EASTBOROUGH OIL FIELD, SEDGWICK COUNTY, KANSAS

WARD ROLLIN VICKERY

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EASTBOROUGH OIL FIELD, SEDGWICK COUNTY, KANSAS

A DISSERTATION
SUBMITTED TO THE GRADUATE FACULTY
IN CANDIDACY FOR THE DEGREE OF
MASTER OF SCIENCE

DEPARTMENT OF GEOLOGY

THE UNIVERSITY OF WICHITA

BY
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WICHITA, KANSAS
MAY, 1932

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Abstract

The Eastborough Oil Field was discovered in 1929 and since that time has developed into one of the important fields of Sedgwick County. Its production comes from the top of the "Mississippi Lime", Misener Sand and Viola Lime. Its stratigraphy is typical of that of south central Kansas. The field is on a well defined subsurface anticline which has been the governing factor in the accumulation of the oil. The field has produced over 4,000,000 barrels to date.

Acknowledgment

The writer is indebted to Dr. W. A. Ver Wiebe, of the Department of Geology, for his helpful criticisms and suggestions, and to Anthony Folger for assistance in correlation work.

CHAPTER I

INTRODUCTION

The Eastborough oil field is located in Township 27 South, Ranges 1 and 2 East, Sedgwick County, Kansas. It constitutes one of the major oil pools of Sedgwick County, having a producing area of about 1000 acres, and has produced approximately 4,000,000 barrels of oil. Approximately 45 wells have been drilled in this field, of which 35 have been producing oil wells, and 10 have been dry holes. Figure 1 shows the location of the Eastborough oil field and surrounding area.

History and Development

The discovery well in the Eastborough pool was drilled by E. W. Marland Company, Incorporated, and Fisher and Lauck, and located near the center of the southwest quarter of Section 30, Township 27, Range 2 East, known as the R. J. Mackey well. This well was completed August 30, 1929, for an initial production of 65 barrels, and encountered the top of the Mississippi Lime (Chat) pay at 2961 to 2970 feet.

The second well was drilled to the northwest, approximately one mile distant, by Fisher and Lauck. This well, known as the Trustee Number 1, was located in the center of the north line of the southwest quarter of the southeast quarter of Section 19, Township 27, Range 2 East. It was completed December 3, 1929 at a depth of 2958 feet, for an initial production of about 150 barrels, and was located on the site of the present center of the pool. The production

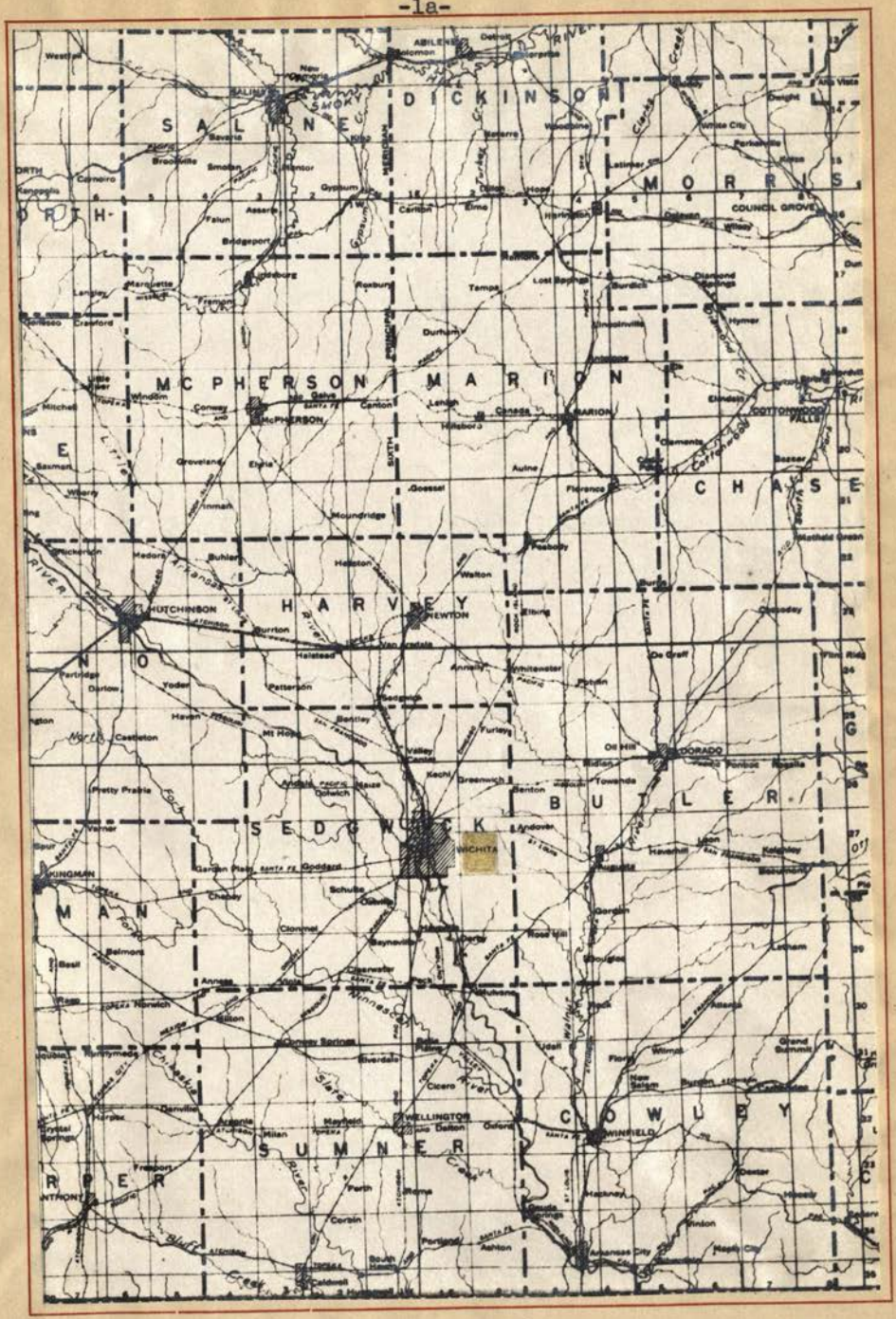

Figure 1. Map Showing Location of the Eastborough Oil Field and Surrounding Area.

from the above well increased gradually to over 200 barrels per day in three months' time, suggesting the possibility that it might be drawing from a slightly deeper oil horizon. An offset well, the Trustee Number 2, (located in the southwest corner of the southeast quarter of Section 19, Township 27, Range 2 East), discovered a very hard streak in the "Chat" separating the two softer "Chat" pay zones and was completed June 18, 1930 at 2973 feet for an initial production of 1400 barrels.

The producing area was extended rapidly northwest and southeast by extensive drilling until the peak of the "Chat" production was reached late in 1930.

The Vickers Petroleum Company and G.W. Hinkle in their Keys Number 1 well, (located in the northeast corner of the northwest quarter of the northeast quarter of Section 30, Township 27, Range 2 East), drilled through the Mississippi Lime reaching Misener Sand, and Viola Lime dolomite pay at 3242 feet. It was completed July 20, 1930 for an initial production of 1200 barrels.

The discovery of Viola Dolomite pay and the rapid decline of the production from the "Chat" wells resulted in the deepening of many of these shallower wells to the Viola horizen. The greater number of these wells found oil in this pay zone. At the present writing there are approximately fifteen wells producing from the "Chat" horizon and twenty wells producing from the Viola Dolomite.

CHAPTER II

STRATIGRAPHY

The rocks which crop out in Kansas belong to the Paleozoic, Cretaceous and Tertiary systems. The Paleozoic rocks crop out in the eastern half of the state, the Cretaceous rocks occupy the central portion, and the Tertiary rocks comprise the remaining (western) part of the state.

The Paleozoic rocks of Kansas belong to the Cambro-Ordovician, Siluro-Devonian, Mississippian, Pennsylvanian and Permian systems. The Mississippian rocks crop out in a small area in southeastern Kansas. The Pennsylvanian beds crop out in narrow bands north and south within the boundaries of the state. The Permian system is present in a belt about 200 miles wide at the southern boundary of the state narrowing to a width of less than 50 miles at the northern extremity. The remainder of the state is occupied by Cretaceous and Tertiary rocks whose outcrops are irregular with the Tertiary overlapping from the west onto the Cretaceous unconformably.

The subsurface stratigraphy consists of Pre-Mississippian rocks including, in descending order, the following systems: Devonian, Silurian, Ordovician, Cambrian and Pre-Cambrian. The rocks of Devonian and possibly Silurian age in Kansas are confined to the Salina Basin. Where Barwick[1] describes a zone of white to gray dolomite limestone interbedded

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[1] John S. Barwick, "The Saline Basin of North Central Kansas," Bulletin of American Association of Petroleum Geologists, XII (February, 1928), 177.

with lenses of sand as the "Younkin Formation". These rocks may be equivalent at least in part to the Hunton Formation of Oklahoma. The Ordovician rocks consist of limestone, shale, sandstone and dolomite. The uppermost formation of Ordovician age in Kansas is a bluish gray or greenish shale correlated with the Sylvan Shale of Oklahoma and the Maquoketa Shale of Iowa. A limestone fairly widespread in Kansas underlying the Maquoketa, where the Maquoketa is present, and otherwise underlying the Kinderhook of Mississippian age, is correlated with the Viola Limestone of Oklahoma. The Simpson Formation is present in Kansas in varying thicknesses. It is chiefly composed of green shale and sandstone. The sandstone in the Simpson is correlated with the "Wilcox" of Oklahoma and the Saint Peter of Missouri.

The Cambro-Ordovician rocks are represented by the "Siliceous Lime", a siliceous dolomite correlated with the Arbuckle Limestone of Oklahoma and the Jefferson City Limestone of Missouri. It is questionable whether any part of the "Siliceous Lime" as found in Kansas is of Cambrian age. However, a basal sand is sometimes encountered below the "Siliceous Lime". This sand is considered upper Cambrian in age, and is correlated with the Reagan Sand of Oklahoma.

Pre-Cambrian gneisses, schists and granite are present below the Paleozoic rocks as shown by 175 wells scattered over practically the entire state, which have entered these rocks.

Permian Rocks

Sedgwick County is located in the belt of Permian rocks and near the south central portion of the state. The following description of stratigraphy is confined to the surface and subsurface formations as found in the Eastborough oil field, located in Township 27 South, Ranges 1 and 2 East. The reader may refer to the Type Well Log Figure 2. Permian rocks belong to three groups, namely, the Sumner, Chase and Council Grove.

Sumner Group.- The Sumner group as described by Bass[2] includes all strata lying between the top of the Winfield Limestone and the red beds. The upper limit of this group is in the lower 100 feet of the Wellington Formation. The group is characterized by a large percentage of soft shale, with minor amounts of limestone decreasing in abundance upward; beds of gypsum are found in parts of the group and in central Kansas, it includes thick beds of salt.

Wellington Formation: Strata with a thickness of about 200 feet occur above the Herington Limestone. They are composed of red and gray soft clay shales, thin limestones and gypsum beds. The lower part of the Wellington Formation belongs to the Sumner group as re-defined by Bass,[3] and this group is now recognized by the United States Geological Survey. The Wellington forms the surface outcrops in the

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[2]N. W. Bass, The Geology of Cowley County Kansas, State Geological Survey of Kansas, Bulletin XII (May,1929), 93.

[3]Ibid., p. 99.

Eastborough district, but there is no individual bed or group of beds that can be readily distinguished at the surface except in local areas, and such beds are not well adapted to surface mapping.

Herington Limestone: Below the Wellington Shale is a unit of light-buff to gray limestone and dolomite about 30 feet thick. The lower part is fossiliferous, and the whole is known as the Herington Limestone.

Enterprise Shale: The Enterprise Shale occurs between the Luta and Herington Limestones, and is composed largely of greenish and blue shale beds with two thin limestones. The thickness of the Enterprise Shale is about 60 feet.

Luta Limestone: Underlying the Enterprise Shale and composing the basal formation of the Sumner Group is 20 to 30 feet of thin bedded light blue limestone known as the Luta Limestone.

Chase Group.- The Chase group as a whole and its several divisions were described in detail by Prosser[4] in 1895 from field studies in Chase and Marion Counties and surrounding areas. Alternately bedded limestone (in part cherty) and shale constitute the Chase group. The two types of rock form about equal parts of the group. The limestone beds are light buff or gray in color and the interbedded shales are drab, gray, brown and maroon. The abundance of chert found chiefly

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[4]Chas. S. Prosser, "Revised Classification of the Upper Paleozoic Formations of Kansas", Journal of Geology, X (1902), 713,714.

in the lowermost and middle limestone members, namely the Wreford and the Winfield Limestone, is probably the most characteristic feature of the group.

Winfield Limestone: The Winfield Limestone is light gray, coarse and granular. It is about 10 feet thick, and forms the uppermost formation of the Chase group.

Doyle Shale: The Doyle Shale below the Winfield Limestone is composed of green, maroon, tan and vari-colored shale, with a few thin beds of limestone. This formation is from 90 to 105 feet thick.

