EAST TEXAS OIL FIELD

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ABSTRACT

The East Texas field, as the name implies, is located in the extreme eastern part of Texas. The discovery of this field was made on October 3, 1930, by C. M. Joiner et al. The field has produced 234 million barrels of oil to January 1, 1933. At the present time (January 1, 1933) the field is restricted to a flow of 28 barrels per day per well. There were approximately 9,600 producing wells on January 1, 1933. Estimates of the total production vary from 1 billion to 2 billion barrels. The actual potential production of this field is estimated to vary from 2 million to 4 million barrels per day. A total ranging from 10,000 to 12,000 wells will probably be drilled, representing a total drilling investment of $250,000,000 to $300,000,000. The field comprises approximately 110,000 acres, and covers portions of Rusk, Cherokee, Smith, Gregg, and Upshur counties. The production is derived from sand members of the Eagle Ford-Woodbine group, of Cretaceous age. The structure of the reservoir is a broad, westward dipping, truncated homocline.

INTRODUCTION

The East Texas oil field comprises approximately 110,000 acres, covers portions of four counties, and has produced under restricted flow over 234 million barrels of oil to January 1, 1933.

An attempt to forecast the future productive possibilities of a field of this magnitude at such an early date in its development is difficult and hazardous.

The manner in which this major field of multi-ownership is being developed and extended is a decided deviation from past methods of field development.

1 Read before the Association at the Oklahoma City meeting, March 24, 1932. Manuscript received, April 21, 1933. Published with permission of the Gulf Production Company.

2 Geological department, Gulf Production Company.
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ACKNOWLEDGMENTS

The writers express their appreciation to W. B. Milton for assistance in preparation of manuscript, to J. S. Woods and B. E. Carson for drafting, and to Herbert Oliver for stenographic work.

LOCATION

The location of the oil fields and the salt domes of the East Texas basin is shown in the sketch map (Fig. 1).

The East Texas field has a length of 39 miles and an average width of 4½ miles. Its area of 172 square miles is situated in the several counties, by acres, approximately as follows: 44,096 in Rusk, 220 in Cherokee, 3,123 in Smith, 54,500 in Gregg, and 8,448 acres in Upshur County.

On account of the sequence of discoveries and the magnitude of the field, three separate districts are recognized and are known as the Henderson, Kilgore, and Longview or Gladewater districts.

The Henderson district comprises that part of the field in Rusk, Cherokee, and Smith counties north to a line extending east from Overton.

The Kilgore district is joined on the south by the Henderson district and includes that area in Rusk and Gregg counties with its northern boundary being determined by Sabine River.

The Longview district includes the remainder of the field in Gregg and Upshur counties north of Sabine River.

The nearest producing fields are: the Boggy Creek field, 27 miles southwest, in Anderson and Cherokee counties, Texas; the Van field, 40 miles west in Van Zandt County, Texas; and the Caddo field, 50 miles east in Caddo Parish, Louisiana.

HISTORY

The exploration of C. M. Joiner, discoverer of the East Texas field, began in August, 1927, when his first location was made for Bradford No. 1 in the Juan Ximines Survey in Rusk County. In the drilling of the first test, numerous difficulties were experienced, many of which were attributed to inferior equipment. After 6 months' effort this hole was junked and the test abandoned at a depth of 1,098 feet.

At this time, financial difficulties (so common to the majority of wildcatters) confronted Joiner and it was not until April, 1928, that he was successful in locating and spudding his second well, Bradford No. 2. This location was made 100 feet northwest of Bradford No. 1.

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and 11 months of intermittent drilling were required to reach a depth of 2,518 feet, at which depth, this well, like its predecessor, was junked and abandoned. However, before the abandonment of the hole an attempt was made without success to test a showing of oil at the shallower depth of 1,437–1,460 feet.

With unlimited faith in his prospect, and determined that he would make a fair test of the area, Joiner sacrificed much of his original 10,000-acre block in order to finance the third well. Partially successful in raising funds, he located Bradford No. 3 only 300 feet south of his original well and in January, 1930, the well had reached a depth of 1,530 feet and was shut down. Operations were resumed on this test in the spring of 1930. The funds of Joiner et al. had shrunk to such an extent that it became necessary to fire the boilers with wood taken from the lease, and in many cases stock was given in return for labor and supplies. A showing of oil was encountered at 3,592 feet and in order to secure casing from one of the supply companies, a drill-stem test was required. The test was made and the well showed considerable amounts of oil and gas. Casing was secured on the strength of the favorable test. The reward for perseverance and determination came to Joiner on October 3, 1930, when Joiner et al. Daisy Bradford No. 3 was completed as a 300-barrel well at a depth of 3,592 feet.

After the completion of the Joiner well, other discoveries followed in rapid succession. Many of the subsequent wells were so far removed from the original discovery that the majority of the oil fraternity were bewildered as to whether a single pool or three separate pools had been found. It began to appear as though an oil well had become the rule and a dry hole the exception in this new oil territory, which seemed to have no limits.

The first extension to the Joiner area was that of the Deep Rock Oil Company on the Ashby 75-acre tract, located 1 mile west. This well was completed December 4, 1930, with an initial flow of 3,000 barrels. Ten miles northwest the Bateman Crim No. 1, in the E. G. Sevier Survey in Rusk County, was being drilled and on December 28, 1930, this well was brought in, flowing 10,000 barrels per day from a depth of 3,652 feet. The next extension to the field was the Farrell and Moncrief Lathrop No. 1, 15 miles north and slightly east of the Bateman Crim No. 1. This well came in, January 26, 1931, making 500 barrels per hour from a total depth of 3,587 feet.

At this stage of development in the East Texas field there were four wells completed: one, 1 mile west; another, 10 miles north; and still another, 25 miles north of the original discovery well. Surface structure had failed to aid in the solution of the problem; conse-
quently, the intelligent buying of acreage at this time had to be based on what meager surface and subsurface information the individual or company had at hand. It was not until the gaps were finally closed that the magnitude of this gigantic pool was fully realized. The areal magnitude of the field is made more impressive by the graphic comparison with other large fields as shown in Figure 2.

