The Ryan Oil and Gas Pool of Rush and Pawnee Counties, West-Central Kansas

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THE RYAN OIL AND GAS POOL OF RUSH AND PAWNEE COUNTIES, WEST-CENTRAL KANSAS

by

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ABSTRACT

The Ryan oil and gas pool is located in west-central Kansas on the southwestern flank of the subsurface structure of the Central Kansas Uplift, embracing approximately 850 acres in northeastern Pawnee and southeastern Rush counties. Production is obtained from the Arbuckle dolomite of Cambro-Ordovician age.

The broad arch of the Central Kansas Uplift was a land area of igneous and metamorphic rocks undergoing erosion in early Cambrian time. During late Cambrian and early Ordovician time 560 feet of Cambro-Ordovician dolomite was deposited by a transgressing sea. They were buried under 40 feet of Simpson shale and probably 650 feet of younger pre-Pennsylvanian strata. Erosion accompanied by slight uplift culminated in the formation of an early Pennsylvanian peneplain which truncated the younger pre-Pennsylvanian strata and exposed the Arbuckle as a broad plain.

The broad plain of Cambro-Ordovician dolomite presented ideal conditions for development of solutional topography. This surface was buried in late Desmoinesian time by a transgressing sea which deposited the strata of the Marmaton group, and it has remained buried ever since. Today there are approximately 3,660 feet of Pennsylvanian, Permian and Cretaceous sediments above the Arbuckle surface.

The Arbuckle reservoir of the Ryan pool is defined by 23 producing wells and two dry holes. It consists of a stratigraphic

trap formed by a local topographic high on the eroded surface of the dolomite capped by impervious shales of the Marmaton group. The formation of this topographic feature was effected by the development of a youthful karst surface on the broad outcrop belt of the Arbuckle; however, some remnants of Simpson shale occur immediately adjacent to the field. Cumulative production from the reservoir stood at 175,976 barrels of oil January 1, 1946. It is probable that future production may extend southeastward to include the Ryan Southeast pool, northward into sec. 35, T. 19 S., R. 16 W., and northwestward into sec. 34, T. 19 S., R. 16 W.

INTRODUCTION

Location--The Ryan pool is situated in west-central Kansas, partly in southeastern Rush County and partly in northeastern Pawnee County, approximately 18 miles west of Great Bend, Kansas in the upper drainage of Little Walnut Creek. The field includes parts of sections 34 and 35, T. 19 S., R. 16 W. and sections 2 and 3, T. 20 S., R. 16 W., covering an area of about 850 acres (see plates I, IV, V, and VI).

Acknowledgments--Valuable assistance and cooperation in securing well sample sets of the pool for study by the author, production data and many constructive suggestions is acknowledged to Virgil Cole of Gulf Oil Company, E. P. Philbrick of Magnolia Petroleum Company, T. G. Wright of Stanolind Oil and Gas Company

Plate 1

Outline map of the State of Kansas showing the position of the Ryan pool in relation to the structural features of subsurface west-central Kansas. The Central Kansas Uplift and the Salina Basin are after Lee (1939) and the Dodge City Basin is after McClellan (1930).

STATE OF KANSAS

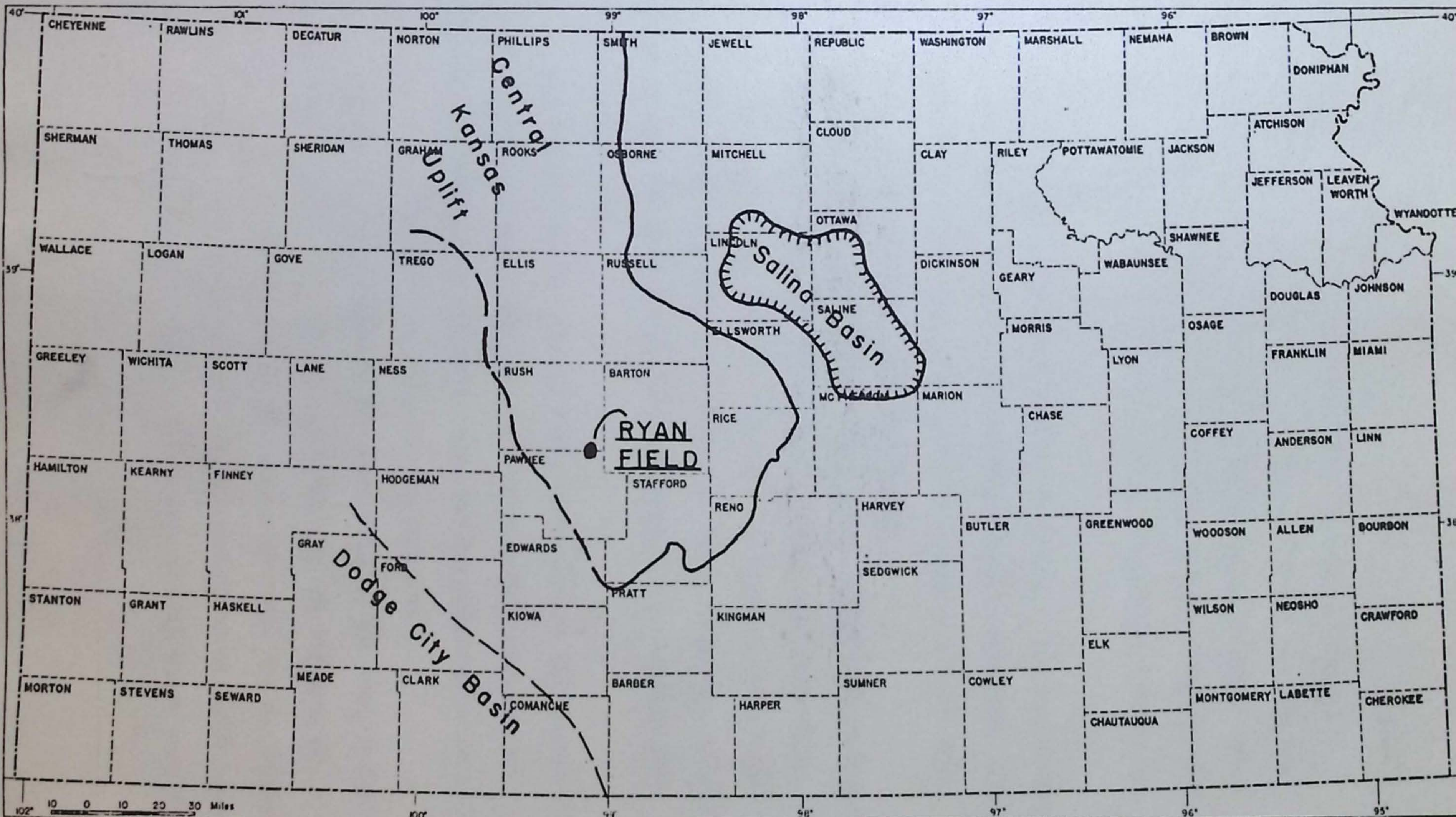

PLATE I

and Francis Mettner of Transwestern Oil Company. Very able assistance and advice was also contributed through the aid and cooperation of Wallace Lee of the U. S. Geological Survey and Dr. M. L. Thompson, late of the University of Kansas faculty and the Kansas State Geological Survey and now at the University of Wisconsin.

Special appreciation is expressed to Dr. R. C. Moore, Kansas State Geologist and Director of the Kansas State Geological Survey for permission to use available electrical logs, drillers' logs and other Survey records at the University.

Purpose of the report—This first study of the Ryan pool was suggested to the author by Dr. M. L. Thompson, then University of Kansas faculty member. It was undertaken as partial fulfillment of the requirements for a Master of Science Degree in Geology at the University. The information contained herein is presented with this view in mind.

The purpose of the report, then, is to present all available information in a detailed picture of the structure and related general stratigraphy with reference to the accumulation of the oil and gas in the Arbuckle reservoir of the Ryan Field.

History of the field—The discovery well in the Ryan pool, the Inland Oil Company No. 1 Peterson, in the SE¼ SE¼ SW¼ sec. 35, T. 19 S., R. 16 W., was completed January 22, 1945. The well had an initial flow of 45 barrels of oil per hour with a potential of 2,591 barrels of oil and 36 barrels of water. By the end of 1945 there were 23 producing wells in the pool, of which 12 were in Rush County and 11 were in Pawnee County (see plates IV, V and VI). There were also two dry tests in the pool at this time; one of which was the Stanolind Oil and Gas Company No. 1 Tammen, in the NW¼ SE¼ SE¼ sec. 35, T. 19 S. R. 16 W., Rush County, and the other was the Magnolia Petroleum Company No. 3 Fleske, in the NW¼ NE¼ SE¼ sec. 3 T. 20 S., R. 16 W., Pawnee County.

