peak limestone.		
			Walnut clay.	100-200	Calcareous clays and impure marly and chalky limestones.
		Trinity.	Paluxy sand.	125-200	Fine-grained sand and lenticular beds of clay.
			Glen Rose limestone.	300-500	Impure limestone, marl, and calcareous shales.
			Travis Peak sand.	250±	Conglomerate, sand, sandstone, shales, and impure limestones.

<sup>a</sup> The formations below the Navarro formation crop out west of the Corsicana field and dip under it. The Upper Cretaceous formations have been penetrated by the drill in this field and are known from well records; the Lower Cretaceous formations have not been penetrated by the drill in this field but are known from outcrops and well records west of the field. The data relating to the Lower Cretaceous are taken largely from a report by R. T. Hill (Geography and geology of the Black and Grand prairies, Tex.: U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, 1901).

The Navarro formation crops out in the western part of the field and the Midway in the eastern part; the contact between them extends from a point about  $1\frac{1}{2}$  miles east of Angus northward 2 miles west of Powell. (See sketch map, Pl. XVIII.) As the strata of the Navarro and Midway in this area are similar in composition and appearance, their separation is based primarily upon the fossils they contain.

The accompanying diagram (Pl. XIX) shows the character of the Cretaceous and the lower part of the Tertiary in eastern Texas. The Lower Cretaceous portion of this diagram was compiled from the log of the well at the Southern Methodist University at Dallas; the lower portion of the Upper Cretaceous was compiled from the log of the refinery well at Corsicana; and the upper portion of the Upper Cretaceous and the lower portion of the Tertiary from the log of Focke No. 2 well, in the Mexia-Groesbeck gas field. The Focke No. 2 well reached the sand that is the approximate equivalent of the sands exposed in the creeks near the west edge of Corsicana and the sands that yield the heavy oil in the Powell district.

#### CRETACEOUS SYSTEM.

##### COMANCHE SERIES (LOWER CRETACEOUS).

The Lower Cretaceous formations have not been reached in any of the wells in the Corsicana field, and therefore their depth, thickness, and character in this area are imperfectly known. The depths to the Paluxy and Travis Peak sands, as estimated from well drillings in the neighboring area to the west, are 3,400 and 4,100 feet. (See Pl. XIX.) As these formations contain potable water at a number of localities not far distant, it is possible that they do here also and that they do not contain oil and gas, which are usually associated with salt water or brine. The arrangement and character of the Lower Cretaceous formations are shown in the table of geologic formations and in the nearly complete generalized section of the well of the Southern Methodist University, at Dallas (Pl. XIX).

##### GULF SERIES (UPPER CRETACEOUS).

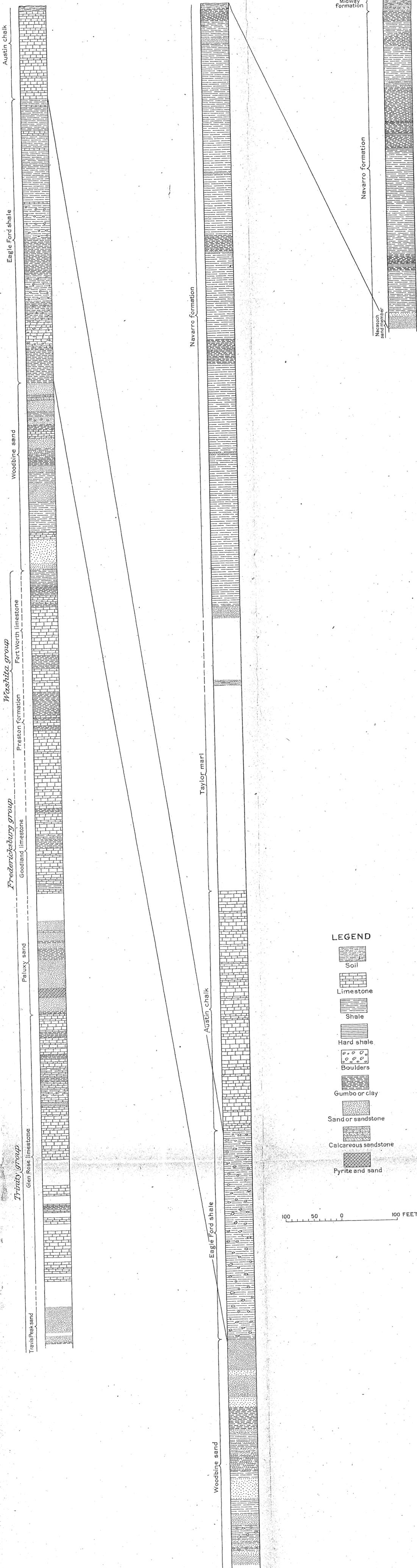
*Woodbine sand.*—The Woodbine sand is the lowest formation of the Upper Cretaceous series in northeastern Texas, where it consists of medium to fine grained sand, clay, and in some places beds of lignite and thin beds of hard sandstone. This formation retains its sandy character over a large area in northeastern Texas, and yields much water. In the Caddo field it is thought to be the source of some gas and most of the high-gravity oil.<sup>1</sup> Outside of that field,

<sup>1</sup> Matson, G. C., The Caddo oil and gas field, Louisiana and Texas: U. S. Geol. Survey Bull. 619, pp. 48-49, 1916.

Southern Methodist University, 4 miles northeast of Dallas, Tex.

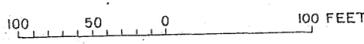
Magnolia Refining Co. Corsicana, Tex.

Focke well No. 2 Mexia, Tex.



LEGEND

-  Soil
-  Limestone
-  Shale
-  Hard shale
-  Boulders
-  Gumbo or clay
-  Sand or sandstone
-  Calcareous sandstone
-  Pyrite and sand



DIAGRAMS OF MATERIALS PENETRATED IN WELLS

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

which extends a short distance into Texas, no commercial accumulations of oil and gas have been found in it in this State, with the possible exception of a small pool at South Bosque, near Waco.

The deep well at the Corsicana refinery reached the Woodbine sand at 2,381 feet, and after passing through three water-bearing beds was completed in that formation at 2,781 feet. (See Pls. XIX and XX.) The water from this sand is slightly saline, but not a brine such as usually accompanies oil and gas.

*Eagle Ford shale.*—The Eagle Ford shale overlies the Woodbine sand and in this area consists of gray to dark-colored fine-grained clay and thin layers and, probably, concretions of limestone. The deep well at the refinery in Corsicana penetrated 376 feet of strata that are referable to this formation. In this area it is not believed to be of any economic value except that it serves as an impervious cover which retains the water in the underlying sand.

The Eagle Ford shale contains sand beds, called the Blossom sand member, in its upper part in northwestern Louisiana, southwestern Arkansas, and the adjacent part of Texas. In the Caddo field some oil and gas have been found in these beds.<sup>1</sup> They are not present in the Corsicana area.

*Austin chalk.*—The Austin chalk is one of the most easily recognized formations of the Cretaceous, both at its outcrop and in well borings, and constitutes a datum from which the position of other formations may be determined. It consists of alternating beds of white to light-gray chalk and marl of different degrees of hardness. Well drillers commonly call it white rock or limestone. As determined from the log of the deep refinery well at Corsicana, the Austin has a thickness of 425 feet.

So far all the oil and gas of the Coastal Plain of northeastern Texas has been found above the Austin chalk, with the exception of that in Marion and Harrison counties, which represent the western part of the Caddo oil and gas field, and that near South Bosque. In northwestern Louisiana, however, the most productive sands are below the Annona chalk, which is regarded as the eastward extension of a part of the Austin.

*Taylor marl.*—The Taylor marl consists in general of a uniform series of light to dark gray fine-grained, highly calcareous clay or clay marl. In the Corsicana area it contains some beds of fine argillaceous sand and sandy clay but no coarse sand. It is calcareous throughout and contains rounded limestone concretions. The Taylor marl weathers on exposure to the black plastic clay that is characteristic of the Black Prairie.

Lithologically the Taylor marl is not very different from the overlying Navarro formation, but it contains less sand and glauconite.

<sup>1</sup> Matson, G. C., op. cit., p. 48.

The contact between these formations can not be easily drawn at the surface, and from well records their separation can be made only in the most general way.

The oil in the Corsicana pool is obtained from a sand in the upper part of the Taylor marl. This sand ranges in thickness from a few feet to a maximum of nearly 60 feet, and according to the reports of well drillers it is in general fine grained and is accompanied by numerous thin layers of shale. Another sand in the Taylor, of somewhat similar character, occurs on the Edens League,  $3\frac{1}{2}$  miles south-southeast of Corsicana. This sand, which is gas bearing, is apparently lenticular, for it is not recognized in wells near Corsicana. It may be essentially the equivalent of the gas-bearing sand in the vicinity of Chatfield.

The well logs given on pages 219 and 220 show the character of the the strata of portions of the Taylor formation.

*Navarro formation.*—The Navarro formation consists of gray, greenish-gray, and yellow, nodular, calcareous clay, and sandy clay and fine glauconitic calcareous sand. (See log of the American Well & Prospecting Co.'s well, p. 219.)

The sand beds composing the Nacatoch sand member of the Navarro are well exposed near the western edge of Corsicana and a few miles north of that city. Locally the sand is firmly cemented by lime to form hard, dense calcareous sandstones or irregular-shaped concretions. The sand ranges from medium grained to very fine grained and contains glauconite, which is more abundant in some beds than in others. These sands are considered to be the same as the Nacatoch sand of northwestern Louisiana, which is an extensive gas-bearing formation. The Nacatoch sand is believed to be the gas sand in the Mexia-Groesbeck gas field,<sup>1</sup> as well as the productive sand in the Powell district, which yields the heavy oil of the Corsicana field. No fossils have been obtained from the wells to show that the oil sand in the Powell district is the Nacatoch, but it is known that this sand dips eastward from its outcrop near Corsicana at an angle that would carry it to about the depth of the oil sand near Powell. The productive sands are the shallowest encountered in the wells near Powell, and they are similar in composition and texture to the Nacatoch sand, and these facts, together with the rate of dip, make it seem safe to conclude that they are the same.

The clays of the Navarro, which occur above the sands, are slightly sandy and glauconitic. They contain numerous calcareous concretions, some with septarian form, some with cone in cone structure,

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<sup>1</sup> Matson, G. C., Gas prospects south and southeast of Dallas: U. S. Geol. Survey Bull. 629, pp. 80-81, 1916.

and others of hard, dense limestone. The clay is dark blue when fresh and weathers on exposure to greenish yellow, then to dark olive-gray, and finally to the black waxy soil which is present at the surface over the greater part of the outcrop of this formation.

The following logs show the character of the strata that make up the Navarro formation:

*Log of well of the American Well & Prospecting Co., lot 1, block 42, Corsicana, Tex.*

[Log made from well samples. Below 45 feet samples were taken at intervals of 10 feet.]