Fort Riley Limestone: The Fort Riley Limestone underlies the Doyle Shale and is a massive buff limestone with thin interbedded shaly strata in the upper part. This limestone seems to occur in wells in the Eastborough district in greater thickness than outcrop sections nearby show. As recognized in well logs in this field the thickness is about 100 feet. The drillers may have logged calcareous shale in the lower part of the overlying Doyle as limestone, thus giving an exaggerated thickness of the Fort Riley. However, Folger[5] gives the interval between the top of the Fort Riley and the base of the Florence Flint as from 110 to 160 feet, with an average of 140 feet. This indicates that the foregoing thickness of 100 feet seems reasonable.

Florence Flint: The Florence Flint is a thick bedded limestone containing abundant chert nodules and layers and is

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[5]Anthony Folger, "Discussion on Kansas Subsurface Stratigraphy," Kansas Stratigraphical Society, (December,1930),10.

about 30 feet thick. This formation is easily recognized because of its chert and is a reliable key horizon for subsurface correlation.

Matfield Shale: The Matfield shale occurs between the Florence Flint and the Wreford Limestone and consists of vari-colored shale interbedded with gray limestone, with a thin red shale usually in the uppermost part of the formation. The thickness of the Matfield shale is about 65 feet.

Wreford Limestone: The Wreford Limestone is light gray with an abundance of chert. The Wreford is about 40 feet thick including a zone of red rock at its base. This red rock is very persistent in well records of this area.

Council Grove Group.- This group was named in 1902 by Prosser[6] from exposures in the bluffs of Neosho River in the immediate vicinity of the town of Council Grove, Marion County, Kansas. The group consists of alternate beds of shale and limestone and is the lowermost group in the Permian system. The Cottonwood Limestone occupies the lowermost 10 feet and the remainder of the group is termed the Garrison Shale. The limestone beds of the group are light gray and the shale beds range in color from gray to tan with a considerable portion of red and dark brown colored beds.

The Council Grove group is not easily distinguished in well logs, but its approximate position can generally be located by the interval between the Wreford Limestone above and

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[6]Chas. S. Prosser, op. cit., p. 718.

the Neva Limestone beneath.

Garrison Shale: Underlying the Wreford Limestone is the Garrison shale consisting of 130 feet of interbedded shale and limestone. The shale beds are in part limy and varied in color, ranging through gray, tan, maroon and brown. A light gray limestone, known as the Crouse Limestone member, occurs near the middle of the formation.

Cottonwood Limestone: The lowest formation of the Council Grove group, and the basal formation of the Permian series in this area, is the Cottonwood Limestone. It is a grayish limestone of about 10 feet in thickness, and contains many Fusulinas.

Pennsylvanian Rocks

In 1893 Keyes[7] proposed the names Des Moines stage and Missouri stage to apply essentially to the lower and upper coal measures. These terms with some modifications have gained general recognition, and the Pennsylvanian system in Iowa, Kansas, Missouri and Nebraska is now subdivided into the Des Moines and Missouri series.

Missouri Series.- On the basis of fauna and lithology the Missouri series has been subdivided into five formations, which, named in descending order, are: Wabaunsee, Shawnee, Douglas, Lansing and Kansas City. This important series is formed principally of interstratified shale and limestone,

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[7]C. R. Keyes, The Geological Formations of Iowa, Iowa Geological Survey, I (1893), 85-114.

but includes some sandstone and a few thin beds of coal. These beds crop out as a broad band southward and southwestward across Kansas, Missouri and Oklahoma to north central Texas. There is no widespread unconformity between the Des Moines and Missouri groups.

Wabaunsee Formation.- This formation at the top of the Pennsylvanian system was named by Prosser[8] from Wabaunsee County, Kansas. It consists mainly of shale with a few persistent and important limestone members. There has been much misunderstanding regarding the units of the Wabaunsee Formation due to the method employed in establishing them and a lack of field investigation and correlations over wide areas. It is generally accepted that the Cottonwood Limestone, at the base of the Permian, fixes the upper limit of the Wabaunsee. The lower boundary of the formation is placed as the bottom of the Burlingame Limestone which is widely persistent and a good horizon marker. The following members of the formation in descending order are recognized by the Kansas State Geological Survey: Eskridge Shale, Neva Limestone, Elmdale Shale, Americus Limestone, Admire Shale, Emporia Limestone, Willard Shale and Burlingame Limestone.

Eskridge Shale: The Eskridge Shale is the uppermost formation of the Pennsylvanian system in Kansas, and is at the top of the Wabaunsee Formation. The Eskridge consists of

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[8]Chas. S. Prosser, "The Classification of the Upper Paleozoic Rocks of Central Kansas," Journal of Geology, III (1895), 682-705 and 764-800.

red, green and gray shale, and is in part limy. It ranges in thickness from 25 to 35 feet. The red shale zone in the base of this member is persistent in well logs throughout central Kansas.

Neva Limestone: The Neva Limestone is one of the most persistent limestone members in Kansas, both in well records and outcrops. The Neva has a deep buff color and contains a small amount of chert. It is about 20 feet thick and usually yields water when encountered in wells. The Neva Limestone is easily recognized below the red shale of the lower Eskridge shale above it; and on account of this as well as its persistence it is often used as the top of the Pennsylvanian system in Kansas.

Elmdale Shale: The Elmdale Shale as defined by Prosser[9] includes a series of beds of shale and limestone above the Americus Limestone and below the Neva Limestone, with a thickness of 130 feet. This series as recognized in the Eastborough district is about 120 feet thick and is composed of red and gray shale with gray and blue-gray limestones.

Americus Limestone: The Americus Limestone is a blue-gray and buff limestone with interbedded gray limy shale, containing Fusulinas abundantly. The writer was unable to separate the Americus and the overlying Foraker Limestone in well records, but the unit is recognized as about 35 feet thick and is considered a reliable marker for subsurface

[9]Chas. S. Prosser, "Revised Classification of the Upper Paleozoic Formations of Kansas," Journal of Geology, X (1902), 718.

correlation.

Admire Shale: As revised by Condra,[10] the Admire Shale includes only strata from the base of the Brownville limestone to the base of the Americus Limestone, which includes in ascending order, Brownville Limestone, Aspinwall Shale, Falls City Limestone and West Branch Shale. This series, as near as the writer can determine from well records in the Eastborough district is about 90 feet thick.

McKissick Grove Shale: The definition of the McKissick Grove Shale as revised by Condra[11] is made to apply to the strata between the Tarkio and Brownville Limestones. This series would include in ascending order, Pierson Point Shale, Maple Hill Limestone, Table Creek Shale, Dover Limestone and Pony Creek Shale. Some of these smaller units can be recognized in well logs, and the thickness of the entire McKissick Grove appears to be about 150 feet.

Tarkio Limestone: Underlying the McKissick Grove Shale is the Tarkio Limestone, about 10 feet in thickness and containing many large Fusulinas.

Willard Shale: The Willard Shale as described by Beede[12] occurs between the Tarkio and Emporia Limestones,

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[10] G. E. Condra, The Stratigraphy of the Pennsylvanian System in Nebraska, Nebraska Geological Survey, Bulletin I (1927), 71-76.

[11] Ibid., p. 75.

[12] J. W. Beede, "Stratigraphy of Shawnee County," Kansas Academy of Science, XV (1898), 27-34.

and consists of bluish and reddish argillaceous shale, and some sand. The Willard shale appears to be about 40 feet thick.

Emporia Limestone: The Emporia Limestone as described by Condra[13] denotes the first limestone unit below the Willard Shale, and consists of grayish and bluish limestone. The Emporia Limestone as correlated in the Type Well Log (Figure 2 accompanying this paper) is 30 feet thick.

Humphrey Shale: The Humphrey Shale applies to the interval between the Burlingame and Emporia Limestones. Its thickness is about 55 feet including the Soldier Creek Shale, Wakarusa Limestone and Auburn Shale; however, these members were not recognized by the writer.

Burlingame Limestone: The basal formation of the Wabaunsee Formation is the Burlingame Limestone. It is composed of gray and yellowish-brown limestone with shale often present in the middle portion of the formation. This member as recognized in this locality varies from 15 to 25 feet in thickness.

Shawnee Formation.- This formation was named by Haworth[14] from Shawnee County, Kansas. The upper limit of the Shawnee Formation is placed at the base of the Burlingame Limestone; and the lower boundary is at the base of the

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[13] G. E. Condra, op. cit., pp. 67-72.

[14] Erasmus Haworth, "Stratigraphy of the Kansas Coal Measures," Kansas University Geological Survey, III (1898), pp. 93 and 94.

Kanwaka Shale member or at the top of the Oread Limestone. Condra[15] states:

"The Shawnee as now defined is not distinctly set off by faunal and lithologic change. Its lower beds resemble those of the Douglas Formation with no marked change in fossil species, and the upper portion of the top member carries a fauna more like the lower members of the Wabaunsee Formation."

The members of the Shawnee formation have been traced through the exposures of Iowa, Nebraska, Kansas, and in some cases to Oklahoma and found to be very persistent. The Shawnee Formation is subdivided into the following members: Scranton Shale, Howard Limestone, Severy Shale, Topeka Limestone, Calhoun Shale, Deer Creek Limestone, Tecumseh Shale, Lecompton Limestone and Kanwaka Shale.

Scranton Shale: At the top of the Shawnee Formation occurs the Scranton Shale, consisting of clay and sandy shale, prevailingly gray, and blue, in color, with a thin bed of sand in the lower part. The thickness of the Scranton is about 70 feet.

Howard Limestone: The Howard Limestone is a bluish gray, dense, fossiliferous limestone, 20 to 30 feet in thickness.

Severy Shale: The Severy Shale underlying the Howard Limestone, has a thickness varying from 70 to 90 feet, consists principally of bluish argillaceous shale, and is sandy in certain localities. In the particular locality being described in this paper the Severy Shale contains considerable limestone in the central portion.

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[15] G. E. Condra, op. cit., p. 39.

FIGURE 2.