The original estimated potential of the Ryan pool was approximately 1,000,000 barrels of oil. Many of the wells, however, as exploration continued, has much smaller initial production than that of the discovery well, and most of them produced some water with the oil (see table 2).

The southeastern wells in sec. 34, T. 19 S., R. 16 W., the southernmost wells in sec. 35, T. 19 S., R. 16 W., and the northeastern wells in sec. 2, T. 20 S., R. 16 W., produce much gas along with the oil. The gas-oil ratio of these wells is fairly high, standing at 12,182 to 1 in the Gulf Oil Company No. 2 Nelson, in the NW¼ NW¼ NW¼ in sec. 2, T. 20 S., R. 16 W. which has a potential of 3,000 barrels of oil, no water and 5,982,400 cu. ft. of gas. This gas is termed a sour gas by the operators in the field. There are no dry gas wells producing commercially in the pool since no market outlet for it has been provided to date; however, two gas pipelines are under consideration, one by the Kansas-Nebraska Natural Gas Company and one by the Inland Oil Company. The gas that has been produced from the combination wells in the area has all been vented.

This vented gas had not been metered prior to May 1, 1946.

Cumulative oil production for the pool totaled 175,976 barrels to the end of 1945 (see table 1). Since that date all wells originally completed to produce are still in production, and no wells have been plugged. Present indications in the area are that water disposal wells will have to be developed in the near future.

TABLE 1

CUMULATIVE PRODUCTION TO THE END OF 1945

Operator	Location	Wells	Production
Gulf--Hageman	34-19S-16W	2 Wells	15,608 bbls.
Inland--Peterson	35-19S-16W	4 Wells	36,918 bbls.
Magnolia--Peterson	35-19S-16W	3 Wells	19,970 bbls.
Stanolind--Mausolf	35-19S-16W	2 Wells	8,105 bbls.
Bird-Hanley-Sheedy--Dirk	2-20S-16W	2 Wells	12,657 bbls.
Gulf--Nelson	2-20S-16W	4 Wells	68,578 bbls.
Transwestern--Fleske	2-20S-16W	2 Wells	4,340 bbls.
Magnolia--Fleske	3-20S-16W	3 Wells	19,970 bbls.

STRATIGRAPHIC SECTION

A composite stratigraphic columnar section of the rocks penetrated by drilling in the Ryan pool is shown in plates II and III. The key horizons used in the construction of the structure maps are indicated by the letter K at the right of the columnar sections. The reference horizons used in well to well correlation and as controls for picking the key horizons are indicated by the letter R.

Method of study--In the course of this study sets of rotary samples starting at an average depth of 2,000 to 2,500 feet and extending to an average total depth of 3,760 feet were available for examination. Detailed lithologic examination of the sample sets was conducted for the purpose of checking horizon identification and tops as determined from regional correlation of electrical logs. Easily recognizable horizons were picked as correlated regionally by Theodore Botinelli of the U. S. Geological Survey located at the University. Where possible interpretation between these key horizons was made by the author in an effort to identify formations and or members within the formations. Once identification of datum strata was established, tops of the beds were verified from examination of the sample sets.

TABLE 2

PRODUCTION DATA FOR WELLS DRILLED IN THE RYAN POOL

Well	Location	Potential Capacity
T. 19 S., R. 16 W.		
1. Gulf		
No. 1 Hagerman	34-19S-16W	2239 BO 18% wtr. and 1,710,000 G.
No. 2 Hagerman	34-19S-16W	2340 BO no wtr. and 7,488,000 G.
2. Inland		
No. 1 Peterson	35-19S-16W	2591 BO plus 36 BW
No. 2 Peterson	35-19S-16W	1190 BO plus wtr.
No. 3 Peterson	35-19S-16W	77 BO 24% wtr and 12,000,000 G.
No. 4 Peterson	35-19S-16W	1242 BO and 800,000 G.
3. Magnolia		
No. 1 Peterson	35-19S-16W	2272 BO
No. 2 Peterson	35-19S-16W	24 BO & 6 BW PD
No. 3 Peterson	35-19S-16W	344 BO

4. Stanolind		
No. 1 Mausolf	35-19S-16W	660 BO 2% wtr.
No. 2 Mausolf	35-19S-16W	42 BO 5 BW
No. 1-B Mausolf	35-19S-16W	874 BO

T. 20 S., R. 16 W.

1. Bird-Hanley-Sheedy		
No. 1 Dirks	2-20S-16W	956 BO 2% wtr.
No. 2 Dirks	2-20S-16W	1735 BO
2. Gulf		
No. 1 Nelson	2-20S-16W	2911 BO now wtr. and 6,598,400 G.
No. 2 Nelson	2-20S-16W	3000 BO no wtr. and 5,982,400 G.
No. 3 Nelson	2-20S-16W	3000 BO no wtr.
No. 4 Nelson	2-20S-16W	3000 BO no wtr. and 1,712,000 G.
3. Transwestern		
No. 1 Fleske	2-20S-16W	42 BO plus 2% wtr.
No. 2 Fleske	2-20S-16W	186 BO and 62,000 G.
4. Stanolind		
No. 1 Bowyer	2-20S-16W	48 BO 12 BW
5. Magnolia		
No. 1 Fleske	3-20S-16W	316 BO
No. 2 Fleske	3-20S-16W	74 BO
No. 3 Fleske	3-20S-16W	DRY

Of the 25 wells drilled in the field there were 18 electrical logs available. Out of these 18 logs there were 12 which covered the wells from depths of 1,020 feet to the total depth, the remaining 6 covered only the lower 200 to 500 feet of the wells. In the latter case it was necessary to call the higher horizon tops from examination of the well sample sets alone. It must be realized that inaccuracies of as much as two or three feet are to be expected since well samples were in intervals of five

Table 3

List of wells drilled in the Ryan pool with the depths and altitudes of recognisable important strata given.

Well Name		Location	Section	Top Stone Corral	Top Nolans	Base Wreford	Base Foraker	Base Permian	Top Topeka	Base Oread	Top Lansing	Base Bronson	Top Simpson	Top Sooy Congl.	Top Arbuckle
T. 19 S., R. 16 E.															
1. Gulf No. 1 Hagerman		SE SE SE	34												
Elev. 1989	Depth			1013						3338	3382	3602			3661
	Alt.			976						-1349	-1393	-1613			-1672
2. Gulf No. 2 Hagerman		SE NE SE	34												
Elev. 1986	Depth														
	Alt.			1003											
				983						3326	3374	3610			3654
										-1340	-1388	-1621			-1668
3. Inland No.1 Peterson		SE SE SW	35												
Elev. 1992	Depth			1007	1980	2275	2570	2736	3045	3330	3375	3618			3653
	Alt.			985	12	-283	-578	-744	-1053	-1338	-1383	-1626			-1661
4. Inland No. 2 Peterson		SE SW SW	35												
Elev. 1993	Depth			1007	1986	2278	2575	2740	3053	3338	3382	3626			3662
	Alt.			986	7	-285	-583	-747	-1060	-1345	-1389	-1633			-1669
5. Inland No. 3 Peterson		SE NE SW	35												
Elev. 1992	Depth			1013	1990	2280	2580	2745	3050	3330	3386	3630			3660
	Alt.			979	2	-288	-588	-753	-1058	-1338	-1394	-1638			-1668
6. Inland No. 4 Peterson		SE NW SW	35												
Elev. 1985	Depth			998	1975	2275	2569	2735	3044	3335	3380	3620	3656		3660
	Alt.			987	10	-290	-584	-750	-1059	-1350	-1395	-1635	-1671		-1675
7. Magnolia No. 1 Peterson		SE SE NW	35												
Elev. 1977	Depth			1007	1970	2270	2560	2719	3034	3325	3372	3614			3647
	Alt.			970	7	-293	-583	-742	-1057	-1348	-1395	-1637			-1670
8. Magnolia No. 2 Peterson		SE SW NW	35												
Elev. 1977	Depth			1004	1958	2245	2560	2725	3032	3328	3374	3618	3654		3668
	Alt.			973	19	-278	-583	-748	-1055	-1351	-1397	-1641	-1681		-1691