		Thick- ness.	Depth.	
		<i>Feet.</i>	<i>Feet.</i>	
Navarro formation.	Nacatoch sand member.	Clay, gray, highly calcareous, fine grained, gypsum bearing.....	35	35
		Clay, marl, light gray, chalky.....	20	55
		Same as above, with thin yellow layers of chalky limestone.....	10	65
		Same, medium fine grained, clear quartz and glauconitic, calcareous.....	10	75
		Sand, fine grained, dark gray; contains small amount of glauconite.....	10	85
		Sand, argillaceous, highly glauconitic, calcareous, fine grained, dark gray; contains marine shells.....	10	95
		Same as above, very fine grained.....	10	105
		Sand, fine grained, dark greenish gray, highly glauconitic, cleaner and slightly coarser grained than above; fossil shells abundant.....	10	115
		Sand, medium fine, dark greenish gray, highly glauconitic, probably 40 per cent calcareous, coarser than that above.....	10	125
		Sand, loose, fine grained, greenish gray, glauconitic, clear quartz.....	60	185
		Sand, dark gray, very fine grained, hard, calcareous, argillaceous, glauconitic.....	20	205
		Same as above, becoming more clayey.....	10	215
		Clay, dark gray, sandy, calcareous.....	10	225
		Same as above but more sandy in places.....	20	245
		Sand, dark greenish gray, hard, very fine grained, glauconitic, argillaceous.....	10	255
		Same as above but slightly coarser grained.....	10	265
		Sand, dark gray, hard, very fine grained, calcareous, argillaceous.....	20	285
		Clay, sandy, and very fine sand, dark greenish gray, glauconitic, calcareous; fragments of naeroseous shells.....	10	295
		Clay, dark gray, sandy, calcareous.....	10	305
		Sand, very fine grained, dark gray, calcareous, argillaceous.....	10	315
		Clay, hard, dark gray, sandy, calcareous.....	10	325
		Same as above, with some very fine sand; fossil shells.....	10	335
		Same as above, glauconitic.....	20	355
		Clay, dark gray, sandy, highly calcareous, glauconitic.....	20	375
		Same as above, with some very fine sand.....	10	385
		Clay, dark greenish gray, sandy, highly calcareous; fossil shells.....	30	415
		Marl, dark gray, clay, with plates of aragonite.....	10	425
		Same as above, with some sandy beds.....	30	455
		Clay and sandy clay, highly calcareous, dark gray, glauconitic.....	30	485
		Same as above but more glauconitic.....	40	525
		Clay, gray, highly calcareous, fine grained.....	10	535
		Clay, gray, calcareous, and sandy clay.....	30	565
		Same as above, with some highly glauconitic sandy layers.....	10	575
		Shale, gray to light gray, calcareous; contains little or no sand.....	90	665
		Same as above; when roasted gives an odor of sulphur but no distillate.....	125	785
		Shale, light gray, calcareous, with small fragments of bituminous matter which may have got into the sample accidentally.....	20	805
		Shale, light gray, calcareous; no sand or bituminous matter.....	50	855
		Same as above, with thin layer of limestone, fragments of shells.....	20	875
		Shale, light gray, calcareous.....	20	895
		Shale, light gray, as above, and sand.....	10	905
		Shale, light gray, calcareous.....	40	945
		Same as above, with some fine sand.....	10	955
		Shale, light gray, calcareous, sandy.....	10	965
		Same as above, with hard pyritic limestone.....	10	975
		Shale, gray, calcareous, with dark specks of bituminous matter, and hard sandy limestone.....	20	995
Shale, light gray, platy, calcareous.....	20	1,015		
Shale as above, with fine-grained sand.....	15	1,030		
Same as above, with less sand.....	5	1,035		
Sand, fine, gray, calcareous in part, loosely cemented, and some shale.....	5	1,040		
Same as above, with gray sandy shale.....	5	1,045		
Sand and shale, laminated, gray, calcareous, and fine-grained quartz sand; contains traces of bituminous matter (probably plant remains).....	5	1,050		

*Log of well No. 22 on B. T. Barry farm, 5 miles east of Corsicana, Tex., in Powell district.*

[Made from samples taken at intervals of 20 feet. All the strata belong in the Navarro formation; the Nacatoch sand member from 700 to 810 feet.]

	Thick- ness.	Depth.
	<i>Feet.</i>	<i>Feet.</i>
Clay, dark gray, almost black, gritty, and brown limy clay or clayey limestone.....	20	20
Sand, brown, limy.....	40	60
Shale, gray and greenish gray when wet.....	20	80
Shale, soft, gray, micaceous; contains small shells (Foraminifera?).....	20	100
Shale, soft, gray, limy.....	20	120
Shale, hard, gray, with soft limy streaks.....	20	140
Shale, gray, slightly limy.....	20	160
Shale or clay, greenish gray, slightly limy.....	80	240
Shale, soft, gray, slightly limy, sandy.....	40	280
Shale or clay, dark gray, very limy and slightly gritty.....	20	300
Same but more calcareous.....	20	320
Sand or sandy shale, dark gray, highly calcareous, fine grained, argillaceous.....	20	340
Clay, gray, slightly limy and gritty; contains numerous small fossils.....	20	360
Same, with streaks of hard calcareous sandstone.....	20	380
Shale or clay, greenish gray, limy, sandy.....	60	440
Shale, gray, calcareous, with sandy streaks.....	20	460
Shale, soft, gray, calcareous, with dark-gray sandy streaks; contains shell fragments.....	20	480
Shale or clay, soft, gray, with limy streaks.....	20	500
Shale, greenish gray, slightly limy, and fine glauconitic sand.....	20	520
Shale, greenish gray, calcareous; contains marine shells and hard, dense limestone concretions.....	20	540
Same, more slimy.....	20	560
Shale, greenish gray, calcareous.....	60	620
Shale, greenish gray and brownish gray, calcareous and noncalcareous, with some thin pyrite layers.....	20	640
Shale, greenish gray, calcareous.....	20	660
Same, fine grained, dense.....	20	680
Same; contains little or no grit.....	20	700
Shale, fine grained, calcareous, with some sand layers, very fine grained.....	20	720
Sand, very fine grained, greenish brown, limy, glauconitic; contains fragments of shells.....	20	740
Same, containing some sandy shale, highly calcareous and very glauconitic.....	40	780
Sand, fine grained, but coarser than that above, highly glauconitic, calcareous.....	30	810

*Log of Millican well No. 13, of Corsicana Petroleum Co., 3½ miles southeast of Corsicana, Tex.*

[Drilled in April, 1909.]

	Thick- ness.	Depth.
	<i>Feet.</i>	<i>Feet.</i>
Surface soil.....	35	35
Shale and rocks.....	637	672
Hard sand; show of oil.....	4	676
Shale and mud.....	11	687
Hard sand.....	5	692
Gumbo and shale.....	42	734
Oil sand.....	9	743
Hard shale.....	10	753
Hard sand; show of oil.....	3	756
Rock.....	2	758
Oil sand.....	9	767
Rock.....	3	770
Gumbo.....	22	792
Oil sand.....	21	813
Mud and shale.....	22	835
Shale.....	20	855

TERTIARY SYSTEM.

EOCENE SERIES.

*Midway formation.*—The lowest formation of the Eocene, the Midway, is at the surface in the eastern part of the Corsicana oil field,

but the exposures there are very poor. According to the reports of drillers, it is apparently a marl containing a few thin beds of limestone. It weathers to a black calcareous clay soil that contains a small percentage of sand and is like some of the soils produced by the more sandy phases of the Upper Cretaceous formations. In the southwestern part of Navarro County and in Limestone County some massive beds of gray and yellow limestone occur in the Midway, but apparently they do not extend into the Corsicana field, though they may be represented there by the numerous limestone concretions that are encountered in the wells.

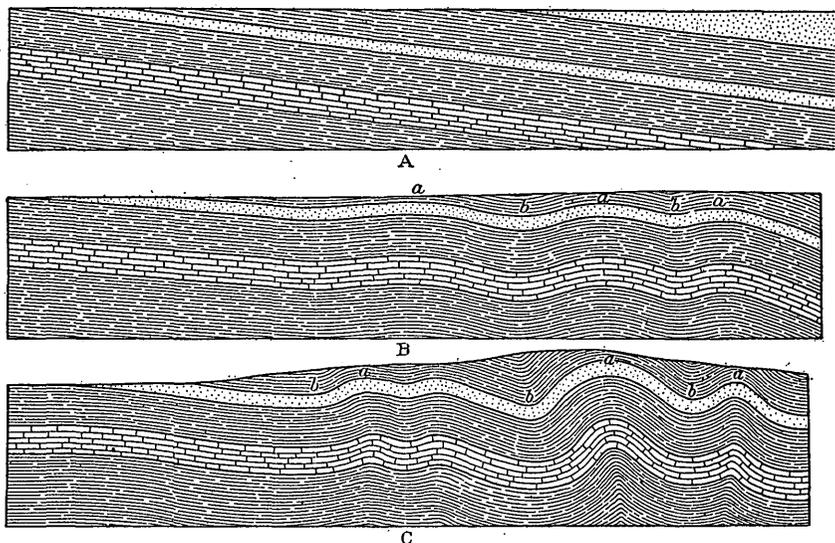


FIGURE 30.—Section showing simple types of structure. A, Sedimentary beds with gentle dip; B, the same beds gently folded; C, the same beds more intensely folded; *a*, anticline; *b*, syncline.

## STRUCTURE.

### MEANING OF THE TERM.

Most sedimentary rocks, such as clay, shale, limestone, and sandstone, were deposited as horizontal or approximately horizontal layers of sediment and later consolidated into rock. These rock beds, as they are observed to-day, may be only slightly disturbed from their original position or they may be intensely folded and broken, or faulted. The attitude of the beds or their position with reference to a horizontal plane is called structure; the upfolds or upward bends of the beds are called anticlines, and the downfolds synclines. (See fig. 30.) The importance of determining the structure in oil and gas investigations depends upon the fact that oil and gas are commonly associated with anticlines.

Where the beds are highly tilted from their original horizontal position the presence of anticlines or synclines may be determined from observations on the dip or slant of the beds. In an anticline (*a*, fig. 30) the beds dip in opposite directions away from the apex of the fold, called the axis; in a syncline (*b*, fig. 30) the beds dip from opposite sides toward the center or toward the axis. Where the beds are only gently folded it may be necessary to know the altitude at different places of some particular bed, commonly called a key rock, in order to determine the direction of dip and to outline the folds. If the bed whose altitude is to be ascertained is not exposed at the surface it may be encountered in a drill hole, and by subtracting its depth in the hole from the altitude of the surface at that point its position with respect to sea level may be determined.

#### STRUCTURE-CONTOUR MAP.

Structure may be represented diagrammatically by cross sections which show the arrangement and dip of the beds along a certain line (see fig. 30), or by structure contours on a map (see Pl. XXI, in pocket). The shape and extent of a fold are best shown by structure contours, which are lines represented as connecting points of equal altitude of the key rock. They are drawn to indicate regular intervals of altitude, such as 10 or 100 feet. Where the contours are closest together they represent the area of steepest dip; where they are farthest apart the area of gentlest dip. If the contours represent depths below sea level, as on the map accompanying this report (Pl. XXI), the direction of dip is from the contour with a smaller number to the adjoining one with a larger number. If the dip of the beds is uniform in direction and rate, the structure contours are parallel and uniformly spaced; if the dip is not uniform in direction and amount—in other words, if folds are shown—the contour lines are irregular and variously spaced. The contours on Plate XXI represent the key rocks as they would appear if the overlying formations were removed. The contours bearing the smaller numbers indicate the highest points, and the vertical interval between the contours is 10 feet.

In determining the structure of the Corsicana field the productive sands were used as key rocks—in the Corsicana pool the Corsicana sand,<sup>1</sup> in the Edens and Chatfield pools the gas sand, and in the Powell district one of the beds of the Nacatoch (?) sand, which may not be the same in the different pools. In the Powell district, however, an effort was made to use consistently the upper sand of the Nacatoch (?) beds.

<sup>1</sup> Not the "Corsicana beds" of Hill, which are the same as the Nacatoch sand, but an unexposed sand 800 feet stratigraphically lower than the Nacatoch.

Level lines were carried over the field to all the wells whose logs were available, about 700 in all. The depth of the oil sand below sea level was determined by subtracting the altitude of the well from the depth to the sand. This gave the depth of the sand below sea level in the wells and furnished the datum on which the contours were drawn. Much difficulty was experienced in interpreting these data. Most of the well records showed only the depths of the sands, and in the absence of some of the sands it was difficult to determine which ones were recorded; the numbers on many of the leases, as well as the names, had been changed one or more times, and it was difficult to connect a well record with the well in which it was obtained; finally, many of the wells had been abandoned and the casings pulled, and it was not possible to get their exact altitudes because their exact locations were not known. However, where the structure is indicated by solid lines the mapping is believed to be correct within 10 feet; where broken lines are used the error is probably not greater than 20 feet, except where a question mark appears on the map.