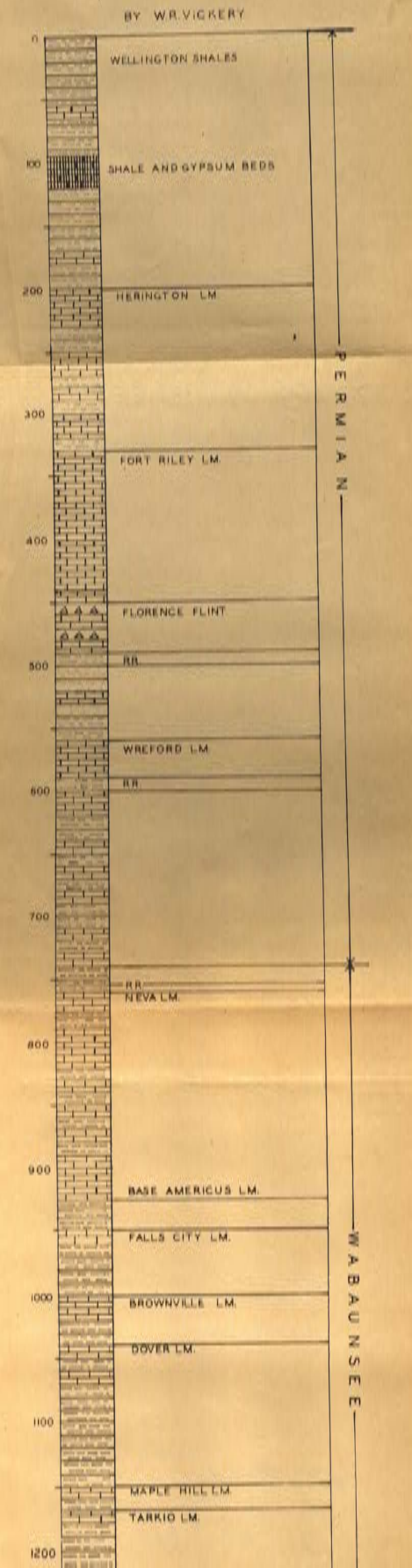
TYPE WELL LOG

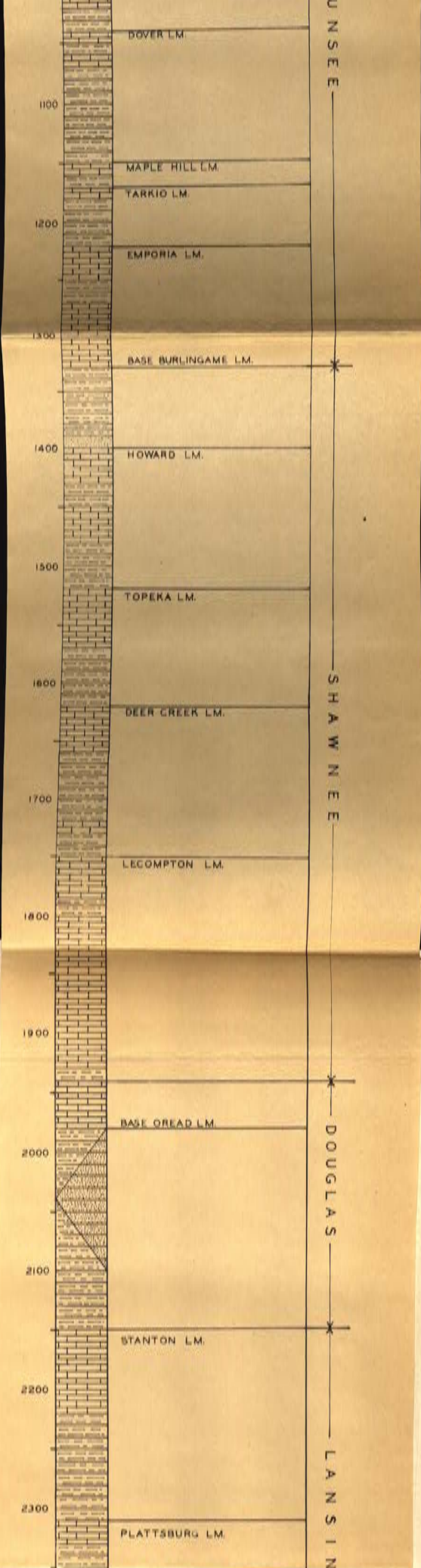
OF THE

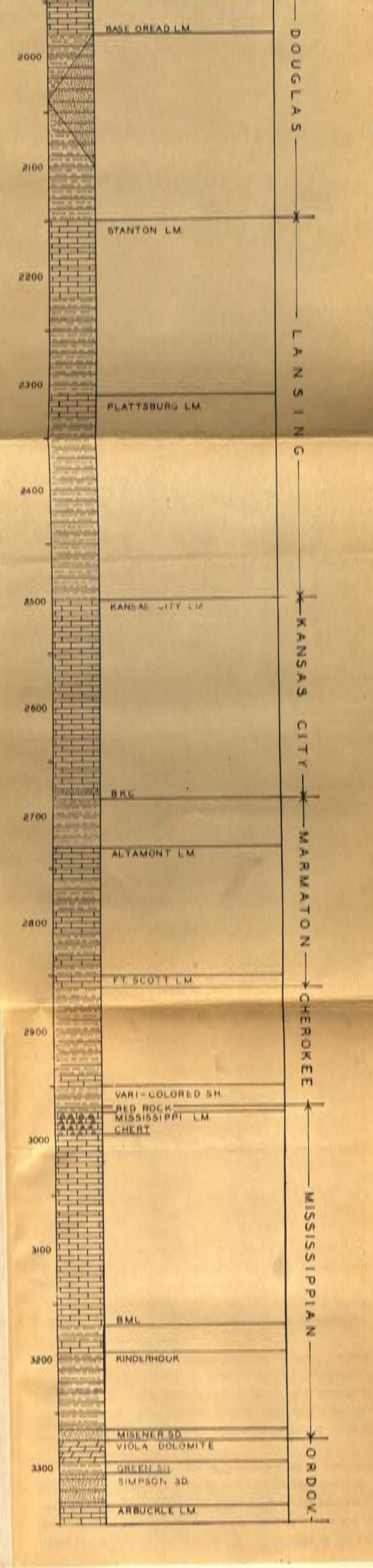
EASTBOROUGH OIL FIELD

TWP 27S R2E SEDGWICK CO. KAN.

BY W.R. VICKERY




DOVER LM.
1100
MAPLE HILL LM.
TARKIO LM.
1200
EMPORIA LM.
1300
BASE BURLINGAME LM.
1400
HOWARD LM.
1500
TOPEKA LM.
1600
DEER CREEK LM.
1700
LECOMPTON LM.
1800
1900
BASE OREAD LM.
2000
2100
STANTON LM.
2200
2300
PLATTSBURG LM.
UNSEE
SHAWNEE
DOUGLAS
LANSIN


BASE OREAD LM.
STANTON LM.
PLATTSBURG LM.
KANSAS CITY LM.
BKC
ALTAMONT LM.
FT. SCOTT LM.
VARI-COLORED SH.
RED ROCK
MISSISSIPPI LM.
CHERT
BML
KINDERHOOK
MISENER SD.
VIOLA DOLOMITE
GREEN SH.
SIMPSON SD.
ARBUCKLE LM.
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
3300
DOUGLAS
LANSING
KANSAS CITY
MARMATON
CHEROKEE
MISSISSIPPIAN
ORDOV.

Topeka Limestone: The Topeka Limestone comprises about 50 feet of dark blue, dense, brittle, and quite fossiliferous limestone. This limestone is considered a reliable subsurface key horizon for mapping in Kansas.

Calhoun Shale: The Calhoun Shale underlying the Topeka Limestone is formed of argillaceous shale and sandy shale. It is about 50 feet in thickness.

Deer Creek Limestone: The Deer Creek Limestone is blue or gray in color, and rather thin bedded with interbedded shale. It has a thickness of about 40 feet.

Tecumseh Shale: The Tecumseh comprises a thickness of from 70 to 90 feet and is composed of argillaceous and sandy shales, but contains some limestone.

Lecompton Limestone: The Lecompton Limestone is yellowish-gray in color, having a thickness of about 35 feet, and containing many Fusulinas.

Kanwaka Shale: The Kanwaka Shale is the basal division of the Shawnee Formation. It seems to thicken in southern Kansas, and also to become quite limy in the area covered by this paper. The shaly portion is thin, with heavy lime beds appearing downward, comprising a total thickness of about 130 feet.

Douglas Formation.- The Douglas Formation is essentially a body of shale and sandy shale with an important limestone member in the upper part. The upper limit of the Douglas Formation is placed at the top of the Oread Limestone and the lower boundary is at the base of the Weston Shale or the top

of the Stanton Limestone. The Oread Limestone at the top of the Douglas Formation is one of the most persistent limestones in the Kansas Pennsylvanian series. The shale members of the Douglas are variable in composition and texture, changing markedly from point to point. In the north, there is a predominance of clay shale, but toward the south the proportion of sand is notably increased. The Douglas includes four members of alternating shale and limestone, namely, in descending order: Oread Limestone, Lawrence Shale, Iatan Limestone and the Weston Shale. An unconformity at the base of the Oread Limestone is generally noted in the central parts of Kansas.

Oread Limestone: The Oread Limestone consists of buff or gray limestone, and contains considerable chert. It is very persistent and has a thickness of about 60 feet. Because of its chert-bearing character the Oread is usually easily recognized in well samples; however, because of an unconformity at its base, in the area under consideration in this paper, it is not considered reliable for subsurface mapping.

Underlying the Oread Limestone in the Eastborough district is a thick series of shale, sandy shale, and some sand, comprising a thickness of 170 feet. The writer feels that the Weston Shale is present making up the major basal portion of this series. The Iatan Limestone is probably absent, or if present is not recognized. The remaining upper part of the series probably consists of the lower one-third of the

Lawrence Shale.

Lansing Formation.- The Lansing Formation appears on the surface in Kansas in a rather narrow band which crosses the state in a direction slightly west of south from Leavenworth to the vicinity of Sedan in Chautauqua County. This formation was named by Hinds and Greene[16] from Lansing, Leavenworth County, Kansas. The Lansing as described by Hinds and Greene includes four subdivisions, two prominent limestone members and two shale members. These members, in descending order, are Stanton Limestone, Vilas Shale, Plattsburg Limestone and Lane Shale. In the eastern part of the state, the shales compose the major part of the formation; however, in the central and western part, the limestone proportion increases. In well records it is sometimes impossible to make a distinction between the limestones of the Lansing and the underlying Kansas City.

Stanton Limestone: The uppermost member of the Lansing Formation is the Stanton Limestone. It consists of gray limestone beds interbedded with blue and gray shale. Its thickness varies considerably in this area, averaging around 60 feet.

Vilas Shale: Separating the Stanton and the Plattsburg Limestones there is about 100 feet of dark gray and black

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[16]Henry Hinds and F. C. Greene, Stratigraphy of the Pennsylvanian Series, Missouri Bureau of Geology and Mines, XIII (1915), 16.

shale known as the Vilas Shale.

Plattsburg Limestone: The Plattsburg Limestone although thin is persistent, and is usually recognizable because of its position in a thick series of shales. Its thickness ranges from 15 to 20 feet.

Lane Shale: The Lane Shale is a series of clayey and sandy shales, 170 feet thick, underlying the Plattsburg Limestone. The Lane Shale is the basal member of the Lansing Formation.

Kansas City Formation.- The Kansas City Formation, at the base of the Missouri series, was named by Hinds and Greene[17] from the vicinity of Kansas City, Missouri. Its outcrop in Kansas form a somewhat irregular but clearly defined belt trending west of south from Kansas City to Montgomery County. This formation is one of the best defined stratigraphic horizons in the eastern part of Kansas. The Kansas City Formation is characterized by its high percentage of limestone, with shale very subordinate. There is very little sandstone in the formation although thin beds occur locally. The Kansas City Formation at its outcrop includes nine members of alternating limestone and shale, and these, in descending order, are: Iola Limestone, Chanute Shale, DeKalb Limestone, Cherryvale Shale, Winterset Limestone, Galesburg Shale, Bethany Falls Limestone, Ladore Shale, and Hertha Limestone.

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[17] Ibid., p. 23.

Kansas City "Lime": The Kansas City Formation, in this locality, is not divisible into its members. The formation is made up almost entirely of limestone, with only a small amount of sandstone usually present at or near its base. The formation ranges from 170 to 190 feet in thickness in the records of the wells located in the Eastborough field. The Kansas City Lime is easily recognized and both its top and bottom are used by geologists for subsurface mapping.

Des Moines Series.- The Des Moines series is exposed on the surface in a wide belt extending from south central Iowa through central and southwestern Missouri, northwestern Arkansas, southeastern Kansas, and Oklahoma. The area of outcrop of these beds, in southeastern Kansas, extends from Miami County on the northeast to Montgomery County on the southwest, including all or portions of Linn, Bourbon, Crawford, Neosho, Cherokee and Labette Counties. The beds of the Des Moines consist chiefly of plastic materials such as shale and sandstone, but contain an important minor content of limestone. The porous sandstones of this series are producing horizons of oil and gas in Kansas and Oklahoma.

The Des Moines series has been divided into two formations of approximately equal thickness, the Cherokee Shale below and the Marmaton Formation above. The Cherokee is essentially a shale and sandstone formation, almost lacking in limestone; but the Marmaton, with the persistent Fort Scott Limestone at its base, contains a number of well defined limestone members. These two formations thin westward from

their outcrop.

Marmaton Formation.- The Marmaton Formation was named by Haworth[18] from Marmaton River in eastern Kansas. The outcrop of this formation appears as a broad band twenty to thirty miles wide trending in a direction from northeast to southwest across southeastern Kansas. It is the most important surface formation in Labette, Crawford, and Bourbon Counties. The Marmaton Formation is a natural lithologic unit and has a fauna which is distinct both from that of the underlying Cherokee and from that of the beds of the succeeding Missouri series. This formation includes eight members of alternating limestone and shale. They are, in descending order: La Cygne Shale, Lenapah Limestone, Nowata Shale, Altamont Limestone, Bandera Shale, Pawnee Limestone, Labette Shale, and Fort Scott Limestone.

Marmaton Formation.- The Marmaton Formation is represented by 165 feet of shale and limestone of which the writer was able to recognize only the following members: Altamont Limestone 30 feet, Bandera shale 30 feet, Pawnee Limestone 20 feet, Labette Shale 40 feet, and the Fort Scott Limestone 10 feet at the base of the formation.

Cherokee Shale: This division was named by Haworth and Kirk[19] from Cherokee County, Kansas. It is the lowest and

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[18]Erasmus Haworth, op. cit., pp. 92 and 94.

[19]Erasmus Haworth and M. Z. Kirk, The Neosho River Section, Kansas University Geological Survey, II (1894), 105.

thickest division of the Des Moines series in Iowa, Missouri and Kansas; but older beds of the series occur between it and the Mississippian in Oklahoma and Texas. Its exposure in Kansas is over most of Cherokee County and in the eastern portions of Crawford and Bourbon Counties. It is formed of sandstone, shale and sandy shale, and rests on the uneven surface of the "Mississippi Lime". The Cherokee formation is important because its sandstones have been the source of a great deal of the oil production of southeastern Kansas and the adjacent portion of Oklahoma. The Bartlesville and the Burgess Sands are the most important oil and gas horizons of the Cherokee. Going westward from the outcrop, the Pennsylvanian section is progressively cut out from the bottom up. In Central Kansas the Cherokee has thinned considerably, and in ranges west it is usually absent.

Cherokee Shale: Only the upper part of the Cherokee Shale is represented by 90 feet of dark gray and black shale, with some limestone. It is often logged as shells and shale by the drillers. The Cherokee is the basal formation of the Pennsylvanian system in Kansas.

Mississippian Rocks

The Mississippian rocks in Kansas are confined to two formations, namely, the "Mississippi Lime" and the Kinderhook Shale. Only the "Mississippi Lime" occurs at the surface in Kansas. The exposure is a very limited area in the southeastern portion of Cherokee County in the extreme southeast-

ern corner of the state. The "Mississippi Lime" as reported by drillers is composed almost entirely of light gray to dark gray cherty limestone. However, some report beds of sandstone and shale interbedded with limestone in the upper part.

The subdivisions of the "Mississippi Lime" are not all recognized in Kansas. This limestone is correlated with the Boone Limestone of Missouri. However, abnormal thicknesses up to as high as 1500 to 1700 feet have been reported in wells in southwestern Kansas. The upper 600 feet at least is thought to be Chester in age. The upper surface of the "Mississippi Lime" is irregular owing to erosion throughout a long period prior to the deposition of the overlying rocks. Either through non-deposition or post-Mississippian erosion all of the Mississippian is missing over the Barton arch and the northern part of the Granite Ridge.