Well Name		Location	Section	Top Stone Corral	Top Nolans	Base Wreford	Base Foraker	Base Permian	Top Topeka	Base Oread	Top Lansing	Base Bronson	Top Simpson	Top Sooy Congl.	Top Arbuckle
9. Magnolia No. 3 Peterson		SE NE NW	35												
Elev. 1984	Depth			1014							3368				3661
	Alt.			970							-1384				-1677
10. Stanolind No. 1 Mausolf		SE SW SE	35												
Elev. 1986	Depth			1008	1980	2280	2575	2742	3053	3340	3384	3627			3663
	Alt.			978	6	-294	-589	-756	-1067	-1356	-1398	-1641			-1677
11. Stanolind No. 2 Mausolf		NW NW SE	35												
Elev. 1988	Depth			1005	1980	2275	2574	2740	3050	3340	3383	3640			3663
	Alt.			983	8	-287	-586	-752	-1060	-1352	-1395	-1652			-1675
12. Stanolind No. 1B Mausolf		NW SW NE	35												
Elev. 1976	Depth			1000	1970	2260	2552	2715	3024	3315	3360	3602			3641
	Alt.			976	6	-284	-576	-739	-1048	-1339	-1384	-1626			-1665
13. Stanolind No. 1 Tammen		NW SE SE	35												
Elev. 1982	Depth			1015	1986	2282	2576	2743	3055	3342	3388	3632	3670		3684
	Alt.			967	-4	-300	-594	-761	-1073	-1361	-1406	-1650	-1688		-1702
T. 20 S., R. 16 E.															
14. Bird Sheedy No.1 Dirks		NW NW NE	2												
Elev. 1989	Depth			1014							3382				3650
	Alt.			975							-1393				-1661
15. Bird Sheedy No.2 Dirks		NW SE NE	2												
Elev. 1992	Depth			1015						3342	3386				3662
	Alt.			977						-1350	-1394				-1670
16. Gulf No. 1 Nelson		NW NE NW	2												
Elev. 1994	Depth			1015						3338	3382	3627			3658
	Alt.			980						-1343	-1387	-1632			-1663
17. Gulf No. 2 Nelson		NW NW NW	2												
Elev. 1990	Depth			1005						3335	3386	3624			3664
	Alt.			985						-1345	-1396	-1634			-1674

Well Name		Location	Section	Top Stone Corral	Top Nolans	Base Wreford	Base Foraker	Base Permian	Top Topeka	Base Oread	Top Lansing	Base Bronson	Top Simpson	Top Sooy Congl.	Top Arbuckle
18. Gulf No. 3 Nelson		NW SE NW	2												
Elev. 1997	Depth			1012						3340	3387	3627			3665
	Alt.			985						-1343	-1390	-1630			-1668
19. Gulf No. 4 Nelson		NW SW NW	2												
Elev. 1990	Depth			1006						3340	3382	3626			3664
	Alt.			984						-1350	-1392	-1636			-1674
20. Transwestern No. 1 Fleske		NW NE SW	2												
Elev. 1997	Depth			1021						3350	3398	3642			3682
	Alt.			976						-1353	-1401	-1645			-1685
21. Transwestern No. 2 Fleske		NW NW SW	2												
Elev. 1999	Depth			1021							3411				3696
	Alt.			978							-1412				-1697
22. Stanolind No. 1 Bowyer		NW NW SE	2												
Elev. 1989	Depth			1009	1990	2273	2570	2740	3055	3344	3392	3632			3667
	Alt.			980	-1	-284	-581	-751	-1066	-1355	-1403	-1643			-1678
23. Magnolia No. 1 Fleske		SE NE NE	2												
Elev. 1991	Depth			1019											
	Alt.			972	1990	2280	2580	2745	3060	3342	3388	3636			3668
					1	-289	-589	-754	-1069	-1351	-1397	-1645			-1677
24. Magnolia No. 2 Fleske		SE SE NE	3												
Elev. 1988	Depth			1018							3391	3636			3673
	Alt.			970							-1403	-1648			-1685
25. Magnolia No. 3 Fleske		NW NE SE	3												
Elev. 1992	Depth			1012											
	Alt.			980							3405			3684	3698
											-1413			-1692	-1706

to ten feet. From examination of both the electrical logs and the sample sets the composite columnar section was constructed. The classification of the section is in accordance with the usage of the Kansas State Geological Survey wherein possible. Only the more prominent formations are differentiated.

Cretaceous Rocks

Electrical logs and sample sets were not available for the study of these rocks, but Landes and Keroher (1938) attribute from 550 to 660 feet of Cretaceous and younger sediments as present in the area. These include some 65 feet of alluvium and or terrace sands of Recent and Pliestocene age. The Cretaceous rocks consist of 108 feet of Greenhorn, 35 feet of Graneros and 400 feet of Dakota. It is probable that the lower portion of the Dakota may correspond to the Kiowa and Cheyenne formations of the Commanchean (Ver Wiebe, 1938).

Permian Rocks

Guadalupian and Leonardian Series

Cimarron group--The top of the Permian occurs about 600 feet below the surface, consisting of brick-red shale and sandstone with thin beds of anhydrite (Landes and Keroher, 1938). These strata of the upper Permian in the area occur between the base of the Dakota and the top of the Stone Corral, and are herein grouped under the heading Cimarron. This term is merely a collective one as applied to these sediments, including all those Permian beds

Plate II

Generalized columnar section of the strata above the Stone Corral anhydrite. This section is only of a general nature since no electrical logs nor sample sets were available for the study of the rocks included. Column is after Moore, Frye and Jewett (1944) and Landes and Keroher (1938). Classification is in accordance with the usage of the Kansas State Geological Survey as near as possible.

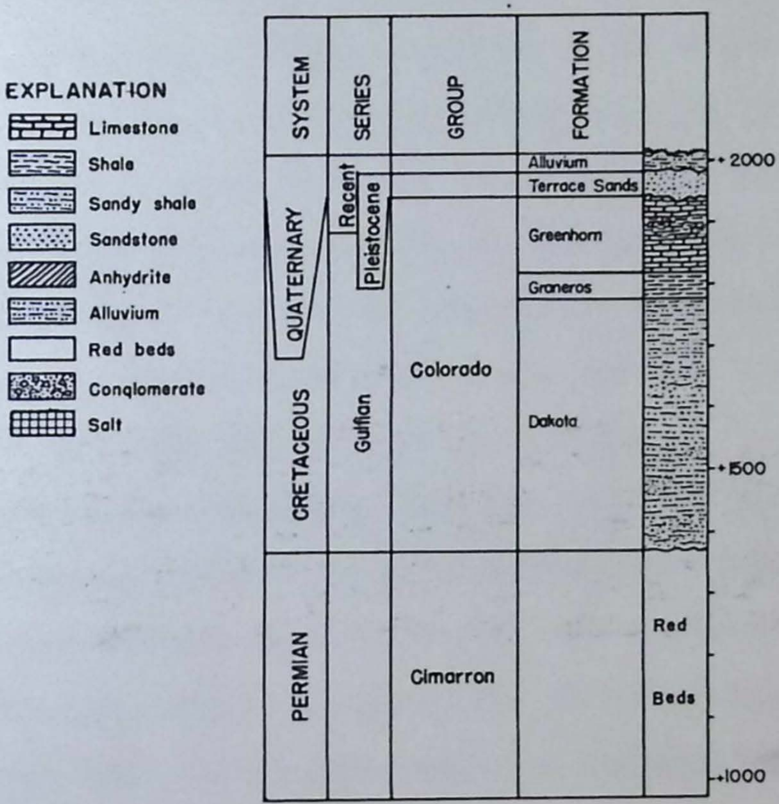
EXPLANATION
Limestone
Shale
Sandy shale
Sandstone
Anhydrite
Alluvium
Red beds
Conglomerate
Salt
SYSTEM
SERIES
GROUP
FORMATION
QUATERNARY
Recent
Pleistocene
Alluvium
Terrace Sands
Greenhorn
Graneros
CRETACEOUS
Gulfian
Colorado
Dakota
PERMIAN
Cimarron
Red
Beds
2000
1500
1000

PLATE II

above the Stone Corral since no electrical logs or samples were available for study to enable further designation. Thick beds of evaporite in the upper portion are thought by some to correspond to the Blain or Medicine Lodge gypsum (Ver Wiebe, 1938).

Sumner group--The upper formation of this basal group of the Leonardian series, the Stone Corral anhydrite (Moore, Frye and Jewett, 1944), occurs at depths averaging 1,010 feet. It is a very conspicious marker found in all electrical and sample logs of the area. It is also often reported to be a good reflecting horizon for seismograph surveys in most areas of the state. The average thickness over the pool is 25 feet.

The strata immediately underlying the Stone Corral make up the Ninnescah formation of undifferentiated red beds. The resistivity curve of the electrical log of these strata is included in the columnar section (see plate III). Further interpretation than is shown there was not attempted. The Ninnescah averages 400 feet in thickness in the Ryan area.

A salt section 375 feet thick underlies the Ninnescah, and the top of it is taken as the top or slightly below the top of the Wellington formation. This salt is considered to correspond to the Hutchison salt member usually found in the subsurface Wellington in most of western Kansas (Moore, Frye and Jewett, 1944). It is entirely possible that the top of the Wellington actually occurs in the lower portion of what is herein designated as the Ninnescah formation, but for the purposes of correlation it was

Plate III

Composite columnar section of the strata between the Stone Corral anhydrite and the Arbuckle dolomite.

