BULLETIN

OF

The University of Kansas

Published Semimonthly [redacted]

STATE GEOLOGICAL SURVEY of KANSAS

RAYMOND C. MOORE

State Geologist and Director

KENNETH K. LANDES

State Geologist and Assistant Director

OIL AND GAS RESOURCES OF WESTERN KANSAS

By

WALTER A. VER WIEBE

MINERAL RESOURCES CIRCULAR 10

Publications of the State Geological Survey are distributed from Lawrence, Kansas

Volume 39 April 1, 1938 No. 7

Entered as second-class matter December 29, 1910, at the post office at Lawrence, Kan., under act of July 16, 1894.

MYERS & CO., PLANOGRAPHERS TOPEKA

STATE OF KANSAS

Walter A. Huxman, Governor

STATE BOARD OF REGENTS

C. M. Harger, Chairman

E. F. Beckner	Drew McLaughlin
John Bradley	Ralph T. O'Neil
Fred M. Harris	Howard Payne
Lester McCoy	Dr. H. L. Snyder

STATE GEOLOGICAL SURVEY OF KANSAS

Ernest H. Lindley, Ph. D., LL. D.,
Chancellor of the University of Kansas, and
ex officio Director of the Survey.

Raymond C. Moore, Ph. D., Sc. D.,
State Geologist and Director

Kenneth K. Landes, Ph. D.,
State Geologist and Asst. Director

CONTENTS

	Page
Introduction	7
Acknowledgments	7
Development of oil and gas industry in Kansas	8
Statistical data	10
Natural gas	16
Shut-in gas pools	16
New discoveries	16
Producing horizons	17
Structure	18
Barber County	19
Areal geology and stratigraphy	19
Tertiary rocks	19
Mesozoic rocks	19
Permian rocks	19
Pennsylvanian rocks	20
Pre-Pennsylvanian rocks	20
Structure	21
Oil and gas development	21
History	21
Whelan pool	21
Aetna gas pool	22
Lake City pool	22
Important test wells	23
Barton County	24
Areal geology and stratigraphy	24
Surface geology	24
Subsurface geology	24
Structure	26
History of oil and gas development	26
Marketing facilities	29
Clark County	30
Areal geology	30
Cretaceous rocks	31
Permian rocks	31
Subsurface geology	32
Pennsylvanian rocks	32
Pre-Pennsylvanian rocks	32
History of oil and gas development	32
Edwards County	34
Surface geology	34
Subsurface geology	34
Pennsylvanian rocks	34
Pre-Pennsylvanian rocks	35
Structure	35
History of oil and gas development	36
Important test wells	37
Ellis County	37
Areal geology and stratigraphy	37
Structure	40
Surface	40
Subsurface	41
History of oil and gas development	41
Ellsworth County	44
Areal geology	44
Subsurface stratigraphy	45

Page

Lower Permian rocks 46
Pennsylvanian rocks 46
Pre-Pennsylvanian rocks 47
Mississippian system 47
Ordovician rocks 47
Reagan sandstone 48
Structure 48
History of oil and gas development 49
Wilkins pool 50
Stratman pool 50
Stoltenberg pool 50
Breford pool 50
Lorraine pool 50
Satarn gas field 50
Important Test Wells 51
Finney County 53
Areal geology 53
Cretaceous rocks 53
Subsurface stratigraphy 53
Permian rocks 53
Pennsylvanian rocks 54
Pre-Pennsylvanian rocks 54
Structure 54
History of gas development 55
Important test wells 56
Grant County 56
Harvey County 57
Areal geology 57
Subsurface stratigraphy 57
Mississippian rocks 58
Siluro-Devonian rocks 59
Ordovician rocks 59
Structure 59
History of oil and gas development 60
Hesston pool 60
Showalter pool 60
Sperling pool 61
Halstead pool 61
Hollow-Nikkel pool 61
Burrton pool 62
Pipelines and refineries 62
Important test wells 63
Haskell County 64
Geology 64
Subsurface stratigraphy 64
History of gas development 64
Santa Fe gas field 64
Kearny County 65
Kingman County 65
Areal geology 65
Subsurface geology 67
Structure 69
History of oil and gas development 69
McPherson County 71
Areal geology 71
Comanchean rocks 72
Paleozoic rocks 72
Subsurface geology 73
Big Blue series 73
Pennsylvanian rocks 74
Mississippian rocks 74
Siluro-Devonian rocks 75
Ordovician rocks 75

Page

Structure..... 76
History of oil and gas development..... 76
Chindberg pool..... 77
Johnson pool..... 77
Voshell pool..... 78
Nikkel pool..... 78
Ritz-Canton Pool..... 78
Graber pool..... 79
New pools..... 79
Important test wells..... 81
Pipe lines and refineries..... 82
Morton County..... 82
Ness County..... 83
Areal Geology..... 83
Tertiary rocks..... 83
Cretaceous rocks..... 83
Subsurface stratigraphy..... 83
Permian strata..... 84
Pennsylvanian rocks..... 84
Pre-Pennsylvanian rocks..... 85
Ordovician rocks..... 85
Structure..... 85
Aldrich pool..... 85
Important test wells..... 87
Pawnee County..... 87
Areal geology..... 87
Cretaceous rocks..... 87
Subsurface stratigraphy..... 88
Pennsylvanian rocks..... 88
Pre-Pennsylvanian rocks..... 88
Structure..... 89
History of oil and gas development..... 90
Important test wells..... 90
Pratt County..... 90
Geology..... 90
History of oil and gas development..... 92
Important dry holes..... 94
Reno County..... 94
Areal geology..... 94
Subsurface stratigraphy..... 95
Pennsylvanian rocks..... 95
Pre-Pennsylvanian rocks..... 96
Pre-Mississippian rocks..... 96
History of oil and gas development..... 97
Burrton pool..... 98
Yoder pool..... 99
Hilger pool..... 99
Lerado pool..... 99
Production data..... 99
Important dry holes..... 100
Rice County..... 101
Areal geology..... 101
Permian rocks..... 102
Subsurface stratigraphy..... 102
Pre-Pennsylvanian rocks..... 103
Structure..... 104
History of oil and gas development..... 105
Welch pool..... 106
Wherry group..... 106
Chase pool..... 107
Keesling pool..... 107

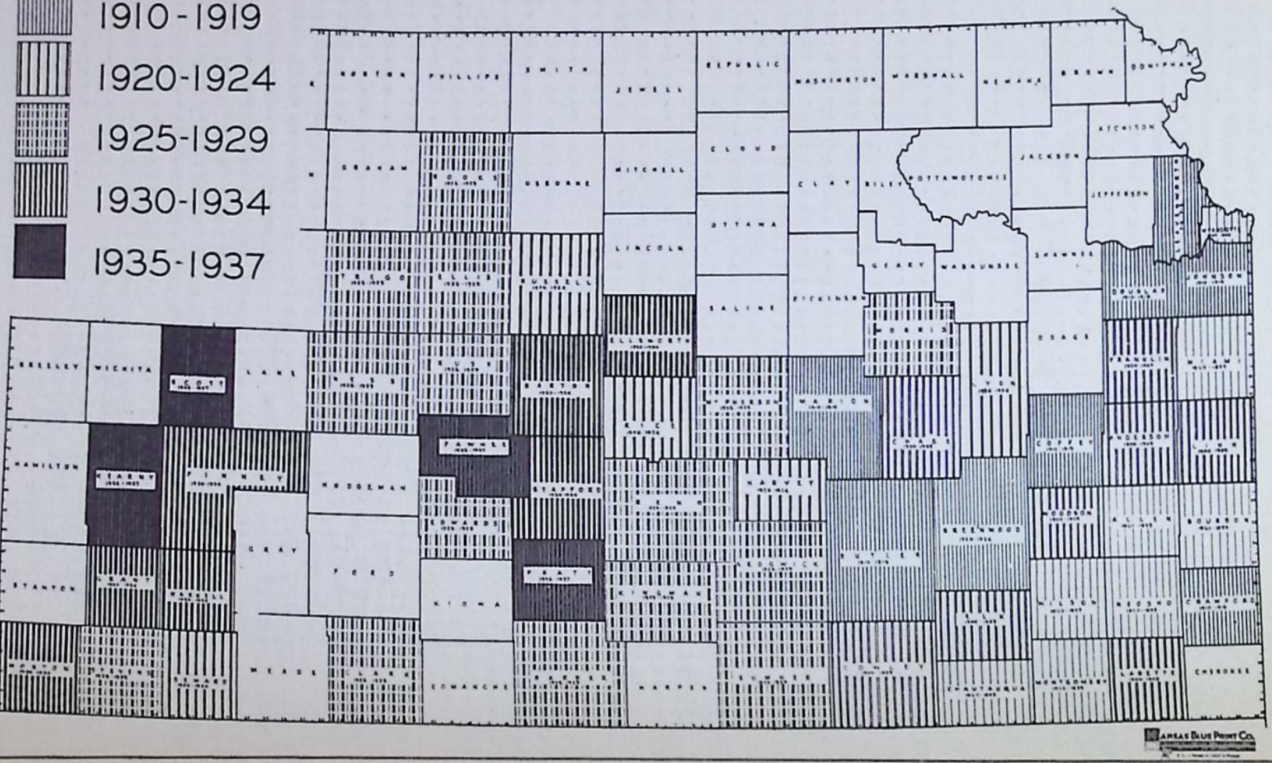
Page

Ploog Pool 108
Guldner and Rickard Pools 108
Stumps and Orth Pools 108
Brandenstein pool 109
Wenke, Mantel, and Raymond pools 109
Geneseo, Galt, and Edwards pools 109
Recently discovered pools 110
Data on important test wells 113
Pipe lines and refineries 114
Rooks County 115
Areal geology 115
Subsurface geology 116
Structure 117
History of oil and gas development 117
Important dry holes 118
Pipe lines and production statistics 119
Rush County 120
Areal geology 120
Subsurface stratigraphy 121
Structure 122
History of oil and gas development 122
Important dry holes 123
Russell County 124
Areal geology 124
Subsurface stratigraphy 125
Pennsylvanian rocks 125
Structure 126
History of oil and gas development 126
Important test wells 131
Relationship between structure and production 132
Pipe lines 133
Saline County 133
Areal geology 133
Permian strata 134
Subsurface stratigraphy 134
Pennsylvanian rocks 134
Mississippian rocks 135
Siluro-Devonian rocks 135
Ordovician rocks 135
History of development 136
Olsson oil pool 136
Important test wells drilled 136
Scott County 137
General geology 137
Permian rocks 137
Pennsylvanian rocks 138
Pre-Pennsylvanian rocks 138
Structure 138
Oil and gas development 138
Shallow Water oil pool 138
Wildcat wells 138
Sedgwick County 139
Areal geology 139
Tertiary rocks 140
Permian rocks 140
Subsurface stratigraphy 140
Pennsylvanian strata 141
Mississippian rocks 142
Ordovician rocks 142
Simpson formation 143
Arbuckle limestone 143
Structure 143

Page

History of oil and gas development..... 143
Goodrich pool..... 145
Cross and Bentley pools..... 145
Greenwich pool..... 145
Kechi and Kuske pools..... 146
Eastborough pool..... 146
Robbins pool..... 146
Schulte pool..... 146
Discovery wells of 1937..... 147
Important dry holes..... 148
Seward County..... 150
Stafford County..... 150
General geology..... 150
History of oil and gas development..... 152
Snider pool..... 154
Jordan pool..... 154
Kipp pool..... 154
Important dry holes..... 155
Stevens County..... 156
Areal geology..... 156
Cretaceous rocks..... 156
Subsurface stratigraphy..... 156
Pennsylvanian rocks..... 157
Hugoton gas field..... 157
Producing horizon..... 158
Production data..... 158
Structure..... 159
Sumner County..... 159
Areal geology and stratigraphy..... 159
Tertiary rocks..... 159
Permian rocks..... 160
Pennsylvanian rocks..... 16
Mississippian rocks..... 1
Ordovician rocks..... 1
Structure..... 1
History of oil and gas development..... 1
Padgett pool..... 1
Rainbow Bend pool..... 16
Rutter pool..... 16
Oxford pool..... 16
Churchill pool..... 165
Wellington pool..... 166
Corbin pool..... 166
Caldwell pool..... 166
Hunnewell oil and gas pool..... 167
Anson gas pool..... 167
Latta oil and gas pool..... 167
West Oxford pool..... 167
New pools discovered in 1937..... 167
Important test wells..... 169
Trego County..... 171
General geology..... 171
Areal geology..... 171
Subsurface stratigraphy..... 171
Structure..... 172
History of oil and gas development..... 172
Important wildcat wells..... 173
Production data..... 174
Bibliography..... 174
Bulletins and reports..... 174
Maps..... 174
Articles..... 175
Index of Pools..... 176

WESTWARD THE COURSE OF KANSAS' EMPIRE OF OIL & GAS



INTRODUCTION

Acknowledgments

The first of a series of reports on the development of the oil and gas resources of Kansas covered the year 1927 and was published in 1928 by the State Geological Survey as Mineral Resources Circular No. 1. Two other numbers have appeared since then, one covering the period from January, 1928, through December, 1930, and the other from January, 1931, through December, 1932. During 1937 Circular No. 6 appeared, which brings the information on the oil and gas pools up to date to the end of 1936. In the present report the fundamental information incorporated in all these is reviewed, and the new developments for 1937 are added.

During the school years 1934-35 and 1935-36 two students at the University of Kansas, Ellis Gordon and Max Shoemaker, were employed on a College Students' Employment Project under the supervision of Kenneth K. Landes, to assemble data in the files of the State Geological Survey on the oil and gas fields of Kansas west of the Prime Meridian. These data were then worked into a manuscript, and other information added by Dr. Walter Schoewe during the summer of 1936. The present author found this manuscript most helpful.

As it stands the present report must be considered a compilation of data from a great many sources. The geologists representing oil companies with headquarters in Wichita have contributed material, without which it would have been impossible to complete the report. Some of these geologists, such as Roy Hall, Anthony Folger, and George Norton, have been in Kansas for over 15 years. They have not only had an active part in the drilling of important wells, but have spent much time in the study of well cuttings and cores. Only by this method has it been possible to build up the present knowledge of precise detail on the underground formations summarized in this report. Tracing the formations from the outcrop on the surface underground to the west has been a tremendous task. It has required dozens of paleontologists who devoted their whole time to the study of well cuttings and who were willing to cooperate toward a common goal.

The first concrete result of this concentrated research work on the part of many specialists appeared in print when the Kansas Geological Society published its cross section during 1932. This work was undertaken under the chairmanship of Betty Kellett, paleontologist for the Amerada Oil Company at that time. The geologists in Wichita, including the representatives of the Carter, Shell, Skelly, Ohio, Magnolia, Gulf, Atlantic, Empire, Mid-Continent, Phillips, Sinclair-Prairie, Stanolind, and Texas companies, cooperated in the project. It was necessary to compile information on 135 wells across Kansas, using both well-log correlations and sample determinations. The cross section proved that the strata of eastern Kansas can be traced mile by mile toward the Colorado boundary.

The slight local variations in stratigraphy which occur make it necessary for oil companies to keep on hand a staff of experts to study well cuttings as the wells are drilled. On the basis of careful determinations it was possible for several ge-

ologists to publish maps portraying the areal geology beneath the Pennsylvanian or Mississippian rocks in western Kansas. The first of these was published by John Barwick (see bibliography) and the second by Hugh McClellan.

The interpretation of these fundamental data is a matter of concern to every chief geologist. Contour maps and areal geology maps must be prepared to bring out significant relations. Reports embodying such information have appeared in the Bulletins of the American Association of Petroleum Geologists, for instance the report on the Central Kansas Uplift by Edward Koester, and the regional investigations by Hiestand.

Information on individual pools giving historical data, as well as geological data, has appeared from time to time. Allan and Valerius published an account of the Fairport pool of Russell County in 1929. Five years later the exhaustive report on the Voshell pool in McPherson County by Hiestand appeared. Early in 1937 the report on the Cunningham pool, by Rutledge and Bryant, was published. A summary of the gas pools in western Kansas was published by John Garlough in 1935. In the meantime statistical data on Kansas pools have been prepared and published by various authors in the Transactions of the A. I. M. E. Also the State Geological Survey has published many bulletins giving detailed geological information on western counties, such as Russell, Ellis, Ness, Hodgman, and others.

All this information was available to the author when he began writing this report. In addition he has been permitted to include many data that were made available to him through the generous help of friends in Wichita. To list all these would involve a roster of members of the Kansas Geological Society. The fundamental data on underground geology as presented in this report were derived from well logs in the University of Wichita collection. These were made during the last ten years from well cutting samples of cable tool wells.

Thanks are due to H. G. Hotchkiss, and the Kansas Blue Print Company of Wichita, for their courtesy in furnishing copy for the illustrations included in the introductory part of this report. The county pool maps were drafted in the offices of the State Geological Survey under the direction of Raymond P. Keroher. The manuscript was edited by Kenneth K. Landes.

Development of Oil and Gas Industry in Kansas

As the year 1937 draws to a close it has become evident that western Kansas contains one of the largest reserve areas for oil exploration left in the United States. The development of this area into its present important position in the petroleum industry has taken 77 years. When Col. Drake put down his now famous well in western Pennsylvania during the year 1859, the valuable properties of petroleum were just beginning to be appreciated. It was the urge to find new deposits of oil from which kerosene might be distilled that brought about drilling in many parts of the United States, shortly after Drake's well was completed. Among the places selected for exploration was Miami County in eastern Kansas. An engineer had reported that oil oozed out of the ground at several places in the county. This reminded some enterprising men of the oil seepages around Drake's well. Their pioneer efforts in drilling three wells started the oil industry in Kansas, even though the results were negligible. Some time elapsed before others, actuated largely by the possibility of

finding gas, started to drill wells in southeastern Kansas. For, as a result of exploration in western Pennsylvania, the utilization of gas had come about naturally and rather quickly. One of the earliest successful wells drilled for gas in eastern Kansas was the Acers well near Paola, completed in 1873. A revival of drilling in Miami County resulted in the discovery of commercial supplies of gas near Paola in 1882, and oil in 1889.

Under the stimulus of such successes in eastern Kansas many towns and communities started test wells near their city in order to enjoy the benefits of cheap gas for fuel and light. Among them was the city of Lyons in Rice County, where some influential citizens had banded together as the Natural Gas, Oil, and Mineral Products Company. A well drilled under their auspices struck gas at a fairly shallow depth in 1888. The quantity was sufficient to be piped to town and was used for over a year in the hotel as an illuminant. The importance of this discovery was not appreciated at that time. In addition, the oil men had by that time become rather busy drilling wells in southeastern Kansas and northern Oklahoma.

As is usually the case in oil exploration, it was simpler to drill within short distances of actual oil production, than to reach out many miles to the west in Kansas. In the course of orderly extensions of drilling campaigns the oil development finally reached Butler County and the El Dorado pool in 1914. This find proved to be of such monumental proportions that much drilling was stimulated and many small pools were opened up in nearby counties from Marion on the north to Cowley on the south. Among these discoveries was the North Vernon pool in eastern Sumner County, where gas was found in June, 1915.

Wildcatting in Harvey County also met with some success, for one of the test wells put down during 1919 made considerable oil. Other wells drilled in the central part of Kansas, however, were generally failures and threw much doubt on the probability of oil or gas being present in quantity. Among many tests drilled during the decade from 1915 to 1925 was one which seemed to be far beyond any possible oil territory. This well was drilled in 1922 in Seward County, southwestern Kansas. In it gas was found, at a relatively shallow depth, and this well proved later to be the first in the now famous Hugoton gas area. A well drilled by the Empire Oil Company in 1923 in Barton County on the Sooy farm did much to reestablish faith in the possibilities of western Kansas. The good showings of oil in this hole from the Pennsylvanian strata were definite and convincing. That same year a most sensational development in Russell County proved to be the turning point in the oil history of western Kansas. For it was in 1923 that the Valerius Oil Company drilled its No. 1 Carrie Oswald well, which was completed early in 1924 for a production of 200 barrels. This large showing started not only an intense exploratory campaign in the near vicinity, but also caused many wildcats to be drilled in other counties of western Kansas. Among them was one in Kingman County which did a great deal to keep alive the interest of the oil fraternity. This was the first well drilled by Fleeger on the Richardson farm in the north-central part of the county. An initial production of 120 barrels per day gave additional proof that there was oil in western Kansas, even though the immediate offsets later proved to be dry.

One year after the famous Oswald discovery in Russell County, the first well in the Welch pool in southeastern Rice County

was drilled. Since then important discoveries have been the rule almost every year. Oil was found far out in Rooks County in 1927, as well as near Abbyville in Reno County. In 1928 the important Valley Center pool in Sedgwick County was found. In 1929 two other large producing centers were opened up, one the Voshell pool in southwestern McPherson County, and the other the Ritz-Canton area in the eastern part of the same county.

Rice County came forward during 1930 with one pool, the Raymond, in the southwestern part. The year 1933 saw the discovery of the Hollow and Nikkel pools in Harvey County, and in 1934 the now famous Burrton pool had its first development. Since then activity has taken place on such a wide front that it is difficult to itemize the discoveries. Many pools were found in Russell County during 1935 to 1937. Similarly, Barton and Ellis counties each furnished a number of pools. Rush, Trego, and Rooks counties had several discoveries, some of which later proved to be important areas of production. Meanwhile Reno, Rice, Ellsworth and McPherson counties continued to show intense drilling activity which was rewarded by the discovery of some large pools. In 1937 the largest success yet attended the drilling campaign in Stafford County. Two discoveries of oil in the Viola limestone at widely separated points, one in Barber County and the other in Clark County, must be regarded as the forerunners of exploration on a wide front. In addition the "Wilcox" sand, which had been somewhat neglected, yielded oil in two pool opening wells in Sedgwick County, as well as causing a rejuvenation of the old Ritz-Canton pool in McPherson County.

Statistical Data

During the year 1937 no fewer than 37 new oil pools were discovered in Kansas west of Range 3 E. In addition 2 gas pools were found which may eventually develop into oil pools when deeper strata are explored. The amount of oil produced annually since the development of western Kansas began has risen almost without exception year after year until a grand total of 53,838,171 barrels was marketed in 1937. These data are presented in table I.

At the present time Kansas is exceeded only by Texas, California, Oklahoma, and Louisiana in the matter of production of oil. The importance of western Kansas in this connection is brought out by the data in table I. It shows that over 60 per cent of all Kansas oil has come from the western counties and suggests that the high rank among oil-producing states is likely to be maintained for some time to come.

TABLE I

Oil production of western Kansas, and percentage of state total, 1930-1937.

Year	Production	Percent
1930	18,418,423	43.6
1931	19,833,928	50.4
1932	17,745,860	49.1
1933	25,186,734	60.9
1934	30,855,307	66.3
1935	37,357,957	68.1
1936	40,595,639	71.2
1937	53,838,171	79.3

Since oil was first found in Harvey County each year has witnessed the addition of other counties to the list until now 28 counties west of the Prime Meridian have one or more oil or gas pools. These counties are: Barber, Barton, Clark, Edwards, Ellis, Ellsworth, Finney, Grant, Harvey, Haskell, Kingman, McPherson, Morton, Ness, Pawnee, Pratt, Reno, Rice, Rooks, Rush, Russell, Scott, Sedgwick, Seward, Stafford, Stevens, Sumner, and Trego. The location of these counties is shown in Fig. 1. It is the purpose of this report to describe the oil and gas developments in each of these counties separately, with such additional data as are necessary.

TABLE II

Rank and production of western Kansas counties.

Rank	County	Total to End of 1937	Production during 1937
1	McPherson	55,537,862 barrels	5,037,862
2	Sedgwick	39,252,616	1,002,616
3	Rice[1]	37,993,266	8,373,266
4	Sumner	37,729,959	3,029,959
5	Russell	35,811,431	11,811,431
6	Reno	23,833,614	6,933,614
7	Harvey	17,199,808	1,509,535
8	Barton[1]	11,329,283	4,566,908
9	Ellsworth	10,850,957	2,350,957
10	Ellis	4,525,882	2,694,663
11	Stafford	3,100,600	1,126,084
12	Kingman[2]	1,472,304	230,473
13	Rooks	401,461	147,491
14	Rush	273,045	234,290
15	Trego	237,566	115,925
16	Scott	151,446	117,465
17	Barber	117,812	73,020
18	Edwards	98,690	12,000
19	Clark	31,226	28,926
20	Ness	19,174	1,174
21	Pawnee	9,876	8,676
22	Pratt[2]	2,921	2,921

1 Includes part of the Silica pool, which has produced over 12 million barrels to date.

2 Kingman County includes all production of Cunningham pool, which lies partly in Pratt County.

At the present time McPherson County ranks first among these counties in total amount of oil produced (table II). Nearly one-fourth of all oil marketed to the end of 1937 has come from this county. The counties which have most recently greatly increased their production are Barton, Ellis, and Stafford, which ranked 9th, 10th, and 11th at the end of 1936. No doubt the relative ranking will change in the future as it has in the past, depending somewhat on the trend in drilling activity and the facilities for transportation of oil. In the various chapters of this report it will be shown that these large totals reflect the production from one or two outstanding pools in most cases. The Ritz-Canton and Voshell pools, for instance, furnished a large portion of the total shown by McPherson County. Similarly the Churchill and Oxford pools supplied most of the oil for Sumner County. The Burrton pool in Reno County and the Valley Center

pool in Sedgwick were the chief producers in those counties.

The oil from western Kansas has been supplied by a total of 192 pools. This may appear to be a surprisingly large number and is partly accounted for by the fact that many small pools containing one well or only a few wells are listed separately. As time goes on many of these smaller pools will become merged into larger fields. The Kansas Nomenclature Committee is constantly striving to adjust pool names to the results of drilling. They have recently incorporated the Isern, Schartz, Kowalsky, and Peters pools into one under the name of Silica pool. In table III the pools in each county are tabulated. Russell County has the largest number of pools, with Rice in second place, and Ellis, Barton, Sedgwick, Sumner, and Stafford following in that order. Rice had the largest number of new pools found in 1937, a total of 8. Barton and Ellis each had 6, while Russell added 4 and Stafford 3 pools.

TABLE III

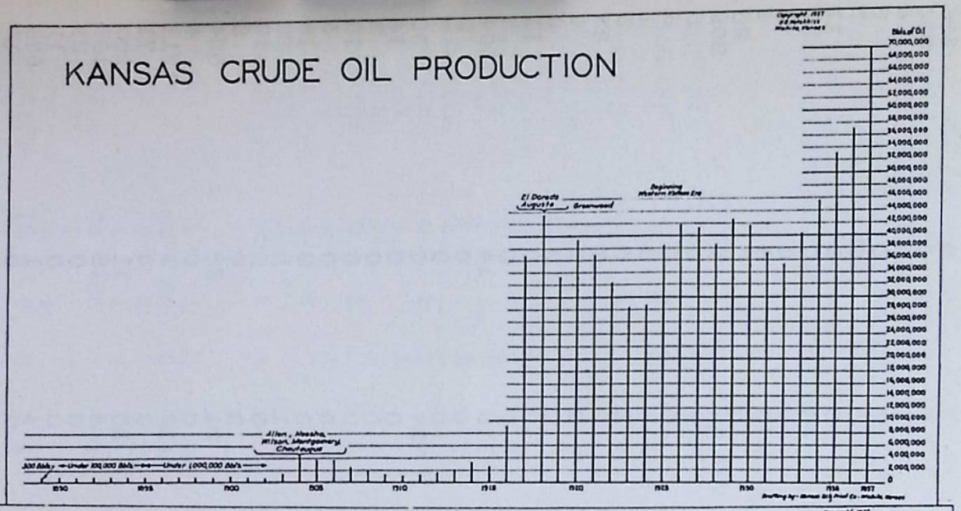
COUNTY	TOTAL POOLS	OIL	GAS	OIL AND GAS	ABANDONED	FIRST POOL	DISCOVERY DATE
BARBER	4	2	1	1		Medicine Lodge Gas	Jan.,1927
BARTON	21	19		2	1	Davidson	Mar.,1930
CLARK	1			1		Morrison Gas	Nov.,1928
EDWARDS	1			1		McCarty	May,1929
ELLIS	22	21			1	Shutts	Nov.,1928
ELLSWORTH	8	5	1	1	1	Ellsworth Gas	1904
FINNEY	1		1			Holcomb Gas	Dec.,1932
GRANT	1		1			Hugoton Gas	Nov.,1927
HASKELL	1		1			Santa Fe Gas	Sept.1931
HARVEY	6	1	1	3	1	Walton	?June,1919
KEARNY	1		1			Santa Fe Gas	Sept.1937
KINGMAN	2			1	1	Kingman	Jan.,1925
McPHERSON	8	3		5		McPherson Gas	Sept.1926
MORTON	1		1			Hugoton Gas	Nov.,1927
NESS	1	1				Aldrich	Oct.,1929
PAWNEE	1			1		Pawnee Rock	Sept.1936
PRATT	2	1	1			Cairo	Nov.,1935
						Cunningham extension	July,1935
RENO	7	4	1	2		Abbyville	Jan.,1927
RICE	26	20	2	4		Lyons Gas	1888
ROOKS	9	8		1		Laton	July,1927
RUSH	4	1	1	1	1	Bison Gas	Nov.,1928
RUSSELL	29	26		1	2	Fairport	July,1923
SALINE	1				1	Olsson	Dec.,1929
SCOTT	1	1				Shallow Water	Dec.,1934
SEDGWICK	15	8	2	1	4	Valley Center	Aug.,1928
SEWARD	1		1			Liberal Gas	Dec.,1922
STEVENS	1		1			Hugoton Gas	Nov.,1927
STAFFORD	10	9			1	Richardson	Sept.1930
SUMNER	15	9	1	2	3	Vernon north	June,1915
TREGO	3	2			1	Rega	May, 1929

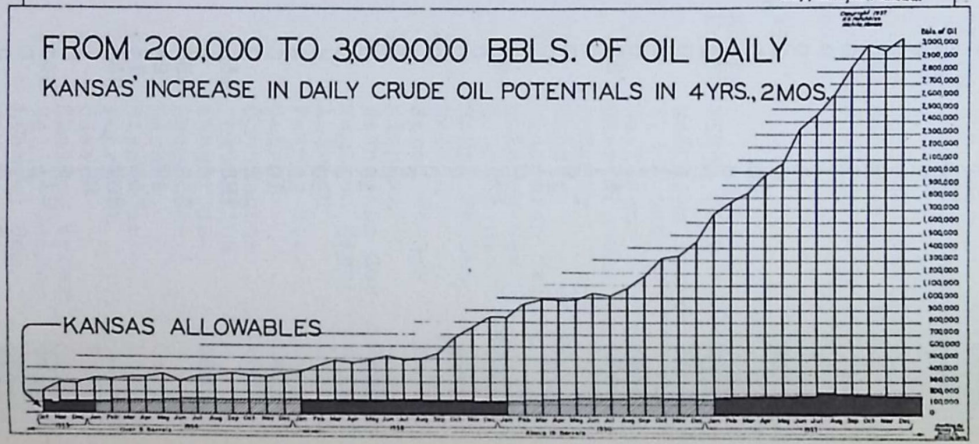
Table IV contains a list showing the number of wells drilled in western Kansas counties from the inception of the drilling campaign up to the close of 1937. The total number of dry holes indicates that the wildcatter has had much to do with the development of this part of the state.

TABLE IV

Summary of drilling in western Kansas

COUNTY	DRY	OIL	GAS	OIL AND GAS	TOTAL
BARBER	33	7	20	1	61
BARTON	157	407	10	6	580
CLARK	6	3	1	0	10
CLOUD	4	0	0	0	4
COMMANCHE	2	0	0	0	2
DECATUR	4	1	0	0	5
EDWARDS	8	3	2	2	15
ELLIS	115	271	0	0	386
ELLSWORTH	97	204	5	0	306
FINNEY	5	0	1	0	6
FORD	7	0	1	0	8
GOVE	3	0	0	0	3
GRAHAM	11	0	0	0	11
GRANT	1	0	36	0	37
GREELY	1	0	0	0	1
HAMILTON	4	0	0	0	4
HARPER	20	0	0	0	20
HARVEY	68	218	12	1	299
HASKELL	0	0	5	0	5
HODGEMAN	5	0	0	0	5
JEWELL	1	0	0	0	1
KEARNEY	1	0	2	0	3
KINGMAN	47	22	7	7	83
KIOWA	4	0	0	0	4
LANE	2	0	0	0	2
LINCOLN	11	0	0	0	11
LOGAN	8	0	0	0	8
McPHERSON	192	683	115	14	1004
MEADE	2	0	0	0	2
MITCHELL	7	0	0	0	7
MORTON	3	0	27	0	30
NESS	9	5	0	0	14
NORTON	2	0	0	0	2
OSBORNE	16	0	0	0	16
OTTAWA	3	0	0	0	3
PAWNEE	10	4	0	2	16
PRATT	13	3	1	5	22
PHILLIPS	10	0	0	0	10
RAWLINS	2	0	0	0	2
RENO	125	450	24	25	624
REPUBLIC	4	0	0	0	4
RICE	239	957	12	3	1211
ROOKS	47	24	0	0	71
RUSH	46	14	35	11	106
RUSSELL	207	958	4	18	1187
SALINE	22	1	0	0	23
SCOTT	4	7	0	0	11
SEDGWICK	217	344	4	1	566
SEWARD	6	0	7	0	13
SHERIDAN	3	0	0	0	3
SHERMAN	3	0	0	0	3
SMITH	8	0	0	0	8
STAFFORD	72	91	0	0	163
STANTON	2	0	0	0	2
STEVENS	3	0	159	0	162
SUMNER	83	290	28	1	302
THOMAS	1	0	0	0	1
TREGO	35	20	0	0	55
WALLACE	3	0	0	0	3


KANSAS CRUDE OIL PRODUCTION
Bbls. of Oil
Beginning Modern Refining Era
El Dorado Augusta Greenwood
Allen, Neosho Wilson, Montgomery Chautauqua
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1937


FROM 200,000 TO 3,000,000 BBLS. OF OIL DAILY
KANSAS' INCREASE IN DAILY CRUDE OIL POTENTIALS IN 4 YRS., 2 MOS.
Bbls. of Oil
KANSAS ALLOWABLES

In the upper figure on the opposite page, data on Kansas crude oil production are presented in graphic form. It will be noted that the first large increase came in 1917 with the discovery of the Butler County pools. The gradual increase beginning in 1925 marks the entry of western Kansas. The effect of this new series of discoveries died down in 1931 and 1932. However, the striking revival indicated by the precipitous rise of the production curve in later years proves that the productivity of western Kansas has a substantial foundation.

This feature is even more prominently shown in the lower figure in which the potential capacity of all producing wells in Kansas is plotted. It reveals that the potential number of barrels of oil from Kansas wells was only 200,000 barrels per day as recently as October, 1933. However, two years later the potential capacity began to rise and three years later it exceeded one million barrels per day. In May, 1937, the two million barrel mark was passed and by the end of the same year the three million barrel mark was attained. Meanwhile the amount of oil actually taken out of the ground has increased only from 100,000 barrels per day to a figure twice that amount. This fact indicates that the building of pipe lines and the market demand have not been able to keep pace with the rapidly increasing number of wells.

Natural Gas

Western Kansas contains one of the largest known gas reserves in the country. The greater part of this reserve lies in southwestern Kansas where the Hugoton field is the nucleus of a gas district over 1,500 square miles in area. Inasmuch as the producing horizon and the rock pressure in the Hugoton, Liberal, Santa Fe, and Holcomb fields is the same, it is entirely logical to expect these now separated areas to merge eventually into one large field. During 1937, this area produced 40,300,000,000 cubic feet of gas, all of which was sold and marketed. Previous to 1937 the total production amounted to 103 billion cubic feet.

The next largest gas field is the Otis field which lies mainly in eastern Rush County, but extends over into Barton County as well. During 1937 the number of producing wells was increased to 55, which produced a total of 15,600,000,000 cubic feet of gas. This field is described under Rush County. The large oil-producing area now called Burrton and Yoder also furnished a considerable amount of gas during 1937. The sales from this field approximated 14,400,000,000 cubic feet. When this is added to the previous total of 18 billion, it will be apparent that the gas production has been a very important item in the economic importance of this area.

Next in size is the Medicine Lodge pool, which is more fully described under Barber County. It had produced 21 billion cubic feet to the beginning of 1937, and added another 5,200,000,000 cubic feet during that year. The Ritz-Canton area, described under McPherson County, produced somewhat less than the Medicine Lodge pool, but had exceeded the latter previously with its total of 44 billion cubic feet to the beginning of 1937. The Wellington pool of Sumner County produced to capacity during 1937, and furnished over one billion cubic feet.

Shut-In Gas Pools. Quite a number of gas pools are shut in on account of lack of outlet. Among those which are entirely or partly shut in are the following: Aetna in Barber County; Lanterman in Barton County; Morrison in Clark County; McCarty in Edwards County; Lorraine and Satran in Ellsworth County; Friesen, Halstead and Sperling in Harvey County; Cunningham in Kingman County; Cairo in Pratt County; Guldner, Little River, Lyons, Orth, and Stumps in Rice County; Bison in Rush County; Fairport in Russell County; and the Anson, Latta, Padgett and North Vernon in Sumner County. Some gas is being used for power, and for repressuring oil wells in nearby areas.

New Discoveries. During 1937 several new gas pools were discovered. One of the most promising is the Pawnee Rock pool described more fully under Pawnee County. Here gas is produced with the oil. One well has a measured capacity of 38 million and the other of 26 million cubic feet per day. At present this is not being marketed. Another prolific source of gas was found in the western extension of the Stumps pool (at first called Habiger pool). The potential capacity of some of the wells in this pool exceeds 40 million cubic feet. This gas also occurs with oil and is not being marketed at present.

A new pool was opened up in Rice County when Pulse and Gerbrand discovered the Thurber pool, described under Rice County. The possibilities of this area are problematical in view of the fact that an offset well was drilled through the producing hori-

zon and down into the Arbuckle without finding commercial amounts of oil or gas. In Sedgwick County (q.v.) two new pools were discovered during 1937. One of these is the Andover South, and the other is the Derby. A second well has been drilled in both pools. The wells in each pool had commercial quantities of gas in the Stalnaker sand, so it appears as if both discoveries will prove up considerable territory.

At present the gas resources of western Kansas are barely touched. Despite the past production of over 210 billion cubic feet, and the 75 billion produced during 1937, these amounts must be looked upon as a mere beginning to an important annual contribution to the wealth of Kansas. During the past year 122 gas wells were added to the previous total of 472 wells making a grand total of 594 wells in western Kansas.

Producing Horizons

Before entering upon a detailed discussion of the geology and oil history of each county, it is advisable to include remarks about the producing horizons in western Kansas and also about the important matter of structure. Although 17 different levels or producing horizons have been found at one place or another, the great majority are quite unimportant from the standpoint of total production. Beginning with the youngest, the Big Blue limestones, their yield has been almost wholly gas in the southwestern gas area. Yet it is interesting to record that the gas found in the very first well drilled in western Kansas also came from this horizon and that small amounts of gas are still encountered in scattered localities. Two sands in the Wabaunsee, the Admire and the Scranton, produce small amounts of gas in Kingman and Pratt counties. Occasional shows are found in wells drilled on the Central Kansas Uplift. The Tarkio limestone in the middle of the Wabaunsee produces considerable oil from a few wells in Russell County. The Topeka limestone at the top of the Shawnee group is quite important. Here again it is Russell County which has most of the production. The Howard limestone above produces some gas in Kingman and Pratt counties.

Much oil has been taken from the various porous zones in the Lansing-Kansas City sequence of limestones ("Oswald" zone). Production from this level may be expected in almost any favorably located area in western Kansas. Probably one-third of the counties have important production from this zone at present. The Fort Scott limestone at the base of the Marmaton produces in only one field, the Aldrich pool of Ness County. It is a coarsely oolitic limestone with good porosity. Relatively little oil or gas have been obtained from the basal conglomerate of Pennsylvanian age.

The thick limestone called the "Mississippi lime" or, where eroded, the "chat", has produced a significant share of the total production to date. It is especially outstanding on account of the gas it contains, but oil production is important and has been found from one end of the productive territory to the other. The Misener sand at the base of the Mississippian is always very thin and patchy. Nevertheless, it has accounted for a certain amount of the production in McPherson and Reno counties. The limestone called Hunton, which is believed to be of Siluro-Devonian age, produces large amounts of oil in Reno, Harvey, and McPherson counties.

The Ordovician formations produce the most oil and some of

the gas as well. The Viola limestone is important in Reno, Barber, Sedgwick, Clark, and McPherson counties. The Simpson or "Wilcox" has been somewhat disappointing. In many places it has produced wells with good initial production, but attempted extensions have failed. There are a few areas, however, where it has held up reasonably well, as the Ritz-Canton pool and possibly a few pools in Sumner County. The formation which exceeds all others in oil production by a wide margin is the Arbuckle or "Siliceous lime." Almost every oil-producing county has one or more pools in which the Arbuckle is the main horizon. It is almost the only important one in some counties as, for instance, Barton, Rice, and to a large extent Ellis and Russell counties. The Reagan sand is important only in Rush and Barton counties. Pre-Cambrian rocks produce oil in Rice County.

Structure

For years the word structure was a magic word in petroleum geology. Anticlines were sought because the oil and gas are known to seek out the high places in a porous medium. Now it is known that many other considerations are as important or more so than structure. Many dry holes have been drilled on anticlines in western Kansas. Some of these wells found insufficient porosity in the potential reservoir rocks, and some perhaps were not favorably situated with reference to original source rocks. At present the tendency is to look for "highs", no matter whether they are structural or topographic. This is especially true of the Arbuckle, which is definitely known to be high not on account of structure but rather on account of erosion. In other words, with a few exceptions, the so-called anticlines in the Arbuckle formation are topographic hills and not arched strata.

BARBER COUNTY

Areal Geology and Stratigraphy

Barber County lies along the Oklahoma line in a part of Kansas where the geological formations are unusually interesting. A considerable variety of formations of various ages is exposed at the surface. The youngest of these occupies the flood plain and channel of Medicine Lodge River which flows diagonally across the county from northwest to southeast through Medicine Lodge. Somewhat older are the fine silts which make terrace deposits around Sharon, Hazelton, and Kiowa in the eastern part of the county. They belong to the Gerlane formation. Both formations are classed as Pleistocene or Quaternary and have been assigned to the Cenozoic group.

Tertiary Rocks. In the northern townships there is a layer of gravel from a few feet to perhaps 100 feet thick. This has been interpreted as a deposit made by ancient streams which flowed into Kansas from the Rocky Mountain region during Tertiary time. Considerable sand and silt are mixed with the gravelly material. Some of the same formation is found within a narrow strip of high country on the divide between the Medicine Lodge and the Salt Fork rivers, in the area northwest of Lasswell.

Mesozoic Rocks. In the extreme northwestern corner of the county small areas of Cretaceous rocks are exposed. They belong to the Dakota sandstone and the Belvidere formations. These are more fully described in the chapter on Clark County, to which the reader is referred.

Permian Rocks. All the younger rocks described rest unconformably upon some portion of the Permian strata. In this county the Permian is represented by a very great thickness as well as a great variety of rocks. The undifferentiated uppermost strata consist of red beds of various kinds. They probably include the Greer and Woodward formations (named by Cragin), from the Big Basin sandstone down to the Dog Creek shale. Cragin named the next lower unit the Cave Creek and divided it into the Shimer gypsum and Medicine Lodge gypsum with the Jenkins red shale between. These members are well exposed south of Sun City where they have been quarried for a long period of time. The other members of the Cimarron series from the Flowerpot shale down to the Harper sandstone are exposed over a wide area in central and western Barber County. The oldest of these crops out only in the eastern part of the county. In well logs Permian red beds occupy about 1,100 feet of section. They show up in the well samples as red clays and red siltstones, with occasional layers of gypsum.

The gray beds which underlie the red beds belong to the Wellington formation, a part of the Big Blue of Cragin. In this county they appear at a depth of around 1,000 feet, being higher in the east and lower in the west. They have a thickness of approximately 800 feet and include near the middle a zone of salt, which varies from about 150 to 400 feet in thickness. In Range 12 the salt lies at a depth of 1,400 feet in some wells, and in Range 14 it has been found at about 1,450 feet. Below the salt anhydrite layers appear down to the Herington limestone.

The next lower sequence of rocks is very persistent over western Kansas. It is about 700 feet thick in Barber County and has at its top the Herington limestone and the Americus limestone at the base. The cherty zones which correlate with the Florence and the Wreford are very much in evidence in well cuttings. The shales are mostly red. The Americus carries the usual abundance of fusulinids.

Pennsylvanian Rocks. The top of the Pennsylvanian rocks is usually found at a depth of around 2,700 feet. The topmost strata are clastic in nature and have a thickness of about 500 to 600 feet. Although consisting of shale, mostly, there are thin, sandy, micaceous zones near the top and limestones at various intervals. Fossils are found rather commonly in well samples. Near the base the limestones are oolitic. The next lower sequence of strata, the Shawnee group, has the Topeka limestone at the top and the Oread limestone at the base. It is 400 feet thick in Barber County and is composed of thick limestone layers which contain chert in some quantity, especially near the middle, and black shale (Heebner) near the base.

Another clastic group follows which is, presumably, the Douglas group of eastern Kansas. It is characterized by the presence of sandstones which may have considerable thickness and of which there may be as many as three in a given well. One of these is probably the Ireland sandstone. The next below is the Lansing-Kansas City-Bronson limestone unit. It appears in wells, at a depth of 3,700 to 4,000 in different parts of the county. The greater depths appear in the south and the west. This unit is characterized by much chert and black shale. The chert is often so abundant that one suspects that the "Mississippi lime" is present. Black shale is particularly abundant in the lower half. There are also a number of oolitic zones present in this unit which aid in its identification.

The shales below the Bronson limestone are black near the top and red at the base. They correspond to the Marmaton of eastern Kansas. Some Cherokee equivalents may also be present. Everywhere in Barber County the Pennsylvanian rocks have been found upon the remnants of the "Mississippi lime."

Pre-Pennsylvanian Rocks. The "Mississippi lime" has been very deeply eroded in this county, for usually only a small thickness of cherty residue is found in deep wells. It appears at depths around 4,300 to 4,500 feet in the north, and 4,450 to 4,850 feet in the southern townships. The black Chattanooga shale lies under it and is commonly present with a thickness of 130 feet. In some wells a thin sandstone corresponding to the Misener has been found at the base of the Chattanooga.

An unconformity below the Mississippian accounts for the absence of the Hunton and Sylvan over most of this county. A few wells in the southeastern townships have encountered these formations. One well in T. 33 S., R. 10 W. found the Hunton nearly 20 feet thick and the Sylvan shale about 90 feet thick. As a general rule, however, either the Viola or the Simpson formation underlies the Chattanooga. Data on their distribution and thickness may be gathered from an inspection of the accompanying table of important test wells. The Viola is a white rather coarsely crystalline limestone. It contains considerable chert and some layers are quite dolomitic. The thickness varies from a few feet to about 90 feet. The Simpson formation consists of

green shale and sandstone. In many wells the upper part of the formation contains the shale and the lower part the sandstone. The thickness commonly found is from 90 to 120 feet, but few wells have penetrated this formation, so that the data are meager. The Arbuckle or "Siliceous lime" has been entered in a few wells and entirely penetrated in several. It consists of coarse-grained dolomitic limestone, which generally shows a pale-cream discoloration. The thickness found in the Boggs well was over 800 feet. In this well a basal sand, probably equivalent to the Reagan sandstone of Oklahoma, was found at a depth of 6,070 to 6,130 feet. It lies upon pre-Cambrian schist in that part of Barber County.

Structure

The surface beds of Barber County dip gently toward the southwest. They are not of such nature as to encourage structure mapping. For that reason core-drilling has been used by oil companies to determine underground structure. In this way certain favorable areas for exploration have been mapped. Seismograph surveys have also been made in Barber County during the last 10 years. The results of such surveys are not yet determinable. The attitude of the salt beds indicates a regional dip to the south in the lower Permian strata. Most of the older units also have either a south or a southwest dip.

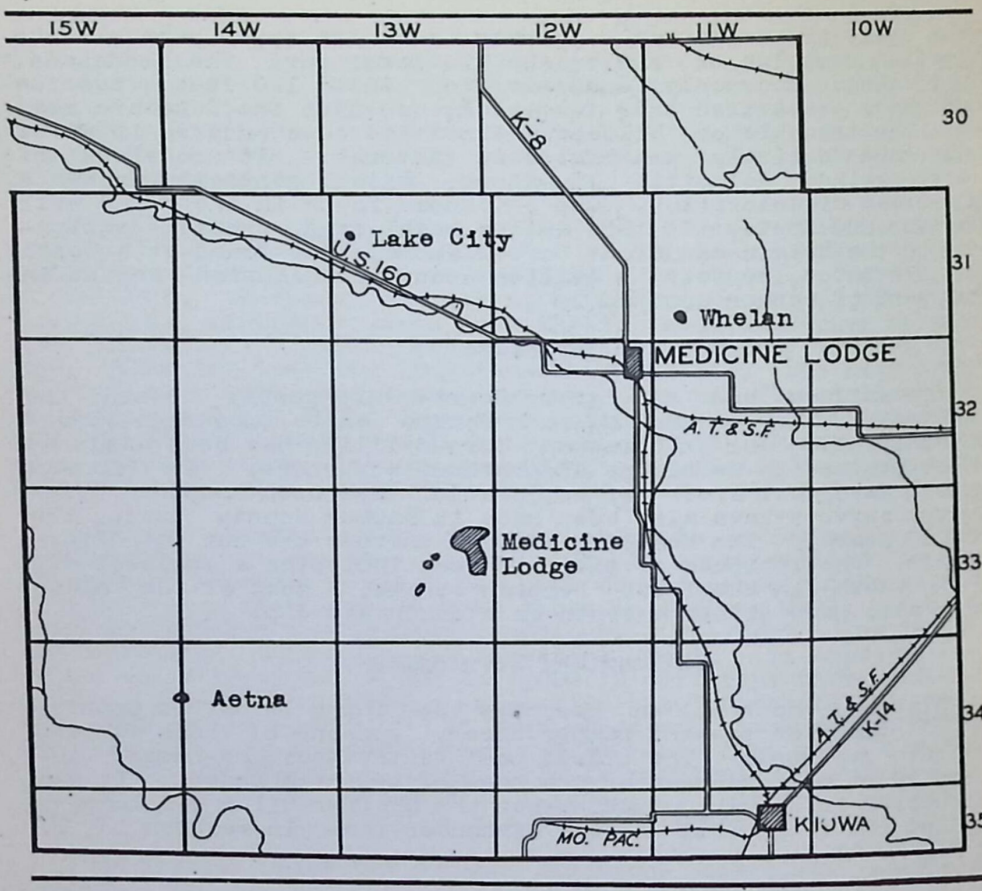
Oil and Gas Development

History. Both oil and gas have been found in Barber County. The oil pools at present number three, and one of these is also the main gas pool. The oldest pool is the Medicine Lodge, located 10 miles southwest of the town of Medicine Lodge. It was discovered in January, 1927, when the Shaffer Oil & Gas Company drilled the first well on the Alexander farm in section 13, T. 33 S., R. 13 W.

Medicine Lodge Pool. The discovery well found gas in the top of the Mississippian chat at a depth of 4,440 to 4,447 feet. The field at the end of 1937 had 15 producing gas wells and one oil well. The oil was discovered in 1937 when one of the wells, the No. 1 Holmes in sec. 27, was deepened to the Viola limestone at 4,845 to 4,847 feet, and a potential of 441 barrels was established. During the last 10 years four dry holes were also drilled, some of which penetrated the Arbuckle limestone for varying distances.

Up to the end of 1936 this pool had produced 21,000 million cubic feet of gas. The initial pressure of this gas was 1,625 pounds. The average open flow of the wells amounted to from 5 to 50 million cubic feet. At the close of 1937 the productive area covered 6,000 acres and the limits of the pool had not been determined.

Whelan Pool. The Whelan pool, the second to be discovered, lies 3 miles northeast of Medicine Lodge. After a magnetometer survey, the Lario Oil & Gas Company drilled their first well on the Whelan ranch in sec. 32, T. 31 S., R. 11 W., and found oil in the chat at 4,355 to 4,384 feet. Considerable water came into the hole with the oil, but the well was plugged back and made into a producer. At present there are 5 oil wells in the pool and 1 dry hole. The oil wells produced a total of 102,812 barrels to the close of 1937. The dry hole penetrated the top



Barber County

(Solid areas are oil pools; lined areas are gas pools)

of the Arbuckle "lime" and thus tested all likely lower formations. The structure of the pool appears to be anticlinal as far as present data permit deductions to be made.

Aetna Gas Pool. A gas discovery was made in July, 1935, in the southwestern part of the county. Southern and Thurmond Drilling Company drilled a test on the Davis ranch in sec. 13, T. 34 S., R. 15 W., which found production in the Viola limestone at a depth of 5,215 to 5,260 feet. An initial production of about 2 million cubic feet was secured. Since only one additional well has been drilled in this pool, the possibilities for future production are still unknown. One deep dry hole drilled by the Skelly Oil Company on the Temple lease nearby passed through all likely producing zones down to and including the Arbuckle dolomite without finding encouraging showings.

Lake City Pool. The first well in the Lake City pool was drilled by Pryor and Lockhart on the Gant ranch in sec. 7, T. 31 S., R. 13 W., about 15 miles northwest of Medicine Lodge. It produces from the Viola limestone at 4,435 to 4,440 feet. Ini-

ttial production is estimated at 1,350 barrels per day. This well was completed in September, 1937, and no additional wells were drilled in the immediate vicinity before the close of the year.

Table of producing fields in Barber County

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS.
AETNA	July,1935	2	5215-60	Gas only
13-34-15W	40 acres		Viola	
LAKE CITY	July,1937	1	4435-40	Pot.1351
7-31-13W	40 acres	8,292 Bbls.	Viola	
MEDICINE				
LODGE	Jan.,1927	15	4440-47	Gas
13-33-13W	6000 acres	6,708 Bbls.	Chat	
15-33-13W	Mar.,1937	1	4845-47	Oil
	40 acres		Viola	
WHELAN	Aug.,1934	5	4355-84	One dry hole to Arbuckle Grav. 27
32-31-11W	620 acres	102,812 Bbls.	Chat	

Important Test Wells

Allison & Fitzwilliams No.1 Kumberg, in sec. 2, T. 30 S., R. 12 W., top of Salt, 1,400; Herington, 2,050; Wabaunsee, 2,740; Topeka, 3,230; Douglas, 3,620; Bronson, 3,730; Chat, 4,390; Kinderhook, 4,434; Viola, 4,560; Wilcox, 4,680; Arbuckle, 4,790; total depth, 4,825 feet.

Merriam No.1 Hastings, in sec.30, T. 30 S., R. 14 W., top of Wellington, 1,155; Salt, 1,445; Herington, 1,625; Wabaunsee, 2,310; Topeka, 3,090; Douglas, 3,780; Bronson, 4,178; Marmaton, 4,340; Chat, 4,500; Tyner, 4,650; Arbuckle, 4,695; total depth, 4,746 feet.

Lario No.1 Whelan in sec. 32, T. 31 S., R. 11 W., top of Chat, 4,355; Kinderhook, 4,455; Viola, 4,575; Simpson, 4,665, Arbuckle, 4,750.

Wentz No.1 Skinner, in sec. 29, T. 31 S., R. 14 W., top of Bronson, 3,890; Chat, 4,538; Simpson, 4,690.

Phillips No.1 Hilliard, in sec. 11, T. 32 S., R. 10 W., top of Chat, 4,388; Kinderhook, 4,600; Viola, 4,673; Wilcox, 4,759; total depth, 4,868 feet.

Pure Oil No.1 Palmer, in sec. 10, T. 33 S., R. 10 W., top of Bronson, 3,818; Conglomerate, 4,476; Chat, 4,505; Kinderhook, 4,558; Hunton, 4,655; Sylvan, 4,672; Viola, 4,768; Wilcox, 4,872; Arbuckle, 5,010; total depth, 5,061.

Barbara No.1 Boggs, in sec. 19, T. 33 S., R. 12 W., top of Bronson, 3,880; Chat, 4,457; Kinderhook, 4,655; Viola, 4,800; Simpson, 4,892; Arbuckle, 5,234; Reagan sand, 6,070; pre-Cambrian schist, 6,130; total depth, 6,185.

Shaffer No.1 Blunk, in sec. 20, T. 34 S., R. 13 W., top of Topeka, 3,120; Bronson, 3,925; Chat, 4,680; Kinderhook, 4,975; Viola, 5,085; Tyner, 5,225; Wilcox, 5,240; Arbuckle, 5,365;to-

tal depth, 5,395.

Skelly No.1 Temple, in sec. 13, T. 34 S., R. 15 W., top of Topeka,3,285; Bronson, 4,220; Marmaton, 4,805; Chat, 4,839; Kinderhook, 5,188; Viola, 5,240; Simpson, 5,393; Arbuckle, 5,518; total depth, 5,664.

BARTON COUNTY

Areal Geology and Stratigraphy

Surface Geology. The northern part of Barton County has Cretaceous rocks at the surface, while the southern part is covered by rocks of much younger age. The reason for this disparity is the Arkansas River, which enters the county near the southwest corner, flows across the southern part, and leaves again near the southeast corner. Deposits of river alluvium border the northern banks of the river and extensive deposits of Quaternary dune sands mask the southern banks.

The Carlile shale of Cretaceous age covers large areas in the northern part of the county. Only the lowest part of the upper or Blue Hill member of this formation, consisting of gray, fissile, clay shale, is present in Barton County. Approximately 85 feet of calcareous shale and thin chalk beds underlie the Blue Hill member. This lower member was named the Fairport by Rubey and Bass[1] from outcrops near the town of that name in Russell County.

The Greenhorn limestone, nearly 100 feet thick, appears under the Carlile where outcrops are favorable. The hard and persistent chalk layers in the Greenhorn can be used for structure mapping in parts of western Kansas. However, the limited number of outcrops in Barton County makes this kind of geologic work very difficult. A dark bluish-gray shale 20 feet thick which occurs beneath the Greenhorn is the Graneros shale. This formation was named by Gilbert from outcrops on Graneros Creek in Pueblo County, Colorado.

The most important surface rock in the county is the Dakota formation. It crops out east and west of Hoisington as well as between Hoisington and Claflin, northeast of Claflin, and southwest of Hoisington. The complete section of this formation is not exposed. Although sandstones are more prominent, most of the formation consists of shale. This shale is of various colors and textures. The formation was named by Meek and Hayden from exposures near the town of Dakota in northeastern Nebraska.

Subsurface Geology. Many wells have been drilled in Barton County, so the underground geology is fairly well known. Beneath the Dakota sandstone an unconformity at the top of the Permian red beds creates considerable irregularity and uncertainty. The Cimarron red beds are nearly 550 feet thick in Barton County. A convenient marker for core drilling is found near their base. This is the Enid or Cimarron anhydrite, sometimes

---

1. Rubey, W. W., and Bass, N. W., Geology of Russell County, Kansas: Kansas Geol. Survey, Bull. 10, p. 40, 1925

also called the Stone Corral dolomite[2]. After passing through the red beds the drill encounters the gray shales of the Wellington member of the Big Blue formation. This member is usually 475 feet thick and includes near the middle a zone of alternating salt and shale 175 feet thick. Below this, well cuttings show a zone of about 125 feet in which there is much anhydrite. A dolomitic limestone found below the Wellington is interpreted as the Herington. The Big Blue section below the Herington is uniformly 600 feet thick and can be traced over the whole county by certain definite chert zones near the middle. These chert zones are believed to be the same as the Florence and Wreford layers, which are characteristically cherty on the outcrop. The lowest limestone in this sequence contains many fusulinids and is therefore correlated with the Americus of the Flint Hills section. It forms an easily identifiable subsurface marker, for which reason the boundary between the Permian and the Pennsylvanian is usually drawn at its base.

The Pennsylvanian strata of Barton County are usually 1,200 feet thick and are divisible into five or six lithologic units. The topmost, the Wabaunsee, is characterized by much shale in which there are thin limestone layers and thin micaceous sandstones. The thickness of 600 feet for this group is a common average. The limestone zone which lies beneath it is the Shawnee group with the important Topeka limestone at the top. These limestones and thin shales have a thickness of 250 feet, and below is a clastic group, the Douglas. In Barton County the Douglas is rather thin, reaching a maximum of probably 80 feet. It is characterized by shales, sandy layers, and occasional thin limes. The succeeding groups are the Lansing, Kansas City, and Bronson which are usually placed in one unit by those studying well cuttings. Porous limestones, which are oolitic in many places, differentiate this unit from others. The thin black shales are also characteristic. Some chert is found in the limestones. The thickness departs but little from an average of about 275 feet. Red shales which appear below are believed to belong to the Marmaton group. They grade into cherty conglomerate below, which is called the Pennsylvanian basal conglomerate where typically developed.

Apparently this conglomerate was deposited on a surface that had long experienced erosion, for all lower systems and formations are absent with the exception of the "Arbuckle limestone" and older rocks. Over most of the county, therefore,it is usual for the bit to pass directly from the conglomerate into the dolomite of Ordovician age. Since there is such a pronounced unconformity at the top of the "Arbuckle" it must not be expected that the same member of this formation will be found in adjacent wells. Indeed there is abundant evidence that quite the opposite is true, for some wells offsetting each other encounter entirely different portions of the "Arbuckle". The thickness of the "Arbuckle" is also quite variable ranging from 0 to over 400 feet. In the Silica pool a number of water disposal wells have penetrated the "Arbuckle" and have found it to be approximately 2200 feet thick. The insoluble residues in this formation will eventually reveal the data needed to determine what member is found in each well drilled.

---

2. See state geologic map published in 1937 by the Kansas Geological Survey.

Below the Arbuckle, or, where it is absent, the Reagan sand (sometimes called LaMotte sand) is generally found. It is a very coarse sand containing grains that are well rounded and may be frosted. The thickness is probably 40 feet on the average, but no doubt variations from this figure will be revealed by future drilling. The pre-Cambrian rocks have been drilled into at several places in the county. Generally a coarse-grained pink granite is encountered. Sometimes other kinds of rock appear as, for instance, quartzite, schists of various kinds, and so forth. Some of these are noted in the discussion of important wildcat wells given on a subsequent page.