**Stratigraphy**

**Regional Geology**

The East Texas oil field lies within the broad belt of Cretaceous and Tertiary rocks which border the Gulf of Mexico and unconformably overlap the pre-Cretaceous rocks of the interior. No wells in the immediate vicinity of the field have penetrated to the unconformity between the Cretaceous and pre-Cretaceous, although the contact is exposed at the surface less than 100 miles north. The areal geology of the immediate area is well shown on the recent United States Geological Survey map of Texas.\(^4\) The contact relationship of the Cretaceous and pre-Cretaceous is well shown on the United States Geological Survey map of Oklahoma\(^6\) and Arkansas\(^6\). Moody's\(^7\) map of 1931 shows the areal geology of Louisiana and Mississippi and adjacent states.

**Major Regional Tectonics**

The subject of structural movement is too broad to be discussed in detail in this paper. Only the fundamentals involved in the formation of the East Texas structure are considered.

The major regional tectonic features of the East Texas and adjacent west Louisiana area consist of a southward and eastward dipping homocline of Cretaceous and Tertiary rocks extending as an arc through the counties including Bowie, Delta, Hunt, Kaufman, and southward beyond Limestone. This southward and eastward dipping homocline is broken with strike faults, such as those of the Powell-Mexia district. Within the homocline are such major features as the Van structure and the Athens flexure. This homocline descends south and east into the East Texas geosyncline which extends in general north and south through Smith, Anderson, and Cherokee

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counties. At its northward end, the geosyncline passes east around the north side of the Sabine uplift. From Smith County, Texas, the formations rise east, culminating in the Sabine uplift of eastern Texas and western Louisiana. The general character of the homoclines on either side of the East Texas geosyncline is shown on Plummer's Woodbine map. Moody has discussed the general character and history of the Sabine uplift.

The East Texas field lies on the westward dipping homocline between the Sabine uplift and the East Texas geosyncline. In general, the closure of the East Texas field against the Sabine uplift is due to the unconformable overlap of the Austin chalk across the Eagle Ford-Woodbine section onto the Washita. In detail, as discussed later, the closure is somewhat more complicated than this.

Section $AB$ indicated in Figure 1 represents a cross section (Fig. 3) of the East Texas basin, constructed from well logs, and extends from Ferry Lake, Louisiana, on the east, to the Powell field in Limestone County, Texas, on the west.

**FORMATIONS WITHIN EAST TEXAS FIELD**

**CLAIBORNE GROUP**

Figure 4 shows graphically the formations encountered in wells drilled within the East Texas field. Due to the fact that the lithological units within these formations are lenticular, the section of Figure 4 is idealized. Depending on the location of wells within the field and the variation in elevation, the thickness of Claiborne drilled is variable. With the exception of the Eagle Ford-Woodbine section, the remainder of the formations within the field are more or less constant in thickness.

Only the lower members of the Claiborne group are present within the area of the East Texas field. With the possible exception of a few outcrops of the Weches in the northern and northwestern section of the field, only the two lower members of the Claiborne are present: the Queen City above and the Reklaw below.

The Queen City is predominantly a sand member. Wendlandt and Knebel stated,

The Queen City consists of local clay zones, zones of sandy clay, beds of almost pure, cross-bedded, light-colored quartz sand, thin beds of lignite, and possibly two local beds of bentonitic clay.

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9 C. L. Moody, *op. cit.*

About two-thirds of the way down in the Queen City section are the green sand Omen beds.

The Reklaw, basal member of the Claiborne, consists chiefly of green sands and glauconitic clays.

Wendlandt and Knebel\textsuperscript{11} gave the thickness of the Queen City within the East Texas basin as varying from 0 to 480 feet, and the thickness of the Reklaw as varying from 30 to 130 feet.

Both the Omen beds and the Reklaw were used for control in making near-surface structural contour maps within the general area of the East Texas field.

**WILCOX GROUP**

In the idealized columnar section as found in the East Texas field (Fig. 4) approximately 1,300 feet of beds have been assigned to the Wilcox group. The Wilcox group consists of massive beds of sand which are in many places highly cross-bedded, sandy shales or clays, beds of shales or clays, lignitic clays, lignites, and beds of white kaolinitic clay. For the most part the beds of the Wilcox group are non-marine.

In this article the sand zone commonly found at the base of the Claiborne or the top of the Wilcox, usually referred to as the Carrizo, has been included in the Wilcox group. It is placed by many at the base of the Claiborne. Since sufficient evidence has not been presented definitely to place it in one or the other, it is allowed to remain in the Wilcox in this article.

**MIDWAY GROUP**

The Midway group within this area is usually considered the basal group of beds of the Tertiary. The beds consist of shales, sandy shales, sandy and shaly limestones, and beds of glauconitic sands and shales. For the most part it is sufficiently marine to allow definite recognition on the basis of fossils. In the idealized section, 500-550 feet of beds have been assigned to the Midway group.

**NAVARRO FORMATION**

In general, the Navarro formation consists of dark shales and sandy shales. At the base, in many places, is found a sand and sandy shale zone which can be considered approximately the equivalent of the Nacatoch sand zone of Arkansas. In the idealized section, approximately 350 feet of beds have been assigned to the Navarro formation.

\textsuperscript{11} E. A. Wendlandt and G. Moses Knebel, \textit{op. cit.}, p. 1371.
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UPPER CHALK GROUP

Controversy exists as to what constitutes the base of the Navarro formation and the top of the Taylor formation. In this article the top of the Taylor is placed at the top of the upper chalk. This contact is approximately the equivalent of the top of the Saratoga of the Arkansas section. The base of the upper chalk is approximately the equivalent of the base of the Annona of the Arkansas section. It has not been found convenient to separate the upper chalk into the Saratoga-Marlbrook-Annona members, although there is variation in the shale-chalk character within the unit. In general, the upper chalk consists of shale, chalk and chalky shale in the upper part, whereas the lower portion consists chiefly of chalk with lesser amounts of shale and shaly chalk. In the idealized section, 800 feet has been assigned to the upper chalk member (top Taylor to base of Annona).