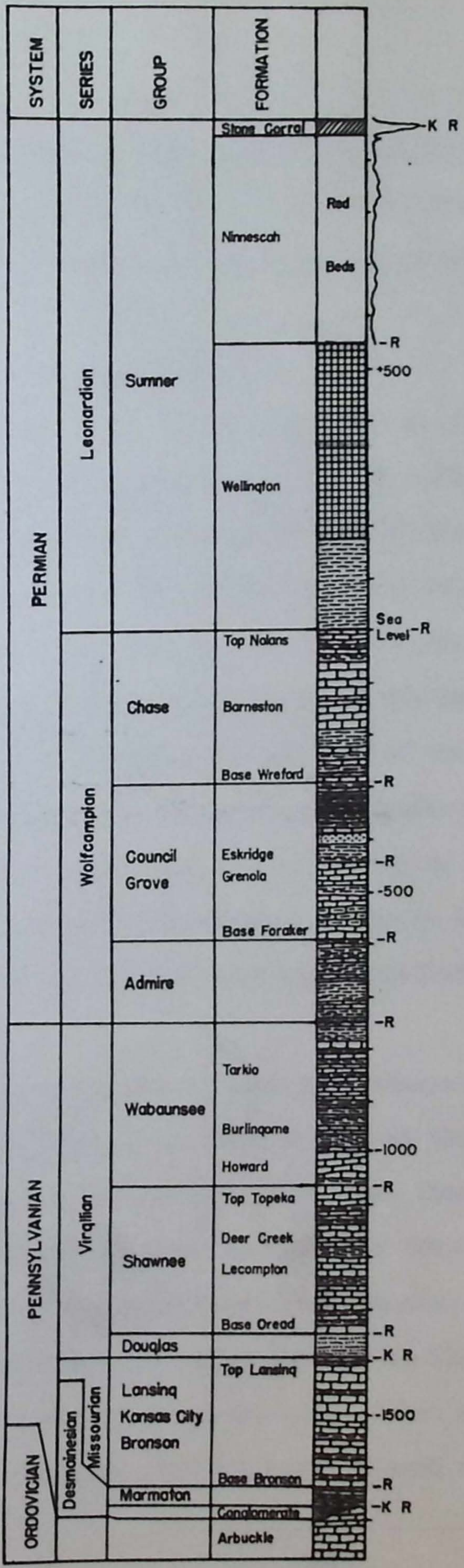
SYSTEM
SERIES
GROUP
FORMATION
PERMIAN
PENNSYLVANIAN
ORDOVICIAN
Leonardian
Wolfcampian
Virqilian
Missourian
Desmoinesian
Sumner
Chase
Council Grove
Admire
Wabaunsee
Shawnee
Douglas
Lansinq Kansas City Bronson
Marmaton
Stone Corral
Ninnescah
Red Beds
Wellington
Top Nolans
Barneston
Base Wreford
Eskridge
Grenola
Base Foraker
Tarkio
Burlingame
Howard
Top Topeka
Deer Creek
Lecompton
Base Oread
Top Lansinq
Base Bronson
Conglomerate
Arbuckle
K R
R
+500
Sea Level
-500
-1000
-1500

PLATE III

chosen at the top of the salt section. Underlying the thick salt section and marking the base of the Wellington are some 175 feet of undifferentiated red and green shales and broken anhydrite.

Wolfcamp Series

Chase group—This topmost group of the Wolfcamp consists of about 300 feet of prominent limestones and shales, marked at the top by the occurrence of the tannish dense Nolans limestone and at the bottom by the base of the light gray and somewhat flinty Wreford limestone. The group is, for the most part, undifferentiated, but the Barneston limestone was picked as the thick limestone about midway between the top and the base of the group. This formation was identified by its stratigraphic position and the regional correlation of electrical logs on the top of the Nolans and the base of the Wreford formations. However, the characteristic flinty part of the Barneston was identifiable from rotary samples.

Council Grove group—The strata of this group consists of 300 feet of limestones and shales, of which in general the limestones are thinner, less massive and less flinty than those of the overlying group. It includes all those beds between the base of the Wreford and the base of the thick basal light tannish gray to bluish gray Foraker limestones. Identification of the light gray Grenola limestone and the overlying red and green shales of the Eskridge formations was possible. The thickness of each as established by electrical logs averaged 35 and 40 feet respectively. The Foraker limestone was interpreted as having a thickness of about 50 feet. The remainder of the group remains undifferentiated.

Admire group—A thickness of 165 feet of red and some gray shale with a few thin limestones make up this basal Permian group. The columnar section of the group is completely undifferentiated since it was not possible to identify any of the formations or members thereof from examination of either the sample sets nor the electrical logs. The base of the group is identified by a regional correlation of electrical logs of what was taken as the sand or sandy zone corresponding to the Indian Cave sandstone, determined to be everywhere present at the base of the Permian of Kansas (Moore, Frye and Jewett, 1944).

Pennsylvanian Rocks

Virgilian Series

Wabaunsee group—These strata in the area average 310 feet of relatively thin limestones and thicker shales. Three horizons were identified in the group; however, it is the very fossiliferous Howard limestone which is best recognized by the contrast of its relatively thick sequence of limestone strata as compared to the overlying shales. It was possible to identify tentatively the fusilinid-bearing Tarkio and Burlingame limestones from the sample logs and from their stratigraphic position as shown by the electrical logs. The thin basal gray Severy shale immediately below the Howard is not always recognized in the sample logs, but is everywhere recognizable in the electrical logs.

Shawnee group—Lying underneath the Wabaunsee group and marked at the top by the blue gray Topeka limestone are 285 feet of alternating limestones and shales which comprise the Shawnee group. In descending order the four limestone formations identifiable in these strata consist of the Topeka, Deer Creek, Lecompton and Oread. In several of the sample logs and most of the electrical logs the black shale of the Heebner member of the Oread can be recognized. The group as a whole is easily recognized as a zone of limestones and shales which are separated from the underlying Missourian strata by the sandy shales of the Douglas group and from the overlying Wabaunsee by the thin Severy shale member.

Douglas group—This basal group of the Virgilian series consists of 45 feet of red and green shales and sandy shales lying between the base of the Oread above and the top of the Lansing below. It presents a very good correlation zone in all the well logs of the area, especially so in the electrical. No subdivision of the group was possible, but it probably corresponds to the outcropping Douglas ~~and possibly including some Weston shale of Bourbon~~ age in the lower portion.

Missourian Series

Lansing-Kansas City-Bronson groups—These strata consist of 245 feet of light colored limestones with a few thin shale breaks recognizable from the electrical logs. The drillers have logged the entire section as one of limestone. The top of the Lansing is one of the most important horizons for correlation of sample logs in the area since it contains numerous fossils and oolite zones at several levels. The sequence of Mississippian strata below the Lansing could not be subdivided into its component parts, but was regionally correlated to include all three groups of the Lansing, Kansas City and Bronson.

Marmaton group--The relatively thin beds of red shale and gray limestone lying between the base of the Bronson above and the top of the Arbuckle below comprise this group, averaging 40 feet thick over the area. At the base of the group there may or may not be found a reddish tight conglomerate, the basal Pennsylvanian conglomerate. This clastic unit consists of a tight reddish clayey matrix containing well rounded colorless sand grains with a few angular fragments of brightly colored chert. Its thickness reaches a maximum of 25 feet on the southwestern edge of the field.

Ordovician Rocks

On the eastern edge of the pool some remnants of the greenish clayey Simpson shale are found, here reaching a thickness of 14 feet. It is also thought by the author that the same formation is present on the northwestern boundry of the field where it reaches a thickness of 13 feet, however the identification of the latter beds as Simpson is somewhat questionable.

Cambro-Ordovician Rocks

The Cambro-Ordovician "siliceous lime" underlies most of the area immediately below the Marmaton sediments of Pennsylvanian age, but may be covered locally by the greenish clayey Simpson shale. These sediments are commonly logged as cherty or sandy dolomitic gray to cream limestone by drillers and identified as belonging to the Arbuckle dolomite formation. They are herein described as consisting of pale cream dolomite with a fairly coarse crystalline texture containing numerous oolitic and cherty zones. The thickness of this formation is not determinable for the Ryan area since none of the wells penetrated the base. It is considered, however, that about 560 feet of dolomite and other Cambro-Ordovician sediments were originally deposited over this and adjacent regions of the Central Kansas Uplift (Walters, 1946).

STRUCTURE

Resume of structural history of Central Kansas—The detailed picture of the regional structure of the Central Kansas Uplift was recently presented by Walters (1946), and a brief resume will be given here as a background for understanding the structural conditions of the Ryan pool.

Warping and folding in the central and west-central parts of Kansas first developed in post-Algonkian time (Koester, 1935) to form the northwest-southeast trending structural feature termed the Central Kansas Uplift (Morgan, 1932). There followed a prolonged period of erosion, presumably in late pre-Cambrian and early Cambrian time, ending in the formation of an extensive peneplain across the terrane of complex igneous and metamorphic rocks. This peneplained land surface was preserved by burial under the transgressing sediments of the Cambro-Ordovician seas, which deposited approximately 560 feet of dolomitic and in part oolitic strata. In late Ordovician time this positive area was buried under 40 feet of Simpson shale and an estimated 100 feet of Viola and Maquoketa beds (Walters, 1946), all of which are now absent over the crest of the structure. Remnants of the Simpson are found in the area of the Ryan pool, however.

