THE UNIVERSITY OF TEXAS

PUBLICATION NO. 5716

August 15, 1957

Occurrence of Oil and Gas in West Texas

Edited by Frank A. Herald

BUREAU OF ECONOMIC GEOLOGY

THE UNIVERSITY OF TEXAS, AUSTIN

John T. Lonsdale, *Director*

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

Mirabeau B. Lamar

OCCURRENCE OF OIL AND GAS IN WEST TEXAS

Compiled by
BUREAU OF ECONOMIC GEOLOGY, THE UNIVERSITY OF TEXAS
in cooperation with
WEST TEXAS GEOLOGICAL SOCIETY

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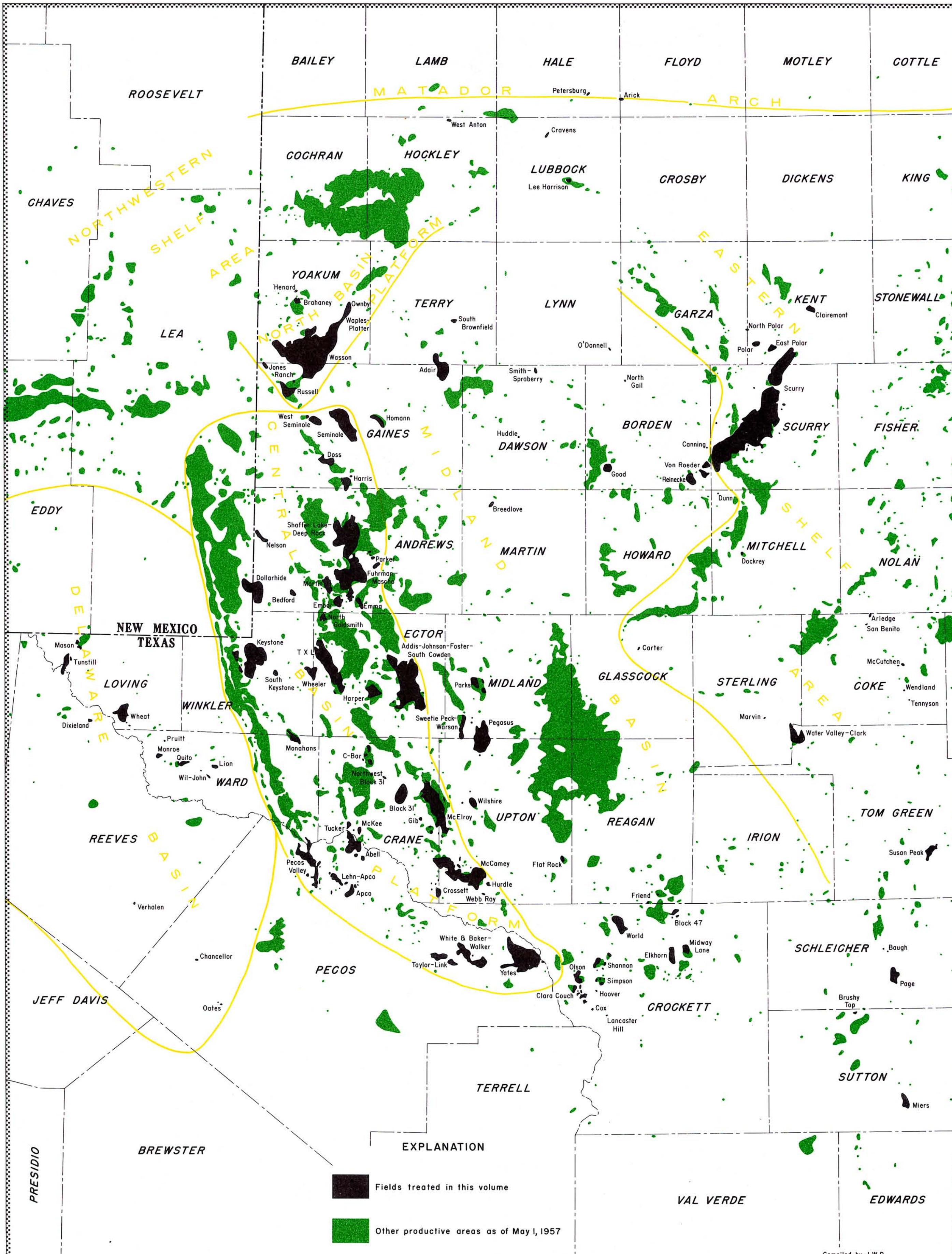
EXPLANATION

Boundary of area covered by map on opposite page. All fields treated in this volume are located within this boundary

Boundary of area defined as WEST TEXAS for the purposes of this project

Boundary of area defined as NORTHEAST TEXAS for the purposes of Publication 5116, OCCURRENCE OF OIL AND GAS IN NORTHEAST TEXAS

OCCURRENCE OF OIL AND GAS IN WEST TEXAS



PREFACE

This volume is the second in a series which was planned for presentation of data pertaining to the occurrence of oil and gas in Texas. The prior volume, OCCURRENCE OF OIL AND GAS IN NORTHEAST TEXAS (Publication 5116) includes treatment of every commercial occurrence of oil and/or gas discovered in the designated area prior to January 25, 1950. When the project for West Texas was undertaken, it was hoped to present corresponding data for all fields in West Texas which had been discovered prior to a definite date (later set as Jan. 1, 1951). Although we were not able to accomplish that goal, the papers presented in this volume serve remarkably well to convey an understanding of the occurrence of oil and gas in West Texas. The fields treated provide examples of nearly all significant conditions of nature which would have been exemplified if coverage were complete.

This volume contains 112 papers by 104 authors. The distribution of fields treated is indicated on the map on the next preceding page. That map also indicates the geographic relationships with other productive areas. The approximate distribution of productive areas is shown as of May 1, 1957. Field names for only the fields treated in this volume are entered on that map. Names of many nearby fields are shown on the maps in the following papers and also are entered in the FIELD NAME INDEX at the back of this volume. During the time the project has been in progress, there has been extensive development in West Texas. Many new fields have been discovered and new reservoirs have been discovered in known fields.

The manuscripts on which this publication is based were received in this office throughout the period since shortly after the project was launched until shortly before the completed volume goes to the printer for printing by the offset process. The first paper was received on June 11, 1951, and processing for publication was immediately initiated. As soon as practically possible after its receipt, each paper was set up and submitted to its author for checking and then it was put in final form (except for page numbers and for certain changes of type in headings) for printing by the offset process. Many papers have been revised to recognize all developments subsequent to the dates entered on the original manuscripts; the dates of such papers have been changed accordingly. Each paper presents data available as of a particular date, which date is clearly indicated in the heading.

In this project, the primary units of presentation are field papers. The fact that the reservoir is the basic unit in nature is recognized in the design of the field papers. To accomplish maximum utility, to assist in getting comparable data for the many fields and to facilitate state-wide summarizations, an effort is made to standardize the contents of the field papers to the greatest extent feasible without forfeiting meager data where only meager data are available and without any limitations on presentation of significant facts in addition to those indicated on the check-list.

In order to accomplish clear presentation of data for each reservoir separately, the method of presentation in this project relies largely on graphic representation on TYPICAL SECTION OF ROCKS PENETRATED. Since only few West Texas reservoirs are named, the designations that are herein used, generally, are the names of the smallest stratigraphic units which wholly contain the respective reservoir rocks; however, designations that are established as reservoir names are used in a few of the papers. Generally, the designations in the text are inclusive stratigraphic names which serve as references to TYPICAL SECTION OF ROCKS PENETRATED, where the stratigraphic position and vertical extent of each reservoir rock are shown by symbol (vertical bars in the extreme right column).

In the preparation of their papers for this volume, the authors were guided by Publication 5116, OCCURRENCE OF OIL AND GAS IN NORTHEAST TEXAS. The original check-list and the original suggestions to authors continued effective and are presented in the appendix at the back of this volume. These items were supplemented by circular letters, one of which contains a definition which is appropriately presented here. That definition is as follows:

> DEFINITION OF RESERVOIR ROCK: As to each reservoir, the reservoir rock is that portion of the stratigraphic section which yields, or has yielded, commercial oil and/or gas within the area of the field. Such stratigraphic unit constitutes the reservoir rock and is the unit for treatment regardless of its fluid contents at the margins of the field. This definition means that the downward extent of the reservoir rock is commonly determined by the chance position of the stratigraphically lowest commercial oil or gas; the chance position of water-level may determine the downward extent of the stratigraphic unit. The lithologic characteristics may be equally favorable throughout considerable additional section, but the mere fact that only water is yielded eliminates such additional lithologically favorable rock.

The significance of the last two sentences of the above definition (applicable anywhere by deletion of "stratigraphic" in three places) may be illustrated by reference to the cross section in the accompanying paper on the Wheeler field where the thickness of the Ellenburger reservoir rock is represented by the distance from the top of Ellenburger at Well #7 to the oil-water contact below that well (page 405).

The following listed annual publications, or their predecessors (names of certain organizations and certain titles of publications have been changed slightly), have presented regularly several items of information relative to the occurrence of oil and gas in West Texas:

Statistics of Oil and Gas Development and Production, American Institute of Mining, Metallurgical and Petroleum Engineers (AIME). 1933 et seq.; irregular and general, 1921 to 1933.

Oil and Gas Field Development in United States, National Oil Scouts & Landmen's Association. 1931 et seq.

Developments in West Texas and Southeastern New Mexico, Bulletin, American Association of Petroleum Geologists, August issue in 1937; June issue thereafter.

Annual Reports of the Oil and Gas Division of the Railroad Commission of Texas. 1939 et seq.

Since most of the above indicated publications contain data relative to every field in West Texas producing at time of respective issues, specific references are omitted from SELECTED REFERENCES in the following papers; their complete listing in each paper would require much space. However, for every field, these sources should be examined in any exhaustive research study. They have been used extensively in the compilation of this volume.

Operators' engineering committees functioning in connection with cooperative operations in several fields keep good records and issue occasional reports to the respective operators. These reports are valuable sources of information relative to certain fields and would be helpful in any exhaustive research studies of the particular fields. Since these reports have not been published, they are not sufficiently readily available to justify entries under SELECTED REFERENCES in the following papers.

July 11, 1957

Frank A. Herald
Project Supervisor

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ABELL FIELD

Pecos and Crane Counties, Texas

JACK G. ELAM
Consulting Geologist, Midland, Texas
June 20, 1953

LOCATION and INTRODUCTION

The Abell field is mainly in north-central Pecos County with minor extensions across the county boundary into southwest Crane County.

The Abell field includes 16 fields as designated by the Railroad Commission of Texas. Two of the Commission units, the Abell 2200-foot Permian and the Abell 3800-foot Permian, were designated as Abell Permian until July 1, 1949, when they were designated as separate fields by the Commission. The Commission designations are entered alphabetically as column headings in the following tabulation; the stratigraphic positions of the reservoirs producing in such units are indicated by entry of letters. These letters serve to identify, on the accompanying maps, the wells which produce from the respective stratigraphic positions as well as from the respective Commission units.

STRATIGRAPHIC POSITION \ COMMISSION DESIGNATION	Abell	Abell Byerley	Abell Clearfork	Abell East Waddell	Abell North San Andres	Abell Northwest	Abell Permian	Abell Silurian-Montoya	Abell Southeast Clearfork	Abell Southeast McKee	Abell South Ellenburger	Abell South San Andres	Abell 3800-foot Permian	Abell 2200-foot Permian	Abell Upper McKee	Abell Upper Permian
San Andres					Ab		Aa					Ac		Aa		
Glorieta							Ba						Ba			Bb
Upper Clear Fork			C													
Lower Clear Fork							Db		Da				Db			
Wichita		E														
Fusselman - Montoya								F								
Upper McKee	G														G	
Lower McKee	Ha					Hb				Hc						
Waddell	Ia Ic			Ib												
Joins	J															
Ellenburger	Ka										Kb					

SURFACE FORMATION and ELEVATION OF SURFACE

Surface elevation ranges from 2,350 feet to 2,400 feet. Quaternary alluvium deposited by the Pecos River occurs over most of the area of the field. North of the river, in the Pecos River cutbank, Cretaceous Edwards limestone overlies red, green and maroon shales of the Triassic Dockum group.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Study of subsurface data led to the discovery of this field. In 1936, George T. Abell acquired leases on 13,000 acres of land including most of the present area of the field. On the basis of data provided by three San Andres tests and by numerous core holes to the Yates formation, Abell caused the drilling of Tex-Mex Petroleum Co. #1 J. F. McKee in Sec. 24, Block 9, H. & G. N. R.R. survey, which flowed sulphur water and gas from its total depth of 2,720 feet and was shut down with a string of cable tools in the hole. Abell then assigned leases on 7,000 acres to Magnolia Petroleum Company in consideration of its deepening the test to 6,000 feet. It was impossible to deepen the original hole. A second hole was started and was junked at 1,210 feet. The rig was skidded southeastward and Magnolia Petroleum Co. #1-A J. F. McKee was drilled at the location where total depth 6,267 is indicated on accompanying maps. After finding showings of oil and gas in the Lower McKee, gas in the Waddell and water in the Ellenburger, this test was finally abandoned on September 14, 1938. In the fall of 1940, about a mile south of the Magnolia test, Taubert, McKee and Simeoneit #1 Mrs. V. W. Crockett was completed in the Lower McKee reservoir as the discovery well of the field. It flowed 933 barrels of 43 gravity oil in $11\frac{1}{2}$ hours through $\frac{1}{2}$-inch choke on 2-inch tubing with a gas-oil ratio of 783:1; T. D. 5,357 feet.

OLDEST HORIZON PENETRATED

The oldest horizon penetrated is in pre-Cambrian granite. Stanolind Oil & Gas Co. #1 Conry-Davis-Graham Unit (No. 14 on the accompanying cross section) penetrated 915 feet of Ellenburger, 20 feet of coarse quartzitic sandstone of Cambrian age and bottomed in pre-Cambrian granite. The Ellenburger, which is higher at this location than anywhere else in the field, yielded only salt water. As indicated on the accompanying cross section, the upper portion of the Ellenburger has been removed by truncation at this location.

WATER PRODUCTION

San Andres: Certain zones of the San Andres yield considerable amounts of water, while others yield none. Even offset wells completed in the same zone vary greatly in the amount of water produced; water varies from 0 to 80%. Several wells have been plugged and abandoned because of excessive water production.

Glorieta, Upper Clear Fork and Lower Clear Fork: Several wells have been abandoned because of excessive water production.

Wichita: The one well has not yielded an appreciable amount of water.

Fusselman - Montoya: No water encroachment is apparent.

Lower McKee: Many of the edge wells have had less than average decline in rate of oil production, indicating that there is no substantial water drive. However, in the northwest Lower McKee reservoir (Hb), one well has been plugged and abandoned because of water encroachment.

Waddell: Water encroachment has forced abandonment of 4 structurally low wells.

Joins: Water constitutes 25% of gross production.

Ellenburger: One well has been abandoned because of excessive water production.

DISCOVERIES

San Andres:
- Abell 2200-foot Permian (Aa): December 1, 1941;
  - Magnolia Petroleum Co. and George T. Abell #1-B State-Myrick
- Abell North San Andres (Ab): March 15, 1950;
  - George T. Abell #1-A R.G. Peiper
- Abell South San Andres (Ac): November 12, 1950;
  - C. H. Murphv & Co. #2 Ben Dansby

Glorieta:
- Abell 3800-foot Permian (Ba): August 16, 1941;
  - Stanolind Oil & Gas Co. #1 Thrapp-Walker Unit
- Abell Upper Permian (Bb): April 7, 1947;
  - Magnolia Petroleum Co. #2 State-Grove

Upper Clear Fork:
- Abell Clearfork (C): February 9, 1950;
  - Magnolia Petroleum Co. #4 State-Myrick

Lower Clear Fork:
- Abell Southeast Clearfork (Da): June 1, 1951;
  - Wood River Oil & Ref. Co. #2-A J. Williams
- Abell 3800-foot Permian (Db): July 2, 1941;
  - Stanolind Oil & Gas Co. #1 Conry-Davis-Graham Unit

Wichita:
- Abell Byerley (E): March 3, 1950;
  - George T. Abell #1 L.G. Byerley, Jr.

Fusselman - Montoya:
- Abell Silurian - Montoya (F): August 25, 1948;
  - Magnolia Petroleum Co. #2 J.W. Lutz

Upper McKee:
- Abell Upper McKee (G): September 26, 1949;
  - Magnolia Petroleum Co. #1 J.F. McKee (No. (on line of cross section)
  - George T. Abell et al #1 E.J. Rixse (No. 6 on line of cross section), completed on May 13, 1941, was the first well to produce from this zone, but it was classified as in the Railroad Commission Abell field.