OZAN-BROWNSTOWN

The beds found between the base of the Annona and the top of the Austin chalk are termed Ozan-Brownstown in this article. The Ozan-Brownstown within the East Texas field consists of shales, thin lenses of sand, and sandy shales, together with a few chalky or limy shales. In the idealized section, approximately 425 feet of beds have been assigned to the Ozan-Brownstown.

AUSTIN CHALK

The Austin chalk, as shown in the idealized section, consists of hard chalk with minor amounts of chalky shale and shale. The lower few feet are conglomeratic, with the pebbles and boulders composed of various types of material of pre-chalk age. As indicated in the idealized section, the Austin chalk has been taken as a lithologic unit rather than a faunal unit. The correlative of the top of the Austin chalk of the type locality probably lies considerably above the top as given in the idealized section, making the idealized section Austin chalk approximately the equivalent of the Ector tongue as found in the northwestern part of the basin. In the idealized section, approximately 125-150 feet of material has been assigned to the Austin chalk.

EAGLE FORD-WOODBINE GROUP

GENERAL STATEMENT

The Eagle Ford-Woodbine group is the producing horizon of the East Texas field. Lithologically the group is composed of black fissile shales, gray and greenish shales, mottled or red-bed shales, sandy
Plates I

Fig. 1.—Core showing differential saturation. Gulf Production Company's Brightwell No. 5, Kilgore district, Rusk County. Depth, 3,629-35 feet. A—Sand with only trace of saturation. B—Dark silty shale. C—Excellenty saturated sand. Magnification, 0.78 X.

Fig. 2.—Core of conglomeratic sand with clay matrix. In this type, sand is bound with clay rather than silt as in Figure 2, Plate 2. Gulf Production Company’s Spear No. 7, Kilgore district, Gregg County. Depth, 3,537-46 feet. A—Large sand pebble. B—Dense clay matrix. C—Rock pebbles. Slight oil stains in more porous sand areas. Porosity, 6.20 per cent. Magnification, 1.2 X.

Fig. 3.—Core of excellently saturated sand. Gulf Production Company’s Brightwell No. 5, Kilgore district, Rusk County. Depth, 3,629-35 feet. Core leached of oil before photograph was taken. This saturated sand was a thin zone in non-saturated silty sand and silty clay zone. Magnification, 1.2 X.

Fig. 4.—Irregularly laminated silty sand. Gulf Production Company’s Fonville No. 2, Longview district, Gregg County. Depth, 3,504-13 feet. A—More sandy part. B—More silty part. No saturation. Porosity, 17.5 per cent. Magnification, 1.2 X. (See No. 7, Fig. 5.)
shales, shaly and silty sands, homogeneous and saccharoidal and cross-bedded sands, as well as silty and sandy conglomerates. Due to the predominantly non-marine character of the beds, a multiplicity of disconformities, cross-bedding, and channeling existed at the time of deposition. In consequence, the beds are variable both horizontally and vertically. In general, the group is heterogeneous and clastic. Little calcareous material other than secondary cement is found within these beds.

LITHOLOGICAL CHARACTERISTICS

Shales.—Shales of several types are present. Black fissile shales have been cored in several of the wells, particularly in the northwestern section of the field. Few fossils have been found within them. Megascopically they suggest the fissile Eagle Ford shales of the west side of the basin, but microscopically they differ in several respects. It is possible that some of these black fissile shales may grade westward into the typical Eagle Ford of the west side of the basin. Stratigraphically they occur in the upper part of the Eagle Ford-Woodbine group along the western and northwestern side of the field. The dark shales along the eastern part of the field and at the base of the sand section lie stratigraphically below the shales previously mentioned and many of them contain Washita fossils. They are not to be confused with the black fissile shales which occur higher in the section.

Gray and greenish shales are present in many of the wells. The gray shales are largely of clastic origin, being at the fine end of the sand-shale series of sediments. Many of the greenish shales, on the other hand, have the appearance of waxy bentonites. Neither of these shales was detailed petrographically.

Red-bed shales are common. Most of them are mottled with shales of gray, green, violet, red, and brown. Many cores have been noted, however, in which one of these colors predominated or existed throughout.

Silt.—Well sorted silts (0.05 to 0.005 millimeter) are not common within the East Texas field. Finer or coarser material is almost invariably present.

Sands and conglomerates.—Sandstones and conglomerates are the reservoir rocks of this field. Considerable variation exists between the different sand lenses within this group of beds.

The photograph (Plate 1, Fig. 4) and the corresponding sand analysis (Fig. 5, No. 7) illustrate one type of silty sand found in the field. The material is irregularly banded with dark, shaly silt, as at B in the photograph. The lighter areas of the core are silty rather than shaly sand. The silt is light-colored, finely granular, lime-free material.
Unfortunately, time has not been available for a detailed petrographical study of the silty material of these cores. Such silty sands are usually referred to as ashy or trashy sands. In part, the material may be altered ash, although in certain instances it is of secondary origin, possibly transported and precipitated from circulating waters which have been in contact with altering ash beds. When the silt is removed from these silty sands by sieving, the more sandy material consists of

![Figure 5](image_url)

**FIG. 5.**—First column shows percentage of material by weight which passed through 200-mesh sieve. Second column shows percentage of material by weight retained on 200-mesh sieve. Third column shows percentage of material by volume caught on 200-mesh sieve but which had passed through 140-mesh sieve, et cetera.

No. 1. Core from Gulf Production Company's Murphy No. 2, Henderson district, Rusk County. Depth, 3,774-78A. Excellent saturation. Porosity, 27.2 per cent. Largest porosity found in sands examined from East Texas field.

No. 2. Core from same well as No. 1. Depth, 3,774-78C. Fair saturation. Porosity, 17.55 per cent.

No. 3. Core from same well as No. 1. Depth, 3,774-78D. Poor saturation. Porosity, 11.0 per cent.

