AN ABSTRACT OF THE THESIS OF

Gregory M. Saint Clair for the Master of Science
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Abstract Approved: Thomas E. Bridge

The discovery well of the Seydell oil pool was completed in January, 1958. Since that time, approximately 50 wells have been drilled in the field. The oil pool is located in the Sedgwick Basin of south-central Kansas.

Production is primarily obtained from the Simpson sandstone of the middle Ordovician age. Minor production is also obtained from the Mississippian and Kansas City group. As of November, 1984, approximately 2,000,000 barrels of oil have been produced.

The structure shown by subsurface mapping is a northerly trending, southerly plunging anticline with a closure of approximately 77 feet on top of the Simpson group. The closure of the structure increases with depth.

GEOLOGY OF THE SEYDELL OIL POOL

A Thesis
Presented to
the Department of Earth Science
EMPORIA STATE UNIVERSITY

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

By
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The author is especially grateful to his family, particularly to Emerson and Lee St. Clair, for their patience and support toward the completion of this study and degree.

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LOCATION

The Seydell oil pool is located in Sumner County, Kansas, (Fig. 1) in sections 8, 9, 16, 17 and 20, T. 30 S., R.1 E (Fig. 2). Physiographically, the pool is in the Arkansas River Lowlands.

TOPOGRAPHY

The surface rocks in the immediate area of the Seydell pool are predominently Quaternary alluvial deposits, situated in the flood plain between the Arkansas and Ninnescah Rivers.

The surface rocks dip gently in a southeasternly direction, with elevation ranging from approximately 1260' in the northern end of the field to 1220' in the southern end of the field (Topographic map).

HISTORY OF THE SEYDELL POOL

The discovery well of the Seydell pool, the Shawver-Armour Oil Company 17-1 Seydell well, located in SW SW SE 17. T. 30 S., R.1 E., was completed in January, 1958. The well had an initial bottom hole pressure of 1400 #, with a natural flow of 45 barrels of oil at a depth of 3826 feet producing from the Simpson sandstone (St. Peter sandstone).

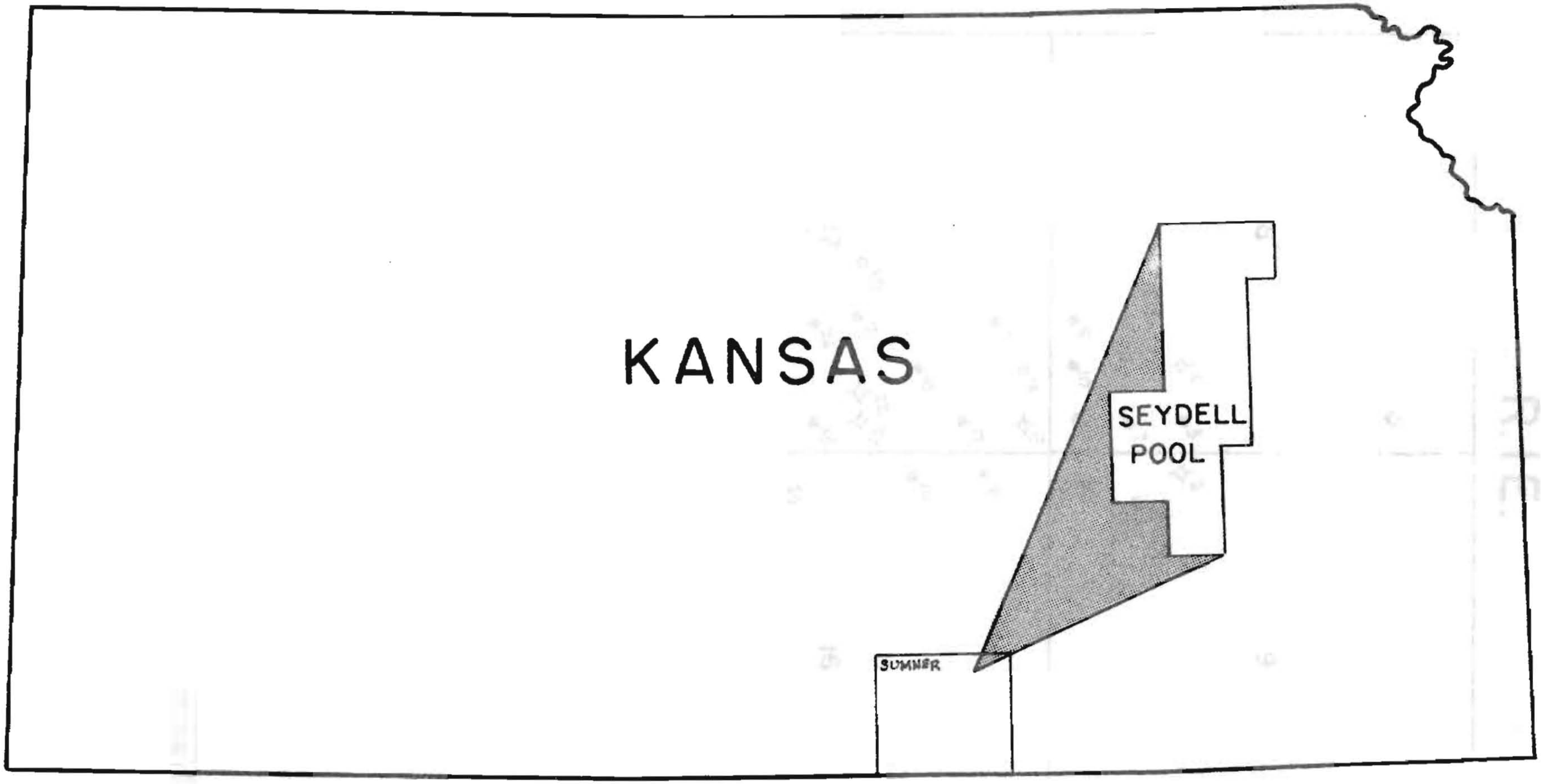


FIGURE 1

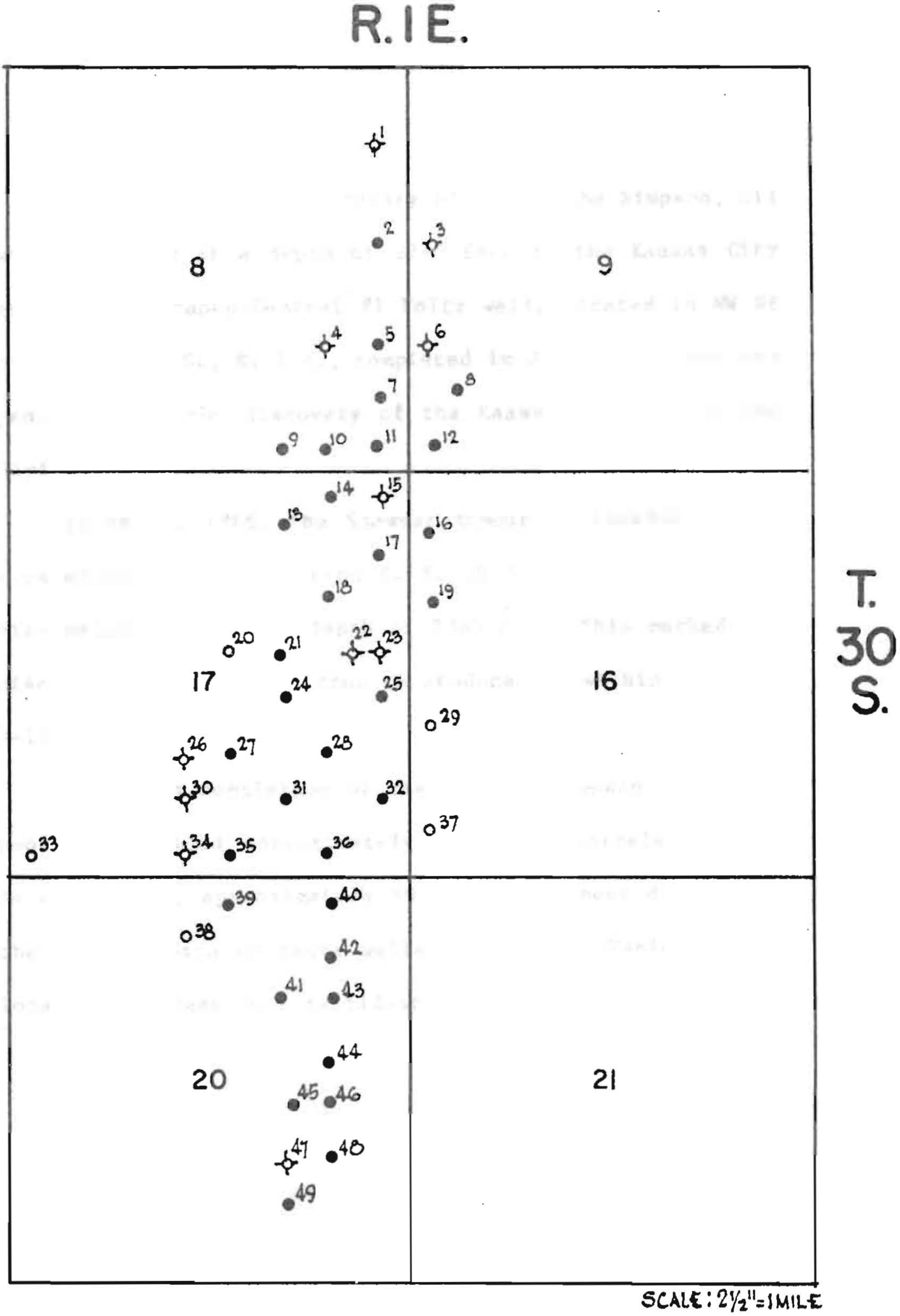


FIGURE 2 INDEX MAP SHOWING LOCATION OF WELLS DRILLED IN THE SEYDELL FIELD.

Subsequent to the discovery of oil in the Simpson, oil was discovered at a depth of 2747 feet in the Kansas City group. The Franco-Central #1 Foltz well, located in NW NE SE, 20. T. 30 S., R. 1 E., completed in July, 1959, was repsonsible for the discovery of the Kansas City oil in the Seydell pool.

In March, 1965, the Shawver-Armour #1 Lockhart well, located in SE SE NE section 8. T. 30 S., R. 1 E., yielded Mississippian oil at a depth of 3349 feet. This marked the discovery of the third group to produce oil within the Seydell field.

Since the completion of the initial Simpson well, the pool has yielded approximately 2,000,000 barrels of oil. As of 12-1-84, approximately 50 wells have been drilled in the area. (Data on these wells is given in Table 1. The location of these well is illustrated in Figure 2).

TABLE #1

No. on Map	Well Name	Location	Initial Production (BOPD)	Date Completed	Subsea Elevation of Lowest Formation Penetrated (feet)
1	Shawver-Armour #2 Lockhart	8-30S-1E SE NE NE	D&A	1965	Miss.-2105
2	Shawver-Armour #1 Lockhart	8-30S-1E SE SE NE	33	1965	Simp.-2561
3	Kennedy-Mitchell #44-660 Murray	9-30S 1E SE SE NW	D&A	1981	3960 TD
4	Petroleum Inc. #1 Nordstrom	8-30S-1E SW NE SE	D&A	1959	Arb.-2611
5	Shawver-Armour #1 Nordstrom	8-30S-1E SE NE SE	85	1961	Simp.-2540
6	Shawver-Armour #3 Stunkel	9-30S-1E SW NW SW	D&A	1961	Arb.-2619
7	Petroleum Inc. #3 Forney	8-30S-1E NE SE SE	25	1970	Simp.-2528
8	Solar Oil #2 Stunkel	9-30S-1E N2 SW SW	25	1960	Simp.-2550
9	Shawver-Armour #1 Costin	8-30S-1E SE SW SE	127(pp)	1959	Simp.-2537
10	Petroleum Inc. #1 Forney	8-30S-1E SW SE SE	67	1959	Simp.-2527
11	Petroleum Inc. #2 Forney	8-30S-1E SE SE SE	48	1960	Simp.-2523
12	Solar Oil #1 Stunkel	9-30S-1E SW SW SW	100	1960	Simp.-2526
13	Petroleum Inc. #2 Sprout	17-30S-1E C-E/2 NW NE	31(pp)	1960	Simp.-2545
14	Petroleum Inc. & Lebow	17-30S-1E NW NE NE	51(pp)	1959	Simp.-2533
15	Avanti Petro. #1 Sprout	17-30S-1E NE NE NE	D&A	1983	tight
16	Petroleum Inc. #1 Seydell	16-30S-1E C-W/2 NW NW	99(pp)	1960	Simp.-2532