#### GENERAL STRUCTURE OF THE FIELD.

The strata in the Corsicana field dip in general to the southeast at a rate of 50 to 100 feet to the mile. The uniformity in direction and amount of dip is interrupted at a number of places by folds, as shown on the accompanying map (Pl. XXI), but none of the folds are continuous over large areas. The greatest dips observed on the folds are at the rate of 560 feet to the mile, and these high dips are confined to small areas. The irregularities in the normal position of the strata seems to have been produced by forces acting in two directions, as the folds trend noticeably in two directions—one approximately parallel to the dip of the rocks and the other at right angles to it. So far as observed, there is no evidence of faulting, or breaking of the rock strata, in this field.

#### STRUCTURAL FEATURES IN DETAIL.

##### CORSICANA POOL.

In the Corsicana pool the producing sand has a southeasterly dip of 80 to 100 feet to the mile. Slight variations, both in the direction and amount of dip, appear in different parts of the pool, and toward the north end there is some evidence of a westerly dip. The depth of the productive sand increases from 530 feet below sea level about 4 miles north of Corsicana to about 800 feet below near the old waterworks. The dip of the beds west of the pool is not shown by well records, but surface exposures indicate that it is in the same

general direction at a slightly lessened rate. Between Forreston and Corsicana, a distance of 21 miles, the average dip is about 65 feet to the mile, as shown by the altitude of the Austin chalk at these two places, but to judge from the character of the surface exposures within 5 miles of Corsicana the dip is somewhat lower than 65 feet to the mile near the city and therefore it must be greater than the average rate farther west. Local variations in the rate of dip of the sand near the southern boundary of Corsicana may account for the presence of accumulations of gas, though there is some doubt as to the correlation of the gas-bearing sand with the oil sand. If they are the same, there is apparently a low, flat-topped dome at this locality in which only the upper portion of the sand is filled with gas. If the sand had been folded into a sharp dome or anticline a greater thickness of the sand at the apex of the fold would have been filled with gas, and the wells there would have furnished gas for a longer period before they were filled with salt water.

#### EDENS POOL.

Twenty-five or more wells, many of which produced gas, have been drilled on the Edens League, 3 miles south-southeast of Corsicana. At the time when the study of this field was made all the gas wells on this and adjoining leases, forming the Edens pool, had been abandoned and the casings pulled. The location and altitude of many of the wells could not be ascertained, and consequently it was not possible to contour the gas sand of this pool accurately.

The fragmentary data available indicate that a low northeastward-trending anticline crosses the northern part of Edens League, and that its highest part is in the valley of Elm Creek. Most if not all of the gas wells in this area produced from depths of 630 to 660 feet below sea level.

#### CHATFIELD POOL.

The structure of the pool south of Chatfield, as outlined from the well records, shows a low, irregular anticline that trends northeast and is 2 miles long and about three-quarters of a mile wide. The dips on its flanks are as much as 2°. The accumulation of gas is in the crest of the anticline and is backed up on all sides by salt water. All the gas wells except one encountered the sand where it is less than 420 feet below sea level, or above the 420-foot contour. One small gas well on the T. B. Roberts property is near the 440-foot contour. So far as known oil was not found in this pool. The wells here were drilled during 1905 or a short time thereafter, and by 1911 all of them had been abandoned and the casings pulled.

**MILDRED POOL.**

The structure of the pool near Mildred is complex; its principal features consist of a well-defined branching anticline at the north end, a shallow eastward-trending syncline, a low dome or structural terrace, and beds of practically uniform dip at the south end. It is evident that this complex structure was produced by forces acting in two directions, approximately at right angles to each other. The details of the structure of this pool, so far as it has been possible to outline them from the data available, may be best understood from an inspection of Plate XXI.

At the north end of the pool the oil sands dip to the northeast, and most wells reaching the sands at a depth greater than 450 to 460 feet below sea level were "dry." The productive area at the southwest end of the pool is between the 300 and 210 foot contours, which represent the depth of the oil sand below sea level. It is evident that the productive area does not follow the trend of the contour lines and that the accumulation of the oil does not depend alone on the structure. Some wells beyond the western limit of the productive pool encounter sands that yield only traces of oil. This condition may be due to decrease in the porosity of the sand or to the lack of sufficient pressure to cause the oil to flow freely into the wells.

**WITHERSPOON-McKIE POOL.**

The Witherspoon-McKie pool, southwest of Powell, lies along the crest of a low, flat-topped anticline which extends from the southeastern part of the Witherspoon tract southwestward  $1\frac{1}{2}$  miles to the McKie tract. Although extensive drilling has been done in this pool, few well records have been preserved, and it is impossible to outline accurately the details of the fold. The highest part of it is on the south side of Post Oak Creek, a quarter of a mile above its junction with Chambers Creek. The depth to the highest productive sand is 825 to 875 feet, and to the lower sand about 100 feet more. Oil and gas were present only along the crest of the anticline, and water was troublesome over practically the entire pool. Gas was present originally in both the upper and lower sands, but more abundantly in the lower. All the wells at the north end of the pool have been invaded by salt water and abandoned.

**CLEMENTS-BUCHANAN POOL.**

The accumulation of oil in the Clements-Buchanan pool, northeast of Mildred, is associated with a sharp downward bend of otherwise gently dipping beds. The dip of the beds appears to be locally as much as 560 feet to the mile to the southeast, and the oil occurs in

the area of steep dip where the beds are at depths between 395 and 490 feet below sea level. Northwest of the productive area the beds dip to the southeast at a smaller angle, probably less than 180 feet to the mile.

#### BURKE POOL.

The Burke pool, 1 mile south of Powell, is associated with the most pronounced fold that has been found in the Corsicana field. Only the south end of the fold can be outlined, because the well logs were available only for that part of the pool. As shown on Plate XXI, this fold, which is probably a shortened anticline or dome, has dips of about 185 feet to the mile to the northwest, southwest, and southeast. Oil occurs in the upper part of the fold, where the upper sand is from about 400 to 480 feet below sea level. Where the sand is more than 480 feet below sea level it is generally saturated with brine, although in that area a number of wells have yielded some oil and a few producing wells have been completed.

#### ANGUS POOL.

The strata in the pool south of Angus dip gently to the east at a fairly uniform rate, and the upper oil sand, which is about 200 feet below sea level in the southwestern part of the pool, lies at a depth of 340 feet or more in the eastern part. The oil is followed up in the eastern part of the pool by salt water, which is practically absent in the western part of the development area, where the beds are higher.

So far as can be determined from the available well records the dip of the beds within the Angus pool is practically normal for this region—that is, to the east or southeast. The oil sand which is contoured in the Angus pool is believed to be the same as that in the Tilton-Havener pool, where it is about 200 feet deeper.

#### RELATION OF OIL AND GAS TO STRUCTURE.

A review of the discussion of the structure or a study of the structure map of the Corsicana field will show that oil and gas occur in this field under two different structural conditions. They have accumulated along the crests of well-defined anticlines, as in the Burke pool, and also in beds of fairly uniform dip, as in the Corsicana pool. In this field no two of the three sands, the Corsicana, Edens, and Nacatoch, are productive at any one place. This may be due to the fact that the deeper sands have not been reached by the drill in places where production was obtained from the shallower sands; or the productive area in the deep sand may be limited to the Corsicana pool,

for there are other factors than structure that control the accumulation of oil and gas, among them the distribution and porosity of the productive sand. If the productive sands were uniform in thickness and porosity over the entire field, in an area where the structure is favorable for the accumulation of oil and gas in one sand, it might be favorable for accumulation in the other sands also. Drilling has shown, however, that the sands of this field are lenticular and vary in porosity and thickness from place to place. The accumulation of oil and gas in some places may be due to the pinching out of the sand, which prevents the oil and gas, backed up by salt water, from migrating farther up the dip. This condition would account for the accumulation of oil in the Corsicana pool, where a portion of the western limit of the pool may also be the western limit of the porous sand that yields the oil. The location of this pool with reference to the structure shows that there is also a structural reason for the accumulation of the oil. The decrease in the rate of dip of the oil sand west of Corsicana would check the migration of fluids, and the low dip would be less favorable for their migration and accumulation than the steeper dip farther east. Low hydrostatic head combined with low gas pressure in thin, fine-grained sands having moderate dips favor a slight migration of the fluids in the direction of the dip and a wide distribution of the oil, such as exists in the Corsicana pool.

The accumulation of oil in the Angus, Tilton-Havener, and Clements-Buchanan pools may be controlled by the same factors as those that control it in the Corsicana pool, but the evidence is not conclusive, and variations in the sand may have been an important controlling factor. The largest gas pools in this field, such as the Edens, Witherspoon-McKie, and Chatfield pools, are associated with anticlinal folds. On the other hand, the most pronounced fold in the area, that associated with the Burke pool, contains much oil but little gas.

## OIL AND GAS.

### OCCURRENCE.

#### GEOLOGIC DISTRIBUTION.

In the Gulf Coastal Plain the two important series of petroliferous strata are the Upper Cretaceous and the late Tertiary, which contain oil in different areas and under different structural conditions. The Upper Cretaceous fields, such as those of northwestern Louisiana and the Corsicana, Powell, Mexia-Groesbeck, and Thrall fields of Texas, lie at considerable distances from the coast. The late Tertiary or early Quaternary fields, such as the Jennings, Vinton, Spindletop, and Humble, are near the coast. The Upper Cretaceous beds that yield oil and gas are usually more or less extensively folded, and

the areas of production may be several miles across. On the other hand, most of the Tertiary and Quaternary fields occur where there are masses of rock salt that form cores of domes (saline domes) from which the oil-bearing beds dip steeply, and these fields are all small, generally covering not more than a few hundred acres.

The Upper Cretaceous series includes two commercially productive formations—the Woodbine, the most productive oil sand of northwestern Louisiana, and the Nacatoch, the most widely distributed gas sand of the Coastal Plain. In Texas the Woodbine is productive only in the Caddo field, which extends into Marion and Harrison counties, and probably at South Bosque, near Waco. At Corsicana the Woodbine yields water which is only slightly saline, and not such brine as is usually associated with oil and gas. The Nacatoch, on the other hand, supplies gas in all the fields of northwestern Louisiana and in the Mexia-Groesbeck field, Tex.,<sup>1</sup> and oil in some areas in northwestern Louisiana and probably in the Powell district of the Corsicana field, Tex. The Taylor marl, which is productive in the Corsicana district, is not productive, so far as known, at any other locality in Texas except Thrall, where the conditions are unusual.

The productive formations are not the same in the Corsicana and Powell districts. The Taylor marl, which yields light oil in the Corsicana district, dips under the Powell district but has not been exploited there; the Nacatoch sand member of the Navarro formation, which yields heavy oil in the Powell district and which is probably the equivalent of the Nacatoch sand of Louisiana and Arkansas, is not productive in the Corsicana district and crops out a short distance west of it. Plate XX shows the approximate relative positions of the sands of the Corsicana and Powell districts.

#### CORSICANA DISTRICT.

##### PRODUCING SANDS.

In the Corsicana district there are at least two productive sands which are believed to belong to the Taylor formation—the Corsicana and Edens sands. (See generalized section, Pl. XX.) The Corsicana sand is the principal producing sand and yields light oil and a small amount of gas at a number of places, particularly toward the north end of the district. The Edens sand formerly yielded gas in a small area 2 miles southeast of Corsicana; it may be the equivalent of the sand which yields gas in the gas pool south of Chatfield. The age of the sand near Angus, which yields light oil similar to that

<sup>1</sup> Matson, G. C., Gas prospects south and southeast of Dallas: U. S. Geol. Survey Bull. 629, pp. 81-82, 1916.