Structure

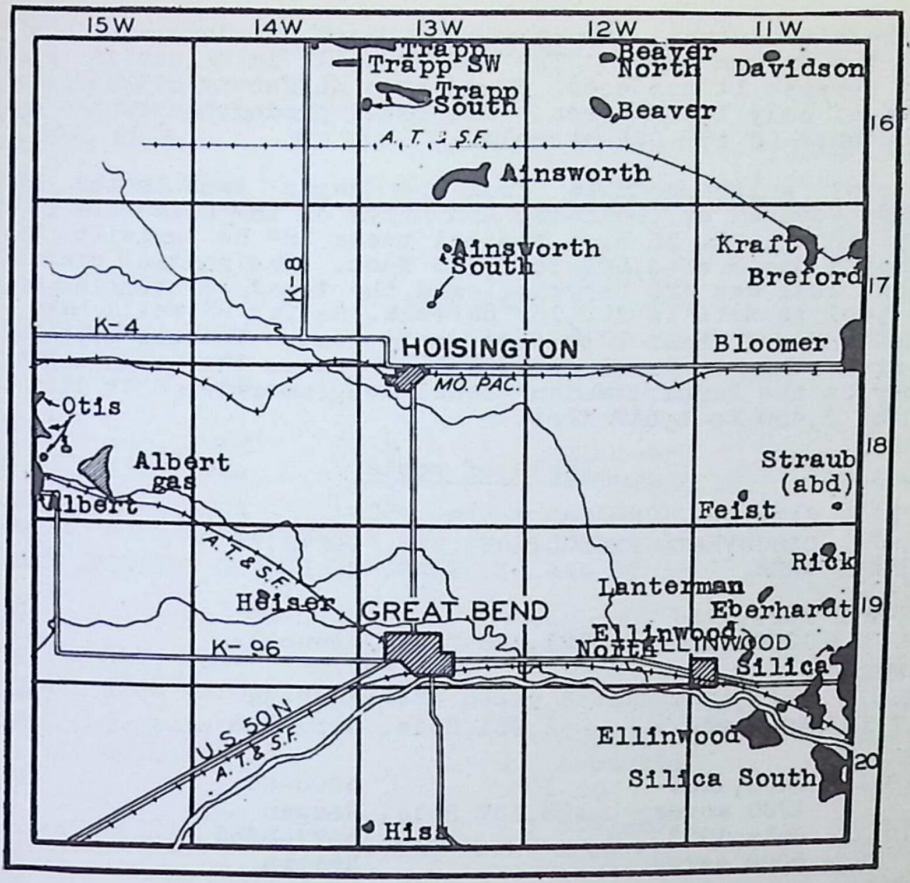
The surface rocks of Barton County reveal a gentle dip toward the north, while the subsurface rocks show a similarly gentle dip toward the west. The dividing line is the unconformity at the top of the Permian red beds. While it is believed that certain north-south anticlinal trends exist in this county, the main controlling feature is undoubtedly the Central Kansas Uplift (Barton Arch). One of the axes of this buried anticlinal structure passes almost through the center of Barton County. It is extremely broad and has very gentle dips toward the northeast and the southwest. At the time of its highest topographic relief, probably in early Pennsylvanian time, it was deeply eroded. The "Siliceous lime" was stripped off the top in places and long belts of cuestas were formed parallel to its axis. In such belts the dolomite was left relatively high, making possible the later arching of younger strata above them. These are the structures that now contain oil.

History of Oil and Gas Development

At the present time there are 21 oil and gas pools in Barton County. The oldest is the Davidson pool located in the north-central part of T. 16 S., R. 11 W. It was discovered in March, 1930, by the Prairie Oil Company when they drilled the first well on the Davidson farm in Section 4. Production was found in the Arbuckle at a depth of 3,314 to 3,340 feet in a porous zone of the dolomite 18 feet below the top of the formation. The initial production amounted to almost 200 barrels per day. This well had produced over 17,000 barrels to the end of 1937, and is still the only well in the pool.

The second pool to be discovered in Barton County is the Silica pool. It is not only the largest in the county, but the largest in western Kansas as well. It now includes what were formerly called the Schartz, Steckel, Isern, and Kowalski pools. The first well was drilled by Hilligoss and Torry Oil Company on the Isern farm in sec. 12, T. 20 S., R. 11 W. It came in for 1,023 barrels per day from a depth of 3,309 feet, where a porous zone in the Arbuckle lime was encountered. Subsequently the Steckel portion was discovered in April, 1932, the Schartz portion, which lies in Rice County, in June, 1936, the Peter portion in October, 1935, and the Kowalski portion in March, 1937. These areas now cover 6,100 acres on which 405 wells have been drilled. The total production to the end of 1937 has been 12,114,096 barrels. The gravity of the oil is 42° Bé.

Another pool which gives indication of future large extent and great production is the Bloomer pool discovered in February, 1936. This pool is located in T. 17 S., R. 11 W., at the eastern border of the county, and extends into Ellsworth County. At



Barton County

the end of 1937 it had an area of 2,000 acres and a cumulative total of 1,769,720 barrels production. The producing strata are the Arbuckle, here found at a depth of 3,257 feet with porosity at 3,271 to 3,281 feet, or at a distance of 14 feet below the top, and the Lansing-Kansas City group of limestones. The discovery well was drilled by Yarnell and Spencer on the Bloomer farm in sec. 36, T. 17 S., R. 11 W., in February, 1936. The total number of wells drilled to date is 82.

Most pools in Barton County produce from the Arbuckle limestone. The Hiss and Heizer pools produce from the Lansing-Kansas City limestone zone. The former was discovered in 1936 and the latter in 1935. Production comes from a depth slightly below 3,200 feet in both pools. The gravity of the oil in the Heizer pool is 48° Bé, while that of the Hiss pool is only 36° Bé. Four wells have been drilled in the Hiss pool, but the Heizer is still a one-well pool.

An extremely interesting pool is the Beaver pool. It is located in the middle of T. 16 S., R. 12 W., and was discovered by the Darby Oil Company when they drilled their No. 1 Jarus in December, 1934. This well obtained production from the Arbuckle at a depth of 3,348 to 3,351 feet. The fact that this formation might be very thin was proved by later wells, some of which found it entirely missing. Consequently these wells are producing from the Reagan sand. In one well a sand was found above

the Arbuckle in the Pennsylvanian basal conglomerate. This is called the Gorham sand. The Beaver pool is unique in western Kansas because it produces from three different oil horizons in an area of only 1,000 acres. The total production to the end of 1937 amounts to 388,369 barrels.

A pool which produces from the Reagan sand is the Albert pool, discovered by Treleaven and Brimm on the Haas farm in sec. 30, T. 18 S., R. 15 W. The oil tests 38° Bé gravity and is found at a depth of 3,603 to 3,613 feet. The initial production of this well was 320 barrels, and the total production of the whole pool to date is 125,157 barrels. So far 23 wells have been drilled and of these 8 produce only gas. The gas appears to come from a higher level and for that reason the producing horizon may be the Pennsylvanian basal conglomerate. It lies at a depth of 3,486 to 3,518 feet.

Table of pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
AINSWORTH 26-16-13	Dec.,1936 1800 acres	35 221,635 Bbls.	3390-95 Arbuckle	5 dry
AINSWORTH SOUTH 10-17-13	Oct.,1937 40 acres	2 2,951 Bbls.	3342-52 Arbuckle	Pot.255 Grav.38
ALBERT 30-18-15	Feb.,1935 1200 acres	10 125,157 Bbls.	3603-06 Reagan	5 dry
36-18-16	July,1935 5000 acres	8	3577-3636 Reagan	Gas
BEAVER 16-16-12	Dec.,1934 1000 acres	14 388,369 Bbls.	3348-51 Arbuckle 3335-41 Reagan	3 dry Grav.38
BEAVER NORTH 4-16-12	Nov.,1937 40 acres	1 2,498 Bbls.	3316-26 Arbuckle	Pot.949 Grav.39
BLOOMER 36-17-11	Feb.,1936 2000 acres	79 1,769,720 Bbls. 1	3257-81 Arbuckle Lansing - K.C.	2 dry Grav.44
DAVIDSON 4-16-11	Mar.,1930 40 acres	1 17,437 Bbls. 1	3314-40 Arbuckle Conglomerate	Grav.38
EBERHARDT 14-19-11	June,1935 160 acres	4 85,136 Bbls.	3311-60 Arbuckle	Grav.38
ELLINWOOD 9-20-11	July,1932 1200 acres	16 1,199,622 Bbls.	3304-34 Arbuckle	5 dry Grav.41
ELLINWOOD NORTH 33-19-11	July,1937 40 acres	2 8,087 Bbls.	3328-3350 Arbuckle	Pot.551
FEIST 29-18-11	Oct.,1935 40 acres	1 29,359 Bbls.	3430-33 Arbuckle	Grav.39
HEISER 16-19-14	Aug.,1935 40 acres	1 7,458 Bbls.	3228-3253 Oswald	One dry to P.C. Grav.48

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
HISS 31-20-13	May,1936 160 acres	4 139,158 Bbls.	3270-85 Oswald	3 dry to Arb. Grav.36
KRAFT 10-17-11	June,1937 1200 acres	16 75,486 Bbls.	3281-89 Arbuckle	
LANTERMAN 15-19-11	Oct.,1934 200 acres June,1937	2 64,511 Bbls. 4	3232-35 Arbuckle 3040-3115 Lansing - K.C.	1 dry Grav.38
RICK 1-19-11	Aug.,1936 160 acres	5 97,429	3353-55 Arbuckle	3 dry Grav.36
SILICA 12-20-11	Oct.,1931 6100 acres	405 12,114,096 Bbls.	3309-28 Arbuckle	17 dry Partly in Rice Co. Grav.42
SILICA SOUTH 24-20-11	Oct.,1935 1800 acres	62 917,922 Bbls.	3274-3284 Arbuckle	8 dry Grav.42
STRAUB 36-18-11	7-24-34 40 acres	1	3286-3310 Arbuckle	Grav.40 1 dry
TRAPP SOUTH 16-16-13 7-16-13	Dec.,1936 1200 acres	18 120,300 Bbls.	3357-3372 Arbuckle	Formerly Susank & Stickney
TRAPP SOUTHWEST 1-16-14	Oct.,1937 40 acres	1 None	3341-66 Arbuckle	

Marketing Facilities

During 1936, Barton County produced 1,163,590 barrels of oil. The following year it produced 1,500,000 barrels, making a grand total of 12,500,000 barrels for the entire period of its productive history. Most of this oil was run through the pipe lines of the Kaw Pipe Line Company which is now transporting oil from the Ainsworth, Bloomer, Davidson, Feist, Kraft, Lanterman, South Silica, South Trapp, and a large part of the Silica pool. The pipe lines of the Continental Oil Company are transporting the oil from the Ainsworth and South Trapp pools. A large number of pools, including the Albert, Beaver, Eberhardt, Ellinwood, Hiss, Lanterman, South Silica, Rick, and a portion of the Silica pool are served by the Stanolind pipe line. Some of the oil from the Bloomer and the Silica pools is run by the Skelly Oil Company, while the Sinclair Oil Company takes care of some from the Silica and South Silica pools.

A distillation plant has been erected by the Falcon Refining Company at Great Bend. It is supplied by crude oil from the Silica pool as well as some pools in Stafford and Rush counties. The plant is of the skimming type, producing gasoline, kerosene, gas oil and fuel oil.

Important Test Wells

Wolf Creek No.1 Kraft, in sec. 26, T. 16 S., R. 11 W.,top of Salt, 1,205; Herington, 1,555; Ft. Riley, 1,690; Neva, 2,060; Tarkio, 2,425; Howard, 2,635; Topeka, 2,710; Oread, 2,893; Lansing, 3,070; Conglomerate, 3,367; Arbuckle, 3,372.

Sinclair No.1 Turgeon, in sec. 3, T. 16 S., R. 12 W., top of Lansing, 3,060; Conglomerate, 3,360; Arbuckle, 3,401; Granite, 3,419; total depth, 3,479 feet.

Wixon No.1 Buhrle, in sec. 14, T. 16 S., R. 13 W.,top of anhydrite, 852; Topeka, 2,735; Lansing, 3,145; Conglomerate, 3,398; Arbuckle, 3,405; total depth, 3,448 feet.

Lario No.1 Nuss, in sec. 11, T. 16 S., R. 14 W., top of Cimarron, 520; Anhydrite, 890; Salt, 1,285; Herington, 1,766; Topeka, 2,825; Douglas, 3,095; Lansing, 3,156; Arbuckle, 3,338; total depth, 3,396 feet.

Harris & Haun No.1 Deitz, in sec. 21, T. 16 S., R. 15 W., top of Lansing, 3,292; Conglomerate, 3,553; Arbuckle,3,608; Reagan, 3,660; total depth, 3,678 feet.

Davidson No.1 Birzer, in sec. 22, T. 17 S., R. 12 W., top of Anhydrite, 760; Topeka, 2,770; Lansing, 3,115; Arbuckle, 3,399; total depth, 3,430 feet.

Herndon No.1 Schneider, in sec. 18, T. 18 S., R. 15 W., top of Reagan, 3,495; Granite Wash, 3,548; Granite, 3,569; total depth, 3,570 feet.

Mid Continent No.5 Schmidt, in sec. 36, T. 19 S., R. 11 W., top of Arbuckle, 3,324; Reagan, 3,758; total depth, 3,796 feet. Water Disposal Well.

Palmer No.1 Morris, in sec. 6, T. 19 S., R. 15 W., top of Anhydrite, 996; Lansing, 3,315; Conglomerate, 3,535; Arbuckle, 3,627; Reagan, 3,644; total depth, 3,673.

Stanolind No.1 Herter, in sec. 17, T. 20 S., R.11 W., top of Lansing, 3,065; Arbuckle, 3,430; total depth, 3,593. Water Disposal Well.

Atlantic No.1 Titus, in sec. 30, T. 20 S., R. 13 W., top of Anhydrite, 775; Topeka, 2,870; Lansing, 3,256; Viola, 3,530; Simpson, 3,550; Arbuckle, 3,580; total depth, 3,650. Water Disposal Well.

CLARK COUNTY

Areal Geology

Clark County is located in southwestern Kansas in the southern tier of counties. Cimarron River cuts across the southern half and drains the entire county. The youngest rocks are river deposits, occurring in the bed of Cimarron River and its tributaries. In addition to these narrow belts of alluvium, there is considerable dune sand, and terrace material of the Gerlane formation. These relatively soft and unconsolidated materials rest upon an uneven surface of much older rock. In the northern tier of townships the surface is floored with sands and gravels be-

longing to the Ogalalla formation of Tertiary age, which here has a thickness of not more than 200 feet. Some of the beds of the Ogalalla formation are indurated, and form the so-called "mortar beds."

Cretaceous Rocks. In the northern half of the county a narrow band of older rock projects from under the Tertiary. It consists of sandstones and shales of Cretaceous age. These beds have been subdivided into the Dakota sandstone, the Kiowa shale, and the Cheyenne sandstone at the base. Because there is a pronounced unconformity at the base, the Cheyenne sandstone varies considerably in thickness, but probably does not exceed 50 feet. The Kiowa shales are dark colored and very fissile. They are abundantly fossiliferous and have been placed in the Comanchean or Lower Cretaceous system[3]. The Dakota sandstone, on the other hand, is a deposit of rather coarse sand laid down in a slowly advancing sea as the initial deposit of the Upper Cretaceous system.

Permian System. Under the Cretaceous rocks and, in southern Clark County, under the Quaternary rocks, various members of the Permian system appear. They have been studied by Cragin and others[4] and subdivided into members according to variations in lithology. The highest beds consist of red shales 25 to 40 feet thick. They may be seen near the junction of Bluff and Hackberry Creeks, northwest of Protection, as well as on Bear Creek and Kiger Creek. These beds were named the Greer formation by Gould. The sandstone at the top, called the Big Basin sandstone by Cragin, may be seen at many places in the county, especially in the northern and northwestern part where it underlies the Cretaceous rocks. The Day Creek dolomite, which underlies the Greer, is thin, but very persistent. Its line of outcrop has been carefully traced by geologists and may be found on a map published by the Kansas Geological Society[5]. It crops out in a narrow band extending through townships 31 S., R. 22 W., 32 S., R. 22 W., and westward to T. 33 S., R. 24 W. Good exposures may be seen along the highway east of Ashland.

Below the Day Creek are several hundred feet of fine-grained reddish sandstones and shales, which were named the Whitehorse by Gould and rather fully described by him[6]. Later Cragin added some details and described the outcrops across central Clark County. The most recent data on this interesting formation were published by Darsie Green[7], who believes that the base of the Whitehorse is also the base of the Marlow formation. Good outcrops of this sandstone may be seen in the banks of Cimarron River valley and in the slope north of the Great Salt plain. The dull-red argillaceous shales of the Dog Creek formation appear only in southeastern Clark County.

---

3. For information on these fossils and strata consult Kansas Geol. Survey, Bull. 9.
4. See Kansas Geol. Survey, Bull. 6, #pt. 2, p. 65, 1920.
5. Kansas Geol. Soc., Proc. 8th Ann. Field Conf., p. 10, Sept., 1934.
6. Gould, C. N., Geology and water resources of Oklahoma: U. S. Geol. Survey, Water Supply Paper 148, p. 52, 1905.
7. Am. Assoc. Petroleum Geologists, Bull., vol. 21, p. 1526 etc., Dec., 1937.

Subsurface Geology

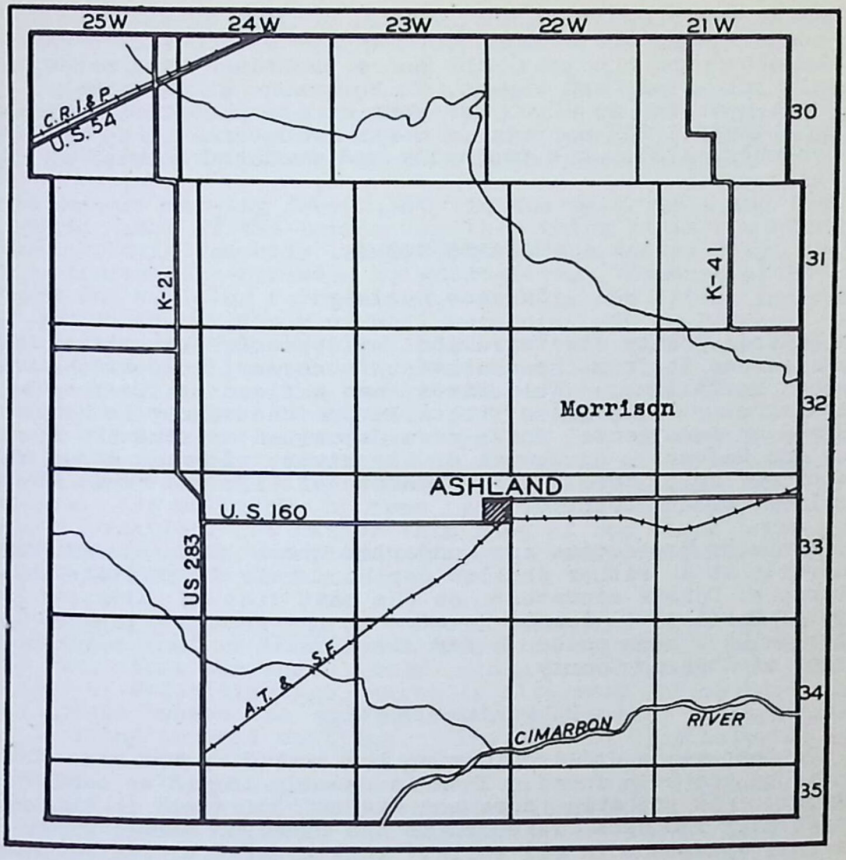
The lower members of the Cimarron series from the Blaine gypsum down to the Harper sandy portion, have been found in a deep test well drilled in Clark County. In well cuttings it is possible to distinguish the Blaine or Medicine Lodge gypsum and the Enid or Cimarron anhydrite near the base of the red beds, but otherwise it is not possible to make finer distinctions. The lowest red beds seem to occur at a depth of about 1,650 feet. At that point the predominance of gray clays and shales indicates the presence of the Wellington formation of the Big Blue series. The salt near the middle of the Wellington appears at a depth of 1,940 feet in eastern Clark County. Below it the usual anhydrite layers of the lower Wellington are found in well cuttings. The Herington dolomite marks the top of a thick sequence of limy beds which extends down to about 3,100 feet. In it the cherty equivalent of the Florence and the Wreford can be identified.

Pennsylvanian Rocks. Approximately 2,200 feet of sediments intervene between the Americus limestone and the Mississippian rocks. They are presumed to belong to the Pennsylvanian system. The Topeka limestone lies at a depth of 3,840 feet in eastern Clark County, and the Lansing limestone at a depth of 4,385 feet. The latter marks the top layer of a zone of thick limestones which extends down to over 5,000 feet in depth. In the lower portion of this zone is considerable black shale. The equivalent of the Marmaton also seems to consist of limestones with some black shale breaks. The typical red and green shales of the basal conglomerate begin to appear at a depth of nearly 5,300 feet and they continue down to the top of the Mississippian rocks.

Pre-Pennsylvanian Rocks. A few wells have penetrated the Mississippian and older rocks in this county. They encountered a considerable thickness of the Mississippian between depths of approximately 5,400 feet and 6,400 feet, or about 1,000 feet. The Mississippian rocks lie upon the eroded surface of the much older Viola limestone, which here is quite cherty and contains green shale layers. The tripolitic chert indicates long continued erosion before the Mississippian sediments were laid down. The Viola is believed to be 160 feet thick and rests upon an equal thickness of Simpson. The Arbuckle dolomite has been found in one well which penetrated some 56 feet of it.

History of Oil and Gas Development

Both oil and gas have been found in commercial quantities in Clark County. Although hardy pioneers began to drill tests for oil as early as 1911, it was not until 1926 that success attended their efforts. In that year the Watchorn Oil and Gas Company completed its well on the Morrison ranch in sec. 20, T. 32 S., R. 21 W. An initial production of 10 million cubic feet of gas seemed to corroborate the indications of surface structure. The top of the Pennsylvanian basal conglomerate was found at 5,305, and it contained gas to 5,312 feet. Instead of taking the gas from this horizon the well was drilled deeper, entered the Mississippian at 5,345 and finally was abandoned at 5,707 where the tools were lost in the hole. One of the surprising results attained was the information that the "Mississippi lime" was unusually thick in this county. Two later attempts to test the original gas horizons were failures because in each case trouble developed which caused abandonment above the proper



Clark County

depth. The third attempt, however, was more successful. In a well on the Stephens ranch, in sec. 21, T. 32 S., R. 21 W., the same operators found 20 million cubic feet of gas at a depth of 5,443 to 5,465 feet, also in the basal conglomerate.

After a pipe line had been laid this well started producing and accounted for a total yield of 136,516,245 cubic feet to the close of 1930. In that year another well was completed which also was made into a test of the deeper horizons. The Mississippian was penetrated from 5,392 to 6,380 feet, the Viola from 6,528 to 6,696, and the Simpson from 6,696 to 6,853 feet at which point the drill entered the Arbuckle dolomite. This well, the No. 2 Morrison in sec. 20, was abandoned at a total depth of 6,909, as no important showings were found in the older rocks.

Another effort to find deep production was made in 1937. A well was started on the Morrison ranch in sec. 17 and drilled to a depth of 6,467 feet where oil started to come into the hole. Deeper drilling to 6,481 feet allowed more oil to appear, so that when a test was made after acidizing, the well flowed 22 barrels in 15 minutes, 28 barrels the next 15 minutes and so on until a six hour test revealed a potential of 622 barrels per day. This high yield caused more excitement and interest than Kansas had seen for several years. Early in 1937 the No. 2 well

on the Morrison ranch in sec. 20 was drilled to the same producing horizon, the Viola limestone, and it also became a producer. At the close of the year the No. 1 Morrison was rated at 63 barrels potential and the No. 2 Morrison at 92 barrels. The pool was prorated to 27.53 per cent of its potential production, which allowed 1,252 barrels a month production. Up to the end of December, 1937, the two wells had produced a total of 31,226 barrels.

EDWARDS COUNTY

Surface Geology

Edwards County is traversed by the Arkansas River which flows across it from the southwestern corner to near the center of the north line. This river has a flood plain from 3 to 6 miles wide. Southeast of the alluvium the county is completely covered by dune sands which were deposited during the Pleistocene and Recent. Northwest of the river, terrace deposits, of Quaternary age, form a thin blanket of silt and sand over the remainder of the county.

Rocks of Cretaceous age underlie these Cenozoic materials, generally at a rather shallow depth. This is indicated by the outcrop of Dakota sandstone on the east side of Arkansas River east of Garfield in Pawnee County to the north. Similar small outcrops have been noted a few miles north of the northwestern corner of Edwards County.

Subsurface Geology

In deep wells drilled during the last 20 years some Dakota sandstone has been found. This is usually logged as sand by the driller. It probably does not exceed 350 feet in thickness. The Permian red beds referred to the Cimarron series appear below this sandstone in all wells. They consist of red shales and clays with much gypsum at certain levels. The gypsum beds belong to the Medicine Lodge member of the Cimarron and to the so-called Enid anhydrite member near the base. Since the latter is found at depths of around 1,200 feet, it follows that the Cimarron series must be from 1,100 to 1,200 feet thick in Edwards County.

The gray shales of the Wellington formation lie below the red beds. They are about 600 feet thick and include much anhydrite, especially in the lower portion. Some salt is present near the middle, and the thickness of the salt is believed to be close to 200 feet. As practically all wells in this county have been drilled with rotary tools, no precise data are at hand. The main portion of the Big Blue sequence from the Herington down to the Americus limestone can be identified in well cuttings. The Herington may be expected around 2,200 to 2,300 feet. It is a thin dolomitic limestone. Below it other thin limestones appear with much red shale interbedded. The two chert horizons, one at the Florence level and the other at the Wreford level, are present. The appearance of abundant fusulinids around 2,750 feet suggests the presence of the Americus limestone and the top of the Pennsylvanian.

Pennsylvanian Rocks. Pennsylvanian rocks are approximately 1,700 feet thick in Edwards County. They consist of clastic materials in the upper 500 feet. This unit may be correlated

with the Wabaunsee group of eastern Kansas. Some thin micaceous sandstones and siltstones appear at several horizons. The Topeka, which appears in wells around 3,300 to 3,500 feet, marks the top of a prominent limestone zone some 400 feet thick. In it there are black shales especially near the base. Thin oolitic limestones also appear in the Shawnee group. The Douglas is represented by a thin interval of red and green shales.

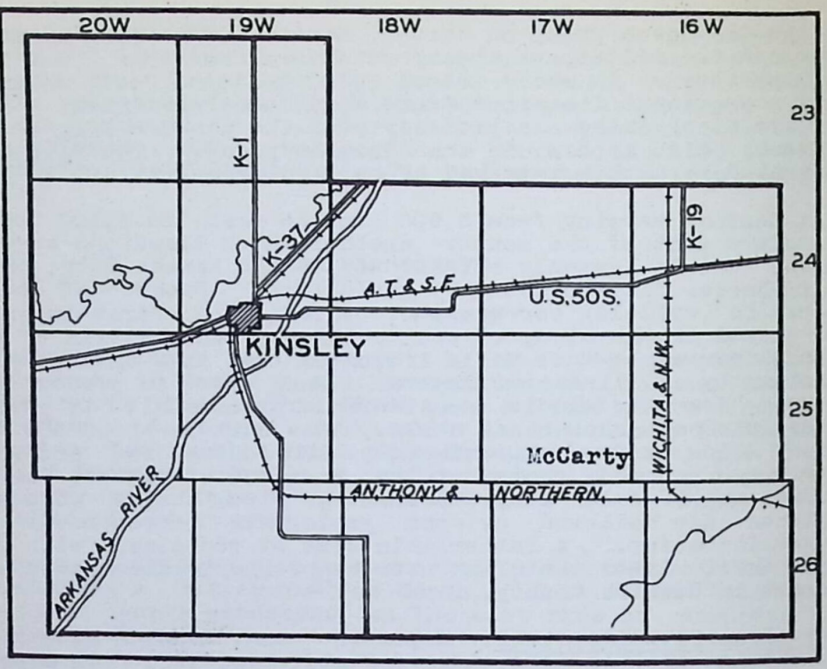
At depths varying from 3,900 in the east to 4,100 feet in the western part of the county another thick limestone sequence appears. It is commonly referred to as the Kansas City, or the Lansing-Kansas City-Bronson, by geologists. Because of its importance in well-log correlation, this is the first important "top" picked in the study of well cuttings. An analysis of well cuttings from cable-tool wells indicates that this unit consists predominantly of limestone layers. Much chert is present near the top. Near the middle considerable green shale is present and near the base much black shale. This unit is about 300 feet thick. Below it are approximately 100 feet of red and green shales which probably represent the Marmaton of eastern Kansas. An additional 75 feet of predominantly black shales with some limestones are believed by some geologists to represent the Cherokee formation. A rather thin zone of red clays with some decayed chert takes the place of the Pennsylvanian basal conglomerate in Edwards County.

Pre-Pennsylvanian Rocks. Below the Pennsylvanian either the Mississippian chat or some older formation appears. On account of the fact that the most likely older formation is the Viola limestone of Ordovician age, which is also very cherty here, some doubt exists where the unconformity below the Pennsylvanian rocks is found in well cuttings. The chat of Mississippian age has been reported in wells drilled in the two northern townships (23 and 24). It has also been found in one well in township 25 S., R. 17 W. However, its patchy distribution is further indicated by complete absence of Mississippian rocks in a well drilled in T. 24 S., R. 16 W.

Under the Mississippian rocks, or, where they are absent, under the Pennsylvanian, the residual chert from the weathering of the Viola limestone may be expected. The chert and the coarsely crystalline limestone of the Viola formation may have a thickness of 50 to 60 feet. They lie above green shales and sandstones of Simpson age which have a thickness of about 80 feet. Finally, the Arbuckle limestone, which is perhaps the most widespread rock in western Kansas, is encountered in deep wells. It has been penetrated in at least one well where it had a thickness of about 400 feet. It produces the usual pale, cream-colored, dolomitic cuttings, which are so characteristic of this formation elsewhere.

Structure

Practically nothing is known regarding the structure of the rocks in Edwards County. The surface rocks cannot be used for structure mapping, and core drilling is not feasible on account of the great depth of marker rocks. In the last eight years much seismograph work has been done in this county in an effort to discover buried anticlines or other favorable traps for oil and gas. The results of subsequent drilling have been non-committal. Some "highs" exist as has been proved in T. 24 S., R. 16 W., but the extent of these "highs" and their significance are still unknown.



Edwards County

History of Oil and Gas Development

Although a good show of gas was struck as early as February, 1927, in the Nubergall well in sec. 7, T. 23 S., R. 19 W., it was over two years later before the first commercial production was found. In May, 1929, the British American Oil Company drilled a deep test well on the McCarty ranch in sec. 31, T. 25 S., R. 17 W. The top of the Pennsylvanian basal conglomerate was found at 4,535 feet, and 34 feet lower the first gas came into the hole. Drilling was continued to 4,571 feet where the estimated flow reached 15 million cubic feet per day. In a sandy zone at 4,545 to 4,553 the well also encountered a flow of oil estimated at 60 barrels. The initial pressure of the gas was 1,310 pounds and the gravity of the oil was 35° Be.

A second well drilled in the same section found an initial production of 521 barrels of oil with 3 million cubic feet of gas in the same producing stratum at 4,527 to 4,546 feet. The third well was drilled in section 22 of the same township, and this well also found considerable gas in the same formation. It was drilled deeper, to 4,960 feet, and found Viola limestone beneath the Pennsylvanian. Subsequently it was plugged back to 4,480 to 4,489 feet, where it was capable of producing some 8 million cubic feet of gas per day. A fourth well, also drilled by the Dixie Oil Company, was completed in November, 1930, in sec. 30. This well produced 1½ million cubic feet of gas from 4,560 to 4,580 feet. Late in the same year the Barnsdall Oil Company completed its well, on the Maude Carroll ranch in sec. 32. for an initial production of 9 million cubic feet of gas. These wells prove an area of 1,500 acres for gas, but perhaps only 80 acres for oil. The gas produced during 1929, 1930, and 1931 amounted to 743 million cubic feet. Up to the close of

1937 the oil production totalled 98,690 barrels. Periodical tank car shipments up to the close of 1937 indicate that the possibilities of this pool have not been exhausted. The gas is being transported by the Kansas Pipe Line and Gas Company.

Data on important test wells drilled in Edwards County are given in the following section.

Important Test Wells Drilled In Edwards County

Edwards Pet. Co. No.1 Nubergall, in sec. 7, T. 23 S., R. 19 W., top of Chat, 4,612; total depth, 4,653 feet. Completed Feb. 9, 1927.

Amerada No.1 Bradbridge, in sec. 1, T. 24 S., R. 16 W., top of Lansing, 3,647; Conglomerate, 3,999; Viola, 4,002; Simpson 4,070; Arbuckle, 4,115; pre-Cambrian granite, 4,478 feet, total depth. Completed, Jan. 17, 1934.

Mid Kan. No.1 Converse, in sec. 30, T. 24 S., R. 18 W., top of Topeka,3,555; Chat, 4,545; Arbuckle, 4,968 feet, total depth. Completed, Nov. 16, 1932.

Royal No.1 Krupp, in sec. 18, T. 24 S., R. 19 W., top of Topeka, 3,580; Lansing, 4,050; Conglomerate, 4,628; Chat, 4,770; Viola, 4,885; Simpson, 5,010; Arbuckle, 5,070; total depth, 5,135. Completed, June 13, 1937.

Douglas No.1 Mead, in sec. 33, T. 25 S., R. 16 W., top of Lansing, 3,915; Conglomerate, 4,370; Viola, 4,505; Arbuckle, 4,768; total depth, 4,798 feet. Completed, Sept. 14, 1937.

Amerada No.1 Tansil, in sec. 32, T. 25 S., R. 19 W., top of Topeka, 3,605; Lansing, 4,105; Marmaton, 4,430; Cherokee, 4,595; Chat, 4,750; Viola, 4,995; Simpson, 5,105; total depth, 5,195 feet. Completed, June 15, 1929.

Skelly No.1 Johnson, in sec. 21, T. 26 S., R. 17 W., top of Herington, 2,250; Wabaunsee, 2,785; Topeka, 3,280; Lansing, 4,038; Conglomerate, 4,540; Chat, 4,600; Viola, 4,690; Simpson, 4,799; Arbuckle, 4,885; total depth, 5,220 feet. Completed, May 16, 1930.

Stanolind No.1 Donovan, in sec. 14, T. 26 S., R. 18 W., top of Anhydrite, 1,167; Lansing, 4,028; Viola, 4,642; Simpson, 4,790; Arbuckle, 4,872. Completed Feb. 12, 1937.

ELLIS COUNTY

Areal Geology and Stratigraphy

Most of the rocks exposed in Ellis County are of Cretaceous age. On some of the highest divides are thin sheets of gravel of Tertiary age. Along the present river channels are gravel deposits of Quaternary age. The geologic map of the State of Kansas published by the Kansas Geological Survey in 1937 shows the various formations and members of the Cretaceous system. The highest occurring in Ellis County is the Niobrara, which is subdivided into the Smoky Hill chalky shale and the Hays limestone. The former, with a maximum thickness of 100 feet in this county, makes typical badland topography. The scenic effects of this topography are further enhanced by the white, yellow and

orange colors which result when the chalky shale of the Smoky Hill member weathers. The Hays chalk, on account of its superior hardness and its thickness of 55 feet, makes prominent bluffs along the main streams. These may be seen on the south side of Saline River, which flows eastward across the northern part of the county, and along Big Creek, a tributary of Smoky Hill River which crosses the center of the county.

The Blue Hill shale member of the Carlile formation directly underlies the Fort Hays, and makes a long gentle slope. It averages 200 feet in thickness. The shale is grayish black and non-calcareous and contains several zones of septarian ("cannon-ball") concretions, especially near the top. An important geological marker is a thin sandstone which lies at the very top of the Blue Hill shale. This was named the Codell sandstone bed by Bass[8], on account of an excellent exposure 5 miles south and a short distance west of the town of Codell in Rooks County. Water seeps mark the line of outcrop and a number of farm wells produce from it. By means of these characteristics it has been traced over a wide area on the surface and has been used for the purpose of making structure maps. It can be similarly traced underground in far western Kansas to the Colorado border by means of well cuttings.

The Fairport shale lies below the Blue Hill shale. It is about 100 feet thick and can be distinguished from the overlying shale by its calcareous nature. In addition, thin chalky limestones and abundant fossils are diagnostic. Although blue when fresh, it weathers readily to a light tan color.

The Greenhorn formation is the best known in this county. The feature that makes it stand out is the presence of an 8-inch bed of limestone at the top which may be quarried and cut into long rectangular blocks, ideally suited for use as fence posts. In this treeless country, the "post-rock" has proved a boon to the ranchers. The Greenhorn formation maintains its character and thickness of 100 feet over a wide area. This permits geologists to use its various limestone layers in making structure maps and thus to anticipate the possibility of oil accumulations below the surface. Most of these limestones are from 3 to 12 inches thick and are interbedded with chalky shales.

The bluish-black shale which occupies the slope below the Greenhorn is called the Graneros because of its correlation with the formation of that name in Colorado. Although only 32 feet thick in this county, it may be readily identified by the numerous thin layers of sandstone, ironstone concretions, and selenite crystals which weather out of it.

The lowest exposed rock in this county is the Dakota sandstone. It is found only in the deepest parts of the large river valleys and even there only the uppermost 20 feet of the formation may be seen. A good exposure may be studied in the NW ¼ sec. 35, T. 15 S., R. 16 W., where it is arched over the axis of the Pfeifer anticline. Records of numerous wells drilled in this county prove that both the Dakota sandstone of the upper Cretaceous as well as the Cheyenne sandstone of the lower Cretaceous are present. The total thickness approximates 400 feet,

---

8. Bass, N. W., Geology of Ellis County, Kansas: Kansas Geol. Survey, Bull. 11, 1926.

and includes much dark and red shale, as well as sandstone. Furthermore, the sandstone beds thicken or thin with confusing rapidity from well to well, indicating that the formation was laid down under conditions varying from continental to marine.

A great unconformity separates the Dakota from the underlying Permian rocks. Evidently this part of western Kansas was not covered by the Triassic and Jurassic seas. The Permian strata are 1,000 feet thick and may be subdivided into three units, the Cimarron, the Wellington, and the limestone portion of the Big Blue. The Cimarron beds are easily distinguished by their red color and the presence of the Cimarron anhydrite near the base. Many wells drilled in all parts of the county encountered the Cimarron anhydrite at depths between 950 and 1,600 feet. It is the first important marker sought by the geologists, not only in well cuttings but also in seismograph surveying. It seems to be an excellent reflection surface for seismograph work. The red beds commonly occupy the upper 600 feet of the Permian. The next 450 feet are composed of shale, salt, and gypsum in descending order, and are usually classified together as the Wellington member of the Big Blue formation. The next lower 600 feet of strata are perhaps the most reliable in the underground sequence. Dolomitic limestones alternating with shales make up this part of the stratigraphic column. It is possible to pick out the Herington, Florence, Wreford, and Americus formations on account of lithologic peculiarities in the well cuttings.

The Pennsylvanian rocks in Ellis County are approximately 1,000 feet thick. The Wabaunsee group takes up nearly 550 feet of this amount and may be distinguished by the predominance of shaly and sandy layers in the sequence. Near the middle lies the Tarkio limestone. The Shawnee group with the Topeka limestone at the top may be distinguished by the predominance of limestone in well cuttings. In this county the Topeka is often oolitic. The average thickness of the Shawnee is 200 feet. The Douglas group is very thin in this county, but may be identified by the red shale and other types of material which appear between the Oread limestone and the top of the Lansing. The Lansing, Kansas City, and Bronson are commonly grouped together under the name of "Oswald lime." The predominance of thick limestones separated by thin sheets of dark shale, and the presence of oolitic limestones, are "Oswald" criteria. The thickness in Ellis County approximates 225 feet. In general the top of the Topeka is found at 2,900 feet, but variations on account of topography make the minimum about 2,600 feet and the maximum about 3,100 feet. The top of the Lansing similarly varies from 2,900 feet to 3,500 feet in different parts of the county.

The great mixture of materials at the base of the Pennsylvanian system, usually referred to as the Pennsylvanian basal conglomerate, appears in well cuttings at depths of from 3,200 to about 3,850 feet. It is composed of red and green clays which are often very gummy. Interspersed in these clays are chert fragments that were carried from some high hills of Mississippian or Ordovician limestones, which existed in the early Pennsylvanian sea. In some townships thin sandstone zones have been discovered in this conglomerate. This was particularly true in the Twin Drilling Company No.1 Copeland well in sec. 26, T. 14 S., R. 19 W. The conglomerate varies greatly in thickness, and even in two wells which offset each other this difference may be striking.

Mississippian rocks appear to be entirely lacking in Ellis County. They were probably laid down here as elsewhere in western Kansas, but were removed during early Pennsylvanian time after the formation of the Central Kansas Uplift. The Hunton limestone found in parts of Kansas is also missing. Therefore the rocks underlying the Pennsylvanian basal conglomerate are formations of Ordovician and possibly Cambrian age. In the northeastern part of Ellis County the Simpson green shale and thin sandstones are found in deep wells. This formation varies considerably in thickness, however, indicating both erosion at the top and an unconformity at the base. In the Bemis pool, for instance, the thickness varies from 2 to 63 feet, and the top varies from a depth of 3,300 feet to 3,500 feet, depending partly on structure but mostly on differences in surface elevation of wells. Beneath the Simpson all wells encounter the Arbuckle; in fact this formation appears directly under the Pennsylvanian strata in most wells drilled in the county. It is a coarse-grained dolomite which has several zones containing chert. In certain zones thin streaks of green shale have also been found. The usual depth varies from 3,400 feet to 3,850 feet below the surface. The thickness has been ascertained in only a few places. The maximum was found in T. 13 S., R. 17 W., where one well penetrated 157 feet. In the southwestern part of the county the Arbuckle becomes very thin and is actually missing over a considerable area.

In T. 14 S., Rs. 19 and 20 W., the Pennsylvanian rocks rest directly upon a sandstone which has been called Reagan. Many believe this to be of Cambrian age, for which reason it is often called Cambrian sand. A few wells have penetrated the Reagan, logging an average thickness of about 90 feet. The Reagan consists of rather large, well-rounded grains of sand, which suggests that it may originally have been a wind-blown deposit, which was later rearranged in marine waters. The rock which appears under the Reagan sand is granite of pre-Cambrian age. This was found in a well in sec. 34, T. 14 S., R. 17 W., again in a well in sec. 16, T. 14 S., R. 20 W., and in the Penney Wann well in sec. 12, T. 15 S., R. 20 W.

Structure

Surface. The surface structure of Ellis County was worked out by Bass[9], who shows that the Cretaceous rocks dip regionally toward the north at a rate of about 10 feet to the mile. The most pronounced departure from the regional dip is a narrow zone of warped rocks in the eastern part of the county which trends northward from a point east of Pfeifer, between Victoria and Walker toward Fairport in Russell County. A similar uparched zone of rocks trends northward in Ts. 11 and 12 S., R. 19 W., some distance northeast of the town of Ellis. Southwest of the same town and on the border of Trego County there is another anticlinal trend. Smaller modifications of the regional dip are present in other parts of the county.

These structures may or may not reflect subsurface structures of similar character. Nevertheless they furnish a starting point for drilling exploratory wells. An interesting feature, reported by Bass, is that many faults appear in the Creta-

---

9. Kansas Geol. Survey, Bull. 11, pl. 3, 1927

ceous beds of Ellis County. He states that of 81 faults noted, 74 occur in the Smoky Hill chalk member of the Niobrara and the remainder in the Fort Hays chalk and the underlying Carlile shale (Fairport member).

Subsurface. On account of the angular unconformity between the Dakota and the Permian red beds, it is hazardous to project the surface structures downward. Furthermore, the regional dip on the Permian and older rocks is mostly toward the west and slightly toward the north. It is generally assumed that the older rocks have been folded in long trends which strike mostly north and south. At great depth it is apparent that the structure of the Central Kansas Uplift is of paramount importance. This arch enters Ellis County from Rush County in T. 15 S., R. 19 W., and trends west-northwest into Trego County. It was so deeply eroded that granite appears locally under the Pennsylvanian rocks. Northeastward from its axis there are undoubtedly topographic ridges (ancient cuestas) which put the Arbuckle relatively high.

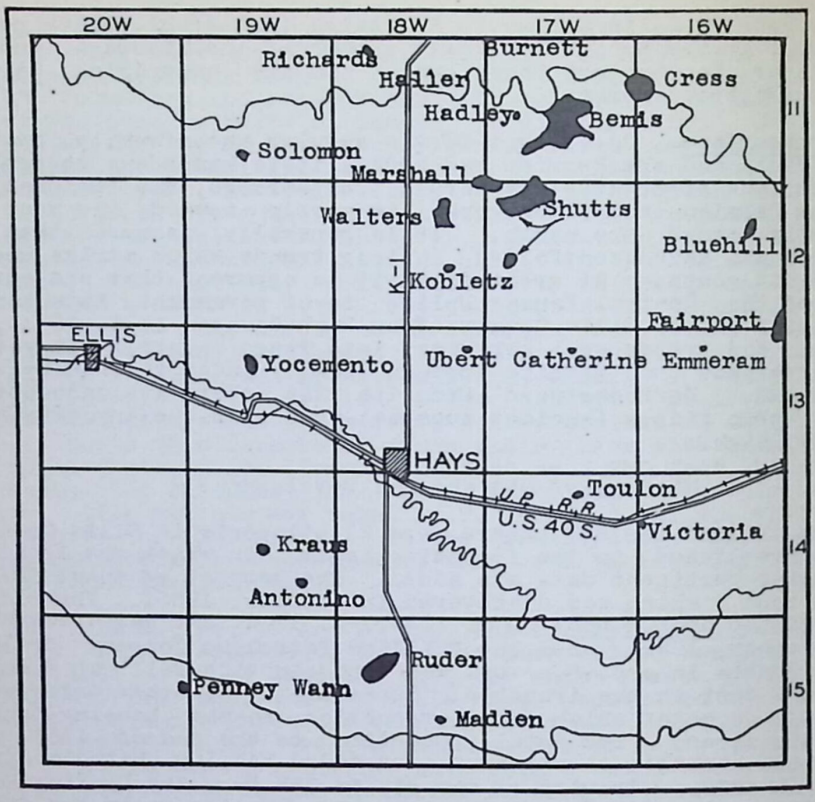
History of Oil and Gas Development

At the end of 1937 there were 21 oil pools in Ellis County. These are listed in the following table, in which the location and other pertinent data are added. The largest of these is the Bemis pool, which was discovered in October. 1935. The oldest pool is the Shutts pool in T. 12 S., R. 17 W. It was discovered in November, 1928, when the Phillips Petroleum Company drilled No. 1 Shutts in sec. 5. Oil was found in this well at a depth of 3,569 feet in the Arbuckle. Subsequently 24 other wells were drilled, some of which found production in the Lansing-Kansas City limestone. The total production to the end of 1936 was 1,192,861 barrels, to which must be added 243,309 barrels produced in 1937. Gravity of the oil is 35° from the Lansing-Kansas City zone and 29° from the Arbuckle. Incidentally the first well in the Shutts pool also holds the honor of being the first to find commercial production in the Arbuckle in western Kansas.

In the Bemis pool the discovery well, the Roark No. 1 Bemis, was drilled in sec. 16, T. 11 S., R. 17 W. Oil was found in the Topeka limestone at a depth of 3,032 feet. Subsequently many other wells were drilled until at the end of 1937 the pool had 148 wells. Most of them produce oil from the Arbuckle, where the initial production runs from 500 barrels to 4,000 barrels. The gravity of the oil is 29° from the Topeka and 33° from the Arbuckle.

Another pool of considerable size is the Ruder pool, located in T. 15 S., R. 18 W. When this pool was discovered in August, 1935, it was first called the Schoenchen pool after a near-by village. The original well was drilled by Tom Palmer and Storm King Oil Company. It had an initial production of 818 barrels derived from two zones in the Lansing-Kansas City, the top one of which was encountered at a depth of 3,334 feet. The two producing zones are 90 feet apart. Up to the end of 1937 a total of 19 wells had been drilled in the Ruder pool, many of which found production in the Arbuckle at a depth of approximately 3,572 to 3,582 feet. The total production to the end of 1937 amounted to 384,462 barrels. The gravity of oil is 34° from the Lansing-Kansas City and 36° from the Arbuckle.

With the exception of the Hadley pool, discovered in 1929, all of the other pools listed in the table were opened during



Ellis County

1935, 1936, and 1937. Most of them have only one well, or a few wells at the present time. The producing formation in most is the Arbuckle. The "Oswald" zone is second in number and in importance. The Topeka limestone produces in the Bemis and in the Walters pools, while the Pennsylvanian basal conglomerate produces in the Antonino, Hadley, Kraus, and Penney Wann pools. Production from the Pennsylvanian basal conglomerate has not been important up to the present time. The producing structures are anticlinal or domal.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
ANTONINO 26-14-19	June,1936 20 acres	0 9,028 Bbls.	3703-10 Conglomerate	2 dry Grav.32 1 abd.
BEMIS 16-11-17	Oct.,1935 3200 acres Apr.,1936 3200 acres	148 1,887,390 Bbls.	3032-40 Topeka 3380-82 Arbuckle	3 dry Grav.29 Grav.33

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
BLUEHILL 14-12-16	Aug.,1937 640 acres	1 7,864 Bbls.	3360-85 Arbuckle	1 dry
	Oct.,1937 640 acres	1	3072-3105 Lansing - K.C.	1 dry
BURNETT 1-11-18	Sept.,1937 40 acres	1 None	3570-74 Arbuckle	Grav.32
CATHERINE 3-13-17	June,1936 160 acres	4 48,716 Bbls.	3274-3362 Lansing - K.C.	Grav.30
CRESS 13-11-17	Mar.,1937 200 acres	18 130,809 Bbls.	3293-3302 Arbuckle	Grav.35
EMMERAM 4-13-16	June,1937 40 acres	1 10,683 Bbls.	3260-67 Lansing - K.C.	
HADLEY 20-11-17	Aug.,1929 10 acres	1 75,000 Bbls.	3428-40 Conglomerate	Grav.29
HALLER 10-11-18	July,1936 40 acres	1 8,022 Bbls.	3036-45 Topeka	1 dry Grav.40
KOBLETZ 23-12-18	May,1937 40 acres	1 1,745 Bbls.	3694-98 Arbuckle	
KRAUS 22-14-19	July,1936 10 acres	2 25,307 Bbls.	3735-40 Conglomerate	Grav.35
MADDEN 26-15-18	June,1936 160 acres	1 26,196 Bbls.	3260-3341 Lansing - K.C.	Grav.37
	Oct.,1936 160 acres	1	3589-95 Arbuckle	1 dry
MARSHALL 36-11-18	Nov.,1936 1000 acres	12 123,681 Bbls.	3650 Arbuckle	2 dry
PENNEY WANN 13-15-20	Sept.,1936 10 acres	1 4,946 Bbls.	3653-58 Conglomerate	Grav.31
RUDER 17-15-18	Aug.,1935 700 acres	17 384,462 Bbls.	3243-3440 Lansing - K.C. 3572-82 Arbuckle	2 dry Grav.34 Grav.36
SHUTTS 5-12-17	Nov.,1928 2000 acres	16 1,436,170 Bbls.	3280-84 Lansing - K.C. 3569-75 Arbuckle	7 dry Grav.35 2 abd. Grav.29
SOLOMON 28-11-19	June,1936 160 acres	3 24,261 Bbls.	3629-32 Arbuckle	2 dry Grav.21
TOULON 3-14-17	Dec.,1935 160 acres	3 49,171 Bbls.	3298-3303 Lansing - K.C. 3512-60 Arbuckle	1 dry Grav.36 Grav.33
UBERT 12-13-18	Nov.,1936 80 acres	2 17,950 Bbls.	-3707 Arbuckle	

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
VICTORIA 18-14-16	Sept.1935 40 acres	1 None	3225-68 Lansing - K.C. 3422-3464 Arbuckle	
WALTERS 2-12-18	May,1936 Feb.,1937	19 193,590 Bbls.	3030-3165 Topeka 3619 Arbuckle	1 dry Grav.35 Grav.26
YOCEMEN-TO 9-13-19	June,1929 40 acres	1 60,891 Bbls.	3592-97 Lansing - K.C.	2 dry 4 abd.

The total production of Ellis County to the end of 1937 is 4,528,882 barrels. The lion's share of this amount has come from the Bemis and the Shutts pools. During 1937 the former produced 1,630,740 barrels and the Shutts pool 243,309 barrels. Pipe lines have been built into the county by the Stanolind and Kaw companies so that now all pools except the Kobletz have a market outlet by pipe line. Oil from the Kobletz pool is transported by truck to the Falcon Refinery at Great Bend.

ELLSWORTH COUNTY

Areal Geology

Ellsworth County is divided into two nearly equal halves by Smoky Hill River which enters from the west just south of the town of Wilson and flows southeastward past the city of Ellsworth, leaving the county near its southeastern corner. Along its path both the oldest and the youngest rocks in the county are found. A narrow flood plain adjacent to the present channel is occupied by Quaternary sands and gravels.

In the southwestern corner of the county a small area is covered by similar material, occurring in flat-lying terrace deposits which are remnants of the flood plain of an ancient river that wandered over this part of Kansas in early Pleistocene time. Beneath the gravel is an unconformity representing a long span of geologic time, for all the Tertiary rocks are missing here. Strata of Cretaceous age appear where the gravels are stripped away. In the highest hills of the county, such as those in T. 16 S., R. 10 W., are remnants of the Carlile shales which cover such a large area in Russell County. Only the lowest part, the Fairport chalky shale member, of this 300 foot formation is present in Ellsworth County. The lower 20 to 25 feet of the Fairport member consists in part of thin chalk layers which are very persistent and which make slight benches in the topography.

Somewhat larger areas are covered by the Greenhorn and Graneros formations of Cretaceous age. These appear in the northern tier of townships and also in the southwestern part of the county around Hollyrood and Lorraine. The Greenhorn formation consists of chalk beds of varying thickness between beds of chalky

shale. The thickness is approximately 95 feet where the entire section is present. The chalk layers are gray when fresh, but weather rapidly to a pale-cream or yellowish color. Fossils are abundant in some beds. Shells of Inoceramus labiatus are particularly conspicuous. Much of the topographic relief of northern Ellsworth County is due to the superior hardness of the Greenhorn chalks.

The Graneros formation consists of soft, dark, bluish-gray shales, which have a thickness of approximately 40 feet in western Ellsworth County. It can be recognized in some places by the presence of selenite crystals strewn over its gentle slopes. A yellow powder, also common on these slopes, has been identified as melanterite, an iron sulphate with a bitter, astringent taste. Several zones of concretions are present which distort the bedding of the shales somewhat. Within these concretions fossils are often found as nuclei.

Beneath the Graneros is a thick zone of shale and sandstone which has been named the Dakota formation. The Dakota outcrop widens from west to east across Ellsworth County due to the erosion by Smoky Hill River. Where the river enters at the west the outcrop is 4 miles wide, but eastward it expands until it takes in the whole width of the county along the east line. Excellent outcrops may be seen along the highway from Ellsworth to Brookville in western Saline County and southward from Ellsworth toward Lyons. The thickness of the Dakota formation varies greatly on account of differences in sedimentation and degree of erosion. Its probable maximum in Ellsworth County is close to 300 feet. The color of the sandstone layers is generally brownish, due to the presence of iron minerals in the cement. Beneath the Dakota is a great mixture of materials with most remarkable color variations. This phase is especially well developed along Highway 14 from Ellsworth southward toward Lyons. Shales and clays predominate, but occasional thin layers of lenticular sandstone are also present. This material has been mapped as a part of the Comanche system of Kansas by Twenhofel,[10] and may correspond to the so-called Mentor beds, or to his Belvidere formation. In well cuttings this interval varies considerably in thickness as well as in composition. Since oil companies do not collect samples from the upper part of the hole it is difficult to give additional data on this interesting problem.

Subsurface Stratigraphy

With the exception of a small area in the southeastern township of Ellsworth County, where a few feet of Permian red beds are exposed, no rocks older than the Comanche crop out. In well cuttings the red beds are called the Cimarron series, and are quite thick. In Range 6 W. the thickness is about 450 feet, and in Range 10 the thickness reaches 700 feet. Near the base of the Cimarron red beds is a zone of gypsum with dolomite below it, which is of great importance in subsurface studies because of its persistence. Core-drill holes are usually bored to this bed for structure control. It is always picked in the study of well cuttings for the first intimation regarding the relative

---

10. Kansas Geol. Survey, Bull. 9, pl. 1, opp. p. 12., 1924.

altitude of a wildcat well. In Range 6 this layer appears at a depth of about 200 feet, but farther west it is lower, and in Range 9 it is reported at 750 feet in some wells. This variation is partly accounted for by difference in surface elevation.

Red siltstones and clays abruptly give way to gray shales at the top of the Wellington formation of the Big Blue series. The Wellington may be divided into three members. The upper one is 150 feet thick and contains a thin red zone similar to the Cimarron shales. The middle or salt member is quite thick in Ellsworth County. In Range 6 W. it appears at a depth of about 850 feet and has a thickness of not quite a hundred feet. In Range 8 W. it appears at 800 feet to 1,050 feet and in Range 10 W. it is found from 1,150 feet to 1,400 feet in depth. The lower member is a uniform series of anhydrites and thin shales which are found over the whole county. They average slightly over 100 feet in thickness.

Lower Permian Rocks. The sequence from the Herington to the base of the Americus limestone is probably the most distinctive of any group of subsurface rocks. The Herington is easily picked in well cuttings because it is the first dolomitic limestone of any consequence in the section. Below it is a thin zone of gypsiferous shale which is followed by the Winfield limestone. Another shale, which is usually red, is underlain by the Ft. Riley limestone. This formation is an important one for subsurface correlation and is usually determined in well logs of wildcat wells. Its position is corroborated by the cherty base which corresponds to the Florence member. Another cherty limestone, the Wreford, lies about 75 feet lower. In the next 300 feet are thick limestones with thin red shale breaks down to the base of the Americus which can be identified by its abundance of fusulinids. The whole section is slightly over 600 feet thick. The Herington appears at a depth of 900 feet in the eastern ranges and at 1,500 feet in the western ranges of Ellsworth County.

Pennsylvanian Rocks. The average thickness of Pennsylvanian rocks is 1,900 feet. It is divisible into five lithologic units. The uppermost or Wabaunsee group contains clastic materials, among which red and green shales, micaceous sandstones, and a small amount of black shale near the middle are distinctive. This unit varies from 500 to 600 feet in thickness and is underlain by a limestone unit corresponding to the Shawnee group. The Topeka limestone at the top of the Shawnee is found at depths ranging from 2,200 feet in the east to 2,700 feet in the western part of the county. Thick limestones alternate with gray and black shales. In the basal Oread the Heebner black shale is especially prominent and persistent.

Another clastic unit, the Douglas, follows. It is characterized by red and green shales in which are thin beds of limestone. This unit is from 100 to 130 feet thick. The next limestone, the Lansing, is considered the most important horizon for correlation and structure mapping. In the eastern range it is found at a depth of about 2,700 feet, but in the western ranges it is somewhat deeper, around 3,100 feet. Thick limestones in which five distinct oolitic zones are conspicuous make up the Lansing-Kansas City-Bronson group of rocks. Most of the limestone is white in color and rather crystalline in texture. The thickness of the unit varies from 200 to 300 feet. Below this group red and green shales appear in the well cuttings. Near the base of the Pennsylvanian in some wells is much chert, and

in places a little sand. Such conglomeratic material is often referred to as the Pennsylvanian basal conglomerate. In certain areas only this much of the Marmaton is present. It may lie upon rocks of all ages down to the Arbuckle limestone.

Pre-Pennsylvanian Rocks. There is probably no county in Kansas where the pre-Pennsylvanian areal geology is so diverse and complicated as in Ellsworth County. Mississippian rocks are found only in the eastern ranges, and even there they are thin. Small local areas have been found in the western ranges where a remnant of Mississippian has been preserved. In addition to the great unconformity above the Mississippian there is also one at the base of this system. For, with the exception of a small area in the northeastern corner of the county, no Hunton limestone of Siluro-Devonian age has been found in wells drilled to date. Therefore, the Mississippian strata, or, where they are missing, the Pennsylvanian rocks rest directly upon Ordovician strata. It is at this place that the greatest and most confusing complications are introduced. Any of the Ordovician formations, including the Sylvan, Viola, Simpson and Arbuckle, may be found immediately beneath the Carboniferous rocks. In the following pages a few of these variations will be described.

Mississippian System. The Mississippian rocks consist of two lithologic types, a limestone above and a shale unit below. The limestone is usually eroded so that a much reduced thickness is found in Ellsworth County. In Range 6 from 50 to 70 feet of limestone has been found in some wells. In Range 7 the lime or its chert equivalent varies from zero to 300 feet. The most rapid variations are found in T. 16 S., R. 7 W. The Kinderhook shale is reported from Ranges 6 and 7 and certain parts of Range 8. It varies in thickness from a few feet to about 100 feet. In many cases it lies on the Sylvan shale and cannot be easily distinguished from the latter.

Ordovician Rocks. The Sylvan shale appears beneath the Carboniferous rocks in Range 6 and also in the three eastern ranges of Township 17 S. It is a greenish gray, splintery shale which varies from a few feet to probably a maximum of 90 feet. The Viola limestone beneath it is distributed over a wider area. It is reported from all wells in the county, with the exception of those in the southwestern three townships and a central area around the townsite of Ellsworth. Much interest attaches to this central area and a number of deep tests have yielded good data on its character. In one well the Arbuckle was found directly beneath the Pennsylvanian basal conglomerate while in other wells not many miles distant the Simpson and the Viola were found to be present. In sec. 19, T. 16 S., R. 8 W. the Mississippian rocks are also present above the full Ordovician sequence. The same contrast may be pointed out between wells in T. 16 S., R. 7 W. One well in section 7 has the Pennsylvanian lying on Arbuckle limestones, while another in section 13 has Chat, Kinderhook, and a full section of Ordovician strata.

The Viola limestone in Ellsworth County is a coarsely crystalline, white to gray, slightly dolomitic rock. Its average thickness is about 50 feet. The Simpson beneath it is characterized by green shales and sandy streaks. The sand is often coarse and the grains are likely to be well rounded and frosted as if fashioned by wind action. The thickness of the Simpson formation is from 30 to 90 feet. It rests with irregular contact upon the very coarse dolomitic limestone usually called "Siliceous lime" and correlated with the Arbuckle of Oklahoma.

Its presence is often indicated by oolitic chert and other chert of various bright colors, either above it or within it. A number of wells penetrated the Arbuckle and found it of greatly varying thickness. In a well in sec. 34, T. 17 S., R. 8 W., the top of the Arbuckle was found at 3,316 feet and the base at 3,823 feet, making a thickness of over 500 feet. Another well, located in sec. 29, T. 15 S., R. 8 W., found the Arbuckle high, with its top at 2,990 feet and its base at 3,100 feet, a thickness of 110 feet. In a third well in T. 15 S., R. 10 W., a thickness of 218 feet was found.

Reagan Sandstone. The basal sandstone of the Kansas section is variously called Basal sand, Reagan sand, or LaMotte sandstone. It has been drilled into at several points in Ellsworth County and completely penetrated at a few places. One of the wells mentioned above, in sec. 34, T. 17 S., R. 8 W., found the basal sand from 3,823 to 3,880, the total depth of the well. Another well, in sec. 29, T. 15 S., R. 8 W., found sand with dolomitic streaks and conglomerate from 3,102 to 3,204 feet. Below 3,204 feet a great mixture of materials consisting of quartz, feldspar, chlorite, muscovite and magnetite down to a depth of 3,593 feet indicated the presence of a very thick section of arkosic detritus above the pre-Cambrian rocks. By contrast one well in sec. 7, T. 17 S., R. 10 W. found no basal sand, and the Arbuckle was only 27 feet thick. The pre-Cambrian basement there lies at a depth of 3,397 feet. In the next township east a well in the southwestern part of section 14 found the Arbuckle at 3,211 feet with a thickness of over 500 feet, and the Reagan sand with a thickness of about 50 feet. The pre-Cambrian was found at 3,770 feet. In T. 17 S., R. 6 W., one well found the Reagan below a thickness of 315 feet of Arbuckle.