TABLE #1

No. on Map	Well Name	Location	Initial Production (BOPD)	Date Completed	Subsea Elevation of Lowest Formation Penetrated (feet)
17	Petroleum Inc. #3 Sprout	17-30S-1E SE NE NE	64(pp)	1960	Simp.-2533
18	Petroleum Inc. #3 Corfield	17-30S-1E NW SE SE	70(pp)	1960	Simp.-2541
19	Petroleum Inc. #1 Sydell	16-30S-1E NW SW NW	"B" 89	1960	Simp.-2543
20	Rains&Williamson#1 Corfield	17-30S-1E SW SW NE	D&A	1974	K.C.-1528 B.K.C.-1759
21	Petroleum Inc. #2 Corfield	17-30S-1E SE SW NE	94(pp)	1959	Simp.-2552
22	Petroleum Inc. #4 Corfield	17-30S-1E C-S/2 SE NE	D&A	1960	Simp.-2542
23	Petroleum Inc. #1 Corfield	17-30S-1E SE SE NE	D&A	1958	Simp.-2542
24	Shawver-Armour #6 Seydell	17-30S-1E NE NW SE	51	1959	Simp.-2561
25	Shawver-Armour #8 Seydell	17-30S-1E NE NE SE	109	1959	Simp.-2552
26	Hammer&MacLean #2 Winstead	17-30S-1E SE NE SW	D&A	1958	Simp.-2587
27	Shawver-Armour #5 Seydell	17-30S-1E SW NW SE	80(pp)	1958	Simp.-2573
28	Shawver-Armour #4 Seydell	17-30S-1E SW NE SE	90(pp)	1958	Simp.-2557
29	Brunson-Spines #2 La Force	16-30S-1E WL NW SW	D&A	1959	Simp.-2642
30	Hammer&MacLean #2 Winstead	17-30S-1E SE NE SW	D&A	1958	Simp.-2587
31	Shawver-Armour #2 Seydell	17-30S-1E NE SW SE	200(pp)	1958	Simp.-2564
32	Shawver-Armour #7 Seydell	17-30S-1E NE SE SE	80	1959	Simp.-2565
33	Messman-Rinehart#1 Winstead	17-30S-1E SW SW SW	D&A	1957	Simp.-2608

TABLE #1

No. on Map	Well Name	Location	Initial Production (BOPD)	Date Completed	Subsea Elevation of Lowest Formation Penetrated (feet)
34	Messman-Rinehart #2 Winstead	17-30S-1E SE SE SW	D&A	1958	Simp.-2632
35	Shawver-Armour #1 Seydell	17-30S-1E SW SW SE	300(pp)	1958	Simp.-2580
36	Shawver-Armour #3 Seydell	17-30S-1E SW SE SE	1698(pp)	1958	Simp.-2572
37	Brunson-Spines #1 LaForce	16-30S-1E WL SW SW	D&A	1959	Simp.-2581
38	Stelbar #1 Downs "A"	20-30S-1E C-E/2 NE NW	D&A	1959	Arb.-2679
39	Stelbar #1 Downs	20-30S-1E NW NW NE	28	1958	Simp.-2580
40	Stelbar #2 Downs	20-30S-1E NW NE NE	128	1958	Simp.-2574
41	Shawver-Armour #2 Downs	20-30S-1E NE SW NE	137(pp)	1959	Simp.-2581
42	Stelbar #3 Downs	20-30S-1E SW NE NE	120	1959	Simp.-2579
43	Shawver-Armour #1 Downs	20-30S-1E NW SE SE	35(pp)	1958	Simp.-2581
44	Shawver-Armour #3 Downs	20-30S-1E SW SE NE	154(pp)	1959	Arb.-2661
45	C.R.A. #1 Beams "A"	20-30S-1E NE NW SE	26	1959	Simp.-2588
46	Franco-Central #1 Foltz	20-30S-1E NW NE SE	567(pp)	1959	Simp.-2589
47	Docking #1 Beams	20-30S-1E SE NW SE	D&A	1982	K.C.-1531
48	Franco-Central #2 Foltz	20-30S-1E SW NE SE	100(pp)	1960	K.C.-1530
49	C.R.A. #2 Beams "A"	20-30S-1E NE SW SE	51(pp)	1960	K.C.-1533

Detailed subsurface structural mapping was responsible for the discovery of the field. The subsequent development of the field was due largely to the activities of the Shawver-Armour Oil Company.

PURPOSE

The primary purpose of this study is to determine the geologic nature of the Seydell oil pool. By studying and interpreting the various geologic parameters, the writer intends to determine the geologic history and nature of the traps.

This study also intends to analyze and interpret the stratigraphic and structural characteristics of the Seydell pool as compared to the regional geology.

A brief investigation into the production statistics is also included.

METHODS OF INVESTIGATION

Study of the structure and stratigraphy is based on the analysis and interpretation of sample cuttings, electric and radioactive logs, completion reports, as well as rate of penetration logs, collected from over 80 wells.

Sample cuttings were analyzed to determine lithological characteristics. Due to the variable percentage of caved and re-circulated cuttings, accurate interpretations of formation thicknesses and correctly identifying bed boundries are somewhat difficult. Wire line logs and rate of penetration logs are used to aid in the determination of vertical as well as lateral changes in lithology.

Study of the structure is based on the interpretation of structural maps and cross sections, that were constructed from data obtained from wire line log interpretations.

PREVIOUS INVESTIGATION

There are no previous publications that are devoted specifically to the Seydell pool. However, there are works that cover the area on a general, regional basis. Listed below are the publications used which best pertain to the objectives of this study: Merriam (1963), Zeller (1968) and Lee (1956).

GEOLOGICAL HISTORY

DEPOSITIONAL HISTORY

The sediments of the Sedgwick Basin are shelf and shallow marine deposits, that thicken to the south and west, and thin rapidly to the north and east towards the margins of the basin.

The Paleozoic era began with the study occupying a position on a broad nearly level peneplain of crystalline rocks. This peneplaination was the result of a major regional pre-Paleozoic post-Precambrian unconformity (Merrian, 1963). A thin veneer of poorly sorted arkosic sands was then deposited on the basement complex.

The region was subsequently inundated by warm, shallow, clear, Cambro-Ordovician seas. This resulted in the deposition of the Arbuckle group. The seas temporarily receded, allowing for a short period of erosion prior to the deposition of the initial Simpson sediments. The numerous unconformities present in the Simpson group indicates that Simpson seas were oscillatory in nature. These flucuations may have been related to the initial positive movement of the Nemaha Anticline (Cronenwett and Disney, 1956).

If present, the Hunton group and Viola limestone were entirely stripped away by major, regional, pre-Chattanoogan erosion.

The Chattanooga shales were unconformably deposited on the Simpson group during late Devonian - early Mississipian time.

Numerous uncomformities characterized the deposition of the Mississippian marine limestones and dolomites on the underlying Chattanooga shales. Wallace Lee (1940), suggests that the region was periodically elevated out of the sea due to the intermittent uplift of the Nemaha Anticline and Central Kansas Uplift, resulting in numerous unconformities.

Major post-Mississippian pre-Desmoinesian uplifts elevated the Central Kansas Uplift, the Nemaha Anticline, and adjacent areas out of the epicontinental seas. Consequently, extensive erosion occurred in the region removing nearly all indications of surface relief yielding a nearly level plane prior to Pennsylvanian deposition.

Cyclic depositonal sequences of sandstone, shale and limestone characterized the region during Pennsylvanian and Permian time. The stratigraphic sequence suggests that the depositional environment was an unstable shelf area with numerous transgressions and regressions of the seas. The region was inundated for the last time during the Wolfcampian epoch of Permian time. The Permian deposition ended with the deposition of evaporite sequences.

An unconformity indicates that a lengthy period of erosion occurred prior to the deposition of Quaternary alluvial deposits that currently cover the study area.

REGIONAL STRUCTURE

The Seydell oil pool is located in the Sedgwick Basin (Figure 4). The Sedgwick Basin is bounded by the Nemaha Anticline to the east; by the Salina Basin to the north; by the Central Kansas Uplift to the northwest; and by the Pratt Anticline to the west. Tectonically, the region is part of the Midcontinent Craton, which is a concealed southern extension of the Canadian Shield.

The development of the major structural features can best be expressed by the use of maps that illustrate tectonic features that were present at particular periods of time.

Pre-Mississippian tectonic events are typically difficult to interpret; however, the existing rock record supplies sufficient data to construct a generalized post-Devonian pre-Mississippian tectonic map (Figure 3).

There is evidence that the initial positive movements

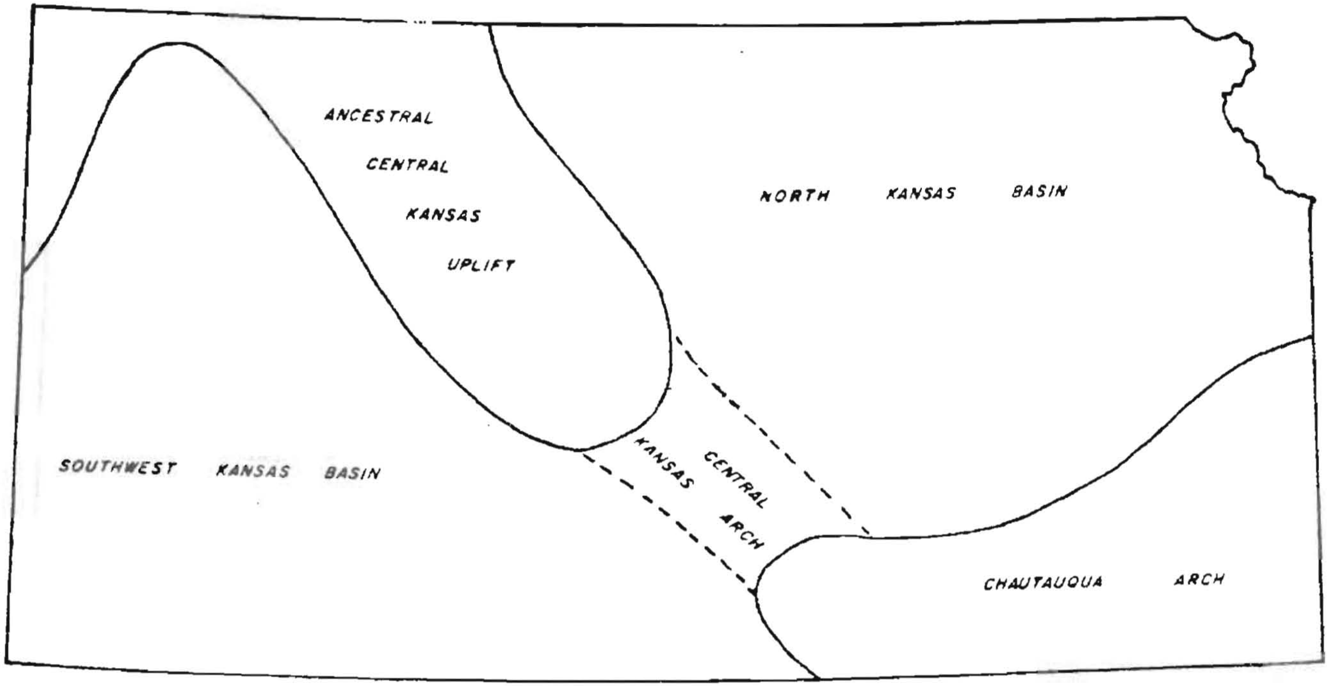


FIGURE 3 PRE-MISSISSIPPIAN POST-DEVONIAN STRUCTURES (MERRIAM,1963)