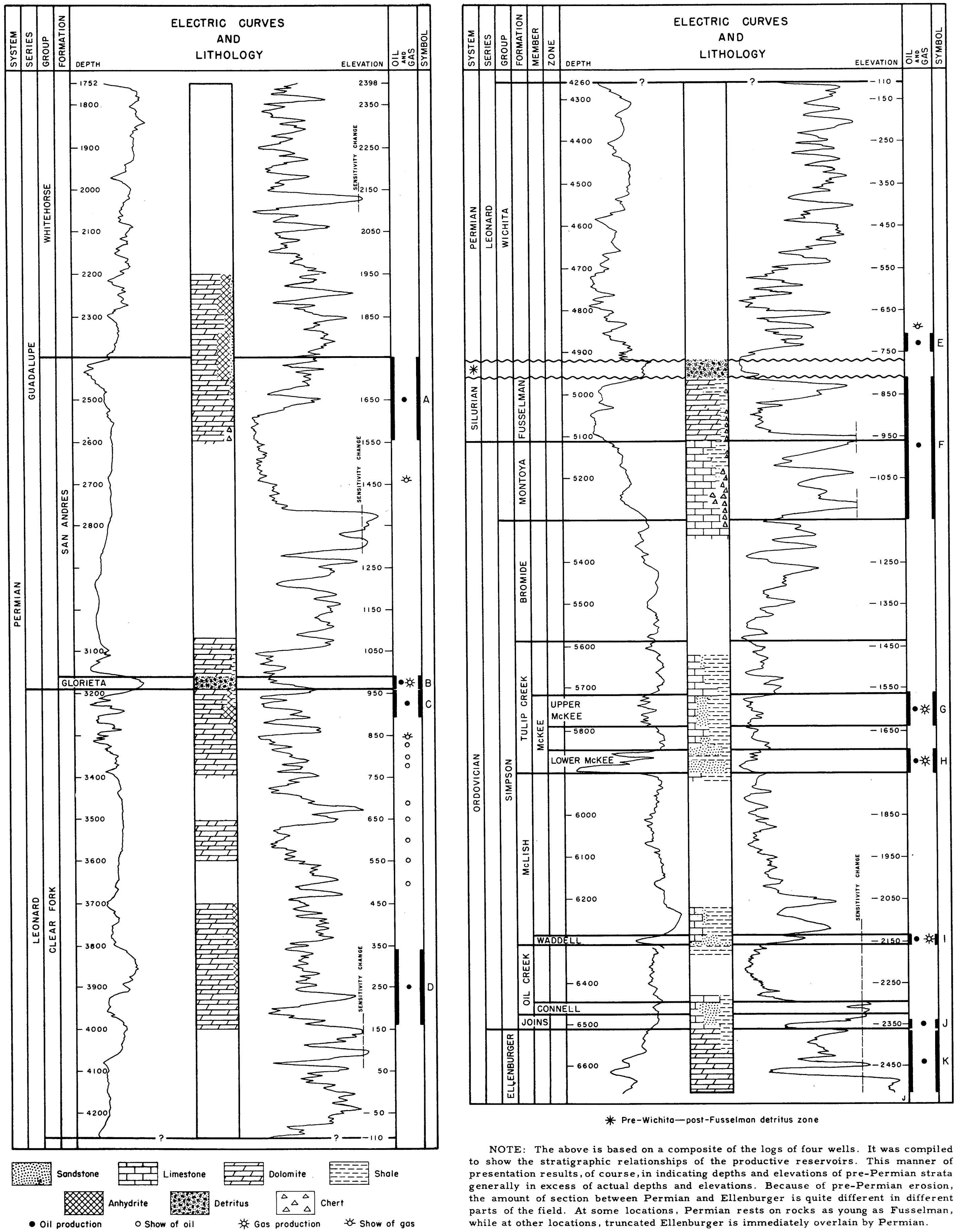
Lower McKee:
- Abell (Ha) and Field: October 17, 1940;
  - Taubert, McKee and Simeoneit #1 Mrs. V. W. Crockett (Now, Stanolind Oil & Gas Co. #1 Mrs. V. W. Crockett)
- Abell Northwest (Hb): August 21, 1948;
  - E. A. Hall #1 E. A. Hall (Now, George T. Abell #1 E. A. Hall)
- Abell Southeast McKee (Hc): September 9, 1951;
  - C. H. Murphy & Co. #1 Maud E. Ford

Waddell:
- Abell (Ia): March 13, 1941;
  - Magnolia Petroleum Co. #1 State-Sharp
- Abell East Waddell (Ib): May 23, 1950;
  - Magnolia Petroleum Co. #2 State-Vollmar
- Abell Humble - Tucker (Ic): January 1, 1946;
  - Humble Oil & Ref. Co. #1 N.M. Tucker et al

Joins:
- Abell (J): July 6, 1941;
  - Magnolia Petroleum Co. #3 Mrs. V. W. Crockett

Ellenburger:
- Abell (Ka): June 18, 1941;
  - Magnolia Petroleum Co. #1 J.F. McKee
- Abell South Ellenburger (Kb): September 9, 1951;
  - C. H. Murphy & Co. #1 R.D. Blaydes

TYPICAL SECTION OF ROCKS PENETRATED



✱ Pre-Wichita—post-Fusselman detritus zone

NOTE: The above is based on a composite of the logs of four wells. It was compiled to show the stratigraphic relationships of the productive reservoirs. This manner of presentation results, of course, in indicating depths and elevations of pre-Permian strata generally in excess of actual depths and elevations. Because of pre-Permian erosion, the amount of section between Permian and Ellenburger is quite different in different parts of the field. At some locations, Permian rests on rocks as young as Fusselman, while at other locations, truncated Ellenburger is immediately overlain by Permian.

NATURE OF TRAPS

San Andres: There are three areas on the general regional structural high where San Andres is productive. These productive areas occur where a condition of favorable porosity and permeability is present, and only in area Aa is this related to a local San Andres high. Even here, production is restricted to the south flank. Uncommercial shows in this zone have been noted in numerous other wells in the field.

Glorieta: The accumulation at each of the two productive areas (one with two wells and one with one well) is on the axis of the main Abell anticline, but production results from favorable porosity conditions at these areas.

Upper Clear Fork: A single well has encountered sufficient porosity to yield oil in this zone, although shows have been logged in numerous other wells. It is presumed to be a porosity trap in high structural position.

Lower Clear Fork: There are two areas where Lower Clear Fork is currently producing and one area where the one producing well has now been abandoned. The reservoir in each of these areas is presumed to be separate and distinct. The trap in each case is stratigraphic, and the accumulation results from a variation in degree of porosity.

Wichita: The sole Wichita producer is located in close proximity to the fault bounding the east side of the Fusselman-Montoya graben, and it appears that the accumulation is in a fracture zone associated with that faulting.

Fusselman - Montoya: The accumulation in this reservoir is primarily due to updip termination of reservoir rock by truncation and to overlap by impervious beds. Lateral closure is effected by faulting.

Upper McKee: Only two wells are producing from the Upper McKee reservoir, which is located near the axis of the Abell anticline. It appears that faulting and truncation with overlapping impervious beds are the controlling trap-forming factors.

Lower McKee: There are four reservoirs in the Lower McKee sandstone. The accumulation in each occurs on the flanks and/or in the downfaulted blocks on the Abell anticline. In the highest structural locations, this zone has been removed by erosion, and the cap is provided by impervious beds of Leonard age. Within the local lower fault blocks, gas is encountered at the crest of the anticline, and markedly different elevations of gas-oil and oil-water contacts in the field attest to the presence of fault barriers. The Lower McKee sand has been tested by only a single well (near center of Sec. 27) on the north flank of the Abell anticline, and here it is tight and silty.

Waddell: There is commercial production from the Waddell sandstone at nine places in the Abell field; the number of separate, distinct reservoirs is not known. The productive areas, each with one to four wells, are scattered over the field in various structural positions. It appears likely that variation in degree of porosity in sloping reservoir rock is

NATURE OF TRAPS (Continued)

the principal trap-forming factor, with faulting playing a minor role. However, it is recognized that the degree of porosity and permeability required for commercial production is greater than that required for migration of reservoir fluids in geologic time and that the nine productive areas may be all in a single area of accumulation; in which case, convex folding would appear to be the dominating factor.

Joins: The trap at the location of the single well appears to be due to fracturing along a fault.

Ellenburger: There are two productive reservoirs in the Ellenburger dolomite. Each is at the apex of a convex fold. Faulting is not a trap-forming factor in either case. However, on the contrary, fracturing associated with faulting has provided avenues of escape from nearby Ellenburger closures formed partly by faulting.

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Gray, dense, slightly fractured dolomite and dark brown, soft, finely crystalline dolomite; good vuggy type porosity in reservoir Aa.

Glorieta: Finely crystalline dolomite, with intergranular porosity, interbedded with detrital sands and limestone.

Upper Clear Fork: Finely crystalline gray dolomite with scattered vuggy type porosity.

Lower Clear Fork: Finely crystalline to lithographic dolomite; in scattered areas, porosity is of large vuggy to cavernous type. The porosity is extremely erratic as evidenced by patchy productive areas and by yielding of sulphur water both laterally and updip from oil productive areas.

Wichita: Slightly porous, fractured, gray-brown dolomite.

Fusselman - Montoya:

Fusselman: White to light gray, crystalline dolomite with secondary vugs, caverns and fractures.

Montoya: Brown, dense and cherty dolomite and limestone; characterized by fractures, vugs and caverns that contain many secondary calcite crystals.

Upper McKee: At the locality in Sec. 25, Block 9, where two wells are producing from Upper McKee, the reservoir rock is sandstone, fine-grained, green, with abundant rounded, frosted sand grains with some silt intermingled.

Lower McKee: Coarse green sandstone with very abundant rounded, frosted sand grains. A shale parting occurs at several places.

Waddell: Varies from a coarse-grained, calcareous sandstone to a fine- to coarse-grained, loosely cemented white sandstone.

Joins: Gray-green marly limestone.

Ellenburger: Massive, gray and brown, finely crystalline dolomite, with solution cavities and narrow irregular fractures lined with calcite and dolomite crystals.

PRODUCTIVE AREAS, ELEVATION AND RELIEF OF PRODUCTIVE ZONES and CHARACTER OF OIL

	PRODUCTIVE AREAS	ELEVATION AND RELIEF (feet)			CHARACTER OF OIL
	(acres)	Top of oil	Bottom of oil	Relief	Gravity (A.P.I. @ 60° F.)
San Andres:					
Abell 2200-foot Permian (Aa)	320	144	35	109	35
Abell North San Andres (Ab)	150	1	-46	47	37.2
Abell South San Andres (Ac)	80	-31	-55	24	32
Glorieta:					
Abell 3800-foot Permian (Ba)	100	-799	-834	35	26
Abell Upper Permian (Bb) (one well)	40	-767	-791	24	34
Upper Clear Fork:					
Abell Clearfork (C): (one well)	40	-967	-977	10	34.7
Lower Clear Fork:					
Abell Southeast Clearfork (Da) (one well)	80	-1,460	-1,509	49	38
Abell 3800-foot Permian (Db, southeast)	250	-1,445	-1,610	165	34
Abell 3800-foot Permian (Db, northwest)	250	-1,463	-1,580	117	37
Wichita: (E): (one well)	40	-2,544	-2,569	25	41
Fusselman - Montoya: (F):	1,200	-2,426	-2,698+	272+	41
Upper McKee: (G): (two wells)	40	-2,551	-2,618	67	38.6
Lower McKee:					
Abell (Ha)	2,150	-2,575	-3,044	*	41-43
Abell Northwest (Hb)	720	-3,012	-3,198	186	41.6
Abell Southeast McKee (Hc)	200	-2,682	-2,770	88	43
Waddell:					
Abell (Ia) (7 areas)	450	-3,064	-3,553	**	43
Abell East Waddell (Ib)	160	-3,519	-3,662	143	44.2
Joins: (J): (one well)	40	-3,322	-3,345	***	42
Ellenburger:					
Abell (Ka)	540	-3,410	-3,547	137	42
Abell South Ellenburger (Kb) (one well)	40	-3,417	-3,554	137	42

PRODUCTIVE AREAS: The above estimates total 6,890 acres. Allowing for overlapping of areas, the total area of the Abell field is estimated to be 6,200 acres. It is probable that future development will warrant increasing the above estimates for Fusselman - Montoya and Waddell.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES:

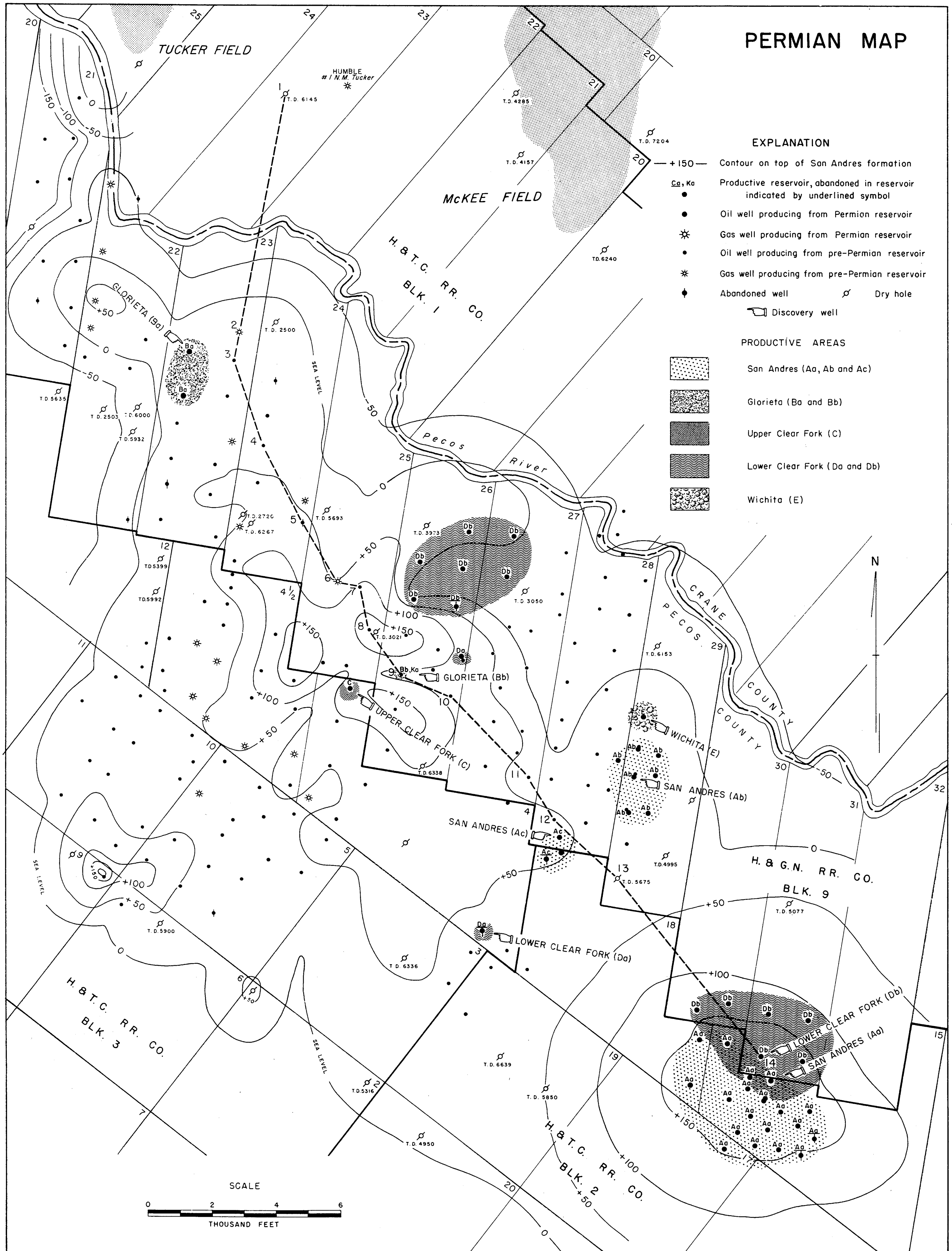
*In Lower McKee Abell (Ha), fluid elevations are different in the several fault blocks. Gas has been produced from -2,518 in Magnolia #1 Grove to -2,969 in Stanolind #1 Thrapp-Walker; oil, from -2,575 in Magnolia #2 Francisco to -3,044 in Magnolia #1 McIntosh; water, from -2,957 in Magnolia #1 J. W. Lutz to -3,066 in Sinclair #3 Heirman.

**In the seven Waddell Abell (Ia) areas, there is considerable range in elevations of fluid contacts. Gas has been produced from -3,019 in Magnolia #2 Grove to -3,327 in Magnolia #2 State-Baldwin; oil, from -3,064 in Stanolind #1 Wright to -3,553 in Magnolia #5 Silverman; water, from -3,049 in Stanolind #1 Grove to -3,446 in Stanolind #1 Thrapp-Walker.