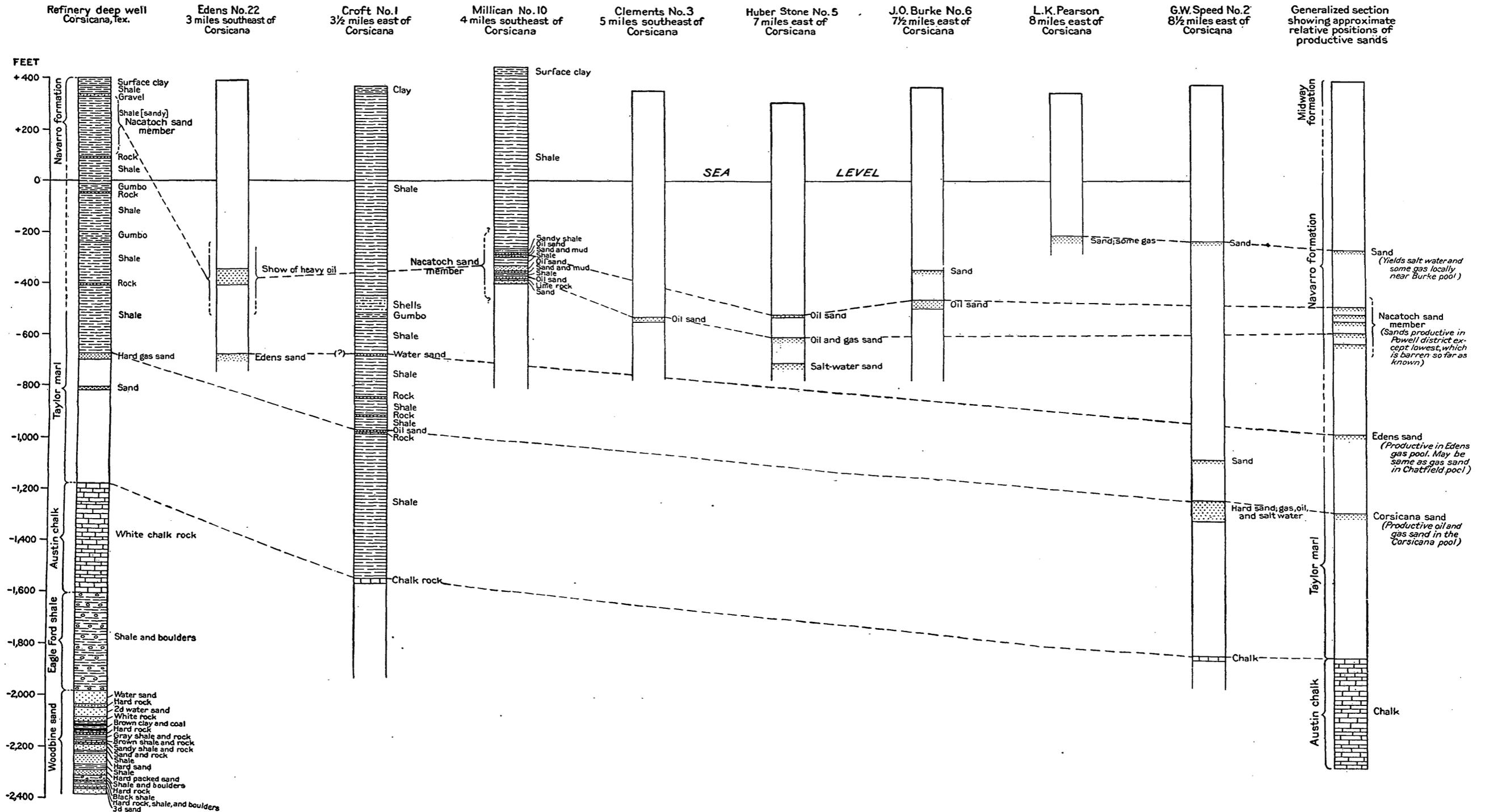


DIAGRAM SHOWING THE POSITION OF THE SANDS IN DIFFERENT PARTS OF THE CORSICANA OIL AND GAS FIELD, TEX., AND THEIR TENTATIVE CORRELATIONS IN THE GENERALIZED STRATIGRAPHIC SECTION.

from the Corsicana sand, is not known, although geologic evidence suggests that it belongs to the Nacatoch member of the Navarro formation.

#### CORSICANA POOL.

The Corsicana sand is 500 to 550 feet above the top of the Austin chalk, about 800 feet below the Nacatoch sand and about 300 feet below the Edens sand. (See Pl. XX.) In the Corsicana pool it ranges from a few feet to 60 feet in thickness and consists of fine-grained sand and sandy shale. It has been described by Oliphant<sup>1</sup> as consisting of almost pure dark-gray quartz sand containing Foraminifera of several kinds, among which are *Rotalia*, *Nomionina*, and *Globigerina*. This sand is fairly persistent in character and thickness over the productive area and is underlain and overlain by impervious, massive plastic clay. It ranges in depth from 800 feet below sea level, or about 1,200 feet below the surface, near the old waterworks, 2 miles southeast of Corsicana, to 530 feet below sea level, or 900 feet below the surface, 4 miles north of the city. (See Pl. XXI, in pocket.) This sand has been productive over the greater part of an area 6 miles long from north to south, 2 miles wide at the south end and half a mile wide at the north end. The upper 10 to 20 feet or more of sand, although it commonly gives a show of oil or gas, is so fine grained that it does not yield its oil as readily as the coarser sand below. The wells are drilled into the sand from 25 to 60 feet and are completed when the flow of oil into the well is sufficient to make pumping profitable, or abandoned when the amount of water is so great in proportion to the oil that pumping is unprofitable.

In the early history of the field some of the wells flowed, owing to the pressure of the gas that was originally present, but for many years all the wells have been pumped. After the wells are completed they are allowed to stand for a day or two, and during that time they fill up from 300 to 800 feet with oil, oil and water, or water. Gas occurs in small areas near the western limit of the pool, where the beds are highest; salt water or brine occurs in small quantities over much of the pool but increases in amount toward its eastern and southeastern limits, where the beds are lower. In general the productivity of the wells depends on the thickness and porosity of the sand; the accumulation of the oil and gas depends on the structure and the distribution and character of the sand. As the yield of oil in the pumping wells declines, the percentage of water increases. The flow into the wells is slow at the present stage of development because of the almost complete absence of gas pressure and the fineness of the productive sand.

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<sup>1</sup> Oliphant, F. H., U. S. Geol. Survey Nineteenth Ann. Rept., pt. 6, continued, p. 102, 1898.

## EDENS POOL.

The Edens sand produced considerable gas in the early history of the Edens pool, but the wells were soon exhausted, and all of them have been abandoned and the casings pulled. The principal productive area was on the Edens League, 3 miles southeast of Corsicana. The wells were drilled 10 to 20 feet into the sand and originally showed a rock pressure of 150 to 200 pounds to the square inch.

## CHATFIELD POOL.

It is not possible to correlate the gas sand of the Chatfield pool accurately with those near Corsicana, but it is believed that this sand is of Taylor age and approximately the equivalent of the Edens gas sand. It ranges in thickness from 8 to 16 feet and lies about 850 feet below the surface. Approximately 180 feet below it is another sand, which produces large quantities of salt water, and this may be the equivalent of the Corsicana sand. The following well log shows the depths and relations of the sands in this area, although the thickness of the first sand is probably exaggerated:

*Log of T. B. Roberts well No. 3 of Houston Oil Co., near Chatfield, Tex.*

	Thick- ness.	Depth.
	Feet.	Feet.
Soil.....	1	1
Yellow clay.....	34	35
Hard bluish sand.....	48	83
Gravel and white sand.....	5	88
Brownish shale.....	293.5	381.5
Black quartz.....	58.8	440.3
Brownish shale.....	405.8	846.1
Through sand into shale; good gas pressure.....	40.8	886.9
Shale.....	118.1	1,005
More gas sand and better pressure.....	18.7	1,023.7
Shale.....	8.3	1,032
Salt-water sand.....	13	1,045
Shale and bluish mud; abandoned at this depth.....	139.2	1,184.2

The gas wells here, some four or five in number, were small producers, and the gas was piped to Corsicana for domestic use. Most of these wells were drilled in 1906 and 1907, and all of them were abandoned and the casings pulled before the end of 1911.

## ANGUS POOL.

The fragmentary records available suggest that a number of different sands that may belong to the Nacatoch sand are present in the pool near Angus. The sands occur within a vertical interval of

about 150 feet, and the wells are completed at depths of 600 to 800 feet. As no complete logs of the wells in this pool are available, the number and relations of the sands can not be determined, and their correlation with the sands of the other pools is uncertain. The light gravity of the oil suggests that they may be the equivalent of the Corsicana sand instead of the Nacatoch sand. Gas is most abundant in the southwestern part of the pool, where the beds are in the highest structural position; water is most abundant in the eastern part of the pool, where the beds are lowest.

Showings of oil have been found in a number of wells between the Angus pool and the town of Angus, among them being wells Nos. 1 and 4 on the property of Latta Bros., which are dripping oil at the present time. Much salt water is reported on this and adjoining leases from what appears to be the upper sand.

A number of gas wells have been drilled northeast of Angus, mostly on the Petty and Birdwell leases, but no records of them have been kept, and it is not known whether the sands here are the equivalent of the Edens or the Nacatoch sand. On the Birdwell lease gas, which was formerly piped to Corsicana, was found at a depth of about 700 feet and a trace of oil at 725 feet.

#### TILTON-HAVENER POOL.

The oil from the Tilton-Havener pool, east of Angus, may be derived from the equivalent of the highest sand of the Angus pool, although the well data are not sufficient to make the correlation conclusive.

#### POWELL DISTRICT.

#### GENERAL FEATURES.

The Powell district includes all the pools in the Corsicana field that produce heavy oil. It is not possible, with the fragmentary records available, to correlate accurately all the sands in this district. The productive sands, which are lenticular and vary in porosity and thickness, are believed to occur within an interval of about 100 feet. In this district usually two or three and exceptionally four productive sands are reported, besides a shallow sand that yields a small amount of gas at a few places, as in the L. K. Pearson and G. W. Speed wells. (See Pl. XX.) The productive oil sands in this district are believed to represent a part of the Nacatoch sand member of the Navarro formation and are grouped under the name Nacatoch sand.

In the productive area these sands lie at depths ranging from 650 feet west of Mildred to 950 feet north of Powell. They are about 800 feet above the Corsicana sand and about 1,300 feet above the Austin chalk. They are overlain and underlain by thick beds of massive, impervious clay or clay marl of marine origin.

The productive sands of the Powell district are separated into individual sand beds by lenses of finer-grained sand and shale. It is doubtful whether any one of the four sands that are reported from some wells is present at every locality where wells have been drilled in the district. In most of the well logs two or three sands are reported, and in many of them only one sand is recognized, a condition that is not uncommon in logs of wells drilled by the rotary process. The following well records show the relative positions of the sands:

*Log of W. L. Derden well No. 5 of Marnet Oil Co., 3½ miles east of Corsicana, Tex.*

	Thick- ness.		Depth.	
	<i>Ft.</i>	<i>in.</i>	<i>Ft.</i>	<i>in.</i>
Shale.....	120	0	120	0
Rock.....	6	6	120	6
Shale.....	250	0	370	6
Rock.....	6	6	371	0
Shale.....	245	0	616	0
Rock.....	1	6	617	6
First oil sand.....	26	0	643	6
Shale.....	7	0	650	6
Sand.....	28	0	678	6
Mud.....	2	0	680	6
Sand.....	6	7	687	1
Rock.....	1	2	688	3
Good sand.....	19	0	707	3
Shale.....	8	0	715	3
Gumbo.....	3	6	718	9
Rock.....	2	7	721	4
Sand.....	14	0	735	4
Shale.....	7	0	742	4
Sand.....	9	0	751	4
Shale.....	2	2	753	6
Gumbo.....	10	0	763	6
Rock.....	10	0	764	4
Sand.....	18	0	782	4
Rock.....	6	6	782	10
Sand.....	10	0	792	10
Gumbo.....	7	2	800	0

*Log of J. W. Combest well No. 5, 1 mile northeast of Powell, Tex.*

	Thick- ness.		Depth.	
	<i>Ft.</i>	<i>in.</i>	<i>Ft.</i>	<i>in.</i>
Soil.....	50	0	50	0
Rock.....	4	4	50	4
Shale.....	151	2	201	6
Rock.....	6	6	202	0
Shale.....	311	4	513	4
Sand; show of oil and gas.....	8	0	521	4
Shale.....	447	0	968	4
Rock.....	4	4	968	8
Oil sand; good show of oil.....	25	10	994	6
Gumbo.....	1	0	995	6