No. 4. Core from same well as No. 1. Depth, 3,778-80. Good saturation. Porosity, 19.66 per cent.

No. 5. Core from same well as No. 1. Depth, 3,785-80. Fair saturation.

No. 6. Core from same well as No. 1. Depth, 3,785-80A. Slight saturation. Porosity, 11.0 per cent.

No. 7. Core from Gulf Production Company's Fonville. No. 2, Longview district, Gregg County. Depth, 3,405-13. No saturation. Porosity, 17.5 per cent. (See Plate 1, Fig. 4.)

No. 8. Core from same well as No. 7. Depth, 3,555-50. Excellent saturation.

No. 9. Core from Gulf Production Company's Brightwell No. 5, Kilgore district, Rusk County. Depth, 3,635-41. Excellent saturation. (See Plate 2, Fig. 4.)
subangular grains of various sizes as shown in the analyses of Figure 5. The individual grains are predominantly of quartz. Feldspars are not uncommon. Pink orthoclase is generally more abundant in the lenses in which material as large as small gravel is present. In the samples examined there has been only a small proportion of heavy minerals.

It has been interesting to note the variation in oil saturation in respect to silt percentage. The core shown in Plate 1, Figure 4, and sand analysis (Fig. 5, No. 7), had a porosity of 17.5 per cent, yet showed no oil in any of the common solvents. This might be due to presence of water or saturation with gas. The former appears to be the fact, since a sufficient amount of water circulated through this sand after deposition to allow precipitation of siliceous cement, and it is commonly stated that all gas within this field was in solution at the time the field was discovered. Although this silty sand had a porosity higher than other saturated sands, the water was not displaced by oil. When this core was dried and placed in East Texas crude, it very quickly became saturated with oil. Differential saturation in silty sand cores has been observed in many other East Texas cores. The photographs of Plate 1, Figure 1, and Plate 2, Figure 1, show marked difference in the degree of saturation in cores with variation in silt percentage.

The best reservoir sands of the field are shown in the photographs (Plate 1, Fig. 1 at C, Plate 1, Fig. 3, and Plate 2, Fig. 4). They are more or less homogeneous in megascopic aspect and saccharoidal in texture. The percentage of material finer than 200 mesh is shown in the sand analyses of Figure 5. When freed of oil they are light in color and are composed predominantly of quartz. Heavy minerals are not abundant. The presence or absence of ashy material apparently depends on the position of the sand lens within the columnar section. The majority of grains vary in size between 0.1 and 0.25 millimeter.

Some of the sands from wells adjacent to the field are green, suggesting glauconite. On close examination, however, the green material is found to be only a thin coating over the grains and not of sufficient amount to appreciably change the porosity. It is very probable that some sands of this character are present in the northern part of the field, although none has been observed by the writers.

The conglomerates of the field can be readily separated into two groups. First, the conglomerate at the base of the Austin chalk (Plate 2, Fig. 3) which consists of pre-Austin chalk sand and pebbles of various types and ages imbedded in a chalk matrix containing Austin chalk fossils. The pebbles of the chalk conglomerate are much the same as those of the second type of conglomerate. The second type of
conglomerate is the sand conglomerate found within the Eagle Ford-Woodbine group. The photograph (Plate 2, Fig. 2) shows one of these conglomerates. The area, A, shows soft, white, chalk-like, lime-free pebbles which in thin sections are similar to the phonolite and ash pellets figured by Ross, Miser and Stephenson. Thin sections were not made of the rock pebbles shown at B. Some fine ashy material was found as a part of the matrix in this core. Plate 1, Figure 2, shows another type of these conglomerates. In this core the matrix is a dense clay. Ashy and rock pebbles are present as well as a large sand pebble. Pink orthoclase was common in this core. Other variations are present in these intra-group conglomerates, but these will suffice to indicate their general character.

**CEMENTATION**

Secondary cementation is a dominant characteristic of the silts, sands, and conglomerates of this group of beds. No sample has been examined by the writers from the East Texas field in which secondary siliceous cement was not present. Even those cores which were found as loose sand in the core barrel contain secondary cement. Many of the grains have new faces developed. One reason the more permeable sands form an ideal reservoir is that the individual grains are held rigid by the small amount of this siliceous cement. The loose sand cores are not due to the sand in place being loose, but rather to the method of coring.

Secondary calcareous cementation is common within the silts, sands, and conglomerates of this group of beds. Many cores have been examined in which no porosity could be found. The cement was preponderantly calcium carbonate. It was interesting to note that the precipitation of this calcareous cement occurred after siliceous cement, since the sand grains were firmly held together by siliceous cement after calcareous cement was removed with hydrochloric acid. Many wells have been finished without even setting perforated pipe. As far as the writers are aware the cementation has been sufficient to prevent these wells from making sand.

**THICKNESS**

The thickness of the Eagle Ford-Woodbine group ranges from almost zero on the east side of the field to possibly 1,000 feet in the center of the East Texas basin.

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12 Clarence S. Ross, Hugh D. Miser, and Lloyd W. Stephenson, "Water-Laid Volcanic Rocks of Early Upper Cretaceous Age in Southwestern Arkansas, Southeastern Oklahoma, and Northeastern Texas," *U. S. Geol. Survey Prof. Paper 154* (1928), Pl. 21, Fig. B; Pl. 22, Fig. A.
PLATE 2

FIG. 1.—Core showing slight dislocation and with differential saturation. Gulf Production Company's Brightwell No. 5, Kilgore district, Rusk County. Depth, 3,623-29 feet. \( A \) —Silty sand with no saturation. \( B \) —Porous sand with saturation. Magnification, 1.2 X.

FIG. 2.—Conglomeratic sand. Gulf Production Company's Alexander No. 1, Kilgore district, Gregg County. Depth, 3,522 feet. \( A \) —Soft white pebbles. \( B \) —Rock pebbles. \( C \) —Porous sand. Differential saturation. Porosity, 17.65 per cent. Magnification, 1 X.