***The only Joins well produces from -3,322 to -3,345. Water constitutes 25% of the gross production.

CHARACTER OF OIL: For oil analyses see:

U. S. Bureau of Mines	Lab. ref. No.	41398	46113	46094	46096	46095	50050
Analyses of Crude Oils from Some Fields of Texas R.I. 3699 (1943)	Item	1					
Analyses of Crude Oils from Some West Texas Fields R.I. 4959 (1953)	Item		1	2	3	4	5


PERMIAN MAP
EXPLANATION
+150 Contour on top of San Andres formation
Ca, Ka Productive reservoir, abandoned in reservoir indicated by underlined symbol
Oil well producing from Permian reservoir
Gas well producing from Permian reservoir
Oil well producing from pre-Permian reservoir
Gas well producing from pre-Permian reservoir
Abandoned well
Dry hole
Discovery well
PRODUCTIVE AREAS
San Andres (Aa, Ab and Ac)
Glorieta (Ba and Bb)
Upper Clear Fork (C)
Lower Clear Fork (Da and Db)
Wichita (E)
TUCKER FIELD
McKEE FIELD
HUMBLE # 1 N.M. Tucker
H. & T. C. RR. CO. BLK. 1
H. & T. C. RR. CO. BLK. 3
H. & T. C. RR. CO. BLK. 2
H. & G. N. RR. CO. BLK. 9
Pecos River
CRANE COUNTY
PECOS COUNTY
GLORIETA (Ba)
GLORIETA (Bb)
UPPER CLEAR FORK (C)
WICHITA (E)
SAN ANDRES (Ab)
SAN ANDRES (Ac)
LOWER CLEAR FORK (Da)
LOWER CLEAR FORK (Db)
SAN ANDRES (Aa)
SEA LEVEL
SCALE
0 2 4 6
THOUSAND FEET
N

CONTINUITY OF RESERVOIR ROCKS

San Andres: The stratigraphic unit in which there are productive wells at three localities appears to be continuous throughout the area of the field, but it is only locally sufficiently porous to yield oil into bore holes. Porosity is erratic and is independent of structural position. In the productive area at the southeast end of the field, the best porosity is at the crest and on the south flank of the Abell anticline. The other productive areas are considerably lower structurally. At the locations of several wells at the crest of the anticline, porosity is too low for commercial production.

Glorieta: The continuity of the reservoir rock is not known. Porosity adequate for commercial production is a local condition.

Upper Clear Fork and Lower Clear Fork: The stratigraphic units appear to be continuous throughout the area of the field but they are only locally sufficiently porous to yield oil into bore holes. Porosity is erratic and is independent of structural position.

Wichita: The continuity of the reservoir rock in the Wichita is unknown and appears to be of little importance. It appears that the accumulation of oil is a result of trapping after escape along a fault from the Fusselman - Montoya reservoir.

Fusselman - Montoya: The Fusselman and Montoya groups are eroded from the crest of the Abell anticline. They are productive only on the northeast flank where their truncated sub-crops are overlain by impervious Permian beds, mainly where they have been preserved in a down-dropped block. Normally, the Montoya is dense and impervious. Porosity in the productive area has resulted from pre-Permian weathering. Less vigorously weathered Montoya in downdip wells fails to yield commercial oil, but here overlying Fusselman is productive.

McKee: The McKee member was deposited as a blanket stratigraphic unit over the entire area of the field, but subsequent erosion has removed it from the structural crests. The porosity of the sandstones in the McKee member is quite variable within the area of the field. The upper sandstone is sufficiently porous to yield oil in only a very limited area. While the lower sandstone has adequate porosity for commercial production over a much greater area, even in this sandstone, such porosity is not continuous throughout the area of the field.

Waddell: The Waddell sandstone is a blanket deposit which is locally silty and highly cemented. It has exhibited an erratic pattern of production; but this is, in part, the result of non-uniform exploitation.

Joins: The Joins has produced in only one well. In view of the fact that this well cut several faults, it is suggested that this zone is productive only because Ellenburger oil has migrated up the shear zone.

Ellenburger: The productive portion of the Ellenburger was deposited throughout the area of the field but has been removed by erosion from the apex of a structural high at the southeast end of the field. Its continuity is interrupted in a minor way by a series of northeast-southwest normal faults.

THICKNESSES OF RESERVOIR ROCKS

	Net productive, feet		
	Min.	Max.	Avg.
San Andres	5	43	18
Glorieta	24	40	32
Upper Clear Fork	10	10	10
Lower Clear Fork	11	100	50
Wichita	35	35	35
Fusselman - Montoya	41	220	100
Upper McKee	10	10	10
Lower McKee	0	60	30
Waddell	3	30	15
Joins	23	23	23
Ellenburger	18	152	75

COMPLETION TREATMENTS

San Andres, Glorieta, Upper Clear Fork, Lower Clear Fork and Wichita: Most of the wells completed in the Permian reservoirs were treated with 500 to 1,000 gallons of acid at time of completion; as much as 3,000 gallons was used in a few wells. However, some of the better wells were completed without either acid or fracture treatment.

Fusselman - Montoya: Most of the wells were completed without either acid or fracture treatment, but, downdip where porosity of Montoya is low, one well was shot with 610 quarts of nitroglycerin and was treated with 3,000 gallons of acid.

Lower McKee: Most early wells were completed "natural". In some of the more recently completed wells in Abell Northwest (Hb) the reservoir rock was hydraulically fractured with 1,500 gallons of fluid.

Waddell: Most Waddell wells were completed "natural", but in Abell East Waddell (Ib) most wells were given hydraulic fracture treatments with 1,500 gallons of fluid.

Joins: The well was treated with 2,000 gal. of acid.

Ellenburger: Most of the Ellenburger wells were acidized with 2,000 to 3,000 gallons of acid.

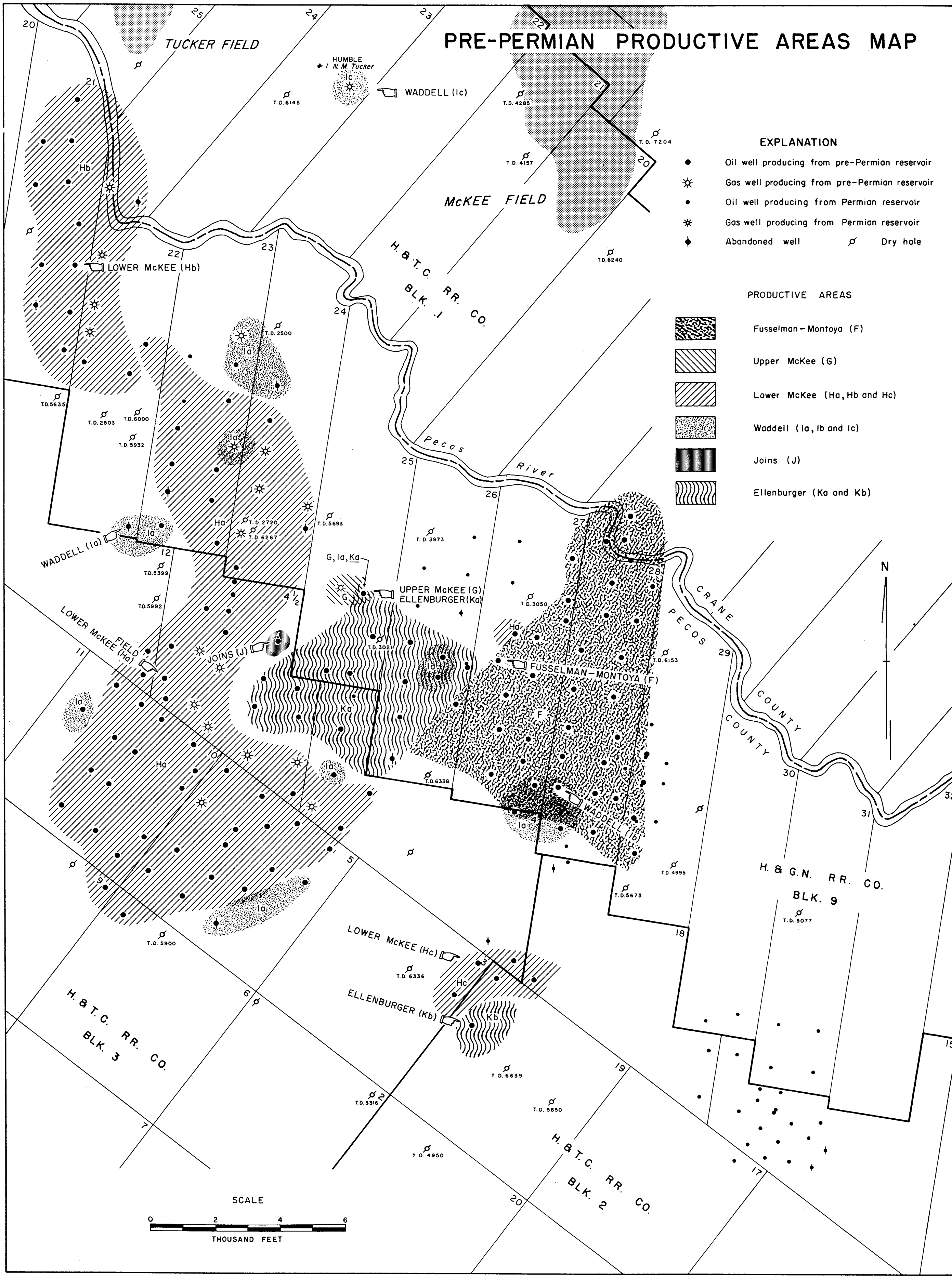
SELECTED REFERENCES

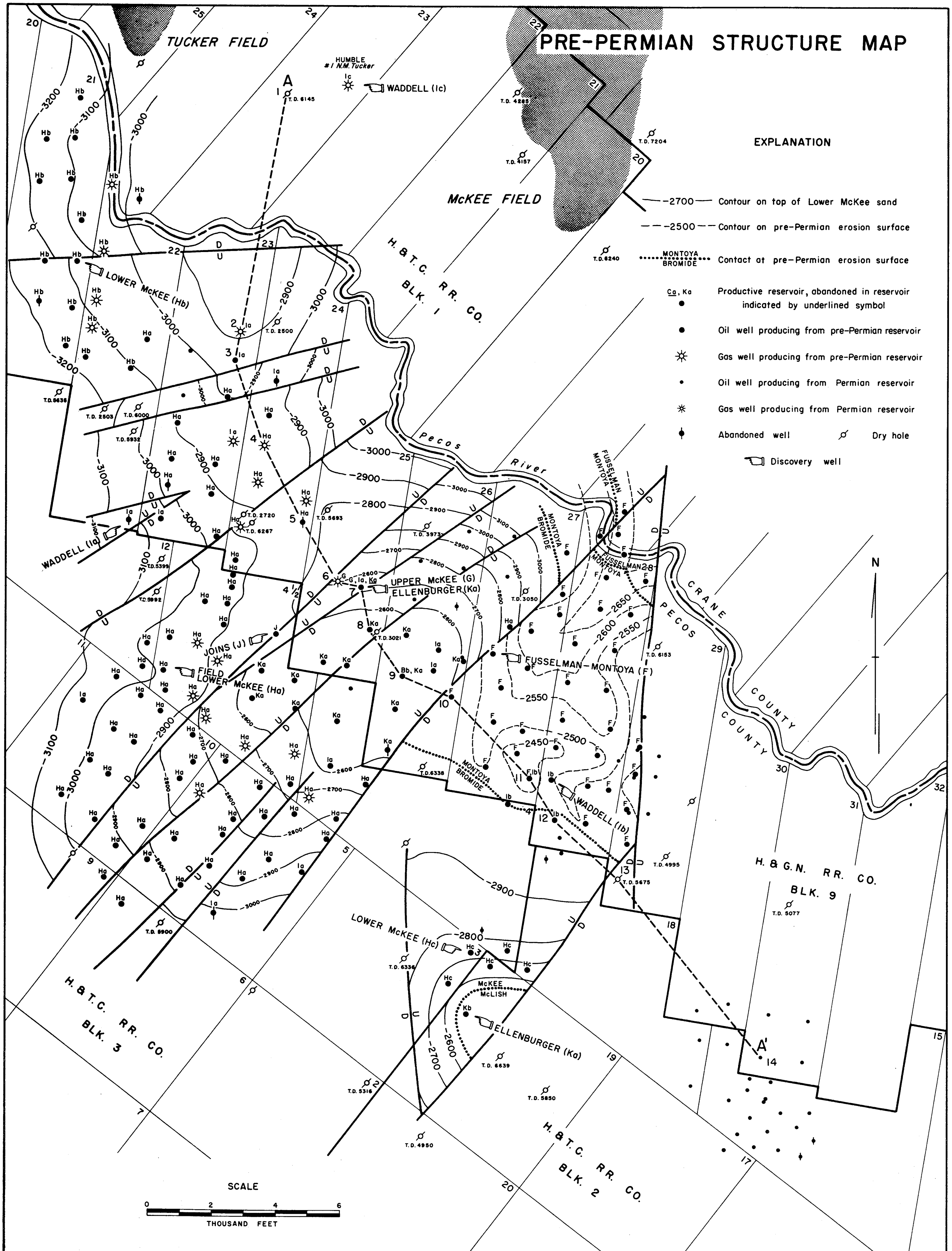
Cole, T., Cordry, C. D., and Hemphill, H. A. (1942) McKee and Waddell sands, Simpson group, West Texas: Amer. Assoc. Petr. Geol., Bull., vol. 26, pp. 279-282.

Cole, T., Dickey, R. I., and Kraus, E. (1941) Developments in West Texas and Southeastern New Mexico during 1940: Amer. Assoc. Petr. Geol., Bull., vol. 25, pp. 1056-1057.

Powers, Elliot H. (1940) Sand Hills area, Crane County, Texas: Amer. Assoc. Petr. Geol., Bull., vol. 24, pp. 119-133.

Stratigraphic Problems Committee of West Texas Geological Society (1951) North-South cross section through Permian Basin of West Texas; West Texas Geol. Soc.


PRE-PERMIAN PRODUCTIVE AREAS MAP
EXPLANATION
Oil well producing from pre-Permian reservoir
Gas well producing from pre-Permian reservoir
Oil well producing from Permian reservoir
Gas well producing from Permian reservoir
Abandoned well
Dry hole
PRODUCTIVE AREAS
Fusselman-Montoya (F)
Upper McKee (G)
Lower McKee (Ha, Hb and Hc)
Waddell (Ia, Ib and Ic)
Joins (J)
Ellenburger (Ka and Kb)
TUCKER FIELD
McKEE FIELD
HUMBLE
1 N.M. Tucker
WADDELL (Ic)
LOWER McKEE (Hb)
H. & T.C. RR. CO. BLK. 1
Pecos River
WADDELL (Ia)
LOWER McKEE (Ha) FIELD
JOINS (J)
G, Ia, Ka
UPPER McKEE (G)
ELLENBURGER (Ka)
FUSSELMAN-MONTOYA (F)
WADDELL (Ib)
CRANE COUNTY
PECOS COUNTY
H. & G.N. RR. CO. BLK. 9
LOWER McKEE (Hc)
ELLENBURGER (Kb)
H. & T.C. RR. CO. BLK. 3
H. & T.C. RR. CO. BLK. 2
N
SCALE
0 2 4 6
THOUSAND FEET


PRE-PERMIAN STRUCTURE MAP
EXPLANATION
—2700— Contour on top of Lower McKee sand
— —2500— — Contour on pre-Permian erosion surface
MONTOYA BROMIDE Contact at pre-Permian erosion surface
Ca, Ka Productive reservoir, abandoned in reservoir indicated by underlined symbol
Oil well producing from pre-Permian reservoir
Gas well producing from pre-Permian reservoir
Oil well producing from Permian reservoir
Gas well producing from Permian reservoir
Abandoned well
Dry hole
Discovery well
TUCKER FIELD
McKEE FIELD
HUMBLE #1 N.M. Tucker
WADDELL (Ic)
LOWER McKEE (Hb)
WADDELL (Ia)
UPPER McKEE (G)
ELLENBURGER (Ka)
JOINS (J)
FIELD
LOWER McKEE (Ha)
FUSSELMAN-MONTOYA (F)
WADDELL (Ib)
LOWER McKEE (Hc)
ELLENBURGER (Ka)
McKEE McLISH
FUSSELMAN MONTOYA
MONTOYA BROMIDE
Pecos River
CRANE PECOS
CRANE COUNTY
H. & T.C. RR. CO. BLK. 1
H. & T.C. RR. CO. BLK. 3
H. & T.C. RR. CO. BLK. 2
H. & G.N. RR. CO. BLK. 9
A
A'
N
SCALE
0 2 4 6
THOUSAND FEET