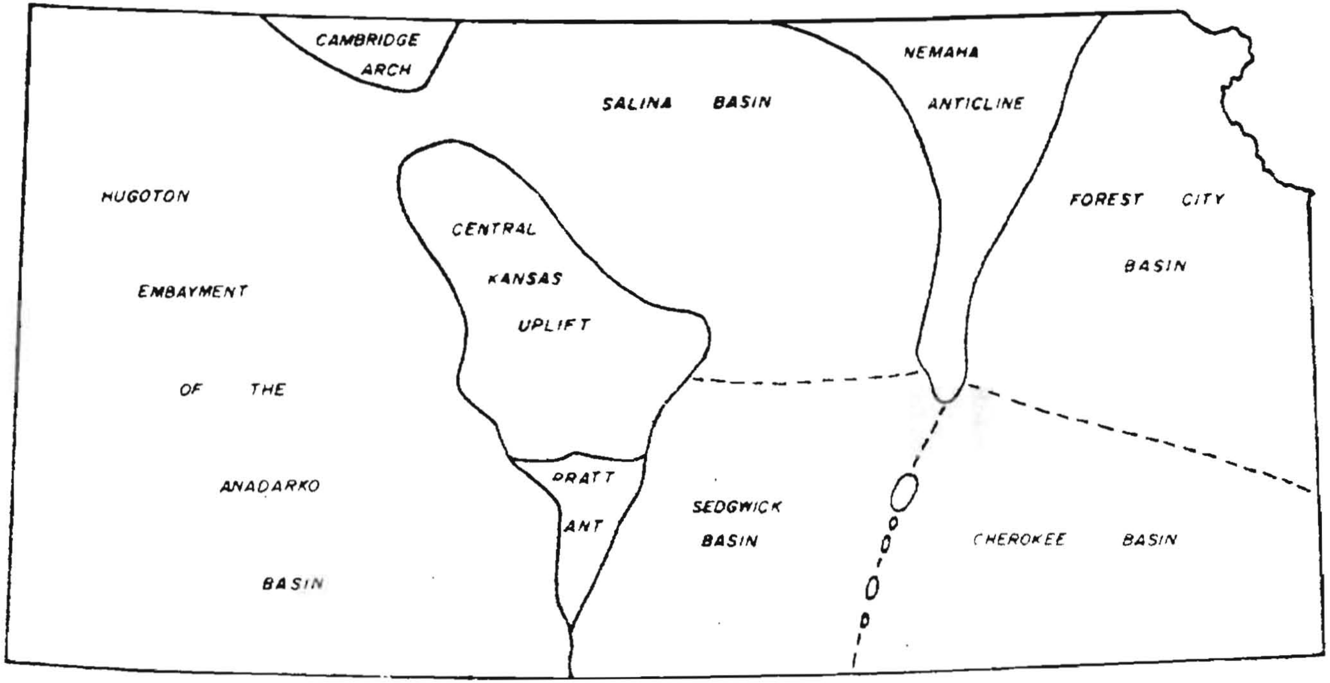


FIGURE 4 PRE-DESMOINESIAN POST-MISSISSIPPIAN STRUCTURES (MERRIAN,1963)

of the Nemaha Anticline began as early as middle Ordovician time (Cronenwett and Disney, 1956). A pronounced thinning of Simpson rocks toward the axis of the Nemaha Anticline supports the theory that the Nemaha Anticline was somewhat positive during Ordovician time.

Wallace Lee (1956), demonstrated that the Nemaha Anticline was uplifted intermittently throughout Mississippian time. However, the major uplift of the Nemaha Anticline took place at the end of Mississippian time and during the early Pennsylvanian time (Figure 4). This period of tectonic activity resulted in the formation of the prominent structural features now present in Paleozoic beds. The structual developments that took place during this period dictates much of the activity that occurs in the petroleum industry of Kansas today.

Since the end of Paleozoic time, the region has been tilted in three directions; west-southwest during Cretaceous time; northwest during Pliocene time; and finally, east during Pliocene time (Walters, 1958).

STRATIGRAPHY

The subsurface stratigraphic sequence includes rocks from the Cambrian, Ordovician, Devonian, Mississippian, Pennsylvanian and Permian systems. Rocks from the Triassic, Jurassic, Cretaceous and Tertiary systems are not present in the study area.

The surface rocks in the immediate area of the Seydell field are Quaternary age alluvial deposits.

General characteristics of the stratigraphic sequences present are discussed below and are accompanied by a composite type electric log (Figures 5 & 6). A more detailed lithological description is presented in Appendix 1.

ROCKS OF ORDOVICIAN AGE

The Arbuckle group includes Upper Cambrian and Lower Ordovician deposits. For convenience, the Arbuckle is considered with Ordovician rocks in this study. The Shawver-Armour Oil Company Seydell "A" No. 1 well in SE SE SW sec. 8, T. 30 S., R. 1 E. penetrated the upper three feet of the Arbuckle group. At this location, the Arbuckle is a gray to brown, fine crystalline, limey dolomite.

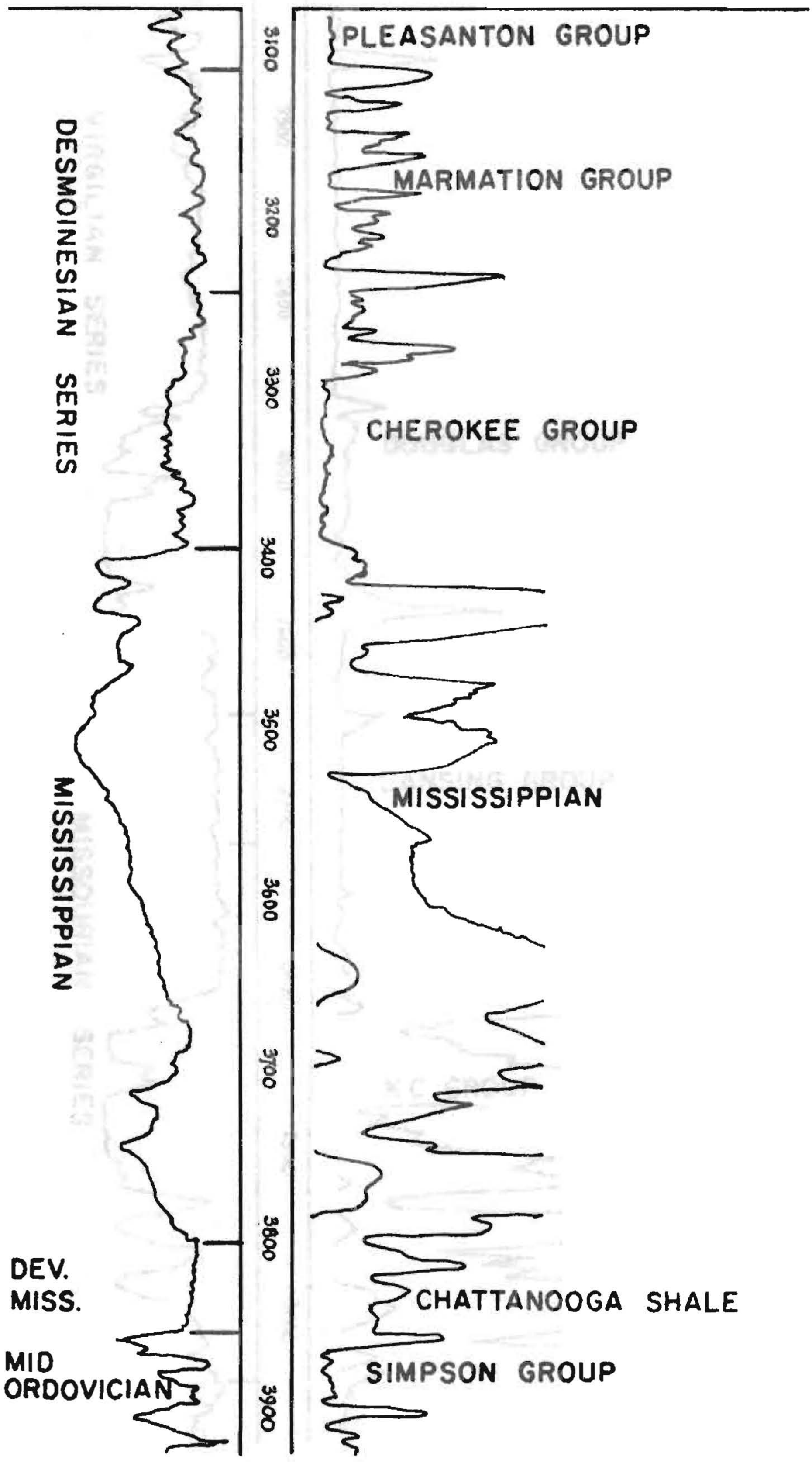


FIGURE 5 TYPE ELECTRIC LOG

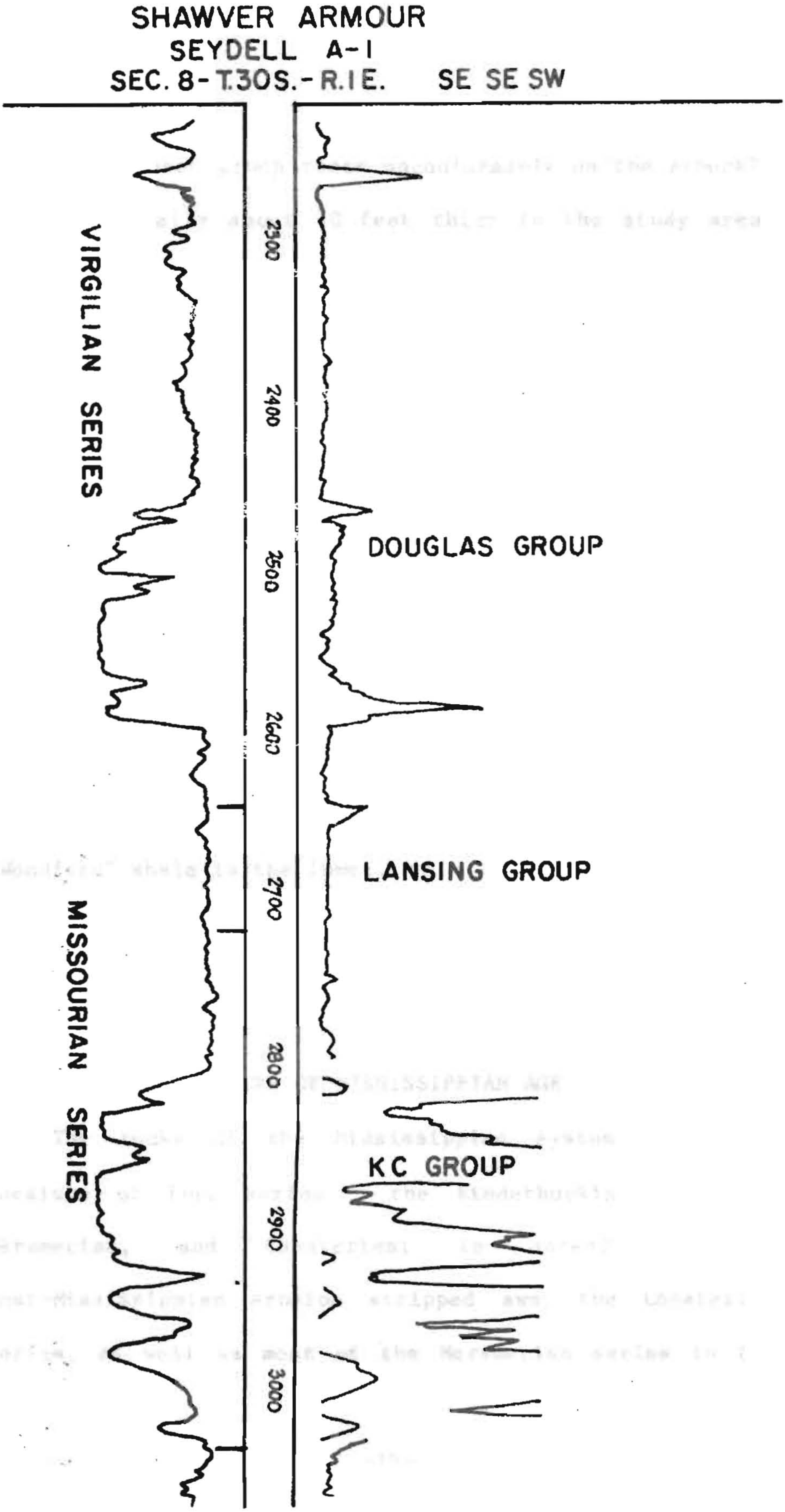


FIGURE 6 TYPE ELECTRIC LOG

The Simpson group rests unconformably on the Arbuckle and is typically about 70 feet thick in the study area. The Simpson sandstone is the primary producting horizon in the Seydell pool. The Simpson pay zone is typically a clear to white, slightly frosted, fine to medium grain, friable sandstone with varying amounts of dolomitic cement. The Simpson rocks were deposited in a shallow shelf environment (Dapples, 1955).

ROCKS OF DEVONIAN-MISSISSIPPIAN AGE

The Chattanooga shale commonly called the "Kinderhook", is a gray to black, finely micaceous shale in the study area. The Chattanooga shale is divided into two shale beds, the "Kinderhook" is the upper shale and the "Woodford" shale is the lower.

The Chattanooga shale is bounded above and below by unconformities and is typically 55-60 feet thick in the study area.

ROCKS OF MISSISSIPPIAN AGE

The rocks of the Mississippian system of Kansas consists of four series: the Kinderhookian, Osagian, Meramecian, and Chesterian; in ascending order. Post-Mississippian erosion stripped away the Chesterian series, as well as most of the Meramecian series in the study area.

The Mississippian rocks present consist predominantly of cherty, marine, limestones and dolomites with occasional shale stringers. The Mississippian deposits are typically 375-400 feet thick in the study area.

ROCKS OF PENNSYLVANIAN AGE

The Pennsylvanian System is represented by rocks of the Desmoinesian, Missourian and Virgilian series. The rocks of the Morrowan and Atokan series are missing in the study area. The total thickness of the Pennsylvanian rocks is approximately 2150 feet in the study area.