FIG. 3.—Chalk conglomerate. Gulf Production Company's Spear No. 7, Kilgore district, Gregg County. Depth, 3,537-46 feet. \( A \) —Rock pebbles. \( B \) —Sandy chalk. No saturation. Porosity, 5.45 per cent. Magnification 1.2 X.

FIG. 4.—Excellently saturated sand. Gulf Production Company's Fouville No. 2, Longview district, Gregg County. Depth, 3,555-56 feet. (See No. 8, Fig. 5.)
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STRUCTURE, AGE, AND CORRELATION

The age and correlative equivalents of the Eagle Ford-Woodbine group of the East Texas field have been moot questions since the discovery of the field. Even to-day unanimity does not exist. The reason for the disagreement is the paucity of fossils within the group. The thesis of this paper is not the settlement of this controversial subject. It will be discussed only in so far as it pertains to the structure of the immediate field.

As indicated in Figure 3, the field lies on the west slope of the Sabine uplift. (In this paper the western slope of the Sabine uplift is considered as terminating on its western side at the axis of the East Texas geosyncline.) The up-dip closure of the field is due to the unconformable overlap of the Austin chalk across the bevelled edge of the Eagle Ford-Woodbine group and onto the underlying Washita group. Many hypotheses have been advanced to explain the wedge-like structure of the East Texas field but, to the writers, the most feasible hypothesis is that periodic structural movements, followed by truncation and overlap, were responsible for the enormous accumulation of oil in this mammoth pool. True, the unconformities may be of limited areal extent, but they are unconformities of sufficient local magnitude to cause the structural conditions existing in this field.

The Eagle Ford-Woodbine group of beds was described in considerable detail by Hill. In his discussion he continued the use of the term, Dexter sands, for the lower sand zone, and introduced the term, Lewisville beds, for the upper brackish-water phases. He placed the Eagle Ford above the Lewisville beds. The clay zone lying at the base of the Dexter sand is discussed but not named. He considered the break between the Lower and Upper Cretaceous to be at the base of the clay member below the Dexter sand.

The threefold division (basal clay, a lower and an upper sand member) has continued in use. Scott was the first to consider the lower clay and the lower sand as the depositional product of a regression. This conception was discussed again by both Scott and Plummer.

STRUCTURAL CONTOUR MAP OF
EAST TEXAS OIL FIELD
CONTOURS DRAWN ON BASAL EAST N CHALK CONGLOMERATE,
CONTOUR INTERVAL 25 FEET.

Fig. 6
at a geological symposium held at Dallas, Texas, March 7, 1931. From information at hand the Woodbine-Eagle Ford group can be divided into four zones: (1) a basal clay zone; (2) a lower ash-free zone, predominantly of sand; (3) an upper sand and shale zone which contains ash and other detrital volcanic material as well as brackish-water fossils; and (4) at the top the typical fissile bituminous Eagle Ford shales of the western portion of the basin. Several individuals have field work in progress which will probably go far in clarifying information concerning the vertical and horizontal sequence and variation in these beds.

Within the East Texas field the clay zone at the base of the sand section contains Lower Cretaceous fossils. That this clay zone is the correlative of the clay zone discussed by Hill, Scott, and Plummer may be disputed.

Sands are found within the field which appear to be ash-free and probably belong to the Dexter sand member.

Many of the sands and clays of the field contain detrital volcanic material and are considered to be the equivalent of the Lewisville beds of Hill. Some of these cores contain brackish-water fossils.

It is very questionable whether any of the beds of the Eagle Ford-Woodbine group of the East Texas field proper are as high in the columnar section as the typical Eagle Ford shale of the west side of the basin.

An unconformity has been postulated at the base of the clay section below the main sand zone and above the Washita limestone section. Sufficient evidence is not at hand to determine positively that no such unconformity exists, but the presence of Lower Cretaceous fossils suggests that it is not present. It is believed that no prominent unconformity, if any, exists between this clay zone and the sands deposited immediately above, suggesting that Scott's contention of a regressive period of deposition is correct for the sands of the lower part of the Eagle Ford-Woodbine group of beds.

Due to change in character of sands and overlapping of facies, there appears to be an unconformity within the sand group in the East Texas field. The upper beds, or those containing volcanic material, have a wider areal extent and apparently overlap the sand beds below. In the northern and northeastern part of the field, apparently only the upper sands are present. Farther south, both appear to be present. However, an insufficient number of cores throughout the field has been examined to justify the use of this break for contouring purposes. The unconformity at the base of the Austin chalk is the more important of the two major unconformities as far as the East Texas
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The field is concerned since it overlaps both the upper and lower zones and causes the closing of the reservoir on the east.

Prior to the deposition of the Austin chalk, there was intermittent or continuous differential movement, which resulted in the tilting of the pre-Austin chalk beds to the west along the western flank of the Sabine uplift. Associated with these movements were periods of erosion which truncated the inclined pre-Austin chalk beds. At the end of these periods of movement, erosion and deposition, a veneer of conglomerate was left on the eroded surface. This conglomerate is of Austin chalk age, as is indicated by the coarse material imbedded in the base of the Austin chalk. The tilting of the pre-Austin chalk beds, combined with the intermittent erosion and deposition, followed by the Austin chalk deposition, formed the eastern closure of the field.

The map (Fig. 6) showing the subsurface structure of the field is contoured on the basal Austin chalk conglomerate. The contours more nearly represent an erosional surface than the surface of a single horizon within the producing zone; yet the structural closure is evident. If it were possible to contour a single member within the producing zone, undoubtedly the structure of the field would be more pronounced, for in contouring on the base of the conglomerate, the contours are continued over successively higher beds.

Periodic movement of the Sabine uplift continued into the Tertiary. However, the closing of the East Texas field structure on the north and south was completed early in the Upper Cretaceous. Late Cretaceous and Tertiary movements as well as deposition and erosion increased the magnitude of the Sabine uplift, but only obscured and buried the East Texas field. In consequence, the surface does not reflect the position of the field, but rather the irregularities resulting from late Cretaceous and Tertiary differential movements in the general uplift.