According to McClelland[20] the Kinderhook Formation contains the Chattanooga Shale in its lower part. The Chattanooga Shale includes only that portion of the Kinderhook which is a black carbonaceous fissile shale. It can be traced northward from Oklahoma into Kansas as far as Marion County where it appears to lose its identity in the lower part of a much thicker light greenish shale which correlates with the Kinderhook of Iowa. The same species of plant spores is found in both shales. In some cases the upper part of the

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[20]Hugh McClelland, "Distribution of the Pre Mississippian," Oil and Gas Journal, (October 23, 1930), 32,33,107-109.

Kinderhook Shale is occupied by a limestone of Kinderhook age. This change seems to take place toward the southern boundary of Kansas where the lower member of the "Mississippian Lime" is non-cherty and sometimes separated from the lime above by a thin greenish gray shale.

In the Eastborough field a zone of vari-colored shale and a thin red shale occurs just above the top of the eroded surface of the "Mississippi Lime". These are quite variable in thickness, ranging from 10 to 30 feet. The age of this zone is questionable, and the writer suggests that it may be Mississippian material re-worked by a Pennsylvanian sea.

"Mississippi Lime": The "Mississippi Lime" is a clearly defined, readily traceable stratigraphic unit, consisting chiefly of crystalline limestone containing a considerable amount of hard, flinty chert. The thickness of the "Mississippi Lime", as shown by records of, and samples from wells, in the Eastborough field, varies from 170 to 200 feet. The surface of this lime is eroded, creating a concentration of chert on the upper surface thereof. This zone of vitreous, white or gray chert is very porous, and is referred to by drillers as "Chat". The "Chat" is one of the two producing horizons in the Eastborough Field.

Kinderhook Formation: Underlying the "Mississippi Lime" is a series consisting chiefly of shale with a small amount of limestone, correlated with the Kinderhook Shale. The major portion of the formation is made up of black carbonaceous shale, which is usually referred to as the Chattanooga

Shale, included in the lower part of the Kinderhook Formation. The Kinderhook Formation is considered as Mississippian in age, in this paper. The average thickness of the black shale portion is about 70 feet in the wells located in the Eastborough field.

Misener Sand: The Misener Sand has been found in the following localities in Kansas: the Valley Center pool just north of Wichita, the Eastborough field east of Wichita and the Voshell pool in Township 21 South, Range 3 West, and between these two points in Harvey and Sedgwick Counties and extending westward into Reno County. The sand occurs just below the Kinderhook Shale. The Misener as used in this paper is restricted to a thin bed of quartz sand. The quartz grains are fine, angular to rounded, and often cemented by dolomite. In the Eastborough field this sand is not present in all the wells, but where present ranges in thickness from 3 to 10 feet.

According to McClelland[21] the Misener occupies the stratigraphic position of the Sylamore Sandstone, and, like it, occurs in isolated lenses on the old eroded pre-Mississippian surface.

The writer is informed that James Daniels, geologist with the Continental Oil Company, believes the Misener Sand is a true detrital deposit, because he finds basal Chattanooga Shale under it. He has found this shale contains the

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[21] Ibid., p. 107.

same spores, as have been found elsewhere in the Chattanooga Shale. This would indicate that the Misener is a part of the Mississippian sequence.

Cambro-Ordovician Rocks*

Deep wells in Sedgwick County and elsewhere in this region have penetrated a thick series of strata commonly reported as interbedded limestone, sandy limestone, sandstone, dolomite and shale, and believed to be Cambrian and Ordovician in age. This series underlies the Kinderhook shale. The chief divisions of these strata, as described by White,[22] are in descending order: Sylvan Shale, Viola Limestone, Simpson Formation, (including its divisions, the Wilcox Sand, Tyner Formation, Burgen Sand, and lower Simpson sandy shale). The foregoing formations are considered Ordovician in age. Another formation of this series is the "Siliceous Lime", and is correlated with the Arbuckle Limestone of Oklahoma, which is of Cambro-Ordovician age. The basal sand underlying the "Siliceous Lime" in Kansas is thought to be equivalent to the Reagan Sand of upper Cambrian age.

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*No Devonian or Silurian rocks are present in the section of the Eastborough field.

[22]Luther H. White, "The Subsurface Distribution and Correlation of the pre-Chattanooga ('Wilcox' Sand) Series of northeastern Oklahoma," Bulletin of Oklahoma Geological Survey, 40-B (June, 1926).

Viola Limestone: The uppermost formation of Ordovician age occurring in the Eastborough Field, is the Viola Limestone. It underlies the Misener Sand and underlies the Kinderhook Shale where the Misener is absent. The Viola consists chiefly of gray to brown dolomite and limestone. In some cases the entire thickness of Viola has been dolomitized. However, some samples show the dolomitization only in zones separated by almost pure limestone. This horizon is very porous and constitutes the main deep producing horizon in the Eastborough field. Its thickness ranges from 10 to 20 feet.

The Viola Limestone horizon in Kansas is similar lithologically to the Fernvale (lower Richmond) of Oklahoma. It is doubtful whether it is entirely correlative with the Viola Limestone of Oklahoma. Some geologists object to this correlation and prefer to call it Simpson dolomite.

The Simpson Formation: The Simpson in Kansas is very similar to that of Oklahoma, consisting of bright bluish green shales, limestone and dolomite, and rounded sands interbedded. White[23] differentiated three divisions of the Simpson on his pre-Chattanooga map of northeastern Oklahoma, namely, the Burgen Sand, Tyner Shale and "Wilcox" Sand.

In tracing the Simpson northward, from Oklahoma, it is found to become much thinner and it is not practicable to

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[23] Ibid., p. 39.

distinguish different members. However, Edson[24] has distinguished the "Wilcox" sand in Kansas by means of heavy mineral analysis and found it only in a limited area. It probably does not extend farther north than the Eldorado field. McClelland[25] states:

"Many occurrences of fossils have been noted and in every case upper Black River age (upper Simpson) was indicated. The Simpson sea therefore, must have been overlapping progressively northward so that only the upper Simpson is represented over most of Kansas."

The Simpson Formation in the area considered in this paper, is composed chiefly of green shale and sand, with a few thin limestone beds. The average thickness of the Simpson Formation encountered in wells in this field is about 40 feet. The sand, comprising the greater part of this thickness, is transparent to translucent and the grains are subrounded to rounded and often frosted.

Arbuckle Limestone: The Arbuckle Limestone is recognized as a hard, gray, cherty dolomite, with some sand and limestone. It is known as the "Siliceous Lime", and as a rule drilling is stopped when it is encountered.

Producing Horizons

The producing horizons in the Eastborough field are the

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[24]Fanny C. Edson, "Pre-Mississippian Sediments in Central Kansas," Bulletin of American Association of Petroleum Geologists, XIII (May, 1929), 451.

[25]Hugh McClelland, op. cit., p. 107.

TABLE I

THICKNESS AND DEPTH OF CERTAIN STRATIGRAPHIC HORIZONS IN THE EASTBOROUGH OIL FIELD

Horizon and Lithologic Description		Well #1 Tuttle #1 1-27-1E	Well #2 Keys #1 30-27-2E	Well #3 Schafer #2 30-27-2E	Well #4 Nagel #1 19-27-2E
"Mississippi Lime" Chert 80% Lime 20%	top	3000'	2935'	2953'	2989'
	base	3257	3122	3155	3203
	thick	257	187	202	214
Kinderhook Shale Black shale	top	3296	3178	3198	3246
	base	3368	3238	3255	3312
	thick	72	60	57	66
Misener Sand Colorless angular quartz sand	top	3368	3238	3255	3312
	base	3371	3242TD.	3259	3316
	thick	3	4	4	4
Viola Lime Brown dolomite and lime	top	3371		3259	3316
	base	3380		3267TD.	3330
	thick	9		8	14
Simpson Fm. Quartz sand and green shale	top	3380			3330
	base	3410TD.			3370
	thick	30			40
"Siliceous Lime" Gray cherty dolomite, lime and sand	top				3370
	base				3450TD.

"Missippi Lime", found at the approximate depth of 2970 feet; the Misener Sand, found at the approximate depth of 3260 feet; and the Viola Lime at 3270 feet. The first two are considered Mississippian in age, and the last is Ordovician.

Many samples were studied from the following wells: Tuttle No. 1, Schafer No. 1 and No. 2, Keys No. 1 and No. 4, Nagel No. 1 and Trustee No. 2. These samples are the ground up rock fragments brought out in the process of drilling, from considerable depths. In nearly every case they began with the top of the "Mississippi Lime" and extended to the bottom of the well. The two Schafer wells and Keys No. 4 showed exceptionally good samples of the Misener Sandstone and the Viola Limestone. The samples from the Trustee No. 2 gave excellent opportunity for studying the "Chat" zone of the "Mississippi Lime".

"Mississippi Lime": The material lying on the eroded surface of the "Mississippi Lime", is locally called "Chat". The "Chat" is composed chiefly of hard, light to dark gray chert, with some reddish residual soil, the insoluble residue of the limestone. It is very porous, and when oil occurs this is found in the upper part, and water is encountered in the lower part. The thickness of the "Chat" is variable ranging from 10 to 40 feet, and its distribution is irregular.

A microscopic examination of cuttings from the "Chat" shows the following physical characteristics: top portion very cherty, the chert varies from fresh, waxy, translucent, in sharp angular fragments, to dull white and cream colored chert. This last shows evidences of transportation in its well rounded appearance. The chalky appearance of these fragments indicates long exposure to weathering. In some

grains evidences of discoloration are observed which may be secondary. Associated with this chert shale is found which may or may not be indigenous to the formation. This shale is red, green, tan, brown and purple in color. Near the top of this cherty zone this shale makes up about 50 per cent of the total, but with depth the percentage dwindles until in the lower zones the percentage of shale is less than 10 per cent. The chert varies from 30 to 40 per cent near the top to almost 100 per cent in the lower portions. Within the chert zone itself the limestone content is very low. Near the top of the hard ("Mississippi") lime the chert fragments become finer and include fragments of a spongy chert and fragments of a peculiar, bluish, banded chert.

Very little gas accompanies the oil from the "Chat"; consequently only a few of the earliest wells drilled in the Eastborough field flowed naturally from this horizon. The production from the "Chat" wells declines rapidly, with water showing either immediately or usually within two or three months' time.

Misener Sand: Immediately underlying the Kinderhook Shale is a thin bed of angular, colorless sand mixed with green shale and cemented with dolomite.

Microscopic examination of this sand shows it to be composed of nearly colorless, slightly frosted, sub-angular to sub-rounded grains. This angularity of an apparently weathered sample is rather unusual. These grains show few

traces of secondary coloring, but in a few instances show rust due to weathering. The grain size ranges from about .2 millimeter to .5 millimeter with the average of about .4 millimeter. In the lower portions of this zone (near the top of the Viola Lime) evidences of cementation are found. A few of the smaller grains, approximately .2 millimeter, seem to be cemented with dolomite, but the larger grains seem unaffected. The shale that appears in these samples varies from black (Kinderhook?) to a dark green sandy shale which seems to be associated (in the Eastborough field especially) with the Misener Sand. This shale is a thin zone, about six inches thick, occurring just above the top of the Misener Sand.

This sand occurs in the Eastborough field at the approximate depth of 3260 feet and where present rests on the Viola Limestone horizon. These two formations both contain considerable dolomite giving them a grayish brown color. The Misener is distinguished from the Viola by its sand content; however, it is often impossible to tell whether the oil is coming from the Misener or the Viola. The Misener is very porous and usually shows oil saturation and water in most wells. It is thought by the writer that the Keyes Well Number 1, in section 30, Township 27, Range 2 East is the only well in the field actually producing from this sand.

Viola Dolomite: The production from the Viola Dolomite is found in a gray to brown dolomitic limestone, with a very small amount of sand present. To the writer's knowledge, this lime horizon, wherever encountered within the limits

of the field has been dolomitized, and is very porous. The thickness of the Viola Dolomite ranges from 10 to 20 feet.

When viewed through a microscope the Viola seems to be as high as 90 per cent dolomite. This dolomite is gray to light brown and seems to have a massive crystalline appearance. The fragments range from angular to blocky granular masses, showing prominent cleavage faces. In some of these fragments crystallization of the dolomite has given the whole a rather spongy, porous appearance. This spongy, porous appearance is probably due to the solution of the purer calcareous portions of the rock. Subsequently some of the holes were filled with secondary crystals. Associated with the dolomite were well developed crystals of Calcite, as well as fragments of shale, and some pyrite.

Contrary to the usual action of dolomite in acid, this particular sample effervesces very rapidly, indicating either that it is low in Magnesium Carbonate, or that there is a large admixture of secondary Calcite. After solution in acid practically no residue was observed. The small amount of residue that remained appeared to be silt fragments of quartz composition.

The decline of production from Viola Dolomite wells is less rapid than from the "Chat" wells; however, the lower part of the dolomite contains water and if wells are "drilled in" too far they produce considerable water and are soon abandoned. A small amount of gas accompanies the oil from

the Viola Dolomite, but not sufficient to "flow" the wells. The wells are usually "pumped" immediately after drilling in, and not "swabbed".