PRODUCTION HISTORY

Year	Wells Producing at end of year: Oil Flow.	Oil Pump.	Gas	Oil Production (barrels) Yearly	Oil Cumulative	Condensate Production (barrels) Yearly	Condensate Cumulative	Gas Production (Mcf @ 14.65# & 60° F.) Yearly	Gas Cumulative
Field totals:									
1940	1	0	0	5,650	5,650	0	0	0	0
1941	53	2	3	205,017	210,667	0	0	50,365	50,365
1942	91	10	6	813,762	1,024,429	0	0	95,360	145,725
1943	91	15	5	1,048,882	2,073,311	0	0	36,328	182,053
1944	99	18	4	1,284,903	3,358,214	0	0	44,878	226,931
1945	86	22	4	907,696	4,265,910	0	0	46,302	273,233
1946	81	18	3	808,080	5,073,990	641	641	87,822	361,055
1947	73	21	7	716,755	5,790,745	473	1,114	133,240	494,295
1948	71	26	11	813,688	6,604,433	1,796	2,910	432,509	926,804
1949	83	43	12	843,300	7,447,733	1,331	4,241	793,217	1,720,021
1950	103	34	9	1,801,603	9,249,336	1,972	6,213	373,704	2,093,725
1951	113	46	10	2,046,646	11,295,982	1,456	7,669	457,098	2,550,823
1952	111	56		1,546,894	12,842,876	2,025	9,694	490,811	3,041,634
San Andres:									
Abell 2200-foot Permian (Aa):									
Prior	Not segregated; included below in Abell Permian.								
1949	0	11		18,005+	18,005+				
1950	0	12		38,262	56,267+				
1951	0	12		34,525	90,792+				
1952	0	12		31,495	122,287+				
Abell North San Andres (Ab):									
1950	4	1		61,070	61,070				
1951	0	8		50,476	111,546				
1952	0	8		37,049	148,595				
Abell South San Andres (Ac):									
1950	1	0		1,531	1,531				
1951	0	3		22,143	23,674				
1952	0	2		12,214	35,888				
Glorieta:									
Abell 3800-foot Permian (Ba):	(2 oil wells): Not segregated; included below in Abell 3800-foot Permian.								
Abell Upper Permian (Bb):	The one well has produced from this reservoir as an oil well and also, at times, as a gas well.								
1947	1	0		943	943				
1948	1	0	?	1,527	2,470			9,589	9,589
1949	0	0	1	967	3,437			15,238	24,827
1950	0	0	1	1,128	4,565			0	24,827
1951	0	0	1	678	5,243	408	408	67,781	92,608
1952	0	1	0	111	5,354	241	649	19,965	112,573
Upper Clear Fork:									
Abell Clearfork (C):									
1950	1	0		2,307	2,307				
1951	1	0		1,152	3,459				
1952	1	0		2,774	6,233				
Lower Clear Fork:									
Abell Southeast Clearfork (Da):									
1951	0	1		1,199	1,199				
1952	0	1		281	1,480				

Abell 3800-foot Permian (Db): Not segregated; included below in Abell 3800-foot Permian.

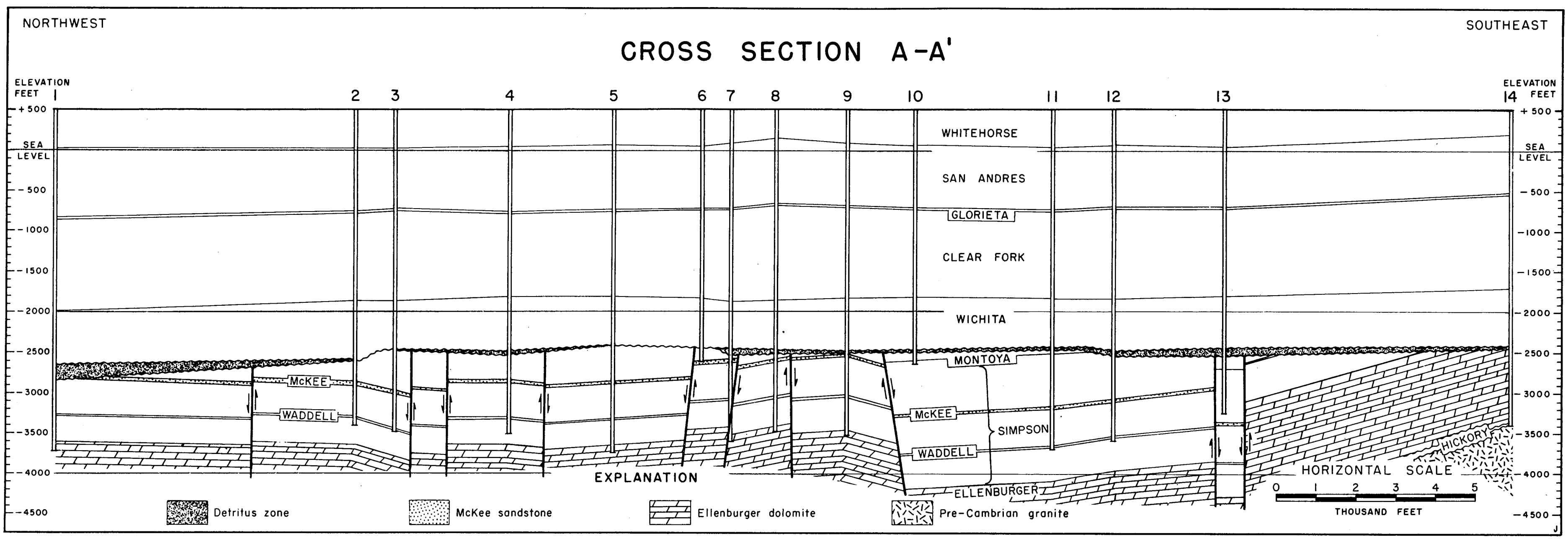
Year	Wells Producing at end of year: Oil Flow.	Oil Pump.	Gas	Oil Production (barrels) Yearly	Oil Cumulative	Condensate Production (barrels) Yearly	Condensate Cumulative	Gas Production (Mcf @ 14.65# & 60° F.) Yearly	Gas Cumulative
Wichita:									
Abell Byerley (E):									
1950	1	0		12,466	12,466				
1951	1	0		3,390	15,856				
1952	1	0		2,327	18,183				
Fusselman - Montoya:									
Abell Silurian-Montoya (F):									
1948	2	0		6,860	6,860				
1949	10	0		158,177	165,037				
1950	24	2		811,109	976,146				
1951	26	2		976,807	1,952,953				
1952	31	1		702,554	2,655,507				
Upper McKee:									
Abell Upper McKee (G):	Earlier production (one well) not segregated; included in Abell.								
1949	1	0	1	969	969	1,191	1,191	339,358	339,358
1950	1	0	1	949	1,918	1,660	2,851	240,383	579,741
1951	1	0	1	769	2,687	921	3,772	208,790	788,531
1952	1	0	1	675	3,362	1,481	5,253	230,170	1,018,701
Lower McKee:									
Abell (Ha):	Oil not segregated; gas and condensate not segregated prior to 1947; included in Abell.								
1947	?	?	5	?	?	0	?	54,046	54,046+
1948	?	?	7	?	?	1,474	1,474+	302,158	356,204+
1949	?	?	6	?	?	0	1,474+	346,412	702,616+
1950	?	?	4	?	?	13	1,487+	72,606	775,222+
1951	?	?	4	?	?	11	1,498+	73,677	848,899+
1952	?	?	6	?	?	14	1,512+	169,092	1,017,991+
Abell Northwest (Hb):									
1949	5	0		108,664	108,664				
1950	7	0		170,604	279,268				
1951	16	0		209,543	488,811				
1952	18	0		132,016	620,827				
Abell Southeast (Hc):									
1951	5	0		92,648	92,648				
1952	4	0		78,605	171,253				
Waddell:									
Abell (Ia, 7 areas) and (Ic):	Oil not segregated; gas and conds. not segregated prior to 1947; in Abell below.								
1947	?	?	2	?	?	473	473+	79,194	79,194+
1948	?	?	3	?	?	322	795+	120,762	199,956+
1949	?	?	4	?	?	140	935+	92,209	292,165+
1950	?	?	4	?	?	299	1,234+	60,715	352,880+
1951	?	?	4	?	?	116	1,350+	73,677	426,557+
1952	?	?	3	?	?	187	1,537+	71,584	498,141+
Abell East Waddell (Ib):									
1950	1	0		11,393	11,393				
1951	3	1		28,542	39,935				
1952	3	1		14,800	54,735				

Abell Humble-Tucker (Ic): (one gas well); Not segregated; included above with (Ia).

PRODUCTION HISTORY (Continued)

Year	Wells Producing at end of year: Oil Flow.	Oil Pump.	Gas	Oil Production (barrels): Yearly	Cumulative	Condensate Production (barrels): Yearly	Cumulative	Gas Production (Mcf@ 14.65# & 60°F.): Yearly	Cumulative
Joins: (J): (one well): Not segregated; included below in Abell.									
Ellenburger:									
Abell (Ka): Not segregated; included below in Abell.									
Abell South Ellenburger (Kb):									
1951	0	1		6,116	6,116				
1952	0	1		6,579	12,695				
NOT SEGREGATED IN ACCORDANCE WITH STRATIGRAPHIC POSITION:									
Abell Permian (includes Aa, Ba and Db prior to July 1, 1949.)									
1941	8	0		14,384	14,384				
1942	16	5		78,143	92,527				
1943	13	9		93,090	185,617				
1944	12	10		141,335	326,952				
1945	9	12		127,908	454,860				
1946	7	13		112,285	567,145				
1947	5	13		104,165	671,310				
1948	5	16		98,177	769,487				
1949	6	15		36,440	805,927				

Year	Wells Producing at end of year: Oil Flow.	Oil Pump.	Gas	Oil Production (barrels): Yearly	Cumulative	Condensate Production (barrels): Yearly	Cumulative	Gas Production (Mcf@ 14.65# & 60°F.): Yearly	Cumulative
NOT SEGREGATED IN ACCORDANCE WITH STRATIGRAPHIC POSITION: (Continued)									
Abell 3800-foot Permian (includes Ba and Db after July 1, 1949; prior thereto their production was reported in Abell Permian.)									
1949	6	4		18,001	18,001				
1950	6	3		36,402	54,403				
1951	6	4		37,148	91,551				
1952	6	4		31,389	122,940				
Abell (includes Ha, Ia, Ic, J and Ka except as to production reported above.)									
1940	1	0	0	5,650	5,650			0	0
1941	45	2	3	190,633	196,283			50,365	50,365
1942	75	5	6	735,619	931,902			95,360	145,725
1943	78	6	5	955,792	1,887,694			36,328	182,053
1944	77	8	4	1,143,568	3,031,262			44,878	226,931
1945	77	10	4	779,788	3,811,050			46,302	273,233
1946	74	5	3	695,795	4,506,845	641	641	87,822	361,055
1947	67	8	0	611,647	5,118,492				
1948	63	10	0	707,124	5,825,616				
1949	61	12	0	502,077	6,327,693				
1950	56	15	0	654,382	6,982,075				
1951	54	13	0	581,510	7,563,585				
1952	47	25		494,025	8,057,610				



ADAIR FIELD

Gaines and Terry Counties, Texas

FRANK L. GLAZE
Exploitation Geologist, Tide Water Associated Oil Co., Midland, Texas
November 14, 1953

LOCATION and OTHER NAME

The Adair field is in northeast Gaines County and south-central Terry County about 15 miles east of the town of Seagraves. During its early development, it was known as the East Seagraves field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Seismograph surveying and interpretation of subsurface data.

DISCOVERIES

San Andres: May 1, 1947; Amerada Petroleum Corp. #1 Sam Adair. Pumped at rate of 608 barrels of oil per day during initial potential test.

Wolfcamp reef: September 25, 1950; Amerada Petroleum Corp. #2 N.W. Willard. This well was the discovery well according to the rules of the Railroad Commission, since it was the first well to be completed. However, commercial production had been proven previously by Amerada #1 Willard. After flowing 144 barrels of oil in 4 hours on a drill stem test of this zone, the #1 Willard was drilled to a total depth of 12,465 feet. In the meantime, the #2 Willard was drilled and completed in the reef for a daily flow of 912 barrels of oil through a $\frac{1}{2}$-inch choke on 2-inch tubing in $5\frac{1}{2}$-inch casing set at 8,573 feet and perforated at 8,500 to 8,560 feet.

ELEVATION OF SURFACE

The average surface elevation is 3,190 feet above sea level. The surface is nearly flat. All elevations are within a very few feet of this average.

SURFACE FORMATION

Quaternary sand.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 95 feet below the base of the Woodford shale. The sample recovered from the bottom of the hole is believed by geologists of Midland Residue Research Laboratory, headed by Eugene W. Vanderpool, to be of the Montoya formation; other leading geologists consider the sample to be of the Devonian system. This penetration was in Amerada Petroleum Corp. #1 N.W. Willard, one of the two wells credited for discovery of commercial production in Wolfcamp reef, at its total depth of 12,465 feet (-9,230 feet).

NATURE OF TRAPS

San Andres: Anticlinal folding is dominant, but variation in porosity has also influenced accumulation.

Wolfcamp reef: Accumulation is limited to the higher portions of a reef mass which is surrounded by shale.

THICKNESSES OF RESERVOIR ROCKS

	San Andres	Wolfcamp
Average net productive, feet	60	80

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomite; anhydritic, buff to gray, finely crystalline to crystalline; scattered intercrystalline, pinpoint and fracture porosity.

Wolfcamp reef: Reef limestone; dolomitic, buff to light greenish-gray, dense, finely crystalline to chalky, fossiliferous; vuggy, intercrystalline, fracture and solution types of porosity; occasional shale partings.

CONTINUITY OF RESERVOIR ROCKS

San Andres: The stratigraphic unit which is productive is continuous throughout the area of the field. Effective porosity is continuous throughout the field, with the top of the porous zone stratigraphically lower southward.

Wolfcamp reef: The productive zone is at the apex of a reef. It is continuous within the presently productive area but probably not far beyond. There are other reefs of about the same age in the general region, but conditions favorable for migration of fluids are not continuous between the several reefs.

WATER PRODUCTION

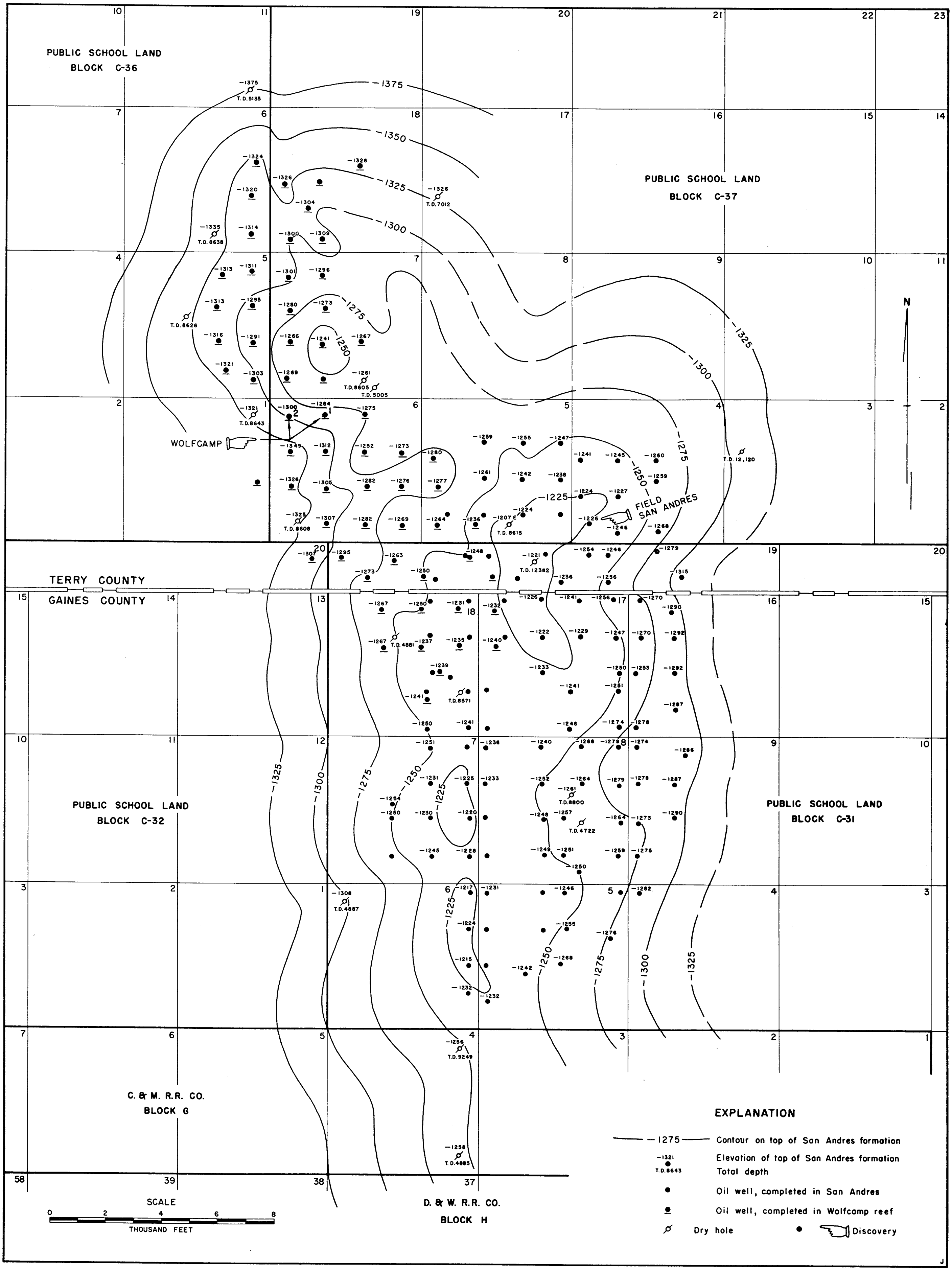
San Andres: No recent water report is available. On May 1, 1952, 98 of the 114 producing wells were making 2% or more water and each of the others was making about 1% water.