*Log of C. P. Kerr well No. 6 of Corsicana Petroleum Co., 3 miles east-southeast of Corsicana, Tex.*

	Thick- ness.	Depth.
	<i>Feet.</i>	<i>Feet.</i>
Shale and boulders.....	700	700
Hard sand.....	6	706
Broken sand.....	12	718
Shale.....	33	751
Sand.....	3	754
Shale and gumbo.....	34	788
Sand.....	4	792
Hard shale, gritty.....	10	802
Sand.....	18	820
Shale.....	21	841
Rock.....	2	843
Shale and mud.....	7	850

*Log of J. W. Millican well No. 10 of Corsicana Petroleum Co., 3 miles east-southeast of Corsicana, Tex.*

	Thick- ness.	Depth.
	<i>Feet.</i>	<i>Feet.</i>
Surface clay.....	30	30
Shale.....	684	714
Sand and shale.....	7	721
Hard sand.....	1	722
Oil sand.....	8"	730
Sand and mud.....	12	742
Hard sand; trace of oil.....	4	746
Shale.....	33	779
Oil sand.....	18	797
Sand and mud.....	5	802
Shale.....	4	806
Hard shale.....	9	815
Do.....	1	815½
Oil sand.....	6½	822
Hard lime rock.....	4	826
Fine-grained sand.....	21	847

*Log of Bryan T. Barry well No. 15, 4 miles east of Corsicana, Tex.*

	Thick- ness.	Depth.
	<i>Ft. in.</i>	<i>Ft. in.</i>
Soil.....	6	6
Clay.....	49	50 0
Rock.....	8	50 8
Shale.....	14	65 0
Rock.....	4	65 4
Shale.....	17	83 0
Gumbo.....	4	87 0
Shale.....	13	100 0
Rock.....	6	100 6
Shale.....	18	119 0
Rock.....	1	120 2
Shale.....	54	175 0
Rock, soft.....	2	177 0
Shale.....	51	228 0
Rock.....	6	228 6
Shale.....	439	668 0
Rock.....	4	668 4
Shale.....	51	720 0
First sand; show of oil.....	27	747 0
Shale.....	72	819 3
Rock.....	1	820 9
Shale.....	3	824 3
Second sand.....	15	840 0

Produced initially 12 to 15 barrels a day.

The highest of the Nacatoch (?) sands of the Powell district ranges in thickness from 8 to 15 feet or more and usually yields some oil but little water. At some places it yields only a trace or a small amount of oil; at others it is the most productive sand. The second and third sands are less persistent than the others and are not recognized at many places; they are fine grained and yield but little oil or water, except locally. The average interval between the first and second sands is 25 feet, between the second and third 40 feet, and between the first and fourth about 100 feet. The lowest sand is the most productive in the western part of the field, where it probably yields two-thirds of the production of the wells. It also contains much salt water near the southeastern limit of the individual pools. In the small pools in the northeast end of the Powell district, near Powell, it is not possible to determine definitely which of this group of sands is the productive one.

The Corsicana sand probably underlies the Powell district, as it appears to have been found in the G. W. Speed well,  $8\frac{1}{2}$  miles east of Corsicana, beyond the eastern limit of the Powell district. Few wells in the Powell district have reached this sand, and the possibility of obtaining oil from it there has not been determined.

#### MILDRED POOL.

In some parts of the Mildred pool, which extends from a point a short distance west of Mildred northward across the Cotton Belt Railroad, all the four sands of the Nacatoch (?) are present. Near the south end of the pool all four sands are productive to a different degree and the wells are drilled to the deepest sand; near the north end, on the other hand, the upper sand is more productive, and on the Junior Pipe Line Co.'s leases only a few of the wells are drilled to the deep sand. Most of the wells in this pool, however, are drilled to the deep sand, and as the casings are set at the top of the upper sand the product thus obtained represents the combined yield of all the sands present. This method is possible because most of the water present is in the lowest sand. The water in the lowest sand is troublesome only in the southeastern edge of the pool, as outlined by existing wells. Near the central and western parts of the pool little or no water is present, and many of the wells are drilled below the base of the lowest sand without being injured by the presence of water.

#### WITHERSPOON-McKIE POOL.

In the Witherspoon-McKie pool the upper and lower sands are productive but not the intermediate ones. The upper sand is inter-laminated with shale and yielded oil and some gas when this pool was first drilled. It was developed first, and a number of oil wells were

completed in it before the presence of the lower sand was known. The interval between the upper and lower sands, which is approximately 100 feet, has been described as follows:

*Partial log of Stone well No. 4, 7 miles east of Corsicana, Tex.*

	Thick- ness.	Depth.
	<i>Feet.</i>	<i>Feet.</i>
Top of first sand.....		880
Hard sand; show of oil and gas.....	15	895
Shale.....	55	950
Hard rock.....	2	952
Soft shale interlaminated with sand.....	28	980
Hard rock.....	1	981
Sand, bearing oil and water.....	5	986

*Log of Stone well No. 5, 7 miles east of Corsicana, Tex.*

	Thick- ness.	Depth.
	<i>Feet.</i>	<i>Feet.</i>
Clay and gravel.....	60	60
Shale.....	784	844
Rock.....	1	845
Sand, with oil and gas.....	3	848
Shale and sand interbedded; made showing of oil and gas.....	26	874
Sand and shale interbedded.....	32	906
Shale and layers of hard rocks.....	29	935
Sand; oil and some gas.....	1	936

Four gas wells besides a number of oil wells have been completed in the lower sand. One of the gas wells, which had a reported pressure of 350 pounds to the square inch and a volume of 4,000,000 cubic feet, supplied the city of Corsicana with gas for three years. At present the gas from these wells is not being used, and the gas pressure has decreased so much that the wells would yield little without the installation of compressors. At least one oil well in this sand flowed for a few days as much as 150 to 200 barrels of oil. In this pool only the top of the sand in places where the structural conditions were most favorable was filled with oil and gas; elsewhere the sand carried salt water. Water was troublesome over the entire pool, and many of the wells that were drilled only a few feet into the sand yielded too much water to justify the cost of pumping. All the wells at the north end of the pool have been abandoned.

**CLEMENTS-BUCHANAN POOL.**

The small oil pool on the Clements and Buchanan leases is believed to be productive from the lower bed of the Nacatoch (?) sand of that area. No complete logs of any of the wells in this area are available, and the partial logs contain no mention of any upper sands;

if such sands are present they were doubtless unproductive. The only gas obtained in this pool is casing-head gas, which is used as a fuel in the gas engine employed in pumping the wells.

#### BURKE POOL.

All the oil from the Burke pool is derived from one sand, which is probably the upper bed of the Nacatoch (?) sand of the district. No gas wells were developed in the main pool; some gas was found, however, at the north edge of it, but whether in the productive oil sand or a shallower sand is not known. A shallow sand about 200 feet above the oil sand yielded gas on the Pearson lease. The oil sand contains water in troublesome quantities only around the edge of the pool; the wells near the center of the pool yield little or no water. The presence of a well-developed fold in this area probably accounts for the fact that the water conditions are different from those in many of the other pools of the field, where water is present in abundance only on the southeast sides of the pools.

#### COMBEST AND WHITE POOLS.

The productive sand in the Combest and White pools, near Powell, is believed to be the same as that in the Burke pool—that is, the highest of the Nacatoch (?) sands in the Powell district—but the lack of accurate well logs makes a definite correlation impossible. Small pockets of gas under considerable pressure have been found in the Combest pool. One gas well in this pool gave considerable promise, and a pipe line to Corsicana was planned, but before the line could be laid the well was practically exhausted.

#### COMPOSITION.

##### OIL.

The accompanying table of analyses shows the general quality of the oil found in the Corsicana and Powell districts. For the purpose of comparison there have been added analyses of the oil from the Nacatoch sand in Caddo Parish and from the deep oil sands of northwestern Louisiana. The sample from the Nacatoch sand (Dawes well) affords the most valuable comparison, because this is the approximate equivalent of the sands in the Powell pool. Northwestern Louisiana does not appear to contain any producing sands equivalent to the Corsicana, and the exact relations of the sand of the Angus pool are unknown. It may prove to be the equivalent of the Nacatoch sand, but if so, the quality of the oil is unlike that of the oil from any other pool in this sand.

*Analyses of oil from the Corsicana and neighboring fields, Texas-Louisiana.*

[Analyses by Bureau of Mines except as otherwise stated.]

Well and location.	Pool or district.	Depth of sand (feet).	Total depth (feet).	Crude (cubic meters and per cent).	Gravity.		To 150° C.		150°-300° C.		Residuum.		Unsaturated hydrocarbons.		Asphalt (per cent).
					Sp. chlc.	Baumé (°).	Cubic centi-meters and per-grav. cent.	Spe-cific and per-grav. cent.	Cubic centi-meters and per-grav. cent.	Spe-cific and per-grav. cent.	Cubic centi-meters and per-grav. cent.	Spe-cific and per-grav. cent.	Crude (per cent).	150°-300° C. (per cent).	
Corsicana field, Tex.: Hartzell Oil Co., No. 8, south of Angus.	Angus.....	560±	725-750	100	0.8279	39.1	20	0.7160	45	0.8005	35	0.8950	10	4	0
Marnet Oil Co., Robbins Nos. 7 and 12, 2 miles southeast of Corsicana.	Corsicana.....	1,108	1,131	100	.8304	38.6	21	.7238	48	.8150	31	.9130	12.8	4	0.83
Houston Oil Co., J. C. Blankenship, Nos. 1-7, 3 miles north of Corsicana.	.....do.....	975±	1,155± 1,000±	100	.8314	38.4	18	.7165	43	.8030	39	.8970	12	5	.66
J. S. Gibson, No. 16, 4 miles south of Corsicana.	Powell.....	658	850	100	.8679	31.3	10.5	.7400	44.5	.8355	45	.9205	18.8	2	.53
Wright, No. 6, 5 miles southeast of Corsicana.	.....do.....	.....	860	100	.9109	23.7	1	.....	33	.8680	66	.9260	30	13	1.14
J. O. Burke, No. 18, 1½ miles south of Powell.	.....do.....	881	7,892	100	.9144	23.1	2	.....	33	.8700	65	.9220	26	12	1.26
De Soto—Red River field, La.: Standard Oil Co., scales No. 1, sec. 35, T. 13 N., R. 12 W.	Naborton.....	2,410	.....	100	.8069	43.5	19	.7230	50	.7960	31	.8870	8.8	6	0
Producers Oil Co., Christine, No. 16, near Naborton, De Soto Parish, Cadjo field, La.-Tex.:	.....do.....	.....	1,186	160	.7973	46.6	27	.7200	55.5	.7990	17.5	.9050	8.8	6	.09
Producers Oil Co., McCue Levee Board No. 2, sec. 36, T. 21 N., R. 16 W.	.....	2,180	2,221	100	.8969	26.1	2.5	.....	35	.8540	62.5	.9130	21.2	7	2.01
Dawes well, sec. 36, T. 22 N., R. 16 W. <sup>b</sup>	.....	.....	1,050	102.9	.9253	21.3	.....	.....	17.0	.8406	85.9	.9302	.....	.....	.22

<sup>a</sup> Oil from chalk rock.

<sup>b</sup> Harris, G. D., Oil and gas in Louisiana: U. S. Geol. Survey Bull. 429, p. 131, 1910. Analysis by U. S. Geological Survey: Oil from Nacatoch sand.

In interpreting the table, it should be remembered that the gravity of the oil distilled at temperatures up to 150° C. corresponds approximately to that of gasoline, though in practice the gasoline supplied by the refineries is intended to meet the requirements of the market, and as the result of distillation to a somewhat higher temperature it may be of slightly lower gravity than that obtained from the samples.

The oil obtained between the maximum temperature of gasoline distillation and 300° represents the kerosene. The residuum is used as a fuel and in the manufacture of the heavier petroleum products, such as lubricating oils.