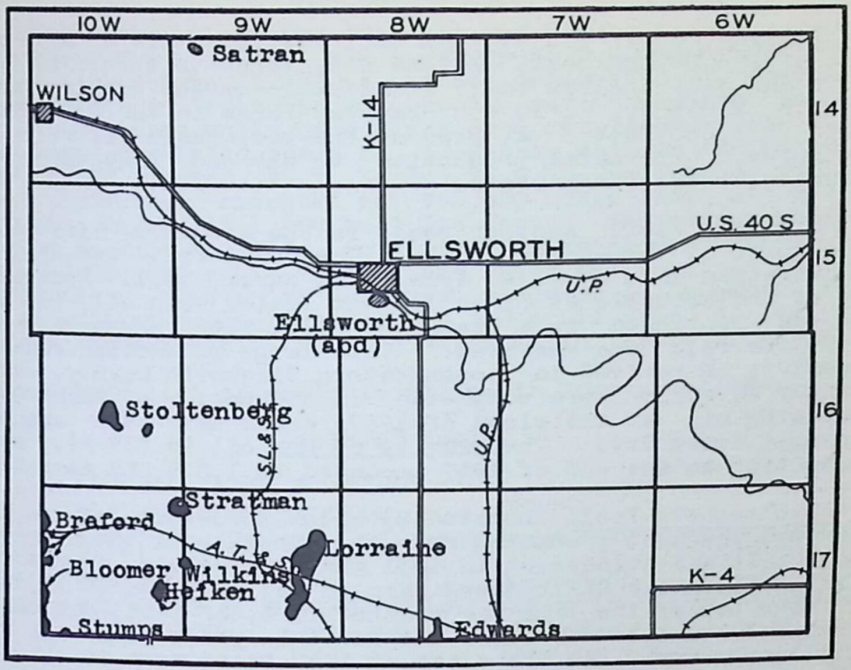
Structure

The surface rocks of Ellsworth County are not regarded as being very favorable toward delineating the subsurface structure. Therefore oil companies have resorted to core-drilling to outline areas favorable for exploration. Some of the prominent "highs" were originally located in this manner. Unfortunately not all of them proved productive. Some were perhaps too high. Deep drilling has revealed a complicated pattern of buried structural elements, the full significance of which is not yet apparent. However, it is evident that two lines of deformation cross each other in this county. One of them trends from northwest to southeast parallel to the great arch known as the Central Kansas Uplift or the Barton arch[11]. The influence of this line of deformation is clearly indicated by a series of "highs" from the northwestern corner of the county through Ellsworth townsite. The other line of folding trends almost at right angles. It is clearly illustrated by the line of "highs" which begins at Ellsworth townsite and passes through the Lorraine pool and thence south into Rice County. As time goes on drilling will more clearly define other lines of folding parallel to these two.

In general, the attitude of the Cretaceous rocks indicates a gentle dip toward the north, as is common in western Kansas.

---

11. Koester, Edward, Am. Assoc. Petroleum Geologists, Bull. vol. 19, p. 1405 ff., 1935.



Ellsworth County

The older rocks below the Cretaceous show a similarly gentle dip toward the west. The structure below the Pennsylvanian is evidently very complicated as indicated by the stratigraphic record.

History of Oil and Gas Development

At the present time there are 6 oil pools and 1 gas pool in Ellsworth County. The oil pools are all located in the southwestern townships. Up to the end of 1936 they had accounted for a total of over 8½ million barrels of oil. During the year 1937 an additional 2,350,957 barrels were produced. The first discovery was made in 1904 when shallow gas was found near Ellsworth, in T. 15 S., R. 8 W. This discovery came incidental to a search for salt and was not used except locally. The gas horizon was found at depths of around 1,100 feet in the lower Permian limestones close to the Winfield and Ft. Riley levels.

Heiken Pool. The first oil was discovered by Slick, Pryor, and Lockhart when they completed the No. 1 Heiken well in sec. 25, T. 17 S., R. 10 W. The well was started in June, 1930, and caused a flurry of excitement when gas was found at 2,500 feet in the Topeka and again at 2,980 feet in the Lansing limestone group. The flow was 6 million cubic feet. The well was then drilled down to the Arbuckle where 1,800 barrels of oil came into the hole at a depth of 3,222 to 3,243 feet. This well produced 8,467 barrels in 1931. During June of 1932 the second well was drilled in, and the production from both wells for 1932 amounted to 27,797 barrels. By the close of 1937, 11 wells had been drilled of which 5 produced oil, 4 were dry, and 2 had been abandoned. The total production up to that date was 285,713 barrels, from approximately 320 acres. The gravity of the oil tests 43° Be.

Wilkins Pool. The Wilkins pool is less than a mile northeast of the Heiken pool. It was discovered in April, 1934, when Smith and Ash drilled their first well on the Wilkins farm in sec. 13, T. 17 S., R. 10 W. Pay was found in the Arbuckle from 3,260 to 3,280 feet. At present the pool has 4 oil wells and 2 dry holes. The total production to the end of December, 1937, amounted to 125,664 barrels.

Stratman Pool. Another pool in the Arbuckle lies about a mile north of the Wilkins pool. The first well was drilled on the Stratman farm by J. A. Aylward in March, 1931. Reaching the top of the Arbuckle at 3,255 feet it filled with oil, but drilling was continued to a depth of 3,271 feet where a flow of 10,991 barrels was measured. This large production caused interest to be revived in southwestern Ellsworth County. Subsequently 26 wells were completed in the pool, of which 17 were producing oil at the close of 1937 and 2 have been abandoned, the rest being dry. The gravity of the oil is 43° Bé., and the production to the end of 1937 amounted to 1,847,867 barrels.

Stoltenberg Pool. Located 2½ miles northwest of the Stratman pool and also producing from the Arbuckle is the Stoltenberg pool. It was discovered in 1931 when Tom Palmer completed the first well on the Stoltenberg farm in sec. 21, T. 16 S., R. 10 W. The top of the lime was reached at 3,333 feet, but drilling continued to 3,347 feet. The initial production was 2,400 barrels per day. At the close of 1937 there were 16 oil wells, 2 dry holes and 3 abandoned wells. The total production amounts to 2,058,180 barrels, of which 467,000 barrels were produced in 1935, 213,579 barrels in 1936, and 213,431 barrels in 1937.

Breford Pool. A fifth Arbuckle pool was found by Slick, Pryor and Lockhart in sec. 7, T. 17 S., R. 10 W. on September 10, 1932. At a depth of 3,385, some 16 feet below the top of the lime, oil started to come into the hole. More was found at 3,392 to 3,395 feet, but drilling continued to 3,407 where the well stopped in pre-Cambrian rock. During 1932 the well produced 2,500 barrels which was run to storage. This pool now extends over into Barton County and has 14 producing wells and 4 dry holes. One of the wells drilled in Barton County by the Transwestern Oil Company, No. 3 Myers, produces from the Kansas City "lime" at 3,150 to 3,180 feet. The gravity of the oil averages 45° Bé. Production to the close of 1937 amounted to 661,464 barrels from about 700 acres.

Lorraine Pool. The largest pool in the county lies about 6 miles east of the others. It was opened when Twin Drilling Oil Company found production in the Arbuckle at 3,200 to 3,205 feet. The well was completed in November, 1934, with an initial production of 526 barrels. Five months later the south part of the pool was opened by Carter Oil Company when the first successful well on the Teubner farm was drilled. Since then over 90 wells have been completed and the area which is productive covers 5,500 acres. Some oil is being recovered from the Lansing-Kansas City "lime" at a depth of 2,953 to 3,060 feet. In March, 1935, a flow of gas was found in the Wabaunsee group, at 2,200 to 2,208 feet. The structure of the pool is anticlinal.

Satran Gas Field. The only gas field in Ellsworth County is in sections 5 and 6, T. 14 S., R. 9 W. The first well drilled was the S. L. Milton and E. M. Site's No. 1 Frank Kasper in the SE. center NE. ¼, sec. 6. The well had shows of gas at 325 feet

and 1,266 feet, 2 million feet of gas at 1,436 feet, 750,000 ffeet of gas at 2,145 feet and more gas at 2,500 and 2,805 feet. The well bottomed in "lime" at a total depth of 3,710 feet. It was completed on September 30, 1931, and abandoned as a dry hole. Three other wells have since been completed. The Viking Oil Company completed their No. 1 Satran well in the center of the NW. ¼, SW. ¼, sec. 5, T. 14 S., R. 9 W., on October 5, 1932. Initial production amounted to 750,000 cubic feet of gas obtained at a depth of 1,380 to 1,385 feet. The second well was completed on June 6, 1934, in section 6 and had an initial production of 700,000 cubic feet of gas which was obtained at 1,258 to 1,384 feet. The third well was completed in December, 1935, with an initial production of 750,000 cubic feet of gas, obtained at approximately the same depth as in the other wells.

A complete list of pools in Ellsworth County follows:

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
BREFORD 17-17-10	Sept.,1932 700 acres Sept.,1937	14 661,464 Bbls. 1	3368-3395 Arbuckle 3150-80 Lansing - K.C.	4 dry Grav.45
ELLSWORTH 29-15-8	Apr.,1935	0	2195-2200 Wabaunsee	Gas shut in
HEIKEN 25-17-10	Oct.,1930 320 acres	5 285,713 Bbls.	3222-43 Arbuckle	4 dry 2 abd Grav.43
LORRAINE 13-17-9	Nov.,1934 5500 acres	96 5,872,069 Bbls.	3200-05 Arbuckle 2953-3060 Lansing - K.C.	8 dry Grav.46 3 abd
STOLTEN-BERG 21-16-10	June,1931 600 acres	16 2,058,180 Bbls.	3333-47 Arbuckle	2 dry 3 abd Grav.44
SATRAN 5-14-9W	Oct.,1932	3	1285-90 Herington	Gas shut in
STRATMAN 12-17-10	Mar.,1931 600 acres	17 1,847,867 Bbls.	3255-71 Arbuckle	7 dry 2 abd Grav.43
WILKINS 13-17-10	Apr.,1934 80 acres	4 125,664 Bbls.	3260-80 Arbuckle	2 dry Grav.46

Important Test Wells

Walker No.1 Remley, in sec. 23, T. 14 S., R. 7 W., top of Ft. Riley, 1,315; Lansing, 2,858; Mississippi lime, 3,418; Kinderhook, 3,477; Viola, 3,556 feet.

Hinkle No.1 Schultz, in sec. 9, T. 14 S., R. 8 W., top of Anhydrite, 475; Lansing, 2,950; Mississippi lime, 3,405 feet.

Sites No.1 Kasper, in sec. 6, T. 14 S., R. 9., top of Ft. Riley, 1,382; Lansing, 2,819; Mississippi lime, 3,223; Viola,

3,360; Simpson, 3,520; Arbuckle, 3,567 feet.

Sinclair No.1 Brach, in sec. 17, T. 14 S., R. 10 W., top of Lansing, 2,830; Basal conglomerate, 3,160; Arbuckle, 3,223 feet.

Keys No.1 Sheridan, in sec. 21, T. 15 S., R. 6 W., top of Ft. Riley, 1,135; Lansing, 2,745; Kinderhook, 3,270; Viola, 3,507; Arbuckle, 3,790; total depth, 4,007 feet.

Lario No.1 Bickerdike, in sec. 29, T. 15 S., R. 8 W., top of Topeka, 2,315; Lansing, 2,590; Conglomerate, 2,930; Arbuckle, 2,991; Reagan, 3,102; total depth, 3,595 feet.

Wilcox No.1 Maixner, in sec. 9, T. 15 S., R. 10 W., top of Ft. Riley, 1,405; Lansing, 2,815; Viola, 3,225; Simpson, 3,260 ; Arbuckle, 3,285; total depth, 3,503 feet.

Empire No.1 Dolechek, in sec. 7, T. 16 S., R. 7 W., top of Lansing, 2,527; Conglomerate, 2,896; Arbuckle, 2,936; total depth, 2,947 feet.

Pryor and Lockhart No.1 Gregory, in sec. 19, T. 16 S., R. 8 W., top of Anhydrite, 590; Ft. Riley, 1,320; Topeka, 2,395; Lansing, 2,790; Conglomerate, 3,124; Mississippi lime, 3,190; Kinderhook, 3,258; Viola, 3,274; Simpson, 3,225; Arbuckle, 3,380.

Ramsey No.1 Gregory, in sec. 25, T. 16 S., R. 9 W., top of Basal conglomerate, 3,197; Viola, 3,220; Arbuckle, 3,317; total depth, 3,323 feet.

Reynolds No.1 Jirek, in sec. 10, T. 16 S., R. 10 W., top of Lansing, 2,545; Conglomerate, 3,302; Simpson, 3,345; Arbuckle, 3,375; total depth, 3,380 feet.

Gypsy No.1 Frevert, in sec. 21, T. 16 S., R. 10 W., top of Arbuckle,3,342; Reagan, 3,805; pre-Cambrian, 3,883; total depth, 3,941. Water disposal well.

Texas No.1 Sherman, in sec. 16, T. 17 S., R. 6 W., top of Anhydrite, 205; Ft. Riley, 1,165; Topeka, 2,220; Lansing, 2,725; Mississippi lime, 3,250; Kinderhook, 3,320; Sylvan, 3,495; Viola, 3,525; Simpson, 3,670; Arbuckle, 3,710; Reagan, 4,025; total depth, 4,042 feet.

Elwell No.1 Campbell, in sec. 20, T. 17 S., R. 7 W., top of Anhydrite, 345; Ft. Riley, 1,310; Lansing, 2,992; Kinderhook, 3,255; Sylvan, 3,280; Viola, 3,370; Simpson, 3,413; Arbuckle, 3,475; total depth, 3,511 feet.

Morgan No.1 Andrews, in sec. 3, T. 17 S., R. 8 W., top of Anhydrite, 310; Ft. Riley, 1,300; Lansing, 2,760; Conglomerate, 3,157; Kinderhook, 3,176; Viola, 3,207; Simpson, 3,348; Arbuckle, 3,398; total depth, 3,400 feet.

Davis No.3 Edwards, in sec. 34, T. 17 S., R. 8 W., top of Anhydrite, 385; Ft. Riley, 1,355; Topeka, 3,440; Lansing, 2,855; Conglomerate, 3,212; Viola, 3,255; Simpson, 3,290; Arbuckle, 3,328; Reagan, 3,823; total depth, 3,880 feet. Water disposal well.

York State No.1 Koestle, in sec. 12, T. 17 S., R. 9 W., top of Lansing, 2,825; Conglomerate, 3,166; Simpson,3,180; Arbuckle, 3,230; total depth, 3,235 feet.

Empire No. 12 Rolfs, in sec. 14, T. 17 S., R. 9 W., top of Simpson, 3,197; Arbuckle, 3,211; Reagan, 3,740; granite, 3,770; total depth, 4,045 feet.

Empire No. 1 Kroesch, in sec. 33, T. 17 S., R. 9 W., top of Anhydrite, 397; Herington, 1,290; Ft. Riley, 1,403; Topeka, 2,460; Lansing, 2,878; Conglomerate, 3,195; Simpson, 3,235; Arbuckle, 3,260; total depth, 3,274 feet.

Smith and Ash No. 3 Heiken, in sec. 25, T. 17 S., R. 10 W., top of Ft. Riley, 1,435; Arbuckle, 3,261; total depth, 3,343 feet.

FINNEY COUNTY

Areal Geology

Finney is the largest county in western Kansas, covering 36 townships or 1,296 square miles. A considerable variety of rocks is exposed at the surface. Through the south center along the banks of Arkansas River is a strip of Recent sand which was deposited by the river during flood stages. Paralleling the river on the south side is a wide belt covered by Quaternary dune sand. On the north side of the river sand and gravel beds of Tertiary age cover all except the northeastern part of the county. These geologically young rocks lie on an unevenly eroded surface of Cretaceous strata.

Cretaceous Rocks. The youngest Cretaceous rocks exposed in Finney County appear on the surface in the northern tier of townships, about 6 miles north of Eminence. They belong to the lower part of the Niobrara formation, and consist of chalky shale and chalk (Hays limestone). On account of their resistance to erosion the chalk beds produce low bluffs in northeastern Finney County. From Eminence eastward a small area is covered with shales of the Carlile formation which underlies the Niobrara, but is also of Cretaceous age. In the upper portion these shales are gray to black in color and rather fissile. They contain several zones of spherical septarian concretions.

Subsurface Stratigraphy

In deep wells drilled for oil or gas the Carlile shales are found to be approximately 300 feet thick and to rest upon another chalky zone called the Greenhorn limestone. It in turn lies upon dark shales of slight thickness, the Graneros formation. The most distinctive rock is the next lower, the Dakota sandstone, which in this county lies at a depth of about 500 below the surface. It consists of coarse sandstones with interbedded shale layers. The thickness is 350 to almost 400 feet.

Permian Rocks. Below the Dakota sandstone, red beds of Permian age have been found in all wells as yet drilled in the county. These are red clays and red siltstones of varying texture, in which several prominent zones of gypsum or anhydrite appear. The uppermost one of these, the Blaine, lies at a depth of 1,400 feet, and the lower one, usually called the Enid anhydrite or the Cimarron anhydrite by geologists, lies about 600 feet lower. Several hundred additional feet of the Cimarron red beds lie below. The gray shales which appear in well cuttings below the Cimarron series belong to the Wellington formation. They contain salt which in Finney County has a thickness of 100

feet near the middle. Below the salt other gray shales and much anhydrite appear, down to the first dolomite, the Herington.

It is interesting to note that the sequence from the Herington down to the Americus, often referred to as the Big Blue, is present in Finney County in its characteristic lithology. Much limestone or dolomite is present in the 600 feet of section. Near the top, and especially above the Ft. Riley limestone, is much red shale and gypsum. Below the Ft. Riley are two chert zones, one at the Florence and the other at the Wreford level.

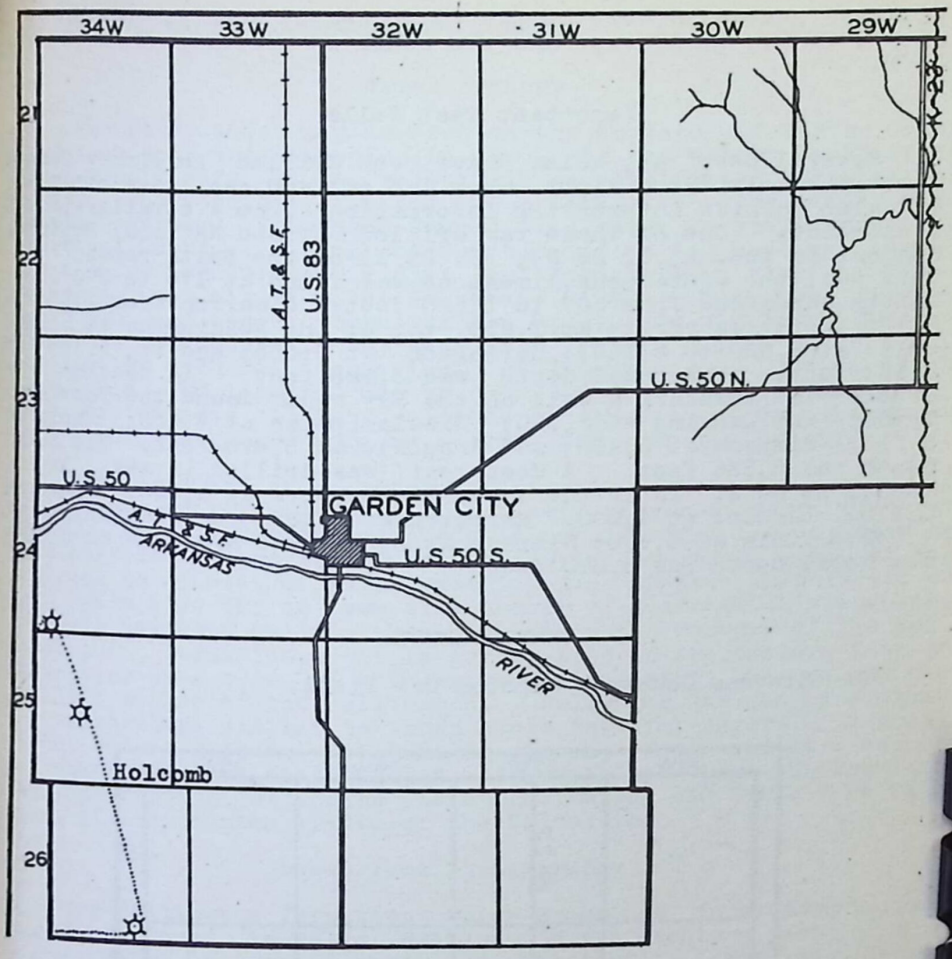
Pennsylvanian Rocks. The next older rocks belong to the Pennsylvanian system, which here is characterized by a preponderance of limestones. The upper or Wabaunsee unit is very limy, but contains thin red shale breaks and some thin sandy zones. The Topeka limestone lies at a depth of about 3,500 feet. It forms the topmost member of an important group of limestones, the Shawnee group. Much chert in the lower part of the Shawnee serves to identify the Oread portion of the formation. The whole interval from the Topeka to the base of the Oread is 300 feet in most places in this county. The Douglas group can also be recognized in well cuttings. Below it, the Lansing-Kansas City-Bronson group of limestones is very prominent. A great deal of chert is present in this section which is about 485 feet thick. The shaly zone below the Bronson is probably the Marmaton of eastern Kansas, but may include also the equivalent of the Cherokee formation. Gray sandy shales, thin limestones, and much red rock characterize this part of the section. A basal conglomerate some 20 feet thick has been found in certain wells.

Pre-Pennsylvanian Rocks. In all wells drilled up to the end of 1937 the "Mississippi lime" was found below the Pennsylvanian rocks. It consists of white, fairly coarse-textured limestone at the top; lower down three cherty zones may be distinguished. The limestone lies at a depth of about 4,750 feet and extends down to perhaps 5,400 feet. It rests upon the eroded surface of the much older Viola limestone. The latter is about 170 feet thick and rests upon the Simpson which in turn lies upon the Arbuckle dolomite.

Structure

The structure of the surface rocks in Finney County indicates a regional dip toward the northeast[12] according to many shallow wells drilled to the top of the Dakota sandstone. The amount of dip from southwest to northeast across the county is about 500 feet, which is a rate of about 10 feet per mile. Additional information regarding structure must be secured by core-drilling or geophysical methods. During the years from 1932 to 1937 a number of seismograph parties have been working in Finney County. As a result of their findings much land has been leased by several major oil companies. In due time this will be tested, but until then, the details of subsurface structure will remain unknown.

12: Kansas Geol. Survey, Bull. 11, pl. 7, p. 85, 1926.



Finney County

History of Gas Development

Up to the time of writing this report five separate gas areas had been discovered in and near Finney County. According to a ruling of the Nomenclature Committee these areas are all to be joined into one field, the name of which will be the Holcomb gas field. The first discovery of gas was made in December, 1932, when Denham and Myers drilled their No. 1 Brown in sec. 16, T. 25 S., R. 34 W. In this test well five million cubic feet of gas were found at a depth of 2,635 to 2,774 feet in several limestones of the Big Blue series. It appears probable that the Herington, Winfield, and Ft. Riley limestones are all likely to be porous in this part of Kansas, and are the producing formations. In June, 1936, the Lone Star Gas Company drilled a successful well on the Hamlin lease in sec. 31, T. 24 S., R. 34 W. In this well the gas was found at depths between 2,418 and 2,700 feet. In August of the same year Helmerick and Payne completed their first well on the Jones lease in sec. 34, T. 26 S., R. 34 W. for an initial production of 3¼ million cubic feet. The top of the Herington was found at 2,507 feet, and the principal pay extends from 2,749 to 2,755 feet. In 1937 two ad-

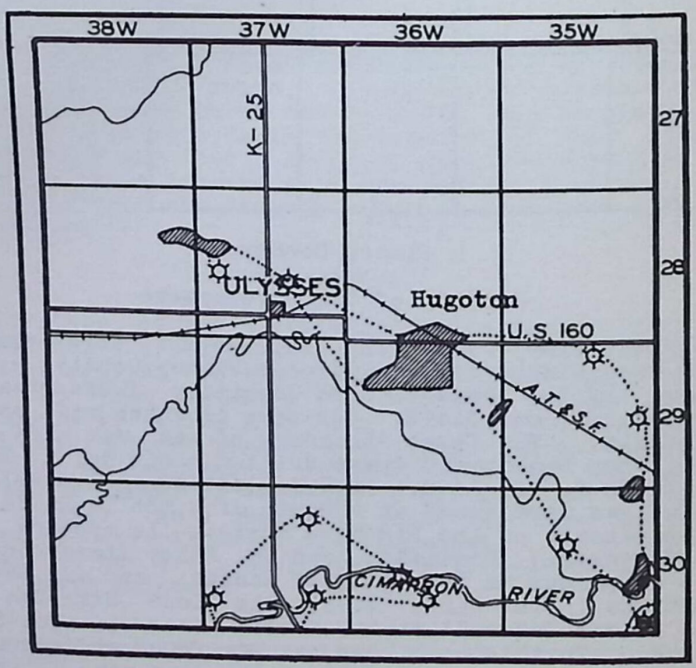
ditional gas wells were completed in Kearny County, one in sec. 32, T. 25 S., R. 35 W., and the other in sec. 36, T. 26 S., R. 35 W.

Important Test Wells

Several deep dry holes have been drilled in Finney County which not only throw light upon the oil and gas possibilities, but also furnish interesting information from a stratigraphical standpoint. One of these was drilled by the National Refining Company in sec. 2, T. 22 S., R. 29 W. on the Smith ranch. In this well the Cretaceous limestone was found at 170 to 370 feet; Dakota sandstone from 387 to 1,180 feet; Cimarron from 1,180 to 2,130 feet; anhydrite at 1,910, top of the Wellington at 2,130; salt at 2,320 to 2,380; Herington at 2,555; and Ft. Riley at 2,690 feet. The total depth was 3,325 feet. In section 24 of the same township a well on the Ely ranch found the Topeka at 3,460; the Lansing at 3,950; Mississippian at 4,655; Viola at 5,315; Simpson at 5,460; and Arbuckle at 5,470 feet. The total depth was 5,556 feet. A deep test was drilled in sec. 13, T. 23 S., R. 30 W. In it the anhydrite appears at 1,995; Topeka at 3,515; Lansing at 4,000; Marmaton at 4,485; Mississippian at 4,742; Viola at 5,405; Simpson at 5,580; and Arbuckle at 5,608; the total depth was 5,872 feet.

GRANT COUNTY

See Stevens County - Hugoton Gas Field.



Grant County

HARVEY COUNTY

Areal Geology

The rocks which may be seen on the surface of Harvey County are Paleozoic and Cenozoic in age. In the western half of the county only soft, loose, relatively unconsolidated materials appear. The youngest of these are probably the dune sands which extend eastward from Reno County and cover a small area just north of Burrton. South of Burrton and as far east as Sedgwick is a large area of nearly flat land underlain by river sands and gravels, the alluvium of Arkansas River. Much of central, northern, and northwestern Harvey County is similarly flat and is likewise underlain by sand and gravel. This material is called the McPherson formation, or "Equus beds". It varies in thickness and locally may be over 100 feet thick. Because of its perviousness it is a valuable storehouse of drinking water and should be looked upon as a great asset to the county.

The sands and other materials described above belong to the Quaternary system and rest upon a very uneven surface of older rock. East of Newton and Sedgwick this older rock appears on the surface. Where it is not too deeply covered by soil, it may be seen to consist of soft, greenish-gray shale. Thin layers of red shale also may be seen at a number of places. This sequence of beds has been called the Highland shale member of the Wellington[13] formation. It is interrupted in the eastern tier of townships by a zone of thin white chalky layers now called the Carlton member of the Wellington. Below the Carlton are other greenish clays similar to those above the limy layers. A prominent bed of gypsum, the Annelly gypsum, crops out at a number of places in this eastern tier of townships. The thickness of the outcropping Wellington is approximately 230 feet. It is a part of the Permian system of the Paleozoic.

Subsurface Stratigraphy

The Wellington formation which crops out in eastern Harvey County is found in wells drilled in the western part of the county where Quaternary sands and gravels form a blanket. There the Wellington is found in some places to have a total thickness of nearly 500 feet. The upper part consists of gray shales with red layers prominent locally. The salt which is present farther west seems to be missing entirely in this county, for it is not reported in well logs. Very probably it was dissolved away by circulating waters when this region was exposed to erosion between Permian and Cretaceous time. The lower part of the Wellington contains alternating layers of greenish-gray shale and anhydrite. The latter is especially prominent in the lowest 125 feet of the formation.

The sequence of rocks from the Herington to the base of the Americus (often called the Big Blue series) can be identified from well cuttings. It is characterized by limestones with thin red shale breaks. About the middle of the section are two cherty zones, one of which is the Florence and the other the

---

13. Municipal Univ. Wichita, Univ. Studies, Bull. 2, May, 1937.

Wreford. Fusulinids are abundant in the basal limestone, and it therefore forms an excellent marker for the top of the Wabaunsee and of the Pennsylvanian.

In the Pennsylvanian system five units may be differentiated in well cuttings. The uppermost is the equivalent of the Wabaunsee group. It has a thickness of approximately 650 feet, and is characterized by the predominance of shale. Thin sandy layers are present at several horizons. In the western part of the county there is also a great deal of black shale in the Wabaunsee. The Topeka at the top of the Shawnee group is fairly prominent in the subsurface geology. The Shawnee as a whole is about 350 feet thick. It contains thick layers of limestone within which are considerable dark shale and some sandstone. In the western tier of townships black and green shale are conspicuous. The 150 feet of section below the Shawnee consists of shale and sandstone. It has been correlated with the Douglas group of eastern Kansas. The two lenticular sandstones in this group may become very thick, in which case the upper is called the Ireland sandstone and the lower the Stranger sandstone. They are often separated by a fairly thick limestone, the Haskell, which may be as much as 40 feet thick. The shale layers are generally dark to black, or greenish gray. Probably the most important layer for correlation purposes is the topmost limestone of the Lansing group. It is found at depths varying from 2,200 feet in the eastern part of the county to 2,500 feet in the western part. The Lansing forms the upper part of a rather persistent limestone zone that corresponds to the Lansing, Kansas City, and Bronson groups of eastern Kansas. The middle portion (Kansas City) in many places contains much black shale. This is especially the case in Range 2 West, where some wells show as much as 150 feet of black shale. The Bronson is predominantly limestone. The appearance of red and green shales in well cuttings below the Bronson indicates the presence of the Marmaton group. Because of an unconformity at the base, this group varies in thickness. The interval from the top of the Lansing to the top of the Mississippian is close to 700 feet in most parts of the county.

Mississippian Rocks. Rocks of Mississippian age seem to be present in all parts of Harvey County, but the thickness varies greatly. This is due to the fact that the "Mississippi lime" was exposed to a long period of erosion before the Marmaton rocks were laid down upon it. Solution of the limestone left behind a layer of insoluble materials, consisting of hard, partly decayed, chert fragments embedded in red clay. In the eastern tier of townships the "chat" or "Mississippi lime" is found at depths of approximately 2,875 feet. The thickness ranges up to 325 feet in certain wells, but may be much less. In Range 1 East the depths approximate 2,900 to 3,000 feet and the thickness ranges from 15 to 300 feet. In Ranges 1 West and 2 West the depths are similar and the thickness is commonly around 300 feet. In the western tier of townships the presence of a pronounced subsurface anticline causes the limestone to become very thin again, so that it may be only 25 feet thick over the crest of the anticline, but 250 feet or more thick off the structure. The depths to the "Mississippi lime" in this part of the county vary from 3,150 feet to 3,380 feet according to variations in elevation and structure.

Below the cherty limestone of this system is a varying thickness of greenish-gray and black shale. This is the Kinderhook formation. In some wells it has a thickness of over 100

feet. At the base is a very thin layer of sandstone which is correlated with the Misener sand of Oklahoma. It is especially well developed in the western part of the county. Where the Hunton limestone is missing, as in the southeastern part of the county, this thin sandy zone is the only distinguishing layer between the Kinderhook and the Sylvan shale.

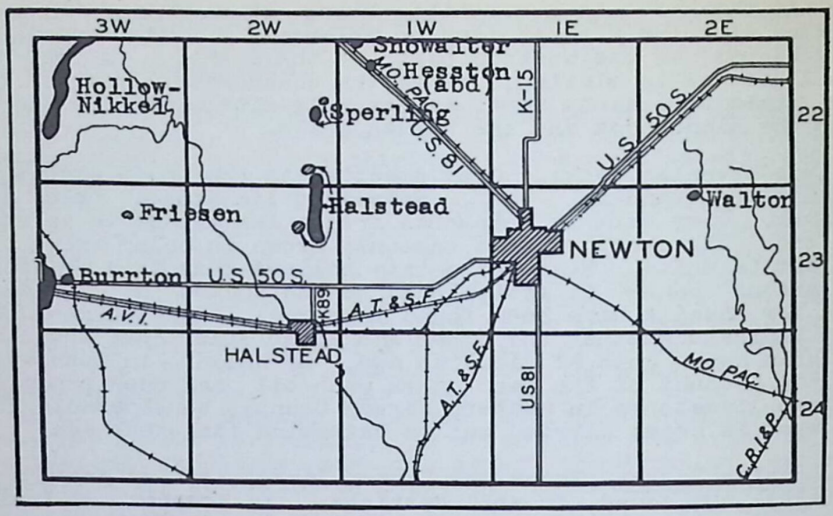
Siluro-Devonian Rocks. Over practically the whole extent of the county are granular, buff, dolomitic limestones below the Kinderhook. They vary in thickness from a few inches to as much as 90 feet. The upper part is commonly brown in color while the lower part is white. Many geologists believe that this sequence of calcareous rocks is equivalent to the Hunton of Oklahoma. While a few fossils have been found in cores, these do not definitely indicate whether the upper and lower limestones are both of Devonian age, both of Silurian age, or belong in both systems. On account of the fact that much oil has been produced from these limestones in western Harvey County, considerable research work is being carried out to determine its exact age.

Ordovician Rocks. Below the Hunton limestone some greenish-gray shales are found in well cuttings. On account of their stratigraphic position they are correlated with the Sylvan shale of Oklahoma. In Range 1 E. this formation appears at depths of about 3,480 feet, while in Range 3 W. it lies about 100 feet deeper. The thickness is usually inconsiderable with an average of probably 30 to 60 feet. Below it is a coarse white to gray limestone, the Viola. This lithologic unit is found at depths from 3,300 feet in eastern Harvey County to about 3,500 feet in western Harvey County. Wells in synclines have found it as low as 3,900 feet. The thickness varies from 14 to 50 feet in Range 1 E. and from 20 to 40 feet in Range 3 W. The appearance of rounded and frosted sand grains beneath it make correlation fairly simple. The sandy material belongs to the Simpson formation (sometimes called "Wilcox"). As a rule the sandy zone is thin, and is underlain by a thicker zone of pea-green shales. Grains of sand are found in some places embedded in this shale as if blown in by the wind while the mud was forming in shallow sea water. The Simpson is found at depths varying from 3,525 feet to 3,700 feet or even lower. The thickness commonly ranges from 40 to 90 feet.

The very thick dolomites that lie below the Simpson are now correlated with the Arbuckle limestone of Oklahoma. In one well in sec. 32, T. 22 S., R. 1 E., over 500 feet of cherty dolomites were found, indicating that this formation probably has a great thickness in Harvey County. Up to the time of writing this report no well had penetrated the Arbuckle in Harvey County.

Structure

Because of the general absence of hard persistent beds at the surface it is difficult to work out the structure of the rocks. Many oil companies resorted to core-drilling during the years from 1920 to 1930 with rather striking success. In this manner the buried anticline in the western part of the county where the Hollow and Nikkel pools are located was discovered. Other smaller anticlines and domes were found in more easterly portions of the county. One of these trends southward through the eastern part of Range 2 W. Others still await testing by the drill.



Harvey County

History of Oil and Gas Development

The first oil to be discovered in Harvey County was found when the Newton Oil Corporation drilled its first well on the Wetschensky farm in sec. 4, T. 23 S., R. 2 E. It was completed in October, 1923, at a depth of 2,430 to 2,450 in the Kansas City limestone. This depth corresponds to a stratum in the Kansas City group of 240 feet below the top of the Lansing. Further exploration in this area was disappointing. A total of 18 wells were drilled in section 4 and adjoining sections, of which 8 proved to be dry. This pool, the Walton, was abandoned in 1936 after producing a total of 123,000 barrels. The production for 1935 was 750 barrels. In 1937 renewed drilling was going forward in the pool but as all deeper horizons have already been tested there appears to be very little hope for large production in the future.

Hesston Pool. Since no other test wells in the two eastern ranges were successful in finding oil, attention was directed to the three western ranges of the county. Two small pools have been opened in the northwestern part of T. 22 S., R. 1 W. Only a mile separates the two, but as there is no present indication that they will merge it is necessary to describe them separately. The first of these is named after Hesston and was discovered in August, 1934, when Hollow drilled the first well on the Sommerfelt farm in section 8. Oil was found in the Hunton limestone at a depth of 3,310 to 3,317 and also 3,355 to 3,356 feet. The initial production amounted to 247 barrels per day of oil with a gravity of 40° Bé. At the time of writing there are two wells in the pool draining an area of about 40 acres. The total production to the end of 1937 was 12,000 barrels.

Showalter Pool. The second pool in the vicinity of Hesston was named after the farm on which the first well was drilled. It was completed in April, 1935, at a depth of 3,298 to 3,320 feet in the Hunton limestone. The oil tested 35° Bé. Two offset wells were drilled subsequently, both being capable of small production. Up to the end of 1936 this pool produced a total of

559,968 barrels; 40,445 barrels in 1936, and 19,523 barrels in 1935. In 1937 the pool was joined with the Graber pool of McPherson County.

Sperling Pool. About 5 miles southwest of the Hesston pool lies the Sperling pool, so named because the first well, drilled by the Imo Oil and Gas Company, was located on the Sperling farm in sec. 24, T. 22 S., R. 2 W. It was completed in February, 1935, for a potential of 1,624 barrels of oil and 22 million cubic feet of gas. As in the pools farther north, the producing rock is the Hunton limestone. The producing zone lies at a depth of 3,279 to 3,327 feet. The gas, however, comes from the "chat" at the top of the Mississippian system. At the present time there are 8 oil wells, 10 gas wells and one dry hole in the pool. One of the oil wells produces from the "Wilcox" or Simpson sand found at a depth of 3,447 to 3,463 feet. This formation may supply additional amounts of oil when the Hunton is exhausted. The total production to the close of 1936 has been 652,685 barrels of which 21,502 were produced in 1936 and the remainder during 1935. The production for 1937 was 31,882 barrels. The area drained covers about 500 acres. The gravity of the oil is 35° Bé.

Halstead Pool. Another pool lies on the same trend about 4 miles south of the Sperling pool. This was named after the town of Halstead which lies about 4 miles farther south. The discovery well was drilled by the Shell Petroleum Company in August, 1928, on the Haury farm in sec. 11, T. 23 S., R. 2 W. It found an initial production of over 8 million cubic feet of gas in the "Mississippi lime" at a depth of 2,961 to 2,972 feet. The first oil was found when the McPherson Oil and Gas Company drilled Palmer No. 1 well in sec. 36, T. 22 S., R. 2 W. This well penetrated the "Mississippi lime" from 2,970 to 3,002 feet, and secured an initial production of 240 barrels of oil a day testing 31° Bé gravity. Subsequently a total of 40 wells were drilled on 1,200 acres. Of these 22 are oil wells, 10 are dry and 8 are abandoned. Production from the wells in the Halstead pool amounted to a total of over 636,656 barrels at the close of 1937. During 1936 the production was 81,750 barrels and during 1937 it was 320,656 barrels.

Hollow - Nikkel Pool. The largest as well as the most interesting pool in Harvey County lies in the northwestern township. In December, 1931, Frank Hollow drilled the No. 1 Fee well in sec. 20, T. 22 S., R. 3 W. and found oil at a depth of 3,509 feet in a limestone of unknown age. In July the well was deepened 3 feet and made a potential of 1,456 barrels per day. It was deepened again the following month to a total depth of 3,514 feet, where it was rated as having a potential of 520 barrels. Later drilling revealed the fact that a new producing horizon had been tapped in this well, and it thus has the distinction of being the first commercial oil well to produce from the Hunton limestone in Kansas. The good showing of this well caused 13 other wells to be drilled during 1932, and by the close of 1936 no less than 140 producers had been drilled. Some of these wells found production in other horizons, for instance, the Lansing limestone at 2,499 to 2,520, the Mississippian "chat" at 3,195 to 3,208, the "Wilcox" sand at 3,500 to 3,515. In October, 1935, one well was completed in the Arbuckle in sec. 7, T. 22 S., R. 3 W. The first chat well, the Frost Drilling Company No. 1 Martens, was a surprise and flowed "wild" at a rate of 5,000 barrels per day. It found production at a depth of 13 feet within the chat.

The production from this pool has been very great. In 1935 it produced 2,833,626 barrels; in 1936, 1,354,600 barrels; and in 1937, 1,216,985 barrels. The grand total to the end of 1937 amounts to 16,333,585 barrels. This pool is one a line of prominent buried anticlines which extends from a point east of McPherson southwestward through the Voshell, Hollow-Nikkel, Burrton and Stone pools. Next to the series of anticlines overlying the famous Granite Ridge which passes through El Dorado, this trend is the most prominent and the most prolific so far uncovered in the state.

Burrton Pool. In recent years additional drilling in an effort to extend the limits of the Burrton pool of Reno County has resulted in considerable production along the county line west of the town of Burrton. This is included with the production from Reno County, and the reader is referred to the section on Reno County for a full discussion of the characteristics of the Burrton pool.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH PRODUCING HORIZON.	REMARKS
FRIESEN	July,1927	1	3256-70	Gas
10-23-3			Chat	
HALSTEAD	Apr.,1929	0	2961-72	Gas
36-22-2	320 acres		Chat	Abd.
11-23-2	Aug.,1928	20	2972-3005	Oil 10
	1200 acres	636,656 Bbls.	Chat	Grav 35° Bé
ESSTON	Aug.,1934	2	3310-17	Grav.40
-22-1	40 acres	12,000 Bbls.	Hunton	
HOLLOW-				
NIKKEL	Dec.,1931		2499-2520	
30-22-3	1500 acres		Lansing - K.C.	
19-22-3			3195-3208	
		132	Chat	
20-22-3			3507-3509	Grav.43
		16,333,585	Hunton	
19-22-3		Bbls.	3500-3514	
			Wilcox	
			Arbuckle	
SPERLING	Jan.,1935	10	2955-3142	Gas
24-22-2	500 acres		Chat	
23-22-2		7	3279-3345	Oil
		94,567 Bbls.	Hunton	Grav.35
23-22-2		1	3447-3463	Oil
			Wilcox	
WALTON	Dec.,1923	0	2440	Abd.
4-23-2E	80 acres	123,000 Bbls.	Lansing - K.C.	Grav.35

Pipe Lines and Refineries

Six different pipe line companies transport oil from the Hollow-Nikkel pool. These are the Magnolia, Shell, Globe, Derby, Sinclair, and Skelly. The oil is taken to various refineries in Sedgwick, Butler, and other counties. Oil from the Halstead pool is transported by the Magnolia and the Shell Oil com-

panies. The former also takes oil from the Hesston and the Sperling pools. Some of the oil from the Sperling pool is purchased by the Derby Oil Company and run to their Wichita refinery.

Important Test Wells

Saco No.1 Guthrie, in sec. 8, T. 22 S., R. 2 E., top of Lansing, 2,187; Mississippi lime, 2,843; base, 3,060; Hunton 3,065; Viola, 3,270; Arbuckle, 3,388.

Flanigan No.1 Sheridan, in sec. 32, T. 22, R. 1 E., top of Topeka, 1,710; Lansing, 2,305; Mississippi lime, 2,951; base, 3,272; Misener, 3,395; Viola, 3,402; Simpson, 3,528; Arbuckle, 3,606; total depth, 4,120 feet.

Bradley No.1 Neufeldt, in sec. 17, T. 22 S., R. 1 W., top of Mississippi lime, 2,975; base, 3,325; Hunton, 3,364; Viola, 3,473; Simpson, 3,510; Arbuckle, 3,589; total depth, 3,608 feet.

Phillips No.1 Ewy, in sec. 24, T. 22 S., R. 2 W., top of Topeka, 1,750; Lansing, 2,338; Mississippi lime, 2,953; base, 3,303; Misener, 3,312; Hunton, 3,314; Sylvan, 3,350; Viola, 3,420; Wilcox, 3,467; Arbuckle, 3,545; total depth, 3,560 feet.

Alco No.1 Heibert, in sec.5, T. 22 S., R. 3 W., top of Lansing, 2,485; Mississippi lime, 3,185; base, 3,435; Hunton, 3,547; Sylvan, 3,620; Viola, 3,678; Simpson, 3,700; Arbuckle, 3,783; total depth, 3,810 feet.

Mid-Kansas No.3 Klassen, in sec. 30, T. 22 S., R. 3 W., top of Mississippi lime, 3,145; base, 3,175; Hunton, 3,325; Sylvan, 3,419; Viola, 3,464; Simpson, 3,490; Arbuckle, 3,572; total depth, 3,763 feet.

Phillips No.1 Wiebe, in sec. 30, T. 22 S., R. 2 E., top of Topeka, 1,680; Lansing, 2,300; Mississippi lime, 2,974; base, 3,219; Hunton, 3,315; Viola, 3,421; Simpson, 3,434; Arbuckle, 3,525; total depth, 3,548 feet.

Shell No.1 Santa Fe, in sec. 19, T. 23 S., R. 1 E., top of Ft. Riley, 520; Topeka, 1,725; Lansing, 2,333; Mississippi lime, 3,315; base, 3,333; Hunton, 3,444; Sylvan, 3,480; Viola, 3,514; Simpson, 3,536; Arbuckle, 3,627; total depth, 3,640 feet.

McCullough No.1 Prunty, in sec. 3, T. 23 S., R. 1 W., top of Mississippi lime, 3,065; base, 3,360; Viola, 3,423; total depth, 3,513 feet.

Shaffer No.1 Steel, in sec. 12, T. 23 S., R. 2 W., top of Mississippi lime, 3,015; Misener, 3,341; Hunton, 3,363; Viola, 3,379; Simpson, 3,473; Arbuckle, 3,580; total depth, 3,615 feet.

Shaffer No.1 Epp, in sec. 15, T. 23 S., R. 3 W., top of Lansing, 2,520; Mississippi lime, 3,280; Hunton, 3,717; Viola, 3,800; Simpson, 3,843; total depth, 3,915 feet.

Jolly Ogg No. 1 Randall, in sec. 11, T. 24 S., R. 1 W., top of Ft. Riley, 540; Topeka, 1,715; Lansing, 2,300; Mississippi lime, 3,045; total depth, 3,760 feet.

Empire No.1 Webster, in sec. 9, T. 24 S., R. 2 W., top of Topeka, 1,920; Lansing, 2,487; Mississippi lime, 3,334; total

depth, 3,338 feet.

Hartman and Blair No.1 Elberson, in sec. 15, T. 24 S., R. 3 W., top of Lansing, 2,615; Mississippi lime, 3,379; base, 3,775; Viola, 3,937; Simpson, 3,969; total depth, 4,015 feet.

Sinclair No.1 Boyle, in sec. 17, T. 24 S., R. 3 W., top of Topeka, 2,030; Lansing, 2,630; Conglomerate, 3,410; Mississippi line, 3,445; base, 3,780; Misener, 3,810; Hunton, 3,817; Sylvan, 3,850; Viola, 3,910; Simpson, 3,938; Arbuckle, 4,010; total depth, 4,160 feet.

HASKELL COUNTY

Geology

Most of Haskell County is covered with a blanket of sand and gravel of Tertiary age. This material was laid down by ancient streams flowing from the region of the Rocky Mountains. It has been consolidated in part into sheets of conglomerate which are locally referred to as "mortar beds". The thickness varies from a hundred to possibly 250 feet. In the northern part of the county a thin veneer of wind-blown sand lies upon the Tertiary strata.

Subsurface Stratigraphy. The rocks which lie below the Tertiary belong to the Cretaceous and Permian systems. They have been encountered in four wells drilled for gas within the last few years. The thickness of the Cretaceous sandstones is not definitely known. Recent water wells drilled in southwestern Kansas indicate that the Dakota sandstones and interbedded shales which might be expected are absent over most of this area.[14] The red beds of the Cimarron series of Permian age appear in all well logs. Still lower down gray shales, with salt layers and anhydrite beds, indicate the presence of the Wellington formation. At a depth of approximately 2,300 feet the characteristic limestone sequence of the Big Blue appears. The Herington, which is the topmost layer, is a dolomite or dolomitic limestone. Where porous it may contain gas. Other limestones of this sequence are the Winfield and the Ft. Riley. Both of these contain porous zones in which commercial quantities of gas have been found.

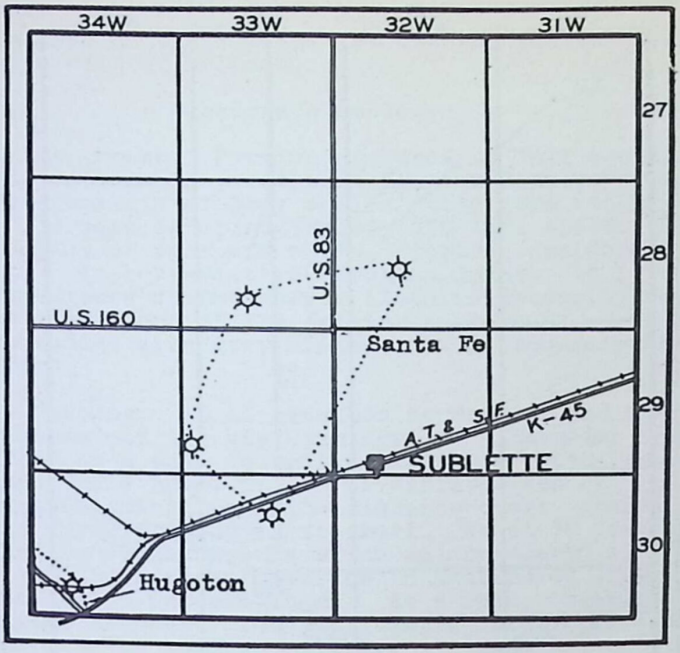
History of Gas Development

Up to the close of 1937 five gas wells had been drilled in Haskell County. All except the first one of these have been placed in the Santa Fe gas field by the Kansas Nomenclature Committee. The first, or discovery, well was the No. 1 Warner well drilled by Kuhn Brothers Drilling Company for the Derby Oil Company of Wichita, Kansas. It is in sec. 29, T. 30 S., R. 34 W., in the southwestern corner of the county. Because of its location this well has been included in the Hugoton field. Gas was encountered at 2,520, 2,536, and at 2,608 feet.

Santa Fe Gas Field. The other four commercial wells in Haskell County are located in sec. 21, T. 28 S., R. 32 W.; sec. 28,

---

14. Information furnished by H. T. U. Smith.



Haskell County

T. 28 S., R. 33 W.; sec. 30, T. 29 S., R. 33 W.; and sec. 10, T. 30 S., R. 33 W. The second of these was drilled by Helmerick and Payne Drilling Company on the Trimpa ranch and the third by the same firm on the Elliott ranch. The latter produces from the Ft. Riley limestone at a depth of 2,744 to 2,747 feet. The initial production was estimated at 2½ million cubic feet. The top of the Ft. Riley was found at 2,618 feet or 126 feet above the pay zone. Interesting also is the fact that a show of oil was found with the gas. The fourth well (in sec. 10, T. 30 S., R. 33 W.) was drilled by the Kuhn Drilling Company on the Meredith ranch. The pay zone was found at 2,650 feet, where an initial production of one-half million cubic feet was secured. Production from gas wells in the Santa Fe gas field is included in the figures pertaining to the Hugoton gas field.

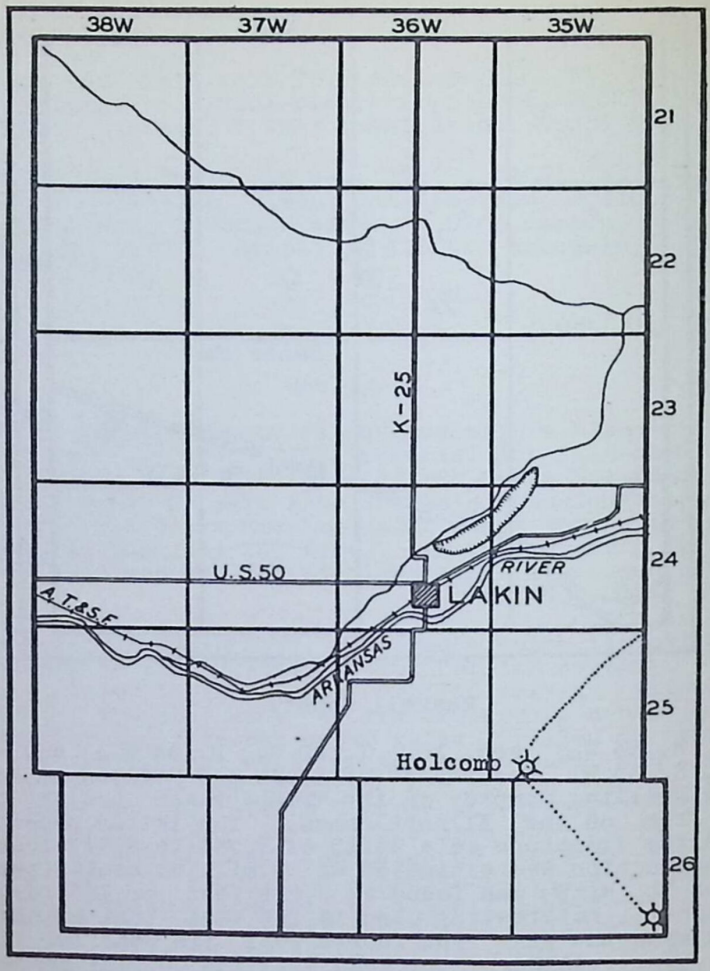
KEARNY COUNTY

See Finney County - Holcomb gas field.(See map on next page)

KINGMAN COUNTY

Areal Geology

The geological formations exposed at the surface of Kingman County include the upper Permian, Tertiary, and Quaternary. A thin sheet of sand and gravel of the Ogalalla formation of Tertiary age covers the western half of the county, and also occupies small areas in the eastern part. It has been dissected by the South Fork of the Ninnescah and Chikaskia rivers in such a way as to expose varying amounts of the underlying Permian red beds. These red beds belong to the Cimarron division of the



Kearny County

Permian system and include strata down to the base of the Enid group.

The basal member, called the Kingman sandstone, was named from the city of Kingman where it may be seen along some of the streets. Its line of outcrop is shown on the state geological map as passing through Townships 27 and 28 S., Range 7 W., and in the northern part of Township 30, Range 7 W. The other prominent marker in the red beds, named the Stone Corral member by Norton[15], may be seen in Townships 27, 28, and 29, of Range 6 W. The anhydrite so common underground is generally missing, but the dolomite just below appears in its full thickness. The red beds which lie beneath the Stone Corral have a thickness of about 200 feet and crop out in the eastern part of the county.

---

15. Am. Assoc. Petroleum Geologists, Bull., vol. 21, no. 12, p. 1557, December, 1937.

They may be seen on the surface at several places west of Cheney, and also east of Belmont.

Subsurface Geology

Below the exposed Permian red beds a full section of the lower Permian strata is present in Kingman County. The Wellington division consists of gray shales with some red layers near the top. This part is approximately 170 feet thick. The middle part, consisting of salt and shale, varies considerably across the county. In northeastern Kingman County it is 300 feet thick. From there southwestward it thins gradually to about 75 feet. The lower part of the Wellington is made up of anhydrite layers interbedded with gray shales. It is commonly from 120 to 150 feet thick.

In well cuttings it is possible to delimit and identify the various members of the Big Blue series with great precision. The Herington is a thin dolomitic limestone with considerable anhydrite and shale below it. The Winfield and Ft. Riley members are also dolomitic, and the Florence chert stands out because of its fossiliferous white chert. About 75 feet lower another cherty limestone appears which is correlated with the Wreford. The next 300 feet of section is made up of limestone beds with reddish shales between them. As a rule, the lowest limestone contains abundant foraminifera so that its equivalence with the Americus is well supported.

The 600 feet of the Big Blue is succeeded by a shaly section somewhat over 600 feet thick. The presence of black shale at many levels is noteworthy, as is also the occasional presence of sandy layers. This part of the section is usually called Wabaunsee. A rather prominent limestone marks the top of the Topeka formation of the Shawnee group. Small amounts of red shale, green shale and black shale serve to break the monotony of the 350 feet of the Shawnee. The Douglas group, which succeeds it, is composed predominantly of gray shale. Lenses of sandstone in a few places reach a thickness of nearly 100 feet. By many geologists these lenses are correlated with the Ireland and the Stranger sands of the surface section farther east in Kansas. The lowest 15 feet of this group contains evidence of the rather widespread unconformity which characterizes this part of the Pennsylvanian system. Hard, siliceous layers of thin-bedded limestone separated by gray shale make up the upper 10 feet. A very persistent black shale, rarely more than 2 feet thick, serves to mark the base of the marine sequence, and below it are varying amounts of red and green shale down to the top of the Lansing or "Oswald".

The Lansing-Kansas City-Bronson "lime" is found at depths of 3,100 to 3,500 feet in different parts of the county depending on elevation, local structure, and regional dip. Commonly it has a thickness of 350 feet, and consists largely of limestones. These are lithologically separable on account of variation in texture and the presence of oolites or chert zones. In cores gray shales of slight thickness are found interbedded with these calcareous rocks. In certain zones oolites have been dissolved in such a manner that the rock is made porous. A number of the oil-producing zones are clearly related to these porous streaks.

The Marmaton group is composed of shales and thin limestones from 100 to 350 feet thick. The limestones are reddish in many places and slightly sandy. The shales are gray at the top but

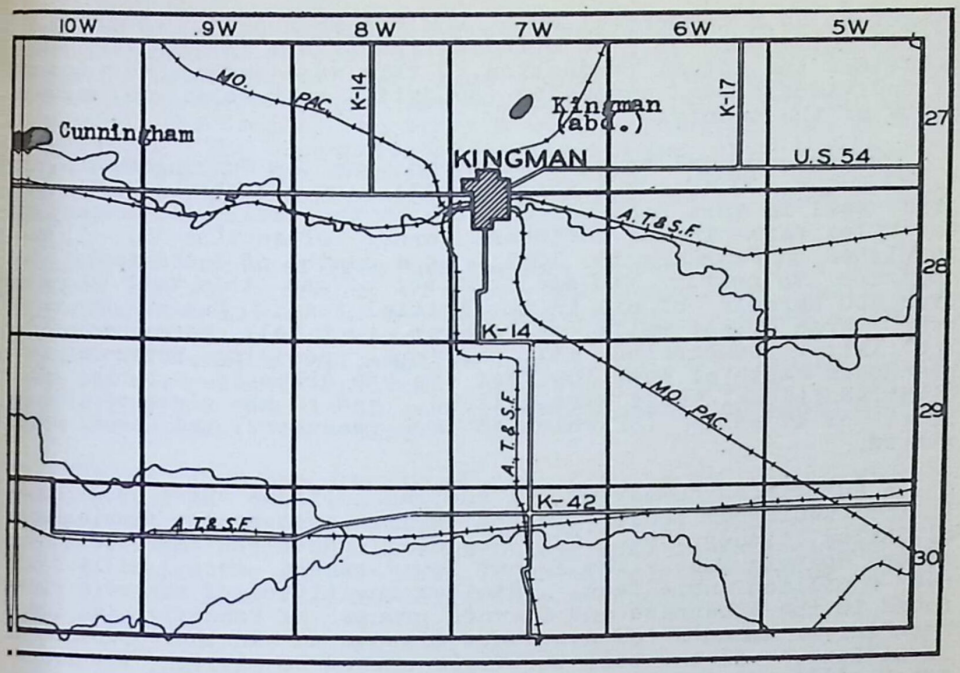
become reddish and greenish toward the base. A certain amount of black shale is found in some localities in this part of the section. The red and green colors mark the approach to the great unconformity between the Pennsylvanian and the Mississippian systems.

The "Mississippi lime" is a white, rather coarsely crystalline limestone with much chert in the upper part. Long erosion during upper Mississippian and lower Pennsylvanian time has removed some of the soluble limestone in local areas leaving the insoluble chert behind. In well cuttings it is therefore common to find only the altered chert or tripoli instead of the limestone. Both the chert and the unaltered limestone, which may remain in place beneath it, vary greatly from place to place. From zero to over 350 feet of the limy portion of the Mississippian system may be expected in wells drilled in Kingman County. The underlying shaly portion of the system, correlated with the Kinderhook, is close to 200 feet thick in most places. It is separated into two members by a prominent dolomite bed which is about 25 feet thick and lies about 125 feet below the top of the Kinderhook. While the upper shales are gray in color the lower shale is distinguished by its black color and the presence of plant spores. For these reasons it is often called the Chattanooga shale.

No Devonian or Silurian rocks are reported from Kingman County. This part of Kansas was either land during those periods of the earth's history or the Silurian and Devonian rocks were removed by pre-Mississippian erosion. Erosion has produced a rather uneven peneplain below the Kinderhook, and in addition has removed the uppermost beds of the Ordovician as well. Locally, as northeast of Kingman, the Sylvan and Viola members are missing, so that the Simpson appears below the Mississippian. Elsewhere it is common to find the Viola present in greater or less thickness. This Ordovician formation is generally very cherty in Kingman County and may be as much as 60 feet thick. Dolomites, limestones, and dolomitic limestones appear with the chert. The erosional rubble made by the solution of the calcareous material may be very similar to the chat found at the top f the "Mississippi lime". The lower 20 feet or more of the Vila is distinctive on account of its white color, coarseness, nd lack of chert.

The Simpson formation, which lies beneath the Viola, is the most distinctive rock found in the deeper parts of test wells. The green color of the shale is peculiar and unmistakable. In addition there are lenses of sandstone which may occupy almost the whole interval of 90 feet usually assigned to the Simpson. These are characterized by rather large grains of sand, which often show rounding and etched surfaces.

The Simpson evidently rests upon an erosional surface of the Arbuckle or "Siliceous lime". This dolomitic limestone has been reached in many wells and in a few it has been penetrated. Although it consists mostly of coarsely crystalline dolomite, certain zones can be determined by means of chert, green shale, or sandy streaks. The chert appears at two distinct levels in a deep well drilled on the Leisman farm by the Skelly Oil Company. This well penetrated the Arbuckle 101 feet and up to the time this report was written no well had found a greater thickness.



Kingman County

Structure

Surface structure is very difficult to work in Kingman County. The Tertiary rocks are not adapted to structure mapping, while the Permian red beds contain too few persistent marker beds. Much core drilling has been done, and a number of domes or anticlines have been located by this method. In recent years a good deal of seismograph surveying has also been carried on in Kingman County. The results of this work still await publication. One of the prominent trends of structural "highs" is shown on a map published in the Bulletin of the American Association of Petroleum Geologists.[16] This trend connects the Herado pool of Reno County with the Cunningham pool in northwestern Kingman County.

History of Oil and Gas Development

In January, 1926, the first oil well was drilled in Kingman County by the Carter Oil Company and D. P. Fleeger on the Richardson farm in sec. 16, T. 27 S., R. 7 W. It produced 120 barrels a day from the chat or top of the "Mississippi lime" at a depth of 3,853 feet. Less than a month later it was deepened to the Simpson or "Wilcox" sand, found at 3,876 feet, and drilled to a total depth of 3,894 feet. Over 800 barrels of oil flowed from this level in the initial test. The oil had a gravity of 33° Be. Production fell off rapidly and soon water appeared with the oil. After 27,000 barrels had been produced the well

16. Am. Assoc. Petroleum Geologists, Bull., vol. 21, no. 4, p. 501, April, 1937.

ceased to be a commercial well and was abandoned. A number of offset wells were drilled without finding oil in quantity. Nevertheless the actual production of this well encouraged a number of individuals and companies to drill test wells in various parts of the county.