Wolfcamp reef: Data are not available.

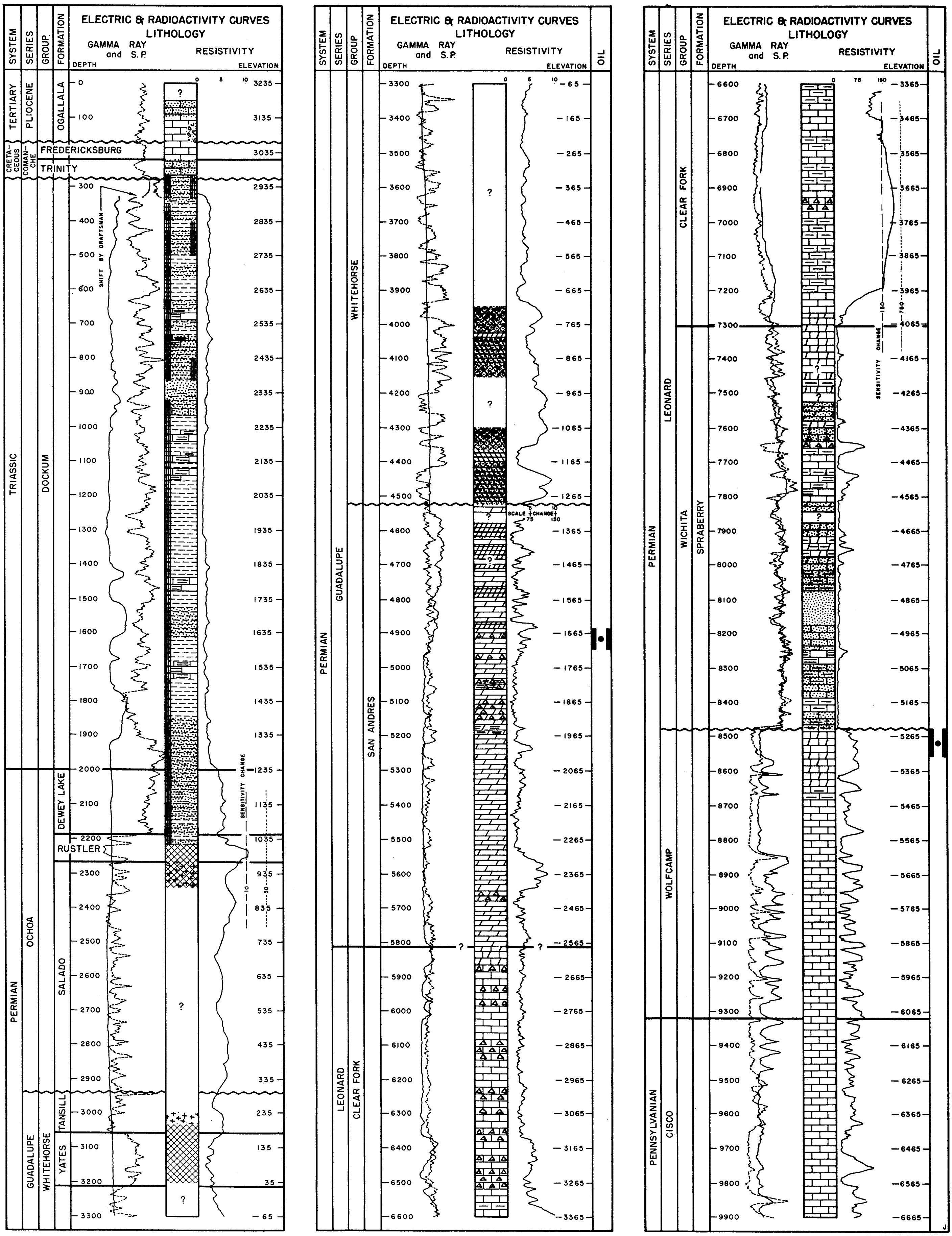
ACID TREATMENT

San Andres: It is customary to treat each well before completion; usually with 5,000 to 12,000 gallons of acid.

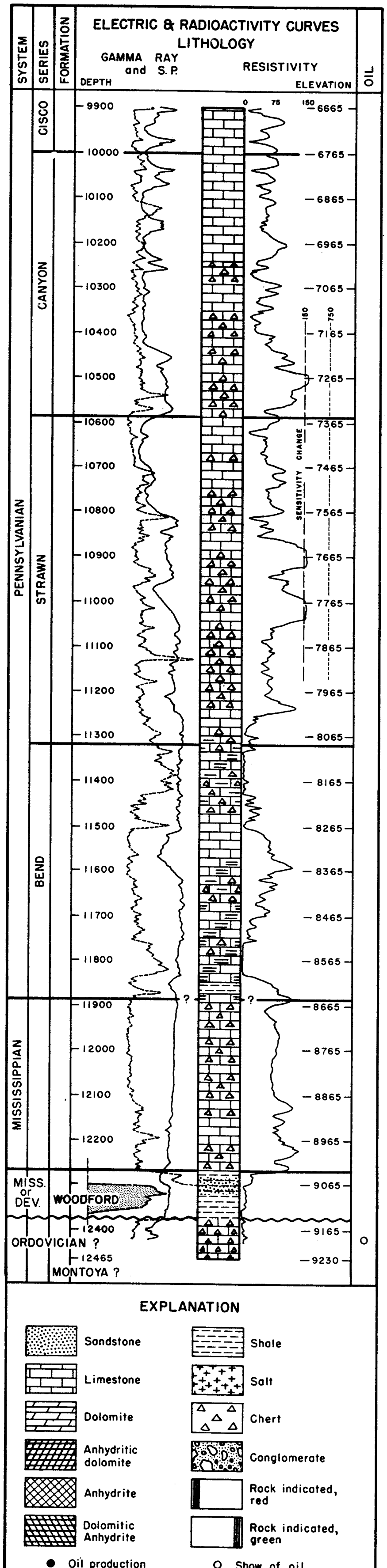
Wolfcamp reef: It is customary to treat each well before completion; usually with about 500 gallons of mud acid.


PUBLIC SCHOOL LAND
BLOCK C-36
PUBLIC SCHOOL LAND
BLOCK C-37
WOLFCAMP
FIELD
SAN ANDRES
TERRY COUNTY
GAINES COUNTY
PUBLIC SCHOOL LAND
BLOCK C-32
PUBLIC SCHOOL LAND
BLOCK C-31
C. & M. R.R. CO.
BLOCK G
D. & W. R.R. CO.
BLOCK H
N
SCALE
0 2 4 6 8
THOUSAND FEET
EXPLANATION
—1275— Contour on top of San Andres formation
-1321 Elevation of top of San Andres formation
T.D.8643 Total depth
Oil well, completed in San Andres
Oil well, completed in Wolfcamp reef
Dry hole
Discovery

TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED



ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Feet
San Andres:	
Elevation of top of oil	-1,549
Elevation of bottom of oil	Between -1,675 and -1,700
Relief	Between 126 and 151
Wolfcamp reef:	
Elevation of top of oil	-5,126
Elevation of bottom of oil	-5,340
Relief	214

PRODUCTIVE AREAS

	Acres
San Andres	4,583
Wolfcamp reef	2,560
Adair field	6,543

CHARACTER OF OIL

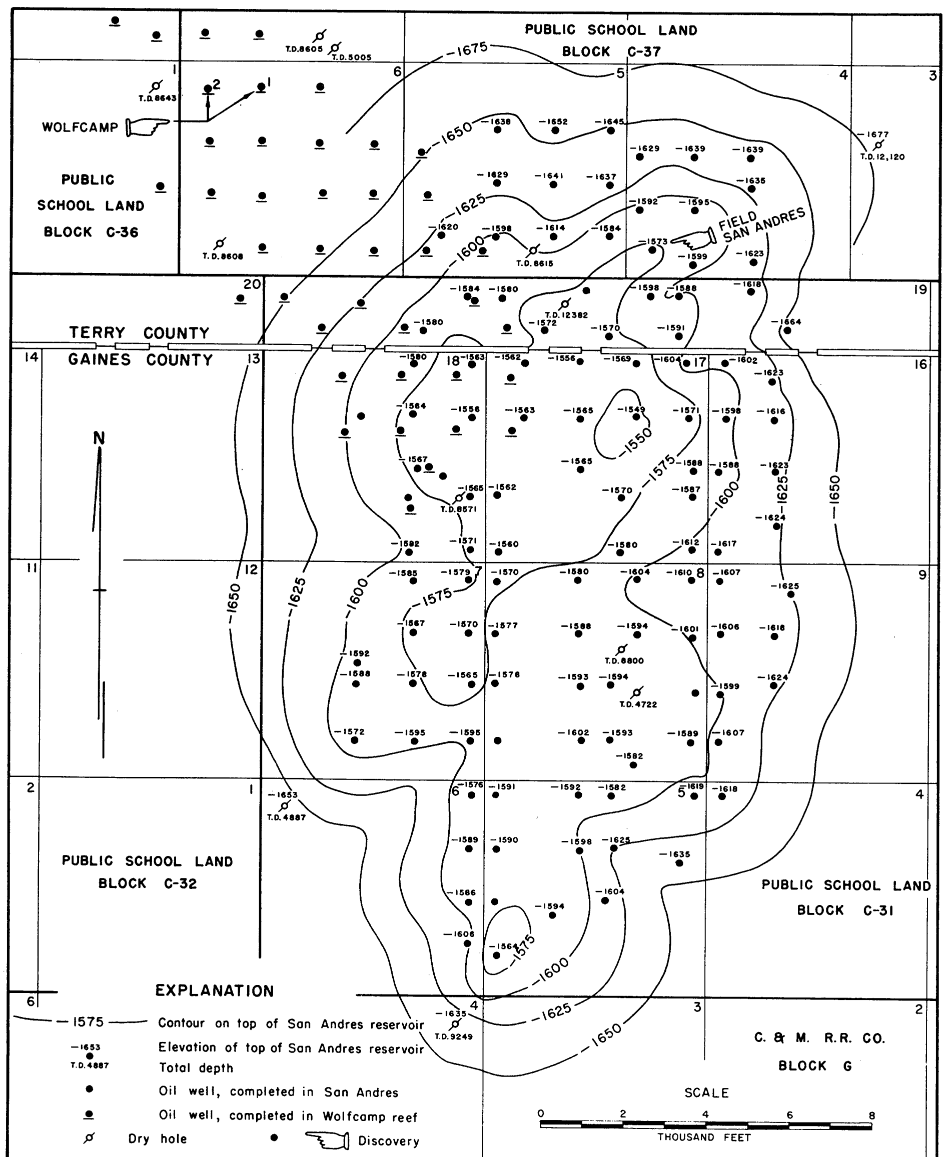
	San Andres	Wolfcamp reef
Gravity, A.P.I. @ 60° F.		
Range	28.7 - 34	?
Average	33.3	44
Sulphur	2.04%	0.4%
Base	Paraffin	?
Color	Green-black	?

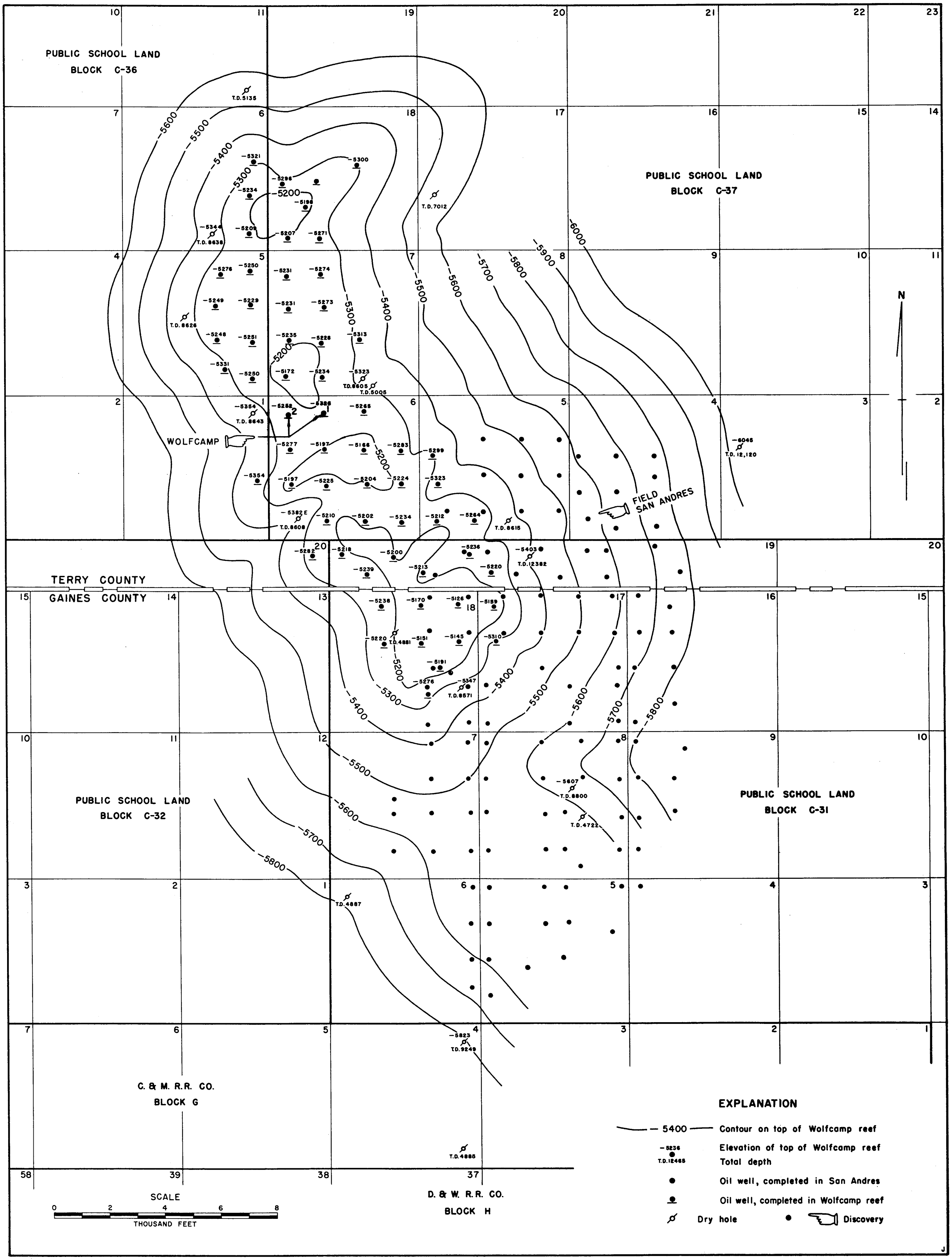
For analysis of San Andres oil see:
U. S. Bureau of Mines — Lab. ref. No. 51052
Analyses of Crude Oil from Some West Texas Fields R.I. 4959 (1953) — Item 6

PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Pumping	Oil production (barrels): Yearly	Cumulative
Field totals				
1947	0	40	156,886	156,886
1948	0	86	894,849	1,051,735
1949	0	110	882,094	1,933,829
1950	8	114	1,009,483	2,943,312
1951	33	115	1,859,064	4,802,376
1952	16	162	2,689,113	7,491,489
1953*	11	159	2,866,725	10,358,214
San Andres				
1947	0	40	156,886	156,886
1948	0	86	894,849	1,051,735
1949	0	110	882,094	1,933,829
1950	0	114	945,079	2,878,908
1951	0	115	1,050,262	3,929,170
1952	0	114	904,319	4,833,489
1953*	0	108	838,991	5,672,480
Wolfcamp reef				
1950	8	0	64,404	64,404
1951	33	0	808,802	873,206
1952	16	48	1,784,794	2,658,000
1953*	11	51	2,027,734	4,685,734

*1953 data added by amendment.