The rocks of the Desmoinesian series are divided into two groups, the Cherokee and the overlying Marmaton group. The Cherokee group is predominantly alternating sandstones, shales and relatively thin limestones. The Cherokee group represents the oldest rocks of Pennsylvanian age to occur in the region, and is separated from Mississippian rocks by a major regional unconformity. Conversely, the Marmaton group contains significantly more limestone and less sandstone. The Marmaton group is composed of alternating limestones and calcareous shales.

The Missourian series is divided into four groups, in ascending order: the Pleasanton, Kansas City, Lansing and

Pedee groups. Post-Missourian pre-Virgilian erosion removed the Pedee group, as well as much of the Lansing group. The Missourian rocks are bounded above and below by unconformities.

The Pleasanton group is composed predominently of med. gray, dark gray, clayey and silty shales, with one prominent limestone bed, the Checkerboard limestone. The Checkerboard limestone is a subsurface marker bed.

The Kansas City group is composed predominently of massive limestones separated by occasional shale beds. The upper portion of the group consists of shale that lacks distinguishing electrical and sample characteristics. Therefore, petroleum geologists use the Drum limestone as a subsurface marker and simply refer to this as the Kansas City lime. The base of the Kansas City group also serves as a good subsurface marker.

The Virgilian series is the youngest series representing Pennsylvanian rocks present in Kansas. The series is divided into three groups, in ascending order: the Douglas group, the Shawnee group, and the Wabaunsee group.

The Douglas group is composed mostly of clastics, predominently sandstone. The Haskell limestone in the upper portion of the group serves as a subsurface marker bed. The Stalnaker sandstone is also a good marker bed. The Shawnee group is composed predominately of limestone with thin interbedded shales. The Heebner shale in the lower portion of the group serves as a good subsurface datum marker due to the Heebner's gamma ray characteristics.

The uppermost group representing Pennsylvanian rocks is the Wabaunsee group. The group consists predominantly of shale, with sandstone stringers and thin, persistent limestone formations.

ROCKS OF PERMIAN AGE

The Permian age rocks are, in ascending order: the Admire, Council Grove, Chase and Sumner groups.

The Admire group is separated from the upper Pennsylvanian group by an unconformity. The Admire group is composed chiefly of shale in the study area.

The Council Grove group consists of thin limestones and shales. The Council Grove group is immediately below the Chase group.

The Chase group contains alternating beds of limestone and shale. The limestones are more masive than those of the Council Grove Group.

Included in the Sumner group are the Wellington formation and the Ninnescah shale. The Sumner group is bounded by an uncomformity above, and is covered by Quaternary alluvial deposits in the study area.

ROCKS OF QUATERNARY AGE

Pleistocene terrace and alluvial clastics have been deposited on the underlying rocks of Permian age. These are primarily Kansan and Illinoisan age terrace deposits in the northern end and chiefly Wisconsinan age terrace deposits in the southern end of the study area. Typically, these deposits are poorly sorted sands and gravels (Walters, 1957).

STRUCTURE OF THE SEYDELL POOL

The structure of the Seydell pool can best be expressed by the use of various structural maps and cross sections. Figures 7 through 11 show the structure of selected datum horizons, which are, in ascending order: top of the Simpson (Figure 7), top of the Kinderhook (Chattanooga) shale (Figure 8), top of the Mississippian (Figure 9), base of the Kansas City lime (Figure 10), and the top of the Kansas City lime (Figure 11). Figures 12, 13 and 14 are cross-sections that were constructed to aid in the interpretation of the structure.

Analysis of these illustrations reveals that the pool is a structural trap, in the form of a northerly trending, southerly plunging anticline. The shape of the Seydell Anticline as shown by the structural maps does not vary greatly from the structure on the top of the Kansas City lime (Figure 11), to the structure on the top of the Simpson (Figure 7). However, the closure of the anticline increases with depth. A measure of the increased closure with depth is demonstrated by the progressively greater depth of each datum horizon logged in Petroleum Inc. #2 Forney well located on the crest of the anticline above its

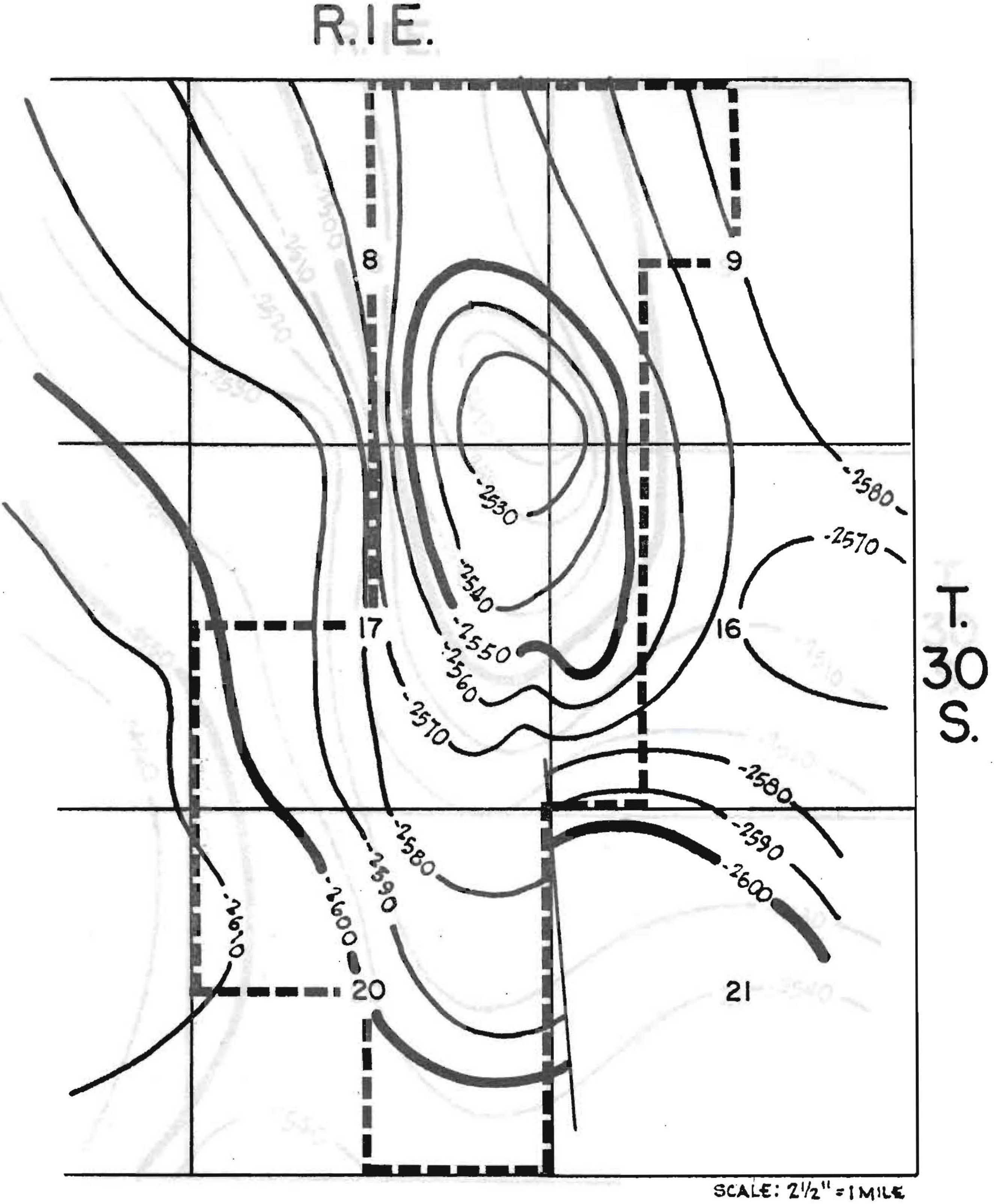


FIGURE 7 STRUCTURAL MAP CONTOURED ON TOP OF THE SIMPSON SANDSTONE.

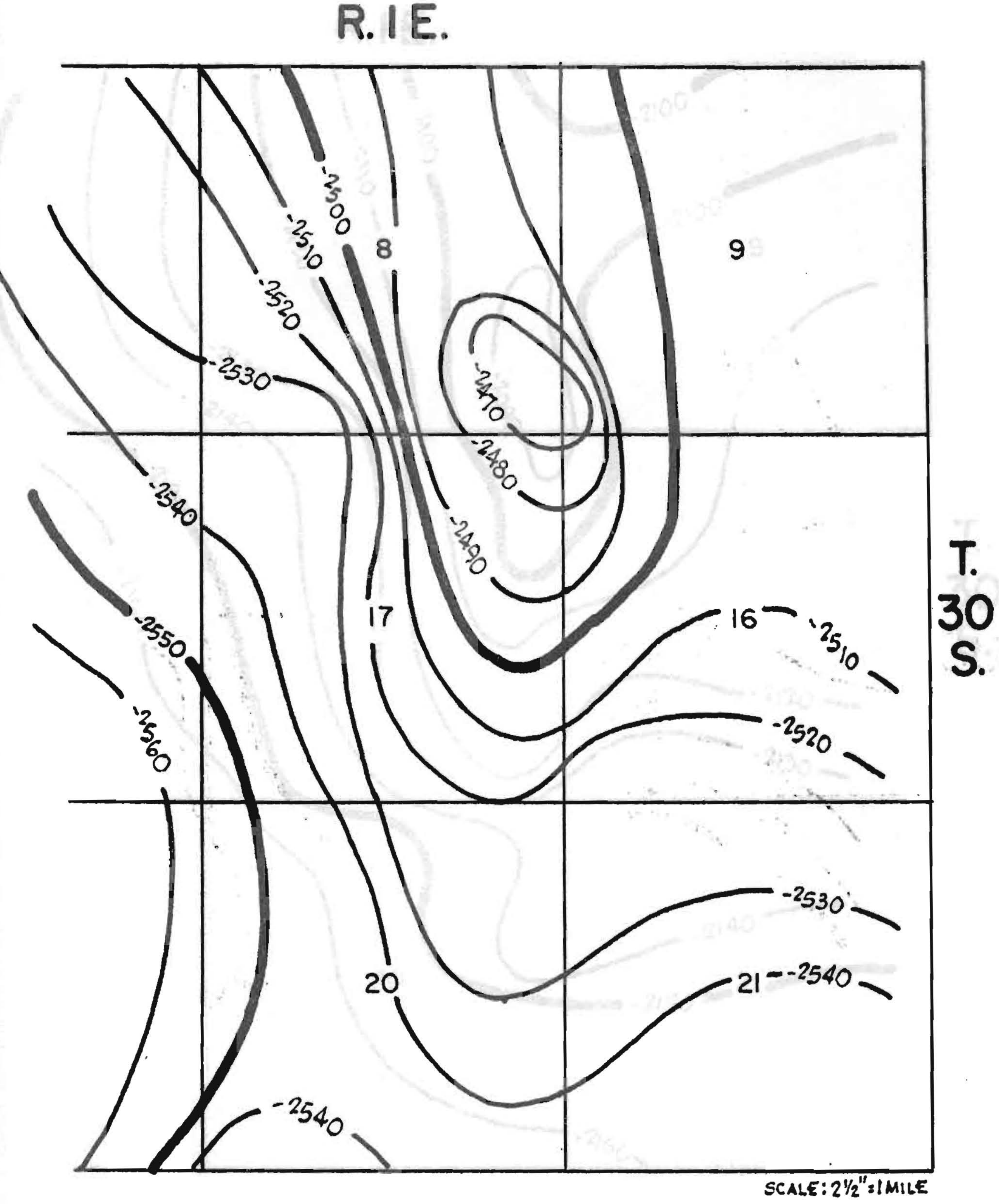


FIGURE 8   STRUCTURAL MAP CONTOURED ON TOP OF THE CHATTANOOGA SHALE.