The second pool to be discovered was the Cunningham pool in T. 27 S., R. 10 W., the northwestern part of the county. The first well in this pool was drilled by the Skelly oil Company on the Miles farm in the northeast corner of section 30. It was completed on February 18. 1931. at a depth of 3,468 feet. In addition to nearly two million feet of gas this well produced over 400 barrels of oil in the initial test. During the next year three offset wells and a deep test well were completed. The latter penetrated all previous producing horizons and reached a depth of over 100 feet in the Arbuckle. During 1933 eight additional wells were drilled, and at the close of 1937 a total of 47 wells (of which 43 are producers) had been completed.

A surprising number of oil and gas horizons have been found in the Cunningham pool. In the Permian system the Herington, Ft. Riley, Kinney, Neva, Cottonwood, GlenRock and Americus limestones contain gas. The amount found ranges from ¼ million to over 6 million cubic feet. Similar quantities of gas were also found in the Wabaunsee and Shawnee groups of Pennsylvanian age. Much larger amounts of gas were discovered in the Ordovician formations. In one well the Viola showed 26 million, the Simpson 9 million, and the Arbuckle 27 million cubic feet of gas. Oil was found principally in the Lansing-Kansas City zone of the Pennsylvanian system. The main pay zone lies at a depth of 30 feet below the top of the Lansing in an oolitic limestone which has a thickness of 4 to 5 feet. Another porous zone, characterized by black chert, appears at a depth of 85 feet below the top of the Lansing. At a depth of 175 feet a second oolitic layer 10 feet thick has porosity and gas production.

The Cunningham pool was located on a core-drilled structure in which the Cimarron anhydrite was used as a marker. This is found at a depth of from 350 to 450 feet, and shows an anticline with a closure of 25 feet. Later a structure map was made with the top of the Lansing as the control bed. This shows 60 feet of closure over the same area (indicating a steepening of dip with depth), and also a total of 120 feet of closure over the total area drilled to date. A few deep tests to the Viola show a further steepening of dip, which amounts to three times that of the Lansing. This is due to a variation in the thickness of the Mississippian, which is missing on the top of the anticline, but thickens to over 100 feet off the structure. There is some evidence pointing to the presence of a fault in the pre-Pennsylvanian beds on the east side of the pool.

With the exception of the first well all wells are drilled to the Lansing with rotary tools. Drilling time is approximately 19 days. Two sets of casing are used, the 12½ inch being set at 285 feet and the 7 inch casing in the top beds of the Lansing. The producing zone in the Lansing-Kansas City is drilled with cable tools and later treated with acid. Up to 5,000 gallons of acid is used which produces an increase in production amounting to an average of 320 percent over the initial production. A second acid treatment results in no measurable increase.

Bottom-hole pressures and temperature readings have been ttaken at intervals since the field was brought in. The first ppressure readings were taken in August, 1933, and showed an aveerage of 1,100 pounds per square inch. Two years and three mmonths later the pressure was 492 pounds. This decline caused tthe Skelly Oil Company to start a repressuring program in Januuary, 1936. The temperatures at the bottom of the hole range ffrom 114° to 120°, the average being 118.5°. These temperatures hhave remained practically unchanged during the 2½ years of testiing.

The gas produced from the Permian limestones is a dry gas wwith an initial pressure of about 700 pounds per square inch. IIt is composed mainly of methane and ethane, and has a heating vvalue of 937 B.T.U. The gas from the "Oswald" is a wet gas conttaining 0.37 gallon of gasoline per 1,000 feet, while the gas ifrom the Ordovician horizons contains 0.41 gallon. The rock ppressure of the Ordovician gas is about twice as great as that ifrom the Permian formations.

The oil from the Lansing-Kansas City zone has a gravity ranging from 31° to 36° Bé. A.P.I. On distillation it produces 35 per cent gasoline and 10 per cent kerosene. The oil flows out naturally, which is somewhat exceptional in Kansas. The largest potential for the pool was 7,565 barrels per day on January 23, 1934, when only 13 wells were producing.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
CUNNING-HAM 30-27-10	Jan.,1931 1200 acres	39 1,445,304 Bbls. 4	3390-3464 Lansing - K.C. 3925-58 Viola 4055-04 Simpson 4094-4109 Arbuckle	4 dry Gas Grav.36 Gas Gas
KINGMAN 16-27-7	Jan.,1926	0 27,000 Bbls.	3853-3894 Chat	10 dry Abd. Grav.31

McPHERSON COUNTY

Areal Geology

The surface rocks of McPherson County present an interesting study on account of their variety and distribution. The youngest rocks belong to the Quaternary system. They are of two different types. In the large river valleys there is a narrow zone of flood-plain material laid down in very recent geologic time. This may be seen along Little Arkansas River, which flows through the southwestern part of the county, and along Smoky Hill River which flows past Marquette and Lindsborg in the northwestern part of the county. Central and southeastern McPherson County is covered by a thick blanket of gravel and sand which has been named the McPherson formation. On account of the fact that bones of early horses have been found in them,

geologists also call these sediments the "Equus Beds." Test holes indicate that this material varies from less than 20 feet to nearly 200 feet in thickness. In it great quantities of excellent potable water are stored.

Older rocks are exposed in northeastern and western McPherson County. The youngest of these are strata of Cretaceous age which belong to the Dakota formations and the Comanchean series. Small areas around Windom and north of Marquette are hilly because of the great resistance to erosion of the Dakota sandstone. In the northeastern part of the county, in the high hills bordering Gypsum Creek, these same sandstones may be seen to advantage. The maximum thickness of the Dakota in this county is probably in the neighborhood of 100 feet, but in most places only a fraction of the total may be observed.

Comanchean Rocks. The Comanchean rocks of McPherson County have been described by Twenhofel[17] in one of the State Geological Survey publications. He states that the Mentor beds, named after a small station in Saline County, crop out in northwestern and northeastern McPherson County. The map (Plate I opposite page 12) which accompanies his report shows the outcrop belt. Twenhofel includes all the beds from the top of the Mentor to the base of the Mesozoic in this area in the Belvidere formation. The best place to study these rocks is in the Natural Corral located about 5 miles southwest of Marquette (sec. 5, T. 18 S., R. 5 W.) where nearly 160 feet of strata are exposed for study. An examination of this section shows a very ferruginous sandstone at the top in which typical Mentor fossils have been found. In the slopes below other sandstones may be seen interbedded with many layers of shales. The shales are predominantly blue, but many other colors at certain levels give the impression that the Comanchean rocks are varicolored. Twenhofel states that the best place to collect fossils from the Mentor sandstone is in the road ditches and plowed fields about 5 miles west of the village of Smolan, in Saline County.

Paleozoic Rocks. The Comanchean rocks rest with angular unconformity upon the much older Permian strata. Evidently this part of the state was land during Triassic and Jurassic time, allowing the Paleozoic rocks to be eroded unevenly, and probably allowing several hundred feet of strata to be entirely removed. Erosion cut away all Permian red beds in the eastern part of the county, but preserved some of them in the western part. These are exposed in the western tier of townships from a point a few miles south of Windom as far south as Medora. Another patch about one township in area is exposed south of Lindsborg. The Permian red beds consist of very fine siltstone and clay which are deeply stained with red pigment. Green bands or spots occur where reduction of the iron oxides has taken place. These Permian red beds lie in the Cimarron series. On the state geological map the Cimarron series is divided into four formations, the Enid being the lowest. Near the base of the Enid is the Stone Corral dolomite which serves as an excellent stratigraphic marker. An outcrop of the Stone Corral is shown on the state map in the southwestern corner of T. 19 S., R. 5 W., a few miles south of Windom. Only the lowest part of the red bed section is preserved in McPherson County.

---

17. Kansas Geol. Survey, Bull. 9, p. 31, 1924.

Below the Cimarron series lies the Sumner group of the Permian, which consists of shales with three prominent limestone zones. The uppermost one of these is the Carlton (named from a village in southwestern Dickinson County) which consists of about six chalky layers each less than a foot thick, but extending through 50 feet of section. This limestone zone is described in several publications[18] and is usually considered a part of the Wellington formation of the Permian. Below it are 300 feet of gray clays and shales with much gypsum down to the Hollenberg limestone. Not all of these strata are exposed in McPherson County, but they are found in deep test wells and core-drill holes. The uppermost beds of the Wellington down to and slightly below the Carlton limestone may be seen in the banks of Gypsum Creek in the northeastern part of the county.

Subsurface Geology

Many wells have been drilled in McPherson County in search for oil. In the central part of the county they encounter from a few feet to several hundred feet of gravel and sand of Quaternary age. Elsewhere they start in various members of the Cretaceous or the Permian described above. A maximum thickness of Wellington of around 400 feet is to be expected, but on account of the unconformity at the top of the Permian this estimate will vary considerably. Indeed, in the western tier of townships where the Cimarron is at the surface, a total thickness of about 600 feet may be expected. Very few wells have been drilled in this part of the county, so exact figures are not available. The cross section of Kansas[19] prepared by the Kansas Geological Society shows the record of the LaDow well No. 1 King drilled in sec. 20, T. 19 S., R. 5 W. In this well a thickness of 250 feet of Cimarron red beds was found. The upper Wellington, consisting of greenish gray shales and some red shales, is 280 feet thick, the middle Wellington salt is 270 feet thick, and the lower Wellington anhydrite section is 150 feet thick.

As these members of the Wellington are traced eastward into McPherson County some striking changes take place. Most notable is the complete pinching out of the salt, which seems to terminate with abnormal abruptness. This is explained by assuming that it originally extended farther east, but has been dissolved away by underground water. A map prepared by Bass[20] shows the salt present in wells as far east as Township 17 S., Range 2 W., but with much reduced thickness. His map indicates a sudden thinning from 300 feet in western McPherson to zero in central McPherson County. Hence in the eastern portion of the county the upper and lower Wellington cannot be clearly differentiated. The upper gray shales merge with the lower gypsiferous shales.

Big Blue Series. Although the Big Blue series includes the Wellington, it has been found convenient in the study of well

---

18. Municipal Univ. Wichita, Univ. Studies, Bull. 2, p. 6, May, 1937.
19. Kansas Geological Society, 6th Ann. Field Conf. Guidebook, Oct.,1932. May be secured by writing to the Society in the Union National Bank Building, Wichita, Kansas.
20. Kansas Geol. Survey, Bull. 11, pl. 8, p. 90, 1926.

cuttings to separate the two at the top of the Herington limestone. This limestone is the first good limestone encountered in well cuttings, and forms the top of a sequence that is more clearly distinguishable than any other unit. For a thickness of about 600 feet there is an alternation of limestones and shales which is found in every well, and the members of which are remarkably persistent over the whole county. The Herington is dolomitic and thin. Beneath it are shales with considerable gypsum. The Winfield limestone follows, and below it is a characteristic red shale zone. This is succeeded by the Ft. Riley limestone, at the base of which is a layer of fossiliferous chert. About 75 feet lower the Wreford cherty limestone appears and 300 feet lower the very fossiliferous Americus limestone.

Pennsylvanian Rocks. The Pennsylvanian rocks in McPherson County are from 1,850 to 1,900 feet thick. They may be conveniently subdivided into five lithologic units of very nearly equal thickness. The uppermost one is the equivalent of the Wabaunsee group of eastern Kansas. It consists of clastic material among which four sandy layers are most distinctive. Two of these lie above the Tarkio limestone, and two lie near the base. The Howard limestone is the thickest limestone in the Wabaunsee. It has one sandstone above it and another beneath it. Although the shales are gray for the most part, some red and green shales are present, especially near the top. The thickness of the Wabaunsee averages 625 feet. Its lower limit is easily fixed by the appearance of the Topeka limestone, the highest formation in the Shawnee group. In general the Topeka may be expected at depths of around 1,800 feet. As the normal dip of the older rocks is toward the west, allowance must be made for slightly deeper depths in western McPherson County. The Shawnee group is about 250 feet thick, and consists of limestone with small amounts of shale, some of which is black.

The next lower group is the Douglas, which is characterized by several thick sandstone bodies and much shale. Red and green colors are also characteristic. In some wells the Ireland sandstone is over 60 feet thick. The sandstone near the base is, as a rule, quite thin. The top of the Lansing limestone marks the base of the Douglas. In general it is difficult to separate the Lansing from the Kansas City and Bronson limestone formations. The whole interval comprises about 350 feet. The middle part is characterized by the appearance of considerable chert, some of which is black in color. There are also a number of oolitic zones which can be traced from well to well in limited areas. The Marmaton, which lies below these limestones, is distinguished by red and green shales interbedded with thin limestones. At the very base some weathered chert fragments may be included with the red shales.

Mississippian Rocks. In McPherson County the Pennsylvanian is always underlain by Mississippian rocks. These, however, vary in thickness on account of the fact that they were eroded before Marmaton time. Long continued weathering and solution caused piles of cherty debris to accumulate. Some remained in place, but much was washed into depressions. The well cuttings, therefore, usually show a varying thickness of decayed chert fragments, called "chat" by the drillers, at the top of the older rocks. The Mississippian limestone and chat varies from 50 to over 250 feet in thickness. The depths at which it is first found in wells varies from 2,700 feet in Range 1 W. to over 3,200 feet in the western ranges of the county. The depth also varies from north to south.

Below the "Mississippi lime" are greenish-gray and black shales with plant spores, which are correlated with the Kinderhook formation. The abnormal thickness of shale over most of the county at this stratigraphic level aroused the suspicion among early research workers that the Kinderhook rested upon another shale of greater age, the Sylvan. Later drilling corroborated this. Where the Kinderhook rests upon the Sylvan shale an attempt is made to separate them by the presence or absence of spores. The thickness of the Kinderhook reaches a maximum of 150 feet.

Siluro-Devonian Rocks. The Hunton limestone of Siluro-Devonian age is found in wells drilled in the northeastern part of the county, and in the southern half of the southernmost tier of townships. It is identified in well cuttings partly by its lithology and partly by its stratigraphic position. The lithology has been very exhaustively described by Johnston.[21] He states that it is possible to differentiate three different types and ages of rock in the Hunton of McPherson and Harvey counties. The upper one he calls the Ediger limestone. It varies in texture from dense to coarsely crystalline, is fossiliferous, and contains sandy and glauconitic streaks at the base. Some chert is found in the upper portion, where also thin green shale layers are present in which fossils have been noted. These fossils include such genera as Atrypa, Polypora, and Spirifer. These are interpreted as being of middle Devonian age and imply a correlation of the Ediger with the Cooper and Mineola formations of Missouri. The middle part of the Hunton is called the Hollow dolomite by Johnston, who states that it is the major oil-producing horizon in the Hollow pool of Harvey County. It is a highly crystalline porous dolomite. The upper part is sandy and phosphatic in many places. The very few fossils which have been found in the Hollow dolomite indicate that it is probably equivalent to the Niagaran of eastern United States (middle Silurian). The lowest member of the Hunton is a pink limestone which may be sandy and crinoidal. It has been identified from a limited number of wells only.

Ordovician Rocks. At the top of the Ordovician system is a shale usually called Sylvan or Maquoketa. It appears under the Kinderhook over the greater part of McPherson County. Since it resembles the latter in appearance, students find it difficult to determine the top in well cuttings. The thickness is therefore somewhat problematical, but probably lies between 20 and 50 feet. Johnston describes it as a gray or olive-green shale with thin zones of dolomitic rock. Near the base the shales are calcareous and may contain phosphatic oolites. The graptolites, which have been found in a few places, definitely indicate the Ordovician age of the shales and serve to separate them clearly from the Kinderhook shales which may overlie them. Graptolites have been found in cores especially, but may also be present in cuttings under favorable circumstances.

The white, crinoidal limestone which appears beneath the Sylvan is usually correlated with the Viola of Oklahoma and the Fernvale of Missouri. Johnston reports that he found a Rhynchotrema capax in a core from a well drilled in sec. 21, T. 22 S., R. 3 W., which seems to prove the Fernvale age of the white

---

21. Tulsa Geol. Soc., Digest for 1934, pp. 12-16.

Viola. In addition, phosphatic gastropods, ostracodes, conodonts, and crinoids have been found which closely resemble Fernvale forms. The lower part of the Viola is a gray limestone which has not yet yielded any fossil evidence of its precise age. On account of its stratigraphic position just above the Decorah shales, it is correlated with the Kimmswick of Missouri. In McPherson County the Viola is found at depths varying from 3,150 to 3,700 feet depending on location. The thickness varies from a few feet to a maximum of about 110 feet (Range 4 W.) with a general average between 30 and 70 feet.

The appearance of sandstone beneath the Viola marks the top of the Simpson. It is probably the most readily identifiable horizon found in well cuttings. Much green shale is mixed with the sand, and in certain wells this shale occupies most of the section. Conodonts and phosphatic nodules further serve to distinguish this formation from others with which it might be confused. The rounded frosted grains of sand which appear in some wells indicate that wind action had much to do with its formation.

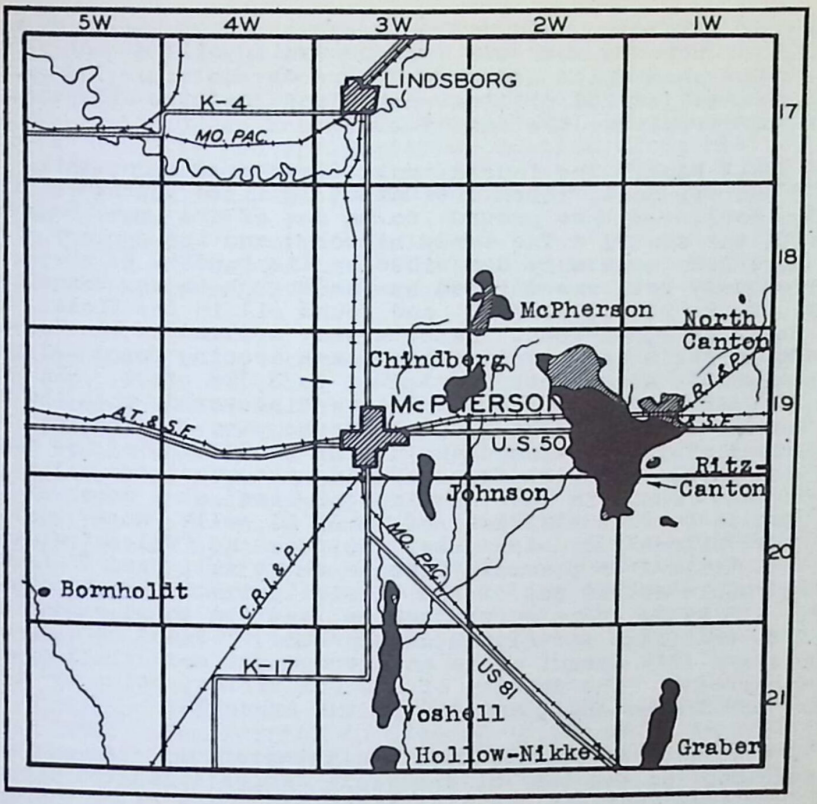
There is a sharp transition from the Simpson lithology to the coarse-grained dolomites below it. The boundary is undoubtedly one of disconformity, because in some wells a distinct erosional rubble is found at the contact. The Arbuckle (or "Siliceous lime" as it is called by the driller) is a pale cream-colored dolomite of coarse texture in which oolitic chert is particularly distinctive. It has been found in all deep wells drilled in McPherson County, but has been penetrated in only a few.

Structure

On account of the cover of unindurated and soft rocks it is practically impossible to work out surface structure in McPherson County. Oil companies have therefore resorted to the core drill to find favorable locations for test drilling. In this manner a definite line of prominent anticlines was discovered extending from T. 17 S., R. 2 W., past the town of McPherson, southwestward through T. 21 S., R. 3 W. The Voshell pool is located on the most pronounced anticline of this group. Several other less prominent lines of relative uplift have been found in the eastern part of the county. In the western part of the county the structural relief is apparently slight.

History of Oil and Gas Development

Eight oil and gas pools have been discovered in McPherson County up to the close of 1937. They are all with one exception in the southeastern third of the county. The first one was discovered in September, 1926, when Merriman, Reeves and Shidel drilled a successful gas well on the Anderson farm in sec. 29, T. 18 S., R. 2 W. An initial production of 7½ million cubic feet of gas was obtained from the "Mississippi lime" at a depth of 2,927 to 2,943 feet. The porous zone was found 22 feet below the top of the lime. By the end of 1936 a total of 18 gas wells had been completed in this pool, the McPherson, and in addition oil was being produced from 30 wells. The oil was not discovered until July, 1928, when the Mid Kansas Oil Company drilled their No. 1 Larson well in sec. 31. In this case also the pay was found in the "Mississippi lime," and at a depth of 2,967 to 2,978 feet. The gravity of this oil is 37° Bé. A small amount of oil has been produced from the Kansas City limestone at a depth of 2,340 to 2,395 feet. One well has found oil in the Vi-



McPherson County

cola "lime" at 3,190 to 3,200 feet. At the close of 1936 the total production from the pool had reached a figure of 573,200 barrels, from an area of 2,000 acres.

Chindberg Pool. Somewhat over a mile to the southwest of the McPherson pool is the Chindberg pool, so named from the farm on which the first well was found productive. It was drilled by the McPherson Oil Company in sec. 18, T. 19 S., R. 2 W., and was completed in November, 1929. Production occurs in the chert of the "Mississippi lime" at a depth of 2,992 to 3,009 feet. Gas was found from 2,992 to 3,007, and oil from that depth to 3,009 feet. By the close of 1937 a total of 35 wells had been drilled. Of these 27 were producing oil, 5 were dry holes and 3 had been abandoned. The production, from an area of 700 acres, totalled 849,349 barrels up to the end of 1937. A small amount of the total came from the Kansas City "lime" at a depth of 2,335 feet.

Johnson Pool. The next pool on this trend is the Johnson pool, the north end of which is about 3 miles southwest of the Chindberg pool. The discovery well, the No. 1 Johnson in sec. 35, T. 19 S., R. 3 W., was drilled by the Shell Petroleum Company in January, 1932. It had gas from 2,984 to 3,019 feet and oil from 3,020 to 3,046 feet in the "Mississippi chat." The initial gas pressure was 990 pounds and the amount 13½ million cubic feet. The oil was estimated at 500 barrels per day with a

gravity of 37° Bé. Eventually a total of 30 wells were completed, of which number 16 were producing oil at the close of 1937, 7 had been abandoned, and 7 were dry holes. The gas production totalled 250 million cubic feet and the oil production 2,100,000 barrels by the end of 1937.

Voshell Pool. The fourth pool discovered along this trend is the Voshell pool, which lies about 3½ miles southwest of the Johnson pool. It has proved to be one of the most remarkable pools in the state. The early history and the geology of this pool have been very ably described by Hiestand[22]. He states that the discovery well was drilled by Washabaugh on the Voshell farm in sec. 9, T. 21 S., R. 3 W. and found oil in the Viola "lime" at a depth of 3,303 feet. Later a well drilled by the Derby Oil Company on the Stucky farm in the same section found oil in the "Wilcox sand" at a depth of 3,322 to 3,325 feet. In March, 1930, another producing horizon was discovered when the first well on the lease of the I. T. I. O. Company in section 9 was completed. This well found an initial production of 889 barrels in the Arbuckle at 3,483 feet. During the same year oil as well as gas were found in the "Mississippi lime" at a depth of 3,055 to 3,108 feet. At the close of 1930, 51 wells were producing from the "Wilcox" and Arbuckle, 38 from the "Wilcox" alone, 3 from the Viola (or possibly Misener above it), and 2 from the cherty rubble at the top of the Mississippian. By the close of 1937, 118 wells were on production and the total amount produced to that time was 21,068,598 barrels. Based on an area of 3,500 acres this amount shows an average per acre yield of about 6,000 barrels. The gravity of the oil varies, being 42° in the Viola, 36° in the chat, and 41° in the Arbuckle.

The structure of this pool is interesting. A subsurface contour map on the top of the Viola shows a faulted anticline with 250 feet east dip in a distance of ¾ of a mile. Hiestand mentions five wells which showed evidence of a fault on the west side of the pool. Such evidence consists of abnormal thickening of certain units, elimination of units, or duplication of parts of formations. Since the fault is limited to pre-Pennsylvanian formations, it is assumed that crustal deformation took place during early Pennsylvanian time allowing the east side to rise. Later erosion eliminated most of the "Mississippi lime" leaving a thin sheet of chat in its place. On the east flank the "Mississippi lime" thickens rapidly. Over this surface the Pennsylvanian and Permian rocks were laid down in normal sequence. Later renewed movement along the fault zone caused them to be arched into an asymmetrical anticline which was found by core drilling.

Nikkel Pool. Scarcely a mile south of the Voshell pool is the northern end of the Nikkel pool, discovered when J. E. Mabee drilled the first well on the Nikkel farm in sec. 33, T. 21 S., R. 3 W. The initial production of the first five wells drilled in this pool averaged 1,500 barrels each. The producing horizon is the Hunton lime. This pool was subsequently connected with the Hollow pool, and the combined pool is described under Harvey County.

Ritz-Canton Pool. This pool comprises a number of individual discoveries which were originally named the Decker, Garrett,

---

22. Am. Assoc. Petroleum Geologists, Bull., vol. 17, No. 2, pp. 169-191, 1933.

Galva, Canton, and Ritz pools. Now the productive area covers about 13,000 acres and the limits have not yet been found. At the end of 1936 there were 266 oil wells and 198 gas wells within the area. The original discovery well was drilled by the McPherson Oil and Gas Company on the Wedel farm in sec. 12, T. 20 S., R. 2 W. It had an initial production of 6½ million cubic feet of gas in the "Mississippi lime" at 2,972 to 2,983 feet. Other wells drilled during 1929 allowed the field to produce 195,644,000 cubic feet of gas. During the same year oil was also found in the "Mississippi lime." The pay zone lies about 40 feet below the top of the "lime" at an average depth of 2,950 feet. The thickness of the producing zone may be as great as 50 feet.

In October, 1930, the McBride Mid Kansas No. 1 Garrett well in sec. 30, T. 19 S., R. 1 W. was drilled deeper because no production was obtained in the usual pay zone. At a depth of 3,412 to 3,414 feet this well secured 2,560 barrels from a porous zone in the Viola "lime." A number of other wells have since been deepened to this horizon with variable success. About two years later another producing horizon was found when the Phillips Company drilled their No. 2 Anna Winn well into the "Wilcox sand" in sec. 7, T. 20 S., R. 1 W. The initial yield was 996 barrels per day. During 1937 a second "Wilcox" area was found west of the townsite of Canton and 10 wells were deepened to this pay zone with initial productions as high as 450 barrels. The average depth to the "Wilcox" is slightly over 3,400 feet in this vicinity.

Production from this field totaled 28,850,360 barrels to the end of 1937. Considering an area of 13,000 acres as productive at the present time, the per acre yield is somewhat over 2,000 barrels. Recent figures on the gas production are not available, but up to the close of 1936 the total approximates 44 billion cubic feet. The structure of the Ritz-Canton pool seems to be that of a very flat dome or terrace. In the deepest producing horizons more relief is present, but the nature of this relief and its relation to production is not known.

Graber Pool. An oil pool was discovered in May, 1934, in the southeastern part of the county. It lies on the northern edge of the Hunton inlier that covers most of Harvey County. The first well was drilled by the Continental Oil Company on the Graber farm in sec. 32, T. 21 S., R. 1 W. It was completed in the Hunton "lime" at a depth of 3,274 to 3,298 feet for an initial production of 25 barrels per day. By the end of 1937, 96 wells had been completed in the Graber pool. Of these 95 are oil wells and only one is a gas well. The productive area covers 2,400 acres. In June, 1937, the Derby Oil Company found a second producing horizon when their No. 8 Goering well obtained a potential of 88 barrels per day in the Misener sand at a depth of 3,323 to 3,360. This well is located in sec. 17, at the north end of the pool where the Hunton "lime" is thin or absent. The gravity of the oil is 41° Be. The production totalled 2,043,081 barrels up to the end of 1937.

New Pools. As the year 1937 draws to a close it appears possible that two new pools have been added to the McPherson County list. One of these is the Bornholdt pool discovered by Bradley Brothers in sec. 30, T. 20 S., R. 5 W. The discovery well had a potential of 131 barrels from the "chat" at a depth of 3,292 to 3,335 feet. It was drilled on a core drill "high". Production in 1937 amounted to 1,647 barrels. The Bornholdt

pool is far from any other producing area, and is the first pool found in Range 5 W. of McPherson County.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
BORNHOLDT 30-20-5	Aug.,1937 40 acres	1 1,647 Bbls.	3292-3335 Chat	
CANTON NORTH 26-18-1	July,1936 40 acres	1 24,827 Bbls.	2803-32 Chat	
CHIND-BERG 13-19-3 18-19-2	Aug.,1929 700 acres	6 849,349 Bbls. 0 19	2363- Lansing - K.C. 2996-3007 Chat 3007-9 Chat	Gas Abd Oil 5 dry Grav.37
GRABER 17-21-1 32-21-1	June,1937 40 acres May,1934 2400 acres	2 2,043,081 Bbls. 3 90	3323-60 Misener Chat 3274-98 Hunton	Pot.88 Oil Grav.41
JOHNSON 35-19-3 2-20-3	Jan.,1932 1200 acres 1200 acres	0 2,100,000 Est. 16	2984-3019 Chat 3032-46 Chat	Gas Abd Oil 7 dry Grav.37
McPHERSON 29-18-2 31-18-2 27-18-2	Sept.,1926 2000 acres July,1928 2000 acres Sept.,1926	18 600,000 Est. 33	2927-43 Chat 2967-78 Chat 3140-3200 Viola 2340-95 Lansing - K.C.	Gas Oil Grav.37 Grav.35
RITZ-CANTON 12-20-2 11-20-2 30-19-1 7-20-1	Dec.,1928 13,000 acres July,1929	198 28,850,360 Bbls 266	2360-99 Lansing - K.C. 2972-83 Chat 2925-60 Chat 3412-14 Viola 3440-44 Wilcox	Oil Gas Oil Grav.32 Oil Grav.37 Oil
VOSHELL 34-20-3 30-19-1 7-20-1 9-21-3	Aug.,1929 3500 acres	 118 21,068,598 Bbls	3055-3108 Chat 3301-04 Viola 3322-25 Wilcox 3394-3483 Arbuckle	Gas and oil Grav.36 Oil Grav.42 Oil Oil Grav.41

Johnson No.1 Johnson, in sec. 33, T. 17 S., R. 1 W., top of Lansing, 2,110; Chat, 2,683, base, 2,880; Hunton, 2,990; Viola, 3,173; Simpson, 3,270; Arbuckle, 3,323; total depth, 3,332 feet.

Simmons No.1 Krehbiel, in sec. 33, T. 18 S., R. 1 W., top of Chat, 2,850, base, 3,116; Viola, 3,383; Simpson, 3,430; Arbuckle, 3,489; total depth, 3,497 feet.

Derby No. 1 Sellars, in sec. 19, T. 19 S., R. 1 W., top of Chat, 2,921; Viola, 3,404; Arbuckle, 3,511; total depth, 3,526 feet.

Hawkins No.1 Bitikofer, in sec.2, T. 20 S., R. 1 W., top of Lansing, 2,335; Chat, 2,910, base, 3,140; Viola, 3,366; Simpson, 3,413; Arbuckle, 3,474; total depth, 3,505 feet.

Ohio No.5 Decker, in sec. 20, T. 21 S., R. 1 W., top of Chat, 2,916; Hunton, 3,293; Sylvan,3,328; Viola, 3,373; Simpson, 3,403; Arbuckle, 3,483; total depth, 3,519 feet.

Madison No.1 Peterson, in sec. 1, T. 19 S., R. 2 W., top of Chat, 2,950, base, 3,188; Viola, 3,453; Simpson, 3,510; Arbuckle, 3,569; total depth, 3,573 feet.

Ohio No.1 Base, in sec. 22, T. 20 S., R. 2 W., top of Chat, 2,985; base Mississippi lime, 3,220; Sylvan, 3,380; Viola , 3,444; Simpson, 3,482; total depth, 3,572 feet.

Magnolia No.1 Stucky, in sec. 28, T. 20 S., R. 3 W., top of Douglas, 2,018; Lansing, 2,435; Bronson, 2,620; Marmaton, 2,815; Chat, 3,020; base Mississippi lime, 3,185; Sylvan, 3,320; Viola, 3,394; Simpson, 3,461; Arbuckle, 3,556 feet.

Lauck No.1 Krehbiel, in sec. 27, T. 21 S., R. 2 W., top of Ft. Riley, 615; Chat, 3,047; Hunton, 3,412; Viola, 3,532; Simpson, 3,560; Arbuckle, 3,635; total depth, 3,665 feet.

Palmer No. 1 Swenson, in sec. 11, T. 18 S., R. 3 W., top of Lansing, 2,370; Chat, 3,080; base, 3,360; Viola, 3,625 feet.

Miller No.1 Husband, in sec. 6, T. 19 S., R. 3 W., top of Lansing, 2,460; Chat, 3,121; Viola,3,630; Arbuckle, 3,754; total depth, 3,758 feet.

Independent No.1 Morehouse, in sec. 3, T. 21 S., R. 3 W., top of Lansing,2,320; Chat, 3,027; base Mississippi lime, 3,132; Viola, 3,381; Simpson, 3,430; Arbuckle, 3,495; total depth, 3,497 feet.

Clum No. 1 Nelson, in sec. 12, T. 18 S., R. 4 W., top of Chat, 2,977; base Mississippi lime, 3,197; Viola,3,427; Simpson, 3,535; Arbuckle, 3,613; total depth, 3,643 feet.

Lario No.1 Schrag, in sec. 22, T. 19 S., R. 4 W., top of Lansing, 2,565; Chat,3,250; base Mississippi lime, 3,500; Viola, 3,726; Simpson, 3,804; Arbuckle, 3,880; total depth, 3,889 feet.

Hinkle No. 1 Aschman, in sec. 8, T. 21 S., R. 4 W., top of Lansing, 2,700; Chat, 3,365; base Mississippi lime, 3,632; Viola, 3,883; Simpson, 3,910; Wilcox, 3,937; Arbuckle, 3,982;

total depth, 3,995 feet.

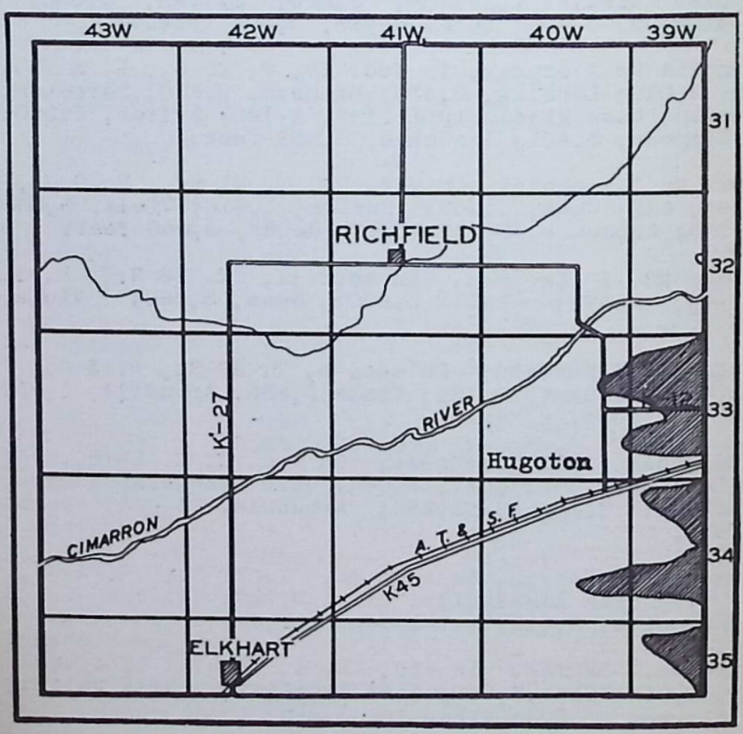
Pipe Lines and Refineries

Nine pipe-line companies provide an outlet for the crude oil production of McPherson County. The Chindberg area is served by the Continental, Globe, Bay, and Sinclair companies. The Graber pool oil is transported by the Continental, Bay, Derby, and Magnolia pipe lines. Oil from the Johnson pool is run through the lines of the Shell and the Bay Petroleum Company. The McPherson pool is served by the Sinclair and the Bay Petroleum Company. The large Ritz-Canton area has outlets through the lines of the Continental, Globe, Bay, Sinclair, Derby, Shell, Magnolia, and Stanolind companies. Oil from the Voshell pool is transported by the Derby, Magnolia, Skelly, and Shell companies.

The refinery of the Globe Oil and Refining Company at McPherson is one of the largest in the state. It has a capacity of 12,500 barrels per day and most of the time it is operating nearly at capacity. The other refinery in the same city is owned by the Bay Petroleum Company. Its capacity is 3,500 barrels per day.

MORTON COUNTY

See Stevens County - Hugoton Gas Field.



Morton County

NESS COUNTY

Areal Geology

The highest land in Ness County is across the northern part on the divide between Smoky Hill and Walnut rivers, and in the south-central section between Walnut and Pawnee rivers. The lowest land is in central Ness County (in the valley of Walnut River and its tributaries) and along Pawnee River in the southeastern corner. These topographic differences correspond very closely to the distribution of geological formations. The low lands along Walnut and Pawnee rivers are covered by alluvium of Quaternary age. These flood plains are relatively narrow, less than a mile in width in most places.

Tertiary Rocks. On the highest hills, especially across the northern part of the county, are sands and gravels of Tertiary age. These materials were brought from the Rocky Mountain region by streams during the Tertiary period. They vary in thickness from a few to about 100 feet. North of Beeler, between the two eastward flowing branches of Walnut Creek, and south of Beeler, in T. 19 S., R. 26 W., are small areas covered by the same kind of rock.

Cretaceous Rocks. Below the Tertiary gravels and sands lie various kinds of rock representing the Cretaceous system in this part of Kansas. The highest and youngest strata belong to the Niobrara formation and consist of beds of chalk and chalky shale, with thin seams of bentonite. This formation has a maximum thickness of 368 feet in Ness County. The lower part of the Niobrara is the Hays limestone member. It is an important unit for mapping purposes, and consists of 80 feet of massively bedded cream-colored chalky rock. On account of its superior hardness compared with the rocks below, the Hays limestone commonly forms cliffs and bluffs. The underlying rock, the Carlile shale, covers the largest area in Ness County. It has a thickness of about 250 feet and consists of a grayish black fissile shale upper member and a chalky shale lower member[23]. The noncalcareous shale in the upper part contains several zones of large concretions, and many crystals of selenite which may weather out on slopes. The lower part of the Carlile consists of calcareous shale in which the chalky layers become more prominent as the base is approached. The abundant fossils, of which Ostrea congesta is perhaps the most typical, also distinguish this unit from other similar strata in the county.

The Greenhorn limestone has become famous on account of the slabs and posts of limestone which have been quarried from the uppermost layers. It underlies the Carlile and is about 90 feet thick. It outcrops only in the east-central and southeastern parts of the county, where rivers have cut through the Carlile shale, but it shows up prominently in well logs.

Subsurface Stratigraphy

In western Ness County wells begin in the Niobrara, and farther east in the lower Cretaceous rocks. The Carlile has been found to have a thickness of 150 feet in well cuttings, the

---

23. Moss, R. G. The geology of Ness and Hodgeman counties, Kansas: Kansas Geol. Survey, Bull. 19, p. 15, 1932.

Greenhorn 100 feet, and the Graneros 20 feet. Below, the widespread series of sandstones usually referred to as the Dakota appears in all wells. In the western part of the county the Dakota is 440 feet thick. Less than half of this interval is occupied by sandstone, the greater part being shale.

Permian Strata. The Permian red beds of the Cimarron series appear in all wells beneath the Cretaceous sandstones. They are about 1,000 feet thick, and are composed of red clays and siltstones. Some gypsum near the top is correlated with the Blaine or Medicine Lodge member. About 600 feet lower, another gypsum and dolomite unit is present. This is called the Enid or Cimarron anhydrite by petroleum geologists, and is regarded as the first important layer below the surface which has value for structure mapping. In seismograph work the reflections from this layer are very strong, and in the early period of seismograph exploration many maps were made on this horizon. It appears in well cuttings at a depth of 1,400 feet in eastern Ness and 1,700 feet in western Ness County. Beneath it are some 200 feet of red beds which also are included in the Cimarron series.

The gray shales, red shales, gypsum and salt beds which lie below the Cimarron belong to the Wellington formation of the Big Blue series. They are generally about 500 feet thick, and have a great abundance of anhydrite near the base. The first dolomitic limestone below the base is the Herington limestone. It appears at depths of around 2,300 feet, but is slightly higher in the east, and lower in the west. The Florence chert and Wreford chert layers are present in all wells and serve to identify this part of the Big Blue series. The basal limestone, the Americus, can also be distinguished, by its characteristic fossils and stratigraphic position.

Pennsylvanian Rocks. In Ness County the Pennsylvanian rocks are almost 2,000 feet thick. Near the top are clastic rocks and limestones in the Wabaunsee. The Topeka limestone, which marks the top of the Shawnee group, occurs at a depth of 3,200 to 3,400 feet. The Shawnee is mostly limestone, but some red shale appears near the middle. Its thickness approximates 300 feet. The underlying Douglas group is quite thin (50 to 70 feet), and consists of red and green shale with some siltstone, black shale, and limestone. As in other western Kansas counties, the top of the next unit is considered the most important for structure mapping. It is the Lansing, sometimes called the Kansas City or "Oswald". The series of thick limestones which begin around 3,600 to 3,800 feet in various parts of the county is the equivalent of the Lansing, Kansas City, and Bronson groups of eastern Kansas. In Ness County these formations occupy an interval of about 400 feet, and consist of limestones which are gray in color and microcrystalline in texture. Some layers of coarse white limestone are present also, and chert occurs at several levels and in some abundance. Fossils of common Pennsylvanian forms are present in well cuttings. Black shale is commonly present near the base.

The shales below the Bronson vary in thickness in different parts of the county. They are usually called Marmaton and Cherokee. The Marmaton contains much black shale in Ness County, and the Cherokee equivalent is composed predominantly of red and green shales. Thin limestones are also present. A basal conglomerate which occurs in some wells grades into the older rocks in such a way that determination of contacts is difficult. The cherty fragments, which represent detritus washed from hills

inn early Pennsylvanian time, are intermingled with the residual cherts of the Mississippian and Ordovician limestones.

Pre-Pennsylvanian Rocks. Due to the condition just described, there is at present no general agreement among geologists who study well cuttings about the exact age and sequence of the pre-Pennsylvanian strata. In many wells the Mississippian limestone and chat have been reported, at depths of 4,100 to 4,300 feet depending upon location and structural positions. Where present the limestone may be as much as 150 feet thick. Below it some wells encounter a thin zone of shale, which is interpreted as the Kinderhook formation. It consists of gray and green shale and may be from 20 to 60 feet thick.

Ordovician Rocks. As a general rule the Viola limestone is found beneath the Carboniferous rocks in Ness County. However, in the northeastern corner it is presumably absent on account of erosion, and there still older Ordovician rocks may lie immediately beneath the Carboniferous. The Viola in Ness County is very dolomitic, usually tan or cream-colored in the lower part and white above. Chert is very abundant, and a cherty residue similar to that at the top of the Mississippian may be present. A little sandstone within the Viola is reported in some wells. The thickness varies from 100 to 220 feet.

The Simpson is not always identifiable in this county. A few wells show the typical sub-rounded sand grains and the green shale of the Simpson, but others seem to pass directly into the Arbuckle. Whether the Simpson is here represented by dolomites similar to those above and below or whether it is missing in some areas is a problem for future investigation. The Arbuckle formation has been partially penetrated by some wells. It consists of coarse, pale cream-colored dolomite, in which oolitic chert is particularly significant. The depths to which this formation has been penetrated in various parts of Ness County are shown in the table on a subsequent page.

Structure

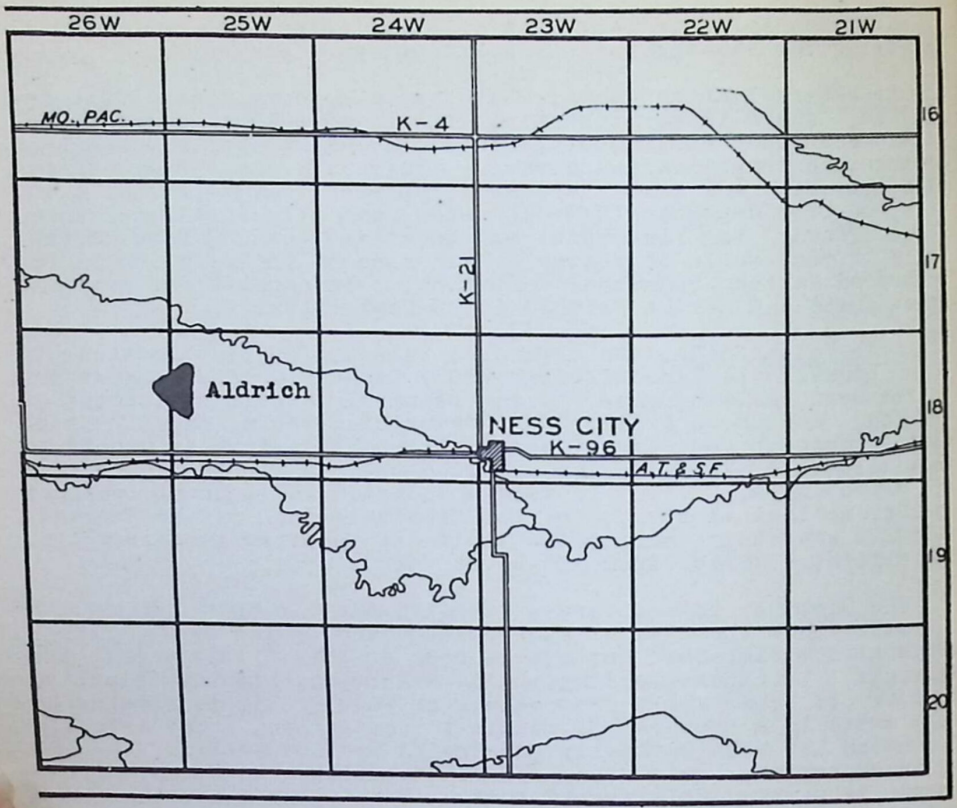
The surface rocks of Ness County dip gently toward the north at a rate equal to about 10 feet per mile. Contours on the Dakota[24] sandstone indicate that major modifications of the regional dip are present in the eastern and western tiers of ranges. This has caused much field work to be undertaken, both in mapping surface structure and in mapping subsurface structure by means of seismographs and other devices. On the strength of the findings quite a number of wells have been drilled. Wells drilled on the western or Beeler anticline have been successful in finding production.

Aldrich Pool

The Aldrich pool, named after the farm on which the Continental Oil Company discovered the first oil, includes all successful wells drilled in Ness County up to the close of 1937. The discovery well was drilled in sec. 7, T. 18 S., R. 25 W., and completed on October 29, 1929. The Marmaton and Cherokee unit was found at a depth of 4,402 feet. Drilling continued to 4,428

---

24. See Kansas Geol. Survey, Bull. 11, p. 85, pl. 7, 1926, and Kansas Geol. Survey, Bull. 19, pl. 7, 1932.



Ness County

where oil appeared in the hole. After drilling 2 feet more an initial production of 210 barrels of 33° Bé. gravity oil was estimated. The actual production was retarded on account of a lack of transportation facilities, and only 6,306 barrels were taken from the well during the next 5 years.

In June, 1936, the second well in the pool was completed. It was drilled on the Thompson ranch in sec. 13, T. 18 S. R. 26 W., also by the Continental Oil Company. This well was drilled deeper than the Aldrich into the Mississippian dolomite where production was found at 4,446 to 4,492 feet. A potential of 684 barrels was established, and the gravity was 36° Bé. The third well, drilled between these two in the southwest corner of sec. 7 on the Everett ranch, was a dry hole. A fourth well was completed during 1936, but developed difficulties which were not adjusted until October, 1937. It was drilled on the Tenny ranch near the center of sec. 19, T. 18 S., R. 25 W., about 2 miles south of the first well, by the Newton Development Company. An initial production of 50 barrels at 4,378 to 4,399 feet in the Fort Scott limestone greatly increased the proven acreage in the pool. An offset to this well was completed during 1937 on the Shiner farm in the northeast quarter of sec. 19, and two additional wells were drilling at the close of the year. A possible extension of this pool is a well drilled by Olson Drilling Company in sec. 5 of the same township. It found oil in the "Mississippi lime" at a depth of 4,301 to 4,302 feet. These produc-

iing formations are of varying age, but they may be very nearly tthe same because of uncertainty regarding the nature of the sediiments at the line of unconformity below the Pennsylvanian. It wwill remain for some future deep test, or possibly two, to decide the question. At the present time the oil is transported bby truck to the Kaw Pipe Line. Cumulative production to the end oof September, 1937, amounted to 19,174 barrels.

Important Test Wells

Gypsy No.1 Coleman, in sec. 25, T. 17 S., R. 25 W., top of DDakota, 460; Cimarron, 880; Wellington, 2,430; Conglomerate, 44,373; Mississippi lime, 4,384; Viola, 4,493; Simpson ? 4,600; AArbuckle ? 4,709; total depth, 4,807 feet in Arbuckle.

Plateau No. 1 Stucker, in sec. 1, T. 17 S., R. 26 W.,top of FFt. Hays, 0 - 220; Dakota, 600; Kiowa, 930; Cimarron, 1,070; BBlaine gypsum, 1,385; Enid anhydrite, 1,945; Wellington, 2,245; ttotal depth, 2,910 feet.

Barnsdall No.1 Lank, in sec. 35, T. 18 S., R. 21 W., top of AAnhydrite, 1,395; Lansing, 3,698; Conglomerate, 4,140; Mississippi lime, 4,207; Base, 4,390; Viola, 4,410; Arbuckle, 4,624; ttotal depth, 4,755 feet.

Sinclair No.1 Wilhelm, in sec. 16, T. 19 S., R.21 W., top of AAnhydrite, 1,420; Salt, 1,900; Herington, 2,250; Topeka, 3,322; LLansing, 3,708; Conglomerate, 4,238; Mississippi lime, 4,350; BBase, 4,527; Viola, 4,560; Simpson, 4,679; Arbuckle, 4,702; totttal depth, 4,777 feet.

Texas No.1 Goodman, in sec. 21, T. 19 S., R. 23 W., top of AAnhydrite, 1,570; Wellington, 1,980; Herington, 2,320; Americus, 22,990; Topeka, 3,420; Douglas, 3,695; Lansing, 3,750; Marmaton, 44,133; Conglomerate, 4,290; Mississippi lime, 4,370; Base, 44,528; Viola, 4,601; Simpson, 4,771; Arbuckle, 4,798; total ddepth, 5,047 feet.

PAWNEE COUNTY

Areal Geology

The highest part of Pawnee County is along the northern borcder. From there the land slopes southeastward toward Arkansas RRiver which cuts diagonally across the eastern half of the countty. The lowest land lies along the river and is composed of alIluvium deposited during Pleistocene and Recent times. Another wwide belt of alluvium lies in the valley of Pawnee River, from BBurdett to Larned. Southeast of Arkansas River are broad areas ccovered with dune sand, which was also laid down during Pleistoccene and Recent times.

Cretaceous Rocks. The unconsolidated Pleistocene and Recent mmaterials lie as an uneven blanket of no great thickness on the eeroded surface of the much older Cretaceous rocks. The rather uuneven character of the Cretaceous surface is suggested by such coutcrops as that of Pawnee Rock (17 miles northeast of Larned), tthe outcrops of similar sandstone just west of Larned, and two ssmall areas of Dakota rocks south of Burdett in the southwest ccorner of the county. This sandstone apparently underlies all cof the county. In the northern tier of townships somewhat yyounger members of the Cretaceous system appear on the surface,

belonging to the Carlile, Greenhorn and Graneros divisions. For details regarding their thickness and character the reader is referred to the chapter on Rush County.

Subsurface Stratigraphy

A sufficient number of deep test wells have been drilled in Pawnee County to convey definite information regarding the rocks which appear beneath the blanket of surface strata. Practically all show Dakota sandstone, but the thickness varies considerably from place to place. The Dakota consists of sandstones and shales, and since they are similar to the surface sands of various kinds it is not always possible to separate them in well logs. Below the Cretaceous rocks red beds appear, both red clays and red siltstones. They belong to the Cimarron series of upper Permian age. Thick beds of gypsum rather high in this series are believed to be the equivalent of the Blaine or Medicine Lodge gypsum. Lower in the red beds the widespread stratum called the Enid anhydrite, or sometimes the Cimarron anhydrite, appears in all wells. Its depth is approximately 1,100 feet below the surface in the eastern part of the county and around 1,400 feet in the western part. Below this layer of gypsum there may be some dolomite and then about 200 feet of red beds down to the top of the Wellington formation. The appearance of gray shales in considerable thickness indicates the Wellington formation. Near the middle are salt beds. In one well this salt was 280 feet thick (sec. 15, T. 23 S., R. 17 W). Below it the Wellington contains a predominance of anhydrite with thin gray shales interbedded.

The lower part of the Big Blue from the Herington to the Americus is well developed in Pawnee County. The characteristic chert zones within it can be traced from well to well. The thickness is approximately 600 feet. The limestones in this sequence are fairly thick and inclined to be dolomitic. Some gypsum occurs near the upper portion, and the shale breaks are predominantly red in color.

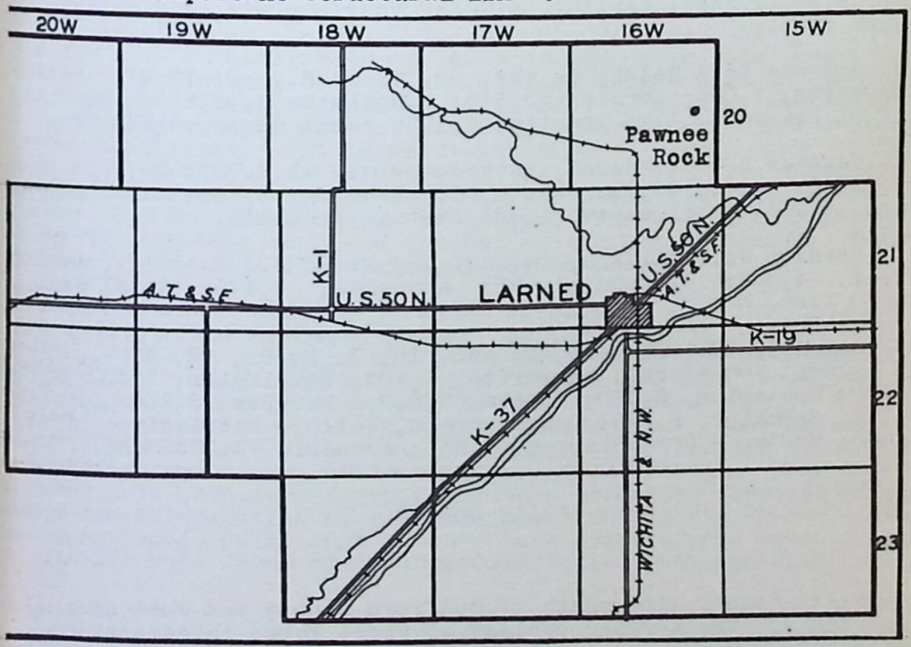
Pennsylvanian Rocks. The thickness of the Pennsylvanian strata in Pawnee County is approximately 1,500 feet. The upper portion is characterized by the presence of much shale with a certain amount of micaceous siltstone. It lies upon the Topeka limestone, which appears in well cuttings at depths of 3,100 to 3,200 feet. The Topeka is the first of a series of rather thick limestones which make up the Shawnee group. This group is slightly over 400 feet thick in Pawnee County. The Douglas group is represented by red and green shales, somewhat less than 100 feet thick. A thick series of white crystalline limestones at a depth of 3,500 to 3,700 feet is considered the equivalent of the Lansing, Kansas City, and Bronson groups of eastern Kansas. Considerable black shale, some chert and several oolitic zones serve to corroborate the identification. This unit has a thickness of 250 feet and lies upon a shaly zone correlated with the Marmaton and possibly the Cherokee. Paleontological work on the micro-fossils in this zone is necessary to determine the exact correlation. Black shales are present, especially in the upper half. Lower, the red and green colors begin to come in until in the basal conglomerate these are characteristic. Chert and other foreign matter also appear in the well cuttings from the basal conglomerate.

Pre-Pennsylvanian Rocks. Rocks of various older ages appear below the Pennsylvanian. In general these are much older, and

belong to the Ordovician system. However, in southeastern Pawnee County there may be some residual remnants of Mississippian limestone. This material is mostly decayed chert, and may be part of the Viola, which here is also cherty. In northeastern Pawnee County the Pennsylvanian conglomerate rests directly upon the Arbuckle dolomite. In the western part of the county the Simpson appears under the Pennsylvanian, and also under the Viola. Besides being very cherty, the Viola is rather coarsely crystalline in texture. It is usually brown in the upper part and white in the lower part. The thickness may vary from 30 to 90 feet, but in all probability this represents only a portion of the original thickness. The Simpson formation, characterized by green shale and some sandstone, varies from 50 to 90 feet. The underlying Arbuckle is a dolomitic limestone of pale-cream color. Its coarsely crystalline texture and the presence of oolitic chert make identification fairly definite. One well penetrated the formation and found it to be 140 feet thick. In general the Arbuckle may be expected to be rather thin in this county on account of the proximity of the Central Kansas Uplift to the northeast.

Structure

Few data are available on the structure of this county. The shallow water wells which penetrate the Dakota sandstone indicate a prevailing dip toward the north at a rate of about 10 feet per mile. There is some probability of an anticlinal trend across the county from north to south nearly through the center. This trend is now being investigated by means of seismograph testing. Other parallel trends may be present. It is more likely however, that the northwest to southeast folds overlying buried escarpments in the oldest rocks will eventually prove to be the most important structural lines.



Pawnee County

History of Oil and Gas Development

The first oil pool to be discovered in Pawnee County was located in September, 1936, when Simpson and Noble drilled their first well on the Gates ranch, in sec. 13, T. 20 S., R. 16 W. This test was completed at a depth of 3,841 feet in the Arbuckle formation. Oil was found 17 feet below the top of the "lime" which appeared at a depth of 3,815 feet, in a porous zone about 9 feet thick. The initial production was 187 barrels of 36° Be gravity oil accompanied by 4 million cubic feet of gas. A second well was completed early in 1937 near the center of the same section. It was drilled by the Stanolind Oil Company and completed for an initial production of 410 barrels of oil and 27 million cubic feet of gas. During December, 1937, three additional wells were completed as producers. Two of these are owned by the Mid-Continent Oil Company and one by the Stanolind and Amerada Oil companies jointly. These five wells produced a total of 9,876 barrels up to the close of 1937. A dry hole was drilled by the Stanolind Oil Company 2 miles south on the Jantz lease, otherwise no limits have been set for the pool.

The pool was named after Pawnee Rock, a village on the Santa Fe Railroad just north of the county line in Barton County. The oil is transported by trucks to the Falcon refinery at Great Bend in Barton County.

Important Test Wells

Kessler No.1 Gustafson, in sec. 27, T. 20 S., R. 16 W., top of Anhydrite, 1,048; Lansing, 3,488; Conglomerate, 3,710; Arbuckle, 3,809; total depth, 4,140 feet.

Phillips No.1 Johnson, in sec. 8, T. 20 S., R. 19 W., top of Anhydrite, 1,345; Lansing, 3,702; Conglomerate, 4,125; Viola, 4,252 feet.

Amerada No.1 Welch, in sec. 30, T. 21 S., R. 17 W., top of Anhydrite, 1,035; Lansing, 3,540; Conglomerate, 3,845; Arbuckle, 3,920; Reagan, 4,117; granite, 4,195; total depth, 4,220 feet.

Capshaw No.1 Riederer, in sec. 29, T. 21 S., R. 19 W., top of Anhydrite, 1,145; Topeka, 3,262; Lansing, 3,700; Mississippi lime, 4,263; total depth, 4,523 feet in Arbuckle.

Kessler No.1 Wallace, in sec. 16, T. 23 S., R. 15 W., top of Viola, 4,008; Simpson, 4,095; Arbuckle, 4,170; total depth, 4,200 feet.

Atlantic No.1 Slepake, in sec. 15, T. 23 S., R. 17 W., top of Dakota, 290 to 650; Anhydrite, 1,103; Wellington, 1,400; Salt, 1,720; Herington, 2,190; Topeka, 3,205; Douglas, 3,640; Lansing 3,731; Marmaton, 3,995; Conglomerate, 4,140; Mississippi lime, 4,208; Viola, 4,273; Simpson, 4,335; Arbuckle, 4,373 feet.

PRATT COUNTY

Geology

Pratt County lies south of Stafford County and west of Kingman County. The surface geology of these three is very similar. Quaternary dune sand covers the northern tier of townships and the northwestern corner of Pratt Crounty, and Tertiary sand and

gravel cover the rest of the county. The dunes reach a height of 80 feet in exceptional cases, but most of them average 30 feet. The materials of the Ogallala formation of Tertiary age vary from place to place. This formation also varies in thickness, with a maximum of about 200 feet, and a common thickness of about 100 feet.

Information regarding the subsurface geology must be gleaned from core-drill records and from deep test wells. These indicate that the Dakota sandstone lies beneath the Cenozoic rocks over most of the county. In the eastern part the Dakota is about 250 feet thick and consists of fine reddish sandstones. It rests unconformably upon the Permian red beds. The latter have a thickness of between 400 and 450 feet and show the unusual silty nature so characteristic in western Kansas. The Wellington gray shale is about 200 feet thick and is underlain by approximately 450 feet of salt and 110 feet of anhydrite. Both the salt and the anhydrite are abundantly interspersed with grayish clays.

The Herington member of the Big Blue is present in all wells and makes an excellent subsurface marker. It is dolomitic, and has considerable anhydrite within it as well as below. The base of the Ft. Riley is characterized by the usual fossiliferous chert. Limestones and thin shales, some of them red, make up the remainder of the 600 feet of this section down to the base of the Americus. The total thickness of the Permian is thus approximately 1,900 feet.

The Pennsylvanian Wabaunsee group is slightly over 500 feet thick, and can be identified by the micaceous siltstones and thin limestones which break the monotony of the shaly zone.

The Shawnee, with the Topeka limestone at the top and the Oread limestone at the base, is commonly 350 feet thick. It is composed of thick limestones interbedded with thin layers of shale. The underlying Douglas is more varied both in composition and thickness. Generally it is made up of gray shales, but occasionally a thick body of sandstone is present. This appears to be lenticular, and is water-bearing. At the base of the Douglas there is some evidence of an unconformity. Thin hard shelly limestones are present in the basal 15 feet of this group. Red and green shales of unequal thickness appear in some wells between this zone and the top of the Lansing group. Where missing a very thin black shale layer is present.