There are no sediments of Silurian and Devonian age present over most of the Central Kansas Uplift, but they were recognized in the Salina Basin (see fig. 1) about 40 miles northeast of the Ryan area by Barwick (1928). There, beds of middle Silurian (Niagaran) and middle Devonian (Onondaga to Hamilton) age, commonly termed "Hunton", are present. It is assumed that these truncated beds, present in the Salina Basin, may have been deposited over the uplift in an unknown thickness, estimated by Walters (1946) to be approximately 200 feet, and later removed by subsequent erosion.

Erosion in pre-Mississippian time removed the Silurian and Devonian beds formerly present in the area. It is the conclusion of Moore and Jewett (1942) that the erosion at this time not only removed any "Hunton beds present, but also removed the Maquoketa and Viola sediments, leaving approximately 600 feet of strata covering the old pre-Cambrian floor at this time. Transgression of the Mississippian seas resulted in the deposition of an estimated 350 feet of sediments over the uplift. These beds are present in the Salina Basin to the northeast, although removed from the broad regional structure of the Central Kansas Uplift. Added to those beds already present the Mississippian strata completed a sedimentary section about 950 feet thick at the close of Meramac time (Walters, 1946).

In pre-Pennsylvanian and early Pennsylvanian time extensive erosion removed the Mississippian and late Ordovician beds. This erosion was accompanied by further folding, tilting and uplifting to elevate and fold the uplift along a northwest-southeast direction, exposing the underlying Arbuckle. This extensive area of the nearly flay-lying Cambro-Ordovician dolomite and the warm moist climate (as indicated by the Cherokee coal beds in eastern Kansas) provided ideal conditions for erosion by solution. Walters (1946) describes the formation of a karst terrane by rain falling of this broad plain. It is herein suggested that the greenish clayey Simpson shale on the northwest and eastern fringes of the Ryan field are preserved in collapsed caverns or sinkholes formed in the Arbuckle prior to the complete removal of the overlying shale.

In late Desmoinesian time the uplift was again covered by transgressing seas, and the Marmaton strata were deposited.

Broad warping of the uplift and folding of its cross-grained northeast-southwest anticlines continued throughout Pennsylvanian and Permian time. The most prominent of these periods of structural growth seems to have occurred in post-Missourian time and is represented by the post-Oswald zone in Kansas (Koester, 1935).

Norton's study of the Permian redbeds of Kansas (1939) indicates that the post-Stone Corral redbeds have a maximum thickness of about 1,300 feet. Since only 400 feet of these sediments are present in the area, it is estimated that approximately 900 feet to 1,000 feet of upper Permian sediments have been removed by pre-Cretaceous erosion.

Cretaceous beds rest unconformably on truncated Permian redbeds over the uplift, and any Triassic, Jurassic and early Cretaceous beds that may have been deposited, were removed in pre-Dakota time. This leaves a thickness of approximately 3,000 feet of section over the uplift above the Arbuckle surface during lower Cretaceous. Walters (1946) estimates that 1,400 feet of sediments were originally deposited over the uplift during Cretaceous time, but that erosion initiated in Tertiary time and continuing to the present has removed approximately 900 feet.

Post-Permian westward tilting has had little effect on the Central Kansas Uplift according to Koester (1935) except "that it has left thinner redbeds on the east side of the uplift than on the west side and consequently caused the lower horizons to be at greater depth on the west and southeast. Post-Cretaceous movements have revived the northeast-southwest anticlines and have flattened the regional dip of the Cretaceous beds over the nucleus of the uplift. This has been effected most likely largely by settling. The last period of structural growth of the Central Kansas Uplift is not definitely known, but it has been a living, growing feature since pre-Cambrian time."

Relation of the Ryan field to regional structure--The position of the Ryan pool in relation to the Central Kansas Uplift and adjacent regional structures is shown in plate I. The outline of the Uplift and the Salina Basin are after Lee (1939), and the Dodge City Basin after McClellan (1930). As shown in plate I, the Ryan field is located fairly well up on the south-western flank of the uplift. The regional attitude of the rocks in the area is one, then, of relatively flatlying strata, gently arched over the broad geanticlinal structure of the Uplift.

The subsurface structure of Rush and the adjacent parts of surrounding counties was mapped from drillers' logs by Landes and Keroher (1938), using the Stone Corral anhydrite as a datum plane. The major structural feature shown by their work was a large anticline, the Fairport-Natoma trend, the axis of which passes into southeastern Rush County from southwestern Barton County. "It trends in a general northwesterly direction across the eastern half of the county.------The anticline plunges moderately toward

Plate IV

Structure map contoured on the datum of the Stone Corral anhydrite.

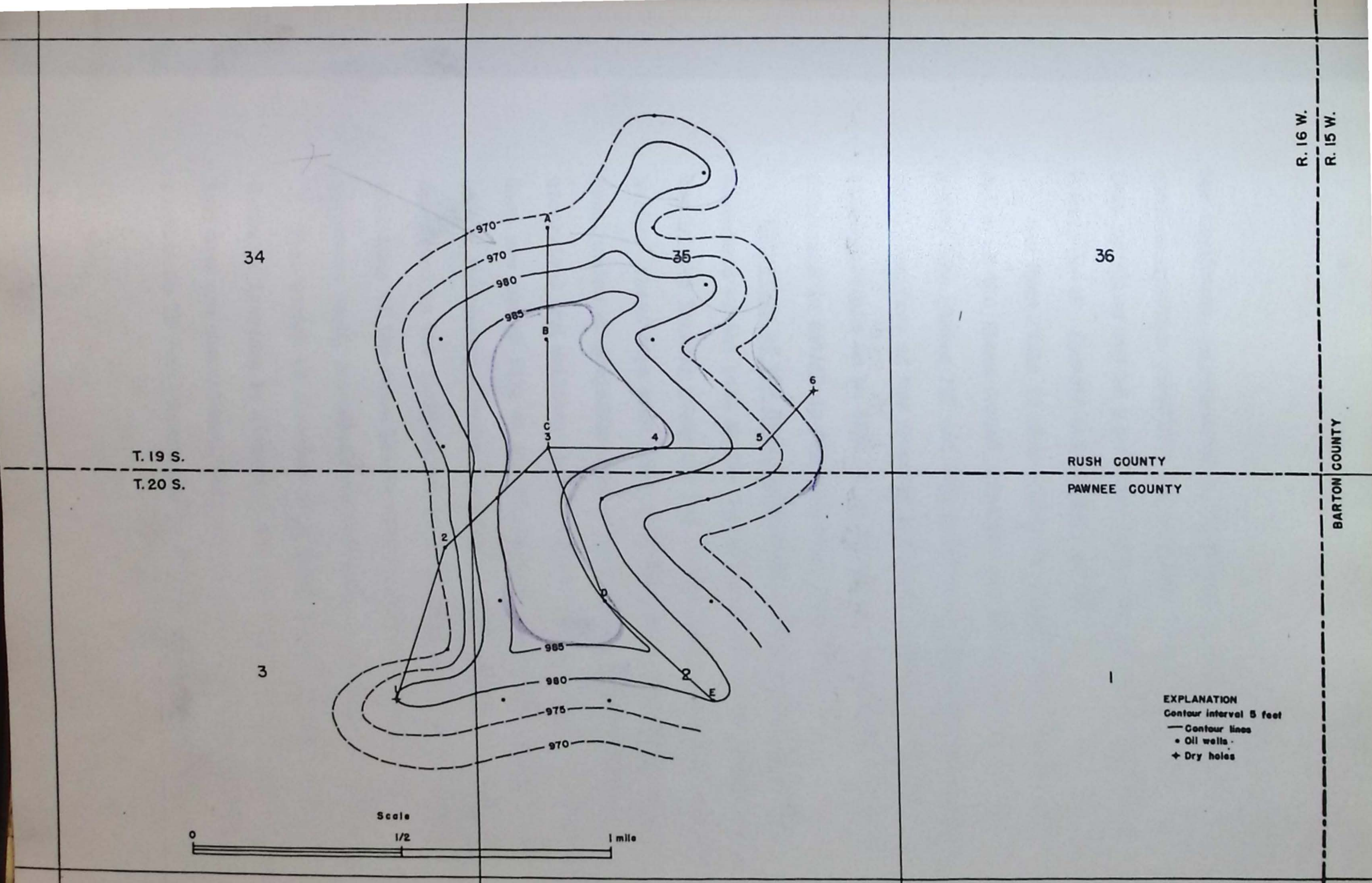
R. 16 W.
R. 15 W.
34
35
36
3
1
T. 19 S.
T. 20 S.
RUSH COUNTY
PAWNEE COUNTY
BARTON COUNTY
970
970
980
985
985
980
975
970
A
B
C
D
E
1
2
3
4
5
6
EXPLANATION
Contour interval 5 feet
Contour lines
Oil wells
Dry holes
Scale
0
1/2
1 mile

PLATE IV

the northwest, disappearing in T. 16 S., R. 18 W. A broad shallow syncline parallels the anticline on the southwest. This syncline may be a northern re-entrant of the Dodge City Basin;------." (Landes and Kercher, 1938).