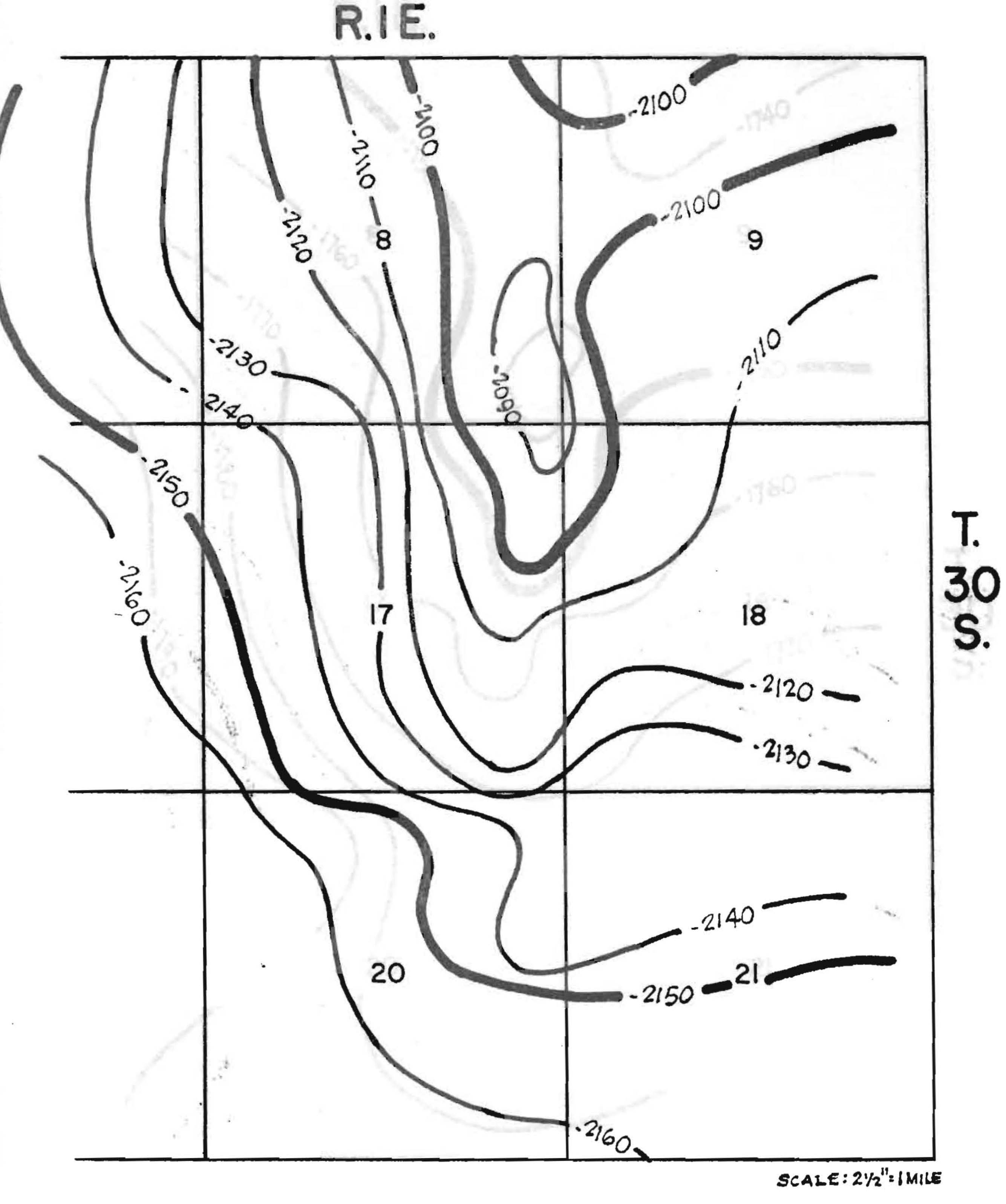


FIGURE 9 STRUCTURAL MAP CONTOURED ON TOP OF THE MISSISSIPPIAN.

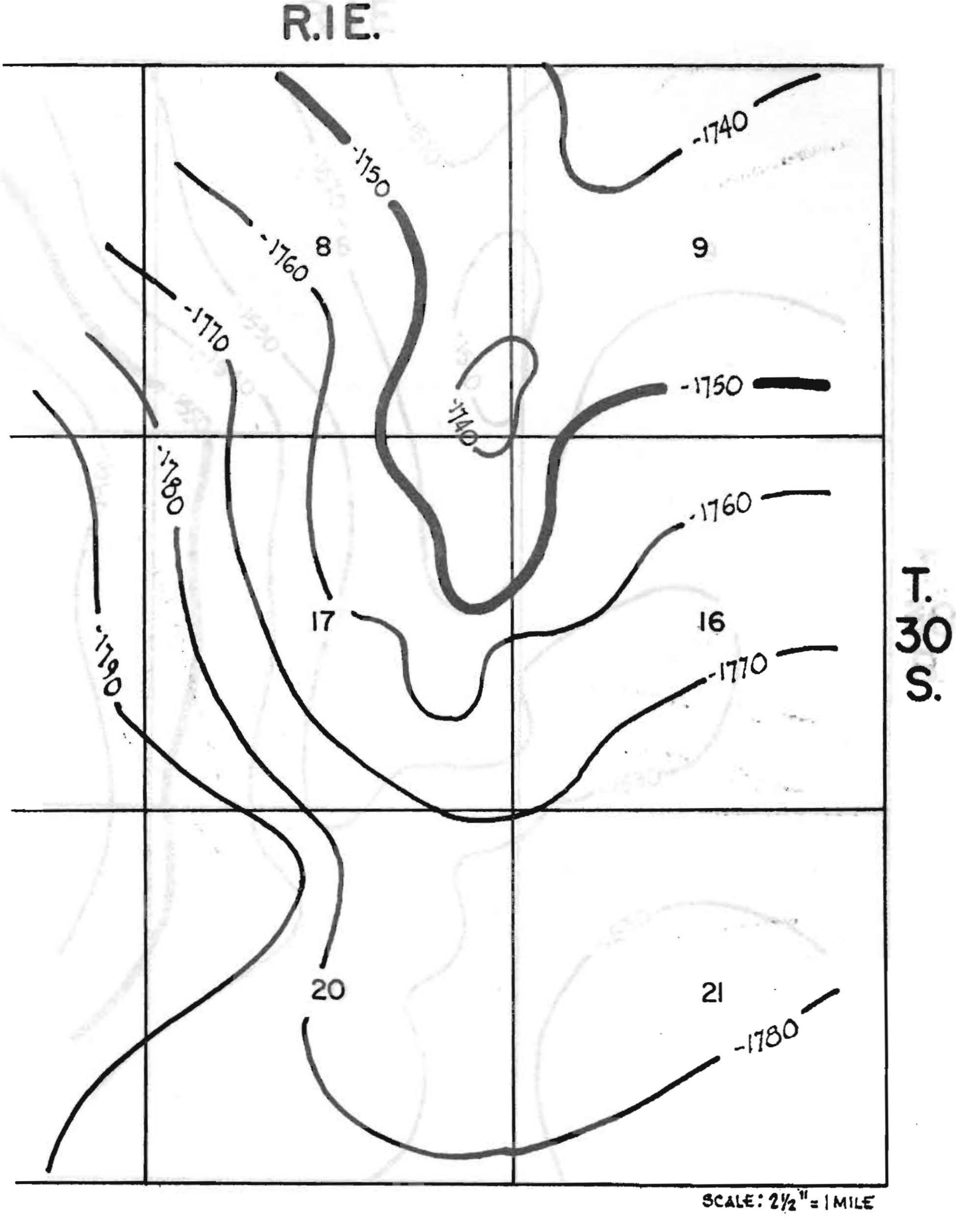


FIGURE 10 STRUCTURE MAP CONTOURED ON THE BASE OF THE KANSAS CITY GROUP.

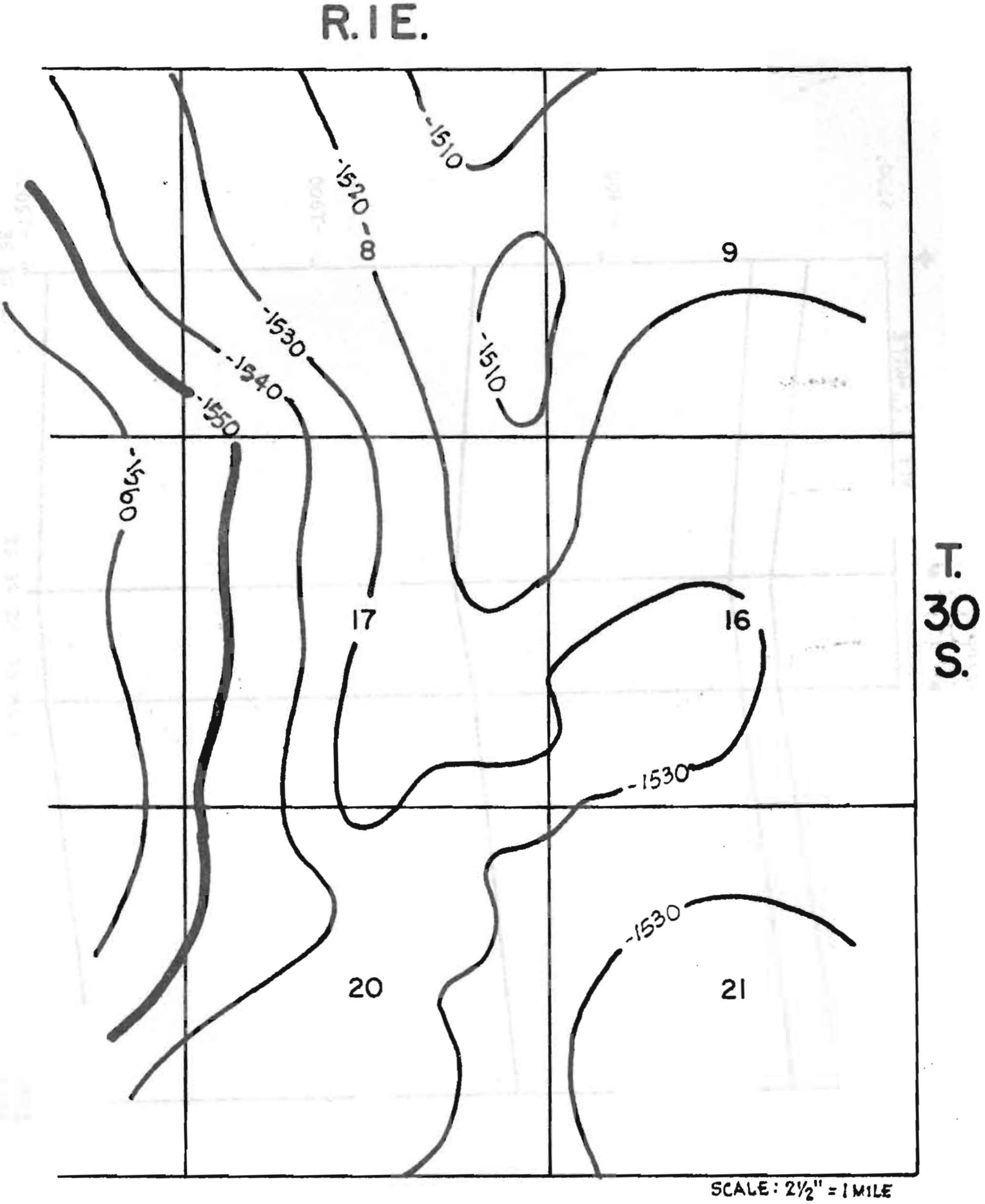


FIGURE 11 STRUCTURAL MAP CONTOURED ON TOP OF THE KANSAS CITY LIME.