The "Oswald" sequence, which correlates with the Lansing, Kansas City, and Bronson groups on the outcrop, is 350 feet thick. Since it contains oil it is frequently cored so that details of lithology may be studied. Such studies reveal white limestones for the greater part of the thickness. These may be coarsely crystalline, or nearly lithographic. Thin layers of dark to black shale appear at intervals. The oolitic zones and the cherty zones can be traced from well to well. Where the oolites have been removed by solution a porosity develops which makes the accumulation of oil possible. One of the cherty zones is recognizable on account of the black color of the chert. Geologists[25] have found that such lithologic peculiarities are

---

25. Rutledge, R. B., and Bryant, H. S., Cunningham field, Kingman and Pratt counties, Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 21, p. 510, 1937.

persistent over considerable areas.

The Marmaton group which lies below the "Oswald" is characterized by thin limestones of reddish gray color interbedded with thicker shales. The latter are grayish near the top, but show red and green colors lower down. They rest upon the deeply eroded surface of the Mississippian strata.

In Pratt County the Mississippian system consists of two units, a limestone commonly 90 feet thick and a shale unit close to 200 feet thick. The surface of the limestone is generally covered with a greater or less thickness of decayed chert fragments. Below these a dolomitic limestone appears in which there is much white unweathered chert. The basal part of the limestone unit is a white to tan crystalline limestone in which chert is much less common. The shale unit is grayish in color at the top, and in many places contains a dolomitic zone in the lower third which may be logged as a limestone by the driller. Below this the shale is much darker and often black. In addition, it is characterized by the presence of round brownish spots which are believed to be spore cases of ancient plants. The name Chattanooga is often applied to these dark shales, and the name Kinderhook to the whole shale unit.

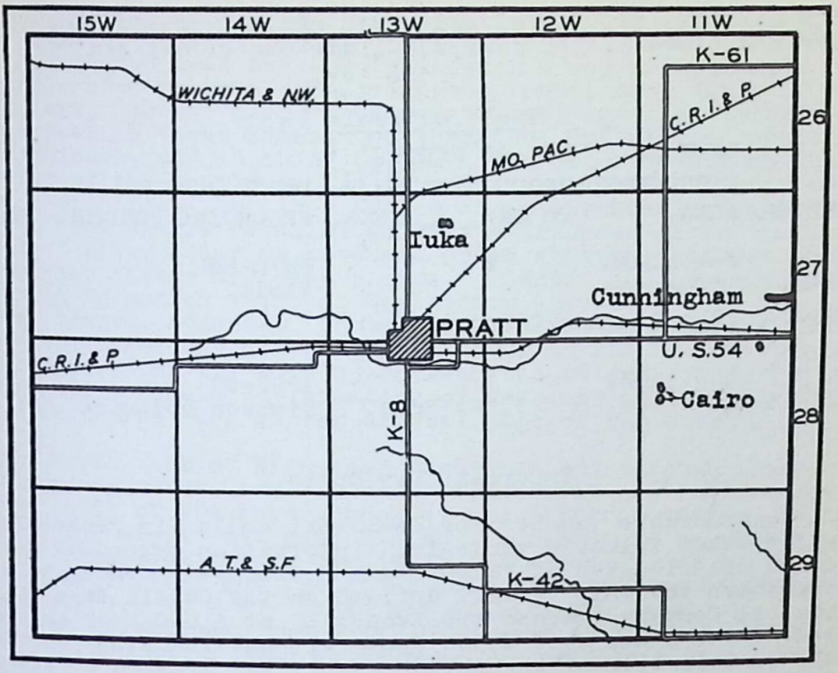
Another unconformity is present below the Chattanooga formation. No Devonian or Silurian rocks have been reported up to date in Pratt County. The Ordovician rocks, therefore, lie directly beneath the Mississippian. The Viola formation of the Ordovician appears in most well cuttings. It is commonly 80 feet thick, rather coarsely crystalline, and very cherty near the top. Dolomites, limestones and dolomitic limestones are present in this unit. The lowest 20 feet are quite free from chert and more coarsely crystalline than the upper 60 feet.

Below the Viola green shales and sandstones appear. These are correlated with the Simpson formation of Oklahoma. The upper 40 feet of Simpson is sandy, and easily identified by the presence of rounded frosted grains of quartz sand. These small grains may be imbedded in the green shale. The lower 50 feet is rather uniformly shaly, but the green color still persists and makes identification simple. The Simpson rests unconformably upon the dolomitic rocks called "Siliceous lime" or Arbuckle. Because few wells have penetrated it, no data are at hand regarding its thickness.

History of Oil and Gas Development

An extension well of the Cunningham pool of western Kingman County provided the first commercial oil well of Pratt County. It was drilled on the Maxedon farm in sec. 25, T. 27 S., R. 11 W., in July, 1935, and found production at a depth of 3,460 feet in the Lansing or "Oswald" limestone. The top of the formation was found at 3,416 feet, indicating that porosity existed at a level 44 feet below the upper surface of the limestone. Other less productive porous zones were encountered at 3,441, 3,445, 3,454, and 3,457 feet. In the adjoining part of the pool still lower porous zones seem to exist in the "Oswald" limestone. They are apparently zones where oolites have existed in the limestone which have been removed by solution. One seems to be a cherty limestone in which the creviced condition of the chert may be responsible for fluid accumulations. According to Rutledge and Bryant[26] many other potential oil and gas horizons ex-

26. Op. cit., p. 509.



Pratt County

ist in this pool. Gas, for instance, has been found in the Permian in no less than seven different horizons. In the Pennsylvanian rocks at least two gas horizons were found above the "Oswald" pay zone. Below the Pennsylvanian a large quantity of gas was found in the Viola "lime" of Ordovician age and smaller amounts in the Simpson as well as in the Arbuckle. Both surface and subsurface evidence indicate that this pool is located on a dome. The amount of closure on the Cimarron anhydrite is 25 feet, but is much greater in the older rocks. Some evidence of faulting was found in the pre-Pennsylvanian strata on the southeast side of the pool.

Cairo Gas Pool. In addition to the large gas reserves discovered in the Cunningham pool and its extension to the southwest, other gas reserves have been discovered near Cairo. The first well in this area was drilled by the Skelly Oil Company on the Gilchrist farm in sec. 7, T. 28 S., R. 11 W. It was successfully completed at a depth of 4,278 in the Viola limestone with a potential production of 14 million cubic feet of gas per day. Before the close of 1937 a second well with a similar potential capacity had been brought in.

Iuka Pool. During the year 1937 the second oil pool of Pratt County was discovered by the Atlantic Refining Company. The first well was drilled on the Runyon farm in sec. 11, T. 27 S., R. 13 W., and completed during the month of August of that year. It encountered a good showing of oil in a dolomite layer at the top of the Simpson formation, but was drilled down to the Arbuckle limestone. A hole full of water was found in this formation. Therefore, the hole was plugged back to the dolomite at 4,292 to 4,299 and acidized with 2,000 gallons of hydrochloric acid. On a test made later the potential of this well was fixed

at 397 barrels per day of oil and 2 million cubic feet of gas. Before the close of the year,2,921 barrels of oil had been taken from the well.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
CAIRO 7-28-11	Nov.,1935 160 acres	2	4278-85 Viola	Gas only
CUNNING-HAM	(See Kingman County)			
IUKA 11-27-13	Aug.,1937 40 acres	1 2,921 Bbls.	4292-99 Simpson dolomite	Oil and gas

Important Dry Holes

A considerable number of deep test wells in Pratt County have furnished valuable geological information regarding the nature and distribution of Paleozoic and Ordovician rocks. In the northwestern township a well drilled on the Battin farm by the Wilcox Oil Company reached the Arbuckle at 4,680 feet and penetrated it to a depth of 4,956 feet without reaching the base. In the eastern tier of townships a well was drilled by the Ninnescah Oil Company on the Hardesty farm in sec. 28, T. 27 S., R. 11 W., to a total depth of 4,427 feet. In this test the Viola was encountered at 4,297 and the "Wilcox" sand of the Simpson at 4,395 feet. The "Mississippi lime" was found at 4,050 feet with a thickness in excess of 100 feet. The top of the "Oswald" appeared in well cuttings at 3,600 feet.

Southwest of Pratt the Jones well of O'Haver found the Pennsylvanian basal conglomerate at 4,477 feet, the Simpson at 4,635 feet, and the Arbuckle at 4,745 feet. Three miles away in the same township, sec. 18, T. 28 S., R. 14 W., the Atlantic Refining Company drilled a well on the Prentice farm which entered the anhydrite at 885 feet and the "Oswald" at 4,605 feet. A thin section of the Mississippian was found, below which the Viola appeared at 4,630 feet and the Simpson at 4,690 feet. After drilling 85 feet the Arbuckle was encountered and drilling was continued to a depth of 4,798 feet.

South of the Cunningham pool, in T. 29 S., R. 11 W., the Indian Territory Illuminating Oil Company drilled a well on the Bolt farm. The Cimarron anhydrite appeared at 1,609, the Topeka at 3,160, the Mississippian at 4,176, the Viola at 4,383, Simpson green shale at 4,474 and sand at 4,484, and the Arbuckle at 4,579 feet. The Arbuckle was penetrated 18 feet to the total depth of 4,597 feet. About seven miles west of this test the Lario Oil Company drilled its No. 1 Lemon well to a total depth of 4,728 feet. The top of the Topeka was at 3,340, the Lansing at 3,840, the "Mississippi lime" at 4,363, the Viola at 4,514, the Simpson at 4,606, and the Arbuckle at 4,699 feet. In this well the "Mississippi lime" is 115 feet thick.

RENO COUNTY

Areal Geology

The surface geology of Reno County is quite varied. Quaternnary rocks of several kinds, Tertiary rocks, and Permian rocks aare distributed over the county in such a way as to make a ratheer complicated pattern. The youngest rocks, dune sands of Quateernary age, occur along Arkansas River and its tributaries. TThey appear in three areas, northwest of Hutchinson, northeast oof Hutchinson, and south of Sylvia. The patch in the northwesteern part of the county is the largest and covers approximately sseven townships. The long narrow strip northeast of Hutchinson eextends from Wherry parallel to Little Arkansas River into Reno CCounty. River alluvium covers a broad stretch between the Arkkansas and Little Arkansas rivers. Sands and gravels of the MMcPherson formation (also of Quaternary age) crop out in a long nnarrow tongue adjacent to the south bank of Arkansas River. MMuch older sands and gravels which occur in the southwestern and ssouthern parts of the county, between Olcott and Pretty Prairie, bbelong in the Ogalalla formation of Tertiary age. This formattion also covers much of the central part of the county.

The North Fork of Ninnescah River has cut through these relaatively young rocks and exposed a wide strip of Permian rocks. AA large part of the Enid group of the Cimarron series is thus eexposed for study and can be used in structure mapping. The KKingman sandstone lentil can be traced across T. 25 S., R. 8 W., ssouth of Arlington, and the Stone Corral lentil can be traced accross T. 25 S., R. 7 W. These are distinctive layers in a serlies of red siltstones, the total thickness of which is about 520 ffeet in Reno County. The upper portion, usually classified as tthe Blaine formation, and higher formations in the Cimarron have bbeen found in deep wells drilled in western Reno County, under a ccover of younger rocks.

Subsurface Stratigraphy

Many wells drilled in all parts of the county have given us ffairly complete information regarding the buried strata. The tthree members of the Wellington formation are present in typical dievelopment. The upper third consists of gray soft shales and cclays with red layers. The middle member is the Wellington ssalt, which here varies in thickness from about 150 to 300 feet. TThe greatest thickness has been found in wells drilled in the ccentral and west-central parts of the county. Toward the southwwest and the northeast the thickness diminishes. As usual much ssoft shale is interbedded with the pure salt. Below the salt llies the anhydrite member, which is commonly 125 feet thick in tthis part of the state and contains much soft gray clay in additton to the typical anhydrite.

The first thin dolomitic limestone marks both the Herington aand the top of a section of limestones and shales 600 feet thick wwhich is correlated with the Big Blue series. A number of markeers important in subsurface correlation appear within this serlies. At a depth of 225 feet the chert of the Florence appears iin the well cuttings. Seventy-five feet lower another chert, ccorrelated with the Wreford, is found. At the base occurs the vvery fossiliferous Americus limestone.

Pennsylvanian Rocks. The succeeding 600 feet of strata are ccharacterized by the predominance of shale, which is usually ggrayish, but in some places reddish and greenish. Thin limesitones interbedded with these shales and sandy zones may make tthis sequence more distinctive. This part of the section is ccorrelated with the Wabaunsee. It is underlain by the limesitones of the Shawnee group. The Topeka limestone at the top is

picked in well cuttings because of its importance in well correlation. The Shawnee group is 375 feet thick in Reno County. At its base is the Oread limestone in which the Heebner black shale makes a convenient marker.

The Douglas group is about 125 feet thick in Reno County and can be recognized in well cuttings by the appearance of shales, sandstone and red rock. It is underlain by the Lansing, Kansas City, and Bronson groups of limestones, which are about 350 to 400 feet thick in most wells. This prominent succession of limestones is broken by thin black shales, as well as some red and green shales. The Marmaton varies considerably in thickness and even more in composition. In some wells it is 250 feet thick and in others it may be less than 100 feet thick. It is composed of red, green, and black shales with thin limestone beds at intervals.

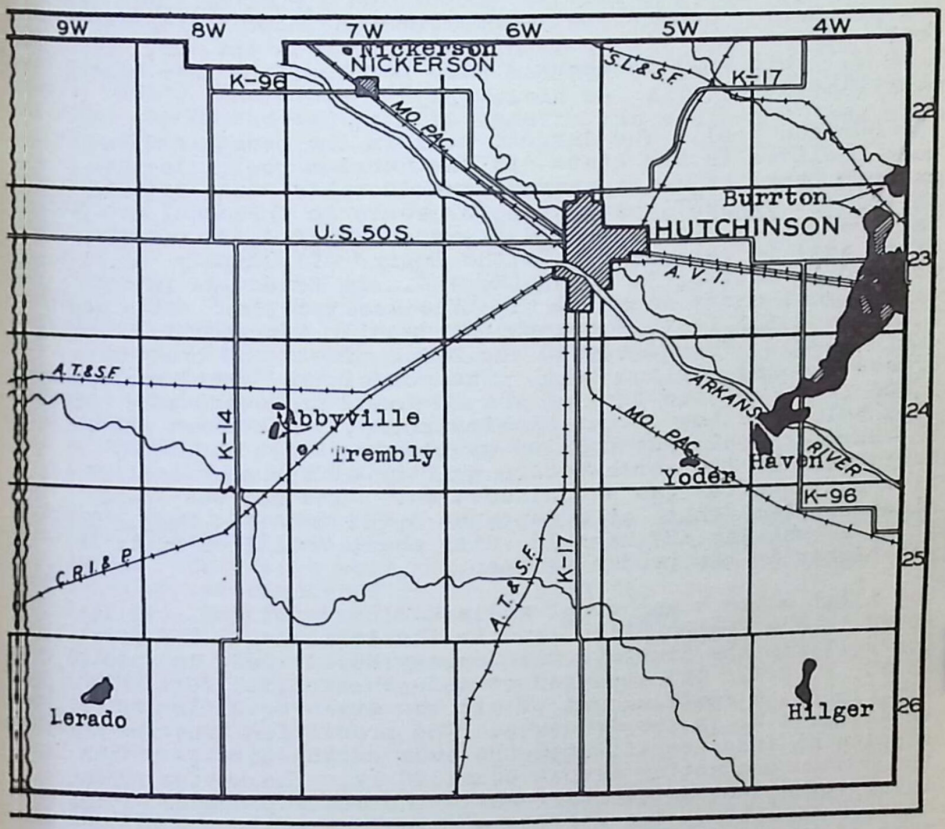
Pre-Pennsylvanian Rocks. An unconformity appears below the Pennsylvanian and for that reason the "Mississippi lime" varies in thickness. The limits are perhaps from a few feet to a maximum of 400 feet. White, rather coarse limestone with much chert or tripoli at the top, occurring at depths varying from 3,200 to 3,900 feet, identify this formation. The appearance of dark-gray and black shales beneath serve to substantiate this determination. The name Kinderhook is commonly applied to these shales, but where they are black the name Chattanooga is preferred. From 100 to 250 feet of Kinderhook is present in Reno County. A thin zone of sandstone, rarely more than 5 feet thick is interpreted as the Misener sand. It is particularly well developed in the northeastern part of the county.

Pre-Mississippian Rocks. The rocks beneath the Mississippian were uplifted and truncated before the Kinderhook was laid down on them. For that reason test wells find Hunton, Sylvan, Viola, or Simpson under the Mississippian rocks. In the five townships of northeastern Reno County the Hunton limestone of Devonian and Silurian age underlies the unconformity. Much of it is coarsely crystalline white limestone, but some is brown dolomitic limestone. The thickness varies, but an average of 40 feet is quite common. The Sylvan shale lies between the Hunton and the Viola limestone. It is the topmost Ordovician formation in Reno County, and is usually about 50 to 60 feet thick.

The Viola limestone is generally thin in Reno County. The upper part is cherty, and when higher Ordovician formations are missing it may consist only of a cherty residue. The lower part is white and coarsely crystalline. The Viola is the producing formation in the Hilger and Lerado pools. Its thickness varies from a very few feet to nearly 100 feet, but a common average is 30 feet. Everywhere beneath the Viola a green shale, the Simpson formation, is found. Many well cuttings show small well-rounded grains of sand imbedded in this shale, and in places the sand forms lenses which may occupy nearly the whole Simpson interval. In studying the records of deep wells one is struck by the fact that the Simpson is very commonly about 90 feet thick over the whole county. The percentage of green shale and sandstone varies, but there is a tendency for the sandstone to predominate.

Many wells have gone into the Arbuckle and have found the usual coarse dolomitic rock at this level. A few wells have penetrated the limestone, one well finding it to be 650 feet thick. A zone of oolitic chert, and another zone of cherty dol-

conite, serve as markers in this interesting formation. Some sand appears at several levels also. The Reagan formation below the Arbuckle consists of coarse white sand in which the grains are well rounded. In one well this sand was found to be 330 feet thick, but the basal part is interpreted by some geologists to be granite wash. Our information on the Reagan will increase as water disposal wells are drilled in various parts of the county.



Reno County

History of Oil and Gas Development

By the end of 1937 seven oil and gas pools had been found in Reno County. The first of these was the Abbyville pool in sec. 24, T. 24 S., R. 8 W., and surrounding sections. The discovery well, which was drilled by Hartman and Skaer in 1927 on the Smith farm, obtained production at a depth of 3,540 to 3,545 feet in the "Oswald" or Lansing limestone zone. Rapid exhaustion of this formation caused the owners to deepen the well to 3,558 feet where no increase was found. A production of about 15,000 barrels was secured from this well between January, 1927, and the end of that year. Eight other wells were drilled within the 200 acre limits of the pool. In one gas was found in April, 1930. At the present time six wells are producing and three have been abandoned. The total production for 1934 was 52,431 barrels; for 1935 about 75,304 barrels; for 1936, 51,135 barrels; and for

1937, 47,936 barrels. The gravity of the oil is 37° Bé. Two wells drilled in the vicinity of this pool are sometimes included in it. One of these is the Skelly Oil Company No. 1 Trembly in sec. 30, T. 24 S., R. 7 W. It was completed in April, 1930, as a gas well in the Admire shale at 2,087 feet depth. All lower formations down to the Arbuckle were barren. The "Mississippi lime" was found at 3,772 feet, with its base at 3,910 feet. The Viola appeared at 4,127, the "Wilcox" or Simpson at 4,161, and the Arbuckle at 4,224 feet. Total depth was 4,247 feet, and the initial production 1,800,000 cubic feet of gas per day. Another well sometimes included in the Abbyville pool is the Dunn Oil Company No. 1 Love in sec. 13, T. 24 S., R. 8 W. This well is about a mile north of the main part of the Abbyville pool.

Burrton Pool. The largest pool in the county and one of the most prolific in the state is the Burrton pool, located in the eastern part of the county about 10 miles east of Hutchinson. At the end of 1937 there were 457 wells in this pool and the total production had reached a figure of 21,410,489 barrels. The first well in this pool was the Empire Oil Company No. 1 Haury drilled in sec. 1, T. 23 S., R. 4 W. It found gas in the "chat" or residual chert zone of the "Mississippi lime" at a depth of 3,298 to 3,333 feet, where the production amounted to 23 million cubic feet. When deepened to 3,368 feet the production increased to 26½ million feet. The top of the "chat" was found at 3,256 feet, so the top of the 70 foot producing zone lies 42 feet below the top of the Mississippian. The first oil well in the Burrton pool was drilled by Lloyd, Frost and Study on the Haury farm in the northwestern quarter of the same section about five months after gas was discovered. The oil was found in the Mississippian "chat" at a depth of 3,254 to 3,364 feet. The initial amount was 327 barrels, with about 7 million cubic feet of gas higher in the producing zone.

After quite a number of wells had been drilled, oil was also found in the Hunton "lime" and in the Arbuckle. The first Hunton well was the Sinclair Oil Company No. 1 Base in sec. 26, T. 23 S., R. 4 W. Oil appeared at a depth of 3,385 feet. In January, 1935, a small amount of oil was discovered in sec. 11, T. 23 S., R. 4 W. in the Arbuckle. The production from the Mississippian at first constituted the bulk of the total, but in 1936 the Hunton production almost equalled it. The Hunton produced a total of 2,458,552 barrels while the chat produced 2,685,105 barrels in 1936. The gravity of the Hunton oil is 42° Bé. and that of the "chat" 37° Bé. The area of the pool (including the portion at first called Stone pool) is about 5,000 acres. The structure is anticlinal in the upper strata, probably overlying a faulted anticline in the older rocks. This is one of the most symmetrical structures in western Kansas.

Many attempts to find the southern extension of the Burrton pool have failed. However, some oil was thus found in two small areas, the Haven and Yoder pools. The former is three miles southwest of the Burrton pool. It was discovered by Tatlock when he drilled his No. 1 Tonn well in sec. 17, T. 25 S., R. 4 W. The initial production of this well was 200 barrels from the "chat", found at 3,605 to 3,609 feet. However, after yielding 5,877 barrels it ceased to produce and was therefore deepened to the Arbuckle, but as no other oil production was found it was abandoned. Some years later the Haynes Drilling Company drilled No. 1 Mueller in sec. 30, T. 24 S., R. 4 W. This well found an initial production of 408 barrels of oil in the "chat" at a depth of 3,400 feet. The oil has a gravity of 40° Bé. Subse-

quently the area between this well and the Burrton pool to the northeast has proved to be productive, so the Haven pool has become a part of the enlarged Burrton pool.

Yoder Pool. Three miles west of the south end of the Burrton pool a well was drilled by the McPherson Drilling Company on the Miller farm in October, 1935. This test found initial production of 176 barrels in the "chat" at a depth of 3,402 to 3,501 feet. Since then four other oil wells and two gas wells have been drilled in the Yoder pool, defining about 500 acres as productive territory. The gravity of the oil is 36° Bé. It is not possible to state what the ultimate limits of the pool will be. Production to the end of 1937 was 40,838 barrels. In September, 1937, the average daily yield was only 35 barrels and the total up to the end of that month was slightly less than 347,000 barrels.

Hilger Pool. In the southeastern township of the county the Stanolind Oil Company opened up a pool in June, 1934, when they drilled in the No. 1 well on the Hilger farm in sec. 16, T. 26 S., R. 4 W. The Mississippian "chat" is present in this area, but carries no oil or gas. The Hunton and Sylvan shale are missing. The Viola was encountered at 4,062 to 4,067 feet and produced almost 1,000 barrels in the initial potential test. The oil is 42° Bé. gravity. A total of 40 wells, of which six were dry holes, have been drilled in an area of 600 acres. The oil wells produced 66,174 barrels during 1935, 310,341 barrels during 1936, and 539,041 barrels during 1937. The total production to the end of that year amounted to 935,604 barrels. The structure of the pool is anticlinal.

Lerado Pool. Another pool which obtains its production from the Viola "lime" is the Lerado pool in the southwestern part of the county. The first well was the Shell Petroleum Company No. 1 Reese which was completed in October, 1935, in sec. 11, T. 26 S., R. 9 W. The Topeka is reached at 2,795, the Lansing at 3,345, and the Mississippian "chat" at 3,876 feet. The first well found the "Mississippi lime" 74 feet thick and drilled on down through 178 feet of shale to the top of the Viola at 4,128 feet. The porous pay zone in this limestone was found 9 feet below the top at 4,137 to 4,156 feet. The initial production was 878 barrels in 24 hours with 1½ million cubic feet of gas.

A total of 43 wells have been drilled, defining a productive area of at least 1,800 acres. Six deep dry holes are included in this number, which define the eastern and western limits for the time being. Two other dry holes drilled on the Shepherd farm a half mile south of the pool are not included. Production from the Lerado pool amounted to 9,186 barrels during 1935, but increased sharply to 334,187 during 1936 and 803,427 barrels during 1937. Total production up to the end of that year amounts to 1,146,800 barrels. The average gravity of the oil is 40° Bé.

Production Data

Reno County began producing in 1930 when 11,508 barrels were marketed. Gradual increases will be noted until 1936 when 6,043,935 barrels were produced and 6,933,614 barrels in 1937, making a grand total of 23,833,614 barrels to the end of that year. The oil from the Abbyville pool is taken by the Skelly Oil Company. The Hilger pool is serviced by the Stanolind pipe line which ran an average of 1,600 barrels per day during September, 1937. Quite a number of pipe lines tap the Burrton

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
ABBY-VILLE 24-24-8	Jan.,1927 1200 acres	6 281,685 Bbls.	3540-44 Lansing - K.C.	3 dry 2 abd Grav.37
BURRTON 23-23-4	Apr.,1931 5000 acres	36 32 billion cu.ft.	3298-3368 Chat	Gas
1-23-4	Feb.,1931 5000 acres	318 21,410,489 Bbls.	3328-3338 Chat	Oil Grav.37
26-23-4	Mar.,1934	102	3585-3591 Hunton	Oil Grav.42
11-23-4	Dec.,1934	1	3775-3784 Arbuckle	Oil Grav.42
HILGER 16-26-4	Apr.,1934 600 acres	34 953,604 Bbls.	4062-67 Viola	6 dry Grav.40
LERADO 11-26-9	Nov.,1935 1800 acres	37 1,146,800 Bbls.	4137-56 Viola	6 dry Grav.40
NICKER-SON 4-22-7	June,1937 40 acres	1 198 Bbls.	3243-87 Lansing - K.C.	Pot.156 B.
TREMBLY 30-24-7	Apr.,1930 160 acres	1	2075-87 Admire	Shut in gas
YODER 34-24-5	Oct.,1935 500 acres	2 40,838 Bbls.	3402-3452 Chat	Gas
		6	3400-3501 Chat	Oil Grav.36

pool, including the Derby, Shell, Sinclair, Skelly, and Magnolia. During September a daily average of 14,600 barrels were run through these lines. In the Lerado pool the largest amount of acreage and production is owned by the Shell Petroleum Company. Other companies interested are the Empire, Ohio, and Gulf who own 10 wells out of the 36 producers. All the oil is carried through the Skelly Oil Company pipe line. In the Yoder pool the acreage is divided among four companies, the Empire, Derby, McPherson, and Ohio, but all the oil is run by the Derby Oil Company. The gas, available from some of the pools, is taken by the Panhandle Eastern, Empire, Kansas Pipe line and Gas, and Consolidated Gas companies.

Important Dry Holes

Quite a few isolated dry holes have been drilled in Reno County. Many of them yield important information on the stratigraphy and structure of the older rocks.

In the northern part of the county the test drilled by Lario Oil Company on the Shepherd farm in sec. 18, T. 22 S., R. 5 W. found the Lansing at 2,950 feet, "chat" at 3,565 with base at 3,783, Viola at 4,050, Simpson at 4,067, and Arbuckle at 4,143 feet. In the next township to the west the Atlantic No. 1 Phillips well in section 22 found the Lansing at 2,855, the "chat" at 3,511, Hunton at 3,885, Viola at 3,943, Simpson at 3,970, and top of the Arbuckle at 4,048 feet in depth. In T. 22 S., R. 7 W., a test drilled by Miller on the Detter farm showed the

Lansing at 2,992, "chat" at 3,525 to 3,583, Viola at 3,825, Simpson at 3,859, and Arbuckle at 3,910. An important test was drilled by Westgate on the Fossey farm in sec. 12, T. 22 S., R. 8 W. It found the Lansing at 3,058, "chat" at 3,566 to 3,650, Misener sand at 3,880, Viola at 3,895, Simpson at 3,916, and Arbuckle at 4,000 feet. In the extreme northwestern township the Carlock No. 1 Brown Royalty well found the Lansing at 3,258, basal conglomerate at 3,605, and Arbuckle at 3,690 feet.

Ten miles west of Hutchinson, the Atlantic No. 1 Page well found the Topeka at 2,583, Lansing at 3,100, basal conglomerate at 3,653, "chat" at 3,675, Viola at 3,965, Simpson at 3,995, and Arbuckle at 4,069 feet. A deep water disposal well drilled by the Gypsy Oil Company on the Myers farm (No. 2), in sec.3, T. 24 S., R. 4 W., furnishes some interesting data on the older rocks. The chat extended from 3,263 to 3,515, Kinderhook to 3,594, Hunton to 3,703, Viola to 3,722, and Simpson to 3,815 where the top of the Arbuckle was encountered. The Arbuckle proved to be 645 feet thick, and had white sand below it for 70 feet. From 4,520 to 4,772 feet, the total depth, red sand was found. The basal sand in the Burrton pool area thus seems to be very thick.

In the southwestern part of the county a well was drilled by Graham on the Miller farm in sec. 36, T. 25 S. R. 10 W. It found the "Mississippi lime" at 3,865, Viola at 4,152, Simpson at 4,245, and Arbuckle at 4,333 feet. The total depth was 4,362 feet. In the south-central part of the county one test well (Skelly No. 1 Cole) found the Lansing at 3,242 with a thickness of 400 feet, the "Mississippi lime" at 3,838 feet, with a thickness of 115 feet, the Viola at 4,177, Simpson at 4,215, and Arbuckle at 4,308 feet. In the southwestern township (T. 26 S., R. 10 W.) the No. 1 Crotts well drilled in sec. 27 found the Topeka at 2,863, Lansing at 3,485, "Mississippi lime" at 3,981 to 4,050, Viola at 4,240, Simpson at 4,325, and Arbuckle at 4,413 feet.

RICE COUNTY

Areal Geology

The rocks which appear at the surface in Rice County are of Cenozoic and Mesozoic age. The Cenozoic is represented by the two kinds of river alluvium, one of which is very young geologically speaking. It occupies a narrow strip along the southern border of the county and consists for the most part of sand and fine gravel. Its proximity to Arkansas River, and the fact that it is low, indicate that this material was laid down in the river valley during times of flood. Cow Creek, which flows parallel to Arkansas River from Lyons southeastward toward Hutchinson, marks the northeastern border of this type of material. Along the eastern bank of Cow Creek a narrow zone of dune sands of Quaternary age is shown on the state geological map. A large area in northern Rice County, north of Raymond, Silica, and Chase, is underlain by another sand and gravel deposit, which has been named the McPherson formation or Equus beds and is of Pleistocene age. Core-drill holes indicate that this water-bearing formation is from 50 to 125 feet thick, and probably at one time was continuous with similar materials now found in the vicinity of McPherson.

At present there is a narrow triangular-shaped area in eastern Rice and western McPherson counties from which the flat terrace gravels have been removed by stream erosion. Little Arkan-

sas River rises just south of Geneseo and flows through this area toward Buhler in Reno County. In doing so it passes across the lowest beds of the Dakota sandstone formation of upper Cretaceous age as well as across some of the Permian rocks of the Cimarron division. The Dakota sandstone is a coarse brownish rock which produces a rather rugged topography. Examination of small pieces shows that it contains much hydrous iron oxide which coats the sand grains. In places the iron is so abundant that hard crusts or sheets are formed. The reader who wishes further details about this interesting formation is referred to an article by Tester[27] in which the grain size, and character of the rock are very thoroughly described. Some details about its character and distribution are also given by Twenhofel[28] in his treatise on the Comanchean and Dakota formations of Kansas. He describes especially a good section of rock in the vicinity of Natural Corral, a box canyon about 5 miles southwest of the town of Marquette in northwestern McPherson County.

Below the hard layers of the Dakota sandstone entirely different material may be seen at many points between Little River and Windom. This lower rock is distinguished by its great variety of colors and its softness. Green, red, purple and yellow muds and clays appear wherever small streams have made cuts into the hillsides. These rocks have been included in the Belvidere formation by Twenhofel. Previously they were named the Mentor beds by Cragin[29]. At present there is still a great deal of uncertainty about the exact age and relations of these interesting beds. By most geologists they are placed in the Comanchean division of the Cretaceous system.

Permian Rocks. Below a striking unconformity, that forms the lower Cretaceous boundary in this part of Kansas, red rocks appear. They belong to the Cimarron division of the upper Permian. The highest beds of this division were removed by erosion prior to the invasion of the Cretaceous seas. Only a limited thickness of the beds above the Stone Corral member (Cimarron anhydrite) are now exposed on the surface. The Stone Corral dolomite may be seen in eastern Rice County south of the village of Little River in T. 20 S., R. 6 W., and T. 19 S., R. 6 W. The outcrop may be followed from the northwest corner of section 11, T. 20 S., R. 6 W., southward to the southwest corner of section 26. A particularly good outcrop may be seen in the southwest quarter of section 23 along the section line read. A good exposure of the basal contact may be studied in the northwest corner of section 14. Additional outcrops have been noted in sec. 9, T. 22 S., R. 6 W., from where the outcrop may be traced southeastward and northwestward. The clayey, reddish siltstones of the Cimarron that lie below the Stone Corral member are seldom exposed in this county.

Subsurface Stratigraphy

In well cuttings it is possible to secure a fairly complete sequence of the Cimarron series. A well in northwestern Rice County encountered the Cimarron at 300 feet below the surface and continued in red beds down to 760 feet. The Stone Corral

---

27. Iowa Geol. Survey, Ann. Rept. for 1929, vol. 35 pp. 199-322.
28. Kansas Geol. Survey, Bull. 9, 1924.
29. Cragin, F. W., The Mentor Beds: Am. Geologist, vol.16, p. 162, 1895.

member in this well was found at 505 feet, or at an elevation of 1,281 feet above sea level. Typical gray shales of the upper Wellington appear in well cuttings below the Cimarron. These are about 150 feet thick, and are interrupted by a thin zone of red shales. The middle Wellington salt is found in practically all wells. It varies in thickness from 300 feet in eastern Rice County to about 200 feet in northwestern Rice County. At Lyons this salt is mined by means of shafts, brought to the surface, crushed and prepared for market. It is also obtained by brine wells. As usual much clay and shale is interbedded with the salt layers. Below the salt is a layer of from 100 to 140 feet thick consisting largely of anhydrite or gypsum in which some shale is also present. This is the lower third of the Wellington formation of the Big Blue series. The main part of the Big Blue, extending from the Herington limestone or dolomite down to the base of the Americus limestone, is also fully developed in this county. Its average thickness is 600 feet. Various beds and layers appear in this sequence which are so distinctive that wupper hole correlations are usually based on them. One is the chert layer about the middle which has fusulinid fossils in great abundance; 75 feet below it is another cherty layer, the Threford. The basal member may be recognized by the profusion of fusulinid fossils.

The Pennsylvanian rocks in Rice County are 1,200 feet thick. They may be divided into five natural units which correspond to the Wabaunsee, Shawnee, Douglas, Lansing-Kansas City-Bronson, and Marmaton strata farther east. The Wabaunsee is composed predominantly of gray shales. Thin limestones, of which the Tarkio and Howard are easily identifiable in well cuttings, serve to relieve the monotony of this shaly sequence. Some sandy shales also come into this part of the section to corroborate the determinations. The succeeding thick limestones with thin shale breaks are correlated with the Shawnee group. It has an average thickness of 260 feet in Rice County. The Douglas is about half as thick and consists of gray shales with a small amount of red shale and some sandstone. Where near the top the sandstone is correlated with the Ireland sandstone, and where near the base with the Stranger sandstone.

On account of its great importance for structural mapping the top of the Lansing is picked with the greatest care. It is a fairly coarse and in most places white limestone, within which are cherty zones and oolitic streaks. The Kansas City division of this series of limestones is difficult to pick, although shaly layers and some sandstone near the middle may indicate its approximate position. Similarly the Bronson is not easy to differentiate except that the base is fairly well marked in most places.

The red shales, gray shales, and cherty detritus at the base of the Pennsylvanian is included in the Marmaton. When the detrital material at the base is coarse and varied it is called Pennsylvanian basal conglomerate, which varies greatly in thickness and composition. Besides chert and red clay, sandstone in well-defined bodies may occur. Such is the case in the Wherry district where oil and gas are stored in the basal conglomerate.

Pre-Pennsylvanian Rocks. In the Wherry district the basal conglomerate lies directly upon the erosional detritus or insoluble residue from the "Mississippi lime". Being very similar it is often difficult to divide them. The decayed chalky appearance of the chert fragments dissolved out of the lime when it

was subjected to weathering aids in distinguishing it in well cuttings. In general very little of the "Mississippi lime" was left in Rice County, as proved by a thickness of less than 50 feet in most deep wells. In fact this limestone is only found in Ranges 6 and 7 in the eastern and southeastern part of the county. It may be expected at a depth of around 3,300 to 3,400 feet. The Kinderhook shale which lies beneath it occurs over a somewhat wider area. It is found not only in Ranges 6 and 7 but also in Range 8 W., especially in Townships 19 S. to 21 S. Dark-gray to greenish shale with occasional black streaks identify this unit in the section. The thickness is not very great and probably nowhere exceeds 50 feet. At the base the thin Misener sand has been found in a few wells.

In Township 20 S., Range 7 W., the Kinderhook is thickest. There the Kinderhook limestone is also found. The latter is a white coarsely crystalline limestone and has a maximum thickness of perhaps 120 feet. It apparently extends into Township 20 S., Range 8 W., but with a much reduced thickness. As a general rule the Viola limestone or some older formation is present beneath the Mississippian in the eastern part, and the Pennsylvanian in the western part of the county. The underground relationships are thus quite complicated and the study of well cuttings becomes most important.

The Viola is found at depths ranging from 3,300 in Range 6 to 3,750 in Range 7. In Ranges 8 and 9 it appears at considerably higher elevations, at depths of from about 3,200 to 3,500 feet. This is partly a reflection of the Ellsworth Arch which passes through the western part of the county, and partly due to the eastern end of the Barton Arch which enters the county from the west.

Where the Viola is present (and this seems to be the case except in the westernmost tier of townships of Rice County), the Simpson appears beneath it. The peculiar green color of the shales and the presence of rounded and frosted grains of sand make this formation easily identifiable. It varies somewhat in thickness, the minimum being nearly nothing and the maximum perhaps 75 feet. Quite commonly it is 35 to 40 feet thick. The Simpson is entirely missing in parts of Range 10.

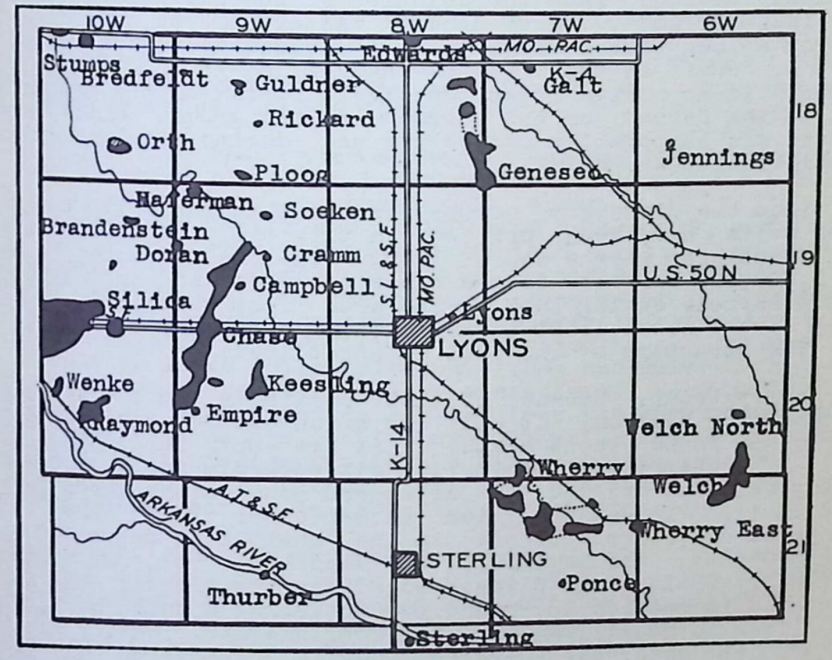
The Arbuckle is also missing in a small part (Orth pool) of Township 18 S., Range 10 W. Elsewhere,however, it is present and in greatly varying thickness. The coarse dolomitic character of the formation and the common appearance of oolitic chert serve to identify it in well cuttings. It is reached at depths of 3,600 feet in the eastern tier of townships, but gets much deeper in Range 7 W. It rises rapidly in Range 8 to depths varying from 3,100 to 3,600, and is uniformly high in Ranges 9 and 10. The wells which have penetrated the Arbuckle have found thicknesses from a few to over 800 feet. Below it either basal sand (Reagan or Lamotte) is found or, as in the Orth pool, pre-Cambrian rocks. In the No. 6 Linke well of the Phillips Petroleum Company the basal sand is 115 feet thick and rests upon granite. In the Orth pool it is entirely absent and the Pennsylvanian rocks rest upon pre-Cambrian quartzite.

Structure

On account of the nature of the surface rocks it is difficult to determine the structure of the shallow rocks. By means of the core-drill, however, many anticlines, domes, and terraces

have been located. It is also possible to decipher a certain amount of structural control from the study of shallow wells drilled for water. Such data indicate that the Cretaceous rocks dip ard the north at a very gentle angle.

- -p drilling has revealed a great many interesting subsurface structural conditions. Perhaps the most prominent buried structure is the Ellsworth Arch which trends toward the south through Range 9 W. On it are located the various parts of the Chase pool. In the western tier of townships the oldest rocks come close to the surface. This is due to the presence of the Central Kansas Uplift (Barton Arch), a broad feature which trends toward the southeast and enters the county near the northwest corner. A small but very high domal area has been found south of Geneseo. A rather low synclinal area has been defined by drilling southeast of Lyons, trending southward past Sterling into Reno County.



Rice County

History of Oil and Gas Development

Rice County has the distinction of being the first county in western Kansas in which the presence of commercial deposits of oil and gas were revealed, for it was at the town limits of Lyons that the first gas well in western Kansas was drilled. A company by the name of Kansas Natural Gas and Oil and Mineral Products Company had been formed in 1887 to prospect for valuable mineral substances. They drilled their first well in the northwest quarter of sec. 34, T. 19 S., R. 8 W., only a few blocks east of the public square of Lyons. It encountered a strong flow of gas at a depth of 1,230 feet. The gas was piped to town and used for a long time in the Interstate Hotel, as well as in some of the residences. Incidentally, this well found a valuable layer of salt 275 feet thick at a depth of 780 feet

below the surface. This discovery overshadowed the possibilities of gas production for a long time, and served as the beginning of a very lucrative industry for the state of Kansas. Other rich salt deposits were discovered at Hutchinson, Kanopolis, and Anthony during the next few years. Many shallow dry holes were drilled in the search for salt, but unfortunately none of these were deep enough to reveal the large stores of oil concealed in Rice and nearby counties.

Welch Pool. It was not until nearly 35 years later, as a result of the discovery of rich oil pools in other parts of Kansas, that a test well was successful in finding oil in Rice County. The Prairie Oil and Gas Company drilled a well in sec. 35, T. 20 S., R. 6 W., on the Welch farm to a depth of 3,416 feet. Oil, amounting to 115 barrels per day, came into the hole from a layer of chert fragments found between 3,370 and 3,416 feet. Later study revealed that these chert fragments were the insoluble residue from the solution of several hundred feet of "Mississippi lime". Much debate was caused by this discovery and for a long time geologists were divided as to the age of the chert or "chat" as the drillers had called it. At present the tendency is to assign it to the Mississippian on the supposition that it was formed on the surface of the ground while western Kansas was temporarily above the sea during the last epoch of the Mississippian period.

Since the discovery of the first oil in the Welch pool, 40 other wells have been drilled in this pool of which 31 were still producing at the end of 1937. The pool produced a total of 3,700,800 barrels to the close of 1936, and an additional 99,974 barrels during 1937. The area from which oil is being drawn covers about 1,500 acres. The gravity of the oil is 33° Bé. The structure of the pool is anticlinal.

Wherry Group. Because of their proximity and the similarity in producing horizon, it will be advantageous to describe the Wherry and Ponce pools next. They are both in T. 21 S., R. 7 W. The Wherry was originally six separate pools. The discovery well was drilled by Garden and Son on the Thode farm in section 11. It was completed in September, 1933, when it encountered 480 barrels of oil in the "chat" at a depth of 3,358 to 3,380 feet. In May, 1936, the Hauschild pool, now a part of the Wherry field, was discovered. The first well, the No. 1 Hauschild in section 15, found production at a depth of 3,363 to 3,393 feet in Pennsylvanian basal conglomerate. During the last month of the same year Sage and Douglas discovered oil in the same horizon in section 5 at a depth of 3,331 to 3,337 feet, opening up the Saxman pool of the Wherry field. One month later Douglas drilled in No. 1 Theede in section 9, finding oil in the conglomerate at a depth of 3,355 feet. In August, 1937, the Republic Oil Company discovered oil one mile north of the Theede pool on the Oden farm in section 5, when the bit entered the conglomerate at 3,320 to 3,333 feet. The last pool to become a part of the Wherry field was the De Weese.

For a number of reasons these pools proved to be quite a surprise to the oil fraternity. On account of the low structural position of the rocks in the general area of the Wherry field, major companies had given up their leases in that part of the county. Secondly, the finding of oil in the basal conglomerate, although it was not unprecedented, proved rather unexpected. Thirdly, the size of the wells was remarkable; in fact, the largest well yet drilled in western Kansas was found here when a

daily potential of 15,149 barrels was established for the No. 2 Douglas well in section 15. Since September, 1933, a total of 1154 wells have been drilled in the Wherry field. Of this number 1141 were productive at the close of 1937, and 13 were dry holes.

The large possibilities of the Wherry field are indicated by three outpost wells which at the present time are carried in the reports as three separate pools. Of these the Ponce pool was discovered in June, 1936, when the first well was drilled in section 28, T. 21 S., R. 7 W. It found oil in the "chat" at a depth of 3,388 to 3,431 feet. The East Wherry pool was discovered in September, 1937, when Holland drilled in the first well on the Brothers farm in section 12 of the same township. This well is only 1½ miles east of the present limits of the Wherry field and as there are no dry holes intervening it is probably an extension. Two other producing wells were drilled in the East Wherry pool before the close of the year. In November, 1937, Will and Murphy drilled a well on the Fair farm in section 4, T. 22 S., R. 8 W., a few miles south of Sterling. They found the conglomerate at 3,330 feet and oil within it from 3,339 to 3,344 feet. The gravity of the oil is 33° Be. This one well pool became known as the Sterling.

In addition to these outpost wells, normal drilling of offsets has extended the Wherry field into section 1 of T. 21 S., R. 7 W. as well as into section 32, T. 20 S., R. 7 W. Therefore, the ultimate limits are still to be determined, and it may become one of the largest fields in western Kansas. The production amounted to 2,735,111 barrels up to the end of 1937. The total proved area of the Wherry pool proper at that time was 640 acres. Structural control in this area is evidently quite subordinate to porosity conditions as proved by the failure of some offsets to large wells, although they encountered the producing formation at relatively high elevations. Most geologists believe that the production is coming from the basal conglomeratte of Pennsylvanian age, but there is still the possibility that much of it is indigenous to the Mississippian "chat". Indeed, both the oil in the original well and that in the East Wherry extension seem to be definitely within the "chat".

Chase Pool. The largest pool in Rice County is the Chase pool in the western part, some 10 miles west of Lyons. It was discovered in four sections which were originally called Beyer, Grove, Sharpe, and Chase pools. The first well was drilled by Muth Brothers on the Beyer farm in sec. 21, T. 19 S., R. 9 W. on February 7, 1931. Oil was found at two levels in the Arbuckle, 3,212 to 3,215, and 3,224 to 3,239 feet. Inasmuch as the top of the dolomite lies at 3,212 feet here, it may be said that porosity begins at the very surface of the formation. The pool now covers an area of over 4,000 acres on which 260 wells have been drilled. Of this number 29 have been abandoned and two are gas wells. The limits of the pool are as yet undefined, and the ultimate number of wells is likely to be at least twice the present number. Practically all the oil secured comes from the Arbuckle and the total production to the end of 1937 was 33,836,088 barrels. The pool is located on a pronounced structural feature called the Ellsworth anticline which is particularly well defined on the Lansing horizon, but was originally detected by core-drilling. It is one of the strongly defined northeast to southwest structural ridges so characteristic of eastern Kansas. The average gravity of the oil from this pool is 40° Be.

Keesling Pool. A pool which probably will become a part of

the Chase pool at some future time is the Keesling, the westernmost well of which is about one mile east of the present limits of the Chase pool. It was discovered when the Gypsy Oil Company drilled its first well on the Keesling lease in April, 1935. Oil was found in the Arbuckle at a depth of 3,261 to 3,265 feet and the initial production was 238 barrels a day. To date 39 oil wells and 3 dry holes have been drilled in the pool without defining the limits. An area of 600 acres is being drained at the present time. Total production amounted to 1,727,843 barrels to the close of 1937.

Ploog Pool. Two pools, the Ploog and the Guldner, lie north of the Chase pool. Both derive their oil from the Arbuckle at a depth of about 3,200 feet. The first well in the Ploog pool was drilled by Tatlock on the Ploog farm in sec. 33, T. 18 S., R. 9 W. in July, 1930. It had a production of 3,000 barrels per day initially from a depth of 3,252 to 3,271 feet. By the end of 1937 ten wells had been drilled and the total production of the pool amounted to 941,435 barrels. The productive area is about 300 acres and the structure is anticlinal.

Guldner and Rickard pools. The Guldner pool is in T. 18 S., R. 9 W. It was discovered in June, 1935, when the Vickers Petroleum Company drilled its first well on the Guldner farm in section 16. Initial production of 600 barrels was found at a depth of 3,227 to 3,230 feet in the Arbuckle. Subsequently ten other tests were drilled, of which three were dry and one was a gas well. The seven oil wells produced a total of 192,356 barrels to the end of 1937. The productive area is about 160 acres. One well, the Aylward No. 1 Rickard, was drilled in section 22 not more than 2 miles to the southeast of the Guldner pool. Two dry holes on the east and one dry hole on the west partially surround this well. It produced 29,988 barrels to the close of 1937. It is interesting to note that this well produces from the "Wilcox" or Simpson formation at a depth of 3,324 to 3,365 feet. It was completed in September, 1935.

Stumps and Orth Pools. In the northwestern township two pools have been found, the Stumps in section 4 and the Orth in section 27. The former was opened by the Atlantic Oil Producing Company in May, 1935. Oil came into the hole when the bit reached a porous zone in the Arbuckle at a depth of 3,229 to 3,261 feet. The gravity of the oil was 43° Bé. and the initial production was 120 barrels per day. Eventually a total of 25 wells were drilled of which one was dry. This pool produced 325,475 barrels to the end of 1937.

The Orth pool is a unique pool not only for Rice County and western Kansas, but probably for the entire world. This is due to the fact that production comes from a pre-Cambrian silicified sandstone or quartzite. The southeastern end of the Central Kansas Uplift has raised the older rocks so high that erosion penetrated all pre-Pennsylvanian strata completely and bared the pre-Cambrian before the Pennsylvanian basal strata were laid down. The first well in this pool was drilled by Slick, Pryor, and Lockhart in July, 1932, on the Orth farm in section 27, T. 18 S., R. 10 W. It encountered oil at a depth of 3,240 to 3,243 feet in the creviced top of the quartzite. The initial production was 1,800 barrels and the gravity was 40° Bé. A total of 17 wells were drilled in the pool, not counting 4 dry holes located at distances of about one-half mile in various directions. At the end of 1937 there were 10 wells producing oil, 6 wells producing gas, 2 dry holes, and 2 abandoned wells. The gas wells

produce from a porous zone within the Lansing-Kansas City limestone. The top of this limestone was found at 2,850 feet and the top of the porous zone at 2,906 to 2,936 feet.

Brandenstein Pool. In the next township to the south are two pools, the Brandenstein in section 10, and, in the southwestern corner, the eastern end of the Silica pool. The latter is described under Barton County. The discovery well in the Brandenstein pool was drilled by the Atlantic Oil Producing Company in November, 1933. Production of 1,100 barrels per day was found in the Lansing-Kansas City limestone at a depth of 3,014 to 3,026 feet. The average gravity is 44° Bé. Ten additional wells were drilled within a radius of a mile, but all except one were dry. Most of these were deep enough to test the Arbuckle as well as the higher formations. The production to the end of 1937 amounted to 309,516 barrels.

Wenke, Mantel, and Raymond Pools. In T. 20 S., R. 10 W., are three pools. The Wenke pool is in section 7, the Mantel in section 18, and the Raymond pool centers about section 21. All three produce from the Arbuckle, except that the Raymond pool also produces from the Lansing-Kansas City limestone. The Raymond pool was discovered by Slick, Pryor, and Lockhart in July, 1929, by a well on the Schurr farm. An initial production of 240 barrels was found at 3,278 to 3,289 feet in the Pennsylvanian basal conglomerate. This production did not hold up, causing the owners to deepen the well into the Arbuckle to a depth of 3,330 feet where it was abandoned. In the meantime the Producers and Refiners No. 1 Thompson well had found production in the Arbuckle at 3,330 to 3,351 feet where a flow of 1,200 barrels appeared. Almost simultaneously the Boucher Oil Company discovered a flow of gas amounting to 11 million cubic feet in the Wabaunsee shale at a depth of 2,217 to 2,326 feet in a well drilled in the southwest corner of section 16. By the close of 1937 there were 70 wells, of which 8 were dry and one was a gas well. The total production to the end of 1937 has been 4,971,184 barrels. The gravity is 41° Bé.

The Wenke pool was discovered by Twin Drilling Company in March, 1935, when oil was found at a depth of 3,360 to 3,373 in the Arbuckle. The top of the formation appeared at 3,306, 53 feet above the top of the porous zone. This pool was extended in 1936 when the Rose Spring Drilling Company drilled the first well on the Mantel farm one-half mile south of the Wenke well. Subsequently five other wells were drilled near these two. The production from the six producing wells up to the close of 1937 was 98,496 barrels.

Geneseo, Galt, and Edwards Pools. In an area somewhat removed from the fields and pools described in the foregoing pages are four pools which have a great deal in common. All are located near the line between T. 18 S., R. 7 W. and T. 18 S., R. 8 W. and all produce from the Arbuckle at depths which approximate 3,200 feet. The character and gravity of the oil are similar. The sequence of rocks is almost identical in the four pools.

Geneseo was the first to be discovered, when in May, 1934, the Continental Oil Company completed its No. 1 Lansing with a potential production of 1,100 barrels at a depth of 3,132 to 3,175 feet. This well was drilled in section 25, T. 18 S., R. 8 W., about 5 miles south of Geneseo. Up to the close of 1937 53 other producing wells and 6 dry holes had been completed. These define area of about 3,000 acres, which must be considered

to be merely the nucleus of a much greater potential field. Production was 1,527,003 barrels to the end of 1937.

The Galt pool was also discovered by the Continental Oil Company. The one and only productive well drilled to date was completed on September 25, 1935, when the No. 1 Ferguson in sec. 8, T. 18 S., R. 7 W. produced 387 barrels from a depth of 3,205 to 3,229 feet. As in the Geneseo pool, the oil occurs in a porous zone of the Arbuckle. Five dry holes within a radius of a mile have been drilled near this well. During 1935 the well produced 1,132 barrels, during 1936, 9,755 barrels, and during 1937 another 5,185 barrels.

The Edwards pool was discovered in January, 1936, when Skiles and Davis drilled their No. 1 Edwards in section 3, T. 18 S., R. 8 W. In this pool the Topeka appears at a depth of 2,450 feet, the Lansing at 2,850, Conglomerate at 3,210, Simpson at 3,250, and the Arbuckle at 3,275 feet. Production was found in the Arbuckle at 3,278 to 3,282 feet. A total of 32 producing wells have been drilled in Rice and in adjoining Ellsworth County. In addition there are 5 dry holes, which define the limits in certain directions. The production of the Edwards pool during 1936, the first year of actual exploitation, amounted to 180,570 barrels. The following year the pool was able to add 497,180 barrels to make a total of 677,750 barrels to the end of 1937. The gravity of the oil is 41° Bé. The structure of this pool is domal and the area proved amounts to 800 acres.

Recently Discovered Pools. A number of other discovery wells have been drilled in various parts of Rice County. Some of these may prove to be extensions of known pools and others may prove to have opened new territory. They will be described from west to east, beginning in the northwestern part of the county.

The Habiger pool lies between the Bloomer and the Stumps pools. A well drilled by the Bridgeport Machine Company in section 5, T. 18 S., R. 10 W. on the Habiger farm found oil at a depth of 3,001 to 3,016 in the Lansing-Kansas City limestone. The top of the Lansing appeared at 2,924 feet, 77 feet above the top of the porous zone. The very high potential of 4,027 barrels encouraged other companies to drill offsets in rapid succession. At the close of 1937, only 4 months after the first well was completed, there were 11 wells in this pool, each capable of a large yield and with a high gas ratio. Its close proximity to the Bloomer pool, which lies three-quarters of a mile to the northwest, and the fact that no dry holes intervene, indicate that it soon may be listed as part of that pool. The same could be said with reference to the Stumps pool which lies one-half mile to the east, as no dry holes have been drilled in the area between these two. (Note: The Habiger pool is now a part of the Stumps pool.)

The Bredfeldt pool was discovered by the Empire Oil Company when the first well on the Bredfeldt farm in section 7, T.18 S., R. 9 W. was drilled. The oil comes from the Arbuckle at a depth of 3,223 to 3,240 feet, and the potential was determined to be 267 barrels per day. One dry hole about one-half mile to the southeast is the only other test of the area. The Bredfeldt pool is located only $1\frac{3}{4}$ miles to the northwest of the Guldner pool, and the intervening area is controlled by the same company.

The Cramm pool lies less than one mile east of the Chase

pool in section 15, T. 19 S., R. 9 W. It was discovered in July, 1937, when the Comanche Oil Company drilled its No. 1 Cramm well. Production appears at a depth of 2,876 to 2,947 in the Lansing-Kansas City limestone. The potential of the first well was 1,719 barrels per day. Production to the close of the year amounted to 16,643 barrels. Since the Chase pool produces from the Arbuckle this pool may not connect with its larger neighbor.

The Soeken pool in section 10 of the same township also produces from the Lansing-Kansas City limestone. It was opened in January, 1937, when the Shell Petroleum Company drilled the discovery well on the Soeken farm in the northwestern quarter of the section. It was drilled to the Arbuckle, but later plugged back to 2,905 to 2,923 and acidized, making a potential of 360 barrels per day. As this well lies less than a mile to the northeast of the Chase pool on a direct trend, it seems to limit the Chase pool in that direction. No other wells were drilled near the Soeken well during 1937. The production from the one well was 3,962 barrels during the year.

An interesting test well which discovered the Thurber pool was drilled by Gerbrand and Pulse on the Wellman farm in section 22, T. 21 S., R. 9 W. It was completed in November, 1937, when a large flow of gas, estimated at 22½ million cubic feet, was found in the Pennsylvanian basal conglomerate between 3,317 and 35,327 feet. Although the top of the conglomerate was logged at 35,308 feet, production was not encountered until the bit had penetrated 9 feet lower. The potentialities of this pool are not known at the time of this report.

Two pools have been found northwest of the Chase pool in T. 19 S., R. 9 W. They are the Haferman pool in section 6 and the Doran pool in section 18. The Doran pool was discovered in September, 1936, when the Weaver Drilling Company completed its No. 1 Doran in section 13, T. 19 S., R. 10 W. In this well the Arbuckle was found productive of oil from 3,291 to 3,311 feet. By the end of 1937 two additional producers and three dry holes had been completed. The production up to that time was 53,266 barrels. The Haferman pool was opened by the drilling of the Shell Company No. 1 Haferman in June, 1936. Production was found in the Arbuckle at a depth of 3,192 to 3,216 feet. Eleven other tests had been drilled to the close of 1937, of which three were dry. The total yield has been 216,805 barrels. During 1936 the production amounted to 54,800 barrels.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
BRANDENSTEIN 10-19-10	Nov.,1933 160 acres	2 309,516 Bbls.	3014-26 Lansing - K.C.	8 dry Grav.44
BREDFELDT 7-18-9	Apr.,1937 40 acres	1 4,012 Bbls.	3223-40 Arbuckle	Pot.267
CHASE 32-19-9	Feb.,1931 4800 acres	229 13,836,088 Bbls. 2	3246-84 Arbuckle 1987-90 Admire	Oil Grav.45 Gas

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
CRAMM 15-19-9	July,1937 160 acres	3 16,643 Bbls.	2876-2947 Lansing - K.C.	Pot. 1719 B
DORAN 13-19-10	Sept.1936 160 acres	3 53,266 Bbls.	3291-3311 Arbuckle	3 dry
EDWARDS 3-18-8	Jan.,1936 700 acres	32 677,750 Bbls.	3278-82 Arbuckle	5 dry Grav.41
GALT 8-18-7	Sept.1935 40 acres	1 16,072 Bbls.	3205-30 Arbuckle	5 dry Grav.39
GENESEO 25-18-8	May,1934 3000 acres	54 1,527,003 Bbls.	3132-75 Arbuckle	6 dry Grav.39
GULDNER 16-18-9 16-18-9	June,1935 160 acres 160 acres	7 192,356 Bbls. 1	3227-30 Arbuckle 2884-3025 Lansing - K.C	3 dry Grav.45 13 M. cu. ft. initial
HAFERMAN 6-19-9	June,1936 500 acres	8 216,805 Bbls.	3192-3216 Arbuckle	3 dry Grav.48
KEESLING 10-20-9	Apr.,1935 600 acres	39 1,727,843 Bbls.	3261-65 Arbuckle	3 dry Grav.42
LYONS 35-19-8	Aug.,1936 160 acres	1 None	3279-85 Arbuckle	Pot.75 M.cu.ft
ORTH 27-18-10	July,1932 600 acres	9 436,402 Bbls. 1 6	3240-43 Pre-Cambrian 2915-2936 Lansing - K.C.	2 dry 2 abd. Gas
PLOOG 33-18-9	July,1930 300 acres	10 941,435 Bbls.	3252-3271 Arbuckle	3 dry Grav.45
PONCE 28-21-7	June,1936	1	3388-3431 Chat	
RAYMOND 16-20-10 21-20-10 22-20-10	July,1929 1000 acres	2 4,971,184 Bbls. 52 0	3130-40 Lansing - K.C. 3330-3351 Arbuckle 2217-2326 Wabaunsee	7 dry Grav.41 2 abd. Grav.43 Gas abd
RICKARD 22-18-9	Sept.1935 40 acres	1 29,988 Bbls.	3324-3365 Wilcox	2 dry holes Grav.47
SILICA	(See Barton County)			
SOEKEN 10-19-9	Jan.,1937 40 acres	1 3,962 Bbls.	2905-23 Lansing - K.C.	Pot. 360 B.
STERLING 4-22-8	Nov.,1937 40 acres	1 None	3339-44 Conglomerate	Grav.33
STUMPS 4-18-10	May,1935 1000 acres	11 325,475 Bbls. 13	3001-16 Lansing - K.C. 3229-67 Arbuckle	Habiger area 1 dry Grav.43
THURBER 22-21-9	Oct.,1937 40 acres	1 None	3317-3327 Conglomerate	Pot.22½ M.cu.ft

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
WELCH 35-20-6	Apr.,1924 1500 acres	31 3,800,774 Bbls.	3370-3414 Chat	Grav.33
WELCH NORTH 23-20-6	June,1937 160 acres	3 9,749 Bbls.	3334-66 Chat	1 dry
WENKE 7-20-10	Mar.,1935 40 acres	6 98,496 Bbls.	3360-73 Arbuckle	1 abd. Grav.40
WHERRY 11-21-7	Sept.,1933 6000 acres	141 2,735,111 Bbls.	3358-3380 Conglomerate	Grav.38
WHERRY EAST 12-21-7	Sept.1937 160 acres	3 6,288 Bbls.	3455-69 Conglomerate	

Important Test Wells

Glimac Sargent, in sec. 31, T. 18 S., R. 6 W., top of Ft. Riley, 1,140; Lansing, 2,705; Viola, 3,350; Arbuckle, 3,466; total depth, 3,488 feet.