CHAPTER III

STRUCTURE

There are two major positive structural features in Kansas. The buried Nemaha Mountain range or Granite Ridge which crosses the state from a point in eastern Sumner County trending north about 18° (degrees) east to Nemaha County. At the northern boundary of the state, the granite is about 550 feet deep, but plunges deeper to the south occurring at around 4000 feet depth at the southern boundary. According to Folger[26], the Granite Ridge is not an anticline but a series of en echelon faults trending northeast and southwest as postulated on rocks older than Pennsylvanian. The faults have not displaced rocks above the Fort Scott Limestone. The Granite Ridge is reflected as an anticline in Pennsylvanian and younger rocks.

Another important structural feature in Kansas is the Barton Arch. It is a much larger and broader feature than the Granite Ridge and extends northwest southeast from Norton County to Barton County. McClelland[27] includes in this uplift the Chautauqua arch which extends from the Ozark uplift in a northwesterly direction through Chautauqua to Barton County. The general trend of this feature is nearly parallel to the buried Wichita Amarillo Mountains of Oklahoma and Texas.

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[26]Anthony Folger, op. cit., p. 1

[27]Hugh McClelland, op. cit., p. 108.

The major synclinal areas are the Forrest City Basin in northeastern Kansas, the Salina Basin in northeastern Kansas, a basin in Harper County, Kansas, and the northwestern extension of the Anadarko Basin or Oklahoma into the southwestern part of Kansas.

Sedgwick County in general lies on the saddle between the Barton arch and the Chautauqua arch. It is located a few miles west of the Granite Ridge. Very little surface mapping has been used to locate the structures in this county because of unreliable key beds. Most of the structures have been located by means of core-drilling and subsurface mapping. Most of the oil fields of the county are located on small domes and anticlines on a regional structural high trending north and northwest. This regional structure is probably an anticlinal nose extending away from the Barton-Chautauqua arch trend. The most important oil fields of Sedgwick County are: the Valley Center pool located in Township 26, Range 1 East, the Wright pool located in Township 26, Range 2 East, the Eastborough field located in Township 27, Ranges 1 and 2 East, and the Robbins field located in Township 28, Range 1 East. The important producing horizons for these fields are, the top of the "Mississippi Lime" ("Chat"), the Viola Lime, and the Simpson Sand.

The subsurface structure as discussed in this chapter is illustrated by means of four subsurface structure maps constructed on different key horizons. The value of a

subsurface map depends upon the selection of reliable key beds or horizons that may be easily recognized, traced, and correlated throughout the region of the mapping. The accurateness of a subsurface map depends upon the correctness of the well logs used and the samples observed, the securing of accurate surface elevations of the wells and the ability of the geologist to recognize and correlate the key beds used. The procedure generally used is to plot the drillers logs on strip logs by means of colors and symbols. The strips are then correlated by formations and the key beds selected. The depth to the top or bottom of the key bed, whichever is selected, is then corrected for the surface elevation of each respective well. This is done so that the final figure for each well obtained and placed on the map shows the elevation of the key bed above or below sea level. These results are then contoured by means of lines running through points of equal elevation, using a contour interval in feet, suitable to show the correct relief of the area mapped.

The key horizons used for the subsurface maps accompanying this paper are as follows: the base of the Florence Flint, the base of the Kansas City Lime, the top of the "Mississippi Lime", and the base of the Kinderhook Shale. The base of the Florence Flint was chosen because it is one of the highest horizons which is reliable for subsurface mapping in this region. It is easily recognized by its abundance of chert and its position under the thick Fort Riley Limestone.

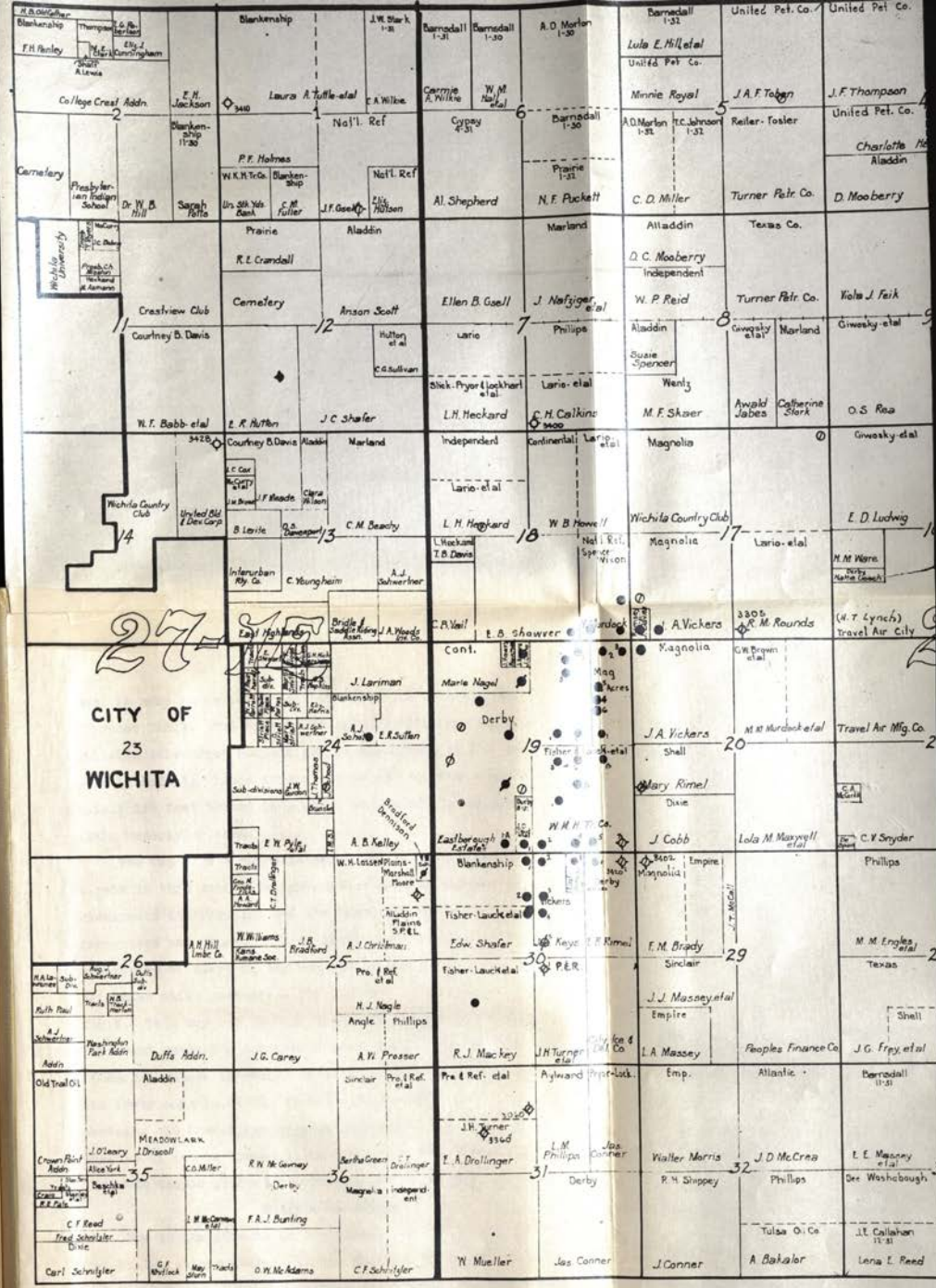


FIGURE 3.

MAP SHOWING THE LOCATION OF ALL WELLS REFERRED TO IN THIS REPORT.

Also in many cases a red rock is found just beneath the Florence Flint. The base of the Kansas City Lime is also a reliable subsurface horizon and is recognized by the prominent lithologic change from a series of limestones approximately 190 feet thick, to a thick series of bluish green shale underlying them.

The top of the "Mississippi Lime" is used very extensively in this region for subsurface mapping because of its widespread distribution and the fact that it can be easily recognized and traced. It is distinctive because of a concentration of chert in its uppermost part and because of its thickness which averages about 200 feet in the Eastborough field. This key bed is also desirable because it contains an important producing horizon in this field. The base of the Kinderhook Shale is easily recognized because this shale in its lower part is black, fissile and carbonaceous. It often contains the fossil Sporangites huronense. It is reliable because it can be traced throughout wide areas and it overlies the deeper producing horizons of the Eastborough field.

Surface Structure

Due to the absence of a suitable key bed in the Wellington Shale, which outcrops in the Eastborough Field, no attempt was made to map the surface structure. The Wellington Shale is composed almost entirely of soft clay shale, and although the unit does contain a few beds of thin limestone and gypsum, there is no individual bed or group of beds that

SUB SURFACE MAP CONTOURED ON THE BASE OF THE FLORENCE FLINT

Eastborough Oil Field
Contour Interval- 20 feet
Elevations above Sea Level
Geology by W. R. Vickery
May, 1932

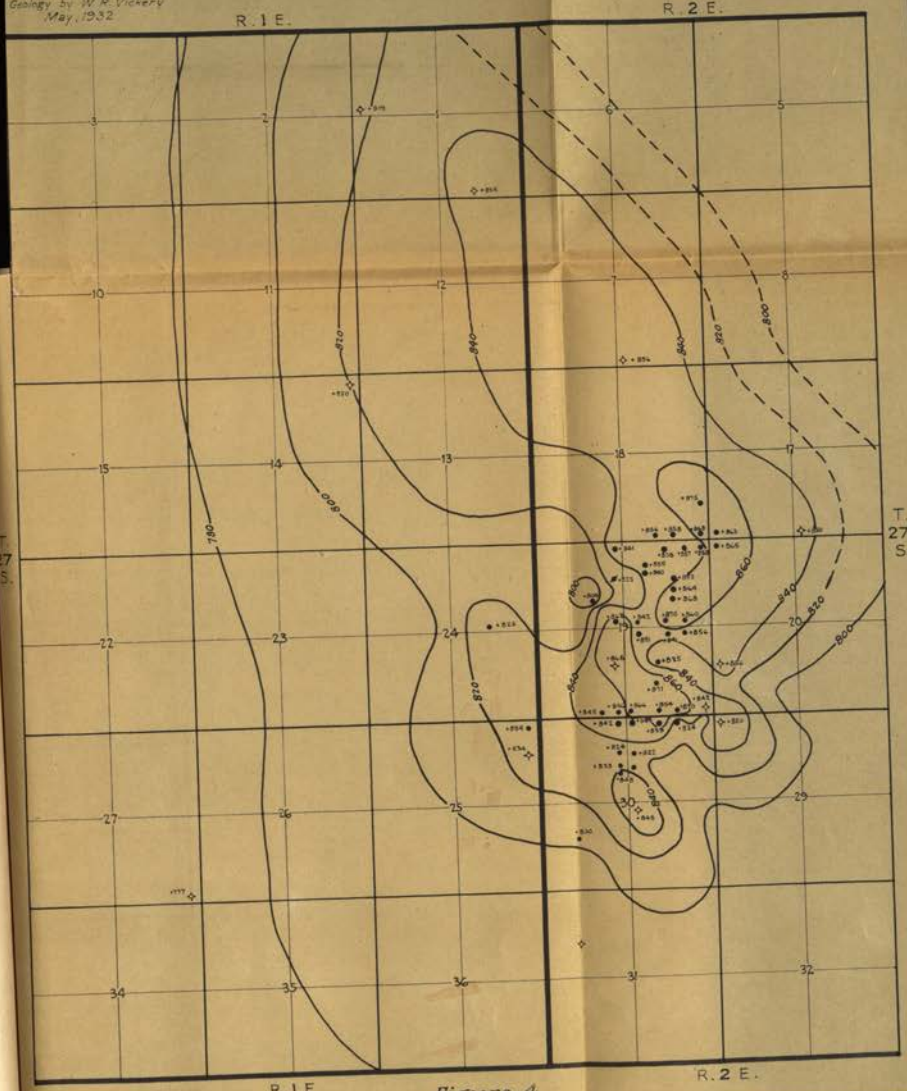


Figure 4

SUB SURFACE MAP CONTOURED ON THE BASE OF THE KANSAS CITY LIME

Easterough Oil Field
Contour Interval - 20 feet
Elevations below Sea Level
Geology by W.R. Vickery
May, 1932