PUBLIC SCHOOL LAND
BLOCK C-36
PUBLIC SCHOOL LAND
BLOCK C-37
PUBLIC SCHOOL LAND
BLOCK C-32
PUBLIC SCHOOL LAND
BLOCK C-31
C. & M. R.R. CO.
BLOCK G
D. & W. R.R. CO.
BLOCK H
TERRY COUNTY
GAINES COUNTY
WOLFCAMP
SAN ANDRES FIELD
N
SCALE
0 2 4 6 8
THOUSAND FEET
EXPLANATION
5400 Contour on top of Wolfcamp reef
-5236 Elevation of top of Wolfcamp reef
T.D.12465 Total depth
Oil well, completed in San Andres
Oil well, completed in Wolfcamp reef
Dry hole
Discovery

ADDIS-JOHNSON-FOSTER-SOUTH COWDEN FIELD

Ector County, Texas

ADDISON YOUNG and J. C. VAUGHN
Geologists, Phillips Petroleum Company, Midland, Texas
January 1, 1954

LOCATION and FIELD NAMES

The Addis - Johnson - Foster - South Cowden field is in eastern Ector County, its eastern edge almost reaching the western outskirts of the city of Odessa. It is on the eastern edge of the Central Basin platform.

The field became a single productive area by coalescence of three separate productive areas, viz., Johnson, Foster and South Cowden, which three areas are still treated by the Railroad Commission as separate fields. The area around the location of the first discovery well was originally called the Addis field, but the name Addis was superseded by the name South Cowden. Later, when pre-Permian production was discovered near the first discovery well (Queen-Grayburg), the name Addis was revived and applied to Cisco and Strawn reservoirs. More recently, the name Addis has been applied also to San Andres and Wolfcamp discoveries. The name Addis is now applied to reservoirs at four stratigraphic positions and each of the names Johnson, Foster and South Cowden is applied to a definite, arbitrary portion of the Queen-Grayburg productive area.

The location of the well which prompted the designation of Douro field is indicated on the accompanying STRAWN MAP near its southern boundary. That well, Forest Development Corp. #1 W. L. Bradley et al seemed to be a commercial well at time of completion on October 8, 1940, with the result that the name Douro appears as a field name in several publications. The only marketed production of oil before abandonment in 1941 was 388 barrels in 1940 and 198 barrels in 1941. Data relative to this well are presented on pages 1050 and 1051, A.A.P.G. Bull. vol. 25 (1941).

METHODS OF EXPLORATION LEADING TO DISCOVERY

The first discovery (Queen-Grayburg) was based principally on refraction shooting by the Southern Crude Oil Purchasing Co. (predecessor of Stanolind Oil & Gas Co.). The later Queen-Grayburg discoveries were the result of subsurface geological studies.

DISCOVERIES

Queen-Grayburg:
- South Cowden (first called Addis): May 10, 1933;
  - L. C. Harrison et al #1 F. V. Addis
- Johnson: January 3, 1935;
  - Landreth Production Corp. #1-A J. L. Johnson
- Foster: January 30, 1936;
  - Barnsdall Oil Co. and York & Harper #1 H. C. Foster

San Andres: March 27, 1953;
- Cities Production Corp. and Union Oil Co. of Calif. #1-E John Cross

Wolfcamp: June 14, 1953;
- Cities Production Corp. and Union Oil Co. of Calif. #1-C John Cross

Cisco: February 27, 1947;
- Stanolind Oil & Gas Co. #1 Eva B. Kayser

Strawn: July 22, 1948;
- Stanolind Oil & Gas Co. #1-D E. F. Cowden

ELEVATION OF SURFACE

Derrick floor elevations: Highest, 3,059 feet; lowest, 2,884 feet.

SURFACE FORMATIONS

Throughout most of the field, the surface formation is a basal sandstone of upper Trinity age. In the southwestern part of the field, limestone of Fredericksburg age crops out. A veneer of windblown sand masks much of the surface.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 340 feet below the top of the Ellenburger group. This penetration was by Stanolind Oil & Gas Co. #2-D E. F. Cowden, at its total depth of 13,593 feet. This well is in Sec. 40, Blk. 43, T. 2 S., T. & P. R.R. survey, at the location indicated on the accompanying map.

PRODUCTIVE AREAS

	Acres
Queen-Grayburg	30,960
San Andres	80
Wolfcamp	40
Cisco	40
Strawn	80
Field	31,200

CONTINUITY OF RESERVOIR ROCKS

Queen-Grayburg: The Grayburg formation is everywhere present throughout the Central Basin platform and far beyond. However, productive porosity within the Grayburg on the platform is limited to a belt along the east flank of the platform. This field is one distinct unit on this regional porosity trend. To the north, the productive area is practically continuous with North Cowden. To the east and south, the limits are determined by structural position. To the west, the porosity diminishes to the point of non-profitable operations.

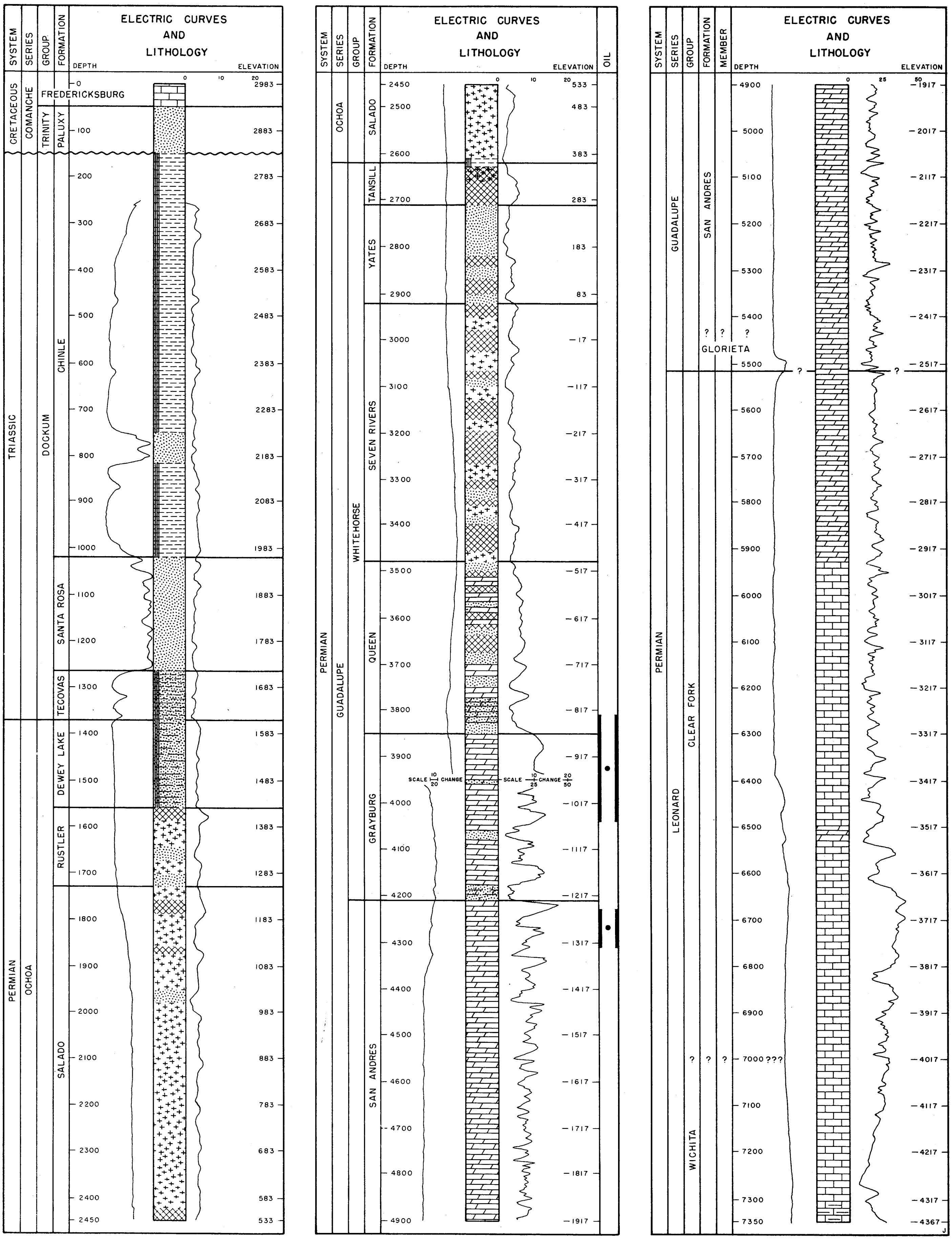
San Andres: The San Andres formation is even more widespread than the Grayburg formation, and the San Andres reservoir in this field is one of several occurrences of productive porosity in the uppermost San Andres of the eastern half of the Central Basin platform in Ector and adjoining counties.

Wolfcamp: The lower Wolfcamp is highly variable in both thickness and character on the Central Basin platform. The reservoir rock in the Wolfcamp in this field can be traced laterally only a short distance.

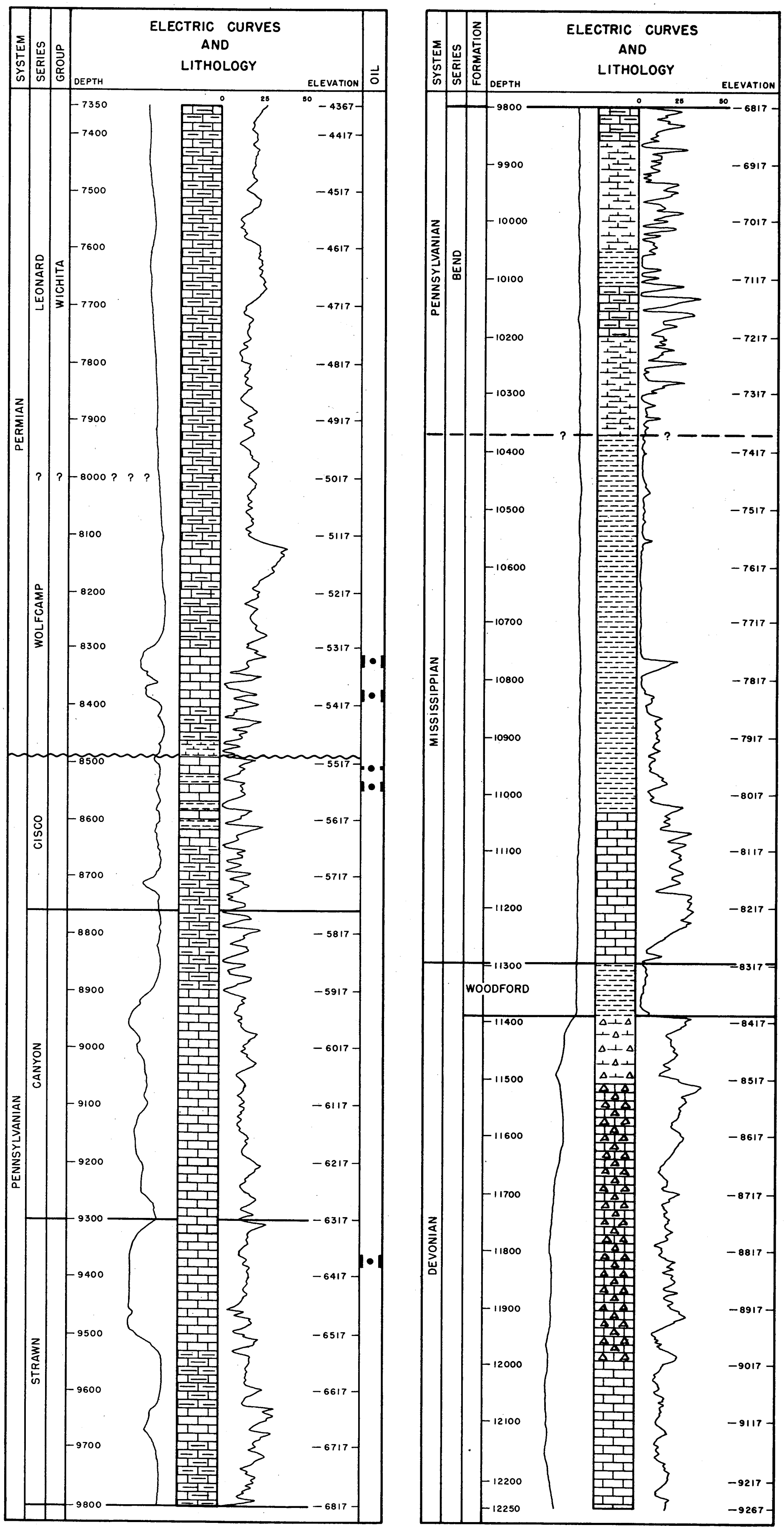
Cisco: The thin limestone beds which produce in the one well appear to be terminated by post-Cisco erosion and overlapped by Wolfcamp beds in the structurally higher portion of the field.

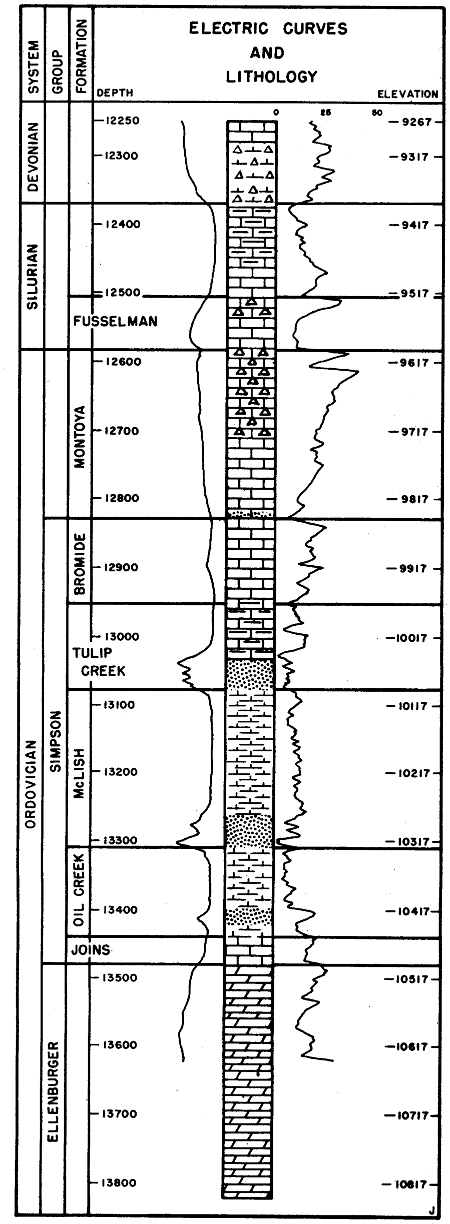
Strawn: Rocks of Strawn age are generally present along the east flank of the Central Basin platform, but rapid facies changes make it impossible confidently to trace this one thin producing bed beyond the two producing wells.