The determinations set forth in the table were made from small samples obtained from only a few of the wells and may not be altogether representative of the character of the oils in the different pools. The sample from the Angus pool compares very favorably with those from the Corsicana pool. These lighter oils may be contrasted with the samples from the Gibson, Wright, and Burke wells, which show the quality of the oil from the Nacatoch(?) sands of the Powell district. The Gibson well supplied oil that is only slightly heavier than that of the Angus and Corsicana pools, the difference being most marked in the quantity of gasoline that can be obtained from it. This oil should be valuable for refining, especially when the lighter products, such as gasoline, are in demand. The samples from the Wright and Burke leases were much heavier than the others and yielded only about two-thirds as much kerosene. The quantity of residuum is naturally higher in the heavier oils than in the lighter oils.

The percentage of unsaturated hydrocarbons in the oils is variable. The unsaturated hydrocarbons in the gasoline are negligible, because they are not distilled in quantity below 150°, but in the kerosene the percentages are noticeable, though the sample from the Gibson well shows an unusually small amount. In thorough refining the unsaturated hydrocarbons will be largely removed and the amount of kerosene will thereby be diminished.

The sample from the Nacatoch sand in the Caddo field (Dawes well) is somewhat heavier than any of the samples examined from the Corsicana field. The oil is used as a fuel and is much less valuable for refining than the oils of the Powell field.

The sample from the Scales well, in De Soto Parish, La., is lighter than any of those from the Corsicana field, but the sample from the McCue Levee Board well, in the Caddo field, is of but very little better grade than the heavier oil of the Powell district, obtained from the Wright and Burke leases. The oil from the Christine well, of the De Soto field, more nearly represents the high-grade oils of northwestern Louisiana than either the Scales or McCue Levee

Board samples. It is the lightest oil represented in the table; its gasoline and kerosene contents are higher than those shown by any of the samples from the Corsicana pool, and the residuum is correspondingly lower. The oil from this well is from the chalk rock, but in composition it resembles the higher-grade oils from the deep sand of the Caddo field more than the oils from the chalk.

Asphalt was present in all the samples from the Corsicana field except one, but the percentage was small in most of the samples. The percentage of asphalt in the sample from the McCue Levee Board well is unusually high; the other samples from northwestern Louisiana contain practically no asphalt.

GAS.

The gases from the upper part of the Upper Cretaceous series are similar in composition in the different fields, as shown by the accompanying table. The combustible constituent that forms a very large proportion of all of them is methane (CH<sub>4</sub>); the minor constituents are carbon dioxide (CO<sub>2</sub>) and nitrogen (N<sub>2</sub>). Some of the deeper gases in the lower part of the Upper Cretaceous and the sample from the Petrolia field contain more or less ethane (C<sub>2</sub>H<sub>6</sub>), but this constituent is not present, so far as has been learned by analyses of a number of samples, in any of the gases from the upper part of the Upper Cretaceous. The presence or absence of ethane has sometimes been used as a means of determining whether a sand contains oil in addition to gas, it being assumed that if no ethane is present there is no oil in the sand. This assumption is erroneous, because the sand that supplied the Edwards well, in the Caddo field (No. 4 in table), contains oil in the same part of the field where the gas sample was taken.

*Analyses of gas from the Corsicana and other fields.*

[By Bureau of Mines.]

	1	2	3	4	5	6	7
Carbon dioxide (CO <sub>2</sub> ).....	1.7	Trace.	0.0	1.0	7.30	0.2	0.2
Oxygen (O <sub>2</sub> ).....	1.1	0.0	.0	.0	.0	.0	.1
Methane (CH <sub>4</sub> ).....	91.9	98.5	96.5	98.5	54.5	52.7	92.4
Nitrogen (N <sub>2</sub> ).....	5.3	1.5	3.5	.5	38.2	37.8	3.9
Ethane (C <sub>2</sub> H <sub>6</sub> ).....						9.3	3.4
Specific gravity determined.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Specific gravity calculated.....	0.60	0.56	0.57	0.58	0.79	0.78	0.60
Heating value, in British thermal units, at 0° C.	979	1,052	1,027	1,030	580	755	.....

1. Well No. 1 on Mackey lease, near Corsicana, Tex.
2. Well on Anglin lease of Robinson Oil & Gas Co., Mexia-Groesbeck field, Tex. U. S. Geol. Survey Bull. 629, p. 102, 1916.
3. Well on L. B. Phillips lease of Southwestern Gas & Electric Co., 10 miles west of Shreveport, La. Depth 1,000 feet.
4. Edwards well No. 1 of Southern Oil & Gas Co., sec. 23, T. 21 N., R. 11 W., Caddo field, near Vivian, La. Depth 1,040 feet.
5. Swamp gas.
6. Beatty well No. 1, Petrolia field, Tex. U. S. Geol. Survey Bull. 629, p. 41, 1916.
7. P. H. Youree well No. 3 of Gulf Refining Co. of Louisiana, sec. 33, T. 17 N., R. 14 W., south of Shreveport, La.

Because of difficulty in collecting sample No. 1, the only one obtained from the Corsicana field, some air was included, which resulted in a slight increase in the carbon dioxide, the introduction of oxygen, and a considerable increase in the amount of nitrogen. This brought about a lowering of the percentage of the combustible constituent methane and a consequent lowering in the heating value. In the samples of gases obtained from the Upper Cretaceous in the Mexia-Groesbeck field (No. 2), the Shreveport field (No. 3), and the Caddo field (No. 4), the percentages of the constituents other than methane are small, and their importance depends upon the fact that they are inert and require a certain amount of heat to increase their temperature, thereby lowering the heating value of the gas. The heating value is expressed in British thermal units.<sup>1</sup> It depends upon the pressure to which the gas is subjected, and a uniform pressure equivalent to that of a column of mercury 760 millimeters high has been used as a standard in making the determinations. The low heating value of the sample from the Corsicana field is probably due to the presence of air in the sample.

The composition of these gases may be contrasted with that of a swamp gas (No. 5) and that of the gas from the Petrolia field (No. 6), in which the low percentages of methane are accompanied by low heating values. Sample No. 7 represents the deep gas from the Shreveport field and shows the general character of the gases from the lower part of the Upper Cretaceous, though some of these gases contain no ethane and others contain more than this sample.

The gases obtained from the upper sands of the Upper Cretaceous compare favorably in heating value with those from the California fields, though some of the samples from Orange and Ventura counties, Cal., have heating values ranging from 1,100 to 1,240 British thermal units. The number of available analyses of Oklahoma gases does not warrant definite conclusions concerning their relative values, though apparently some of them are about the same as the best Upper Cretaceous gases of Texas and Louisiana and some are slightly higher in heating value. Most of the gases from Pennsylvania and West Virginia have higher heating values, many of them exceeding 1,200 British thermal units.

#### ORIGIN.

The oil of the Corsicana field is believed to have originated from organic matter in the shales that inclose the sands and to a minor extent in the sands themselves. The evidence in favor of local origin

<sup>1</sup> A British thermal unit is the amount of heat required to raise 1 pound of water 1° F. at or near its maximum density (about 39.1°).

is given in the following discussion of migration and accumulation. The character of the organic matter that was the source of the oil and gas can not be easily ascertained, though apparently both vegetable and animal matter of marine origin are present. The entire series of beds between levels nearly 600 feet below the lowest sand and 700 feet above the highest sand is of marine origin but was formed near the shore, as is shown by the abundance of land-derived sediments. No remains of terrestrial plants or animals have been found in these sediments, and such remains were probably not abundant enough to yield much of the oil and gas if those substances were formed in place. Although oil may be transported mechanically with sediments, as noted by Stuart,<sup>1</sup> it is improbable that a large amount would be accumulated in that way, and origin from the organic matter in the sediments is believed to be more probable.

The conclusion that the oil and gas were derived from marine plants or animals, or both, is strengthened by the presence in the sands and associated shales of remains of Foraminifera and carbonized residues of what are believed to have been marine plants.

### MIGRATION.

#### VERTICAL MIGRATION.

The productive sands are included in a series of massive clays that would prevent extensive migration of the oil and gas in a vertical direction except where there were faults of large displacement. The region has been thoroughly prospected, and the geology has been studied in sufficient detail to indicate that no such faults exist in the field. Vertical migration between the different sands has not occurred, as is shown by the presence of gas in some of the sands below the beds that yield oil. The presence of the oil and gas in this field is in itself evidence of the absence of extensive vertical migration, because they would have escaped to the surface if uninterrupted vertical migration had been possible, whereas no seepages of oil or gas are known in this field.

The first sand beds encountered below the producing sands belong to the Woodbine sand, and that migration upward from this sand or from lower sands has not occurred is shown by the difference in composition of the water in the sands. The accompanying analyses of water from the Woodbine sand and the Corsicana sand show that the shallower sand contains strong brine, and that the water from the Woodbine is comparatively fresh.

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<sup>1</sup> Stuart, Murray, The sedimentary deposition of oil: Geol. Survey India Rec., vol. 40, pp. 320-333, 1910.

*Analyses of water from the Corsicana and Woodbine sands.*

[Parts per million.]

	1	2		1	2
SiO <sub>2</sub> .....	260	44	K.....	422	.....
Fe.....	Trace.	Trace.	CO <sub>2</sub> .....	0	48
Al.....	25		HCO <sub>3</sub> .....	27	1,390
Ca.....	570	22	SO <sub>4</sub> .....	0	Trace.
Mg.....	146	9.1	Cl.....	14,292	2,411
Na.....	8,045	2,128	NO <sub>3</sub> .....		0

1. Robbins wells Nos. 6, 7, and 12, and Polk wells Nos 7, 8, and 10, Corsicana pool, near Corsicana, Tex. Water from Corsicana sand. S. C. Dinsmore, analyst.

2. Natatorium well, Corsicana, Tex. Water from Woodbine sand at depth of 2,360 feet. S. C. Dinsmore, analyst.

If there had been sufficient migration to bring the oil from the Woodbine sand, or through the Woodbine from lower sands, enough water would probably have risen from the Woodbine to dilute the brine in the higher sands.

## HORIZONTAL MIGRATION.

The distribution of the sands in the Corsicana field favors migration only in a nearly horizontal direction, approximately parallel to the beds. The productive sands are fine grained, and the water does not escape freely in the direction of the dip. It is of course probable that somewhere along the dip the sand beds give place to shale, but this change to finer-grained material must occur some distance southeast of the oil field, because the Corsicana sand has been found in wells some distance beyond the productive area, and the Nacatoch (?) sand was probably encountered in the well of the Mitchell-Crittendon Co., 4 miles northwest of Malakof, where it contained a large amount of salt water and enough gas to burn at the mouth of the well. The sands in the Corsicana field, though fine grained, are apparently very porous—in fact, fine-grained sands are likely to be more porous than coarse-grained sands, because in most coarse sand there is enough fine material to partly fill some of the pores between the larger grains. The fine-grained sands in the Corsicana field have a large aggregate pore space but do not favor free migration of fluids, because of the smallness of the individual openings between the sand grains. The small amount of movement of fluids in the sands is indicated by the presence of salt water within 4 or 5 miles of the outcrop of the formation. This salt water does not indicate, however, that there has been no movement of the fluids away from the outcrop, as the original position of the outcrop, before erosion occurred, was some distance farther northwest than at present, and fresh water may have migrated downward from the outcrop at about the same rate as the change in its position resulting from erosion.

In the Corsicana field and along the strike of the Nacatoch (?) sand for a distance of 100 miles both north and south of the field salt water is found near the outcrop in the lateral extensions of the sand.

#### ACCUMULATION.

It is supposed by many geologists that the transfer of oil and gas from shales to sands is the result of pressure from the materials deposited upon the petroliferous beds. The aggregate weight of the overlying formations may of course be large, but it was added very slowly as the sediments were deposited particle by particle, and the process of compacting the shales and associated sands kept pace with the addition of the materials to the overlying formations. In this process the amount of pore space in both sands and shales was reduced—that of the sands by readjustment between the more or less angular grains. At the same time and subsequently a certain amount of cementation took place which further reduced the pore space and increased the rigidity of the beds, especially those of sandstone, which consisted of grains that in themselves were strong enough to be rigid. This compacting and cementing must have resulted in the transfer from the shales to the sands of a part of the salt water that had been included in the beds when they were deposited and, with the water, some of the oil and gas that had already been formed, because the shales were softer and the aggregate pore space was reduced more than the aggregate pore space of the sandstones.