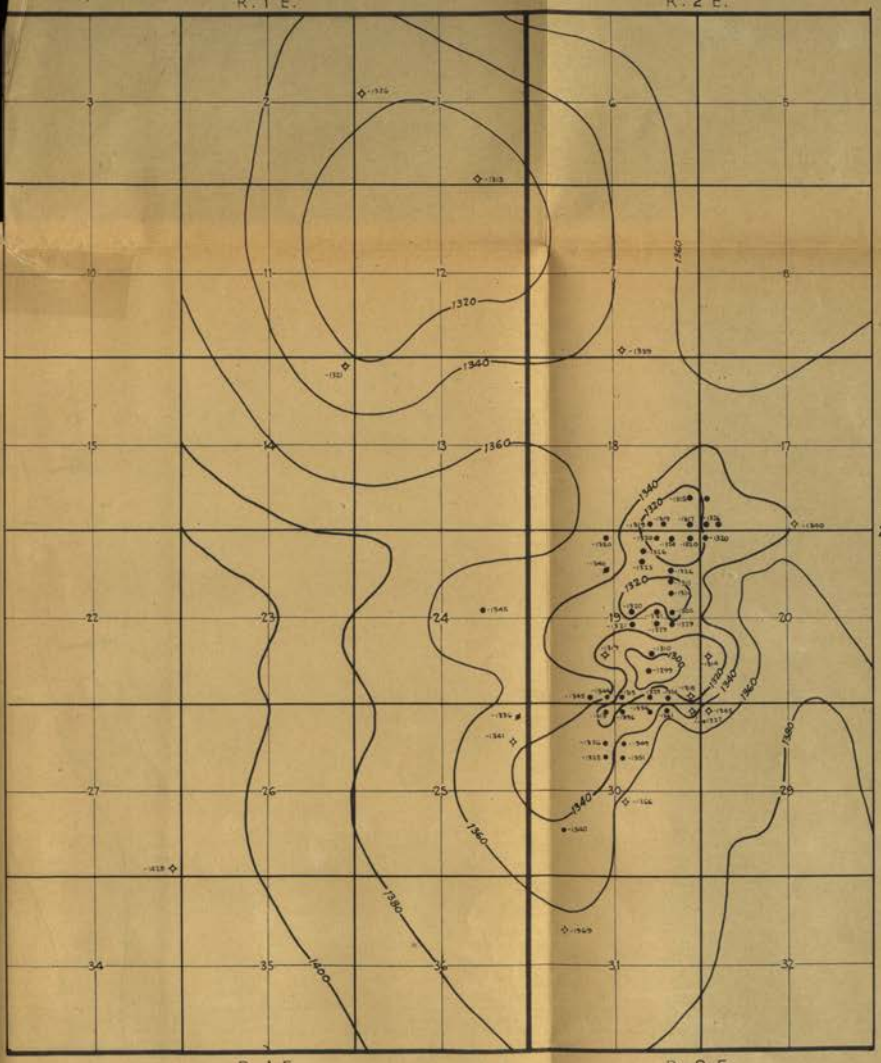


Figure 5

SUB SURFACE MAP CONTOURED ON THE TOP OF THE "CHAT"

Eastborough Oil Field
Contour interval - 20 Feet
Elevations below Sea Level
Geology by W.R. Vickery
May, 1932.

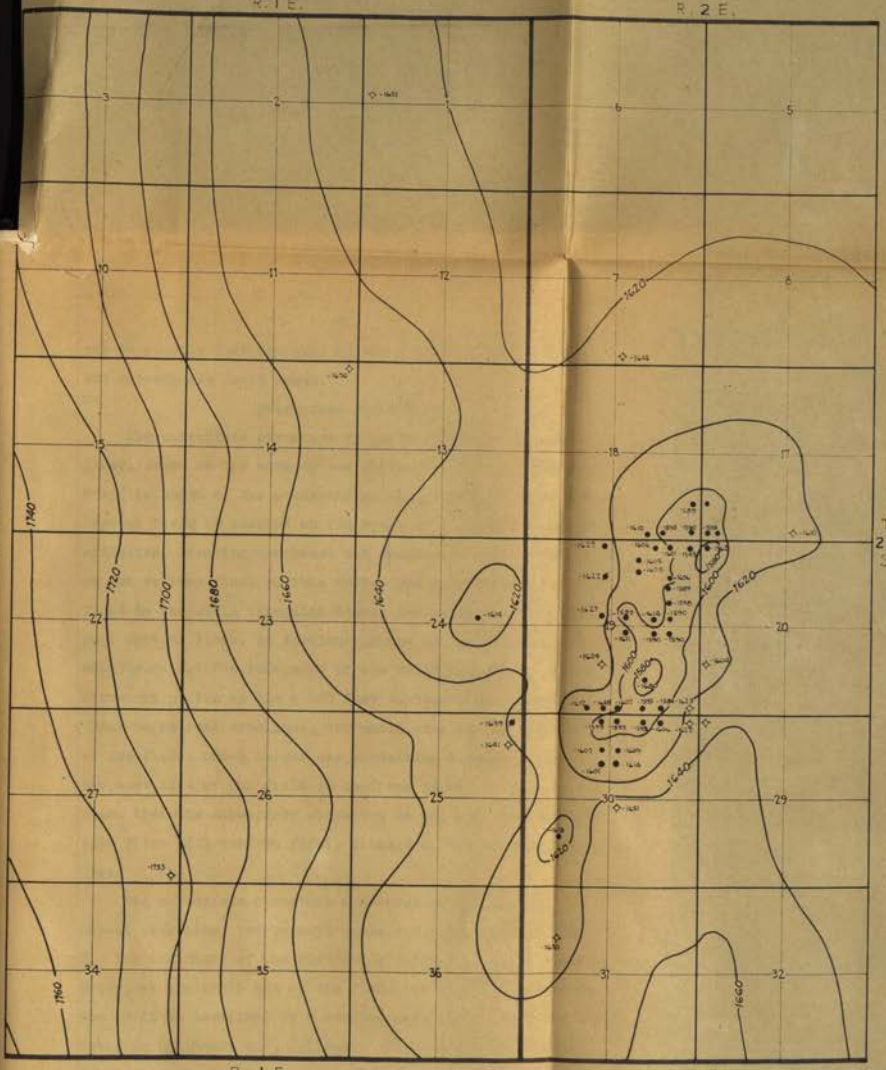


Figure 6

can be readily distinguished at the surface throughout any but exceedingly local areas.

Subsurface Structure

The subsurface structure as shown by means of contour lines, drawn on the base of the Florence Flint, (of Permian age), is shown on the accompanying map, Figure 4. The Eastborough field is located on the crest of a regional elongated anticline, trending northwest and southeast, and extends down on the western flank of this fold. The largest wells are confined to two small irregular domes, indicated by the + 860 foot contour lines, in sections 18 and 19, as noted on the map Figure 4. The remainder of the wells range down on the structure as far as the + 820 foot contour line. There are three re-entrant synclines, two small ones on the southeast of the field, and a larger one containing a small basin on the west side of the field in sections 24 and 19. It is assumed that the subsurface structure on the base of the Florence Flint will conform fairly closely to the surface structure.

The subsurface structure contoured on the base of the Kansas City Lime, (of Pennsylvanian age,) is shown in Figure 5. The influence of the regional structure is still clearly shown, at the north end of the field, on this map. However, the field is localized on a smaller anticlinal fold, its axis trending northeast and southwest. There are several small domal closures located on the crest of this anticline in

TABLE II

BASIC DATA FOR SUBSURFACE MAP ON THE BASE OF THE FLORENCE FLINT

Well	Location	Elevation	Base of Florence Flint	Elevation of Key Bed
Trustee #1	19-27-2	1346	475	871
Trustee #2	19-27-2	1350	484	866
Trustee #3	19-27-2	1354	503	851
Trustee #4	19-27-2	1342	488	854
Trustee #5	19-27-2	1351	481	870
Trustee #6	19-27-2	1356	515	841
Trustee #7	19-27-2	1357	515	842
Trustee #8	19-27-2	1356	500	856
Trustee #9	19-27-2	1350	515	835
Eastborough #1A ..	19-27-2	1360	515	845
Eastborough #1 ...	19-27-2	1360	518	842
Eastborough #2 ...	19-27-2	1360	490	870
Eastborough #3 ...	19-27-2	1360	520	840
Eastborough #4 ...	19-27-2	1354	496	858
Wheeler #1	19-27-2	1360	500	860
Wheeler #2	19-27-2	1347	490	857
Wheeler #3	19-27-2	1355	497	858
Wheeler #4	19-27-2	1354	490	864
Wheeler #5	19-27-2	1352	500	852
Wheeler #6	19-27-2	1353	485	868
Freeman #1	19-27-2	1371	530	841
Nagel #1	19-27-2	1367	542	825
Newman #1	19-27-2	1367	567	800
Hoard #1	19-27-2	1362	500	862
Smyser #1	19-27-2	1366	500	866
Cloud #1	19-27-2	1356	510	846
Soukup #1	19-27-2	1360	505	855
Keys #1	30-27-2	1339	480	859
Keys #2	30-27-2	1349	500	849
Keys #3	30-27-2	1351	529	822
Schafer #1	30-27-2	1358	516	842
Schafer #2	30-27-2	1349	525	824
Schafer #1 F&L ...	30-27-2	1348	495	853
Schafer #1A F&L ..	30-27-2	1348	500	848
Turner #1	30-27-2	1339	491	848
Rimel #1	30-27-2	1344	510	834
Mackey #1	30-27-2	1340	540	800
Murdock #1	18-27-2	1353	495	858
Murdock #2	18-27-2	1358	490	868
Murdock #3	18-27-2	1365	490	875
Fee #1	18-27-2	1356	500	856
Davis #1	17-27-2	1353	490	863
Rounds #1	17-27-2	1350	500	850

TABLE II
(Cont'd)

BASIC DATA FOR SUBSURFACE MAP ON
THE BASE OF THE FLORENCE FLINT

Well	Location	Elevation	Base of Florence Flint	Elevation of Key Bed
Vickers #1	20-27-2	1345	480	865
Mary Rimel #1	20-27-2	1356	500	856
Brady #1	29-27-2	1350	500	850
Calkins #1	7-27-2	1386	530	856
Dennison #1	25-27-1	1349	515	834
Christman #1	25-27-1	1344	510	834
Schott #1	24-27-1	1365	540	825
Schweiter #1	27-27-1	1297	520	777
Country Club #1 ..	14-27-1	1399	579	820
Tuttle #1	1-27-1	1369	550	819
Gsell #1	1-27-1	1394	540	854

TABLE III

BASIC DATA FOR SUBSURFACE MAP ON
THE BASE OF THE KANSAS CITY LIME

Well	Location	Elevation	Base of Kansas City Lime	Elevation of Key Bed
Trustee #1	19-27-2	1346	2645	-1299
Trustee #2	19-27-2	1350	2665	-1315
Trustee #3	19-27-2	1354	2675	-1321
Trustee #4	19-27-2	1342	2665	-1323
Trustee #5	19-27-2	1351	2675	-1324
Trustee #6	19-27-2	1356	2685	-1329
Trustee #7	19-27-2	1357	2675	-1318
Trustee #8	19-27-2	1356	2685	-1329
Trustee #9	19-27-2	1350	2660	-1310
Eastborough #1A .	19-27-2	1360	2705	-1345
Eastborough #1 ..	19-27-2	1360	2680	-1320
Eastborough #2 ..	19-27-2	1360	2691	-1331
Eastborough #3 ..	19-27-2	1360	2685	-1325
Eastborough #4 ..	19-27-2	1354	2680	-1326
Wheeler #1	19-27-2	1360	2665	-1305
Wheeler #2	19-27-2	1347	2670	-1323
Wheeler #3	19-27-2	1355	2675	-1320

TABLE III
(Cont'd.)

BASIC DATA FOR SUBSURFACE MAP ON
THE BASE OF THE KANSAS CITY LIME

Well	Location	Elevation	Base of Kansas City Lime	Elevation of Key Bed
Wheeler #4	19-27-2	1354	2665	-1311
Wheeler #5	19-27-2	1352	2678	-1326
Wheeler #6	19-27-2	1353	2667	-1314
Freeman #1	19-27-2	1371	2721	-1350
Nagel #1	19-27-2	1367	2707	-1340
Smyser #1	19-27-2	1366	2685	-1319
Cloud #1	19-27-2	1356	2700	-1344
Soukup #1	19-27-2	1360	2680	-1320
Keys #1	30-27-2	1339	2675	-1336
Keys #2	30-27-2	1349	2685	-1336
Keys #3	30-27-2	1351	2700	-1349
Keys #4	30-27-2	1339	2690	-1351
Schafer #1	30-27-2	1358	2671	-1313
Schafer #2	30-27-2	1349	2675	-1326
Schafer #1 F&L ...	30-27-2	1348	2670	-1322
Turner #1	30-27-2	1339	2705	-1366
Rimel #1	30-27-2	1344	2705	-1361
Rimel #2	30-27-2	1353	2680	-1327
Mackey #1	30-27-2	1340	2680	-1340
Murdock #1	18-27-2	1353	2672	-1319
Murdock #2	18-27-2	1358	2675	-1317
Murdock #3	18-27-2	1365	2680	-1315
Fee #1	18-27-2	1356	2675	-1319
Davis #1	17-27-2	1353	2679	-1326
Rounds #1	17-27-2	1350	2690	-1340
Vickers #1	20-27-2	1345	2665	-1320
Mary Rimel #1	20-27-2	1356	2670	-1314
Brady #1	29-27-2	1350	2695	-1345
Calkins #1	7-27-2	1386	2725	-1339
Dennison #1	25-27-1	1349	2685	-1336
Christman #1	25-27-1	1344	2685	-1341
Schott #1	24-27-1	1365	2710	-1345
Schweiter #1	27-27-1	1297	2725	-1428
Tuttle #1	1-27-1	1369	2695	-1326
Gsell #1	1-27-1	1394	2707	-1313
Country Club #1 ..	14-27-1	1399	2720	-1321