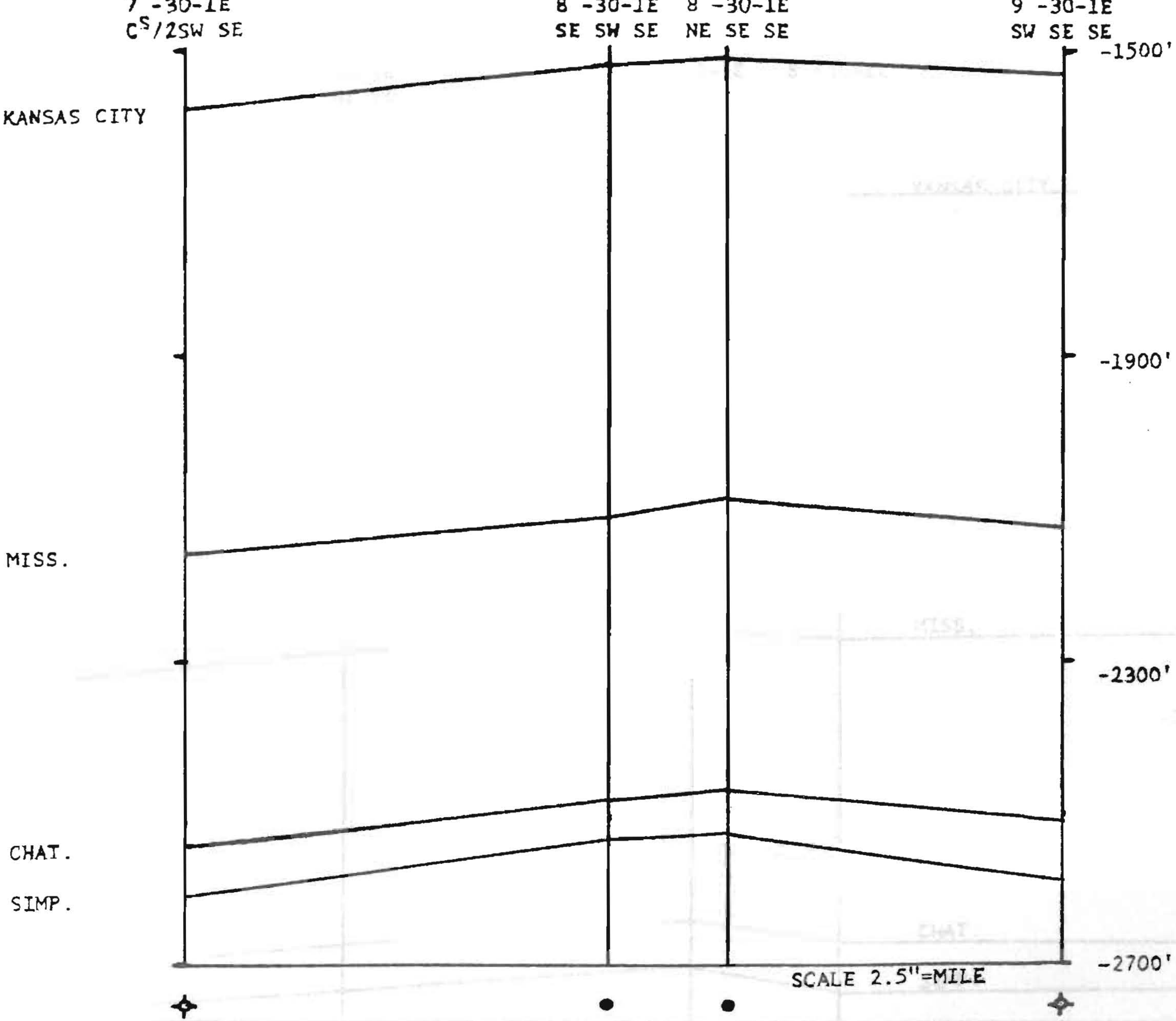
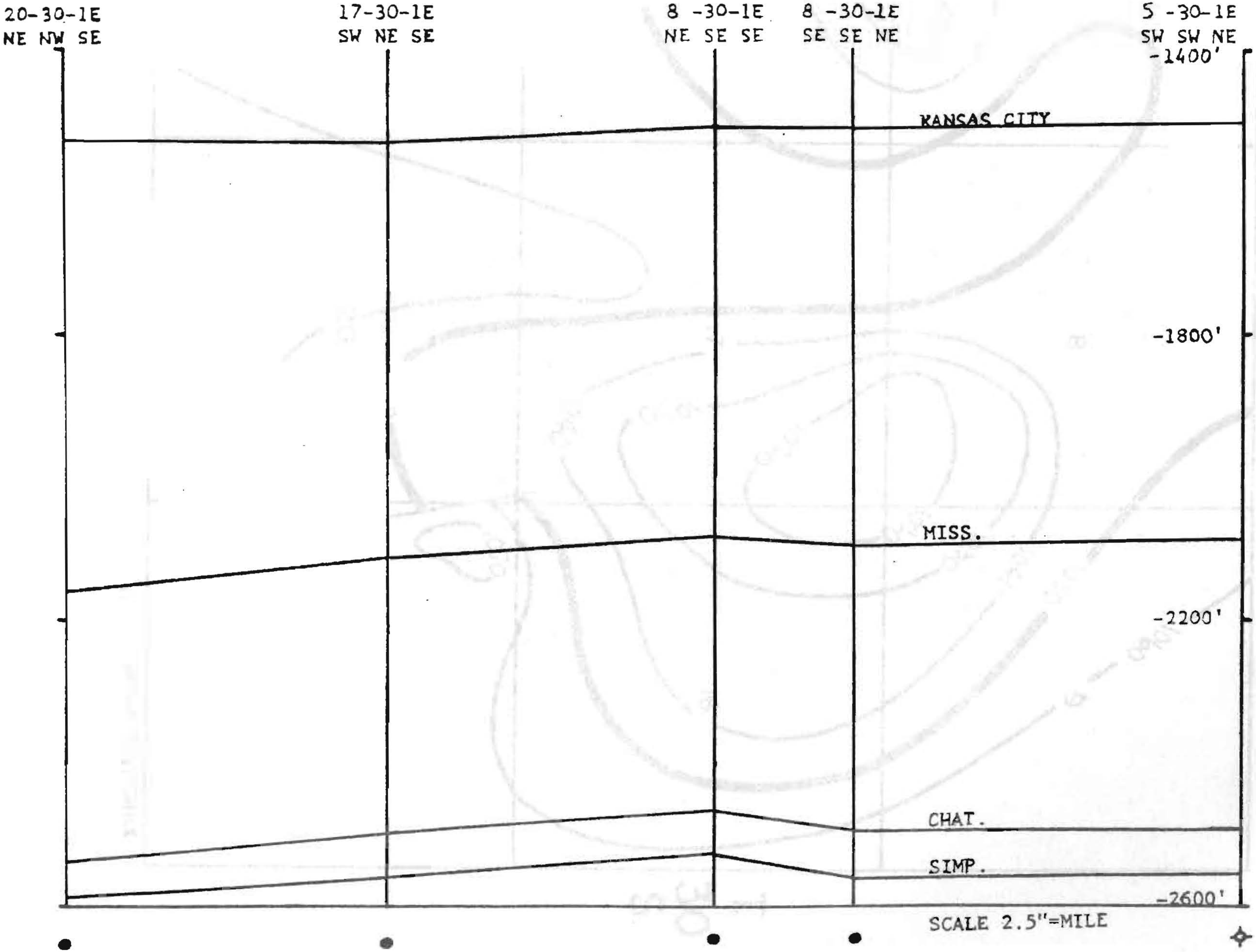


FIGURE 12. East - west cross section.


20-30-1E
NE NW SE
17-30-1E
SW NE SE
8 -30-1E
NE SE SE
8 -30-1E
SE SE NE
5 -30-1E
SW SW NE
-1400'
KANSAS CITY
-1800'
MISS.
-2200'
CHAT.
SIMP.
-2600'
SCALE 2.5"=MILE

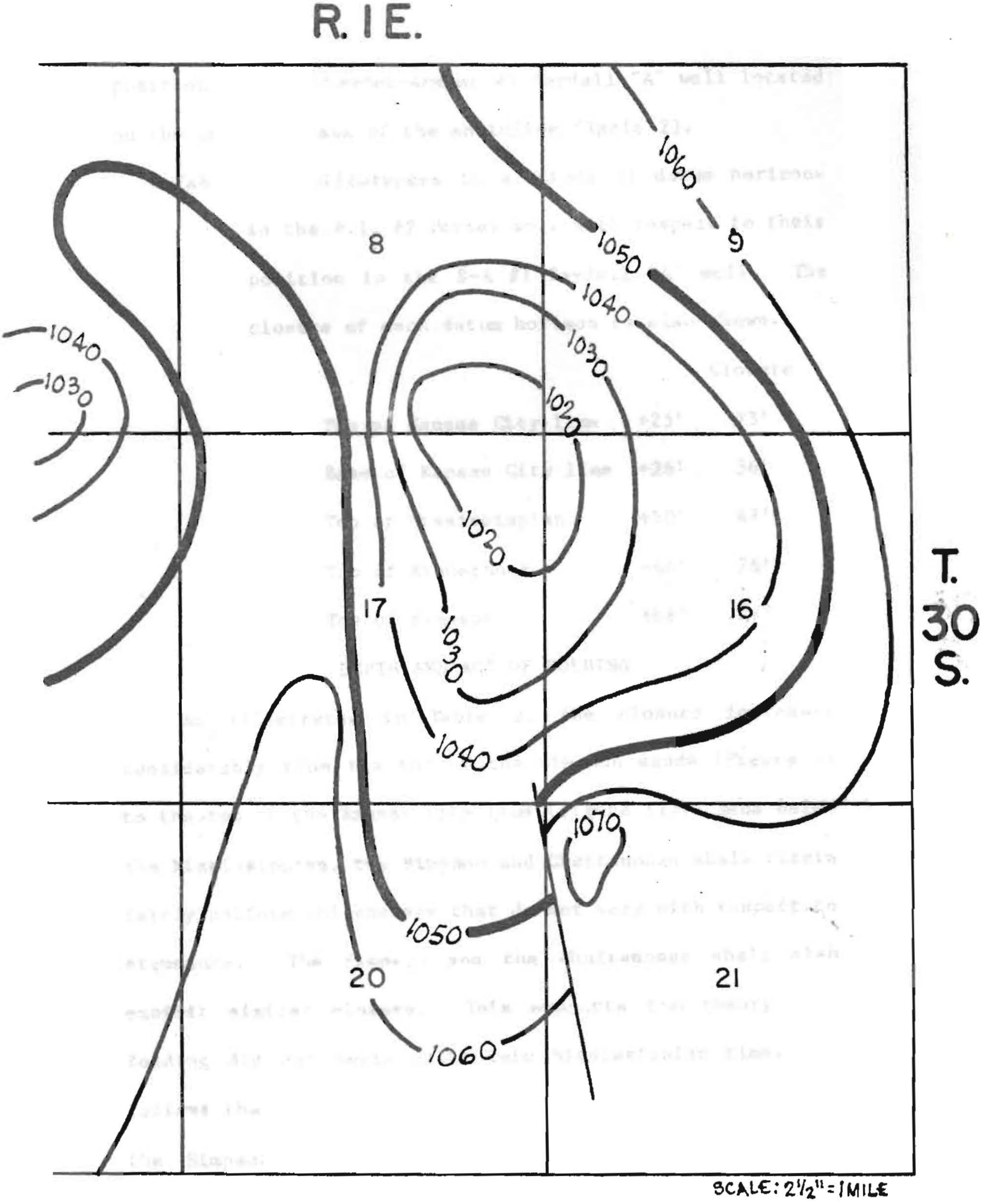


FIGURE 15 CONVERGENCE MAP BETWEEN THE TOP OF THE SIMPSON SANDSTONE TO THE TOP OF THE KANSAS CITY LIME.

position in the Shawver-Armour #1 Seydell "A" well located on the western flank of the anticline (Table 2).

Table 2. Differences in altitude of datum horizons in the P.I. #2 Forney well with respect to their position in the S-A #1 Seydell "A" well. The closure of each datum horizon is also shown.

		Closure
Top of Kansas City lime	+25'	23'
Base of Kansas City lime	+26'	36'
Top of Mississippian	+50'	47'
Top of Kinderhook	+64'	76'
Top of Simpson	+66'	77'

DEPTH AND AGE OF FOLDING

As illustrated in Table 2, the closure increases considerably from the top of the Simpson sands (Figure 7) to the top of the Kansas City lime (Figure 11). Beds below the Mississippian, the Simpson and Chattanooga shale retain fairly uniform thicknesses that do not vary with respect to structure. The Simpson and the Chattanooga shale also exhibit similar closure. This supports the theory that folding did not begin until late Mississippian time. It follows that the structural relief expressed by the top of the Simpson sandstone (Figure 7), or Chattanooga shale

(Figure 8), is representative of the total vertical movement that has occurred, except possibly for minor variations due to the incompetency of beds involved.

The interpretation that movements occurred during periodic intervals of time is expressed by analyzing relative thicknesses and closures of datum sequences and horizons. The closure of the top of the Mississippian (Figure 9) is 47 feet, which is approximately 30 feet less than that of the Simpson sandstone (Figure 7) or Chattanooga shale (Figure 8). The amount of closure of the Mississippian probably approached that of the Simpson and Kinderhook. However, pre-Desmoinesian post-Mississippian erosion exceeded the amount of uplift; thereby, removing nearly all surface relief yielding a nearly flat surface. This leads the author to believe that the amount of relief now present on top of the Mississippian occurred subsequent to the start of Desmoinesian deposition. It seems reasonable to assume that at least 30 feet of vertical movement occurred from late Mississippian to Desmoinesian time. It follows that approximately 47 feet of vertical movement occurred since the beginning of Pennsylvanian (Desmoinesian) deposition.

The amount of structural relief between the top of the

Mississippian and the upper beds of Permian age decreases in a similar manner as it has on top of the Mississippian (Figure 15). Intermittent periods of erosion have reduced the amount of structural relief so that with additional deposition and continued vertical movement, the amount of structural relief above the unconformities is not of the amplitude as that below the unconformities. The folded Florence limestone and other Permian beds reveal that folding continued during and possibly beyond Permian time. There is however, no rock record above the lower Permian in the study area to accurately determine the upward extent of the folding.