After the compacting that resulted from the deposition of the overlying formations both shales and sandstones were subjected to folding, which caused further adjustment between their component particles. In the later stages and possibly throughout all the period of folding the shales were subjected to greater reduction in volume than the sands because they had originally greater pore space and were less rigid. This resulted in the transfer of fluids, consisting in part of salt water and in part of oil and gas, from the shales into the sands. The oil and gas thus transferred to fine-grained sandstone or sand were free to migrate laterally, as they were not in the dense shales.

According to the writers' interpretation of the conditions in the Corsicana field capillary forces, together with the force of gravity, produced some segregation of the oil and gas from the salt water during their migration up the dip. Although the folding was slow, there may have been a sufficient amount of fluid forced into the sand at times to cause a slight movement up the dip toward the outcrop, and such a movement would assist in the accumulation of the oil and gas in the higher structural positions. Circulating waters doubtless

brought both oil and gas to the pools, and these were added to the stores accumulating under the influence of gravity and capillary attraction. The oil accumulated by circulating fluids would naturally be gathered where the circulation was arrested, as for example around the north end of the Mildred pool. Some accumulations occur on areas of steep dip beyond the lower margins of areas of lower dip, as in the Clements-Buchanan pool. If perfect hydrostatic adjustment had been attained, and if the sands were uniform, these areas of low dip would have been the most productive, because the gas and oil would have collected there, but the decreased dip checked the upward migration of the oil and gas, and this check, together with differences in the porosity of the sand, in some places prevented the accumulation of oil and gas on the high portions of the folds, in the areas of low dip. The lack of vigorous circulation and the variations in the porosity of the sands have hindered accumulation of the oil and gas in strict accordance with the structure.

### PRODUCTION.

#### DAILY PRODUCTION.

No large wells comparable to those of the salt-dome fields of the coastal region of Texas and Louisiana or to those of the stratum fields of northwestern Louisiana have been drilled in the Corsicana field; in general the wells of this field are small producers but have a relatively long life. In the early history of the field the maximum initial daily production of the best wells did not exceed 200 barrels and in only a few wells has the initial production exceeded 100 barrels. The most productive individual wells were drilled in the Powell district, where the variation in initial production was large. The average production of the wells in the Powell and Corsicana districts, however, is probably not very different. The early wells in the Corsicana pool produced initially from 15 to 50 barrels a day; in the Burke pool, at Powell, from 10 to 200 barrels; and in the Angus pool 10 to 15 barrels.

*Average initial daily production, in barrels, of oil wells drilled in the Corsicana field, 1908-1915.*

[From U. S. Geol. Survey Mineral Resources.]

Year.	Corsicana district.	Powell district.
1908.....	5.1	12.3
1909.....	6.2	7.8
1910.....	3.2	5.3
1911.....		5.4
1912.....		6.4
1913.....		4.0
1914.....		2.3
1915.....		2.0

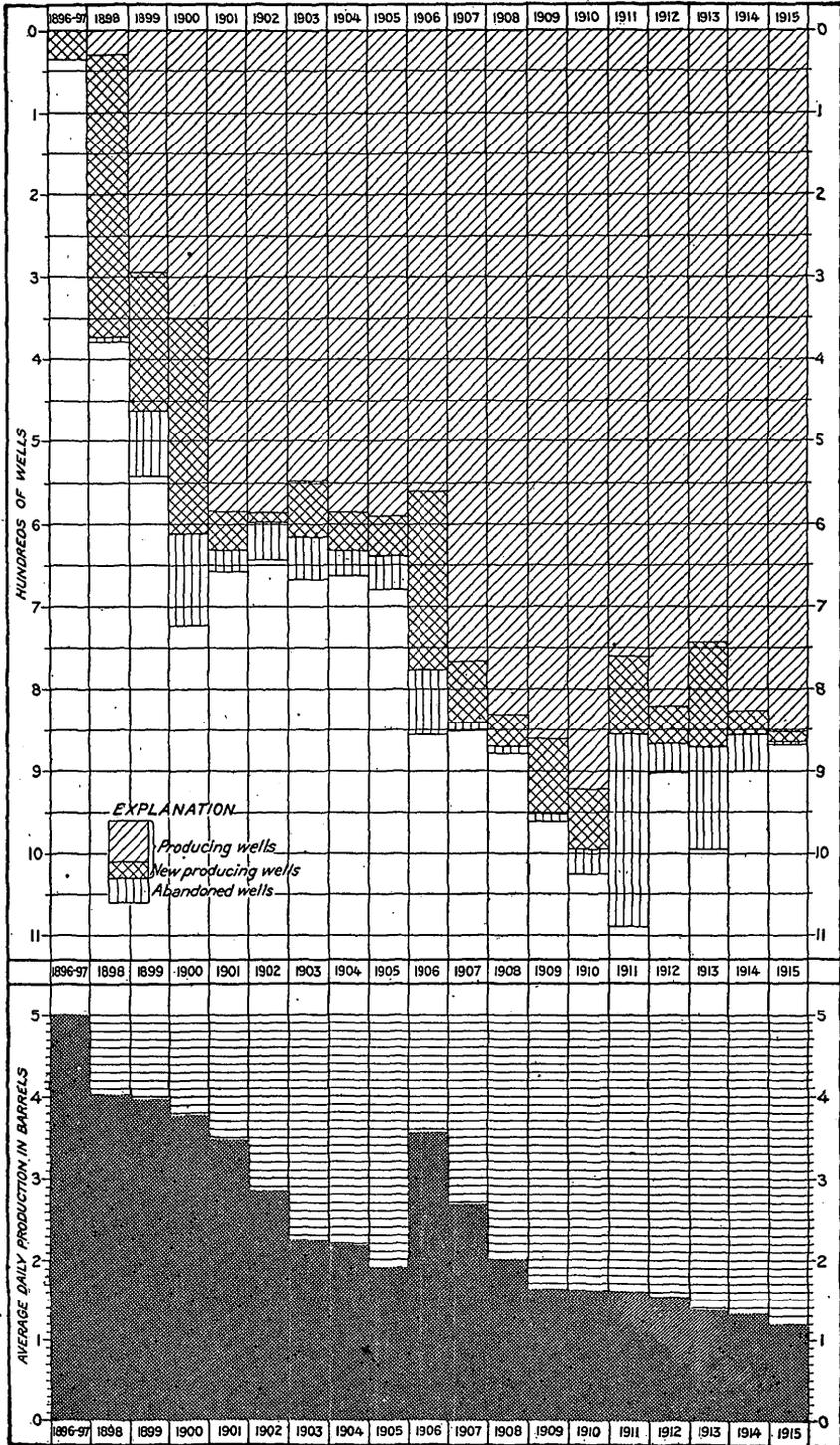


FIGURE 31.—Diagram showing average daily production of wells, number of producing wells, number of new wells, and number of abandoned wells in the Corsicana oil and gas field, Tex., 1896-1915.

After a rather rapid decline during the first few months of production, the wells have produced at a remarkably uniform rate for many years. Unfortunately, statistics are not available for the construction of a curve showing the rate of decline of the wells in this field; but the wells on a number of leases in the Corsicana pool produced almost as much in 1914 as in 1903, and some other wells that had been cleaned and drilled a few feet deeper produced more in 1914 than in 1902.

*Average daily production per well, in barrels, on two leases in the Corsicana district during January, 1902-1904 and 1915.*

Year.	1	2
1902.....	1.80	1.42
1903.....	1.22	1.15
1904.....	1.13	.....
1915 (well cleaned).....	2.11	1.54

The average daily production per well in the Corsicana field for the years 1898 to 1915, as computed from the statistics given in Mineral Resources of the United States, is shown in figure 31. This diagram shows an abrupt drop in 1898, the second year for which the daily production was calculated, and then a gradual decline until 1905. In 1906 the Powell district was discovered and the average daily production of this district was included with that of Corsicana, resulting in an abrupt rise in the average daily production per well. The decline during the next two years was rapid, because the early wells in the Powell district came in with a fairly large yield but quickly declined. Since that time the decline has been very gradual.

#### LIFE OF WELLS.

Many wells in the Corsicana field have been producing for 15 to 18 years, although a greater number have been abandoned after having been pumped a shorter period. The following table gives statistics of the wells that have been drilled annually from 1896 to 1915:

*Wells drilled in Corsicana oil field, Tex., 1896-1915.*

[From U. S. Geol. Survey Mineral Resources.]

Year.	Total completed.	Producing Dec. 31.	Dry.	Gas.	Abandoned.	Year.	Total completed.	Producing Dec. 31.	Dry.	Gas.	Abandoned.
1896-97....	43	37	6	.....	.....	1908.....	g 55	38	17	(f)	(f)
1898.....	374	342	a 28	4	7	1909.....	h 123	91	29	3	(f)
1899.....	268	169	a 90	9	79	1910.....	i 118	73	45	(f)	(f)
1900.....	373	b 261	a 98	14	112	1911 f.....	39	20	19	(f)	(f)
1901.....	68	c 47	16	5	27	1912 j.....	24	17	7	(f)	(f)
1902.....	28	d 12	13	3	45	1913 j.....	4	3	1	(f)	(f)
1903.....	100	70	23	7	51	1914 j.....	15	10	5	(f)	(f)
1904.....	74	46	25	3	31	1915.....	1	1	.....	.....	.....
1905.....	68	45	18	2	41	Total k..	2,224	1,575	586	.....	.....
1906.....	330	217	100	13	79						
1907.....	e 120	74	46	(f)	(f)						

a Includes 2 artesian wells.  
 b Includes 56 in Powell district.  
 c Includes 10 in Powell district.  
 d Includes 2 in Powell district.  
 e Includes 104 in Powell district.  
 f Data not available.

g Includes 42 in Powell district.  
 h Includes 118 in Powell district.  
 i Includes 91 in Powell district.  
 j Does not include wells in Powell district.  
 k Does not include wells in Powell district for 1911-1914.

Approximately one-third of the productive wells that had been drilled prior to the end of 1905 had been abandoned at that time, and as most of these wells had been drilled between 1898 and 1900, the average age of the wells was then about 6 years. At this rate all the wells would be abandoned in 18 years, and the average life of a well would be roughly 9 years. As many of the abandoned wells were located near the edge of the pool, where salt water would drown them in a short time, this figure for the average life of a well might seem to be too low, but a consideration of the total number of wells drilled to 1914, their average age, and the number of abandoned wells bears out the same conclusion—that the average life of a well in the Corsicana field is approximately 9 or 10 years. It must be remembered, however, that many of the wells are pumped when they yield only a small fraction of a barrel a day, because, with the multiple system of pumping, the pumping of an individual well may not have much effect on the cost of operating a lease.

YEARLY PRODUCTION.

The maximum annual production of 829,560 barrels in the Corsicana pool, the light-oil district, was reached in 1900, four years after the pool was discovered. The production has declined gradually since that time. The Powell district, which yields heavy oil, was discovered in 1900 and reached its maximum annual production of 673,221 barrels in 1906. The field as a whole also reached its maximum production in 1906, when it yielded more than 1,000,000 barrels of oil. It will probably be many years, however, before the field is entirely exhausted.