The Ryan field is also mapped as a small anticline on the datum of the Stone Corral anhydrite and the top of the Lansing group (see plates III and IV); however the structure as mapped on the surface of the Arbuckle producing horizon is not considered herein to be that of an anticline. This subject will be discussed in detail in the following paragraphs.

<u>Structure of the Ryan field</u>--Plates III, IV and V show the structure of the pool at the top of the Stone Corral anhydrite, top of the Lansing group and top of the Arbuckle dolomite respectively. These maps were drawn from data determined by microscopic examination of available sets of well samples with the aid of electrical and drillers' logs. All of the electrical and drillers' logs are now on file at the Kansas State Geological Survey office at the University. Table 3 presents a list of all the tests completed in the field before April 1, 1946, and the depths and altitudes of the datum points used in construction of the structure maps, cross-sections and columnar sections of the field.

This series of structure maps shows that there is a very definite increase in closure on the Ryan trap as the deeper horizons are encountered; the maximum closure on the Stone Corral surface is 14 feet, increasing to 23 feet on the top of the Lansing

Plate V

Structure map contoured on the datum of the top of the Lansing group.

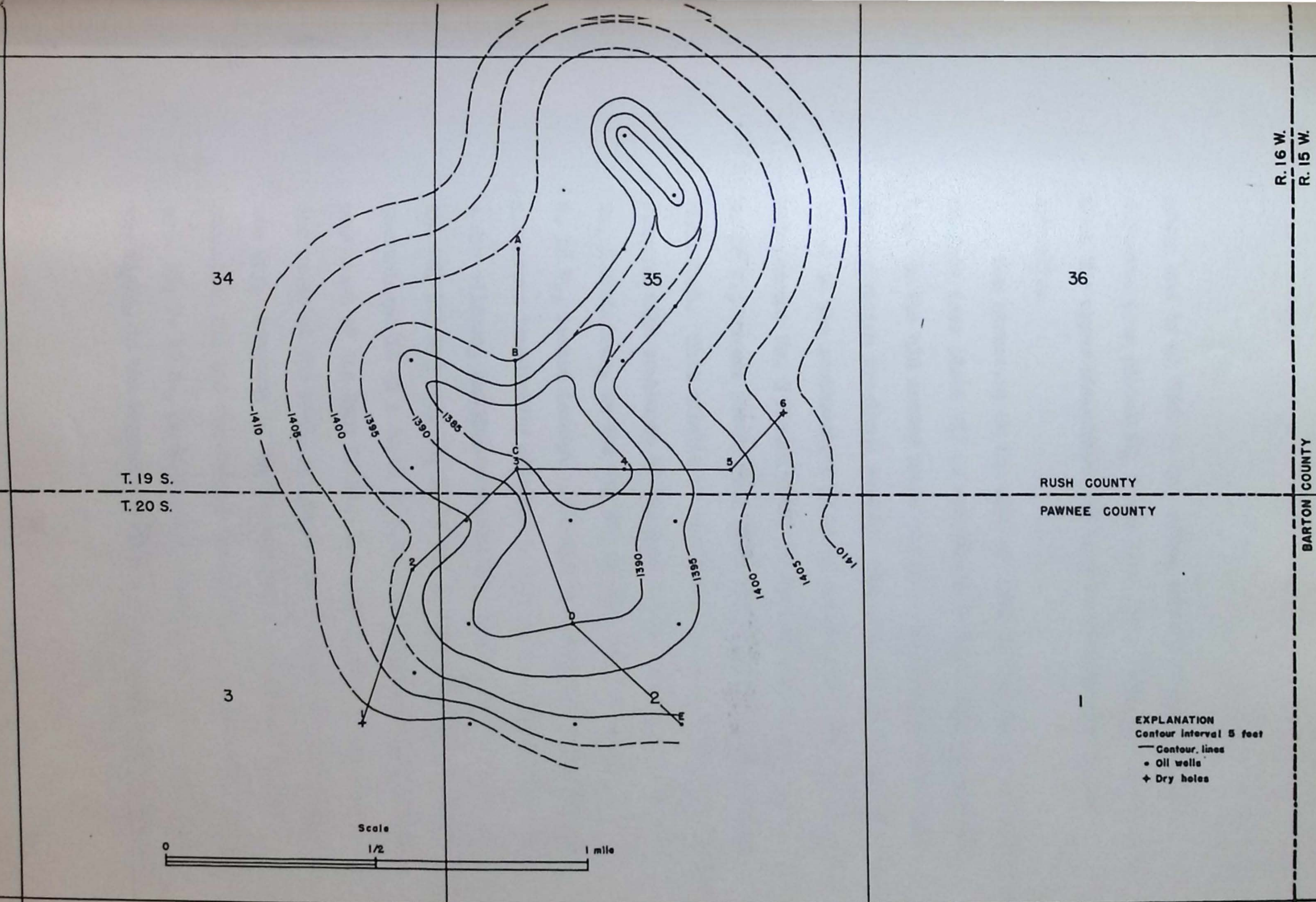
34
35
36
3
1
A
B
C
D
E
1
2
3
4
5
6
2
1410
1405
1400
1395
1390
1385
T. 19 S.
T. 20 S.
RUSH COUNTY
PAWNEE COUNTY
BARTON COUNTY
R. 16 W.
R. 15 W.
EXPLANATION
Contour interval 5 feet
Contour lines
Oil wells
Dry holes
Scale
0
1/2
1 mile

PLATE V

group and to 41 feet on the eroded surface of the Arbuckle dolomite (see plates IV, V and VI). This would seem to indicate that the upper structures are superatenuous on that of the Arbuckle.

The structure of the area as shown by the map of the Arbuckle surface (see plate VI) is considered to be a local topographic high on the old eroded plain formed during the extensive pre-Pennsylvanian erosional period. The presence of the conglomerate found on the southwestern flank of the field in the dry Magnolia Oil Company No. 3 Fleske test, in the NW¼ NE¼ SE¼ sec. 3, T. 19 S., R. 16 W., Pawnee County (see plate VII) partially substantiates this fact. This clastic is also found in another dry hole three-fourths mile southeast of the pool in the Barbara Oil Company No. 1 Wickstrom, in the NE¼ SW¼ SE¼ NW¼ sec. 12, T. 20 S., R. 16 W., Pawnee County. Although no tests penetrated the conglomerate immediately adjacent to the pool on the northern side, a dry wildcat, the Mid-Continent Oil Company No. 1 Werholm, in the NW¼ NW¼ NW¼ sec. 31, T. 19 S., R. 15 W., Barton County, encountered it at a depth of 3,615 feet, approximately one mile northeast of the Ryan field. The conglomerate is not found over the crest of the pool, and those tests which have penetrated it elsewhere are dry. Remnants of the Simpson shale are present in the Stanolind Oil and Gas Company No. 1 Tammen, in the NW¼ SE¼ SE¼ sec. 35, T. 10 S., R. 16 W., Rush County, on the eastern side of the field, in the Magnolia Petroleum Company No. 2 Peterson, in

Plate VI

Structure map contoured on the datum of the Arbuckle dolomite.