TYPICAL SECTION OF ROCKS PENETRATED

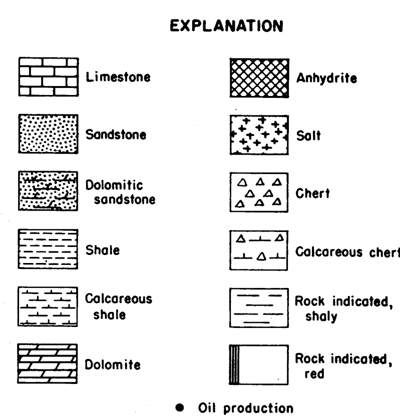


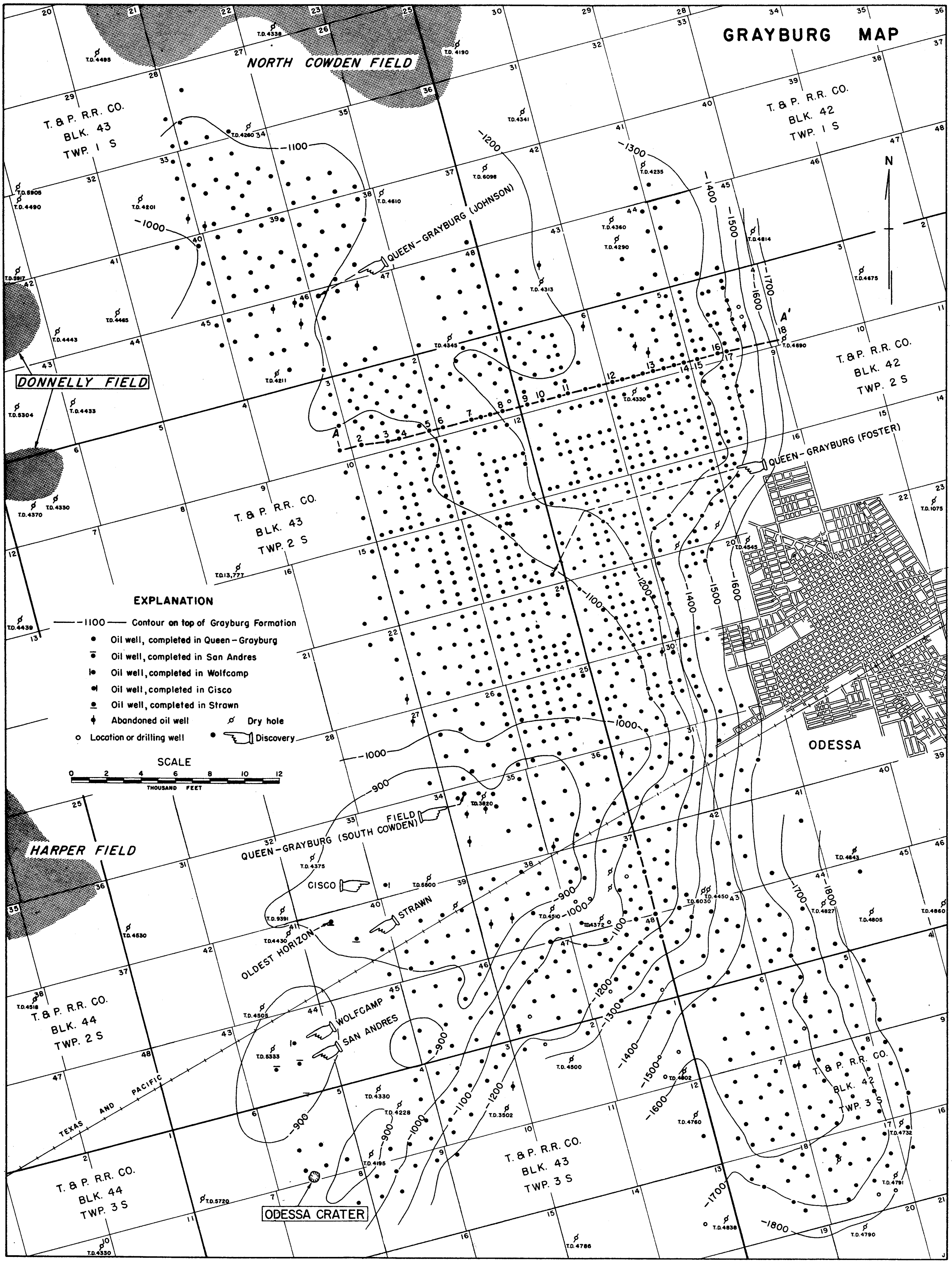
TYPICAL SECTION OF ROCKS PENETRATED

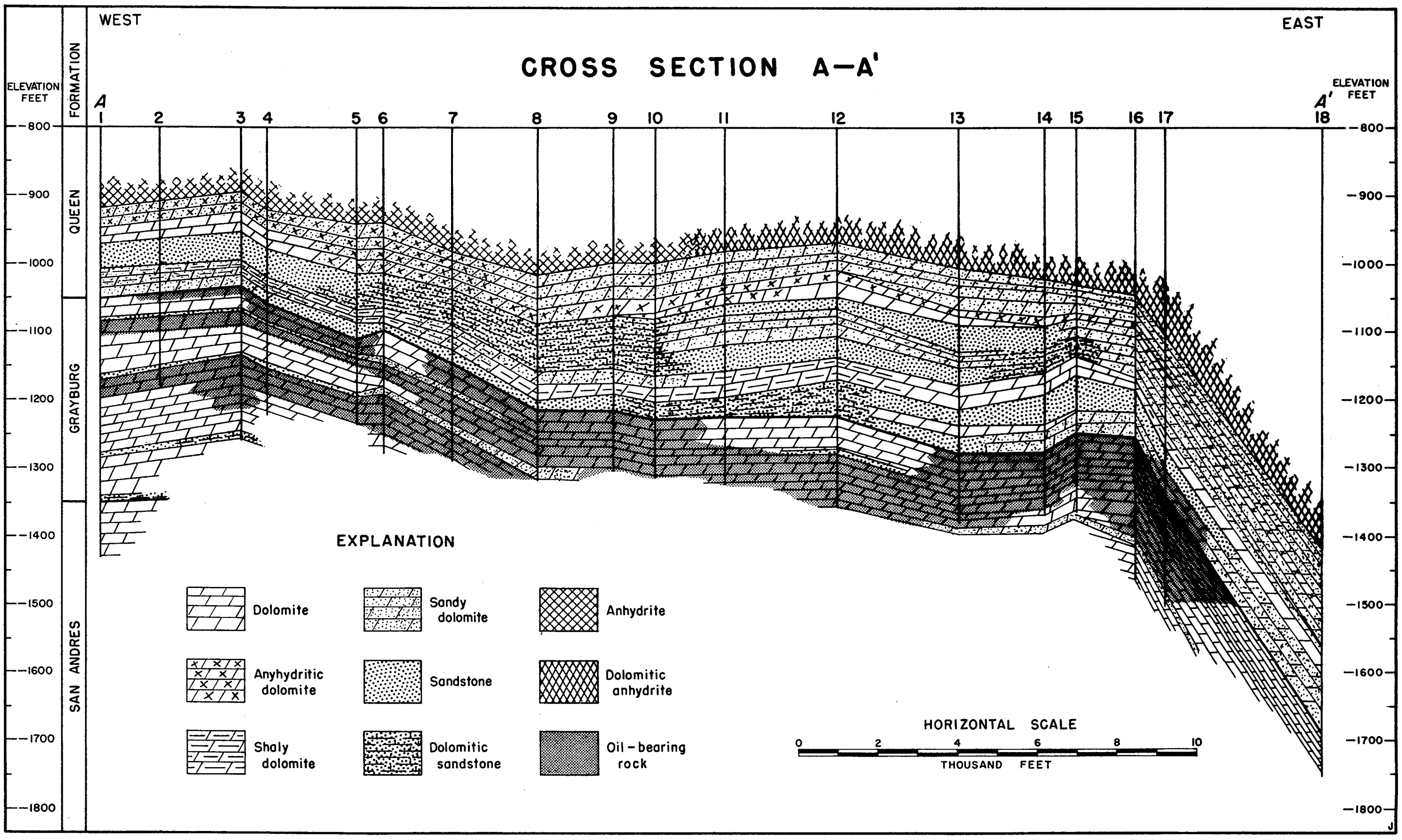


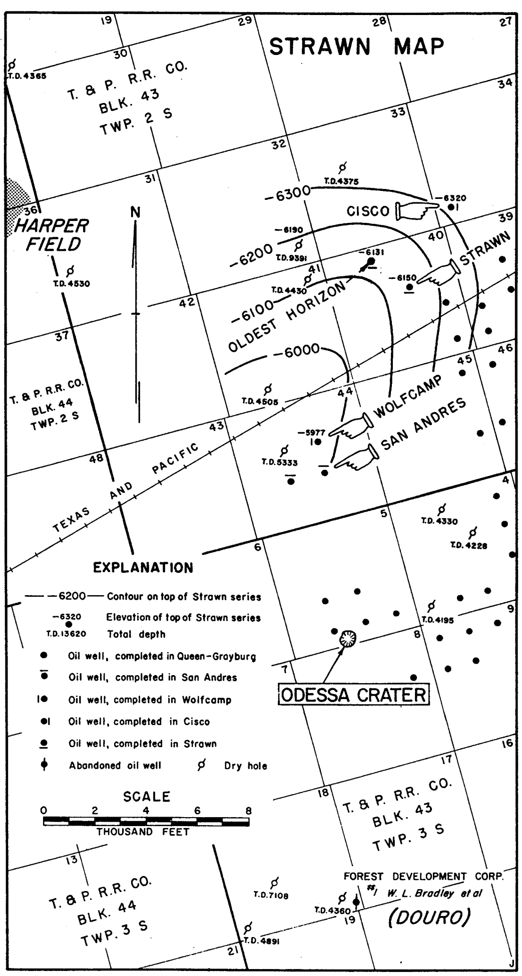


NOTE: The above TYPICAL SECTION is based on the log of Stanolind #1 Kayser, the Cisco discovery well, to its total depth of 13,620 feet and, below that, with depths and elevations adjusted, on the log of Stanolind #2-D Cowden, where the oldest horizon was penetrated.




GRAYBURG MAP
NORTH COWDEN FIELD
DONNELLY FIELD
HARPER FIELD
ODESSA
ODESSA CRATER
T. & P. R.R. CO. BLK. 43 TWP. 1 S
T. & P. R.R. CO. BLK. 42 TWP. 1 S
T. & P. R.R. CO. BLK. 42 TWP. 2 S
T. & P. R.R. CO. BLK. 43 TWP. 2 S
T. & P. R.R. CO. BLK. 44 TWP. 2 S
T. & P. R.R. CO. BLK. 42 TWP. 3 S
T. & P. R.R. CO. BLK. 43 TWP. 3 S
T. & P. R.R. CO. BLK. 44 TWP. 3 S
QUEEN-GRAYBURG (JOHNSON)
QUEEN-GRAYBURG (FOSTER)
QUEEN-GRAYBURG (SOUTH COWDEN) FIELD
CISCO
STRAWN
OLDEST HORIZON
WOLFCAMP
SAN ANDRES
TEXAS AND PACIFIC
EXPLANATION
-1100- Contour on top of Grayburg Formation
Oil well, completed in Queen-Grayburg
Oil well, completed in San Andres
Oil well, completed in Wolfcamp
Oil well, completed in Cisco
Oil well, completed in Strawn
Abandoned oil well
Dry hole
Location or drilling well
Discovery
SCALE
0 2 4 6 8 10 12
THOUSAND FEET
N
A
A'





THICKNESSES OF RESERVOIR ROCKS

	Feet Min.	Feet Max.	Feet Avg.
Queen-Grayburg:			
From top to bottom	10	260	95
Net productive	10	200	70
San Andres: (2 wells)			
From top to bottom	65	65	65
Net productive	40	40	40
Wolfcamp: (1 well)			
From top to bottom	110	110	110
Net productive	40	40	40
Cisco: (1 well)			
From top to bottom	50	50	50
Net productive	20	20	20
Strawn: (2 wells)			
From top to bottom	20	20	20
Net productive	20	20	20

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation of oil, feet Top	Elevation of oil, feet Bottom	Known relief
Queen-Grayburg*	-900	-1,170 to 1,850±	*
San Andres (2 wells)	-1,199	-1,264	65
Wolfcamp (1 well)	-5,167	-5,277	110
Cisco (1 well)	-5,517	-5,567	50
Strawn (2 wells)	-6,190	-6,216	26

*Queen-Grayburg: Elevation of top of gas, -794 ft.; elevation of bottom of gas, -900 ft.; relief of gas column, 106 ft. The water table is not horizontal. Water has been found at various elevations up to as high as -1,170 feet and oil has been found as low as about -1,850 feet, but it is unlikely that there is a continuous oil-water contact through such range of elevation. The base of the oil corresponds roughly to structure.

CHARACTER OF OIL

	Queen-Grayburg*	San Andres	Wolfcamp	Cisco	Strawn
Gravity, A.P.I. @ 60° F.	33° - 36.4°	32.8°	34.4°	33°	39° - 41°

*Queen-Grayburg: Color, greenish black; sulphur, 1.07 - 1.38%; viscosity, Saybolt universal @ 100° F., 41 - 46 sec.; base, intermediate. For analyses see:

		Foster		Johnson	South Cowden
Railroad Commission of Texas					
Analyses of Texas Crude Oils (1940), pp.		32 and 63		33 and 64	
U. S. Bureau of Mines	Lab. ref. No.	40009	41240		34004
Tabulated Analyses of Texas Crude Oils T. P. 607 (1939)	Item				1, Group 2
Analyses of Crude Oils from Some Fields of Texas. R. I. 3699 (1943)	Item	34	35		
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944)	Page	10	11		
Analyses of Crude Oils from 283 Important Oil Fields of the United States R. I. 4289 (1948)	Item	204			198

METEOR CRATER

The meteor crater known as the Odessa crater is at the southwest tip of the field at the location indicated on the accompanying map.

NATURE OF TRAPS

Queen-Grayburg: The trap is due to westward diminution and disappearance of porosity throughout a broad area on the east flank of the Central Basin platform. On the east side of the field, porosity is continuous from top to bottom of the productive zone; but westward this zone grades into a sequence of porous members separated by impervious members. Traced farther westward these porous members become progressively thinner and ultimately grade into impervious dolomite.

San Andres: Oil is trapped in a small dome of low relief.

Wolfcamp: Meager data indicate that the trap is an anticline.

Cisco: The trap is due to updip loss of porosity in a thin limestone reservoir on a structural nose.

Strawn: Meager data indicate that oil is trapped on the northeast plunge of an anticline and that updip loss of porosity may be an important factor.

LITHOLOGY OF RESERVOIR ROCKS

Queen-Grayburg: This reservoir rock is mainly a brown dolomite, in part finely crystalline, in part aphanitic. Oolites are common. Particularly in the northwestern part of the field, a few thin beds of fine-grained sandstone and fine sandy dolomite are interbedded in the main dolomite mass. Porosity in the dolomite occurs as an interconnected system of fine pores with average diameter of less than a millimeter. In general, the sandy beds are non-porous but in places a basal Queen sandstone yields some oil.

San Andres: The reservoir rock is a light gray, very finely crystalline dolomite. Porosity, which is interstitial and of fine size, occurs in thin zones alternating with impervious layers.

Wolfcamp: The upper member of this reservoir rock is a thin fragmental limestone. The lower member is a slightly sandy dolomite, very finely crystalline, with fine, interstitial porosity. The producing strata are interbedded with non-porous limestones and green shales.

Cisco: The reservoir rock is a light gray to light brown limestone, very finely crystalline to aphanitic, interbedded with gray-green shale beds. Porosity is furnished by pores of fine size.

Strawn: The reservoir rock is a light brown limestone, aphanitic to finely fragmental. Porosity occurs as fine-size pores, generally less than 0.5 millimeter in diameter.

COMPLETION TREATMENTS

Queen-Grayburg: Most of the wells were completed with the aid of nitroglycerin. The normal quantity was 400 to 500 quarts. A few wells were completed "natural". Before 1950, only a very few wells were acidized. Most of the later wells in the southwest extension were acidized with an average quantity of about 10,000 gallons. Within the past year, some of the old wells have been helped by hydraulic fracture treatments.

San Andres: The two wells were completed "natural".

Wolfcamp: The lone well was acidized with 2,500 gallons.

Cisco: The single producer was acidized with a total of 15,000 gallons.

Strawn: Each of the two wells was acidized with 500 to 1,500 gallons.

WATER PRODUCTION

Queen-Grayburg: Some water is produced by each of about 30% of the wells. Total water amounts to a quantity nearly equal to 30% of the total amount of oil. Most of the water production is along the east flank.

San Andres, Wolfcamp, Cisco and Strawn: No water is produced.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Queen-Grayburg				
1933	6	0	109,987	109,987
1934	10	2	190,034	300,021
1935	13	4	238,503	538,524
1936	8	15	249,134	787,658
1937	28	62	958,381	1,746,039
1938	106	114	1,935,897	3,681,936
1939	220	174	3,017,298	6,699,234
1940	351	294	4,048,971	10,748,205
1941	478	311	5,843,949	16,592,154
1942	464	348	3,552,348	20,144,502
1943	422	408	4,366,365	24,510,867
1944	368	468	9,044,325	33,555,192
1945	301	550	8,824,737	42,379,929
1946	250	629	8,509,051	50,888,980
1947	175	729	9,055,691	59,944,671
1948	134	856	10,302,268	70,246,939
1949	165	909	9,093,291	79,340,230
1950	76	1,021	8,858,989	88,199,219
1951	76	1,033	8,932,115	97,131,334
1952	63	1,060	8,122,786	105,254,120
1953	53	1,073	7,438,592	112,692,712
San Andres				
1953	0	2	27,427	27,427
Wolfcamp				
1953	0	1	12,204	12,204
Cisco				
1947	0	1	6,902	6,902
1948	0	1	4,656	11,558
1949	0	1	3,746	15,304
1950	0	1	3,294	18,598
1951	0	1	2,905	21,503
1952	0	1	2,569	24,072
1953	0	1	2,400	26,472
Strawn				
1948	1	0	11,078	11,078
1949	2	0	34,841	45,919
1950	0	2	42,879	88,798
1951	0	2	49,196	137,994
1952	0	2	35,939	173,933
1953	0	2	30,727	204,660

APCO FIELD

Pecos County, Texas

SAMUEL P. ELLISON, Jr.
Professor of Geology, The University of Texas, Austin, Texas
September 9, 1955

LOCATION and INTRODUCTION

The Apco field is in north-central Pecos County about 25 miles northeast of Fort Stockton, county seat. It is on the Central Basin platform near its southwestern edge.

The Apco field includes 6 fields as designated by the Railroad Commission of Texas; those designations are entered alphabetically as column headings in the following tabulation. There are 10 reservoirs in 6 named stratigraphic units, which units are listed below in stratigraphic order. The approximate stratigraphic positions of the productive reservoirs in the respective Commission units are indicated by entry of letters which serve also to designate the reservoirs in following entries in this paper. The stratigraphic positions of the several reservoirs are indicated more definitely on the accompanying TYPICAL SECTION. Oil is now being produced from 8 distinct reservoirs; production from two others, San Andres (De) and Clear Fork (Ed) has been abandoned.