Three Rivers No. 1 Buehler, in sec.17, T. 18 S., R.8 W., top of Topeka, 2,400; Lansing, 2,895; Viola, 3,260; Simpson, 3,375; Arbuckle, 3,425; total depth, 3,435 feet.

Shell No. 3 Haxton, in sec. 33, T. 18 S., R. 9 W., top of Arbuckle, 3,241; sand, 3,755.

Slick, Pryor and Lockhart No. 1 Schmidt, in sec. 15, T. 18 S., R. 10 W., top of Topeka, 2,535; Lansing, 2,948; Arbuckle, 3,371; sand, 3,504; total depth, 3,548 feet.

A. & F. No. 1 Fulton, in sec. 24, T. 19 S., R. 6 W., top of Topeka, 2,290; Lansing, 2,833; Mississippi lime, 3,435; Kinderhook, 3,548; Viola, 3,794; Simpson, 3,845; Arbuckle, 3,920.

Slick No. 1 Deeds, in sec. 1, T. 19 S., R. 7 W., top of Topeka, 2,280; Lansing, 2,750; Mississippi lime, 3,265; Viola, 3,353; Simpson, 3,425; Arbuckle, 3,505; Sand, 3,972; total depth, 4,456 feet.

Skiles No. 1 Helmer, in sec. 7, T. 19 S., R. 8 W., top of Topeka, 2,470; Lansing, 2,904; Kinderhook, 3,239; Sylvan, 3,274; Viola, 3,350; Simpson, 3,395; Arbuckle, 3,457; total depth, 3,460 feet.

Sinclair No. 2 Volkland, in sec. 20, T. 19 S., R. 9 W., top of Lansing, 2,903; Arbuckle, 3,202; sand, 3,695; total depth, 3,748 feet.

Phillips No. 6 Linke, in sec. 21, T. 19 S., R. 9 W., top of Arbuckle, 3,252; sand, 3,688; pre-Cambrian, 3,710; total depth, 3,742 feet.

Stanolind No. 3 Mitchell, in sec. 32, T. 19 S., R. 10 W., top of Arbuckle, 3,340; sand, 3,750; total depth, 3,890 feet.

Hipple No. 1 Wernet, in sec. 11, T. 20 S., R. 6 W., top of Topeka, 2,178; Lansing, 2,695; Mississippi lime, 3,225; Kinderhook, 3,287; Viola, 3,537; Simpson, 3,567; Arbuckle, 3,636; total depth, 3,688 feet.

Phillips No. 1 Oden, in sec. 22, T. 20 S., R. 7 W., top of Lansing, 2,915; Mississippi lime, 3,341, Kinderhook, 3,364; Sylvan, 3,612; Viola, 3,624; Simpson, 3,649; Arbuckle, 3,720; total depth, 3,742 feet.

Nickerson No. 1 Lyon, in sec. 27, T. 20 S., R. 8 W., top of Topeka, 2,330; Lansing, 2,925; Kinderhook, 3,317; Sylvan, 3,401; Viola, 3,430; Simpson, 3,485; Arbuckle, 3,555.

Miller No. 1 Darling, in sec. 2, T. 20 S., R. 9 W., top of Topeka, 2,440; Lansing, 2,875; Viola, 3,239; Arbuckle, 3,341; total depth, 3,636 feet.

Gulf No. 1 Morse, in sec. 15, T. 20 S., R. 9 W., top of Arbuckle, 3,260; sand, 3,915; total depth, 4,103 feet.

Slick, Pryor and Lockhart No. 1 Metzgar, in sec. 21, T. 20 S., R. 10 W., top of Arbuckle, 3,373; total depth in Arbuckle, 3,964 feet.

Atlantic No. 1 Tharp, in sec. 33, T. 21 S., R. 6 W., top of Lansing, 2,925; Mississippi lime, 3,584; Viola, 3,952; Simpson, 4,000; Arbuckle, 4,072; total depth, 4,097 feet.

McPherson No. 1 Leonard, in sec. 2, T. 21 S., R. 7 W., top of Mississippi lime, 3,374; Kinderhook, 3,447; Sylvan, 3,545; Viola, 3,700; Simpson, 3,716; Arbuckle, 3,766; total depth, 3,795 feet.

In sec. 21, T. 21 S., R. 7 W., top of Mississippi lime, 3,387; Sylvan, 3,610; Viola, 3,695; Simpson, 3,725; Arbuckle, 3,820.

Mid-Kan. No. 1 Smyser, in sec. 13, T. 21 S., R. 8 W., top of Mississippi lime, 3,348; Viola, 3,620; Simpson, 3,655; Arbuckle, 3,720; total depth, 4,029 feet.

Elbart No. 1 Ehlers, in sec. 8, T. 21 S., R. 9 W., top of Topeka, 2,520; Lansing, 2,956; Kinderhook, 3,316; Sylvan, 3,333; Viola, 3,397; Simpson, 3,465; Arbuckle, 3,523; total depth, 3,534 feet.

Burgher No. 1 Fair, in sec. 14, T. 21 S., R. 10 W., top of Topeka, 2,550; Lansing, 2,985; Viola, 3,330; Arbuckle, 3,435; total depth, 4,003 feet.

Pipe Lines and Refineries

Rice County is well served by pipe lines for the transportation of crude oil. The Stanolind Oil Company takes the oil from the Brandenstein and Raymond pools. The Kaw pipe line handles crude oil runs from the Bredfeldt, Chase, Doran, Edwards, Geneseo, Guldner, Haferman, Keesling, Orth, Ploog, Ponce, Rickard, Soeken, Stumps, and Wenke pools. The Sinclair Refining Company transports oil from the Chase, Doran, Raymond, Wherry, and Wenke areas. Much of the oil from the Wherry district is collected by the Magnolia pipe line. The Skelly Oil Company also takes some of this oil, as well as some from the Chase, Keesling, Raymond,

sand Welch pools. The Continental Oil Company transports oil from the Edwards, Geneseo, Galt and western Stumps (Habiger) pools. Finally, some of the oil from the prolific Wherry district is carried in the pipe line of the Derby Refining Company.

There are two refineries in Rice County, both at Chase near the largest pool. One, the Cusco Oil and Refining Company, has a capacity of 3,100 barrels per day. The other, owned by the Chase Refining Company, has a capacity of 1,000 barrels per day. Neither were operated at full capacity during 1937.

ROOKS COUNTY

Areal Geology

Rooks County is located directly north of Ellis County and therefore bears a great similarity to the latter in its geological characteristics. The South Fork of Solomon River which cuts a broad path through the center of Rooks County exposes the oldest rocks, which belong to the Carlile formation of the Cretaceous system. The immediate channel of the river and the low terraces on both sides are veneered with sand and gravel of Quaternary age. The Niobrara formation covers extensive areas in the northern part of the county, and also in the central and southern part. The highest areas, which lie both in the northwestern corner and across the southern tier of townships, are covered by thick silt, sand, and gravel beds of the Ogalalla formation of the Tertiary.

The thickness of the Tertiary beds is not great, and probably does not exceed 200 feet. The thickness of the underlying Cretaceous beds is much greater. The Smoky Hill member of the Niobrara is approximately 150 feet thick in Rooks County. It consists of chalky shale with thin chalk layers, and erodes into terraces and buttes as well as more fantastic topographic forms. Geologists have learned that the numerous small faults are likely to produce errors in mapping structure in this member. Furthermore the presence of a great unconformity at the base of the Cretaceous has a tendency to neutralize the value of small surface structures.

The Hays member of the Niobrara lies under the Smoky Hill chalk and can be readily identified on account of its massive nature, and the fact that it makes prominent benches. It is 50 to 60 feet thick. Because of its persistence and rather uniform thickness, the base of the Hays member can be used for structure mapping. The top is not so easy to pick.

The Carlile shale, which appears below the Hays in the valley walls of tributaries, is grayish to black shale. It can be identified by its non-calcareous character in the upper part, and by its zones of septarian concretions. Furthermore, the Codell sandy shale or sandstone at the top is a rather persistent layer which weathers to a bright-tan color, and usually forms a curved cliff face. This member is fully described by Bass[30], who named it from exposures near the town of Codell in Ellis County. The uppermost zone of concretions appears about

---

30. Bass, N. W., Geology of Ellis County: Kansas Geol. Survey, Bull. 11, 1926.

25 feet below the Codell sandstone. The concretions are rather large and spherical, and because of their markings are often mistaken for turtles in fossil form.

Subsurface Stratigraphy

No rocks older than the Blue Hill shale member of the Carlile are exposed in this county. A fair number of wells have been drilled, however, and these give us the information about Paleozoic and older rocks needed to determine possibilities for oil occurrence. Below the Carlile lie the Greenhorn, Graneros, and Dakota formations. The Dakota is usually from 300 to 600 feet thick and contains two or three rather thick zones of sandstone. Between are shale layers of various colors. The lowest sandstone is probably the Cheyenne sandstone of Comanchean age.

The Permian rocks may be conveniently divided into five units. The uppermost 600 feet belong to the Cimarron red beds. They consist of red and green clays and siltstones. Near the base is the ever present Cimarron anhydrite, which is used for correlation purposes. Its depth varies from slightly over 1,200 feet in T. 7, R. 17 W. to about 1,500 feet in T. 8, R. 20 W., in the western part of the county. This difference is mostly accounted for by greater elevation above sea level. Below the red beds lie grayish shales which mark the top of both the Wellington and the second unit in the Permian. The salt beds near the middle of the Wellington constitute the third unit. They are missing in the northern half of the county, but are present in the southern half where they reach a maximum thickness of about 100 feet at the south line. In T. 8 S., R. 17 W. the top of the salt was found at 1,650 feet in one well. Below the salt are alternating layers of shale and anhydrite which make up the fourth unit of the Permian. In most wells this interval is about 125 feet thick. The next 500 to 600 feet comprise the Big Blue sequence which is so characteristic in all wells of western Kansas. Certain markers in this sequence are of great value in determining whether a well is running high or low. The total thickness of the various members of the Permian is approximately 1,500 feet.

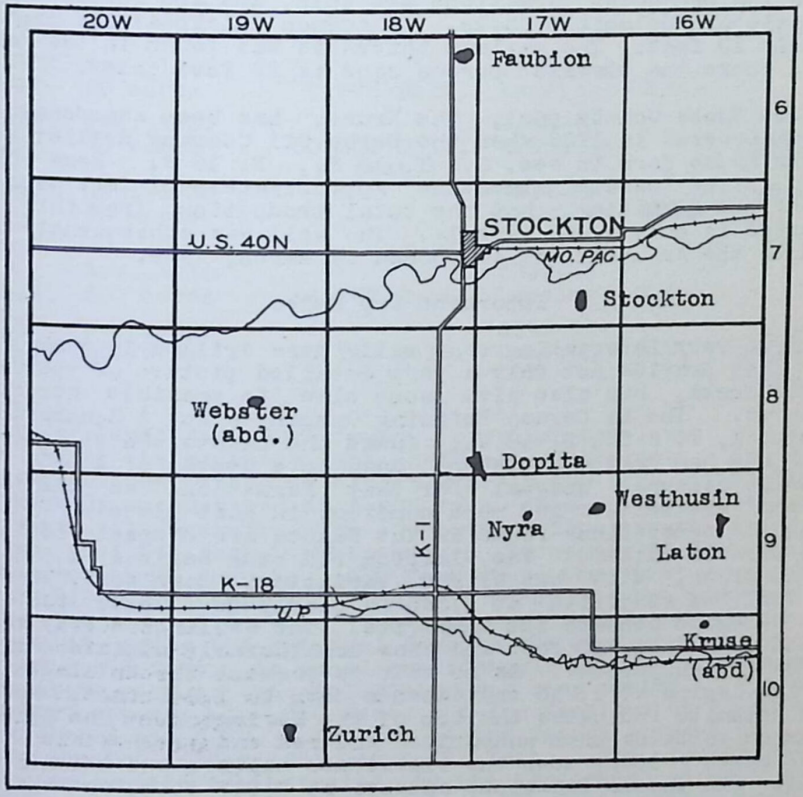
The Pennsylvanian rocks average 900 feet in thickness, and may also be divided into five or six units. The uppermost of these, corresponding to the Wabaunsee, is about 400 feet thick and consists of characteristic micaceous shales with thin layers of limestone. The next unit is characterized by thick beds of limestone, of which the Topeka at the top is most distinctive. This unit is reached at a depth of slightly over 2,900 feet in the eastern part of the county and a depth of 3,000 feet in the western tier of townships. Considerable variation is due to differences in surface elevation. The total for the Shawnee unit is about 200 feet. Thin beds of red shale separate the Shawnee from the Lansing or "Oswald" zone. The top layer of the latter unit is the Lansing limestone which lies at a depth of 3,100 in the eastern part of the county and between 3,200 and 3,300 feet in the western part. It is the most important subsurface marker in well cuttings. The next unit, which probably corresponds to the Marmaton group, is not easily defined as it varies greatly in composition and thickness. Much red and green clay with occasional chert fragments appear in the well cuttings from this unit. The Pennsylvanian basal conglomerate is found at depth varying from 3,400 to over 3,600 in various parts of the county. Below it is a great unconformity.

In Rooks County the rocks of Mississippian, Devonian, Silu-

[illegible]an, and uppermost Ordovician age seem to be missing. There-[illegible]ore, the Pennsylvanian rests upon various portions of the still [illegible]der formations. In the southeastern part of the county the [illegible]ola limestone has been found with the Simpson and Arbuckle un-[illegible]er it in normal sequence. Over most of the rest of the county [illegible]he Pennsylvanian rocks rest directly upon the eroded surface of [illegible]he Arbuckle. This formation is a coarse dolomitic rock similar [illegible]n all respects to that found elsewhere in western Kansas. It [illegible]as been penetrated almost 400 feet in one well drilled in sec. [illegible]9, T. 10 S., R. 17 W.

Structure

The dip of the surface rocks as determined from shallow [illegible]ater well data is toward the north at an angle of 6 or 7 feet [illegible]er mile. A prominent modification of the regional dip is the [illegible]tockton anticline which trends almost north and south through [illegible]he western part of the county. Other smaller structural fea-[illegible]ures have been discovered by means of core-drilling and seismo-[illegible]graph work.



Rooks County

History of Oil and Gas Development

Commercial quantities of oil were first discovered in Rooks [illegible]County in July, 1927, when the Vickers Petroleum Company drilled [illegible]a well on the Lukman farm. Additional wells drilled in sections

11 and 14, T. 9 S., R. 16 W. proved the existence of a pool, which was named the Laton. The producing stratum was found at a depth of 3,261 to 3,264 feet in the "Oswald" approximately 3[illegible] feet below the top of that limestone. The initial production of the first well was 283 barrels, and the oil tested 41° Be. gravity. By the end of 1937 four wells had been drilled, and the total production up to that time was approximately 200,000 barrels.

In addition to the Laton pool, eight other pools have been found in this county. They are the Kruse, Webster, Dopita, Zurich, Faubion, Westhusin, Stockton, and Nyra pools in order of discovery date. The location of these pools, as well as other pertinent data, are given in the following table. All produce oil from the "Oswald" limestone zone, which thus takes rank as the most important producing formation in the county. However, oil has also been found in the Arbuckle in two of these pools, the Dopita and the Webster. In general the oil from the "Oswald" occurs at a depth of 3,128 to 3,340 feet and the oil from the Arbuckle occurs at a depth of 3,340 to 3,409 feet. In both cases the producing formations are thin, and are porous zones in calcitic or dolomitic rocks. A common thickness of producing zone is 10 feet. The maximum thickness was found in the Faubion pool, where the "Oswald" porous zone is 22 feet thick.

One Rooks County pool, the Kruse, has been abandoned. It was discovered in 1928 when the Derby Oil Company drilled a well on the Kruse farm in sec. 3, T. 10 S., R. 16 W. Some oil was found in the "Oswald" limestone approximately 51 feet below the top of the formation, but the total production from this zone amounted to only 6,202 barrels. The well was subsequently deepened to the Arbuckle and abandoned in March, 1929.

Important Dry Holes

Some very interesting test wells were drilled in Rooks County. They provide not only a very detailed picture of the underground rocks, but also give some clue to possible structural features. The El Dorado Refining Company's No. 1 Southard well in sec. 1, T. 6 S., R. 18 W., found the Dakota sandstone at 470 feet and had mostly sandstone down to a depth of 1,080 feet. This is somewhat unusual for that formation, as the shale "breaks" are thicker and more numerous in most places. The iron carbonate concretions found in the Dakota are characteristic for this part of Kansas. The Cimarron red beds begin at 1,078 feet and continue, with but slight variation, down to 1,525 feet. The Cimarron anhydrite at 1,345 is poorly developed, but shows some dolomite beneath the anhydrite. The Wellington gray shales extend down to 1,710 feet and show considerable admixture of red shales and anhydrites. As no salt is present the Wellington anhydrite begins at 1,710 and extends down to 1,845 feet, where a thin dolomite indicates the top of the Herington. The Big Blue sequence contains much anhydrite and red and green shale in the upper part. Lower down the limestones appear, but thinner than usual. The Topeka limestone appears at 2,815 feet, and the Lansing or "Oswald" limestone at 3,025 feet. About 400 feet lower the Arbuckle was found in this test, and the total depth was 3,473 feet.

Another very instructive well is the Empire Oil Company's No. 1 Mira Ham well in sec. 24, T. 8 S., R. 19 W. This test started in the Hays limestone, passed through nearly 300 feet of the Carlile shale into the Greenhorn at 340 feet. The top of the Dakota sandstone was found at 485 feet. Three rather thick

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
DOPITA 31-8-17	Apr.,1934 160 acres	5 26,989 Bbls.	3212-17 Lansing - K.C. 3409-19 Arbuckle	Grav.36 1 dry Grav.25
FAAUBION 122-6-18	Feb.,1936 80 acres	2 18,390 Bbls.	3128-3150 Lansing - K.C.	Grav.36
KERUSE 3--10-16	Jan.,1928 40 acres	0 6,202 Bbls.	3075-3167 Lansing - K.C.	1 dry 1 abd. Grav.41
LAATON 111-9-16	July,1927 200 acres	4 200,000 Bbls. (Est.)	3261-64 Lansing - K.C.	Grav.40
NYYRA 9--9-17	Aug.,1937 40 acres	1 None		
STOCKTON 35-7-17	Apr.,1937 80 acres	2 7,678 Bbls.	3118-3180 Lansing - K.C.	
WEBSTER 211-8-19	Oct.,1930 40 acres	0 50,000 Bbls. (Est.)	3442-45 Arbuckle	Abd. Grav.25
115-8-19	Sept.1934 40 acres	1	3215-25 Lansing - K.C.	Grav.35
WEST- HOUSIN 111-9-17	Nov.,1936 300 acres	7 46,257 Bbls.	3231-42 Lansing - K.C.	
ZURICH 206-10-19	Sept.1935 80 acres	4 52,147 Bbls.	3340-49 Lansing - K.C.	3 dry holes Grav.36

bodies of sandstone were found, of which the lowest one, 200 feet thick, is probably the Cheyenne equivalent. The total thickness of the Dakota is almost exactly 600 feet. The Cimarron red beds encountered at 1,075 feet show characteristic red colors and silty nature, with a prominent development of the anhydrite at 1,375 feet. This marker is nearly 60 feet thick. Red beds continue down to 1,622 feet where the first gray shales of the Wellington appear. The salt occupies the interval between 1,740 and 1,810 feet. The lower Wellington anhydrites and gray shales occupy the interval down to the Herington, which was found at 1,965 feet. As usual considerable anhydrite is present in the upper part of the underlying Big Blue series. The Wreford chert appears at 2,230 feet and the Americus at 2,500 with its base at 2,560 feet. The top of the Topeka appears at 2,950 and the Lansing ("Oswald") at 3,171 feet. The Pennsylvanian basal conglomerate is indicated by the appearance of much chert and red and green clays at 3,456 to 3,522 feet, where reworked Arbuckle fragments can be detected. The top of the unaltered dolomite appears at 3,558 feet, and the total depth is 3,598 feet.

Pipe Lines and Production Statistics

Oil from the Dopita, Faubion, and Zurich pools is transported through the pipe line of the Stanolind Oil Company. Up to

the end of 1937, the total amount from the Dopita pool amounted to 26,989 barrels, from the Faubion pool, 18,390 barrels, and from the Zurich pool, 52,147 barrels. The oil from the Westhusin pool is taken by the United Refining and the Bay Petroleum companies. The total amount produced to the end of 1937 was 46,257 barrels. Oil from the Stockton pool is being transported by truck to the Stanolind pipe line. The total production of the two wells in this pool amounted to 7,678 barrels up to the end of September, 1937.

The total production of all pools in Rooks County to the end of 1937 amounts to 407,663 barrels. During 1936, 50,934 barrels were produced and during 1935, 25,800 barrels. The previous production by years follows:

1930	22,550 barrels
1931	64,208 barrels
1932	49,056 barrels
1933	12,518 barrels
1934	20,053 barrels

RUSH COUNTY

Rush County is west of Barton County and south of Ellis County. Therefore it shows great similarity to both of these in its geological character. Walnut Creek, a large tributary of Arkansas River, flows almost directly through the center of the county from west to east. Smoky Hill River flows eastward along the northern border of the county.

Areal Geology

Within the channels of these two rivers and on low terraces are thin deposits of sand and gravel which belong to the Quaternary system. The banks of the river, and nearby areas, are underlain by the Greenhorn and Graneros formations of the Cretaceous system. The high land between the two rivers, and the rather high land in the southern part of the county, have Carlile shale at the surface.

The Carlile shale is divided into two members, of which the upper one is predominantly dark-colored fissile shale, and the lower one light-colored shale with thin chalk beds. The thickness of the whole formation is over 300 feet where developed to maximum extent. The Greenhorn chalk is about 100 feet thick in this county and can be divided into four members as was done in Ellis County by Bass[31]. The very characteristic "Fencepost limestone" so common in Russell and Ellis counties also appears at the very top of the Greenhorn in Rush County. The Graneros shale crops out only in the northeastern part of the county. It is a bluish black, non-calcareous shale in which are occasional layers of sandy shale and ironstone concretions. The thickness is approximately 40 feet, a figure based mostly on well cuttings.

---

31. Bass, N. W., Geology of Ellis County, Kansas Geol. Survey, Bull. 11, 1926.

Subsurface Stratigraphy

Quite a number of deep wells have been drilled in Rush County, allowing us to obtain a fairly accurate description of the Paleozoic rocks in this part of Kansas. The Dakota sandstone is found in well cuttings under the Graneros. It shows considerable variety from well to well. The sandstones are most characteristic and appear in every well, but with changes in thickness. The interbedded shales are of all colors from red to black and may appear at a number of levels in a given well. The total thickness of the Dakota varies from 300 to 400 feet. It is entirely probable that the lower portion of the so-called Dakota corresponds to the Kiowa and Cheyenne formations of the Comanchean.

Below the Cretaceous rocks red beds appear, as is usually the case in western Kansas. They belong to the Cimarron division of the Permian system. Occupying roughly one-third of the whole Permian, they are characterized by the red and green colors of the clays and siltstones. A very interesting marker, the Cimarron anhydrite, occurs near the base in this county at depths ranging from 1,050 feet in the northeast township to over 1,300 feet in the southwestern township. This bed is useful not only for correlating well logs, but also for seismograph work. The gray shale which appears in well cuttings below the red beds belongs to the middle third of the Permian and is classified as the top portion of the Wellington formation. Thick salt beds lie within the Wellington, and these beds greatly facilitate correlation. They vary from 120 feet to over 200 feet in various parts of the county.[32] The layers which form the lower portion of the Wellington are anhydrites for the most part. They approximate 125 feet in thickness. The lower third of the Permian is often called the Big Blue division. It rarely varies from a thickness of 600 feet over wide stretches in western Kansas. The top member is the Herington and the lowest limestone member the Americus. Several chert zones near the middle are used for correlation purposes.

The Pennsylvanian rocks in Rush County are about 1,000 feet thick and may be subdivided into five units which correspond roughly to groups differentiated on the outcrop in eastern Kansas. The upper 450 feet correspond to the Wabaunsee and consist of shales and thin limestones. Some black-colored shales and certain silty shales are characteristic of this unit in Rush County. The next lower 250 feet consist mostly of limestones in which fusulinids are abundant at certain levels. The topmost limestone is always picked in well logs as the Topeka and the lowest limestone as the Oread. A shaly interval between the base of the Shawnee group and the top of the Lansing is correlated with the Douglas group. It is from 50 to 75 feet thick in Rush County and contains much red shale. The top of the Lansing group is considered most important for correlation purposes in this county. It contains fossils and oolites at a number of levels. Cherty layers are present in a few places. The limestone sequence which has the Lansing at the top varies in thickness from 200 feet to 250 feet. The prominent red shales beneath are correlated with the Marmaton group. At the base there may be a mixture of materials in which chert fragments are characteristically abundant, the Pennsylvanian basal conglomerate. The Marmaton and the conglomerate vary considerably because of

---

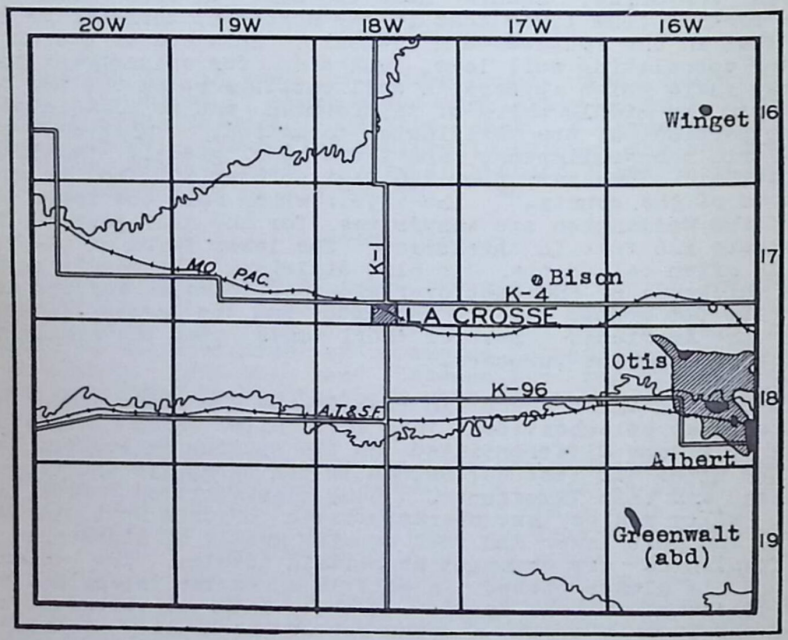
32. Kansas Geol. Survey, Bull. 11, pl. 8, opp. p. 90, 1926.

the great unconformity beneath.

The long period of post-Mississippian erosion which produced this unconformity probably eliminated all rocks of Silurian, Devonian and Mississippian age. No undoubted Mississippian limestone has been reported in any wells drilled in the county to date. One well in the southwestern part of the county, the Piggott No. 1 Maresch in sec.28, T. 19 S., R. 19 W., may have had a small amount, but in most wells the Pennsylvanian rests directly upon Ordovician or older rocks.

Structure

The Cretaceous rocks of Rush County, according to data derived from the drilling of shallow water wells, dip northward at an average rate of 10 feet per mile. This regional dip is modified slightly by the anticlinal fold which trends southward through the eastern part of the county. The subsurface structure based on the Paleozoic rocks indicates a gentle dip toward the west.



Rush County

History of Oil and Gas Development

Up to the present Rush County has been more important from the standpoint of gas production than oil production. The first gas well was drilled on the Scheuerman farm in November, 1928, by the Danciger Oil Company. Although the original rock pressure was 915 pounds, the well did not last and furnished a total of only 524 million cubic feet of gas before it was abandoned. Three dry holes surrounding this test indicate that possibilities of a pool in this vicinity are remote.

Another well, which seemed at first to be a discovery well, was the Dewey and Mitchell No. 1 Greenwalt, in sec. 17, T. 19 S. R. 16 W. This well produced a little oil from the Arbuckle which was found at a depth of 3,820 feet. It was abandoned after producing 6,759 barrels of oil testing 43° Bé. gravity.

Therefore, at the present time, there are only two pools in Rush County. The Otis gas pool was opened in March, 1930, when Morgan and Flynn drilled their first well on the Eitel farm in sec. 11, T. 18 S., R. 16 W. The initial production of this well was large, measuring over 16 million cubic feet per day. The producing horizon is the Reagan or basal sand found at a depth of 3,507 to 3,509 feet. The initial pressure of gas in the pool was 1,350 pounds per square inch. Later, when more wells had been drilled, the pressure dropped, and was 1,140 pounds at the end of 1936. At the end of 1937 there were 35 gas wells in the Otis pool, but in the meantime oil also had been found. The first well to produce oil was the Mid Kansas No. 1 Mohr, in sec. 10 of the same township. In addition to 12 million cubic feet of gas this well also produced 150 barrels of oil having a gravity of 35° Bé. Subsequently other wells struck oil, so that at the end of 1937 there were 20 oil wells. The total production to the end of 1937 was 242,755 barrels of oil.

The Winget pool was discovered in December, 1936, when Schoenfeld and Kotch drilled their initial well on the Winget ranch. This well had a potential capacity of 797 barrels of oil per day from a porous limestone zone in the Lansing-Kansas City group.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
BISON 27-17-17	Nov.,1928 40 acres	1 524 million cu. ft.	3573-78 Conglomerate	Gas shut in
GREENWALT 17-19-16	Aug.,1931 40 acres	0 6,759 Bbls.	3820-35 Arbuckle	Abd. Grav.43
OTIS 11-18-16	Mar.,1930 9000 acres	35	3507-09 Reagan	Gas
10-18-16	July,1934	20 242,755 Bbls.	3527-36 Reagan	Oil Grav.35
WINGET 15-16-16	Dec.,1936 120 acres	3 23,531 Bbls.	3243-47 Lansing - K.C.	One dry hole Grav.39

Important Dry Holes

A number of interesting dry holes have been drilled in Rush County. One of these is the No. 1 Bison, drilled by Sheedy southwest of the Bison gas pool discovery well. It found the anhydrite at 1,140, Lansing at 3,323, Pennsylvanian basal conglomerate at 3,554, Arbuckle at 3,605, and Reagan sand at 3,618 feet. The total depth is 3,700 feet. A well drilled north of the Otis pool is Morgan and Flynn No. 1 Schlegel in sec.26, T.17 S., R. 16 W. In this test the Cimarron anhydrite was found at 1,130; Ft. Riley at 2,095; Florence chert at 2,180; Topeka at 3,085; Lansing at 3,380; Marmaton at 3,565; Pennsylvanian basal

conglomerate at 3,605; Arbuckle at 3,635; and Reagan sand at 3,687 feet. It was abandoned at 3,760 feet still in Reagan sandstone. The Phillips No. 1 Benbow, drilled in the western part of the county in sec. 12, T. 17 S., R. 19 W., found Topeka at 3,100; Lansing at 3,418; basal conglomerate at 3,692; and pre-Cambrian granite at 3,816 feet. In this well the Pennsylvanian formations rest directly on the granite. A well in the southwestern part of the county is Piggott No. 1 Maresch in sec. 28, T. 19 S., R. 19 W. In this test the Cimarron anhydrite appears at 1,320; Ft. Riley at 2,420; Topeka at 3,310; Lansing at 3,680; Viola limestone at 4,120; Simpson at 4,159; and Arbuckle at 4,165 feet. The total depth is 4,225 feet.

RUSSELL COUNTY

Areal Geology

With the exception of thin sheets of river alluvium, only Cretaceous formations crop out in Russell County. Because of the west to east drainage lines these formations appear in narrow bands across the county. In descending order they comprise the Niobrara, Carlile, Greenhorn, Graneros and Dakota divisions.

The Niobrara formation in Russell County consists mainly of the Hays limestone member, which has been used extensively for determining the structure of small areas. It reaches a thickness of 55 feet where present in full thickness, and is composed of either tan or white chalk beds in massive layers. Because of its superior resistance to erosion, the Hays member produces prominent buttes or mesas, especially in the northwest corner of the county. The Carlile formation has been divided into two members by Bass[33], the Blue Hill shale member and the Fairport chalky shale member. The former may be distinguished by the gray color of the shales, the thin sandstone near the top, the conspicuous concretions, and its thickness of nearly 215 feet. The underlying Fairport member is about 85 feet thick, contains thin chalk beds near the base which have a peculiar type of jointing (like the texture of fish meat), and very persistent thin beds of yellow and white clays, which are believed by some geologists to be bentonite or altered volcanic ash layers. The Carlile rocks break down readily into soil, and so rarely make conspicuous topographic features.

The hard chalk and chalky marl which appear below the Carlile are correlated with the Greenhorn formation of Colorado. Because of the value for making structure maps of the hard, persistent, and widely distributed beds of chalky limestone in the Greenhorn this formation is of great interest. At the top lies the famous "Fencepost limestone" from which so many of the fence posts in this part of Kansas are made. It is only 8 to 9 inches thick, but remarkably uniform over wide areas. Lying about 20 feet below this bed is a slightly thicker limestone, the "shell bed" which contains many Inoceramus shells, and can therefore be easily followed and makes an excellent layer for structure mapping purposes. The thickness of the whole formation varies from 85 to 110 feet.

---

33. Rubey, W. W., and Bass, N. W., Geology of Russell County, Kansas: Kansas Geol. Survey, Bull. 10, p. 32 ff., 1925.

The Graneros crops out in a narrow band at the base of the bluffs made by the Greenhorn formation. It is composed of soft, dark bluish-gray shale which is generally noncalcareous and gritless. It may often be recognized by a sulphur yellow powder (the iron sulphate, melanterite) which appears on weathered slopes. Crystals of selenite stained with rust abound in places. A further characteristic is the thinness of this formation, which nowhere exceeds 40 feet.

The Dakota sandstone appears in the stream banks below the Graneros. Only about 160 feet, comprising the upper part of this very widespread formation, are exposed in Russell County. At the top, massive sandstones, which are even bedded and from 5 to 20 feet thick, make a rather decided contrast with the Graneros. Ferruginous layers, carbonized wood, or flat vertical grasslike marks further help to characterize this upper zone. In some places thin beds of lignite coal occur. Clay shale beds lie below these coaly beds and mark the transition to the distinctive mudstone unit which contains clays and sands of many bright colors. Locally, sandstones appear which were evidently laid down in Cretaceous river channels. They are cross bedded and very discontinuous. Good exposures of this interesting type of rock may be seen in "Rocktown", in sec. 4, T. 13 S., R. 11 W.

Records of drilled wells indicate that the Dakota formation is approximately 300 to 350 feet thick in Russell County, and that it consists of many lenticular zones of sands and shales. The sandy zones commonly contain fresh water.

Subsurface Stratigraphy

The Cretaceous rocks rest unconformably upon a series of red siltstones which belong to the Permian system. Because they were subjected to prolonged erosion during Triassic and Jurassic time these red rocks are unequally eroded and vary in thickness. Approximately 500 feet are found in most wells. Near the base lies a layer of anhydrite (the Cimarron or Enid), with here and there layers of dolomite. Inasmuch as this anhydrite is very widespread, it is the most important underground rock stratum for determining structure. This is done either by shallow core holes or by reflection waves in seismograph surveys.

Gray shales with thin streaks of red rock appear beneath the Cimarron red beds. They are especially characterized by the presence of about 250 feet of salt beds near the middle, and about 125 feet of gypsiferous shales and thin beds of gypsum at the base. Prominent dolomitic layers and thick beds of limestone in the succeeding 600 feet mark the Big Blue division of the Permian. By means of well cuttings it is possible to distinguish the Herington, Winfield, Ft. Riley and other limestones down to the Americus or Foraker limestone.

Pennsylvanian Rocks. Below the Americus a series of very thin limestones, shales and thin beds of micaceous siltstones 4400 feet thick appears in the average well log. These rocks make up the Wabaunsee group. Near the middle lies the Tarkio limestone which produces oil in a few pools in this county. The base of the Wabaunsee is marked by the appearance of thick limestones, which are interpreted as the Topeka limestone or uppermost formation of the Shawnee group. This layer is doubly important because it may contain commercial quantities of oil. The Shawnee group is usually 275 feet thick in Russell County, and is sharply delineated at the base by the appearance in well

cuttings of chert and 50 feet of red shale. These are correlated with the Lawrence shale or the Douglas group. In addition to red shales this group is also identified by green shales, sandy shales, and thin limestones with black chert fragments in places.

A second prominent limestone sequence in the well logs is believed to correlate with the Lansing, Kansas City, and Bronson groups of eastern Kansas. Thin layers of black shale, beds of oolitic limestone, and cherty limestones are characteristic of this sequence. It varies in thickness, but commonly approximates 175 feet.

The Marmaton group is found in many deep wells of Russell County. It varies greatly in composition. Most frequently it consists of red and green shales, near the base of which much chert appears. This heterogeneous zone is called the Pennsylvanian basal conglomerate. It rests with marked unconformity upon various older rocks. In the northeastern part of Russell County it lies upon Mississippian limestones. Farther southwest it overlies the basal shales of the Mississippian, the Kinderhook. Still farther to the southwest, basal conglomerate overlies various units of the Ordovician and Cambrian, including the Sylvan, Viola, Simpson, and Arbuckle. In a few places it has even been found resting directly upon the pre-Cambrian granite, as in the Russell (Fairport) oil pool.

Structure

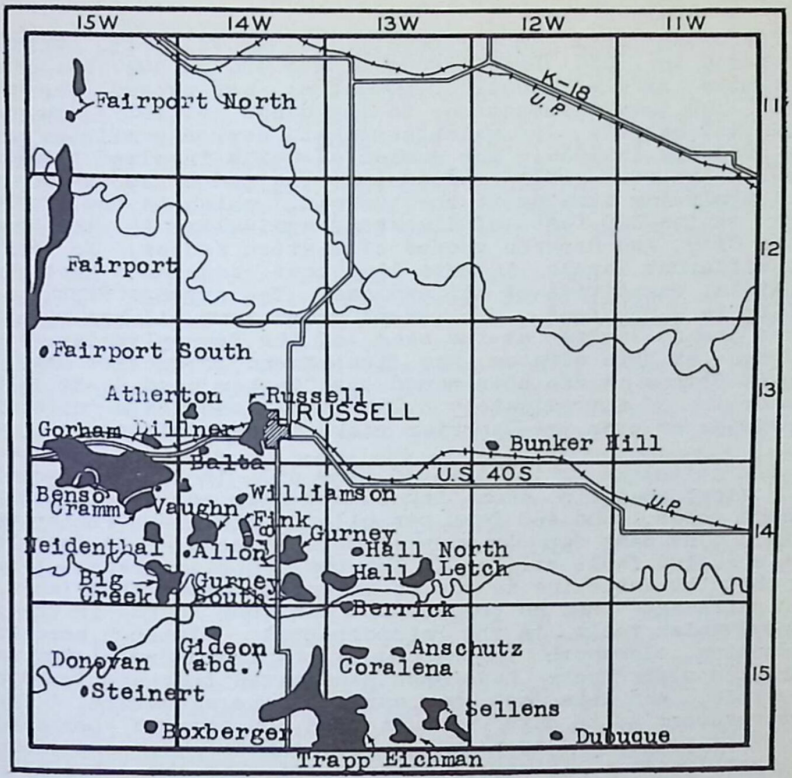
Although the general dip of the surface rocks in western Kansas is northward, there is a decided eastward component in Russell County. The regional north-northeastward dip averages about 7 feet to the mile. It is less in the southern part of the county (about 5 feet to the mile) and higher in the northern part (about 12 feet to the mile). A map based on variations in the altitude of the Greenhorn limestone[34] reveals many local modifications of the regional dip. A number of broad domal areas are shown, as well as areas of basin structure. The most prominent structural feature in the county is the so-called Fairport-Natoma anticline which extends northward along the western side of the county from a point just northwest of Gorham through the center of the northwest township of the county. Prominent domal areas lie south of the village of Bunker Hill, and northwest of Russell.

History of Oil and Gas Development

The first oil well in Russell County was drilled in 1923. At that time the nearest producing well was located fully 135 miles away. However, the prominence of the Fairport-Natoma anticline encouraged the Valerius Oil and Gas Company to test the possibilities of this surface manifestation of a favorable oil trap. The well was drilled on the farm of Carrie Oswald in the SW corner of the SE. ¼ of sec. 8, T. 12 S., R. 15 W. At a depth of 2,998 feet the pioneer oil men were rewarded by a flow of oil which amounted to 224 barrels a day. The gravity of the oil was high (41° Bé.) which indicated that the petroleum would

---

34. Kansas Geol. Survey Bull. 10, pl. 4, 1925.



Russell County

have a high refining value. The phenomenal success of this first well caused many holes to be drilled on the trend of the Fairport-Natoma anticline. Eventually there were 160 wells in the Fairport pool. Other pools were not sought in Russell County for several years. This seems strange in view of the fact that over 29 separate (at present) pools have been found up to the close of 1937.

As a result of wildcatting southward along the trend of the anticline the Gorham pool was discovered in October, 1926, but it was not until the middle of 1929 that another pool was found. In that year the Sellens and Ochs pools were discovered within a few months of each other. During the ensuing year the Gideon and the Dillner pools were added to the list of pools. In 1931 only one pool, the Hall, was found. No pools were discovered in 1932 or 1933, and only two in 1934. The 22 remaining pools were all found in 1935, 1936, and 1937. The impossibility of outlining the probable area of each pool when but few wells have been drilled leads to frequent merging of pools as drilling progresses. Thus it is a probability that (not counting new discoveries) fewer pools will be listed at the close of 1938.

At the present time Russell County has a greater number of pools than any county in western Kansas. Inasmuch as they are very similar in most respects it will be unnecessary to describe them in detail. Pertinent data are given in summary form in the accompanying table, and their geographic location is given on

the county map.

The oldest pool in the county is the Fairport, which was discovered in 1923. Drilling up to the end of 1937 has extended the limits gradually until 3,600 acres are proved for production. The total production to the close of 1937 amounted to 12,490,347 barrels, of which somewhat over one million barrels were produced in 1936. The number of wells involved totals 160, of which 151 were still producing at the end of 1937. The principal producing stratum is the "Oswald," which is the local name given to the 300 feet of limestone equivalent to the Lansing, Kansas City, and Bronson groups of eastern Kansas. No less than nine different levels in this limestone sequence have yielded commercial quantities of oil and gas. The average depth to production is 2,950 feet. In recent years some oil has been found in the sandy layers at the base of the Pennsylvanian system. Inasmuch as this stratum was first found productive near the town of Gorham it has been named the "Gorham sand." It is found at a depth of approximately 3,200 feet, and rests directly on Ordovician or even pre-Cambrian rocks in many places.

The anticline which trapped the oil in the Fairport pool has a steep west dip amounting to 200 feet per mile in the Cretaceous rocks, and 400 feet per mile in the older Pennsylvanian rocks. The east dip is much less pronounced. It is believed that a buried fault exists in the pre-Cambrian basement rocks, and that the anticline is due to movements along this fault. It is significant that no production has been found in the pre-Pennsylvanian rocks in the Fairport pool, although most of the production elsewhere in the county is from Ordovician rocks. Where the older rocks have been penetrated they are found to be very thin, and this fact may explain the situation. The per acre recovery up to date amounts to 3,600 barrels per acre for the whole pool, and to about 7,000 barrels per acre for the choicest leases. It may be anticipated that the total ultimate recovery will approximate 4,000 barrels per acre.

Another large pool in Russell County is the Gorham which covers large parts of townships 13 and 14 south, in Range 15 west. With about the same area as the Fairport pool, it has produced slightly over ten million barrels of oil since October, 1926, when the discovery well was drilled. The same producing strata are found here as in the Fairport pool, but at slightly greater depths. The average gravity of the oil is 38° Bé for the "Oswald" zone and 34° for the "Gorham" zone whereas at Fairport the "Oswald" oil has a gravity of 38° and the "Gorham" oil a gravity of 42° Bé. The total number of wells drilled to date is 291, of which number 28 were dry and 9 have been abandoned.

The Trapp pool stands in first place, although it was not discovered until March, 1936. At present it covers 7,000 acres and its limits have not yet been determined. The production from 269 wells at the close of 1937 was 3,910,186 barrels. The top part of the Arbuckle formation of Ordovician age contains the oil, and it is significant that very little has been found in either the "Oswald" or the "Topeka". Structurally this pool appears to occupy a local relatively high part of the buried Arbuckle surface. Whether this buried hill is also an anticline in the Arbuckle has not yet been determined. The producing zone in the limestone lies at an average depth of 3,250 feet at the top of the eroded surface.

Three other pools in this county have produced over a million barrels of oil to date. These are the Russell, Sellens,

and Sullivan pools. The discovery well in the Russell pool was drilled in February, 1934. Up to the end of 1937 it produced 3,212,118 barrels from approximately 1,200 acres. The oil occurs both in the Arbuckle and in the "Oswald". The number of wells drilled into each producing stratum are about equal. The "Oswald" is found at a depth of about 3,100 feet, and the Arbuckle at 3,350 feet. The Sellens pool was discovered nearly five years earlier. It has accounted for 1,776,236 barrels of oil from 1,200 acres and 30 wells. The main producing stratum is the Arbuckle, but considerable oil was also found in the "Oswald" zone. These occur at nearly the same depths as in the Russell pool.

The Sullivan pool (now part of Gorham pool) deserves special discussion because of the remarkably large number of producing zones in which oil has been found. A large amount of the total oil produced to date has come from the Tarkio limestone which lies near the middle of the Wabaunsee group. Most of the wells produce from the "Gorham sand" at the base of the Pennsylvanian system. Five wells produce from the Topeka limestone at the top of the Shawnee group. One well produces from the "Oswald" zone. Oil has also been found near the middle of the Shawnee group in the probable equivalent of the Lecompton limestone. From this it appears that at least five different and rather widely spaced formations in the Pennsylvanian contain commercial quantities of oil in this part of the county, in addition to the porous zone near the top of the Ordovician Arbuckle.

The Tarkio limestone is important in only two other pools, the Letch and the Williamson, while the Topeka has been of value only in three, the Coralena, Trapp, and the Gurney pools. These facts are difficult to explain. Apparently the Arbuckle and the "Oswald" zone contain the largest and most widespread accumulations of oil. In this connection it is necessary to mention one other producing stratum which may become more important in the future. This is the so-called Reagan or basal sand, thought to be of Cambrian age. At the close of 1937 it had been found productive only in the Big Creek pool.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
ALLON 21-14-14	July,1937 80 acres	2 9,858 Bbls.	3008-55 Lansing - K.C.	
ANSCHUTZ 10-15-13	Apr.,1936 80 acres	2 47,414 Bbls.	3311-27 Arbuckle	3 dry Grav.37
ATHERTON 19-13-14 30-13-14	July,1935	3 176,451 Bbls. 7	3008-55 "Oswald" 3284-89 Arbuckle	1 dry Grav.31 Grav.40
BALTA 32-13-14	Mar.,1936	3 69,419 Bbls.	3200-3220 Lansing - K.C. 3301-3313 Arbuckle	
BENSO 9-14-15	Feb.,1936 10 acres	1 15,771 Bbls.	3030-96 "Oswald"	Grav.37
BERRICK 6-15-13	Dec.,1935 20 acres	3 54,803 Bbls.	2894-2945 Conglomerate	2 dry Grav.39

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
BIG CREEK 36-14-15	July,1935 640 acres	4 658,671 Bbls. 6 25	2982-3022 "Oswald" 3180-84 Arbuckle "Gorham"	3 dry Grav.35 Grav.37
BOXBERGER 36-15-15	Dec.,1935 80 acres	4 86,152 Bbls.	3147-51 "Oswald"	1 dry Grav.37
BUNKER HILL 31-13-12	Oct.,1935 80 acres	4 28,670 Bbls.	2965-81 "Oswald"	Grav.39
CORALENA 17-15-13	Oct.,1936 600 acres	9 203,240 Bbls. 15	2790-2881 Topeka 3183-88 Arbuckle	
DILLNER 35-13-15	May,1930 40 acres	0 61,154 Bbls.	3300-08 Arbuckle	Abd. Grav.30
DONOVAN 10-15-15	Feb.,1935 10 acres	1 16,388 Bbls.	3193-99 "Oswald"	1 dry Grav.41
DUBUQUE 34-15-12	Oct.,1935 80 acres	3 95,043 Bbls.	3275-78 Arbuckle	Grav.40
EICHMAN 34-15-13	May,1935 800 acres	15 372,368 Bbls.	3316-26 Arbuckle	2 dry Grav.36
FAIRPORT 8-12-15	Nov.,1923 3600 acres	151 12,490,347 Bbls.	2998-3057 "Oswald" 3211-17 "Gorham"	Grav.38 Grav.42
FINK 16-14-14	Jan.,1935 40 acres	0 1,714 Bbls.	3155-70 "Oswald"	Abd. Grav.40
GIDEON 8-15-14	June,1930 40 acres	0 25,390 Bbls.	3266-72 "Oswald"	Abd. Grav.36
GORHAM 5-14-15	Oct.,1926 6000 acres	1 10,197,151 Bbls. 129 99 2 10 13	3054-66 Lecompton 3027-57 "Oswald" 3299-3300 "Gorham" 2525-50 Tarkio 2765-2870 Topeka 3289-93 Arbuckle	 28 dry Grav.38 9 abd Grav.34 Grav.40 Grav.35
GURNEY 23-14-14	Feb.,1935 1800 acres	8 437,776 Bbls. 21	2675- Topeka 3001-6 "Oswald"	 4 dry Grav.38
HALL 30-14-13	Oct.,1931 800 acres	28 781,955 Bbls. 6	2985-3085 "Oswald" 3451-54 Arbuckle	2 dry Grav.38 Grav.40

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
HALL NORTH 20-14-13	Nov.,1937 40 acres	1 992 Bbls.	3170-80 Arbuckle	
LETCH 34-14-13	June,1936 600 acres	1 76,695 Bbls.	2396 Tarkio	
		14	2831-80 "Oswald"	Grav.38
NEIDEN-THAL 23-14-15	Aug.,1934 600 acres	14 634,092 Bbls.	3246-50 Arbuckle	2 dry Grav.40
RUSSELL 28-13-14 22-13-14	Feb.,1934 1200 acres	3 3,212,118 Bbls.	3195-3204 "Oswald"	10 dry Grav.38
		49	3280-86 Arbuckle	2 abd Grav.33
SELLENS 36-15-13	June,1929 1200 acres	30 1,776,236 Bbls.	3088-97 "Oswald"	4 dry Grav.37
			3352-65 Arbuckle	Grav.38
STEINERT 21-15-15	July,1936 10 acres	1 19,674 Bbls.	3060-97 "Oswald"	1 dry Grav.35
TRAPP 20-15-13 20-15-13 30-15-13	Mar.,1936 7000 acres	2 3,910,186 Bbls.	Topeka	
		6	3062-64 "Oswald"	5 dry 2 abd.
		261	3252-53 Arbuckle	Now includes Karst and Ochs
VAUGHN 17-14-14	Apr.,1937 200 acres	17 113,746 Bbls.	3004-34 Lansing - K.C.	
WILLIAM-SON 29-14-14	Feb.,1936 40 acres	2 4,274 Bbls.	2522-50 Tarkio	Grav.35

Important Test Wells

Berry No. 1 Cook, in sec. 19, T. 11 S., R. 13 W., top of Anhydrite, 890; Lansing, 3,097; Conglomerate, 3,412; Chat, 3,605; total depth, 3,635 feet.

Pryor and Lockhart No. 1 Spicer, in sec. 21, T. 11 S., R. 15 W., top of Lansing, 2,997; Conglomerate, 3,278; Arbuckle, 3,360; total depth, 3,366 feet.

Merriam No. 1 Murphy, in sec. 11, T. 12 S., R. 12 W., top of Topeka, 2,585; Lansing, 2,930; Conglomerate, 3,290; Viola, 3,442; Simpson, 3,675; total depth, 3,705 feet.

Wilcox No. 1 Wilson, in sec. 14, T. 12 S., R. 13 W., top of Topeka, 2,490; Lansing, 2,828; Conglomerate, 3,255; Viola, 3,258; Arbuckle, 3,375; total depth, 3,561 feet.

Hartman and Blair No. 1 Claussen, in sec. 34, T. 12 S., R. 14 W., top of Topeka, 2,480; Lansing, 2,730; Conglomerate,3,075; Viola, 3,095; Arbuckle, 3,105; total depth, 3,122 feet.

Producers No. 1 Haire, in sec. 24, T. 12 S., R. 15 W., top of Topeka, 2,603; Lansing, 2,925; Arbuckle, 3,240; Reagan, 3,605; total depth, 3,634 feet.

El Dorado No. 1 Waltz, in sec. 29, T. 13 S., R. 11 W., top of Topeka, 2,505; Lansing, 2,975; Conglomerate, 3,280; Viola, 3,365; Simpson, 3,395; Arbuckle, 3,435; total depth, 3,441 feet.

Austin No. 1 Rockefeller, in sec. 6, T. 13 S., R. 12 W., top of Topeka, 2,500; Lansing, 3,003; Conglomerate, 3,347; Chat, 3,351; Viola, 3,434; Simpson, 3,515; Arbuckle, 3,540; total depth, 3,559 feet.

El Dorado No. 1 Scott, in sec. 17, T. 13 S., R. 13 W., top of Anhydrite, 823; Lansing, 3,033; Marmaton, 3,280; Conglomerate, 3,342; Simpson, 3,383; Arbuckle, 3,504; total depth, 3,554 feet.

Empire No. 3 Ehrlich, in sec. 28, T. 13 S., R. 14 W., top of Topeka, 2,725; Lansing, 3,008; Arbuckle, 3,283; Reagan, 3,415; granite, 3,505; total depth, 3,520 feet.

Thayer No. 1 Cook, in sec. 10, T. 13 S., R. 15 W., top of Anhydrite, 780; Lansing, 2,879; Conglomerate, 3,163; Arbuckle, 3,210; Reagan, 3,238; total depth, 3,252 feet.

Palmer No. 1 Pasek, in sec. 3, T. 14 S., R. 11 W., top of Anhydrite, 660; Topeka, 2,680; Lansing, 2,920; Conglomerate, 3,265; Arbuckle, 3,330; total depth, 3,427 feet.

Shoemaker No. 1 Lindsay, in sec. 6, T. 14 S., R. 12 W., top of Topeka, 2,650; Lansing, 2,989; Conglomerate, 3,348; Arbuckle, 3,400; total depth, 3,605 feet.

Darby No. 1 Letch, in sec. 34, T. 14 S., R. 13 W., top of Lansing, 2,831; Reagan, 3,110, granite wash, 3,238; granite, 3,262; total depth, 3,265 feet.

Hartman and Blair Hildebrand, in sec. 12, T. 14 S., R. 14 W. top of Marmaton, 3,189; Conglomerate, 3,210; Reagan, 3,250; pre-Cambrian, 3,280 feet.

Texas No. 5 Anschutz, in sec. 1, T. 14 S., R. 15 W., top of Anhydrite, 895; Topeka, 2,760; Lansing, 3,037; Arbuckle, 3,296; Reagan, 3,304; granite, 3,390; total depth, 3,394 feet.

Marland No. 1 Sellens, in sec. 36, T. 15 S., R. 13 W., top of Topeka, 2,700; Lansing, 3,093; Conglomerate, 3,337; Arbuckle, 3,372; total depth, 3,643 feet.

Empire No. 3 A Krug, in sec. 24, T. 15 S., R. 14 W., top of Anhydrite, 896; Lansing, 3,125; Arbuckle, 3,368; Reagan, 3,532; pre-Cambrian, 3,599; total depth, 3,831 feet.

Relationship Between Structure and Production

Despite the large number of wells drilled in Russell County, it is not yet possible to make a definite statement regarding the type of structure responsible for all the oil accumulations.

n the case of the Fairport pool the anticlinal arrangement of hee rocks seems to point very clearly to a type of oil trap ound in many parts of the world where a blanket sand is the esservoir rock. The definitely arched strata have allowed the ill to migrate upward until it could migrate no farther. Perapps the other pools in which oil occurs within the "Oswald" ome, and in other limestones of the Pennsylvanian system, may lsso reveal a domal or anticlinal structure when they are fully rilled. In the Arbuckle the effect of buried topography seems o overshadow that of structure. In other words, wherever the roducing layer is found at a relatively higher elevation than urrounding areas, the likelihood of oil accumulation is greatr.. Inasmuch as the top of the Arbuckle is known to be very eeeply eroded, and beneath an important unconformity, it is imeddiately apparent that an anticlinal structure is probably not ssssential.

If the trend of the oil pools is studied, a notable tendency orr pools to line up along southeast to northwest lines is aparrent. This reflects the influence of the Central Kansas Upiift (formerly called the Barton Arch). This large buried tiructure underlies the southern and western parts of the county.. The gently dipping pre-Pennsylvanian rocks are inclined owward the northeast. It may be imagined that cuestas or eroiional scarps exist in such layers which parallel the axis of hee main structure. The high points along such buried cuestas ppear to be favored for oil accumulation.

Pipe Lines

An outlet for the crude oil of Russell County is provided by a number of pipe lines. The Kaw pipe line takes the oil from thee Anschutz, Balta, Batt, Berrick, Big Creek, Boxberger, Coraiesna, Cramm, Donovan, Dubuque, Dumler, Eichman, Gideon, Gorham, Gurney, Hall, Karst, Letch, Mitchell, Milberger, Neidenthal, Peterson, Russell, Sellens, Steinert, Trapp, Vaughn, and Williamson pools. The Stanolind Oil Company transports oil from thee Atherton, Benso, Fairport, Gorham, and Russell pools.

There is one refinery in the county. It is owned by the United Refining Company at Russell and is built to accommodate 1,,250 barrels of crude oil per day. During 1937 it was not operating at full capacity.

SALINE COUNTY

Areal Geology

The topography of Saline County depends very largely upon two rivers, the Saline and Smoky Hill, and their tributaries. Thnese streams produce low land along which occur the most recent geological materials, including sands, silts and gravels depositted in the channels during times of flood. About one-third of thhe county is covered with this type of rock. In the uplands, away from the stream channels, and along the divides, are fairly hiigh hills with considerable relief. The hills are composed of brrownish sandstone about 50 feet thick, under which thin beds of vaaricolored shales and clay may be seen. These rocks belong to thhe Cretaceous system and have been named the Dakota sandstone annd the Comanchean shales. They are described rather fully by

Twenhofel[35] and the reader is referred to his article for details.

Permian Strata. The Cretaceous and Quaternary rocks lie upon an unevenly eroded surface of much older strata belonging to the Cimarron and the Big Blue series of Permian age. The Cimarron red beds are not exposed at the surface, but have been found in the cuttings of wells drilled along the western border of the county. The uppermost part of the Big Blue series, the Wellington formation, has been found in small areas around Falun, Smolan, and Bavaria, in places where the Cretaceous rocks have been cut away by stream erosion. The Wellington beds are especially well exposed in the eastern tier of townships on both sides of Gypsum Creek. There a fairly complete sequence of beds from the Highland shale, down through the Carlton limestone and Chisholm Creek shale, to the Annelly gypsum may be studied. In fact, Gypsum Creek was named after the numerous outcrops of the Annelly gypsum. The thickness of these members of the Wellington[36] is approximately 250 to 300 feet.

Subsurface Stratigraphy

Below the exposed portion of the Wellington in this county are other members of the formation. They appear in well cuttings and include the Geuda Springs, Hollenberg, and Pearl shale members. These comprise shales in the upper part and anhydrites in the lower part, and add about 300 feet to the total thickness of the Wellington formation.

Under the Wellington shale is the Herington limestone, which lies so close to the surface here that it has been extensively used for core-drill determinations. The Herington forms the top member of a sequence of rocks that is found in all wells drilled in the county, and which is very distinctive. The thickness rarely departs from 600 feet, and the chert zones near the middle as well as the fossiliferous Americus limestone at the base, are not to be mistaken.

Pennsylvanian Rocks. The Pennsylvanian strata in Saline County measure approximately 1,600 feet in thickness. The uppermost division is composed chiefly of shales, and contains sandy zones at certain levels. It is possible to identify this unit in well logs as the equivalent of the Wabaunsee group, which is found at the surface not many miles to the east. Below is a thick unit of limestones, appearing at depths of from 1,300 feet in the eastern range to 2,050 feet in the westernmost range of the county. The top member is customarily referred to the Topeka limestone, and below it lie the other formations of the Shawnee group, down to and including the Oread at the base. A zone of sandstone appears just below the Topeka in many wells, and a zone of black shale within the Oread makes a good marker near the base. The whole unit measures about 300 feet.

The Douglas group below is composed of clastic materials, including shale and sandstone. It varies in thickness from 100 feet in the east to about 175 feet in the west. The prominent limestone of the Lansing group appears at depths of from 1,800

---

35. Kansas Geol. Survey Bull. 9, p. 31 and pl. 1, 1924.
36. Univ. of Wichita Studies, Bull. 2, p. 17, May, 1937.

in the eastern range to about 2,500 in the western range of the county. Below it occur other thick limestones which are correlated with the various formations in the Lansing, Kansas City and Bronson groups of eastern Kansas. The thickness of these three units is about 350 feet. They lie upon the shales which belong to the Bourbon, Marmaton and Cherokee groups.

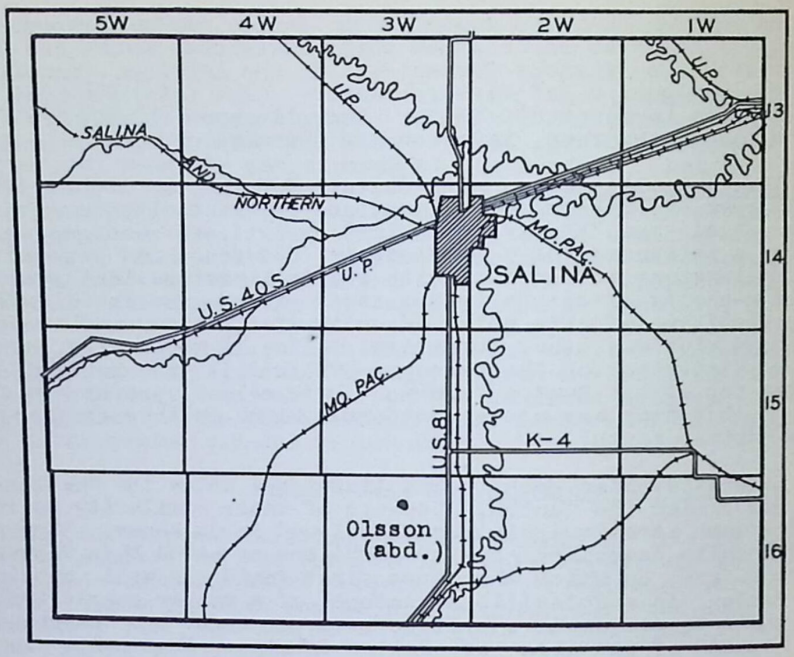
Mississippian Rocks. In Saline County the Pennsylvanian rocks rest everywhere upon limestone of Mississippian age, usually called the "Mississippi lime" by drillers and geologists. It has a thickness of approximately 250 feet and generally is solid limestone at the top with cherty limestone in the middle, and non-cherty limestone in the lower part. The white crystalline limestone of this unit is quite distinctive and is seldom confused with any other formation. Below it are shales, usually called Kinderhook or Chattanooga, which fill the interval down to the top of the Hunton "lime". Dark colors prevail in these shales, but they are not as uniformly black as they are in counties farther south.