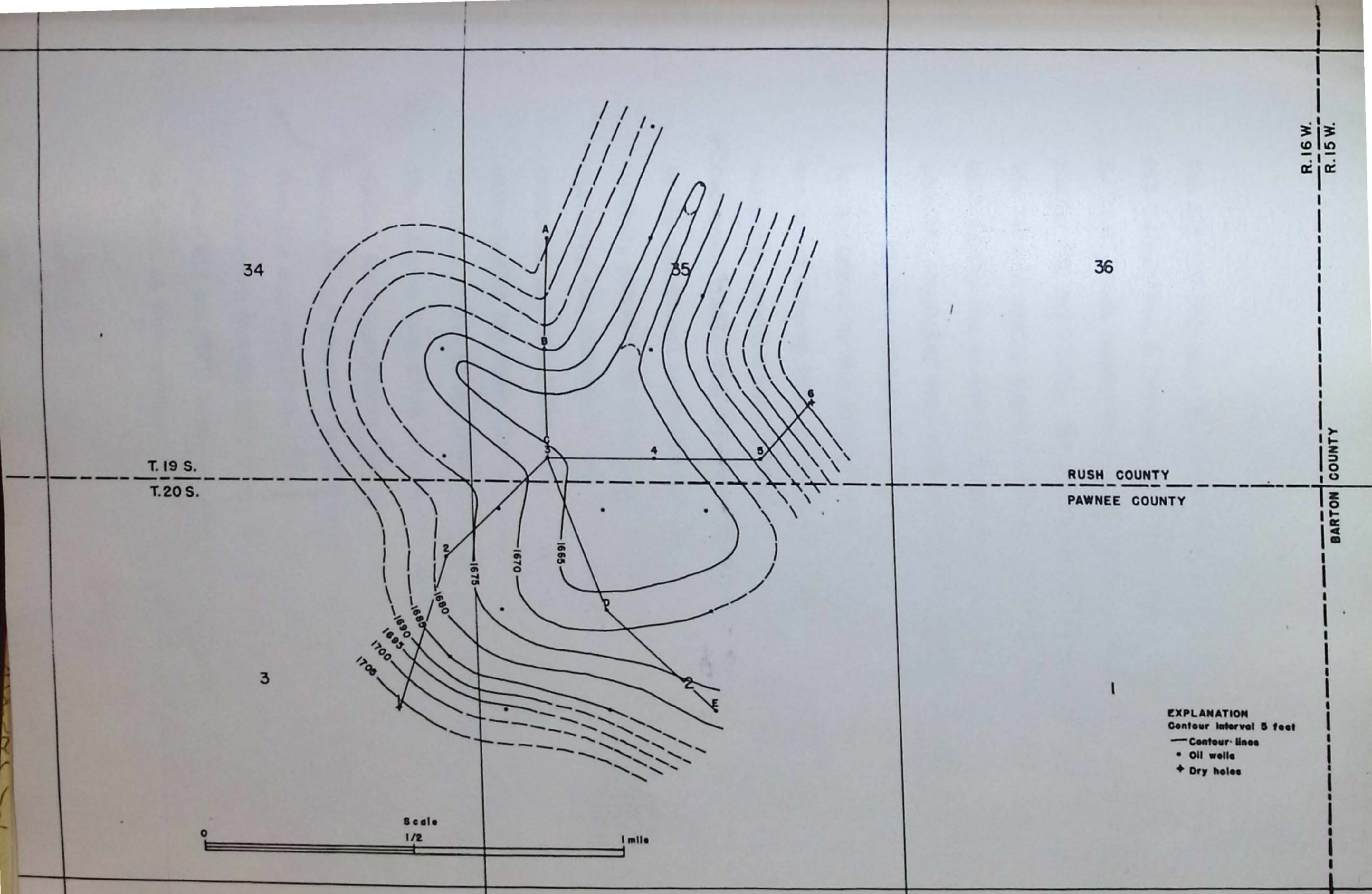
34
35
36
3
1
R. 16 W.
R. 15 W.
T. 19 S.
T. 20 S.
RUSH COUNTY
PAWNEE COUNTY
BARTON COUNTY
A
B
C
D
E
1665
1670
1675
1680
1685
1690
1695
1700
1705
EXPLANATION
Contour interval 5 feet
Contour lines
Oil wells
Dry holes
Scale
0
1/2
1 mile

PLATE VI

the SE$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 35, T. 19 S., R. 16 W., and in the Inland Oil Company No. 4 Peterson, in the SE$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 35, T. 19 S., R. 16 W., Rush County on the northwestern edge of the pool (see plates VII and VIII). The occurrence of the conglomerate and the Simpson shale, seems to indicate that the Ryan field was a hill during the period of deposition of the conglomerate, possibly supplying some sediments to the surrounding areas.

The low relief of the land surface, the warm moist climate (as indicated by the Cherokee coal beds in eastern Kansas), and the broad outcrop belt of the nearly flat Cambro-Ordovician dolomites provided ideal conditions for erosion by solution (Walters, 1946). The formation of this hill is, then, attributed to the solutional activities of rain falling on the old Arbuckle surface, percolating along joint planes and fractures and disolving the dolomite to develop a youthful karst topography of sinkholes and or solution valleys (Von Engeln, 1942). The angular character of the chert fragments contained in the conglomerate indicates little if any transportation before deposition, and thus the solution took place leaving the chert practically in situ. Whether this topographic high is surrounded by one or more solution valleys or by several sinkholes is not completely determinable from the data available. The presence of the remnants of Simpson shale on the eastern and northwestern flanks of the field (see plates VII and VIII) seems to indicate the existence of sinkholes at least at these points. Since the paleo-areal outcrop of the

Plate VII

Cross section of the Ryan pool from southwest to northeast.

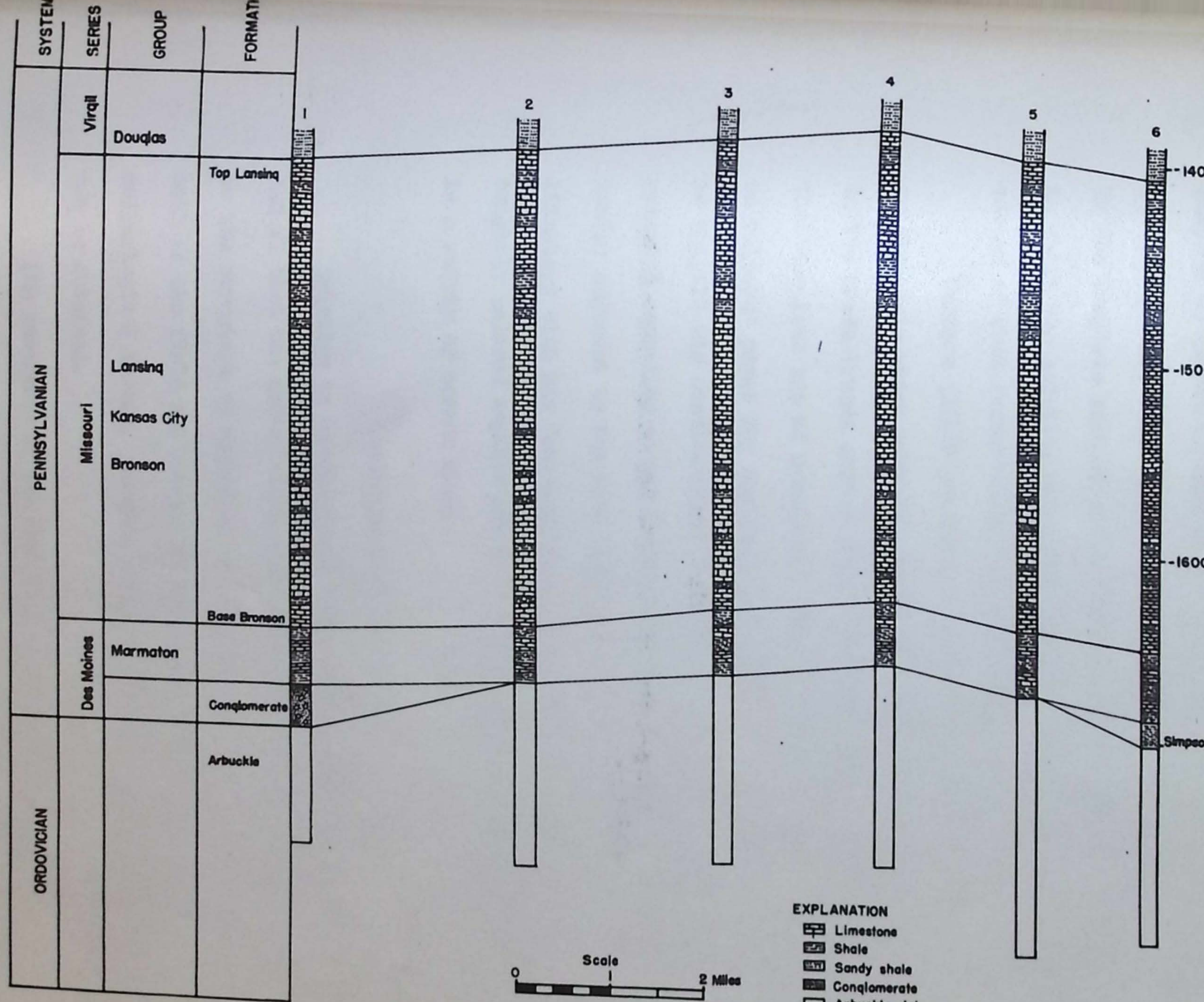
SYSTEM
SERIES
GROUP
FORMATION
PENNSYLVANIAN
ORDOVICIAN
Virgil
Missouri
Des Moines
Douglas
Lansing
Kansas City
Bronson
Marmaton
Top Lansing
Base Bronson
Conglomerate
Arbuckle
1
2
3
4
5
6
-1400
-1500
-1600
Simpson
Scale
0
1
2 Miles
EXPLANATION
Limestone
Shale
Sandy shale
Conglomerate
Arbuckle dol.