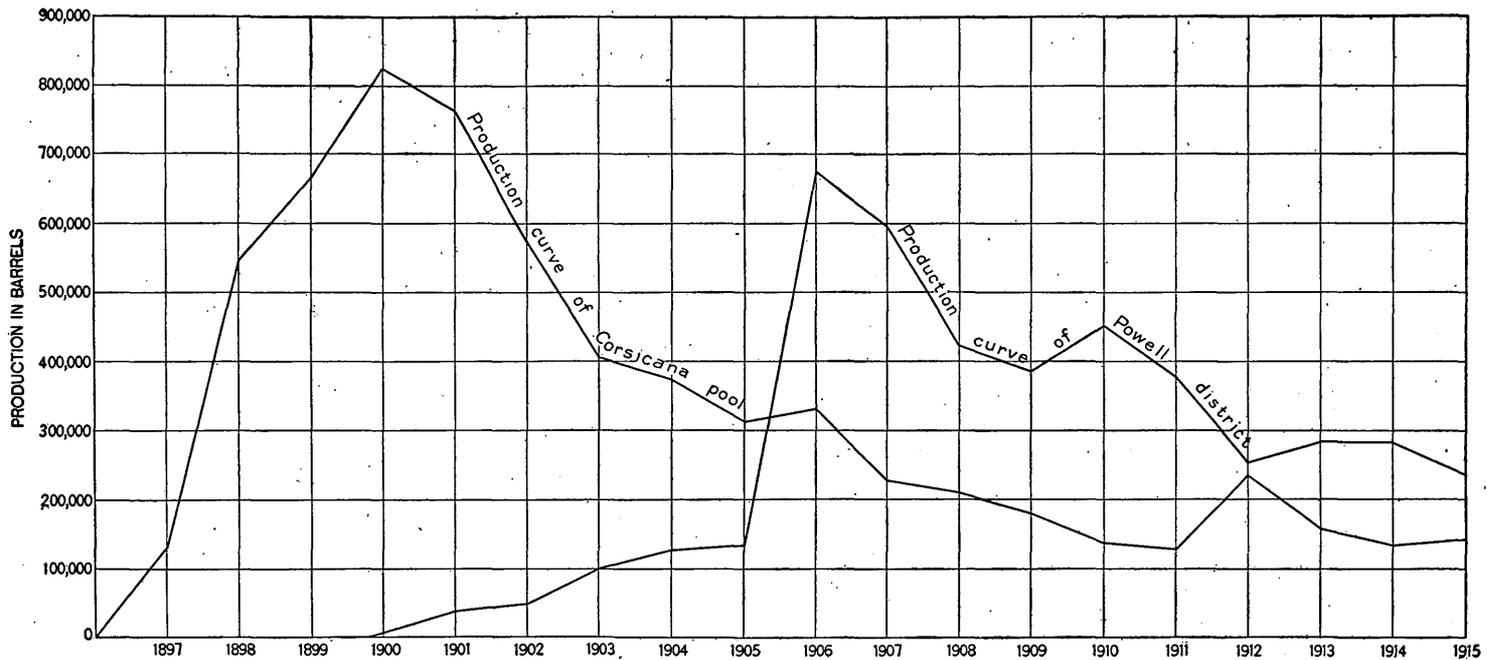


FIGURE 32.—Diagram showing production of oil in the Corsicana pool and Powell district, Tex., from discovery until 1915.

The production of the Corsicana field is shown in the following statistical table and also by figure 32:

*Oil produced in the Corsicana field, Tex., in barrels, 1896-1915.*

[From U. S. Geol. Survey Mineral Resources.]

Year.	Corsicana district.	Powell district.	Year.	Corsicana district.	Powell district.
1896.....	α 1,450	.....	1907.....	226,311	596,897
1897.....	α 65,975	.....	1908.....	211,117	421,659
1898.....	544,620	.....	1909.....	180,764	383,137
1899.....	668,483	.....	1910.....	137,331	450,188
1900.....	829,560	α 6,479	1911.....	128,526	373,055
1901.....	763,424	α 37,121	1912.....	233,282	251,240
1902.....	571,059	46,812	1913.....	158,830	282,476
1903.....	401,817	100,143	1914.....	133,811	282,279
1904.....	374,318	129,329	1915.....	143,275	237,410
1905.....	311,554	132,866			
1906.....	332,622	673,221		6,418,129	4,404,312

α Includes a small quantity produced elsewhere in Texas.

PRODUCTION PER ACRE.

The productive area of the light-oil district, as outlined on the map (Pl. XXI), including the Corsicana, Angus, and Tilton-Havener pools, is approximately 3,580 acres. The production from this area to the end of 1915 was 6,418,129 barrels, and thus the average production per acre has been 1,792 barrels. From the production curve shown in figure 32 the total reserve of the pool at the end of 1915 is estimated at 558,000 barrels, or 156 barrels per acre, making the estimated ultimate production 1,948 barrels per acre.

Another figure for the area of the Corsicana pool was obtained by dividing the productive area into 10-acre tracts and counting all the tracts on which there was one or more productive wells and eliminating those on which there were none. The area thus arrived at was 3,185 acres. On this acreage the production per acre to the end of 1915 was 2,015 barrels, the reserve at that time was 175 barrels, and the ultimate production would be 2,190 barrels. The yield of 2,015 barrels per acre is equivalent to a layer of oil covering an acre 0.26 foot deep and 2,190 barrels per acre to a layer 0.28 foot deep. It is impossible, of course, to determine the exact area from which the oil has been obtained, just as it is impossible to estimate the percentage of oil that is recoverable. However, owing to the low gas pressure and the lack of vigorous hydraulic circulation in this pool, it is believed that the productive area is probably nearer 3,185 than 3,580 acres.

In like manner the productive area of the Powell district (including all the small pools of heavy oil) is 2,700 acres, as outlined on Plate XXI, or 2,465 acres, as determined by counting 10-acre tracts containing one or more wells. The production to the end of 1915

was 4,404,312 barrels—1,631 barrels per acre for 2,700 acres, or 1,787 barrels per acre for 2,465 acres. The reserve at that time, as estimated from the production curve shown in figure 32, was 1,135,000 barrels—420 barrels per acre for 2,700 acres, or 456 barrels per acre for 2,465 acres. The total ultimate production is estimated to be 2,051 barrels per acre for 2,700 acres, or 2,243 barrels per acre for 2,465 acres.

#### VALUE.

The table below shows the average value per barrel of the oil in the Corsicana and Powell districts and a number of other fields of the United States.

*Average price of oil per barrel in different fields of the United States for 1913, 1914, and 1915.*

[From U. S. Geol. Survey Mineral Resources.]

Field or pool.	1913	1914	1915	Field or pool.	1913	1914	1915
Texas:				Oklahoma.....	\$0.937	\$0.778	\$0.579
Corsicana.....	\$0.987	\$0.923	\$0.744	California: San Joaquin			
Powell.....	.766	.600	.449	Valley.....	.444	.448	.326
Wichita County.....	1.001	.825	.628	Colorado: Florence.....	.900	.886	.859
Humble.....	.965	.548	.482	Wyoming.....	.493	.472	.522
Louisiana:				Indiana.....	1.337	1.159	.929
Jennings.....	.974	.909	.486	West Virginia.....	2.492	1.908	1.561
Caddo.....	1.003	.948	.710	Pennsylvania.....	2.487	1.906	1.586

### CONDITIONS AFFECTING EXPLOITATION.

#### METHODS AND COST OF DRILLING.

Both hydraulic rotary and cable tools have been employed in the Corsicana field. Because of the softness of the strata and the absence of thick beds of hard rock, the rotary method is the quickest and most economical; it is stated that as much as 1,000 feet has been drilled in 36 hours by this method. It has the disadvantage of obscuring the presence of traces of oil and beds of fine sand and of putting the productive sand under a heavy pressure of mud-laden water. This method has been satisfactory, however, especially in proved territory where the underground conditions are well known from the records of previous wells.

Wells in this field are drilled at a cost of 50 to 60 cents a foot, and the total cost of a well, exclusive of casing, is about \$550 to \$650 in the Corsicana district and \$350 to \$450 in the Powell district. If a paying well is not obtained, the casing is pulled out, and all that is lost is the cost of drilling. With a rotary rig it requires from two days to a week to complete a well in the Powell district and from three to ten days in the Corsicana district.

## WATER CONDITIONS.

The water conditions in the different pools, as described under the heading "Occurrence of oil and gas," are simple and offer few complications. In the Corsicana pool there is in general one productive sand, and that contains water in troublesome quantities only around the border of the pool, although a small amount of water is pumped with the oil over a large part of the pool.

In the Corsicana pool the surface casing, which is usually 6 or 6½ inches in diameter, is set at 40 to 190 feet below the surface; the deep casing, which is usually 4 or 4½ inches in diameter, is set on the top of the oil or gas sand, and the oil is pumped through a 2-inch tube which extends to the bottom of the well. The wells are drilled to different depths in the productive sand, from a few feet to 50 feet or more, but generally about 30 feet, the depth depending on local conditions.

In the Powell district water is usually troublesome only in the lower productive sand, and there only near the edges of the individual pools. In the center or near the western limit of each pool there is usually little water, except in the Burke pool, and many of the wells are drilled below the base of the lowest sand. The surface casing, usually 6½-inch, is set at 50 to 100 feet; the deep casing, usually 4-inch, is set at the top of the highest productive sand; and the interval between the lower end of the 4-inch casing and the bottom of the well is commonly cased with a 3½-inch perforated liner. The oil is pumped through a 2-inch tube.

## METHOD OF PUMPING.

All the wells in the Corsicana field are pumped by the multiple system, which consists of a centrally located power station, pumping frame, transmission lines or jerker lines running to the individual wells, and a pumping jack at each well. The power for operating each pumping station is furnished by a natural-gas engine supplied with casing-head gas from the wells that are being pumped or by a steam engine burning crude oil. The pumping frame consists of a horizontal shaft that drives a vertical shaft to which is attached one or more eccentrics. The jerker lines are attached to the outer edge of the eccentrics and are pulled a distance corresponding to the throw of the eccentric at each revolution, usually about 2 feet. The horizontal pull of the jerker line is converted into a vertical pull at the well by pumping jacks to which are attached the sucker rods.

By this method 15 to 25 wells, suitably located, may be economically pumped from one station. Usually one man operates two stations, most of which are run only a few hours each day. The oil is pumped into small tanks, which are connected by pipe lines with loading racks or large storage tanks.

## CLEANING THE WELLS.

The oil in the Powell district is thick and ropy and contains a considerable amount of an oil, water, and clay emulsion, which gradually chokes up the wells and makes it necessary to clean them. Furthermore, a considerable amount of fine sand, carried up with the oil, cuts the leather cups used in pumping. Generally the cups require changing about once a month, although in some parts of the field they last much longer. Where the derricks have been taken down after drilling, as is the usual practice, the sucker rod is pulled out and the wells cleaned with the aid of a metal or wooden gin pole.

## FUTURE DEVELOPMENT.

Extensive drilling has been done in and around the Corsicana field during the last 20 years, and as records of the location and depth of many of these wells are not available, it is difficult to recommend new territory for testing.

It is believed that no adequate tests have been made of the Corsicana sand in the Powell district, where the structure is most favorable for the accumulation of oil and gas, as in the Burke pool. The presence of a show of oil and gas in what is believed to be the Corsicana sand in the G. W. Speed well, where the structure is considered unfavorable, makes it seem somewhat likely that this sand may contain oil or gas. It is considered worthy of a test in the south-central part of the J. O. Burke 224-acre tract south of Powell. So far as available records show, the Corsicana sand has not been reached in either the Edens or the Chatfield gas pool, and it is possible that a sand equivalent to it, or a deeper one, may underlie these pools and may be found to be productive. Deeper drilling in the parts of both these pools where the structure is most favorable is justified.

The presence of water that is only slightly saline in the Woodbine sand at Corsicana suggests but does not prove the absence of oil or gas in that formation in this field. As the Woodbine is an important oil and gas bearing formation in northwestern Louisiana, it is considered worthy of a test in the area of favorable structure in the Burke pool, in spite of the poor showing made in the refinery well and deep-water wells in Corsicana.

In general, wildcat testing is most likely to be attended with success along the trend of the formations to the north and south, as shown on the sketch map (Pl. XVIII). The Mexia-Groesbeck, Thrall, and San Antonio fields follow the general trend of the formations to the south of the Corsicana field. The absence of good exposures of the formations along this belt makes it difficult if not impossible to locate favorable areas for drilling over much of this region.