Siluro-Devonian Rocks. The limestones below the Chattanooga are now called the Hunton, because of their similarity to rocks of the same stratigraphic position found in Oklahoma. They were rather fully described by Barwick[37] and he named them "Younkin" after a farm on which they were first found in well cuttings. The Hunton is a dolomitic limestone of a rather coarse texture and white to gray color. It is present under the Chattanooga over most of the area of Saline County. Some wells in the southern part of the county have found it missing, with the next older formation appearing beneath the Chattanooga. The thickness of the Hunton commonly reported in wells is from 100 to 1[illegible] feet, but farther north and northeast it is considerably thicker.

Ordovician Rocks. Beneath the Hunton, or the Chattanooga where the Hunton is missing, is a unit of greenish shale correlated with the Maquoketa of northern states or the Sylvan of Oklahoma. It has a thickness of 100 to 150 feet in wells drilled up to date. The lower part is likely to be somewhat variable in composition, and evidently consists of erosional detritus from the underlying limestone. This cherty rubble is 40 feet or more thick in most wells. It has been included with the Viola by some geologists. The true Viola in this county consists of white to brown limestone, which is commonly dolomitic and rather cherty at the top. A thickness of over 100 feet is general throughout Saline County. The appearance of green shales in well cuttings marks the base of the Viola and the top of the Simpson formation. The latter contains shale in the upper half and sandstone in the lower half, and has a thickness of around 990 feet in most wells. A lithologic similarity to the St. Peter sandstone has caused some geologists to apply that name to this unit. Others have called the lower part, where rounded grains of sand are characteristic, the Wilcox sand. The coarse textured dolomite lying below the Simpson is correlated with the Arbuckle limestone of Oklahoma. It has been penetrated to depths approaching 100 feet in some wells, but its actual thickness is at present unknown. Presumably it does not exceed greatly the thickness of 200 feet reported in a well in Clay County to the north.

---

37. Barwich, J. S., The Salina Basin of North-central Kansas, Am. Assoc. Petroleum Geologists, Bull. vol.12, p. 177, 1928.



Saline County

History of Development

Olsson Oil Pool. A great amount of interest in the oil possibilities of this county was created when the Dixie (now Stanolind) Oil Company drilled its first well on the Olsson farm in sec. 10, T. 16 S., R. 3 W. This well was completed on December 4, 1929, but showed only 10 barrels of oil in the initial tests. Subsequently 1,400 barrels were taken from the well, but on account of the small daily yield it was abandoned in December, 1930. In this test the drill was first sent down to a total depth of 3,602 feet, which put the bottom of the hole in the Arbuckle. Not finding commercial production there, the well was plugged back to 3,302 to 3,315 feet where oil was found in a cherty dolomitic rock near the base of the Maquoketa. A second well was drilled in 1937 by Brouck and Murphy on the Thelander farm in sec. 10 of the same township. This well had a good show of oil at 3,294 to 3,311 feet at the same horizon as in the Olsson well. It was later drilled deeper, to a depth of 3,525 feet where it was about 3 feet into the Arbuckle formation. Finding no commercial amounts of oil in any formation, it was abandoned.

Important Test Wells

Dieter No. 1 Herington, in sec. 3, T. 13 S., R. 1 W., top of Topeka, 1,335; Lansing, 1,767; Marmaton, 2,136; Cherokee, 2,290; Mississippi lime, 2,445; base, 2,640; Hunton, 2,795; Sylvan, 2,945; Viola, 3,057; Simpson, 3,137; Arbuckle, 3,224 feet.

Twin Mounds No. 1 Weiss, in sec. 20, T. 13 S., R. 4 W., top of Topeka, 1,948; Lansing, 2,450; Marmaton, 2,775; Cherokee, 2,920; Mississippi lime, 3,091, base, 3,415; total depth, 3,525 in Kinderhook.

Sampson-Deterick et al No.1 Sudendorf, in sec. 30, T. 14 S., R. 2 W., top of Topeka, 1,550; Lansing, 2,045; Marmaton, 2,358; Mississippi lime, 2,703, base, 2,965; Hunton, 3,098; Sylvan, 3,210; Viola, 3,296; Simpson, 3,396; Arbuckle, 3,482;total depth, 3,519 feet.

Kinney No. 1 Veil, in sec. 23, T. 14 S., R. 5 W., top of Topeka, 2,060; Lansing, 2,530; Marmaton, 2,890; Mississippi lime, 3,160, base, 3,487; Hunton, 3,600; Sylvan, 3,680; Viola, 3,790; Simpson, 3,892; Arbuckle, 3,970; total depth, 4,010 feet.

Dixie No. 1 Muir, in sec. 6, T. 15 S., R. 2 W., top of Topeka, 1,543; Lansing, 2,045; Marmaton, 2,375; Mississippi lime, 2,690, base, 2,978; Hunton, 3,098; Sylvan, 3,187; Viola, 3,290; Simpson, 3,394; total depth, 3,442 in Simpson.

Lario No. 1 Fulton, in sec. 14, T. 16 S., R. 2 W., top of Topeka, 1,690; Lansing, 2,215; Marmaton, 2,560; Mississippi lime, 2,852, base, 3,148; Hunton, 3,252; Sylvan, 3,353; Viola, 3,445; Simpson, 3,528; total depth, 3,579 in Simpson.

Brauck No. 1 Thelander, in sec. 10, T. 16 S., R. 3 W., top of Topeka, 1,675; Lansing, 2,185; Marmaton, 2,565; Mississippi lime, 2,815, base, 3,045; Viola, 3,345; Simpson, 3,440; Arbuckle, 3,520; total depth, 3,525 feet.

SCOTT COUNTY

General Geology

Scott County is in the western part of Kansas where the thick mat of Tertiary gravel, sand, and silt covers large areas. With the exception of a small corner in the northeastern part of the county this material only is to be seen on the surface. The thickness of the Tertiary Ogallala formation is from a few feet to a maximum of perhaps 200 feet. In many places the gravels and sands are cemented by calcium carbonate into so-called "mortar beds."

The red rock which outcrops in northeastern Scott County is the Niobrara shale of Cretaceous age. It also unconformably underlies the blanket of Tertiary rocks in other parts of the county. In deep wells the Hays limestone, which is the lower member of the Niobrara, appears at a depth of around 200 feet and extends down to about 300 feet. The Dakota sandstone appears at 700 feet and continues down to about 1,200 feet. It consists of sandstones of rather coarse texture and interbedded shales.

Permian Rocks. Red beds of Permian age are found beneath the Cretaceous rocks in well samples. They consist of red clays and siltstones. The Blaine gypsum member appears around 1,430 feet, and the main or Cimarron anhydrite layer lies at a depth of 2,100 feet. The base of the red beds is not much lower. Gray shales and anhydrites of the Wellington formation occupy the next lower interval, down to 2,800 feet where the first dolomite appears. The latter is correlated with the Herington of eastern Kansas. The remainder of the Big Blue series down to the Americus limestone is characteristically developed. The two cherts, which are so widespread farther east, one at the Florence level and the other at the Wreford level, serve to identify this sequence.

Pennsylvanian Rocks. The Pennsylvanian rocks are approximately 1,400 feet thick in Scott County. The Topeka limestone lies at a depth of 3,600 feet and the Lansing is some 350 feet lower. This interval is characterized, as usual, by limestones, and has a thickness of 330 feet. Below the Lansing-Kansas City-Bronson sequence of limestones are shales which may correspond to the Marmaton and Cherokee groups of eastern Kansas. They are subordinate in this county, however, to coarse limestones of gray to black color. The presence of considerable chert, also, leads to the belief that the composition of the lower Pennsylvanian rocks is somewhat different in this western county. Red and green shales toward the bottom of the system probably belong to the basal conglomerate. They appear some 70 feet above the top of the Mississippian limestone.

Pre-Pennsylvanian Rocks. A rather interesting sequence of older rocks has been found in Scott County. When production first was found in the Shallow Water pool it was believed that the producing limestone was of Chester (upper Mississippian) age. Norton, however, reports that this oolitic limestone is probably the equivalent of the Ste. Genevieve limestone of middle Mississippian age. The top is found in wells at depths of about 4,650 feet. Below the oolitic phase of this limestone are coarsely crystalline gray, mottled limestones which give way at depth to very cherty dolomites. In one well, the Kinderhook formation of the Mississippian system is present at a depth of about 5,300 feet, lying upon an eroded surface of Viola limestone. The Viola is a sugary, dolomitic, and very cherty limestone at the top, but becomes finer grained and non-cherty below. It grades into the Simpson at a depth of about 5,450 feet, and the Arbuckle is encountered at about 5,470 feet. Some geologists believe that the Hunton is present in southern Scott County. The details of the stratigraphy are very obscure at present.

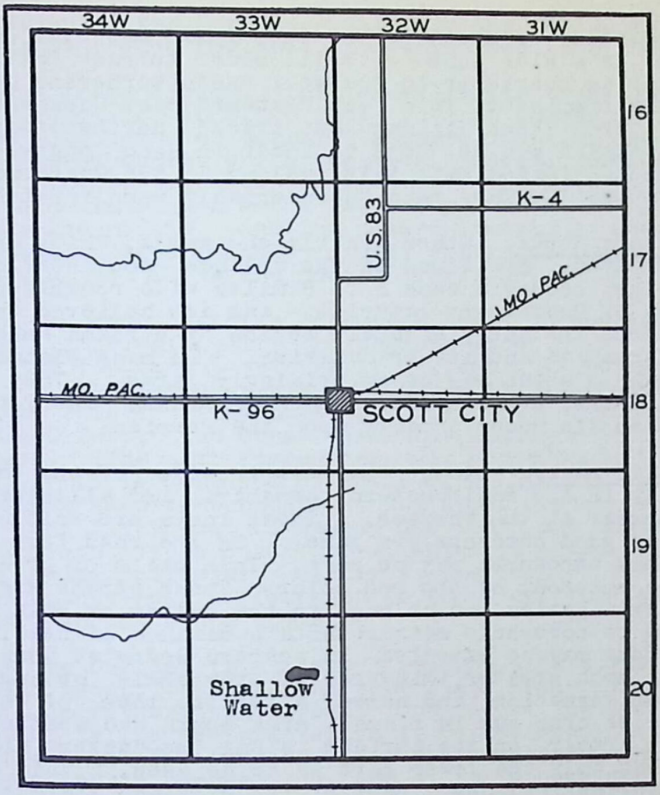
Structure

Practically nothing is available for publication on the structure of this county. Much exploratory work has been done, especially with geophysical instruments. The Shallow Water oil pool was discovered in this manner.

Oil and Gas Development

Shallow Water Oil Pool. The only oil pool in Scott County at the close of 1937 was the Shallow Water pool in the south-central part. It was discovered by the Atlantic Oil Producing Company when the first well on the Vaniman farm was completed in December, 1934. This well was located in the cen. SE.¼ NE.¼ of sec. 15, T. 20 S., R. 33 W. Oil with a gravity of 26° Bé. was found 5 feet below the top of the "Mississippi lime" which was encountered at a depth of 4,665 feet. The porous zone of oolitic limestone extends 16 feet down to a depth of 4,685 feet. The discovery well produced 572 barrels after acidization. Up to the close of 1937 a total of seven wells had been drilled in the pool, of which five are producers. The initial production of some of these exceeded that of the original well by a considerable margin. By October, 1937, these wells had produced over 87,000 barrels of oil. The oil is taken to Shallow Water where the Shallow Water Refining Company has a 1,500 barrel refinery.

Wildcat Wells. Several important test wells have been drilled in Scott County. One of these, drilled by the Olson Drilling Company in sec. 13, T. 19 S., R. 33 W., had the top of



Scott County

the Lansing at 4,106 feet and the top of the Mississippian at 4,810 feet. The total depth was 5,035 feet. In another well, drilled by Watchorn Oil Company in sec. 23, T. 20 S., R. 33 W., the Topeka was found at 3,510; the Lansing at 3,770; basal conglomerate at 4,594 feet, and the Mississippian at 4,665 feet. The total depth of this well was 5,509 feet. It is reasonable to assume that other pools will be found in Scott County.

SEDGWICK COUNTY

Geology

The largest river in the state, the Arkansas, passes through Sedgwick County. Therefore a large part of the county is covered with alluvium, which in the form of flood plains and terraces measures 6 miles in width. These terraces widen out from Wichita northward toward Bentley so as to take in the whole area between the main Arkansas and the Little Arkansas River. The sand and gravel in these terrace deposits has been cored in many places and appears to have a maximum depth exceeding 100 feet. Evidently the ancestor of Arkansas River cut a deep path through the county, and then partially filled it with alluvium. Frequent changes in channel position allowed the material to accumulate to its present great width.

Immediately adjacent to the flood plain material southwest of the river is a wide zone of still older terrace material which is similar in character to the well known McPherson beds. It is especially prominent from Peck westward past Clearwater toward Cheney. From Peck it may be traced northwestward through Shulte, Colwich and Mt. Hope to Yoder in Reno County. All these loose unconsolidated materials belong to the Quaternary system of the Cenozoic. They rest unconformably upon Permian rocks.

Tertiary Rocks. Other gravels and sands, which are slightly more indurated, are found on the uplands southwest of Arkansas River. They occupy a zone 3 to 8 miles wide roughly parallel to the bands of Quaternary material, and are believed to have been brought from the Rocky Mountain region by streams antedating the present Arkansas and its tributaries. In many places only pebbles remain, which may be surprisingly large. They consist of granite, chert, and other resistant minerals. The Tertiary sediments also lie unconformably upon the Permian.

Permian Rocks. Along the western side of the county and especially in the southwestern townships, red siltstones and red shales appear at the surface. These rocks are soft and easily eroded, so good outcrops are rare. On the road from Cheney to Anness some exposures may be seen. Thin white or greenish bands break the monotony of the red color. These strata are a part of the Cimarron series and belong to the lowest or Enid formation. According to core-hole measurements a maximum of nearly 200 feet of red rocks may be expected in western Sedgwick County. They overlie a much greater thickness of gray shale belonging to the Wellington formation, and named after the town of Wellington. These shales crop out in a small area south and west of Clonmel. They also appear on the surface along the eastern side of the county, but only the lower part is to be seen.[38] This section of the Wellington includes a part of the Highland shale and the Annelly gypsum and Geuda Springs members. The total thickness of these strata as determined by core drilling is approximately 200 feet. Below them other members of the Wellington have been found, making a total thickness of 550 feet for the whole formation.

Subsurface Stratigraphy

Many wells have been drilled in Sedgwick County in the search for oil and gas. It is therefore possible to render a fairly accurate account regarding the thickness and detailed lithology of the formations encountered. Below the Wellington gray shales and gypsums is a zone of anhydrite about 125 feet thick. It lies upon the Herington limestone, and forms a convenient reference zone in well correlation. On the outcrop this unit corresponds to the lowest part of the Geuda Springs shale, the Hollenberg limestone, and the Pearl shale. The Herington limestone is the first prominent limestone found in drilling and is, therefore, always picked in studying well cuttings. It is slightly dolomitic in Sedgwick County and usually about 7 feet thick. Below it are 600 feet of alternating limestones and shales which have many distinguishing marks, so the various members can be easily determined when a well is being drilled. The top of the Fort Riley limestone, the Florence and Wreford cherty limestones, and the base of the Americus are all readily distinguished. This group of rocks is often referred to as the Big

38. Univ. of Wichita Studies, Bull. 2, map Fig.2, May, 1937.

Blue division of the Permian, although the original definition of the Big Blue also included the Wellington formation as well.

Pennsylvanian Strata. The Pennsylvanian rocks have a thickness of from 2,000 to 2,100 feet in this county. They may be separated into seven or eight lithologic units. The first of these is the Wabaunsee which has a thickness of from 600 to 650 feet, the greater thickness being toward the south. It contains shales, thin limestones and a few sandy layers. The Tarkio limestone mear the middle, and the Howard limestone near the base, can be readily distinguished in well cuttings. One of the sandy zones occurs just above the Howard limestone.

The appearance of thick limestone beds in the section marks the second lithologic unit, the Shawnee group. The Topeka limestone at the top is not so clearly definable as it is in western Kansas. A sandy zone occurs just below it, but otherwise thin shales and thicker limestones predominate. The thickness is commonly 450 feet, the Oread limestone making a definite marker at the base. The next succeeding unit corresponds to the Douglas group. It is composed of shale with thin limestone layers and prominent sandstone bodies. The upper sandstone may be developed to a thickness of nearly 100 feet and usually carries water. In some places a sandstone, which is always thin and apparently quite lenticular, occurs at the base. The whole unit comprises a thickness of from 150 to 450 feet, thus showing more variation than the other units.

Below the Douglas is another limestone unit corresponding to the Lansing group. It contains some black shale as well as gray shale, but in rather thin layers. The top of the Lansing is usually found in the eastern ranges at depths from 2,150 to 2,400 feet; in Range 1 W. it lies at slightly lower depths, down to 2,600 feet; and in Ranges 2, 3, and 4, it is considerably lower, at depths from 2,575 to 3,000 feet. The underlying Kansas City group consists of clastic materials, such as dark-gray and black shale. It has a thickness of about 100 feet. The next limestone unit corresponds roughly to the Bronson group. A few years ago it was consistently called the "Kansas City lime" by drillers and geologists and was looked upon as the most reliable level on which to draw contours for structure mapping. The revision of the Pennsylvanian rocks made necessary by the extensive investigations of Dr. R. C. Moore[39] has caused geologists to abandon the older usage and use the name Bronson instead. This terminology is followed on the elaborate cross-section of the state prepared for the Sixth Annual Field Conference of the Kansas Geological Society[40] on which the Drum limestone is included in the Kansas City group. The top of the Bronson is found about 300 feet lower than the top of the Lansing, and is sharply marked in most well logs.

A series of shales, sandstones, red rocks, and in some places conglomerate lies below the Bronson group. The uppermost layers belong to the Bourbon formation, but cannot be differentiated in well cuttings. Therefore, it is customary to log the top of the Marmaton at the base of the limestone sequence. In

---

39. Kansas Geol. Survey, Bull. 22, 1935.
40. This may be secured from Harvel White, manager of the Kansas Geol. Soc., Union National Bank Bldg., Wichita, Kansas.

Sedgwick County this unit consists generally of dark to black shales with interspersed thin limestones. The underlying probable equivalent of the Cherokee contains similar materials, but red and green colors are much more prominent. At the base there may be a little conglomeratic and detrital rubble. The Marmaton and Cherokee together have a thickness of from 300 to 400 feet. Variation in thickness is to be expected, as it overlies an angular unconformity.

Mississippian Rocks. In Sedgwick County the Mississippian rocks everywhere appear beneath the Pennsylvanian, but in greatly varying thickness. They consist of limestones at the top, and dark to black shales at the base. The limestone portion is usually called the "Mississippi lime" and the shale portion the Chattanooga shale. In many wells, non-cherty white limestone occurs at the top. Below this is a thick zone of white limestone in which chert is very abundant, underlain by a thinner non-cherty limestone. Because of prolonged erosion during early Pennsylvanian time the upper beds of the "Mississippi lime" are usually missing, and only the chert formerly imbedded in it remains behind. The chert, or "chat" as the drillers call it, shows signs of weathering by its chalky luster. In many wells the chert is quite thick. As a rule the top of the Mississippian is found at a depth of about 3,000 feet in the two eastern ranges of the county. In the western ranges it shows a pronounced drop to depths of 3,300, 3,500, and 3,700 feet. It seems to lie deepest in Range 3 W. Because the actual elevations of top of the Mississippian also show the same dropping off toward the west, structural position must be responsible. A small amount of the difference is accounted for by the thickening of the Pennsylvanian strata toward the south and the west.

The Chattanooga shale is perhaps the most distinctive lithologic unit in the county. The black color, and its stratigraphic position below a cherty limestone zone, are characteristic features not to be mistaken. The thickness varies somewhat from a minimum of about 50 feet to a maximum of about 160 feet. An average of 100 feet is quite common. At the base is a thin layer of sand, the Misener, which has a patchy distribution and variable content. Because it contains oil, this layer has assumed considerable prominence.

Ordovician Rocks. Beneath the Chattanooga only Ordovician rocks have been found in wells drilled up to date. Consequently no Hunton (Siluro-Devonian) rocks are to be expected. Even the Ordovician rocks are present in reduced thickness. The topmost formation, the Sylvan shale, has not been definitely identified in any well so far drilled. It has been questionably reported in some wells drilled in Range 4 W. As a rule, the Viola limestone appears under the Chattanooga. It is a white coarsely crystalline limestone, in many places sufficiently dolomitic to be classified as a dolomite. In the Valley Center pool, where the Viola has been most exhaustively studied, it is 85 feet thick and consists of three dolomitic layers separated by a gray shale above and a sandy layer below. This variation in lithologic character has caused some uncertainty as to its exact age. It was suggested by Folger[41] that the uppermost dolomite belongs to the Misener portion of the Mississippian, and that the shale break is the Sylvan of Ordovician age. This interpretation

---

41. Kansas Geol. Survey, Mineral Resources Circular 2, p. 38 1933.

would leave 50 feet in the Viola formation. According to this interpretation some of the production in the Goodrich pool comes from a Misener dolomite. In the absence of definite proof, and for the sake of uniformity, most oil-company geologists at present regard the dolomitic limestone from top to base as equivalent to the Viola of Oklahoma. On account of the unconformity at the top of the Viola, extreme variations in thickness are recorded. The maximum appears to be about 90 feet.

Simpson Formation. Many wells have been drilled without finding the Viola and in them the Simpson sand, sometimes called "Wilcox", occurs beneath the Chattanooga shale. This condition is to be expected in the southern tier of townships, and also in the southeastern quarter of the county. The Simpson is easily identified by the appearance of sand in considerable thickness mixed with a small amount of pea-green shale. The grains of sand are commonly rounded and frosted as if by wind action. The thickness ranges from 45 to 110 feet, with an average of about 90 feet. Some oil has been found in this formation, as indicated in the following pages.

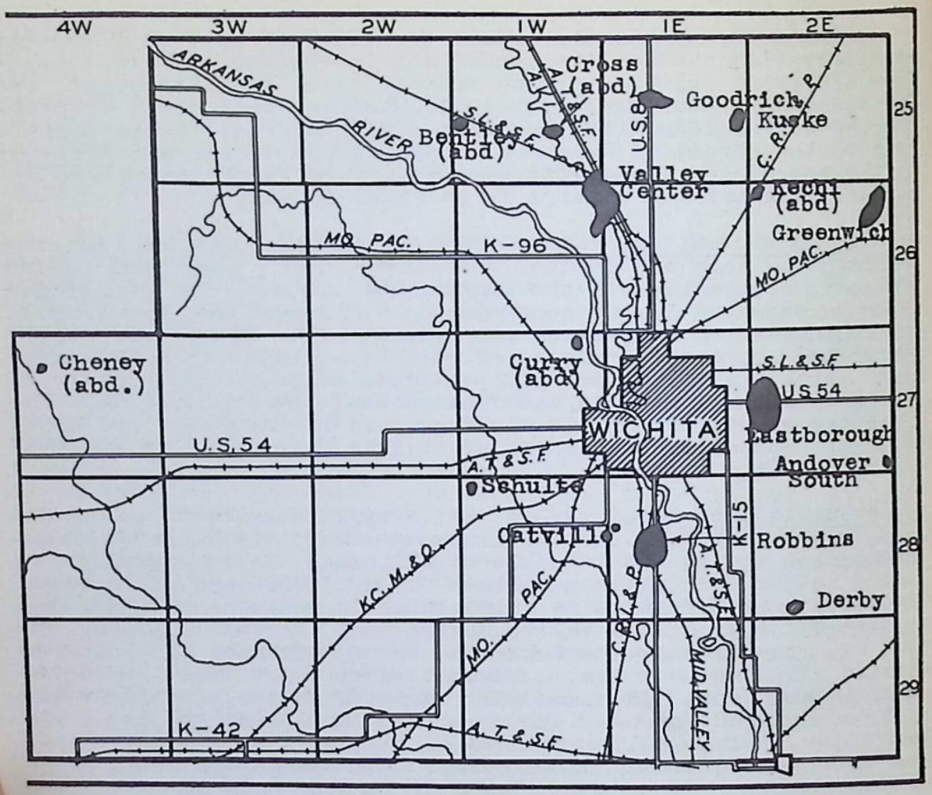
Arbuckle Limestone. Below the Simpson formation all wells have found a coarse dolomitic limestone which is believed to be of the same age as the Arbuckle of Oklahoma. It is usually referred to as the "Siliceous lime" by drillers and geologists. Evidently this formation is quite thick in Sedgwick County. One well at the edge of the Valley Center pool in sec. 1, T. 26 S., R. 1 W., penetrated the Arbuckle for a distance of 539 feet without finding the base. Several zones were found in which chert is abundant. Another well drilled in sec. 1, T. 27 S., R. 1 W., drilled through the formation and found it to be 740 feet thick. This well continued on through the Reagan or basal sand and on into pre-Cambrian rocks. The Reagan was found to be 666 feet thick. The pre-Cambrian consisted of much decayed granitic material in which quartz was particularly prominent. This well was abandoned at a depth of 4,703 feet, some 325 feet below the pre-Cambrian surface. The top of the Arbuckle may be expected at depths of from 3,400 feet in the eastern ranges to a depth of over 4,200 feet in the western ranges.

Structure

The structure of the strata in Sedgwick County cannot be readily determined from the surface outcrops. Core drilling has therefore been resorted to on a large scale, especially between 1925 and 1935. No very prominent anticlines or domes were discovered. A series of "highs" were found along a trend that runs nearly north and south just west of Wichita. This has been named the Bluff City anticline. Its extent and configuration are still relatively unknown, although one important oil field, the Valley Center, has been found on it. Other parallel anticlinal trends are present, but are not characterized by great relief. The regional dip of the surface rocks is toward the west at an angle of about 15 feet to the mile.

History of Oil and Gas Development

Although a number of important pools had been found in Kansas, west as well as east of Sedgwick County, no valuable discoveries were made here until August, 1928, when the Valley Center pool was discovered. The first well drilled by the Bu-Vi-Bar Oil Company on their Wright lease in sec. 12, T. 26 S., R. 1 W., proved to be a gusher of unusual character. It flowed 1,700 barrels a day of high gravity, greenish oil from a depth of



Sedgwick County

3,368 feet. An active drilling campaign started and no less than 135 wells were drilled before the close of 1936. At the end of that year 74 were still producing oil. The total production up to that time amounted to 18,756,611 barrels. As usual with dolomite production, the early years were the best, and almost 9 million barrels were produced in 1929, as against 5 million in 1930, half that much in 1931, and 577,000 barrels in 1936. In later years much water was produced with the oil. Oil occurs in two zones in the Viola limestone. The second "pay" proved to be the best, as a total of 79 wells were productive in it. This zone lies about 35 feet below the top of the formation. In the upper dolomite zone 13 wells found commercial production. One well produced for a time from the Misener sand at the base of the Mississippian system. Fourteen dry holes were drilled, five of which entered the Arbuckle for distances from 12 to 540 feet. The reason for the greater production from the second dolomite is that the first dolomite is missing over the top of the structure, forming what is often called a "bald-headed structure". In such cases the Chattanooga occurs directly above the gray shale zone above the second dolomite. The structure of the Valley Center pool is domal with a greater closure at lower levels. The unconformity at the base of the Mississippian seems to be largely responsible for the accumulation of oil. The existence of a dome was proved by core-drill explorations of the Continental Oil Company. On the basis of an area of 1,500 acres, this pool has produced 12,600 barrels per acre, an unusual figure for Kansas.

Goodrich Pool. Four pools, the Cross, Bentley, Kuske, and Goodrich, have been found north of the Valley Center pool. Of these only the Goodrich has proved to be of major size. It was discovered on December 4, 1928, by the Continental Oil Company when the first well on the Goodrich farm was drilled in sec. 16, T. 25 S., R. 1 E. Oil was found in the "Mississippi lime" at 3,014 to 3,024 feet with an initial production of 4,139 barrels a day with a gravity of 42° Bé. The first well on the Westerfield farm was a failure in the "chat", but drilled on to the Viola and produced 90 barrels a day from that level. In 1931 production was also found in the "Kansas City" (Bronson) limestone on the Casey farm at a depth of 2,614 to 2,616 feet where the well made 480 barrels per day. Thus three producing levels were defined. Up to the close of 1937 a total of 28 tests have been drilled. Of these, 21 are producing oil, 7 are dry, and 1 was abandoned. The total yield has been 1,849,921 barrels to the end of 1937 from an area of 700 acres. From the start much water has been produced with the oil. In 1929, for instance, Folger estimated that nearly as much water was being produced from the "chat" wells as oil.[42] A number of deep tests have found the Simpson and Arbuckle dry. One producer, the No. 1 Casey, has been deepened to the pre-Cambrian, which was found at 4,203 feet and is being used as a water disposal well. The structure, as revealed on the deepest pay horizon, seems to be that of an anticline with an east-west axis.

Cross and Bentley Pools. Attempts to extend the Valley Center pool resulted in two minor discoveries, one on the Cross farm in sec. 27, T. 25 S., R. 1 W., and the other on the Jones farm in sec. 19 of the same township. Both wells found production in the "Kansas City" (Bronson) limestone. In the Cross pool 7 wells were drilled of which 4 were still producing oil at the end of 1935. Up to that time a total of 38,500 barrels had been produced. No oil was produced in 1936 ot 1937. The one well in the Bentley pool produced 5,115 barrels to the close of 1935, and very little since then.

Greenwich Pool. One of the important producing areas in Sedgwick County is the Greenwich pool discovered in April, 1929, when the Shell Petroleum Company found oil on the Lagrisse farm in sec. 1, T. 26 S., R. 2 E. An initial production of 2,118 barrels per day was found in the Viola limestone at a depth of 3,164 to 3,170 feet. In June of the same year another producing horizon was tapped when the Shell Petroleum Company found commercial production in the "chat" at 2,922 to 2,924 feet. In 1931 the Gypsy Oil Company deepened its No. 3 Hamant to the "Wilcox" or Simpson sand and was successful in finding 115 barrels per day initial production at 3,327 total depth. An interesting well was drilled by the Shell Petroleum Company on the Borg farm (No. 2 well). This well had a hole full of water in the upper part of the "Wilcox" at 3,280 feet, but drilled on to 3,352 where oil at the rate of 264 barrels daily came into the hole in the lower porous zone of the "Wilcox" sand. Later deepening of the well showed this porous zone to lie some 50 feet above the Arbuckle. Eventually a total of 61 wells were drilled in this pool, of which number 49 were still producing at the end of 1936. The total production amounted to 8,069,774 barrels, of which 500,000 barrels were produced during 1936. At present the daily production is still considerable, but more water is being

42. Kansas Geol. Survey, Mineral Resources Circular 2,p.36, 1933.

lifted to the surface than oil. One of the water disposal wells in this pool is able to assimilate 10,000 barrels per day. The productive area covers 700 acres, and the gravity of the oil varies from 39° to 42° Bé.

Kechi and Kuske Pools. Drilling toward the northwest uncovered two pools of minor production. Wentz and Patton found production on the Swanson farm in the basal sand of the Pennsylvanian (Burgess ?) in sec. 6, T. 26 S., R. 2 E. near Kechi in May, 1929. Although the initial production was 400 barrels, very little oil has ever been taken from this well. The Kuske pool was opened by the Producers and Refiners Oil Company in July, 1929. Oil was found at 3,013 to 3,017 feet in a basal sand of Pennsylvanian age. This well has produced small amounts of oil consistently ever since that date, but other tests around it have been dry. The total production from the Kuske well to the end of September, 1937, was 131,631 barrels.

Eastborough Pool. A well drilled by the Producers and Refiners Oil Company on the outskirts of Wichita in August, 1929, found production at a depth of 2,970 to 2,983 feet in the "chat" of Mississippian age. This was the No. 1 Mackey well located in sec. 30, T. 27 S., R. 2 E. Initial production was estimated at 70 barrels of 41° Bé. oil with considerable water. A deeper pay zone was found in July, 1930, when Vickers Petroleum Company No. 1 Keys, also in sec. 30, was drilled to a depth of 3,238 to 3,242 feet. This pay zone lies between the Chattanooga shale and the Viola limestone, varies in thickness from 4 to 17 feet, and consists of sand, dolomite and shale. Its age has not been satisfactorily determined, but it is usually called the Misener sand.

A total of 56 wells of which 43 were still producing, were drilled in the Eastborough pool by the close of 1936. The total production from 1,000 acres is 7,216,665 barrels. Somewhat over 300,000 barrels were produced during 1936, and slightly under 400,000 barrels in the previous year. The per acre production to the close of 1937 has been about 7,000 barrels.

Robbins Pool. The Robbins pool is a few miles south of Wichita on highway 81. It was discovered by the Shell Petroleum Company in April, 1929, when the first well on the Robbins farm was completed. Oil was found in Mississippian limestone (not "chat") at a depth of 3,092 to 3,102 feet. The producing rock seems to be a slightly porous dolomitic limestone, at the top of a rather thick section of limestone which averages from 290 to 320 feet in thickness. Several attempts were made during 1937 to find deeper production in the "Wilcox" sand on account of the success of the Martin well, a mile and a half northwest of the pool, but these were unsuccessful.

A total of 70 wells have been drilled in the Robbins pool, of which 56 were producing wells at the close of 1937. Of the others 13 were dry and one had been abandoned. The production at the close of December, 1937, amounted to 2,511,311 barrels. In 1936 the pool accounted for 442,782 barrels, and 1,027,000 barrels during the previous year. Gravity of the oil is 42° Bé. The productive area covers 420 acres, indicating a per acre recovery of almost 6,000 barrels.

Schulte Pool. Oil was discovered by D. R. Lauck on the Jordan farm in sec. 6, T. 28 S., R. 1 W., 8 miles northwest of the Robbins pool, in June, 1934. Production came from a sandstone

at a depth of 3,652 to 3,653 feet. This sand is practically the top of the "Wilcox", which here lies almost directly beneath the Chattanooga shale. The Viola was found to consist of detrital rubble of dolomite, chert, sand and shale with a thickness of perhaps 5 feet. Evidently this is the feather edge of the Viola formation, which becomes thicker toward the northwest. After the Lauck well had produced about 60,000 barrels it was abandoned. Four dry holes drilled around it have temporarily condemned the area. One of these entered the Arbuckle without finding production.

Discovery Wells of 1937. During 1937 a number of wells found production, and it is possible that each of them will prove to be the first well in a new pool. The well drilled by Murfin on the Martin farm, in the SE. corner of the NW.¼ of sec. 18, T. 28 S., R. 1 E., was mentioned above. It found oil in the "Wilcox" sandstone at a depth of 3,489 feet, about 89 feet below the top of the formation. The potential rating of this well is 447 barrels per day, and the gravity is 47° Be. The official name of the pool is Oatville.

Another well was completed in August, 1937, on the Downs farm in sec. 32, T. 28 S., R. 2 E. This well found a flow of gas equal to 7½ million cubic feet per day in the Stalnaker sand at a depth of 2,215 to 2,232 feet. About 6 miles farther north the National Refining Company completed a well in November which also had a strong show of gas in the Stalnaker sand. This well was drilled deeper, to a depth of 3,098 to 3,099 feet, where oil was found in the "Wilcox" sandstone. The official name of this pool is the South Andover.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
ANDOVER				
SOUTH	Nov.,1937	2	2000-22	Gas
36-27-2E	80 acres		Stalnaker	
		1	3098-99	Oil
			Wilcox	
BENTLEY	Mar.,1924	1	2911-12	Grav.34
19-25-1W	40 acres	5,115 Bbls.	Lansing - K.C.	
CHENEY	Oct.,1935	0	4006-17	Abd.
8-27-4W	40 acres	3,700 Bbls.	Viola	Grav.38
CROSS	Mar.,1929	2	2690-2730	Grav.35
27-25-1W	160 acres	38,500 Bbls.	Lansing - K.C.	
CURRY	Oct.,1929	0	3389-91	Abd.
2-27-1W	40 acres	25,145 Bbls.	Viola	Mar.,1931
				Grav.41
DERBY	Aug.,1937	1	2215-32	Pot. 7½
32-28-2E	40 acres	None	Stalnaker	M. cu.
EASTBOR-				
OUGH	Aug.,1929	46	2956-70	Grav.42
30-27-2E	1000 acres	7,216,665 Bbls.	Chat	
			3238-42	Grav.44
			Viola or Misener	

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
GOODRICH 16-25-1E	Dec.,1928 640 acres	21 1,849,921 Bbls.	2614-16 Lansing - K.C.	7 dry 1 abd. Grav.35
			3010-20 Chat	Grav.37
			3334-37 Viola	Grav.38
GREENWICH 1-26-2E	Apr.,1929 700 acres	43 8,513,655 Bbls.	2922-24 Chat 3164-70 Viola 3321-27 Wilcox	Grav.39
KECHI 6-26-2E	May,1929 40 acres	0 32,754 Bbls.	3005-07 Burgess	Abd. Grav.39
KUSKE 24-25-1E	1929	1 132,561 Bbls.	3013-17 Burgess	
OATVILLE 18-28-1E	Nov.,1937 40 acres	1 None	3489-91 Wilcox	Pot. 45 Bbls Grav.45
ROBBINS 20-28-1E	Apr.,1929 420 acres	56 2,511,311 Bbls.	3092-3102 Chat	Grav.42
SCHULTE 6-28-1W	June,1934 80 acres	0 60,000 Bbls.	3652-53 Wilcox	Abd. Grav.44
VALLEY CENTER 1-26-1W	June,1930		2572-2692 Lansing - K.C.	
12-26-1W	Aug.,1928 1500 acres	70 18,863,289 Bbls.	3366-68 Viola	Grav.43

Important Dry Holes

Although no production has been found in the three western ranges of Sedgwick County, quite a number of test wells have been drilled there. Many wells, some located on core-drill "highs", have been drilled also in the three eastern ranges. These are listed in the following pages.

Important Test Wells

Continental No. 1 Casey, in sec. 15, T. 25 S., R. 1 E., deepened from 2,616; found Viola at 3,378; granite at 4,203; total depth, 4,224 feet. Water disposal well.

Alladin No. 1 Symser, in sec. 36, T. 25 S., R. 1 W., top of Chat, 3,055; Kinderhook, 3,338; Misener, 3,430; Viola, 3,450; Simpson, 3,610; total depth, 3,660 feet.

Ryan No. 1 William, in sec. 17, T. 25 S., R. 2 W., top of Lansing, 2,579; Chat, 3,398; Kinderhook, 3,830; Viola, 3,913; Simpson, 3,927; Arbuckle, 4,025; total depth, 4,063 feet.

Conoco No. 1 Lambe, in sec. 12, T. 26 S., R. 1 E., top of Chat, 3,015; Chattanooga, 3,228; Viola, 3,260; Simpson, 3,350;

tcotal depth, 3,460 feet in Simpson.

Cosden No. 1 Deweese, in sec. 1, T. 26 S., R. 1 W., top of Lansing, 2,250; Bourbon, 2,735; Chat, 3,035; Chattanooga, 3,245; Misener, 3,370; Viola, 3,400; Simpson, 3,430; Arbuckle, 3,515; tcotal depth, 4,015 still in Arbuckle.

Sinclair No. 1 Harrison, in sec. 3, T. 26 S., R. 2 W., top off Topeka, 2,005; Lansing, 2,575; Bourbon, 3,232; Chat, 3,495; Chhattanooga, 3,780; Viola, 3,890; Simpson, 3,917; total depth, 3,,958 in Simpson.

Wentz No. 1 Stockemer, in sec. 31, T. 26 S., R. 2 W., top of Lansing, 2,725; Kansas City, 2,910; Bronson, 3,035; Bourbon, 3,,200; Cherokee ? 3,395; Chat, 3,592; Chattanooga, 3,973; Simpscon, 4,038; total depth, 4,107 in Simpson.

West. Kansas No. 1 Betzen, in sec. 17, T. 26 S., R. 3 W., tcop of Ft. Riley, 1,020; Topeka, 2,235; Lansing, 2,830; Bourbon, 3,,280; Chat, 3,657; Chattanooga, 4,045; Misener, 4,130; Viola, 4,,137; Simpson, 4,144; Arbuckle, 4,250; total depth, 4,270 feet.

Yankee No. 1 Tobin, in sec. 5, T. 27 S., R. 2 E., top of Chhat, 2,988; Chattanooga, 3,190; Misener, 3,314; Viola, 3,315; Simpson, 3,348; total depth, 3,352 in Simpson.

Fisher and Lauck No. 5 Trustee, in sec. 19, T. 27 S., R.2E., tcop of Herington, 310; Wabaunsee, 900; Topeka, 1,520; Douglas , 2,,000; Lansing, 2,150; Bronson, 2,485; Bourbon, 2,685; Cherokee, ? 2,855; Chat, 2,935; Chattanooga, 3,160; Misener, 3,235; Viola, 3,,250 feet.

Derby No. 2 Rimel, in sec. 30, T. 27 S., R. 2 E., top of Chhattanooga, 3,257; Misener, 3,306; Viola, 3,316; Simpson, 3,,330; Arbuckle, 3,408 feet.

Davis No. 1 Country Club, in sec. 14, T. 27 S., R. 1 E., top off Lansing, 2,250; Bronson, 2,560; Chat, 3,055; Chattanooga, 3,,315; Viola, 3,395; total depth, 3,428 feet.

Lauck No. 1 McLean, in sec. 1, T. 27 S., R. 1 W., top of Lansing, 2,593; Chat, 3,112; Chattanooga, 3,420; Viola, 3,500; Simpson, 3,512; Arbuckle, 3,604; Reagan, 4,310; pre-Cambrian, 4,,376; total depth, 4,703 feet.

Plains No. 1 Curry, in sec. 2, T. 27 S., R. 1 W., top of Wabaunsee, 1,115; Topeka, 1,670; Douglas, 2,120; Lansing, 2,590; Bourbon, 2,772; Chat, 3,078; Chattanooga, 3,285; Viola, 3,388; Simpson, 3,389; total depth, 3,393 in Simpson.

McCullock No. 1 Roeder, in sec. 23, T. 27 S., R. 2 W., top off Douglas, 2,375; Lansing, 2,625; Kansas City, 2,790; Bronson, 2,,940; Bourbon, 3,150; Chat, 3,600; Simpson, 4,060 feet.

Wallace No. 1 Scheer, in sec. 22, T. 27 S., R. 3 W., top of Toopeka, 2,180; Lansing, 2,779; Bronson, 3,265; Chat, 3,690; Viola, 4,162; Simpson, 4,182; Arbuckle, 4,270; total depth, 4,285 feeet in Arbuckle.

Derby No. 1 Bartholomew, in sec. 8, T. 27 S., R. 4 W., top off Topeka, 2,200; Lansing, 2,804; Chat, 3,607; Base, 3,887; Viola, 4,016; Simpson, 4,035; Arbuckle, 4,137; total depth, 4,145 feeet. Show of 100 B. O. and 42 B. W.

SixForty No. 1 Braley, in sec. 6, T. 28 S., R. 2 E., top of Lansing, 2,220; Bronson, 2,557; Bourbon, 2,755; Chat, 3,033; Chattanooga, 3,245; Misener, 3,339; Simpson, 3,369; Wilcox, 3,412; total depth, 3,435 in Simpson.

Magnolia No. 1 Pendalum, in sec. 31, T. 28 S., R. 1 W., top of Lansing, 2,615; Bronson, 2,860; Bourbon, 3,070; Chat, 3,453; Chattanooga, 3,715; Viola, 3,778; Simpson, 3,799; Wilcox, 3,830; total depth, 3,838 feet in Simpson.

Allison and Fitzwilliams No. 1 Struthers, in sec. 34, T. 28 S., R. 2 W., top of Lansing, 3,022; Bourbon, 3,310; Chat, 3,680, base, 4,015; Simpson, 4,060; Wilcox, 4,104; Arbuckle, 4,205; total depth, 4,215 in Arbuckle.

Roxana No. 1 Goeldner, in sec. 6, T. 29 S., R. 2 E., top of Herington, 400; Wabaunsee, 990; Topeka, 1,675; Douglas, 2,125; Lansing, 2,275; Kansas City, 2,415; Bronson, 2,585; Bourbon, 2,800; Chat, 3,060, base, 3,385; Viola, 3,470; Simpson, 3,482 ; Arbuckle, 3,516; total depth, 3,579 feet in Arbuckle.

Landon No. 1 McNamen, in sec. 2, T. 29 S., R. 1 E., top of Chat, 3,120; Base, 3,360; Simpson, 3,505; Arbuckle, 3,575; total depth, 3,608 feet.

Johnson No. 1 Roy, in sec. 23, T. 29 S., R. 1 W., top of Lansing, 2,455; Kansas City, 2,660; Bronson, 2,800; Bourbon, 3,015; Chat, 3,360, base, 3,725; Simpson, 3,775; Arbuckle, 3,840; total depth, 3,860 feet in Arbuckle.

Empire No. 1 Kimel, in sec. 4, T. 29 S., R. 2 W., top of Lansing, 2,655; Bronson, 3,030; Chat, 3,648, base, 4,005; Simpson, 4,094; total depth, 4,131 feet.

Shawver No. 1 Furman, in sec. 24, T. 29 S., R. 3 W., top of Lansing, 3,030; Chat, 3,645, base, 4,100; Viola, 4,143; total depth, 4,153 feet.

SEWARD COUNTY

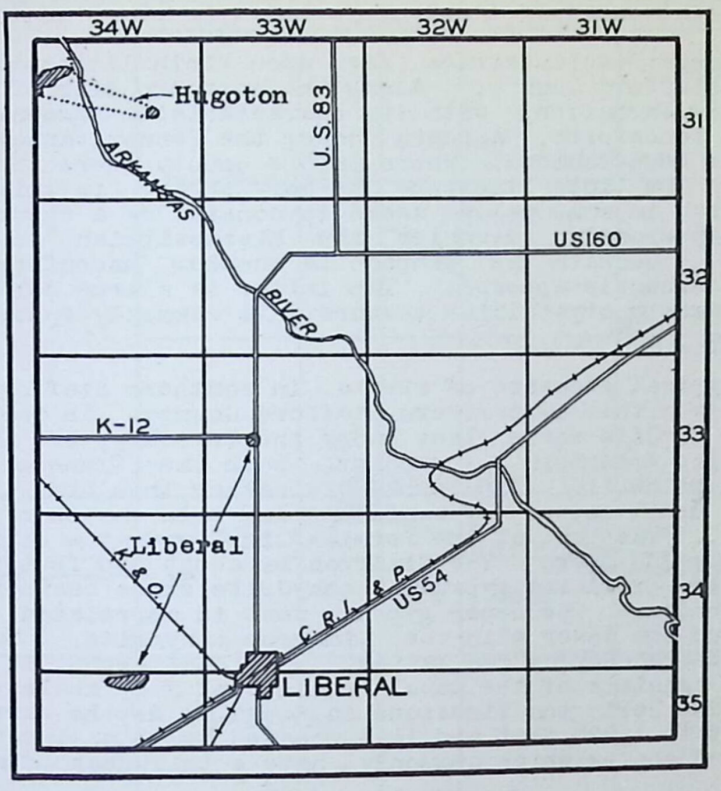
(See Stevens County) See next page for map.

STAFFORD COUNTY

General Geology

Stafford County is almost entirely covered with Quaternary dune sand. Small patches of Ogallala sands and gravels of Tertiary age appear in two places. One of these lies west and southwest of St. John, the county seat, and the other lies southwest of Stafford and south of Zenith. A very small area of Cretaceous Dakota sandstone has been found in the northwestern corner of T. 22 S., R. 11 W.

Fortunately many wells have been drilled in this county so it is possible to give a rather complete account of the subsurface geology. In the northern part of the county the Cretaceous rocks lie under the cover of Quaternary dune sand. In places the Graneros shale is present, but rather thin. The Dakota appears in considerable thickness, and is characterized by red sandstones as well as the usual white sandstones. In the Gates pool, for instance, in T. 21 S., R. 13 W., the base of the Dako-



Seward County

ita probably lies at a depth of 515 feet. Between 260 and 515 feet red rock is more abundant than lighter colored rock. The Permian strata are 1,900 feet thick and divisible into five or more definite units. The uppermost unit is the Cimarron, which consists of red shales and reddish siltstones. It extends down to approximately 1,000 feet. The next unit is the upper Wellington gray shale, the base of which lies at about 1,200 feet. The Middle Wellington salt is 400 feet thick, and the underlying anhydrite sequence is about 150 feet thick. The Herington limestone, which marks the top of the Big Blue series, lies at a depth of 1,750 feet. Below it the usual alternation of limestones and thin shales appears in well cuttings down to approximately 2,400 feet. The cherty zones of the Florence and Wreford members are present, making definitely recognizable horizons in the stratigraphic column. The Wabaunsee group of the Pennsylvanian system is 500 feet thick in northern Stafford County. Below it the Shawnee group appears in its usual limy character, with the Topeka limestone at the top and the Oread limestone at the base. It measures slightly over 300 feet. The Douglas group, which separates the Shawnee and "Oswald" limestone sequences, is 100 feet thick and consists of gray, green, and red shales. The "Oswald" sequence, corresponding to the Lansing, Kansas City, and Bronson groups at the outcrop, is present in typical development. Thick limestones, characteristically white and crystalline and in some places oolitic, characterize this interval. Certain cherty and shale zones can be traced from well to well. The thickness of this section is nearly 300 feet. Below the "Oswald" is the usual rubble found at the unconformity between the Pennsylvanian and older strata. It may be exceedingly thin, but locally increases to surprising thicknesses.

The total thickness of the Pennsylvanian is close to 1,200 feet.

The Pennsylvanian strata rest upon Viola limestone in most parts of Stafford County. Along the northern tier of townships the Simpson formation, with its characteristic greenish shales and thin sandstones, appears under the Pennsylvanian. Small areas have been found elsewhere in the county where the Viola is missing. The Viola limestone is very cherty in this part of Kansas, and in some wells seems to consist of a cherty residue which very closely resembles the Mississippian "chat" found elsewhere. Beneath the Simpson is another unconformity under which the Arbuckle appears. The latter is a true dolomite with rather coarsely crystalline texture. It commonly contains oolitic chert.

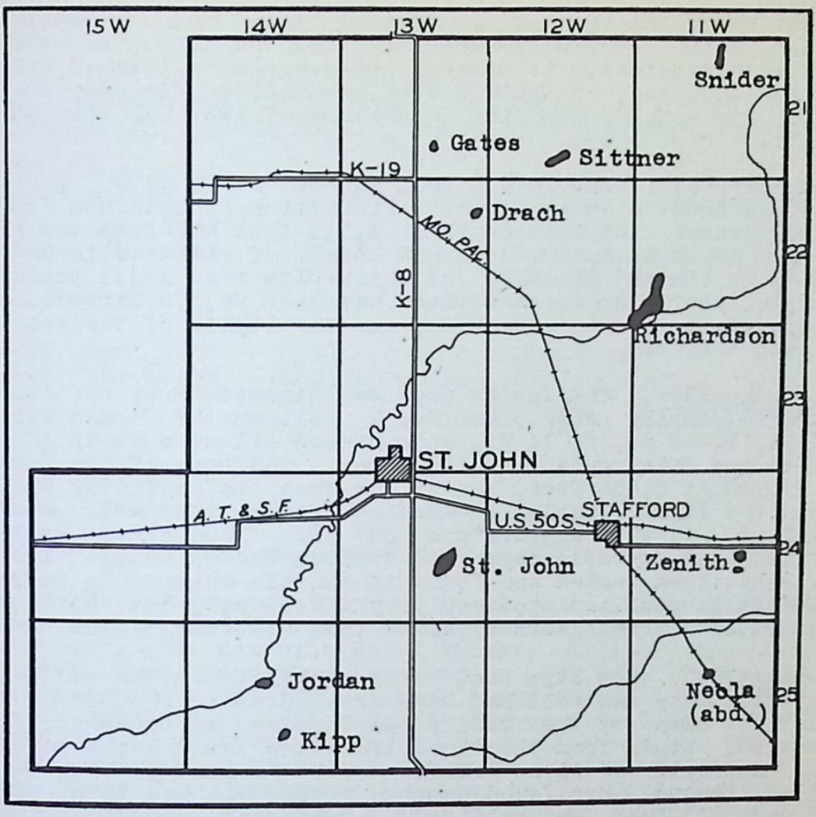
The typical sequence of strata in southern Stafford differs slightly from that of northern Stafford County. In the southern area the Carlile shale lies under the Tertiary or Quaternary rocks. The Greenhorn is present, with the Graneros in full thickness below it. The Dakota is rather thin here, but contains the usual layers of sandstone and thin sheets of variegated shale. The top of the Permian is found at a depth of approximately 800 feet. The Cimarron is about 350 feet thick and contains two prominent gypsum or anhydrite zones besides the usual red shales. The upper gypsum zone is correlated with the Blaine, and the lower with the Cimarron anhydrite. Thin dolomite layers accompany the latter. The Wellington is 700 feet thick and consists of the usual sequence of gray shale, salt and gypsum. The Herington limestone is found at depths varying from 1,700 feet to 1,800 feet and is succeeded by thin limestones and interbedded shales which commonly have a thickness of about 650 feet.

In southern Stafford County Pennsylvanian rocks are approximately 1,400 feet thick. The Wabaunsee shales, limestones, and thin siltstones occupy about 625 feet of this total, while the underlying Shawnee limestones take in an additional 400 feet. The reddish shales and sandstones of the Douglas are slightly over 100 feet thick and rest upon the white, medium-crystalline limestones of the Lansing-Kansas City-Bronson groups. As usual this section of limestones contains cherty layers and zones of oolitic rock. In most places it does not exceed 300 feet in thickness, and overlies reddish shales of the Marmaton group. Near the base of the latter erosional rubble called "basal conglomerate" has been found in most deep wells.

The exact age of the strata beneath the Pennsylvanian basal conglomerate is somewhat in doubt at the present time. In the southeastern township of Stafford County there appears to be a thin wedge of Mississippian limestone and chert, succeeded by 80 feet of Kinderhook shale. This shale rests directly upon the erosional cherty detritus of the Viola formation of Ordovician age. In the Zenith pool area it is believed that a sandstone, which has been called the Misener, lies at the base of the Kinderhook.

History of Oil and Gas Development

The first oil was found in Stafford County in 1930 when the Midwest Exploration Company drilled the No. 36 well on the Richardson farm. Other wells drilled later proved a pool of consid-



Stafford County

erable size. By the end of 1937 there were 55 wells in the Richardson pool and the total production was 2,384,928 barrels. The first well, which was located in sec. 36, T. 22 S., R.12 W., found production at a depth of 3,537 feet in the Arbuckle. The initial production of 2,000 barrels per day was very encouraging as was also the gravity of 41° Be. In addition to the substantial production within the Ordovician, other possible producing horizons were indicated by considerable quantities of gas in the Severy shale and in the "Oswald lime".

The second largest pool in the county is the Gates pool in sec. 27, T. 21 S., R. 13 W. It was discovered in May, 1933, when the Atlantic Producing Company drilled the first well on the Gates farm. By the end of 1937, eight wells had been drilled, four of which were either small producers or dry holes. The total production up to that time has been 319,965 barrels from an area of approximately 380 acres. Oil occurs in a 9-foot pay zone in the Arbuckle, which is here found at a depth of 3,698 feet. During 1934 this pool produced 70,900 barrels of oil, during 1935 almost 120,000 barrels, and during 1936 about 66,580 barrels.

The St. John pool was discovered by H. V. Elwell in 1935 when the first well was drilled on the Tudor-Morgan farm in sec. 23, T. 24 S., R. 13 W. In this well the oil was found within the Lansing-Kansas City zone at a depth of 3,588 feet, which is

75 feet below the top of the Lansing limestone. A second well drilled later secured production from the Arbuckle which was found at 4,075 feet. At present there are more than 16 wells in the St. John pool, of which 5 were productive for only a short time. The total production to the end of 1937 has been 209,780 barrels.

Snider Pool. The Snider pool in sec. 3, T. 21 S., R. 11 W., was discovered in April, 1936. Production is obtained from the Lansing-Kansas City at a depth of 3,111 feet and from the Arbuckle at a depth of 3,340 feet. A total of eight wells had been drilled to the end of 1937, of which five were still producing. The total yield up to that time has been 96,173 barrels. The area involved is over 640 acres, and the limits of the pool have not been defined.

Jordan Pool. The Jordan pool was discovered by the Atlantic Producing Company when their No. 1 well on the Jordan farm in sec. 15, T. 25 S., R. 14 W., encountered oil at a depth of 3,722 feet in the Lansing-Kansas City lime. The top of the "Oswald" was logged at 3,635 feet, so the pay zone is actually 87 feet within the lime. Initial production of the first well was 575 barrels of oil with a gravity of 37° Bé. Three other producing wells and one dry hole have been drilled subsequently. The Arbuckle has been tested and found to contain water. Up to the end of 1936 this pool had produced very little oil, but during 1937 about 51,169 barrels were obtained from the four productive wells.

Kipp Pool. The Kipp pool lies within two miles of the Jordan pool. Only one well had been drilled up to the end of 1937. It was put down by the Skelly Oil Company in December, 1936. Production comes from the Viola limestone at a depth of 4,117 feet. The well was first drilled to the Arbuckle, which was adequately tested, but found unproductive. It was then plugged back to 4,117 feet and acidized. The total production to the end of 1937 has been 22,201 barrels.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
DRACH 12-22-13	Nov.,1937 40 acres	2 1,690 Bbls.	3693-3705 Arbuckle	Grav.35
GATES 27-21-13	May,1933 380 acres.	4 319,965 Bbls.	3698-3714 Arbuckle	4 dry holes Grav.38
JORDAN 15-25-14	Dec.,1936 160 acres	4 51,169 Bbls.	3722-27 Lansing - K.C.	1 dry hole Grav.37
KIPP 27-25-14	Dec.,1936 40 acres	1 22,201 Bbls.	4117 Viola	
NEOLA 15-25-11	Mar.,1934 40 acres	0 5,680 Bbls.	3920-28 Chat	Abd. Grav.40
RICHARD-SON 36-22-12	Sept.1930 1200 acres	55 2,384,928 Bbls.	3537-99 Arbuckle	7 dry holes Grav.41

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
SITTNER 33-21-12	Aug.,1937 300 acres	4 2,927 Bbls.	3278-3414 Lansing - K.C.	1 dry hole
SNIDER 3-21-11	Apr.,1936 640 acres	1 96,173 Bbls.	3070-3111 Lansing - K.C.	Grav.36
		4	3324-43 Arbuckle	3 dry holes Grav.42
ST. JOHN 23-24-13	Apr.,1935 700 acres	11 209,780 Bbls.	3588-3620 Lansing - K.C.	Grav.33
			4075-87 Arbuckle	5 dry holes Grav.35
ZENITH 23-24-11	Sept.1937 160 acres	4 11,767 Bbls.	3804-08 Misener ?	

Important Dry Holes

A number of important dry holes drilled in Stafford County give interesting information on the stratigraphy of the county. One of these, the Magnolia No. 1 Tucker, drilled close to the Gates pool, had the top of the Lansing at 2,340, Pennsylvanian basal conglomerate at 3,572, Viola limestone at 3,623, and Arbuckle at 3,690 feet. The dolomite was penetrated to a depth of 3120 feet, and the total depth of the well was 3,810 feet. In the next township to the west Atlantic Producing Company No. 1 Russell found the Cimarron anhydrite at 870 feet, Topeka limestone at 2,980, Lansing at 3,414; Viola at 3,670, Simpson at 3,714, and Arbuckle at 3,770 feet.

In the northeastern part of the county, Sedgwick Oil Company No. 1 Groves well in sec. 5, T. 22 S., R. 11 W., reached a total depth of 3,518 feet. The anhydrite was found at 480 feet, the Lansing "Oswald" at 3,142; conglomerate at 3,425; Simpson at 3,455, and Arbuckle at 3,507 feet. In the next township to the west Stanolind drilled No. 1 Denker in sec. 10, T. 22 S., R. 12 W., to a depth of 3,680 feet. The anhydrite appeared at 647, Topeka at 2,870; Lansing at 3,352; conglomerate at 3,595; Viola at 3,821; Simpson at 3,862, and Arbuckle at 3,876 feet.

West of St. John the Atlantic Oil Production Company drilled No. 1 Hohner to a depth of 4,085 feet. In it the anhydrite appeared at 890, the Lansing at 3,616; conglomerate at 3,947, Viola limestone at 3,965; Simpson at 3,978; and Arbuckle at 4,075 feet in depth. A very interesting wildcat was drilled by the Amerada Petroleum Company in sec. 11, T. 24 S., R. 13 W., just southeast of St. John. The anhydrite was found at 860; Wellington at 1,050; salt at 1,240; Herington at 1,740, Wabaunsee at 2,408; Topeka at 3,020; Lansing at 3,508; basal conglomerate at 3,762; Viola at 3,992; Simpson at 4,000; and Arbuckle at 4,017 feet. The total depth was 4,052 feet. In the southwestern part of the county the Empire Oil and Gas Company drilled No. 1 O'Connor to a depth of 4,129 feet. It is located in sec. 17, T. 24 S., R. 15 W. The "Oswald" was found at 3,653, Viola at 4,010; Simpson at 4,040; and Arbuckle at 4,083 feet.

STEVENS COUNTY

One of the largest gas fields in the world is located in southwestern Kansas. Inasmuch as it centers about Stevens County, the geology of the whole area will be discussed under the heading of that county. Other counties which supply part of the gas from the Hugoton field are Morton, Grant, and Seward. According to the decision of the Kansas Nomenclature Committee under date of December 28, 1937, the official name of Hugoton gas field takes in all gas production included within townships 28 to 35 which lies in ranges 34 to 40 W. This area therefore does not include the Liberal gas field in T. 33 S., R. 33 W. and T. 34 and 35 S., R. 34 W., nor does it include the Santa Fe gas field which lies in Haskell County (sec. 21, T. 28 S., R. 32 W.; sec. 28, T. 28 S., R. 33 W.; sec. 30, T. 29 S., R. 33 W.; sec. 10, T. 30 S., R. 33 W.;) or the Holcomb gas field which lies mostly in Finney County and which is described under that county.

Areal Geology

The southwestern part of Kansas is almost completely covered with gravels and sands of the Ogallala formation of Tertiary age. This material was brought by streams from the Rocky Mountain region some millions of years ago. Since then some of the layers have been hardened and partly consolidated by percolating water carrying calcium carbonate. For this reason the Ogallala is often referred to as the "mortar beds". The thickness in rare cases reaches 300 feet, but generally it is less and in a few places it is entirely absent. Where that is true older rocks, especially Cretaceous, appear at the surface. In northern Haskell and Grant counties a blanket of Quaternary dune sand effectively covers the Tertiary rocks. Small patches of sands farther south are also shown on the geological map of the state.