TABLE IV

BASIC DATA FOR SUBSURFACE MAP ON THE TOP OF THE MISSISSIPPI LIME

Well	Location	Elevation	Top of Mississippi Lime	Elevation of Key Bed
Trustee #1	19-27-2	1346	2926	-1580
Trustee #2	19-27-2	1350	2952	-1602
Trustee #3	19-27-2	1354	2965	-1611
Trustee #4	19-27-2	1342	2937	-1595
Trustee #5	19-27-2	1351	2935	-1584
Trustee #6	19-27-2	1356	2946	-1590
Trustee #7	19-27-2	1357	2980	-1623
Trustee #8	19-27-2	1356	2946	-1590
Eastborough #1A.	19-27-2	1360	2972	-1612
Eastborough #1 .	19-27-2	1360	2949	-1589
Eastborough #2 .	19-27-2	1360	2974	-1614
Eastborough #3 .	19-27-2	1360	2965	-1605
Eastborough #4 .	19-27-2	1354	2960	-1606
Wheeler #1	19-27-2	1360	2950	-1590
Wheeler #2	19-27-2	1347	2948	-1601
Wheeler #3	19-27-2	1355	2948	-1593
Wheeler #4	19-27-2	1354	2943	-1589
Wheeler #5	19-27-2	1352	2958	-1606
Wheeler #6	19-27-2	1353	2951	-1598
Freeman #1	19-27-2	1371	2998	-1627
Nagel #1	19-27-2	1367	2989	-1622
Newman #1	19-27-2	1367	2994	-1627
Smyser #1	19-27-2	1366	2990	-1624
Cloud #1	19-27-2	1356	2961	-1605
Soukup #1	19-27-2	1360	2965	-1605
Keys #1	30-27-2	1339	2932	-1593
Keys #2	30-27-2	1349	2942	-1593
Keys #3	30-27-2	1351	2960	-1609
Keys #4	30-27-2	1339	2953	-1614
Schafer #1	30-27-2	1358	2953	-1595
Schafer #2	30-27-2	1349	2956	-1607
Schafer #1 F&L .	30-27-2	1348	2949	-1601
Turner #1	30-27-2	1339	2990	-1651
Rimel #1	30-27-2	1344	2950	-1606
Rimel #2	30-27-2	1353	2975	-1622
Mackey #1	30-27-2	1340	2958	-1618
Murdock #1	18-27-2	1353	2951	-1598
Murdock #2	18-27-2	1358	2948	-1590
Murdock #3	18-27-2	1365	2954	-1589
Fee #1	18-27-2	1356	2966	-1610
Davis #1	17-27-2	1353	2951	-1598
Rounds #1	17-27-2	1350	2960	-1610

TABLE IV
(Cont'd)

BASIC DATA FOR SUBSURFACE MAP ON
THE TOP OF THE MISSISSIPPI LIME

Well	Location	Elevation	Top of Mississippi Lime	Elevation of Key Bed
Vickers #1	20-27-2	1345	2907	-1562
Mary Rimel #1 ..	20-27-2	1356	2960	-1604
Calkins #1	7-27-2	1386	3000	-1614
Dennison #1	25-27-1	1349	2988	-1639
Christman #1 ...	25-27-1	1344	2985	-1641
Schott #1	24-27-1	1365	2979	-1614
Schweiter #1 ...	27-27-1	1297	3030	-1733
Country Club #1.	14-27-1	1399	3055	-1656
Tuttle #1	1-27-1	1369	3000	-1631

sections 18 and 19. The small dome, in the southeast quarter of section 19, shows 40 feet of closure.

The Subsurface Structure, contoured on the top of the "Chat", is shown in Figure 6. The regional structure is not so evident as shown by this map; however, the field lies across its trend suggesting the possibility of cross folding.

The "Chat" is irregular in its thickness and distribution in the area shown on the map and it is questionable whether or not it relates the true structural conditions. It does show, however, an anticline trending a little east of north, with two small domes in sections 19 and 20. These domes have a closure of 60 feet, whereas the domes shown on the preceding map, Figure 5, have a closure of only 40 feet, indicating that the structure steepens with depth. The writer feels that the top of the "Chat", in this case, does relate the true structural conditions, the field being confined to

SUB SURFACE MAP CONTOURED ON THE BASE OF THE KINDERHOOK SHALE

Eastborough Oil Field
Contour Interval - 20 feet
Elevations below Sea Level
Geology by – W.R. Vickery
May, 1932

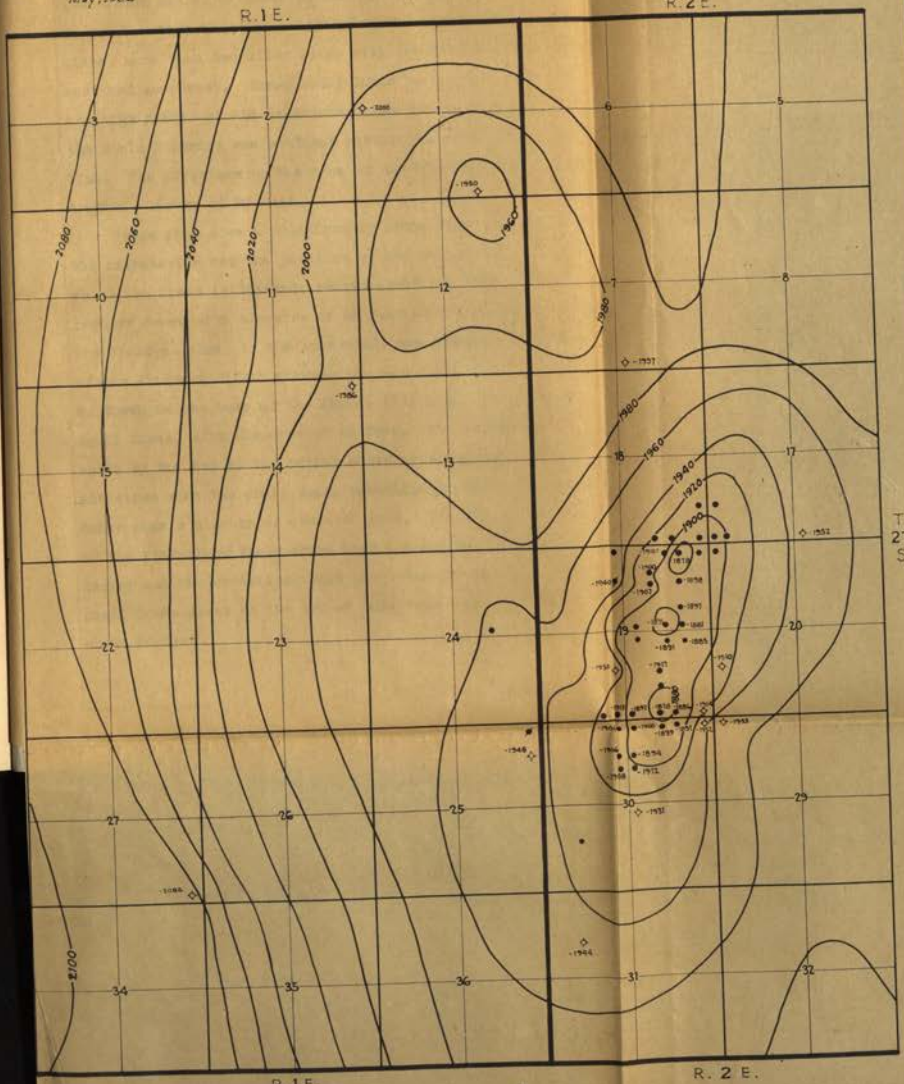


Figure 7

the limits of the -1620 contours enclosing this anticline.

The subsurface structure contoured on the base of the Kinderhook Shale, of lower Mississippian age, is shown in Figure 7. The structure on this horizon is a closed anticline, more than two miles long, with its axis trending northeast and southwest. Three small domes in section 19 denote the high points of the structure. The producing wells from the Viola Dolomite are confined within the -1920 foot contour line. The structure on the base of the Kinderhook Shale shows a total closure of 80 feet.

These maps show a relationship since they indicate that the orientation and the position of the anticlinal fold, on which the field is located, remain about the same. Two irregular domes with closures of 20 feet show the structure of the field as shown by the subsurface map drawn on the base of the Florence Flint; whereas the structure shown by Figure 5, drawn on the base of the Kansas City Lime, shows three small domes, with closures of 40 feet. The structure as shown by the top of the "Chat" shows an elongated irregular anticline with two small domes superimposed upon it. These domes show a closure of about 60 feet. The map on the base of the Kinderhook Shale shows that the structure has become larger and the anticlinal fold more clearly defined. Three small domes occur on the top of this fold with closures of about 80 feet.

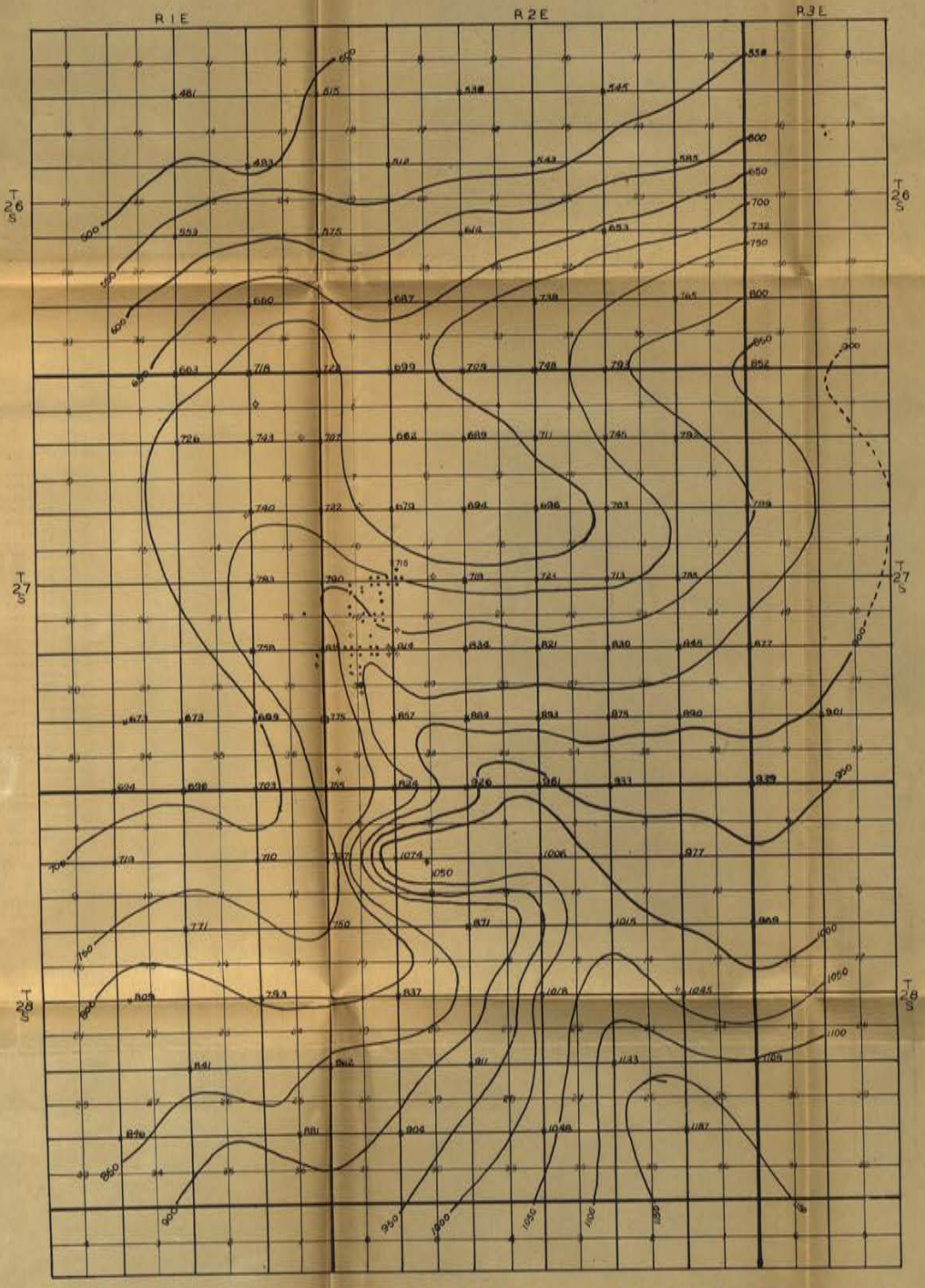
FIGURE 8

MAGNETOMETER SURVEY

OF AN AREA IN

SEDGWICK COUNTY KANSAS

INCLUDING THE EASTBOROUGH OIL FIELD



CONTOUR INTERVAL 50 GAMMA

X POINT OF MEASURMENT

• OIL WELL

✧ DRY HOLE

W R VICKERY OPERATOR

FEB 1932

TABLE V

BASIC DATA FOR SUBSURFACE MAP ON THE BASE OF THE KINDERHOOK SHALE

Well	Location	Elevation	Base of Kinderhook Shale	Elevation of Key Bed
Trustee #2	19-27-2	1350	3242	-1892
Trustee #4	19-27-2	1342	3220	-1878
Trustee #5	19-27-2	1351	3237	-1886
Trustee #6	19-27-2	1356	3247	-1891
Trustee #7	19-27-2	1357	3271	-1914
Trustee #8	19-27-2	1356	3241	-1885
Trustee #9	19-27-2	1350	3267	-1917
Eastborough #2.	19-27-2	1360	3231	-1871
Eastborough #3.	19-27-2	1360	3267	-1907
Eastborough #4.	19-27-2	1354	3255	-1901
Wheeler #1	19-27-2	1360	3241	-1881
Wheeler #2	19-27-2	1347	3225	-1878
Wheeler #5	19-27-2	1352	3250	-1898
Wheeler #6	19-27-2	1353	3250	-1897
Nagel #1	19-27-2	1367	3316	-1949
Smyser #1	19-27-2	1366	3296	-1930
Cloud #1	19-27-2	1356	3271	-1915
Soukup #1	19-27-2	1360	3260	-1900
Keys #1	30-27-2	1339	3238	-1899
Keys #2	30-27-2	1349	3249	-1900
Keys #3	30-27-2	1351	3245	-1894
Keys #4	30-27-2	1339	3251	-1912
Schafer #1	30-27-2	1358	3262	-1904
Schafer #2	30-27-2	1349	3255	-1906
Schafer #1A F&L.	30-27-2	1348	3256	-1908
Turner #1	30-27-2	1339	3270	-1931
Rimel #1	30-27-2	1344	3235	-1891
Rimel #2	30-27-2	1353	3305	-1952
Drollinger #1 HPCo	31-27-2	1321	3265	-1944
Rounds #1	17-27-2	1350	3302	-1952
Mary Rimel #1 .	20-27-2	1356	3266	-1910
Brady #1	29-27-2	1350	3305	-1955
Calkins #1	7-27-2	1386	3383	-1997
Christman #1 ..	25-27-1	1344	3292	-1948
Schweiter #1 ..	27-27-1	1297	3382	-2085
Country Club #1	14-27-1	1399	3385	-1986
Tuttle #1	1-27-1	1369	3367	-2000
Gsell #1	1-27-1	1394	3344	-1950