**Sand Conditions**

To date, the average thickness of the producing sand has not been determined with any degree of accuracy, and it will probably continue to be a debatable question for some time. The lack of better knowledge in regard to sand thickness has been largely due to the orderly manner in which this field has been developed. Under prorated production, each well is restricted to such a small part of its potential flow that a complete change in drilling practice has been brought about; that is, in former years the common practice was to complete wells at their maximum flow, whereas in this field it is the desire of the operator to finish his well in a manner that will insure the allow-
FIG. 8
CROSS SECTIONS
CROSS SECTION
EAST TEXAS OIL FIELD
GRAVITY AREA
MIDLAND AREA
LUCEDAY AREA

FIG. 8
able production, and one which will produce pipe-line oil during the
greatest length of time. Due to this change, the majority of the wells
have been carried only a few feet into the sand. The ease and cer­
tainty with which wells may be completed has made the extensive
use of the core barrel unnecessary. The average depth drilled below
the top of the sand in 2,500 wells is only 20 feet; therefore it is obvious

that with so little penetration in 26 per cent of the wells drilled, only
a very meager conception can be had of the actual average thickness
of the producing sand.

Cores from approximately 50 wells distributed throughout the
field have been examined. The most complete cores observed were
from wells of the Stanolind Oil and Gas Company and the Shell
Petroleum Corporation, from many of which 60–80 per cent recovery
was made. The examination of these cores indicates very definitely
that the pay zone of the field is not a single sand, but a series of rather
thinly interstratified sands, shales, and ashes, which are in all proba­
bility lenticular in nature. However, the readjustment of pressure
which took place in wells after the enactment of proration indicates
that interconnection of sands has not been destroyed by lensing, or
else intercommunication of sands has been established by wells.

The maximum amount of saturated sand seen in any of the cores
CHEROKEE

RUSSK

FIG. 10

BOTTOM HOLE PRESSURE
EAST TEXAS OIL FIELD
AS OF DECEMBER 1931

Scale = Miles

<table>
<thead>
<tr>
<th>Pounds Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300 or less</td>
</tr>
<tr>
<td>1300 to 1350</td>
</tr>
<tr>
<td>1350 to 1400</td>
</tr>
<tr>
<td>1400 to 1450</td>
</tr>
<tr>
<td>1450 to 1500</td>
</tr>
<tr>
<td>1500+</td>
</tr>
</tbody>
</table>

FIG. 10
examined was 40 feet in the Shell Petroleum Corporation's Watson No. 9. The average thickness of all sand logged in cores observed was 22.5 feet, the total amount of sands ranging from 4 feet to 40 feet. One core of excellent recovery showed five separate sands which varied in thickness from 6 inches to 10 feet, all of which were separated by impervious shale and ash beds.

Figure 7 illustrates the character and thickness of beds drilled below the casing seat, or what may be considered the pay zone. Numerous logs could be presented, but the ones taken represent average wells in the various districts.

It is noticeable that the pay zone predominates in sands, sandy shales and ashy material. The natural assumption would be that these beds were all oil-bearing and they no doubt would still be considered as such were it not for the more recent coring of wells. Many sandy shales and ashy sands have been examined from the pay zone which have porosities as high as 18 per cent, yet they show no oil saturation whatever. In the early development, estimates of sand thickness ran as high as 100 feet of saturated oil sand. No doubt these estimates were made in all sincerity, as in many wells 100 feet or more of sandy material had been drilled. It was not until this section had been carefully cored and recovered in numerous wells that the original estimates were proved erroneous.

Cross sections through the Longview, Kilgore, and Henderson areas taken from well records are shown in Figure 8. In the construction of these sections, the top of the sand is shown as recorded in the logs of the wells. It is assumed that the base of the producing sands in the most easterly wells will approximately parallel and conform to the underlying Washita limestone. In support of this assumption it was found that in practically all wells which were drilled deep enough into the section, 75-90 feet of practically barren shales and sandy shales overlie the Washita limestone (Fig. 8). The following wells were used in establishing the Washita control points on the west: the Burnham et al. Beck No. 1, west of the Longview area; the Meeker et al. Bacon No. 1, west of Kilgore; and an interpolation between the Meeker Bacon No. 1 and the Humphreys Stafford No. 1, southwest of the Henderson district.

By the use of these sections a fair estimate may be made of the average thickness of the producing zone in various parts of the field.

It will be noted that along the western edge of the field, due to the low rate of dip of the sand, the water table creates a wedge very similar to the one caused by the erosion of the sand along the eastern limits of the field. Thus, the bevelling of the sand on the east and the
water-created wedge on the west leave only a narrow strip of the field where the maximum amount of sand is available to the drill. This strip conforms approximately to the $-3,220$-foot contour.

The examination of cores from approximately 50 wells indicates that the average thickness of saturated oil sand is only 35 per cent of the total section drilled. Therefore, applying this figure to the average thickness of the producing zone in the cross sections, we would have an average thickness of oil sand in the Longview area of 24 feet; in the Kilgore area, 15.4 feet; and in the Henderson area, 16.4 feet; or an average for the entire field of 18.3 feet.

**Porosity and Permeability**

Tests made on 25 cores taken from 10 representative wells gave an average porosity of 19 per cent. These porosities are not exceptional and fall within the average range of many other fields. The permeabilities of the sands tested are high, giving an average permeability of 1.0 for distilled water (cc./sec./cm.$^2$/atmos./cm.).

Unfortunately, we do not have sufficient permeability data on sands of other fields to make comparisons. However, sands from very good producing fields have permeabilities of 0.1 or less, which would suggest exceptionally high permeabilities for sands of this field if this comparison were made. The very high initial production of wells finished only a few feet in the sand, and the rapid readjustment of pressures which has taken place, can be attributed largely to the high permeability of the sands of this field.