PLATE VII

Simpson is mapped as some 20 miles southwest of the Ryan area (Koester, 1935) these sinkholes (?) must have been formed prior to the complete removal of the shale from the underlying dolomite in which the solution was taking place, thus allowing the preservation of that formation in these features.

Walters (1946) concludes that the composition of the conglomerate which partially fills the topographic depressions in the Kraft-Prussa area of Barton County validates the concept that his lows are of solutional origin. The reader is referred to Walters' paper for the facts and deductions which he amasses to support his conclusions. It suffices here to say that the material described as conglomerate found in the topographic low(s) adjacent to the Ryan field appears to correspond in lithology with his "non-marine conglomerate", consisting of brightly colored angular cherts and rounded quartz sand grains in a matrix of maroon clay.

OCCURRENCE OF OIL AND GAS

Relation to structure—It will be noted in plates IV, V and VI that the distribution of the wells is very closely related to the structure as mapped on all three horizons. The discovery well of the field was located on the structure as indicated by a seismological survey,* however a copy of this seismograph map could not be obtained.

The reservoir of the Ryan pool as shown in plate VI was

*Cole, Virgil B., personal communication, May, 1946.

Plate VIII

Cross section of the Ryan pool from northwest to southeast.

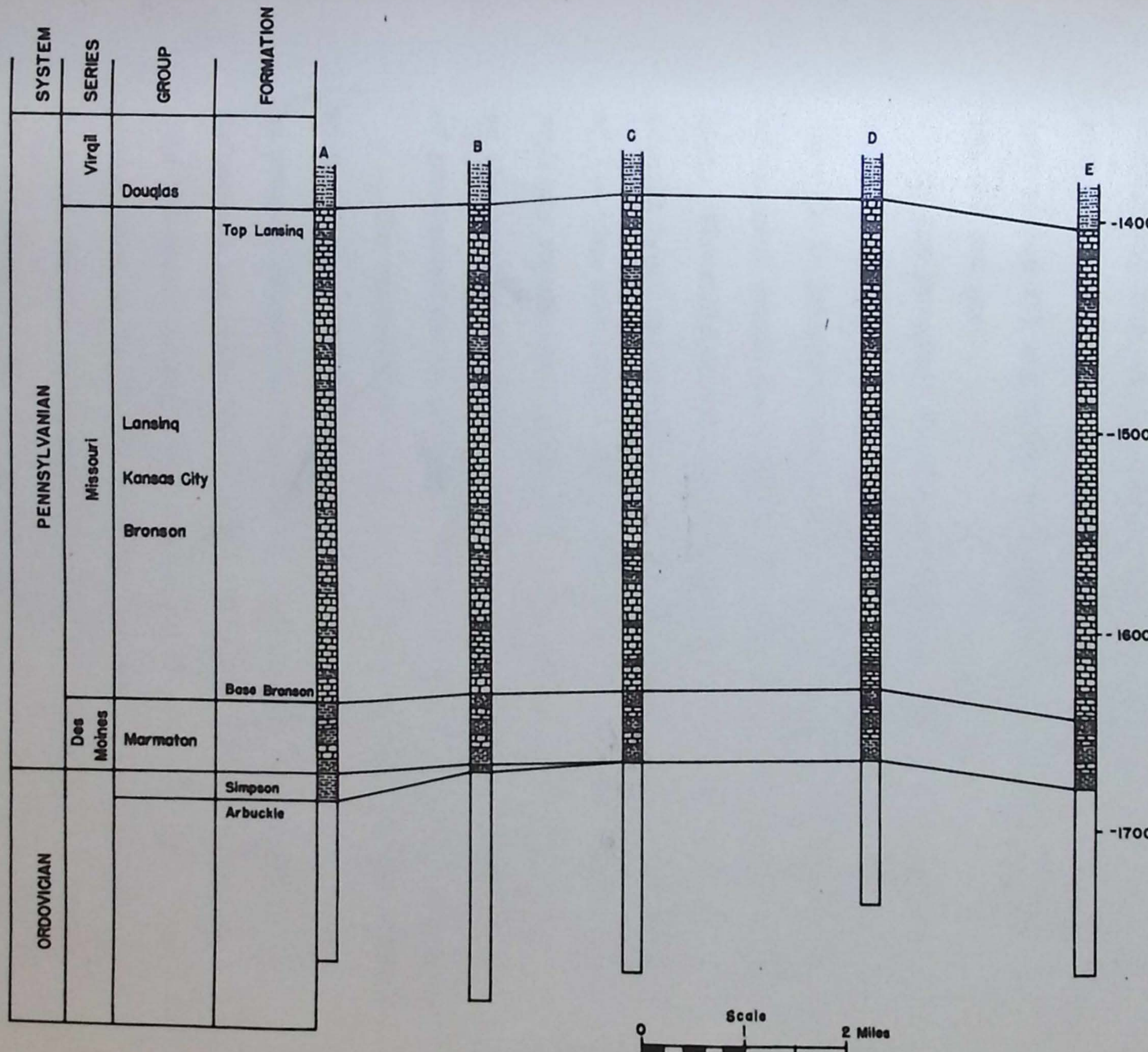
SYSTEM
SERIES
GROUP
FORMATION
PENNSYLVANIAN
ORDOVICIAN
Virgil
Missouri
Des Moines
Douglas
Lansing
Kansas City
Bronson
Marmaton
Top Lansing
Base Bronson
Simpson
Arbuckle
A
B
C
D
E
-1400
-1500
-1600
-1700
Scale
0
1
2 Miles

PLATE VIII

formed at the nonconformable contact of the Cambro-Ordovician Arbuckle dolomite with the overlying Pennsylvanian beds. This topographic high of the Arbuckle forms a stratigraphic trap capped by the impervious basal shale beds of the Marmaton group (see plates VII and VIII), thus allowing local accumulation of the oil and gas.

The structure within the relatively flat-lying Arbuckle dolomite was not conclusively determinable, although an effort was made to interpret possible structural features by correlation of apparent porous zones in the detailed sections of the electrical logs. Plausible correlation between apparent porous zones of several tests was observed, but was not considered representative of the true structure of the dolomite. Instead, such correlation probably represents nothing more than porosity zones developed as the result of solution within the dolomite during the period of pre-Pennsylvanian and early Pennsylvanian erosion of the area.

The accumulation of the oil and gas is herein attributed to the presence of the stratigraphic trap. Such structure as may be present within the dolomite is not considered to have materially influenced the concentration. The lateral migration of the oil into the reservoir has been made possible by the presence of the porous zones in the dolomite which were found to more or less parallel the old pre-Pennsylvanian erosion surface in the area. The source of the oil is a problem considered to be beyond the scope of this paper.

Relationship of gas, oil and water—The normal gravitational relationship of gas, oil and water usually found in most oil fields also exists in the Ryan pool. The principal area of gas production lies in the central and structurally highest portion of the reservoir in the SE¼ sec. 34 and the SW¼ sec. 35, T. 19 S., R. 16 W., and in the NW¼ sec. 2, T. 20 S., R. 16 W. (see plates III, IV and V). The wells in this area are commercially operated for their small production of oil, but the main area of oil output lies outside and structurally lower than the area of highest Arbuckle relief. The energy which forces the oil to the well-bore is considered to be water drive as evidenced by the fact that most of the wells produce some water, increasing down the flanks of the field (see table 2).

Future extension of the Ryan pool—The completion of a wildcat discovery, the W. F. Hildebrand et al No. 1 Wickstrom, in the NW¼ NW¼ NW¼ sec. 12, T. 20 S., R. 16 W., Pawnee County, opened up an area which has been termed the Ryan Southeast field. This area, lying approximately three-fourths mile southeast of the Ryan pool, had five wells producing from the Arbuckle by the end of April, 1946.

It is thought by some that production will extend through the Ryan southeast to and including the Pawnee Rock pool, lying about one mile farther southeast. The existence of a structural trend in that direction (see plates III, IV and V) possibly validates such extension to include the Ryan Southeast field. The presence of three dry holes, the Stanolind Oil and Gas Company No. 1 Edith A. Clemson, in the CS½ SW¼ NE¼ sec. 12, T. 20 S., R. 16 W., the Barbara Oil Company No. 1 Wickstrom, in the NE¼ SW¼ SE¼ NW¼ sec. 12, T. 20 S., R. 16 W., and the J. M. Huber Corporation No. 1 Gustafson, in the NE¼ SE¼ SE¼ sec. 11, T. 20 S., R. 15 W., Pawnee County, which mark the northern and northwestern limits of the Pawnee Rock pool, seems to indicate that any such extension as may occur will not develop to include that area.

The existence of a structural trend northwestward into the SE¼ sec. 34 and northward toward the northern border of sec. 35 T. 19 S., R. 16 W. would seem to indicate the possibility of a limited further extension of production in these directions since these boundries of the pool have not yet been definitely determined.

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