STRESSES OF DEFORMATION

Horizontal or vertical forces can yield anticlinial structures. However, the nature of the structure strongly suggests that vertical rather than horizontal stresses are responsible for the structure. Furthermore, horizontal stresses would have to be transmitted through weak sediments and would surely cause similar type structures with some sort of regularity on either side of the study area. There is little evidence to support this type of movement and the lateral structures simply do not support this type of horizontal stresses. In a paper concerning structure of the Midcontinent Area, Gardner (1917), suggested that due to the small, isolated nature of structures such as this, that they were formed by vertical forces. Fath (1920), suggests that faults in the rigid crystalline basement when acting vertically can result in the formation of small local anticlines. Fath also suggests that faults in the basement complex were the result of Precambrian orogenesis. A major pre-Paleozoic post-Precambrian unconformity subsequently removed most of the indications of structural relief formed during this period of faulting and deformation. Subsequent, intermittent movements along these lines of weakness and faulting resulted in the structures present. This theory is consistent with the history of deformation of the Seydell Anticline as previously outlined. The author also agrees with the concept that structures such as the Seydell Anticline and Nemaha Anticline are related in origin.

In summary, it seems that the forces responsible for the formation of the Seydell Anticline were vertical forces that were transmitted along lines of weakness in the Precambrian basement complex. Subsequent movements along these lines of weakness resulted in the intermittent uplifting of the anticline.

PRODUCTION AS RELATED TO STRUCTURE

By comparing the location of the producing wells in Figure 2, to the structure of the Simpson in Figure 7, it seems obvious that the production is, indeed, controlled by structure. This concept is illustrated in Figure 14, which is a cross-section that shows producing wells on the structural highs and dry holes on the structural lows. However, there are a few dry holes located in favorable structural positions. These wells are located in isolated areas of lower porosities. These isolated areas are exceptions rather than the norm.

The Zyba pool is also shown in Figure 14. The Zyba pool is considerably smaller and has significantly less closure than the Seydell Anticline. It is not surprising that the Seydell pool has produced approximately twice as much oil as the Zyba pool. Therefore, the structure seems to be the controlling factor in production.

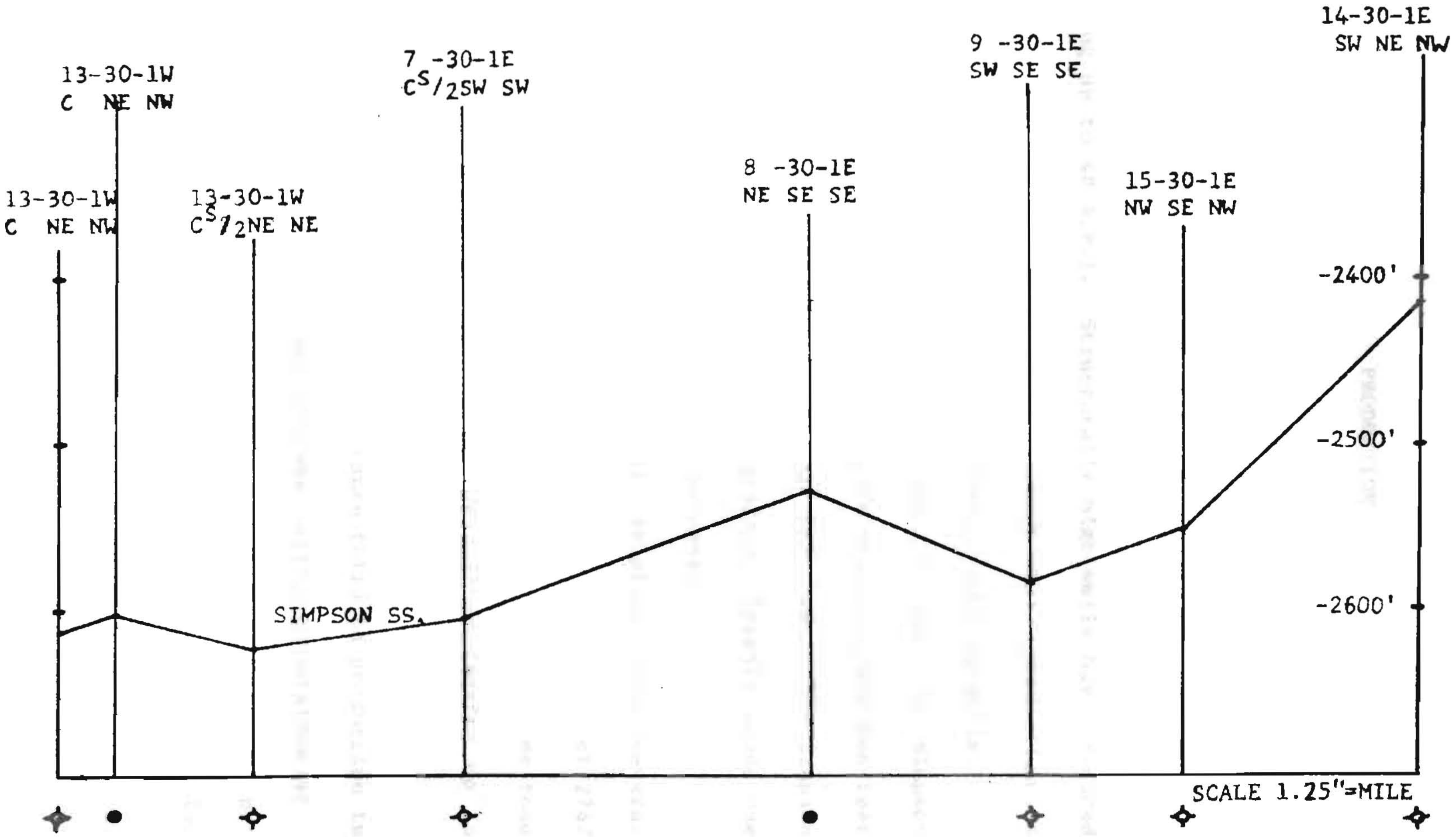


FIGURE 14. East - west cross section.

PRODUCTION

Since the completion of the discovery well in January, 1958, approximately 2,000,000 barrels of oil have been produced. The oil is a relatively high gravity oil, ranging up to 48 A.P.I. Structurally high wells have produced essentially water-free oil, although water production is encountered in the structurally lower producing wells.

Production is obtained primarily from the Simpson sandstone. The Simpson pay zone is approximately ten feet thick and produces from a depth of 3826 feet. The Simpson pay zone is a fine to medium grained, friable sandstone with porosities ranging up to 15 percent.

Kansas City production is attained from several intervals. The discovery well produced at a depth of 2747 feet from a pay zone is typically a crystalline limestone with vuglar and intercrystalline porosities ranging up to nearly 20 percent.

The Mississippian section ranks third in production in the Seydell pool. Production was initially obtained at a depth of 3349 feet from a pay zone six feet thick. The pay zone is typically the upper six feet of the Mississippian dolomite section. The zone has porosities ranging up to over 20 percent.

Production reached a maximum peak in 1961, when an annual production of 229,161 barrels of oil was recorded from 27 Simpson wells and three Kansas City wells. Since 1961, production has steadily declined (Table 3). An initial three-year increase in production climaxed in 1961 (Figure 16), from this year forward annual production decreased an average of 10,443 barrels of oil per year. However, this rate of decreasing production has leveled off since 1973 to a rate of decrease of approximately 1238 barrels of oil per year. The average annual production rate per well (Figure 17), shows a similar initial rate of increase to 1961, and subsequent decrease. From 1961-1973, average annual production per well decreased at a rate of 556 barrels of oil per year. Since 1973, annual production per well has leveled off to approximately 1000 barrels of oil per year. At this current rate of declining annual production, the pool would be expected to be depleted in approximately ten years.

Year	Acres	Annual Production (BBL)	Cumulative Production (BBL)	No. of Producing Wells
1958	340	52,973	52,973	11
1959	520	154,701	207,674	22
1960	640	226,547	434,221	30
1961	680	229,162	663,383	30
1962	680	188,767	852,150	28
1963	680	146,360	998,510	28
1964	600	132,834	1,131,344	26
1965	600	130,006	1,261,350	26
1966	560	116,545	1,377,895	25
1967	560	116,794	1,494,689	25
1968	1000	96,095	1,590,780	25
1969	1000	61,432	1,652,216	25
1970	1000	69,525	1,721,741	26
1971	960	62,690	1,784,431	24
1972	960	37,729	1,822,160	24
1973	880	21,211	1,843,381	22
1974	840	22,670	1,866,051	21
1975	800	18,199	1,884.250	20
1976	600	19,107	1,903,357	16
1977	600	15,605	1,918,962	15
1978	600	15,976	1,934,938	15
1979	600	13,315	1,948,456	15
1980	560	14,181	1,962,637	14
1981	320	12,530	1,975,167	14
1982	320	10,078	1,985,245	8

Table 3. Production statistics (Oil and gas production in Kansas, KGS, 1958-1982).

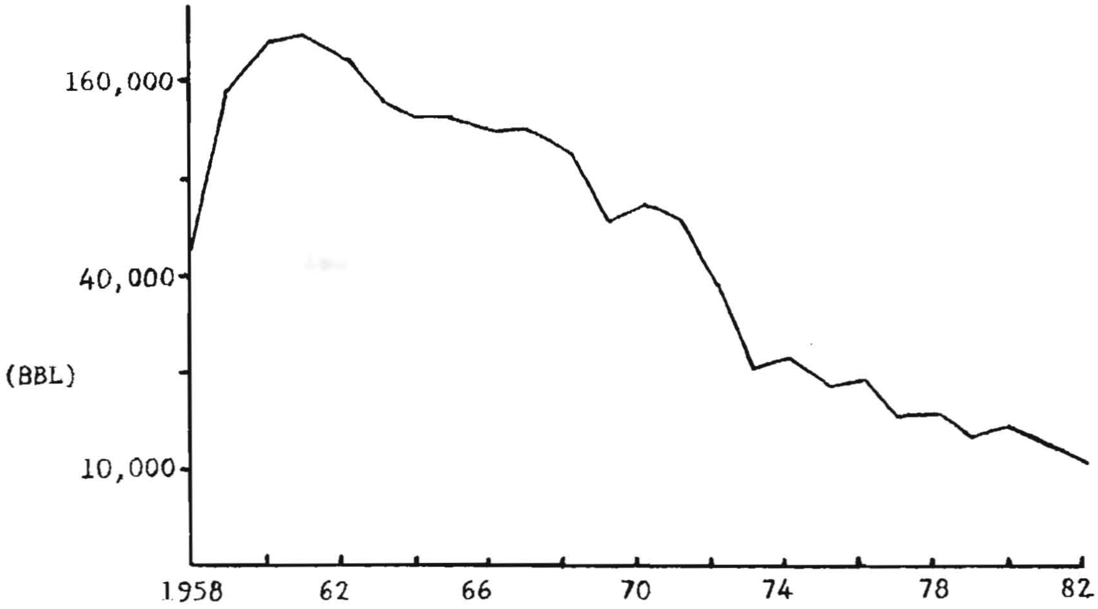


FIGURE 16. Annual production.

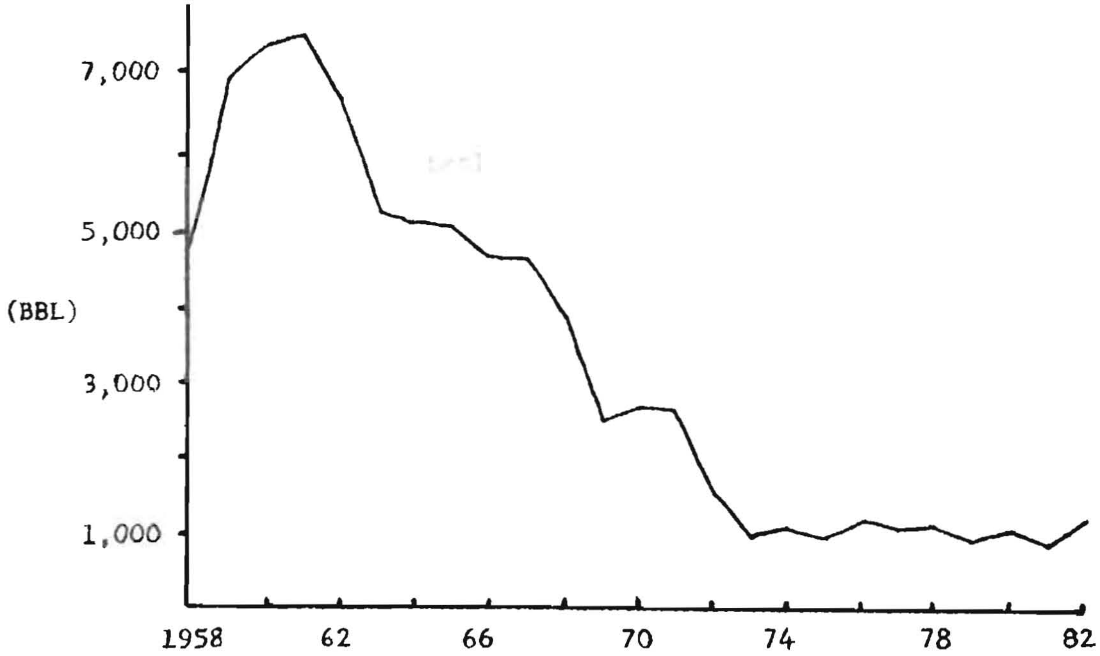


FIGURE 17. Average annual production per well.