Magnetometer Survey

A magnetometer survey was made covering an area adjacent to and including the Eastborough field, to determine whether or not there is a similarity between the structure as indicated by the magnetometer, and the subsurface structure. The magnetometer map is shown in Figure 8. The contours shown on this map are lines connecting points of equal magnetic intensity, with the regional correction* applied to points of observation. The contour interval is 50 gamma**. The Magnetometer shows a long nose pointing northwest, and extending from section 36, Township 28, Range 2 East northwest to section 36, Township 26, Range 1 East. The Eastborough field is located on this nose in sections 17, 18, 19, 24, and 30, Township 27, Ranges 1 and 2 East, as seen on the accompanying map Figure 7. The magnetometer seems to show the position of the regional structure on which the field is located and only in this respect does it show a similarity to the subsurface maps.

Relation of Production to Structure

The oil accumulation in the Eastborough field has been in accordance with the anticlinal theory. However, there are a few important factors which have influenced this accumulation. The structure is anticlinal as shown by the subsurface

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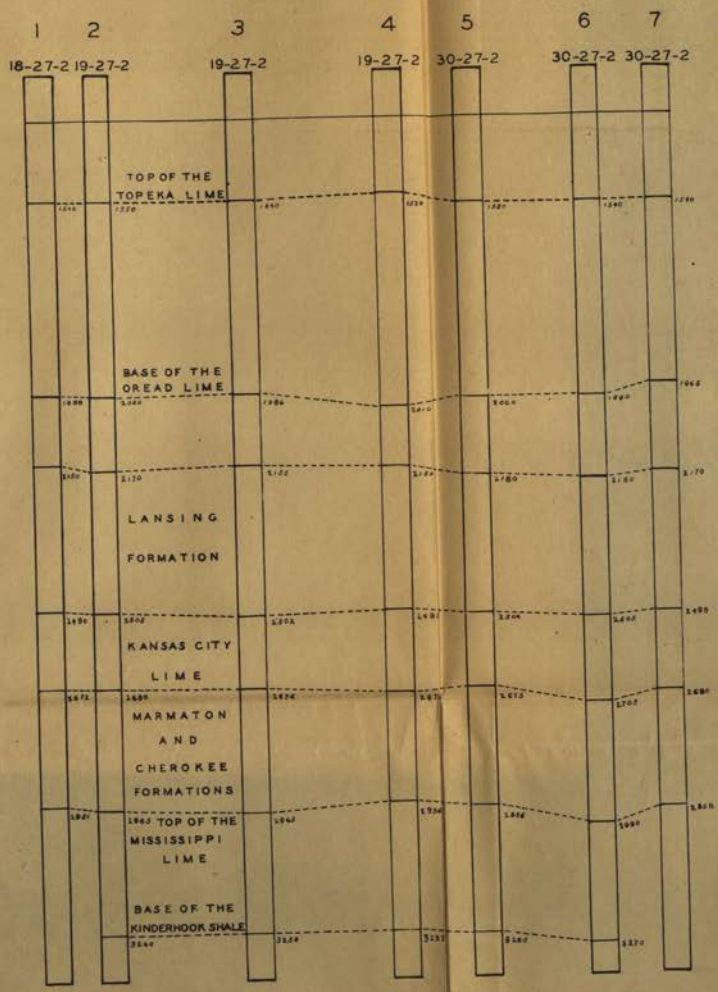
*The regional correction is a correction for the increase to the north and the decrease to the south of the Earth's magnetic field.

**1 gauss unit = 100,000 gamma.



WELLS

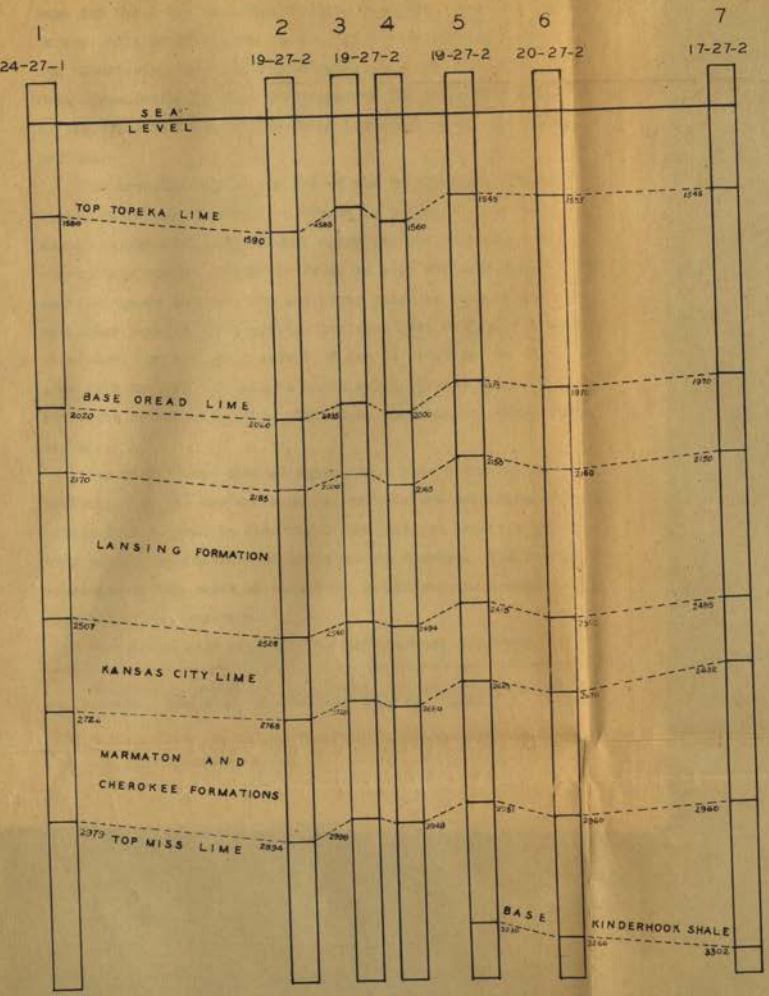
1. NATIONAL MURDOCK NO. 1.
2. SEIGEL BROS. SOUKUP NO. 1.
3. FISHER & LAUCK TRUSTEE NO. 3.
4. FISHER & LAUCK TRUSTEE NO. 5.
5. BLANKINSHIP SCHAFER NO. 2.
6. PRODUCERS & REFINERS TURNER NO. 1.
7. MARLAND ET. AL. MACKEY NO. 1.

FIGURE 10. NORTH-SOUTH CROSS SECTION SHOWING SUBSURFACE CORRELATIONS OF THE EASTBOROUGH OIL FIELD

SCALE

HORIZONTAL 4 INCHES = 1 MILE
VERTICAL 1 INCH = 200 FEET

MAY - 1932 W.R.V.



WELLS

1. BLANKINSHIP SCHOTT NO. 1.
2. H.A. MILLER NEWMAN NO. 1.
3. WORK-COVEL FREEMAN NO. 1
4. DERBY EASTBOROUGH NO. 1.
5. MAGNOLIA WHEELER NO. 6.
6. E.F. JONES MARY RIMEL NO. 1.
7. LARIO ROUNDS NO. 1.

FIGURE 9 EAST-WEST CROSS SECTION SHOWING SUBSURFACE CORRELATIONS OF THE EASTBOROUGH OIL FIELD

SCALE
HORIZONTAL 4 INCHES 1 MILE
VERTICAL 1 INCH 200 FEET
MAY 1932 - W.R.V.

maps and the Cross Sections, Figures 9 and 10. The best wells in the Viola horizon occur on the top of the structure where the "Mississippi Lime" and Kinderhook Shale are thinnest. This accumulation is also influenced by the porosity caused by the dolomitization of the Viola Limestone as the producing horizon.

The accumulation in the top of the "Mississippi Lime" occurs where the thickness of "Chat" is sufficient and high enough on the structure so that water has not completely saturated this "Chat". Water is found in both horizons only a small distance down the dip and often water is encountered in the lower part of the producing horizons even on top of the structure. Only a small amount of gas is found in the horizons with the oil and only in those wells located on the higher points of the structure. This gas, when tapped, diminishes rapidly.

Ver Wiebe[28] has divided Kansas into five producing territories. In the eastern zone he includes the producing territory from Johnson to Chautauqua Counties and here the relation between production and structure is obscure. The patchy character of the sands of this zone influences the accumulation more than structure.

The second zone extends from northeastern Greenwood

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[28]Walter A. Ver Wiebe, Oil Fields in the United States, pp. 207-216. New York: McGraw-Hill Book Co., 1930.

County through eastern Cowley County. Here the accumulation is not in accordance with the anticlinal theory, the oil being found on trends of shoestring sands.

The third zone extends from Chase County to eastern Sumner County. Here production and structure correspond closely. It is in this zone that the Eastborough Field occurs. Other fields in this zone are the Eldorado field and the Augusta field, in Butler County, the Oxford-Churchill field in Sumner County, the Valley Center and Greenwich pools in Sedgwick County.

The fourth zone extends from McPherson County to Barber County. Only a few pools have been discovered in this territory and the relation of production to structure has not yet been determined. The main producing horizons in the fourth zone are the top of the "Mississippi Lime", the Welsh Chert or Pennsylvanian basal conglomerate, and the Viola Limestone.

The fifth zone includes the remaining part of the state. A few pools have been discovered in this area, the most important of which are: the Bushton field, in southwestern Ellsworth and northwestern Rice Counties, the Fairport field in Russell County, and the Hugoton gas field in Morton and Stevens Counties. The main producing horizons in this area are: the "Siliceous Lime", the Oswald Lime, and the Pennsylvanian basal conglomerate (Gorham Sand). The gas production in the Hugoton field occurs in a zone near the base of the Permian.

CHAPTER IV

PRODUCTION STATISTICS

The first wells in the Eastborough field were drilled in the latter part of 1929. Due to the poor market conditions in 1930, only a few operators were able to get pipe line connections to sell the oil produced, and production was held down to a minimum.

The major development of this field occurred in the middle part of 1930, and its peak of production of 365,580 barrels in November of that year. Table Number VI gives the production statistics for the Eastborough field including the production per month, and the daily average production per month for 1929, 1930, and 1931. The approximate total production to May, 1932 is over 4,000,000 barrels. The approximate per-acre production to May, 1932 is 8,500 barrels. (Based on an area of 500 acres, or approximately 10 acres per well.)

The encroachment of salt water and the rapid decline of production made the "Chat" wells expensive to operate, and many of them were deepened to the Viola Lime within a few months' time. The production from the Viola Lime is much longer lived, but some of the wells produce considerable water.

The gravity of the oil from the "Mississippi Lime" averages about 42° (degrees) Be'. The gravity of the oil from the Viola Lime averages about 40° Be'.

TABLE VI

PRODUCTION STATISTICS FOR THE EASTBOROUGH OIL FIELD

Month	Monthly Total			Daily Average	
	1929	1930	1931	1930	1931
January		5536*	245,024	184	7904
February		4719	224,560	157	8020
March		4919	222,053	163	7163
April		4954	190,470	165	6349
May		4940	169,632	164	5472
June		9928	163,800	330	5460
July		34,308	129,270	1143	4170
August		102,021	161,107	3291	5197
September		161,610	163,110	5387	5437
October		241,025	176,143	7775	5628
November		365,580	164,760	12,186	5492
December		317,233	239,227	10,233	7717
Total Production	11,890	1,256,773	2,249,145		
Yearly Average per day				3,431	6,172

*Figures indicate barrels.

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