These very permeable sands have demonstrated the ease and rapidity with which the flow of liquids and pressure adjustments may be made through them. With this in mind, it will not be surprising to see a very rapid encroachment of water as the pressure within the field falls below the effective hydrostatic head, unless a restricted flow is maintained throughout the field, thus maintaining an even advance and rise of the water table. Particularly is it true of this field on account of the flat dipping sands where an average of 10,000 feet of the western side of the field was initially underlain by bottom water. Excessive flow of wells in any of this territory would immediately start water coning and consequent trapping of oil by the water.

**Production**

Nine months after the completion of the discovery well, the production of this field had reached a total of approximately 900,000 barrels per day. The pressure was declining in many parts of the field and many wells in the most favorable parts of the field ceased to flow.
BOTTOM HOLE PRESSURE
EAST TEXAS OIL FIELD
AS OF DECEMBER 1932

Scale in Miles

Pounds Pressure

1300 or less
1300 to 1350
1350 to 1400
1400 to 1450
1450 or more

FIG. 11
Water was rapidly making inroads into the field. Steps were taken to restrict the enormous flow of oil but before this could be accomplished, the market was becoming demoralized. On August 17, 1931, the entire field was closed down for a period of 19 days under military order and on September 5, 1931, it was reopened under prorated flow which is being maintained. After the first shut-down in August, 1931, a complete readjustment of pressure occurred and many dead wells resumed their flow under normal pressures.

In Figure 9 are shown progress curves of field production and well completions. It will be noted that completions have been made at an average rate of 87.6 wells per week. The increased rate in completions has necessitated a progressive reduction in the allowable production per well.

All of the drilling in the East Texas field is by the rotary method. Depths to the producing sand range from 3,540 to 3,850 feet, depending on the location in the field and the elevation of the well. Wells are drilled at an average cost ranging from $20,000 to $25,000. The majority of wells are equipped with tubing on completion for the purpose of conserving the gas energy by reducing the gas-oil ratio of the flow. Wells are drilled and completed in the average time of 18 days. The estimated average production of initial wells varied from 10,000 to 15,000 barrels.

Pressure

The maximum bottom-hole pressure originally recorded in the field was slightly more than 1,600 pounds per square inch. In Figures 10 and 11, graphic maps are shown indicating the general pressure distribution throughout the field. The progressive pressure change is seen by comparison of Figure 10, showing pressures as of December, 1931, with Figure 11, constructed from pressures existing in December, 1932. As indicated on the maps, the pressure decreases toward the east, with the lowest pressures, of 900–1,100 pounds, occurring in the vicinity of the Joiner discovery area. The gradation of pressures from west to east would normally be attributed to the direct influence of the water drive from the west.

Water

The eastward projection of the present water level (Fig. 8) indicates that 20,000 feet of the Longview area, 10,000 feet of the Kilgore area, and 19,000 feet of the Henderson area are underlain with bottom water. The wells used in establishing these levels are The Texas Company's Waddell No. 1 at −3,300 feet in the Longview
Fig. 12

EAST TEXAS OIL FIELD
WELLS SHOWING WATER
PRIOR TO MILITARY SHUT DOWN
AUGUST 16TH, 1931

Scale in Miles
0 1 2 3 4 5

UPSHUR
GREGG
RUSK
CHEROKEE
area, the Sun Oil Company's Barker No. 1 at -3,300 feet in the Kilgore area, and Deering and Sons' Goforth No. 1 at -3,304 feet in the Henderson area.

These encroachment distances, applied to the entire field, show 58,000 acres, or more than 50 per cent of the field, to be underlain with bottom water at the present time (January, 1933).

The lack of immediate and pronounced water encroachment has caused some doubt as to the effectiveness of the water drive. The withdrawal of 234 million barrels of oil, which would void 150,678 acre feet of sand of 20 per cent porosity, has had apparently little effect on the movement of the edge water. This is not surprising when it is considered that 58,000 acres of the field are already underlain with water and such a withdrawal would account for a vertical rise of only 3.9 feet in this area.

The ability of salt water to maintain field pressures has been entirely lacking in sand fields of which the writers have any knowledge.

The quantity of flow of water into a field is dependent on the differential pressure between the effective hydrostatic head and the bottom-hole pressure within the field. As long as field pressures are sufficiently high to flow the oil, the differential pressure will necessarily be low. Consequently, the maximum amount of water ingress will take place after the field has lost its flowing pressure and wells are being pumped from near bottom.

The Powell field, occupying a similar position with reference to the East Texas synclinal basin, being subjected to the same general hydrostatic head, and deriving its oil from the same Woodbine sand members, should be comparable, relatively, to the East Texas field. As an illustration, the Powell field, of 2,800 acres, produced 214,000 barrels of fluid per day, 112,000 barrels of which was water, from 700 pumping wells, 6 months after the peak of production was reached. The present daily withdrawal of fluid is 68,000 barrels, 2,800 of which is oil, from 165 wells.

Approximately 75 per cent of the wells in the Powell field are pumping with tubing submerged from 100 to 200 feet. The fluid stands in these wells from 100 to 1,200 feet from the bottom. The fluid level has remained practically stationary throughout a considerable period of time. Wells closed down for 3-6 months have shown no appreciable rise in fluid level when pumping was resumed.

The fluid level remaining practically constant indicates that the influx of water at its present differential pressure, which is much lower than the original field pressure, is not in excess of 68,000 barrels per day. If the present fluid level were allowed to rise to flowing height
(though it is doubtful if original pressures would ever be re-established, as shown by the inability of the fluid to rise in wells closed in for long periods of time), the present inflow of 68,000 barrels would be greatly reduced. With such a reduction in flow, the impracticability of flowing a field by hydrostatic energy alone is obvious. It is therefore evident that the flowing life of fields of this type depends principally upon its gas energy. However, restricted flow will undoubtedly play a very important part in the control of fluid levels and prevent the development of local low-pressure areas due to excessive flow which were rapidly making their appearance during the open-flow period of the East Texas field. So long as restricted flow and uniform pressure sufficiently high to flow the wells exist within the field, comparatively little salt water ingress can take place.

However, at a time when the pressure shall have declined to a point where pumping will have to be resorted to, with a consequent drop in fluid level, an increasing differential pressure between the hydrostatic head and bottom-hole pressure will be created.