SUMMARY AND CONCLUSIONS

Structures similar in nature to the Seydell Anticline have played an important role in hydrocarbon production. These small, positive structures will continue to yield good quantities of hydrocarbons for many years. To further our understanding of these structures can only serve to enhance future exploration and production practices.

The following conclusions and summations have been drawn from this study:

(1) The upper Simpson sand is the primary producing zone in the Seydell pool. The Simpson was deposited in a shallow shelf environment.

(2) The subsurface strata thins progressively to the north and east, and generally dips southwesterly.

(3) The trap is structural in nature in the form of a northerly trending, southerly plunging anticline. The strike of the anticline is sub-parallel to the strike of the Nemaha Anticline. Closure of the structure increases with depth.

(4) The first major period of deformation occurred during late Mississippian - early Pennsylvanian time. Subsequent intermittent periods of deformation continued on a lesser scale through Pennsylvanian and Permian time, and possibly continued into post-Permian time.

(5) Intermittent vertical movements along lines of weakness and faulting in the pre-Cambrian are responsible for the structure.

(6) Similarities between the structural history of the Seydell Anticline and the Nemaha Anticline supports the theory that they are related in origin.

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SAMPLE MUDLOG DESCRIPTIONS

SHAWVER-ARMOUR SEYDELL "A" #1 8-305-1E SE SE SW

APPENDIX 1

2300-2360	SH:	M DK GRY, OCC LT RD, BLKY, FRM, OCC MIC
2360-2370	SH:	GRY, LT TAN, PLTY BLKY, FRM, MIC, NON CALC
2370-2400	SH:	M DK GRY, BLKY, FRM, MIC, NON CALC
2400-2430	SH:	LT M GRY, PLTY BLKY, FRM, F MIC, NON CALC
2430-2470	SH:	M GRY, BLKY, FRM, F MIC, NON CALC
2470-2480	SH:	M GRY, BLKY, FRM, MIC, NON CALC
	LS:	LT BRN, F XLN, DNS, HD
	SS:	WH, CLR, F GR, W CMT, W SRT, SBRD SBANG, SL CALC
2480-2490	SS:	WH, VF GR, W CMT, W SRT, SBANG SBRD, SL CALC
2490-2500	SH:	M DK GRY, PLTY BLKY, FRM, NON CALC
	SS:	WH, VF GR, W CMT, W SRT, SBANG SBRD, SL CALC
2500-2510	SH:	M DK GRY, PLTY BLKY, NON CALC
	SS:	WH, F GR, M CMT, W SRT, SBANG
2510-2530	SH:	M DK GRY, BK, CARB IP, PLY, OCC BLKY, NON CALC
	SS:	WH, F GR, M CMT, W SRT, SBANG, OCC ARG
2530-2550	SS:	WH, W CMT, M W SRT SBANG ANG, SL CALC
	SH:	M DK GRY, BK, PLTY, NON CALC
2550-2580	SH:	LT GRN, M LT GRY, PLTY, MOTT IP, F MIC, NON CALC
	SS:	WH, F GR, M CMT, W SRT, SBANG, GOOD POR
2580-2600	SS:	WH, F GR, M CMT, W SRT, SBANG, GOOD POR
	SH:	M LT GRY, PLTY, MOTT IP, F MIC, NON CALC
2600-2610	SH:	LT DK GRY, PLTY, FRM, F MIC, NON CALC
	SS:	WH, CLR, F GR, W SRT, M W CMT, SBANG ANG, SL CALC
2610-2630	SH:	LT DK GRY, PLTY, FRM, F MIC, NON CALC
2630-2650	SH:	M DK GRY, OCC MARR BK, PLTY, FROM F MIC, NON CALC
2650-2700	SH:	M GRY, PLTY, FROM F MIC, CALC IP
2700-2750	SH:	M GRY, PLTY, OCC MOTT, FROM, F MIC, CALC
2750-2760	SH:	M DK GRY, BLKY, MOTT IP, F MIC, CALC
2760-2810	SH:	M DK GRY, PLTY, FRM, F MIC, SL CALC
2810-2820	LS:	BUFF, LT GRY, F XLN, DNS, HD
	SH:	M DK GRY, PLTY, FRM, F MIC, SL CALC
2820-2835	LS:	BUFF, LT GRY, F XLN IP, CHKY IP, HD SFT
2835-2870	LS:	BUFF, WH, F XLN IP, CHKY IP, HD SFT, AB CALCITE
2870-2885	LS:	BUFF, LT GRY, F XLN, OCC CHKY, DNS, HD FRM, TR SH
2885-2895	LS:	WH, CKHY, F XLN IP, FRM
2895-2910	LS:	BUFF, F XLN, DNS, HD, TR SH
2910-2930	LS:	LT GRY, F XLN, DNS, HD, CALCITE VEINS, TR SH
2930-2935	LS:	LT GRY, F XLN, DNS, HD
	SH:	M DK GRY, PLTY, FRM, NON CALC
	SS:	CIR, F GR, W CMT, W SRT SBANG, SL CALC
2935-2945	SH:	M DK GRY, PLTY, FRM, NON CALC
	LS:	LT GRY, F XLN, DNS, HD
2945-2960	LS:	LT GRY, F XLN, DNS, HD OCC CHKY
2960-2965	LS:	M GRY, F XLN, DNS, HD
2965-2975	LS:	M GRY, F XLN, DNS, HD
	SH:	M DK GRY, PLTY, FRM, NON CALC
2975-2980	LS:	M GRY, F XLN, DNS, HD
2980-2990	LS:	LT GRY, BUFF, M XLN, HD, GOOD POR
2990-3000	LS:	M GRY, F XLN, DNS, HD
3000-3035	LS:	M DK GRY, F XLN, DNS, HD OCC CHKY
3035-3040	LS:	M GRY, LT BRON, F XLN DNS, HD
3040-3070	SH:	DK GRY, PLTY, FRM, CALC
3070-3090	LS:	WH, LT GRY, F XLN, DNS, HD, OCC CHKY
	SH:	DK GRY, PLTY, FRM, CALC
3090-3110	SH:	LT DK GRY, PLTY, FRM, SL CALC, OCC SNDY

3110-3120	SH: LT DK GRY, PLTY, FRM, SL CALC LS: LT BRN, F XLN, DNS, HD
3120-3130	LS: BUFF, LT GRY, F XLN, DNS, HD SH: LT DK GRY, PLTY, FRM, SL CALC
3130-3140	SH: LT GRY, MOTT, SFT FRM, SL CALC LS: M GRY, M XLN, HD, SL FOSS
3140-3150	SH: LT M GRY, LT GRN, PLTY, FRM, SL CALC
3150-3160	LS: BUFF, LT GRY, F XLN, DNS, HD SH: M DK GRY, PLTY, FRM, SL CALC
3160-3190	SH: M DK GRY, PLTY, FRM, SL CALC LS: BUFF, LT GRY, F XLN, DNS, HD
3190-3200	LS: M DK GRY, F XLN, DNS, HD SH: M DK GRY, FRM, PLTY MOTT, CALC
3200-3210	LS: BUFF, DK GRY, F XLN, DNS, HD OCC CHKY SH: M DK GRY, PLTY, FRM, CALC
3210-3220	SH: LT DK GRY, PLTY BLKY, FRM, SFT IP, CALC, TR LS
3220-3230	LS: BUFF, M GRY, F XLN, DNS, HD SH: LT DK GRY, PLTY BLKY, FRM
3230-3240	SH: M DK GRY, PLTY, MOTT IP, FRM, SL CALC, TR LS
3240-3250	LS: M GRY, F XLN, DNS HD TR SH
3250-3260	SH: DK GRY, PLTY BLKY, FRM, NON CALC LS: M GRY, F XLN, DNS HD
3260-3270	SH: LT DK GRY, PLTY MOT IP, FRM SFT, SL CALC
3270-3280	SH: LT DK GRY, PLTY, FRM OCC SFT F MIC, SL CALC
3280-3305	LS: M GRY, LT BRON IP, F XLN, DNS HD SH: M DK GRY, PLTY, FRM, F MIC, CALC
3305-3320	SH: M DK GRY, PLTY, FRM, F MIC, SL CALC LS: M GRY, F XLN, DNS, HD
3320-3350	SH: LT DK GRY, MARR, PLTY BLKY OCC MOTT, FRM, SL CALC
3350-3355	SH: LT DK GRY, MARR, PLTY BLKY, OCC MOTT, FRM, SL CALC LS: LT GRY, F XLN, DNS, HD
3355-3365	SH: M GRY, PLTY, FRM, F MIC, NON CALC LS: LT GRY, F XLN, DNS, HD
3365-3400	SH: LT M GRY, MARR IP, PLTY, F MIC IP, SL CALC
3400-3415	SH: LT DK GRY, MARR, LT GRN, PLTY, MOTT IP, FRM, CALC LS: TAN, BUFF, F M XLN, DNS, HD DOLO IP, TR CHT
3415-3450	SH: LT M GRY, PLTY, FRM, NON CALC LS: TAN, BUFF, F M XLN, DNS, HD, CHT, DOLO IP
3450-3470	SH: M GRY, PLTY, FRM, NON CALC LS: BUFF, M GRY, M XLN, HD FRM, TR CHT, FAIR POR
3470-3510	SH: LT DK GRY, MARR, PLTY BLKY, NON CALC LS: LT GRY, F M XLN, FRM, DOLO IP
3510-3540	SH: M GRY, YELL, RED, PLTY, OCC MOTT, FRM, SL CALC LS: BUFF, LT GRY, F M XLN, FRM
3540-3560	LS: BUFF, LT GRY, F XLN, DNS, HD SH: M GRY,M YELL, RED, PLTY, FRM, NON CALC
3560-3600	LS: LT GRY, F XLN, DNS, HD
3600-3610	LS: BUFF, LT GRY, F XLN, OCC CHKY, FRM SH: M GRY, PLTY, FRM, NON CALC
3610-3620	LS: M GRY, F XLN, FRM HD, DNS
3620-3630	LS: M GRY, F XLN, FRM HD, DNS, TR SH
3630-3670	LS: M DK GRY, F XLN, DNS, HD
3670-3700	LS: M GRY, F XLN, DNS, HD, TR SH
3700-3730	LS: LT M GRY, F XLN, DNS, HD SH: M DK GRY, PLTY FRM, NON CALC
3730-3740	LS: LT M GRY, F XLN, DNS, HD DOLO IP
3740-3750	LS: LT GRY, F XLN, DNS, HD SH: DK GRY, PLTY, FRM, NON CALC

3750-3775 LS: BUFF, DK GRY, F XLN, DNS, HD OCC CHKY
3775-3785 LS: M DK GRY, F XLN, DNS, HD
SH: M DK GRY, LT GRN, PLTY, FRM, SL CALC
3785-3790 SH: M DK GRY, MARR, PLTY, FRM, SL CALC
3790-3795 LS: LT M GRY, F XLN, DNS, HD
3795-3800 LS: LT M GRY, F XLN, DNS, HD
SH: M DK GRY, PLTY, FRM, SL CALC
3800-3820 LS: BUFF, LT GRY, F XLN, DNS, HD
SH: LT DK GRY, PLTY, FRM, NON CALC
3820-3825 SH: LT DK GRY, MARR, PLTY, MOTT IP, F MIC, FRM, NON CALC
3825-3845 SH: DK GRY, PLTY FRM, F MIC IP, NON CALC
3845-3860 SH: M DK GRY, PLTY BLKY, FRM, F MIC IP, NON CALC
3860-3875 SH: LT DK GRY,PLTY, FRM F MIC IP, NON CALC
LS: LT GRY, F XLN, DNS, HD
SS: CRL, WH F M GR, W SRT, W CMT, SBAND SBRD, NON CALC
3875-3895 SH: LT DK GRY, PLTY, FRM, F MIC IP, SL CALC
SS: WH, F M GR, W SRT, W CMT, SBAND SBRD
3895-3915 SH: LT DK GRY, MARR, PLTY, FRM, F MIC IP, SL CALC
SS: WH, F M GR, W SRT W CMT, SBRD SBANG
LS: LT GRY, F XLN, DNS, HD
3915-3925 SH: LT DK GRY, PLTY FRM, F MIC, SL CALC
SS: WH, F M GR, W SRT, W CMT, SBRD SBANG
3925-3933 SH: LT DK GRY, PLTY, FRM, F MIC, SL CALC
SS: W, F M GR, W SRT, W CMT, SBRD SBANG
DO: LT GRY, LT BRN, F XLN, DNS, HD, LIM