Cretaceous Rocks. The small areas from which the Tertiary rocks have been stripped by erosion reveal mostly sandstones of the Dakota formation. These may be seen in western and southwestern Stanton County, and along an eastward flowing tributary of North Fork in northern Morton County. These outcrops are on both the geologic map of the state and on a map prepared by the Kansas Geological Society[43]. In addition the maps also show a small area of still older rock which has been cut into by Cimarron River at a point between Wilburton and Point Rock in southwestern Morton County. The age of this massive, light-colored, cross-bedded sandstone is briefly discussed in the Proceedings of the Eighth Annual Field Conference referred to above.

Subsurface Stratigraphy

Many wells have been drilled in search of gas in this part of the state. Detailed geologic information, however, is not yet available. Most of the wells have gone only into the lower Permian and therefore our knowledge of the Pennsylvanian and older rocks is still obscure. Some data on deep tests drilled in adjacent parts of other states are given by the Kansas Geological Society[44]. Data on the shallower beds are given in considerable detail by Taylor[45]. He states that the Cimarron series

---

43. Kansas Geol. Soc., Proc. Eighth Annual Field Conf., p. 21, September, 1934.
44. Op cit., pp. 67 and 68.
45. Op cit., pp. 57 to 59.

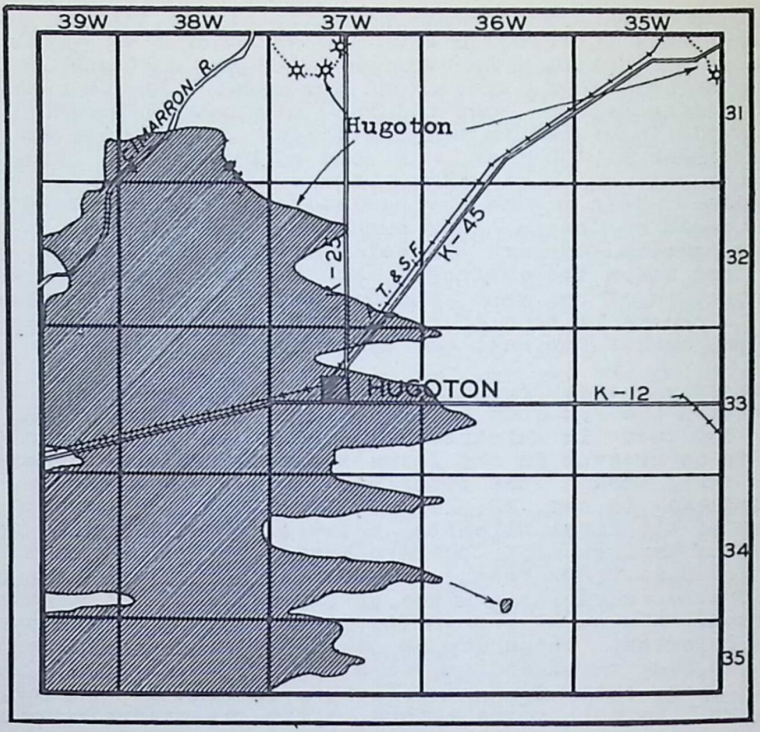
which lies beneath the Dakota consists of red shales, siltstones and sandstones interbedded with lesser amounts of gypsum, dolomite, and anhydrite. An average thickness of 1,500 feet is indicated by well logs throughout the area. The Day Creek dolomite, Blaine gypsum, and the Enid or Cimarron anhydrite can be readily distinguished in well cuttings. The Blaine has an average thickness of 100 feet. A zone of bright-red, fine-grained sandstone appears about midway between the Blaine and the lower anhydrite. This may be the equivalent of the Cedar Hills sandstone named by Cragin from outcrops farther east. The Lower Enid anhydrite appears in well cuttings at a depth of about 11,700 feet below the surface. Mottled gray anhydrite forms the upper portion of the zone, and dolomite the lower portion. The total thickness is from 40 to 70 feet, and it is, therefore, an excellent marker for well correlation.

The gray shales and anhydrites of the Wellington formation lie beneath the red beds of the Cimarron series. They measure about 300 feet in thickness in this part of the state. Salt seems to be present in the formation over most of the area, but only a small amount was reported from the Vickers No. 1 Hitch well drilled in sec. 33, T. 32 S., R. 34 W. in Seward County. The top of the first dolomite below the Wellington is interpreted as the Herington of eastern Kansas. It lies at a depth of about 2,400 to 2,500 feet. Mottled dolomite, in which there is considerable anhydrite, makes up the 20 foot thickness of the Herington. Below it are shales and more anhydrite down to the second dolomite, which may be the Winfield of eastern Kansas. It is 120 feet thick and contains much chert near the base. A red and green shale zone beneath the Winfield is very helpful in making well to well correlations in the gas-producing area. Below this lies the Fort Riley dolomite, about 60 feet thick, with the characteristic cherty zone near the base. Other shales and dolomites follow which are similar. One layer, however, is very distinctive. It lies about 250 feet below the Wellington, and is characterized by its oolitic nature. An additional 350 feet of shales and dolomites extends down to the base of the Permian.

Pennsylvanian Rocks. Rocks of Pennsylvanian age were found in several deep wells, one of which has been mentioned (Vickers No. 1 Hitch). Another, the Slick No. 1 Pyle, was drilled in sec. 14, T. 33 S., R. 33 W. In the Vickers well the Pennsylvanian rocks were encountered at 3,172 feet and drilled to a total depth of 4,037 feet. The Wabaunsee proved to be nearly 700 feet thick, as the top of the Topeka or Shawnee group was found at 3,855 feet. The deepest test in the area was drilled by the Argus Production Company in sec. 10, T. 33 S., R. 39 W., Stevens County. The drill was sent to a depth of 5,521 feet, where it is believed the well was completed in Mississippian or Ordovician rocks.

Hugoton Gas Field

The first test well in which commercial amounts of gas were found was drilled by the Defenders and Traders Gas Company on the Boles lease in sec. 3, T. 35 S., R. 34 W., Seward County. It was completed in 1922 at a depth of 2,755 feet for a production of 5 million cubic feet. This particular well is in the Liberal gas field, but indicated the possibilities of the region and led to further drilling. The first well in the Hugoton field, proper, was drilled 5 years later by the Independent Oil and Gas Company. It was their No. 1 Crawford, located in sec. 31, T. 33 S., R. 37 W., and it had a production of 10 million cubic feet from a depth of 2,713 feet. The first wells in Mor-



Stevens County

ton and in Grant counties were drilled during 1930. Subsequently more than 200 wells with a combined flow of more than one billion cubic feet have been completed.

Producing Horizon. The gas occurs in porous zones of the Permian limestones described above. The Herington seems to be a very poor producing horizon, but the Winfield, Ft. Riley, and possibly Florence limestones contain large amounts of gas where porous. The porosity, which depends somewhat upon the oolitic nature of the limestones, has been estimated to be 18 per cent on the average. The depths to production vary to a small degree over the extremely large area of the field, but the average is about 2,700 feet. In many wells two or three porous zones produce.

Production Data. The initial production from the wells varies from about 1 to over 18 million cubic feet per day, with the average close to 5 million. The total production to the end of 1936 amounted to 103 billion cubic feet. During the last few years the average annual production has been about 21 billion cubic feet. The gas has a high gasoline content, and it is possible to secure over 4 gallons from each 1,000 cubic feet. An analysis of the gas shows that it contains 68 per cent methane, 18 per cent ethane, and 1½ per cent butane. Nitrogen averages nearly 12 per cent, oxygen about 2 per cent, and carbon dioxide is present in very small amounts. The heating value is high, ranging between 1,000 and 1,100 B. T. U's.

At the time of this report only 193 wells out of the 200 or more wells in southwestern Kansas have pipe-line outlet. The

largest amount of gas is transported by the Panhandle Eastern Pipe Line Company, which has a line to Detroit and other large cities. Some 40 million cubic feet per day are sent through its pipe lines, using the output of about 93 wells. The Republic Natural Gas Company of Omaha transports about 35 million cubic feet per day, which it secures from 86 wells and distributes through 2,000 miles of pipe lines. It supplies cities in Kansas, Nebraska, Iowa, and Minnesota. Smaller amounts of gas are distributed to cities in southwestern Kansas and in Colorado by the Argus Pipe Line Company of Dodge City and the Central Gas Utilities of Abilene, Kansas

The Panhandle Eastern Pipe Line Company has a compressor station at Arkalon which produces some 80,000 gallons of gasoline per day. This is sold to the Phillips Petroleum Company of Bartlesville and is shipped by tank car to their refineries. Some of the gas is used to make carbon black. A subsidiary of the Columbia Fuel Corporation operates a six-burner plant near Hickok and converts about a million cubic feet of gas per day into carbon black.

Structure. A map based on the top of the Dakota indicates that the regional dip of the rock in this part of Kansas may be to the north or northeast.[46] Data from well logs indicate a general flat attitude of the gas-bearing strata, with perhaps an east dip on the east side of the field in eastern Stevens County. The western edge of the field seems to be defined by a lack of porosity rather than by any difference in dip. The red shales of the Lower Permian thicken in that direction and the limestones apparently change laterally into shales. As there is no present indication of a change in dip toward the north, it is presumed that the isolated fields like the Santa Fe and Holcomb field will eventually be merged with the Hugoton field. The northern limits of the gas-producing area remain to be defined.

SUMNER COUNTY

Areal Geology and Stratigraphy

Sumner County is located in the south-central part of the state, bordering on Oklahoma. It is traversed by the Arkansas and Chiskaskia rivers and Bluff Creek. The surface rocks along these rivers are very young, consisting of gravels and sands which have been deposited by the streams in times of flood. Along Arkansas River, which passes through the northeastern corner of the county, the river alluvium is from one to five miles wide. Along Chickaskia River and Bluff Creek sand, gravel, and silt occupy a wider zone, in fact, a good deal of the area between them is covered by the Gerlane formation, a Pleistocene river deposit. The southwestern corner of the county from Caldwell to Argonia also is covered with this material.

Tertiary Rocks. Tertiary gravel and sand extend into the northwestern corner of Sumner County for a short distance. These may be seen south of Milton. In many places only remnants of the ancient sheet of river deposits, consisting of isolated pebbles of granite and chert on the upland areas, are left. Below the Tertiary and Quaternary rocks are Permian strata.

---

46. Kansas Geol. Survey, Bull. 11, pl. 7, p. 85, 1926.

Permian Rocks. Permian rocks occur over all of Sumner County either at the surface or under a thin cover of much younger rocks. In the western part of the county, west of Conway Springs and southwest of Corbin, the Permian system is represented by red beds of the Cimarron series. Farther east, and occupying more than half of the county, the gray beds of the Wellington formation appear at the surface. The red beds consist of clays, shales, and fine siltstones. The thickness is usually less than 200 feet, but that thickness has been observed in deep core holes in the westernmost townships. The Wellington formation was named in this county by Cragin years ago.[47] Its various members are quite well shown along Slate Creek where the Afton, Slate Creek, and Highland members crop out. The Carlton limestone is the highest set of beds that can be used for structure mapping over any considerable area. According to Fig. 1 in the bulletin mentioned this limestone crops out southeast of Wellington along the range line between 1 E. and 1 W., T. 33 S. in sections 31 and 6, and then eastward along the south line of sections 6 and 5. A section is exposed there which reveals five thin white chalky layers, each one commonly less than a foot thick. The topmost layer is distinctive due to the presence of contorted algal beds. Between the chalky layers are greenish clays. The whole interval measures about 62 feet.

Below the Carlton zone are more greenish clays, but exposures are poor in this county. From measurements in core holes, and from surface studies elsewhere, the thickness of the Wellington below the Carlton is estimated to be 330 feet. This interval includes the Chisholm Creek shale, Annelly gypsum, Geuda Springs shale, Hollenberg limestone, and Pearl shale, extending down to the top of the Herington. The whole Wellington formation has a thickness of about 575 feet. Some salt beds appear within it in the western half of the county. At Wellington the salt is very thin, but along the western tier of townships it reaches a thickness of 150 feet. In the Wellington pool the salt lies at a depth of 225 to 300 feet.

The Herington limestone is one of the most important formations in the Permian sequence. Between 1920 and 1932, when much core drilling was carried on in Sumner County, this layer was the one usually sought in the borings. It crops out in the western tier of townships in Cowley County, dips toward the west, and underlies all of Summer County at shallow drilling depths. It is found 800 feet beneath the surface in the westernmost ranges. In the study of well cuttings the Herington is the first formation of importance that can be recognized. Below it is a series of thick limestones and thin shales 625 feet thick, which is often called the Big Blue formation[48]. The cherty limestone of the Florence, and the cherty Wreford, can be recognized in all wells. The Americus at the base can be identified by the numerous fusulinids in the well samples. It is also the last thick limestone above a series of shaly rocks.

Pennsylvanian Rocks. The sequence of shaly rocks below the Americus has been correlated with the Wabaunsee group. Besides shale there is considerable sandstone at certain levels, and thin limestones are also present. The thickest limestone, the Howard, lies near the base, and is commonly overlain by dark to black shale. The Topeka limestone is fairly well marked in well

---

47. Univ. of Wichita Studies, Bull. 2, May, 1937.
48. As originally named by Cragin, the Big Blue also includes the Wellington.

logs, and appears at depths of about 1,300 feet in the eastern ranges, about 1,900 feet in Range 1 W., and at deeper depths farther west. The thick limestones of the Shawnee group alternate with much thinner layers of shale, much of which is black. The black shale is especially noticeable in the Oread formation near the base. Some sandstone also appears within the Oread. The next lower unit is the equivalent of the Douglas, Lansing and Kansas City groups. Its top is placed at a depth of about 2,500 feet in Range 1 W., but is higher to the east and lower to the west. In Sumner County this zone of clastic materials is almost 600 feet thick. Near the middle it contains a lenticular body of sandstone which is usually called the Stalnaker sand. Lower, almost at the base, lies another sandstone which is called the Layton by drillers. These two sands are especially well developed in Range 2 E., where considerable oil has been produced from one or both. The Stalnaker reaches a thickness of over 100 feet in several places.

A limestone unit lies below the Douglas-Lansing-Kansas City which corresponds to the Bronson group on the outcrop. It appears at a depth of around 2,600 feet in the eastern part of the county, at 3,000 in Range 1 W., and at depths down to 3,600 and 3,700 feet in the westernmost range. This limestone is cherty in the upper half, white to gray in color, and medium grained in texture. Its thickness, approximately 250 feet, and position also serve to identify it. This limestone is usually called the Kansas City by drillers, and probably includes the Drum limestone at the top as well as the Bronson.

Below the Bronson are the shales of the Bourbon, Marmaton, and Cherokee groups. Together they occupy an interval of about 600 to 750 feet. It is not possible at present to separate the Bourbon from the Marmaton. The appearance of a thick limestone at the base of the Marmaton, the Fort Scott, permits a separation of the Marmaton and the Cherokee in some wells. The Cherokee is usually represented by dark to black shales in well cuttings. Near the base, however, is a zone of variable thickness in which red colors predominate. This usually indicates the near presence of the top of the Mississippian rocks.

Mississippian Rocks. Everywhere in Sumner County the Pennsylvanian strata rest upon Mississippian rocks. The line of junction, however, is a very uneven one, for the top of the Mississippian limestone is commonly eroded. In such cases residual chert from the solution of the limestone appears first in well samples. It is called "chat", and on account of its porosity may contain gas and oil. Such is the case, for example, in the Wellington pool. In general the "chat" may be expected at a depth of about 3,200 feet in Range 2 E. It lies at greater depths in Range 1 E., and in Range 1 W. it appears at 3,600 to 3,900 feet, depending on location and structure. In the ranges along the west side of the county the "chat" may occur as low as 4,300 to 4,400 feet. The thickness of the limestone is commonly around 250 to 300 feet, but may vary considerably even in short distances. Much black limestone within the Mississippian has been found in some wells in this county. Some gray dolomitic limestone is also present. On the whole, there is considerable variation from north to south, and from east to west.

The black Chattanooga shale lies beneath the limestone. It varies from 70 to 180 feet in thickness, but averages close to 900 feet. The color of this unit, and the frequent appearance of plant spores in well cuttings, make it easily identifiable, and serves to corroborate the age of the rocks above and, to a cer-

tain extent, the age of those below.

Ordovician Rocks. A great unconformity separates the Mississippian rocks from those below. All Devonian and Silurian rocks, and some of the Ordovician rocks, are missing. In the eastern part of Sumner County the Arbuckle limestone lies beneath the Mississippian or, in the Oxford pool, the Pennsylvanian. Farther west, and over most of the county, various parts of the Simpson lie beneath the Chattanooga. In the southwestern part of the county, a few wells have found parts of the Viola beneath the Chattanooga. Where present, the Viola is a coarsely crystalline white limestone. One well in sec. 6, T. 34 S., R. 2 W. found the Viola about 26 feet thick. A thin dolomite above the Simpson in sec. 16, T. 35 S., R. 3 W., may represent the Viola.

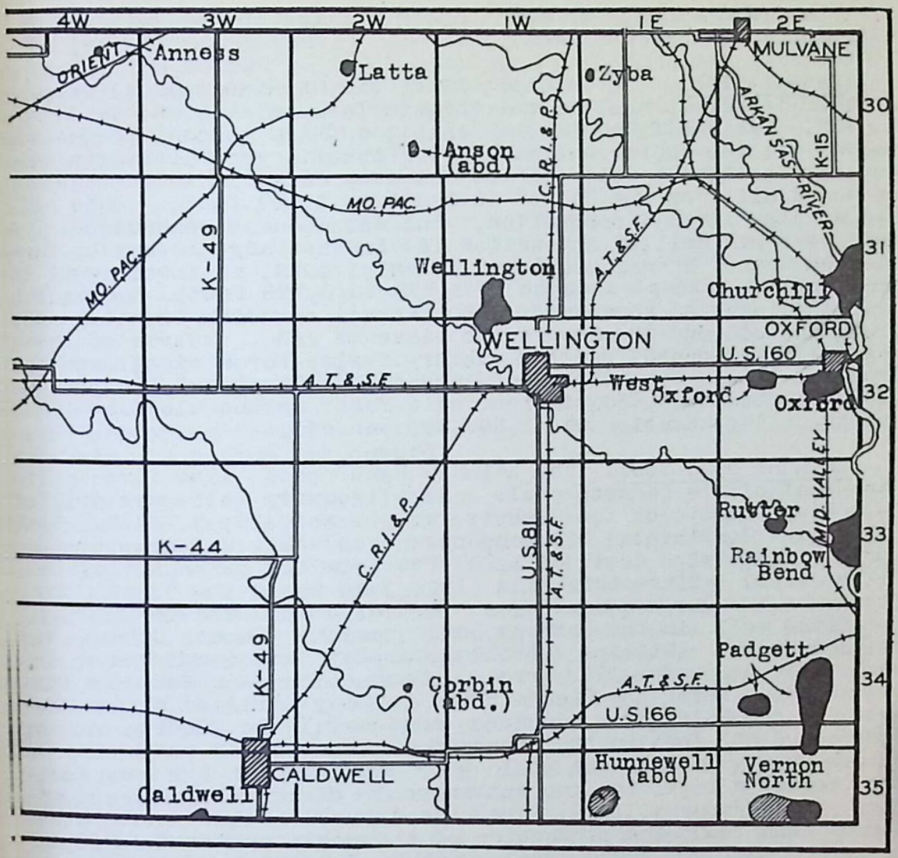
The Simpson, which covers a large area under the Carboniferous rocks of this county, contains green shale of a peculiar color and much sand. In the southeastern and southwestern parts of the county the green shale (Tyner ?) lies above the sand, but elsewhere it is common to find the sand directly beneath the Chattanooga. This formation shows a variation in thickness of from 40 to 140 feet. The sand is commonly rather fine and quite angular. There are zones, however, in which the typical rounded grains appear.

The Arbuckle limestone, or "Siliceous lime" as it is usually called by oil geologists, has been found in every well that was drilled deep enough. It has been penetrated in a few, and shows the usual wide variation in thickness. One well in sec. 9, T. 30 S., R. 1 W. penetrated the Arbuckle for a distance of about 800 feet to find pre-Cambrian granite below. Two wells in sec. 14, T. 32 S., R. 2 E. found 547 and 1,007 feet of Arbuckle respectively. Other wells are listed in the concluding section of this chapter. The Arbuckle is a very dolomitic rock with coarse texture. It contains several zones of chert, some of which is oolitic and vari-colored. Basal sand was found in the Shell No. 1 Nevitt well in sec. 14, T. 32 S., R. 2 E., between 3,939 and 3,951 feet.

Structure

The rocks of Sumner County show a fairly strong dip toward the west, which varies from about 15 to 40 feet per mile. In a few places a reverse dip, or dip to the east, occurs. Such a variation, of course, indicates a favorable structure for the trapping of oil and gas. As the surface rocks are commonly soft and poorly exposed it has been necessary to find these dip reversals by means of core drilling. A number of oil companies have been very successful in locating favorable structures in this county, especially the Shell and the Continental companies. The West Oxford pool, in T. 32 S., R. 2 E., the Oxford pool to the east of it, and the Churchill and Rainbow Bend pools were first located in this manner.

The structure of the older rocks departs somewhat from that of the upper strata. On the "Mississippi lime," for instance, there seems to be a nearly uniform dip toward the southwest averaging about 30 feet to the mile. A striking deviation from the average rate is present in T. 31 S., R. 1 W., where the dip flattens for a considerable distance. The dip on the Ordovician rocks shows strong local variations, the pattern of which cannot be worked out with the data now at hand. In the eastern part of



Sumner County

tthe county, where the influence of the Granite Ridge is manifest, aare some abnormal "highs" in the Ordovician rocks. Details on tthese will be given in the following pages.

History of Oil and Gas Development

Sumner County has had a varied and most interesting history iin connection with the finding of gas and oil. Despite the actttive development of Cowley County, adjoining on the east, active dirilling did not begin in Sumner County until 1914. In June of tthe next year the first gas strike was made, when the Empire Oil CCompany completed the first well in what later was to become the NNorth Vernon pool. Gas was found in the Severy shale between the HHoward and Topeka limestones at a depth of 1,490 to 1,508 feet. DDevelopment was slow, and although ten wells were drilled during tthe next few years, none went deep enough to test the lower oil ppossibilities. It remained for the Prairie Oil Company to discoover oil in this field in August, 1930, 15 years after the gas ddiscovery. This strike was made on the Herrick farm in the same ssection with the first gas well. The oil was found in the top oof the "chat" at a depth of 3,443 to 3,465 feet. The initial pproduction of 395 barrels induced others to drill deeper tests, mmost of which, however, were unsuccessful. The gas production

of this field amounts to about 3,278 million cubic feet, but the oil production has been small.

Padgett Pool. In October, 1924, the Continental Oil Company drilled its first well on the Padgett farm in sec. 23, T. 34 S., R. 2 E. Gas was found in the "chat", and the initial production was 40 million cubic feet per day. About a year later the same company drilled a well on the Thiessen farm in sec. 22 which produced oil from the "chat" at 3,468 to 3,497 feet. This well had a high initial production, but soon became exhausted. A deep test was drilled in section 14 in the Padgett pool by Harris and Haun. It was completed in July, 1927, as an oil well in the "Wilcox" sand at a depth of 3,772 to 3,778 feet. Subsequent drilling involved an area of 1,800 acres on which 20 wells were producing oil and 18 gas at the close of 1936. Three of these gas wells produced from the Severy shale for a time, and one from the Kansas City (Bronson) limestone. The total gas production amounted to 3,430 million cubic feet at the close of 1936, and the oil production was 1,506,605 barrels.

Rainbow Bend Pool. The Rainbow Bend pool lies five miles northeast of the Padgett pool. Its discovery well was drilled in Cowley County on the Heskett farm in sec. 19, T. 33 S., R. 3 E., by the Continental Oil Company. The well was completed in April, 1925, at a depth of 3,207 feet in the Burbank (Bartlesville) sand. Since this sand lies just above the "chat" here, it may be the Burgess sand found farther east, and in Oklahoma. The first well in the Rainbow Bend pool in Sumner County was drilled by the Phillips Petroleum Company and completed on December 24, 1925, for 185 barrels. Production came from the Burbank sand. Later the Sinclair Oil Company drilled a deep test well on the Holt farm and were successful in finding oil at 3,574 to 3,581 feet in the Arbuckle. Three other wells in the Summer County part of the pool were completed in the same horizon, making a total for the entire pool of 12 wells on production until January, 1929, when the Arbuckle wells were abandoned. In 1930 the production of the pool amounted to 22,472 barrels, making a grand total of about 322,000 barrels for all wells up to that date. These figures apply only to the West Extension of the Rainbow Bend pool. The main part of the pool is in Cowley County.

Rutter Pool. A few miles west of the Rainbow Bend pool lies the Rutter pool, discovered in June, 1926, when the Shell Petroleum Company completed its well on the Rutter farm. The producing horizon was the "chat", found at a depth of 3,323 feet, and the well produced for about four years, making a total of 13,601 barrels before being abandoned. Several deep tests to the Arbuckle in the near vicinity of the well make further exploration unattractive.

Oxford Pool. The Oxford pool lies along the south outskirts of the Oxford townsite. It was discovered in June, 1927, when the Shell Petroleum Company completed its first well on the Emrick farm in sec. 14, T. 32 S., R. 2 E. Oil production of 200 barrels per day was found in the Stalnaker sand. It is historically interesting to note that the name of this sand comes from the Stalnaker farm in the area of the present North Vernon pool, on which a dry hole was drilled a year before gas was found. Folger states that the Stalnaker sand lies just above the Lansing limestone in the basal part of the Douglas group. He gives

---

49. Kansas Geol. Survey, Mineral Resources Circular 2,p.68, 1933.

(page 68) many stratigraphic details regarding the succession of strata in the Oxford pool. Some of the intervals follow: From the top of the Topeka to the Hoover sand 250 feet; and from base off Hoover sand to the top of the Oread 100 feet; from the base off the Oread to the top of the Stalnaker sand 150 feet; and from the base of the Stalnaker sand to the top of the Kansas City (Bronson) 300 feet. The latter is found at an average depth of 2,,410 feet and the Topeka at 1,360 feet.

The thickness of the Stalnaker averages 95 feet, although not all is sandstone. Subsequent development indicates that over 90 per cent of the oil, which totalled 7,793,375 barrels at the close of 1930, had come from the Stalnaker sand. However, it is also interesting to note the occurrence of oil in four higher reservoirs: The Emporia and Howard limestones, both in the Wabaunsee group; the Severy shale between the Howard and the Topeka; and the Hoover sand in the Shawnee group. At the close of 1930 Hall[50] reported that 97 wells were producing. Of these 833 were producing from the Stalnaker, 6 from the Hoover, 1 from the Severy and 6 from the Howard.

The next period of exploitation came in June, 1935, when one of these wells was deepened to the Arbuckle. The Barnsdall Oil Company deepened its No. 4 Wenrich in sec. 14 from 2,110 feet in the Stalnaker to 2,889 feet, where an initial production of 136 barrels of oil was found in the top of the Ordovician limestone. The initial production of the next well was 1,288, and the third 5,,820 barrels. These gradually rising figures gave some inkling of the possibilities of the new horizon. However, it remained for the Amerada Petroleum Company to set the maximum when it drilled No. 1A Gassoway. This well encountered the top of the Arbuckle at 2,801 feet, and was drilled to 2,837 feet, where production the first hour measured 1,861 barrels. Successive hours of testing gave a potential of 37,466 barrels, which is the largest ever reported in Kansas.

The structure, as mapped later, on all Ordovician producers shows a peak of limestone, with edge wells 500 feet below those at the top, in a distance of one-quarter mile. The structure in the upper horizons is that of two small domes with moderate amounts of closure. The producing area is less than 200 acres, (6800 for the whole pool) but the yield of 12,684,000 barrels to the close of 1936 shows a very high figure per acre. Water drive seemed to be the actuating force in the Ordovician limestone, as very little gas came with the oil. Therefore, most of the oil was produced within a year's time, and at the end of 19936 many of the wells had been shut in. In September, 1937, the average daily run from the pool amounted to 1,370 barrels.

Churchill Pool. Three miles northeast of the Oxford pool is the Churchill pool. It also overlies on the Granite Ridge, and has had similarly phenomenal production. It has had a somewhat longer history as it was discovered about a year earlier than the Oxford pool. In the first well on the Churchill farm, in sesc. 25, T. 31 S., R. 2 E., the Shell Petroleum Corporation found the Stalnaker sand at 1,822 feet, but did not get oil until the bit reached 1,855 feet in depth. The sand was penetrated for 12 feet, and an initial production of 200 barrels resulted. Later wells found the sand body somewhat variable, in

---

50. Kansas Geol. Survey, Mineral Resources Circular 2, p. 1677, 1933.

fact, two sand bodies in most cases, with considerable shale. The thickness averages 175 feet, with the porous zone lying some 38 to 170 feet below the top. Four test wells were drilled in an attempt to produce oil from lower horizons, but were unsuccessful. This provides a somewhat unique situation in Granite Ridge pools, because all others have found their greatest production either in the Ordovician rocks, or at the unconformity above it. The reason is not immediately apparent, because here also the Pennsylvanian rocks lie directly above the much older Ordovician (Arbuckle) rocks, and not less than 500 feet of intervening strata are missing.

Up to the close of 1937 a total of 17,694,482 barrels had been produced from the Stalnaker zone in the Churchill pool. In addition an almost equal amount of water had come from the same zone. Since 1926 gas has been used to drive the oil from the sand, as normally very little gas is dissolved in the oil. This procedure has been successful in producing the oil more rapidly and more effectively. The productive area covers 1,000 acres, making a per-acre figure of 17,600 barrels or over. The structure in this pool was predetermined by core drilling. The shallow dome mapped by this method was found to be somewhat steeper at the depth of production. In the still deeper Ordovician rocks it was found to be very sharply accentuated, with faults on several sides of the pool, and very pronounced dips.

Wellington Pool. One of the most remarkable pools in the state is located almost in the center of Sumner County, northwest of the townsite of Wellington. It was discovered by Slick, Pryor and Lockhart in December, 1929. Their first well was completed on the Peasel farm at a depth of 3,655 to 3,667 feet in the "chat" for an initial amount of 900 barrels. Subsequently 92 oil wells and only one dry hole have been completed, testifying to an eventually large productive area. At present the pool covers 1,200 acres, and some 2,504,685 barrels of oil have been extracted up to the close of 1937. One well has tested the deeper producing possibilities down to the Arbuckle. The structure is anticlinal, but the amount of relief is not great. Because it is at the level of an unconformity, it is not possible to state definitely whether the arching is structural or topographic. Regionally the pool lies in an area where the "Mississippi lime" is relatively high.

Corbin Pool. A somewhat isolated pool lies in the southern part of the county a few miles northeast of the city of Caldwell. Oil was discovered by the Gypsy Oil Company on the Douglas farm in July, 1927. This well did not find production until the "Wilcox" sand was reached at a depth of 4,490 feet. There the hole filled up with oil, which measured 480 barrels per day and was of 46° Bé. gravity. Production did not hold up, so after producing about 30,000 barrels, the well was deepened, in April, 1931, to the Arbuckle, where water was encountered and the hole abandoned. Three other wells drilled around it have been failures, and each was deep enough to test all likely levels.

Caldwell Pool. Another pool not far from Caldwell lies southwest of that city. It was also opened by the Gypsy Oil Company. The first well was completed on the Williams farm in sec. 16, T. 35 S., R. 3 W., on April 10, 1929. It found production in the "Wilcox" sand, the top of which lies at 4,765 feet. The porous zone lies 13 feet below the top and is five feet thick. By the end of 1930, five wells had been drilled, of which one, in Oklahoma, was dry. The three wells in Kansas produced 1,164,971 barrels up to the end of 1937.

Hunnewell Oil and Gas Pool. The Hunnewell pool lies along the south line of the county about 6 miles west of the North Vernon oil pool. It was discovered in April, 1927, when the Amerada Petroleum Company completed the first well on the Hamilton farm in sec. 18, T. 35 S., R. 1 E. Gas estimated at 8¼ million cubic feet per day was found in a porous zone at 2,286 to 2,320 feet. This zone has been correlated with the lower Endicott sand of Oklahoma, and is believed to lie in the uppermost part of the Lawrence shale of the Douglas group. Subsequently at least three other wells were drilled, some of which found gas in the Kanwaka shale (Jackson Park ?) of the Shawnee group. The production from these wells has been 416 million cubic feet up to the end of 1929. The pool was abandoned shortly after this date.

Anson Gas Pool. Four gas wells were drilled in T. 30 S., R. 2 W., about 12 miles northwest of Wellington. The discovery well, the No. 1 Myers, was drilled by the De Forrest Drilling Company and found gas at a depth of 1,920 to 1,936 feet. Previously the Cosden Oil Company had found a good show of gas in the No. 1 Riner well, which was drilled to the "Wilcox," and abandoned at 4,163 feet. The gas zone lies in the Howard limestone, but in one well a second gas zone was found in the Severy shale. Production to the close of 1929 amounted to 6665 million cubic feet. In 1930 the pool added another 208½ million cubic feet.

Latta Oil and Gas Pool. Four miles northwest of the Anson pool is the Latta pool, which has produced both gas and oil. In the discovery well, drilled by Champlin Refining Company, oil was found at 3,042 to 3,056 feet. This well was completed on June 9, 1927. In October, the No. 2B Latta well found a gas zone at 2,015 to 2,031 feet. The gas and the shallow oil come from zones in the Shawnee group, probably in the Topeka limestone. The gas wells produced 478 million cubic feet before being deepened in 1929 in order to tap the new oil horizon discovered in the Kansas City group (Bronson). Oil was found at two levels, the first 12 to 28 feet below the top of this group, and the other about 175 feet below the top. The Bronson limestone lies at an average depth of 3,040 feet. The total oil production to the close of 1937 amounted to 336,474 barrels, from an area of about 300 acres.

West Oxford Pool. Oil was discovered three miles west of the Oxford pool in April, 1926, by the Shell Oil Company. The first well, drilled on the Miller farm in section 17, found oil both in the "chat" and the "Wilcox" sand. However, drilling was continued into the Arbuckle, where a still larger amount of oil came into the hole. This well was completed as an 800 barrel producer. Eventually five wells were drilled to the Arbuckle and put on production. Because of rapid exhaustion most of these were plugged back before the end of 1929. Some were plugged back to the Kansas City (Bronson) limestone where two were still producing in 1931. The total production up to the close of 1929 amounted to 277,103 barrels from 5 wells. In 1930 another 34,145 barrels from the same 5 wells were produced.

New Pools Discovered in 1937. During 1937 two additional potential oil-producing areas were added to the number of pools in Sumner County. One of these was discovered by the Magnolia Oil Company when the first well on the Baird farm, in sec. 2, T. 30 S., R. 4 W., south of Anness, showed a daily potential production of 378 barrels. The oil occurs in the "Wilcox" sand found at a depth of 4,394 to 4,401 feet. The well was completed

in October, 1937. This pool has received the official name of Anness.

One month later McKnabb et al. drilled their No.1 Blair well into the "Wilcox" sand and found a potential production of 100 barrels. This pool lies six miles west of Mulvane, in sec. 7, T. 30 S., R. 1 E. It has received the official designation of Zyba pool by the Nomenclature Committee. The depth of the producing zone is from 3,866 to 3,869 feet.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
ANNESS 2-30-4W	Oct.,1937 40 acres	1 5,166 Bbls.	4394-4401 Wilcox	1 dry hole
ANSON 26-30-2W	Apr.,1928 80 acres.	4	1920-36 Howard	Gas only
CALDWELL 16-35-3W	Apr.,1929 160 acres	4 1,164,971 Bbls.	4778-4784 Wilcox	Grav.46
CHURCHILL 25-31-2E	July,1926 1000 acres	71 17,694,482 Bbls.	1855-67 Stalnaker	Grav.37
CORBIN 23-34-2W	July,1927 40 acres	0 30,264 Bbls.	4490-98 Wilcox	Abd. Grav.46
HUNNEWELL 18-35-1E	Apr.,1927 300 acres	0	2286-2320 Lawrence	Gas Abd.
LATTA 9-30-2W	June,1927 300 acres	5 366,000 Bbls.	3042-56 Lansing - K.C.	2 levels Grav.40
	Oct.,1927	1 319 Million cu. ft.	2015-31 Topeka	Gas only abd.
XFORD 4-32-2E	June,1927 800 acres	18 13,302,694 Bbls.	2020 Stalnaker	Grav.37
		4	Shallow sands	
		53	2890-03 Arbuckle	Grav.38
OXFORD WEST 17-32-2E	Apr.,1926 160 acres	4 447,194 Bbls.	Arbuckle	
PADGETT 23-34-2E	Oct.,1924 1800 acres	20 1,600,000 Bbls.	3474-3502 Chat	
		18	Chat	Gas
		0	Arbuckle	
RAINBOW BEND WEST 24-33-2E	Dec.,1925	2 500,000 Bbls.	3197-3219 Burbank	
		0	3574-3581 Arbuckle	4 dry holes
RUTTER 21-33-2E	June,1926 40 acres	1 13,601 Bbls.	3315-23 Chat	
VERNON NORTH 15-35-2E	June,1915	100,902 Bbls.	1490-1508 Severy	Gas
15-35-2E	Aug.,1930	4	3443-65 Chat	Oil

Table of Pools (Con'd.)

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
WELLINGTON 33-31-1W	Dec.,1929 1200 acres	92 2,504,685 Bbls.	3655-66 Chat	1 dry hole Grav.41
ZYBA 17-30-1E	Nov.,1937 40 acres	1 None	3866-69 Wilcox	Grav.47

Important Test Wells

Pryor and Lockhart No. 1 Knowles, in sec. 30, T. 30 S., R. 1 E., top of Bronson, 2,859; Chat, 3,499; Simpson, 3,908; Arbuckle 3,990; total depth, 4,131 feet.

Theta No. 1 Sleigh, in sec. 36, T. 31 S., R. 2 E., top of Stalnaker, 2,116; Arbuckle, 2,900; pre-Cambrian granite, 3,540; total depth, 3,565 feet.

Deal et al. No. 1 Peters, in sec. 25, T. 32 S., R. 2 E., top of Stalnkaer, 2,245; Layton, 2,660; Bronson, 2,676; Bourbon, 2,868; Chat, 3,195, base, 3,450; Arbuckle, 3,514; total depth, 3,546 feet.

Shell No. 1 Green, in sec. 3, T. 33 S., R. 2 E., top of Stalnaker, 2,237; Layton, 2,657; Bronson, 2,735; Chat, 3,173; Wilcox, 3,436; Arbuckle, 3,486; total depth, 3,507 feet.

McBride No. 1 Kinlund, in sec. 24, T. 34 S., R. 1 E., top of Chat, 3,538, base, 3,770; Arbuckle, 3,894 feet.

Continental No. 1 Thiessen, in sec. 22, T. 34 S., R. 2 E., top of Chat, 3,468; Arbuckle, 3,807; total depth, 3,920. Produced 315 barrels of oil.

Matthews No. 1 Berry, in sec. 14, T. 35 S., R. 1 E., top of Stalnaker, 2,490; Chat, 3,545, base, 3,695; Wilcox, 3,755; total depth, 3,780 feet.

Watchorn No. 1 Rosecrans, in sec. 17, T. 35 S., R. 1 E., top of Chat, 3,245, base, 3,345; Simpson, 3,396; Arbuckle, 3,490; total depth, 3,522 feet.

Champlin No. 1 Stevens, in sec. 9, T. 30 S., R. 1 W., top of Simpson, 3,961; pre-Cambrian granite, 4,973; total depth, 5,307 feet.

Fitzwilliam No. 1 Hitchcock, in sec. 16, T. 30 S., R. 1 W., top of Bronson, 2,942; Chat, 3,539, base, 3,910; Wilcox, 3,962; total depth, 4,032 feet.

Shawver No. 1 Bryan, in sec. 36, T. 30 S., R. 2 W., top of Bronson, 3,104; Chat, 3,753; total depth, 3,830 feet.

Texas No. 1 Harper, in sec. 9, T. 30 S., R. 3 W., top of Ft. Riley, 965; Stalnaker, 2,918; Bronson, 3,208; Chat, 3,821; Simpson, 4,264; Arbuckle, 4,379; total depth, 4,393 feet.

Magnolia No. 1 Baird, in sec. 2, T. 30 S., R. 4 W., top of

Bronson, 3,345; Chat, 3,968, base, 4,310; Simpson, 4,394; total depth, 4,401; oil well.

Shawver No. 1 Proud, in sec. 33, T. 30 S., R. 1 W., top of Bronson, 2,616; Chat, 3,591, base, 3,917; Simpson, 3,968; Arbuckle, 4,067; total depth, 4,102 feet.

Westfall No. 1 Rogers, in sec. 35, T. 31 S., R. 2 W., top of Howard, 1,950; Bronson, 3,155; Chat, 3,817, base, 4,105; Simpson 4,247; Arbuckle, 4,353 feet.

Carter No. 1 Orr, in sec. 8, T. 31 S., R. 3 W., top of Bronson, 3,265; Chat, 3,925; base Mississippi lime, 4,277; Wilcox, 4,350; Arbuckle, 4,445; total depth, 4,552 feet.

Douglas No. 1 Strickler, in sec. 30, T. 32 S., R. 1 W., top of Lansing, 2,912; Bronson, 3,215; Chat, 3,890; Simpson, 4,265; Arbuckle, 4,407; total depth, 4,457 feet.

Winkler Koch No. 1 Belsley, in sec. 2, T. 32 S., R. 2 W., top of Bronson, 3,177; Chat, 3,844, base, 4,192; Simpson, 4,261; Arbuckle, 4,359; total depth, 4,408 feet.

Graham No. 1 Dawson, in sec. 4, T. 33 S., R. 2 W., top of Bronson, 3,238; Chat, 3,917, base, 4,250; total depth, 4,255 feet.

Burlingame No. 2 Rex, in sec. 22, T. 33 S., R. 3 W., top of Chat, 4,070, base, 4,462; Wilcox, 4,528; Total depth, 4,548 feet.

Spencer No. 1 Porter, in sec. 12, T. 33 S., R. 4 W., top of Bronson, 3,398; Chat, 4,075, base, 4,410; Wilcox, 4,492; Simpson, 4,480; total depth, 4,510 feet.

Austin No. 1 Fox, in sec. 14, T. 34 S., R. 1 W., top of Chat, 3,909, base, 4,238; Simpson, 4,305; total depth, 4,348 feet.

Wentz No. 1 Kern, in sec. 6, T. 34 S., R. 2 W., top of Bronson, 3,458; Chat, 4,145; Viola, 4,511; Wilcox, 4,538; Arbuckle, 4,692; total depth, 4,705 feet.

Jarvis No. 1 Wykoff, in sec. 11, T. 34 S., R. 4 W., top of alt, 570-655; Topeka, 2,535; Wabaunsee, 3,045; Bronson, 3,570; hat, 4,325; Chattanooga, 4,657; Simpson, 4,730; Wilcox, 4,748; total depth, 4,802 in Wilcox.

Wilson No. 1 Clark, in sec. 15, T. 35 S., R. 1 W., top of Chat, 3,996, base, 4,332; Simpson, 4,394; Arbuckle, 4,529; total depth, 4,545 feet.

Gypsy No. 1 Williams, in sec. 16, T. 35 S., R. 3 W., top of Simpson, 4,769; Wilcox, 4,772; Arbuckle, 4,980; total depth, 5,076. Oil well.

Mid-Continent No. 1 Clark, in sec. 31, T. 34 S., R. 3 W., top of Stalnaker, 3,265; Bronson, 3,700; Chat, 4,425, base, 4,780; Viola, 4,810; Simpson, 4,853; total depth, 4,870 feet.

TREGO COUNTY

General Geology

Areal Geology. The Saline River traverses Trego County from west to east along the northern border. In a similar manner Smoky Hill River traverses the county near the southern border. These rivers have cut through a blanket of sand and gravel which once entirely covered the county. This material, which was brought by Tertiary streams, is nearly 200 feet thick on the divide between the two large rivers. It still covers most of the northern half of the county. The Saline River has cut into the Niobrara formation of the Cretaceous system. Smoky Hill River, on the other hand, has cut deeper and has exposed much of the Carlile formation of the Cretaceous. River alluvium of Quaternary age occupies narrow belts in the lower reaches of these rivers. Since the Niobrara and Carlile formations were described in the report on Ellis County, no attempt will be made to describe them again.

Subsurface Stratigraphy. Beneath Cretaceous rocks in Trego County is a widespread unconformity, so that different parts of the Permian red beds appear in well logs. In the eastern part of the county these red beds are 420 feet thick, and consist of siltstones and clays. Near the base the Cimarron anhydrite, so widespread in western Kansas, appears in all well cuttings. It is composed of anhydrite, below which dolomite may occur. The Wellington is recognized by the presence of greenish gray shales in well cuttings. Further corroboration is furnished by the salt layers which are found at an elevation of 250 feet above sea level in eastern Trego County, and successively lower toward the west, being at sea level on the western border. The salt beds thin from 250 feet in the east to 120 feet in the western part of the county. About 100 feet of gray shale and anhydrite layers complete the Wellington sequence.

The 600 feet of limestones and shales which underlie the Wellington belong to the Big Blue series so characteristic farther east. In well cuttings it is possible to differentiate the Herington at the top, the Florence and Wreford near the middle, and the Americus at the base of this important sequence. The Pennsylvanian rocks comprise the next lower 1,100 feet of strata. They may be subdivided into five divisions, the Wabaunsee, Shawnee, Douglas, "Oswald," and basal conglomerate. The first of these, characterized by occasional micaceous siltstones, is 420 feet thick, and the Shawnee with a preponderance of limestone, is 270 feet thick. The Topeka limestone at the top of the Shawnee group is important for correlation purposes, as well as for its possibilities as an oil-producing formation.

The Douglas group is very thin, and is usually represented only by red shale. The "Oswald" limestone sequence, corresponding to the Lansing, Kansas City and Bronson groups farther east, is about 200 feet thick in wells which have gone deep enough to penetrate it. It is characterized by the usual oolitic zones and thin black shales which are diagnostic in counties farther east. The strata below the "Oswald" sequence are difficult to classify. In one well 300 feet of rocks, comprising shales, limestones and a thin basal conglomerate, were found. These may represent the Marmaton or the Marmaton and Cherokee combined.

The Mississippian limestone has been identified in some wells. In the Wakeeney pool it has a thickness of only 27 feet. Below it the Silurian and Devonian rocks are missing. On ac-

count of the unconformity at this level, various formations of Ordovician age appear beneath either the Pennsylvanian or the Mississippian. In the eastern half of the county the Arbuckle underlies the Carboniferous. Farther west it is the Simpson formation, and in the western third of the county, the Viola limestone.

Because of the higher elevation of Trego County, as well as the general regional dip of strata to the west, these older rocks are found at greater depths. The Viola, for instance, is found at a depth of 4,405 feet in the southwestern part of the county. In the same general area the Arbuckle appears at 4,536 feet. In the southeastern part of the county the Arbuckle was found in one well at 3,839 feet, and was 198 feet thick. The Reagan sand was found in the same well at 4,096 feet. The pre-Cambrian was reached in the Central Commercial No. 1 Wagg well drilled in sec. 20, T. 13 S., R. 21 W., at a depth of 4,562 feet and also in the Central Commercial No. 1 Locker at a depth of 4,731 feet.

Structure. The surface rocks in Trego County dip gently toward the north[51]. Data from shallow wells indicate that several long anticlinal trends cross the county from north to south. These have been checked by core drilling and by seismograph surveys. During the last few years drilling has been largely guided by the results of these investigations. However, not enough wells have been drilled as yet to indicate the subsurface structure.

Table of Pools

NAME. LOCATION.	DATE OF DISCOVERY. AREA.	NO. OF WELLS. PRODUCTION TO JAN. 1, 1938.	DEPTH. PRODUCING HORIZON.	REMARKS
GUGLER 36-12-21	Dec.,1936 40 acres	1 5,042 Bbls.	3830-38 Arbuckle	
REGA 20-13-21	May,1929 40 acres	1 14,883 Bbls.	3960-65 Conglomerate	Shut in Grav.35
WAKEENEY 14-11-23	Aug.,1934 1800 acres	12 217,641 Bbls.	3619-27 Lansing - K.C.	3 dry 1 abd. Grav.39

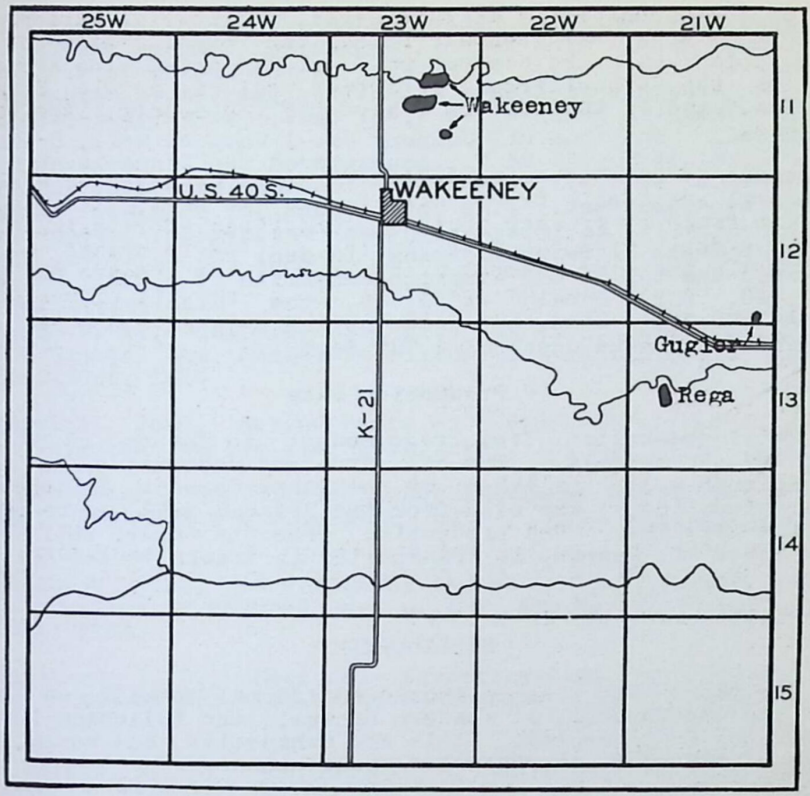
History of Oil and Gas Development

At the close of 1937 there were three oil pools in Trego County. The first of these was discovered in May, 1929, when the No. 1 King well of the Central Commercial Oil Company was completed in sec. 20, T. 13 S., R. 21 W. Oil was found in the Pennsylvanian basal conglomerate at a depth of 3,960 to 3,972 feet. The official name of Rega pool was applied to this well. Later an offset well was drilled to a depth of 4,562 feet without finding commercial quantities of oil.

Wakeeney Pool. The second pool was discovered in August, 1934, by the Alma Petroleum Company when the first well on the Rhodes Estate in sec. 14, T. 11 S., R. 23 W. was completed. In this case the Lansing-Kansas City lime proved to be the producing horizon, in which oil was found at a depth of 3,619 feet.

---

51. Bass, N. W., Geologic structure of the Dakota sandstone: Kansas Geol. Survey, Bull. 11, pl. 7, p. 85, 1926.



Trego County

Subsequently 14 other wells were drilled in this area, of which only three were dry. This number includes the wells originally included in the Holcomb pool which centered about sec. 26, T. 11 S., R. 23 W. The gravity of the oil is approximately 40° Bé. and the total production to the end of 1937 has been 217,641 barrels. Deep tests to the Arbuckle lime have failed to find commercial quantities of oil.

Gugler Pool. The third pool is located five miles northeast of the Rega pool. The discovery well was drilled on the Gugler ranch in sec. 36, T. 12 S., R. 21 W. by the York State Oil Company. Two producing levels were found, one at 3,750 feet in the Pennsylvanian basal conglomerate and the other at 3,830 feet in the Arbuckle lime. Although the well was completed in December, 1936, very little oil was taken from the lease because of a lack of transportation facilities.

Important Wildcat Wells. An interesting wildcat test was drilled south of the town of Wakeeney on the Jones ranch in sec. 26, T. 12 S., R. 23 W. by the Genmar Oil Company. Although the structural situation of this test was regarded as very favorable no oil in quantity was found to the total depth of 4,385 feet. The top of the Lansing limestone was reached at 3,826 feet and the top of the Mississippi lime at 4,320 feet. The No. 1 Lang well drilled by the Olson Drilling Company in sec. 1, T. 14 S., R. 21 W., found Topeka lime at 3,280, the "Oswald" at 3,746, the basal conglomerate at 3,848, the Arbuckle at 3,898, and the Rea-

gan sand at 4,096 feet. It was abandoned at 4,134 feet still in the Reagan sand. The Central Commercial Company drilled a well in sec. 12, T. 14 S., R. 22 W., on the Locker farm. In this well the Arbuckle was found at 4,173; the Reagan sand at 4,707; and pre-Cambrian granite at 4,731 feet, at which depth it was abandoned. The Thom Oil Company No. 1 Koeppen well, drilled in sec. 31, T. 14 S., R. 24 W., encountered the Pennsylvanian basal conglomerate at 4,177, the Viola limestone at 4,293, and the Arbuckle at 4,405 feet. The total depth of this well was 4,429 feet. Finally, an interesting test was the No. 1 Secor drilled by the Vickers Petroleum Company in sec. 25, T. 15 S., R. 24 W. It found the top of the Cimarron anhydrite at 1,708, the Topeka at 3,410, the "Oswald" at 3,635, the "Mississippi lime" at 4,304, the Viola at 4,405, and the Arbuckle at 4,536 feet. It was abandoned at a depth of 4,727 feet.

Production Data

Total production from Trego County to the end of 1937 has been 237,566 barrels. The oil from the Wakeeney pool, except the Holcomb well, is taken by the Texas Company in trucks to their pipe line. The oil from the Holcomb well is carried by the Kaw pipeline. The production from the Gugler well of the York State Oil Company is transported in trucks to the Kaw pipeline.

BIBLIOGRAPHY

For those who wish to secure additional details on the oil and gas development of western Kansas, the following list of references is presented. It is not exhaustive, but contains the names of the most comprehensive publications.

Bulletins and Reports

American Institute of Mining and Metallurgical Engineers, Transactions. Articles on oil and gas in Kansas by various authors in annual Petroleum volumes.

Kansas Geological Society, Wichita, Kansas. Proceedings Eighth Annual Field Conference, 1934. Geologic cross-section from western Missouri to western Kansas, by Betty Kellett, 1932.

Rinehart Oil News Company, Tulsa, Oklahoma. Kansas Oil, November, 1936.

State Geological Survey of Kansas. Various bulletins, including: No. 10, Russell County, by W. W. Rubey and N. W. Bass, 1925; No. 11, Ellis and Hamilton counties, by N. W. Bass, 1926; No. 13, Underground resources of Kansas, by Raymond C. Moore and Kenneth K. Landes, 1927; No. 15, Cloud and Republic counties, by Monta E. Wing, 1930; No. 16, Mitchell and Osborne counties, by Kenneth K. Landes, 1926; No. 18, Wallace County, by Maxim K. Elias, 1931; No. 19, Ness and Hodgeman counties, by R. G. Moss, 1932; and No. 22, Pennsylvanian rocks of Kansas, by Raymond C. Moore, 1936. Also Mineral Resources Circulars, including: No. 1, by L. W. Kesler, 1928; No. 2, by Anthony Folger and Roy Hall, 1931; No. 3, by Edward A. Koester, 1934; and No. 6, by Kenneth K. Landes, 1937.

Maps

Pre-Mississippian areal geology, by Hugh McClellan. Pub-

lished by Kansas Blue Print and Mapping Company, Wichita, Kansas.

Geologic map of Kansas. State Geological Survey of Kansas, Lawrence, Kansas.

Articles

Allan, Thomas H., and Valerius, M. M., Fairport oil field, Russell County, Kansas: Structure of typical American oil fieelds, vol. 1, pp. 35-50, Am. Assoc. Petroleum Geologists, 19229.

Bass, N. W., Geologic structure of the Dakota sandstone in western Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 9, pp. 1019-1023, 1925.

Barwick, John, Salina Basin of north-central Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 12, pp. 177-190, 1928.

Edson, Fanny, Pre-Mississippian sediments in central Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 14, pp. 441-451, 19330.

Garlough, John, Gas fields of Kansas west of Nemaha Granite Ridge: Geology of Natural Gas, p. 459, Am. Assoc. Petroleum Geologists, 1935.

Hiestand, T. C., Regional investigations in Oklahoma and Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 19, pp. 6488-70, 1935.

Hiestand, T. C., Voshell field, McPherson County, Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 17, pp. 169-180, 19333.

Koester, Edw. A., Geology of Central Kansas Uplift: Am. Assoc. Petroleum Geologists, Bull., vol. 19, p. 1405, 1935.

McClellan, Hugh, Subsurface distribution of pre-Mississippian rocks of Kansas and Oklahoma: Am. Assoc. Petroleum Geologists, Bull., vol. 14, pp. 1535-1590, 1930.

Moore, R. C., Early Pennsylvanian deposits west of Nemaha Granite Ridge: Am. Assoc. Petroleum Geologists, Bull., vol. 10, pp. 205-210, 1926.

Rutledge, R. B., and Bryant, Howard, Cunningham field, Kingman and Pratt counties, Kansas: Am. Assoc. Petroleum Geologists Bull., vol. 21, pp. 500-524, 1937.

Snow, D. R., and Dean, David, Rainbow Bend field, Cowley County, Kansas: Structure of typical American oil fields, vol. 1,, pp. 52-55, Am. Assoc. Petroleum Geologists, 1929.

Twenhofel, W. H., Ordovician strata in wells of western Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 11, p. 49-55, 19327.

Udden, J. A., Occurrence of Ordovician sediments in western Kansas: Am. Assoc. Petroleum Geologists, Bull., vol. 10, p. 6334, 1926.

INDEX OF OIL AND GAS POOLS

Page

Abbyville..... 97, 100
Aetna..... 22, 23
Ainsworth..... 28
Ainsworth South..... 28
Albert..... 28
Aldrich..... 85
Allon..... 129
Andover South..... 147
Anness..... 168
Anschutz..... 129
Anson.....167, 168
Antonino..... 42
Atherton..... 129
Balta..... 129
Beaver..... 27, 28
Beaver North..... 27, 28
Bemis..... 41, 42
Benso..... 129
Bentley.....145, 147
Berrick..... 129
Big Creek.....129, 130
Bison.....122, 123
Bloomer..... 26, 28
Bluehill..... 43
Bornholdt..... 80
Boxberger..... 130
Brandenstein.....109, 111
Bredfeldt.....110, 111
Breford..... 50, 51
Bunker Hill..... 130
Burnett..... 43
Burrton.....62, 98, 100
Cairo..... 93, 94
Caldwell.....166, 168
Canton..... 78
Canton North..... 80
Catherine..... 43
Chase.....107, 111
Cheney..... 147
Chindberg..... 77, 80
Churchill.....165, 168
Coralena.....129, 130
Corbin.....166, 168
Cramm.....110, 111
Cress..... 43
Cross.....145, 147
Cunningham.....70, 71, 92
Curry..... 147
Davidson..... 26, 28
Derby..... 147
DeWeese..... 106
Dillner.....127, 130
Donovan..... 130
Dopita.....118, 119
Doran..... 112
Drach..... 154
Dubuque..... 130
Eastborough.....146, 147
Eberhardt..... 28
Edwards.....109, 112
Eichman..... 130

Page

Ellinwood..... 28
Ellinwood North..... 28
Ellsworth..... 51
Emmeram..... 43
Fairport.....127, 128, 130
Faubion.....118, 119
Feist..... 28
Flink..... 130
Friesen..... 62
Galt.....109, 112
Gates.....153, 154
Geneseo.....109, 112
Gideon.....127, 130
Goodrich.....145, 148
Gorham.....127, 128, 130
Graber..... 78, 80
Greenwalt..... 123
Greenwich.....145, 148
Gugler.....172, 173
Guildner.....108, 112
Gurney.....129, 130
Halbiger..... 110
Hadley..... 41, 43
Halferman.....111, 112
Hall.....127, 130
Haller..... 43
Havuschild..... 106
Haven..... 98
Heiken..... 49
Heizer..... 27, 28
Hesston..... 60, 62
Hillger..... 99, 100
Hiess..... 27, 29
Holcomb.....55, 66, 156
Hollow-Nikkel..... 61, 62
Huggoton.....56, 65, 82, 157
Hunnewell.....167, 168
Iseern..... 26
Iuka..... 93, 94
Johnson..... 77, 80
Jordan..... 154
Kecchi.....146, 148
Keesling.....107, 112
Kingman..... 69, 71
Kipp..... 154
Koboletz..... 43
Kowalski..... 26
Kraft..... 29
Kraus..... 43
Kruse.....118, 119
Kuske.....146, 148
Lake City..... 22, 23
Lanterman..... 29
Latton.....118, 119
Latta.....167, 168
Larado..... 99, 100
Letsch.....129, 131
Liberal.....151, 156
Lorraine..... 50, 51
Lyons..... 112
McCarty..... 36
McPherson..... 76, 80
Madden..... 43

Page

Mantel..... 109
Marshall..... 43
Medicine Lodge..... 21, 23
Morrison..... 32
Neidenthal..... 131
Neola..... 154
Nickerson..... 100
Nikkel..... 78
Nyra.....118, 119
Oatville..... 148
Ochs.....127, 131
Olsson..... 136
Orth.....108, 112
Otis..... 123
Oxford.....164, 168
Oxford West.....167, 168
Padgett.....164, 168
Pawnee Rock..... 90
Penny Wann..... 43
Ploog.....108, 112
Ponce..... 112
Rainbow Bend.....164, 168
Raymond.....109, 112
Rega..... 172
Richardson.....153, 154
Rick..... 29
Rickard.....108, 112
Ritz-Canton..... 78, 80
Robbins.....146, 148
Ruder..... 41, 43
Russell.....129, 131
Rutter.....164, 168
Santa Fe..... 64, 156
Satran..... 50, 51
Saxman..... 106
Schartz..... 26
Schoenchen..... 41
Schulte.....146, 148
Sellens.....127, 129, 131
Shallow Water..... 138
Showalter..... 60
Shutts..... 41, 43
Silica..... 26, 29
Silica South..... 29
Sittner..... 155
Snider.....154, 155
Soeken.....111, 112
Solomon..... 43
Sperling..... 61, 62
Steckel..... 26
Steinert..... 131
St. John.....153, 155
Sterling.....107, 112
Stickney..... 29
Stockton.....118, 119
Stoltenberg..... 50, 51
Stratman..... 50, 51
Straub..... 29
Stumps.....108, 112
Sullivan..... 129
Susank..... 29
Theede..... 106
Thurber.....111, 112

Page
TToulon..... 43
TTrapp.....128, 131
TTrapp South..... 29
TTrapp Southwest..... 29
TTrembly..... 100
UUbert..... 43
VWaughn..... 131
VWalley Center.....144, 148
VWernon North.....163, 168
VVictoria..... 44
VWoshell..... 78, 80
VWakeeney..... 172
VWalters..... 44
VWalton..... 60, 62
VWebster.....118, 119
VWelch.....106, 113
VWellington.....166, 169
VWenke.....109, 113
VWesthusin.....118, 119
VWhelan..... 21, 23
VWherry.....106, 113
VWherry East.....107, 113
VWilkins..... 50, 51
VWilliamson.....129, 131
VWinget..... 123
YYocemento..... 44
YYoder..... 99, 100
ZZenith..... 155
ZZurich.....118, 119
ZZyba..... 169