If it is possible to make a comparison of the future water conditions which will exist in the East Texas field with the existing water conditions of the Powell field, we find that Powell, with its 2,800 acres of producing area and its 9 miles of frontal sand exposure, has reached a stage where fluid levels remain constant under a 68,000 barrel fluid withdrawal. If this analogy is applied to East Texas, then when equilibrium between fluid levels and withdrawals has been established, an influx of approximately 408,000 barrels of water can be expected through the 50 miles of frontal sand along the basinward limits of the field. However, as in the case of Powell, when near-bottom pumping occurs in the majority of wells, the differential pressure will be so increased that the East Texas field will be capable of producing possibly 700,000 barrels of water daily.

The result of continuous pumping of 10,000 wells is obvious, provided the maximum ingress of water into the field at the minimum bottom-hole pressure is not more than 700,000 barrels.

Rapid water advancement will, therefore, be held in check until the field pressures adjacent to the water fall below the effective hydrostatic head.

A great many of the west side wells in the East Texas field are completed only 2–6 feet in the sand, and it is not unlikely that the uniform field pressures being maintained by restricted flow will cause such wells to pass from pipe-line oil wells to water wells in a very short interval of time, thus avoiding the cost of producing large quantities of water in order to drain the sand of its oil.
WELLS SHOWING WATER AS OF MARCH 17, 1932
EAST TEXAS OIL FIELD
Scale 1:60 Miles

Fig. 13
WELLS SHOWING WATER
EAST TEXAS OIL FIELD
AS OF DECEMBER—1932

FIG. 14
In Figures 11, 12, and 13 are shown sketch maps of the field. One indicates the location of wells which were making water on August 16, 1931, or during the unrestricted flow of the field. The second sketch represents wells making water as of March 1, 1932, and the third, wells making water as of January 1, 1933.

Many of the interior wells have been plugged back since the shutdown of the field. However, it is interesting to note that not a single well is reported to be making water in the interior of the field at this time, demonstrating the beneficial effects of restricted flow on the control of water coning.

Water analyses have been made of a sufficient number of wells throughout the field to show that the water is practically identical in wells several miles apart. The Woodbine water of the East Texas field is of the secondary saline type, having approximately twice as much concentration of dissolved salts as ordinary sea water. An average analysis will show approximately 67,000 parts per million; the average chlorine content being approximately 40,000 parts per million, or 4 per cent. In recent months a few wells along the eastern side of the field have shown some water, but analyses of the water showed 2.5 per cent or less of chlorine, indicating that the source of this east-side water is not the same as the western flank water developed by wells which encountered the pay at too great a depth or were drilled too deep into the section.

The bevelling of the main producing sands on the east has left only the thin basal portion of the main producing sand along the eastern side of the field. Consequently, wells drilled along this eastern margin of the field are compelled to drill much deeper into the section than wells located in the center of the field in order to find sufficient sand to make commercial wells. Many of these wells are carried to the Washita limestone and include in their settings all sands and sandy shales lying between the base of the Austin chalk and the Washita limestone.

It is very probable that these deeper sands and sandy shale members, though thin and lenticular, contain oil held in place by water. Due to the thinness and lenticularity of these members, the oil content is not large and already sufficient oil has been withdrawn from them to allow the edge water of these pay sands to make its appearance. There is a possibility, if this proves to be the case, of this edge water becoming a top-water menace to adjacent down-dip wells. Wells of this class making 2.5 per cent chlorine water are indicated in Figure 14.

The placing of the East Texas producing horizon into its correct
position in the Eagle Ford-Woodbine group on the west is difficult on account of lack of paleontological information. Although the continuity of the East Texas sand is somewhat in doubt, the water analyses in Table I are presented to show the marked similarity of the waters of the Van field, Van Zandt County, the Amerada Petroleum Corporation’s Wade No. 1, Upshur County, and the field waters of East Texas.

<table>
<thead>
<tr>
<th>Sodium and potassium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Sulphate</th>
<th>Chlorine</th>
<th>Bicarbonate</th>
<th>Total</th>
<th>Secondary alkalinity</th>
<th>Primary salinity</th>
<th>Secondary salinity</th>
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<tbody>
<tr>
<td>East Texas Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kilgore</td>
<td>24,540</td>
<td>1,388</td>
<td>282</td>
<td>278</td>
<td>40,598</td>
<td>67,649</td>
<td>0.8</td>
<td>92.0</td>
<td>7.1</td>
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<tr>
<td>Longview</td>
<td>24,653</td>
<td>1,432</td>
<td>335</td>
<td>250</td>
<td>40,598</td>
<td>68,964</td>
<td>1.8</td>
<td>91.5</td>
<td>6.6</td>
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<td>Nat. Securities</td>
<td>25,182</td>
<td>1,452</td>
<td>330</td>
<td>110</td>
<td>42,245</td>
<td>68,502</td>
<td>9.2</td>
<td>93.5</td>
<td>8.56</td>
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<td>Vernon No. 1</td>
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<tr>
<td>Americada</td>
<td>24,325</td>
<td>1,417</td>
<td>401</td>
<td>42</td>
<td>41,000</td>
<td>67,441</td>
<td>0.36</td>
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<td>Wade No. 1</td>
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<tr>
<td>Van Field</td>
<td>24,325</td>
<td>1,417</td>
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<td>0.36</td>
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<td>Humble</td>
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<tr>
<td>Blake No. 2</td>
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</table>

These waters are practically identical and support the contention that the producing sands of the field are correlative with the Woodbine sands on the west, though subsequent geological nomenclature may alter their relative position in the geological section.

**Summary**

As previously stated, the average thickness of saturated sand in all cores observed was 22.5 feet. The average thickness of sand as indicated by the cross sections, which are broader in scope, was 18.6 feet. Therefore, by allowing an average thickness of 20.5 feet of sand of 20 per cent porosity and 45 per cent recovery, a total ultimate production of approximately 1,600 million barrels would result, or an average yield of approximately 14,000 barrels per acre.