STRATIGRAPHIC POSITION \ COMMISSION DESIGNATION	Apco-Warner	Fromme	Masterson	Masterson (3500')	Shearer	Shearer (1700')
Seven Rivers		Ab	Ac		Ae	
Queen		Bb	Bc		Be	
Grayburg						Cf
San Andres					De	
Clear Fork				Ed		
Ellenburger	Fa					

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of surface and subsurface geology led to the drilling of the well which discovered the field.

ELEVATION OF SURFACE

At well locations: Highest, 2,440 ft.; lowest, 2,390 ft.

DISCOVERIES

Seven Rivers:
- Fromme (Ab): April 15, 1939; Culbertson & Irwin, Inc. #1 Ed Fromme.
- Masterson (Ac) and Field: December 16, 1929; Cranfill-Reynolds Co. #1 J.S.Masterson (later, General Crude Oil Co. #1 J.S.Masterson). Completed for production from reservoir in Queen formation also.
- Shearer (Ae): June 18, 1938; W.H.Street #1 W.T. Shearer (now, Burk Royalty Co. #1 Shearer "B"). Completed for production from reservoir in Queen formation also.

Queen:
- Fromme (Bb): August 19, 1939; Cordova Union Oil Corp. #2 Fee (now, Goal Tullous & Co. #2-E Cordova Union).
- Masterson (Bc) and Field: December 16, 1929; Cranfill-Reynolds Co. #1 J.S.Masterson. Completed for production from reservoir in Seven Rivers formation also. See above.
- Shearer (Be): June 18, 1938; W.H.Street #1 W. T. Shearer. Completed for production from reservoir in Seven Rivers formation also. See above.

Grayburg:
- Shearer (1700') (Cf): April 27, 1949; Childress Royalty Co. #3 J.S.Masterson. This well had been producing from a shallower reservoir and was deepened.

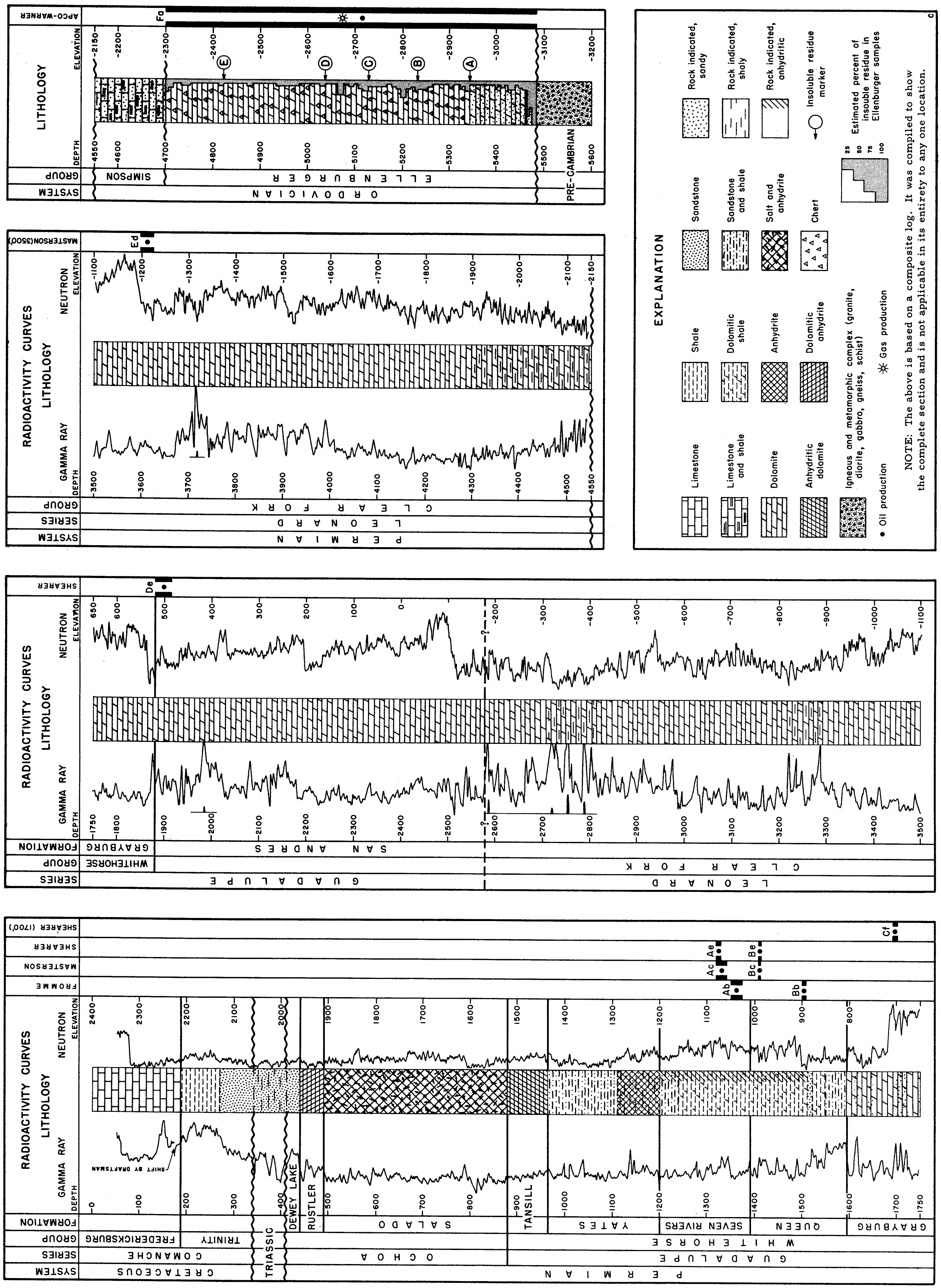
San Andres:
- Shearer (De): November 11, 1940; George Davis & M.L.White #1 Ed Fromme (now abandoned).

Clear Fork:
- Masterson (3500') (Ed): April 13, 1943; Magnolia Petroleum Co. #1 State-Powell Sec. 96 (now abandoned).

Ellenburger:
- Apco-Warner (Fa): June 1, 1939; Anderson-Prichard Oil Corporation and Monte Warner #1 J.S.Masterson.

SURFACE FORMATIONS

Recent and earlier Quaternary alluvium and gravel on terraces of the Pecos River and its tributaries.



TYPICAL SECTION OF ROCKS PENETRATED

OLDEST HORIZON PENETRATED

The oldest horizon penetrated is in the pre-Cambrian complex. Sixteen wells have been drilled into the pre-Cambrian complex, which consists of granite, gabbro, schist and gneiss.

NATURE OF TRAPS

All reservoirs in Seven Rivers, Queen and Grayburg formations: Convex folding.

San Andres (De) and Clear Fork (Ed): Updip decrease of porosity in a sloping reservoir rock.

Ellenburger (Fa): Updip termination of reservoir rock by truncation and with sealing by relatively impervious rock.

PRODUCTIVE AREAS

	Acres
Fromme (Ab) and (Bb)	250
Masterson (Ac) and (Bc)	120
Shearer (Ae), (Be) and (De)	270
Grayburg (Cf)	30
Clear Fork (Ed) (depleted)	40
Ellenburger (Fa)	1,960
Apco field	2,455

THICKNESSES OF RESERVOIR ROCKS

From top to bottom, average, approx.	Feet
Seven Rivers:	
Fromme (Ab)	24
Masterson (Ac)	21
Shearer (Ae)	10
Queen:	
Fromme (Bb)	8
Masterson (Bc)	4
Shearer (Be)	6
Grayburg:	
Shearer (1700') (Cf)	12
San Andres:	
Shearer (De)	35
Clear Fork:	
Masterson (3500') (Ed)	29
Ellenburger:	
Apco-Warner (Fa)	775

The oil-producing rock throughout the Apco-Warner productive area is generally only a small portion of the total reservoir rock. In the eastern part of the productive area, the upper portion of the reservoir rock is absent due to truncation, and, in the western part, the lower portion is below the oil-water contact.

LITHOLOGY OF RESERVOIR ROCKS

All reservoirs in Seven Rivers, Queen, Grayburg and San Andres formations: Silty sandstone and dolomite.

Clear Fork (Ed): Dolomite with relatively high porosity.

Ellenburger (Fa): Dolomite; weathered, cherty, relatively high porosity. From a study of insoluble residues, the writer has been able to distinguish five stratigraphic positions which are usable for correlating from well to well within the field. These are indicated on the accompanying TYPICAL SECTION.

CONTINUITY OF RESERVOIR ROCKS

All reservoirs in Seven Rivers, Queen, Grayburg and San Andres formations: Each of the reservoir rocks is in a zone which is of the same general character throughout the area of the field. However, the productive zones in the four named stratigraphic units are not subject to definite correlation from one geographic sub-division to another. They may or may not provide continuity for migration of reservoir fluids beyond their respective geographic areas.

Clear Fork (Ed): The dolomite member which was locally and temporarily productive may or may not be continuous throughout the area of the field. The favorably porous condition which occasioned commercial production is definitely local and is not continuous beyond the immediate vicinity of the single productive well.

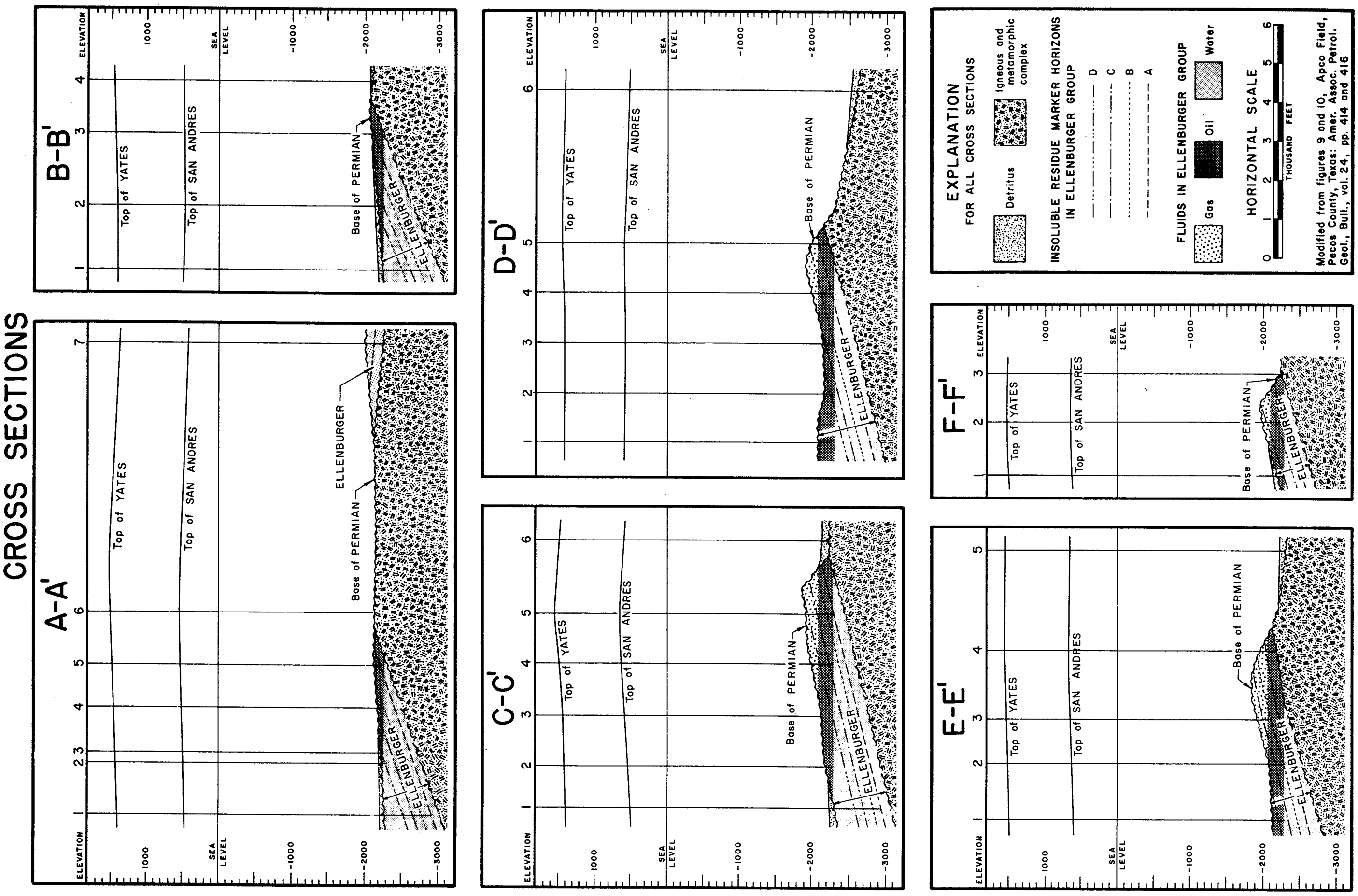
Ellenburger (Fa): The continuity of the Ellenburger reservoir is interrupted by truncation as indicated on accompanying maps and cross sections.

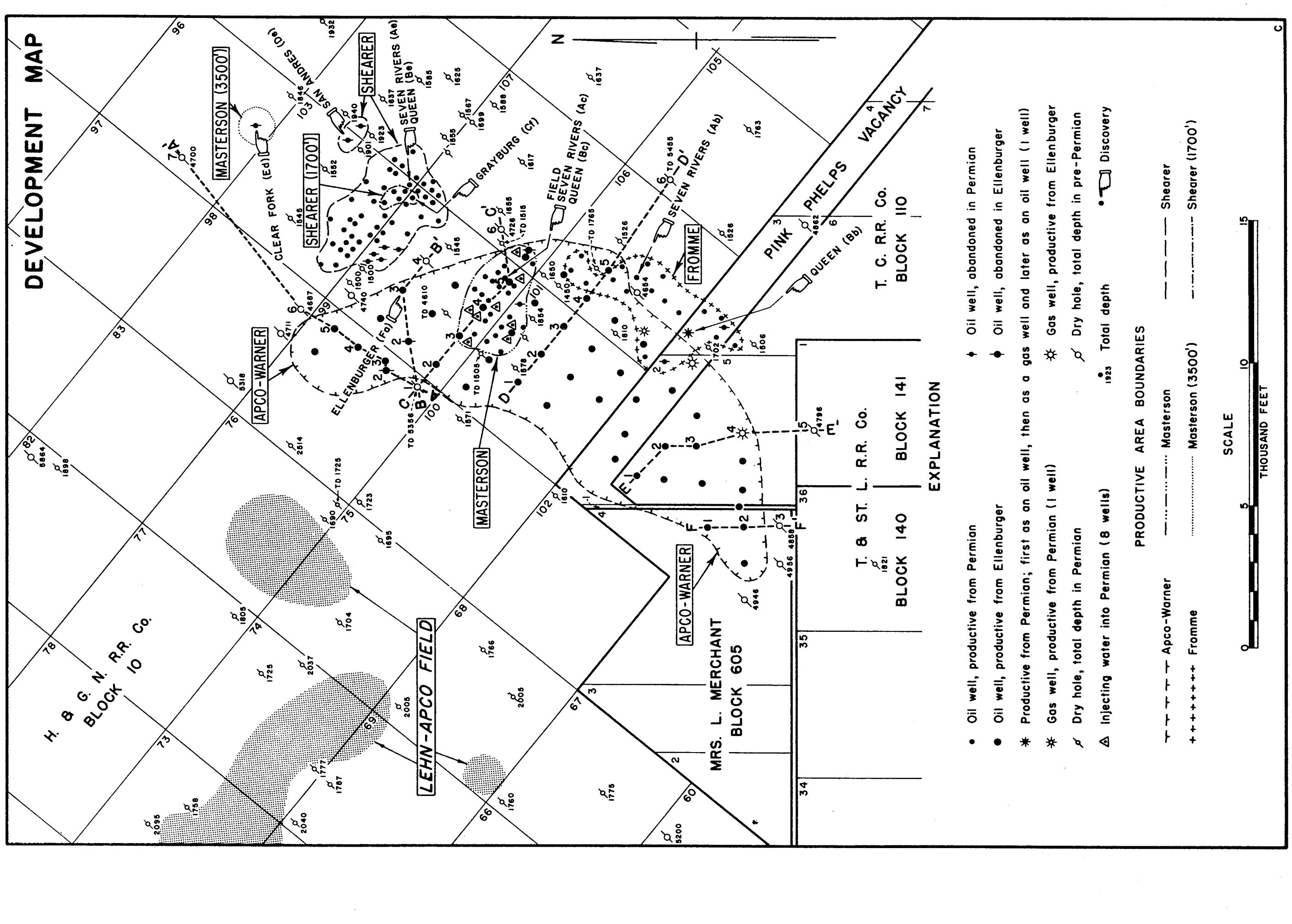
WATER PRODUCTION

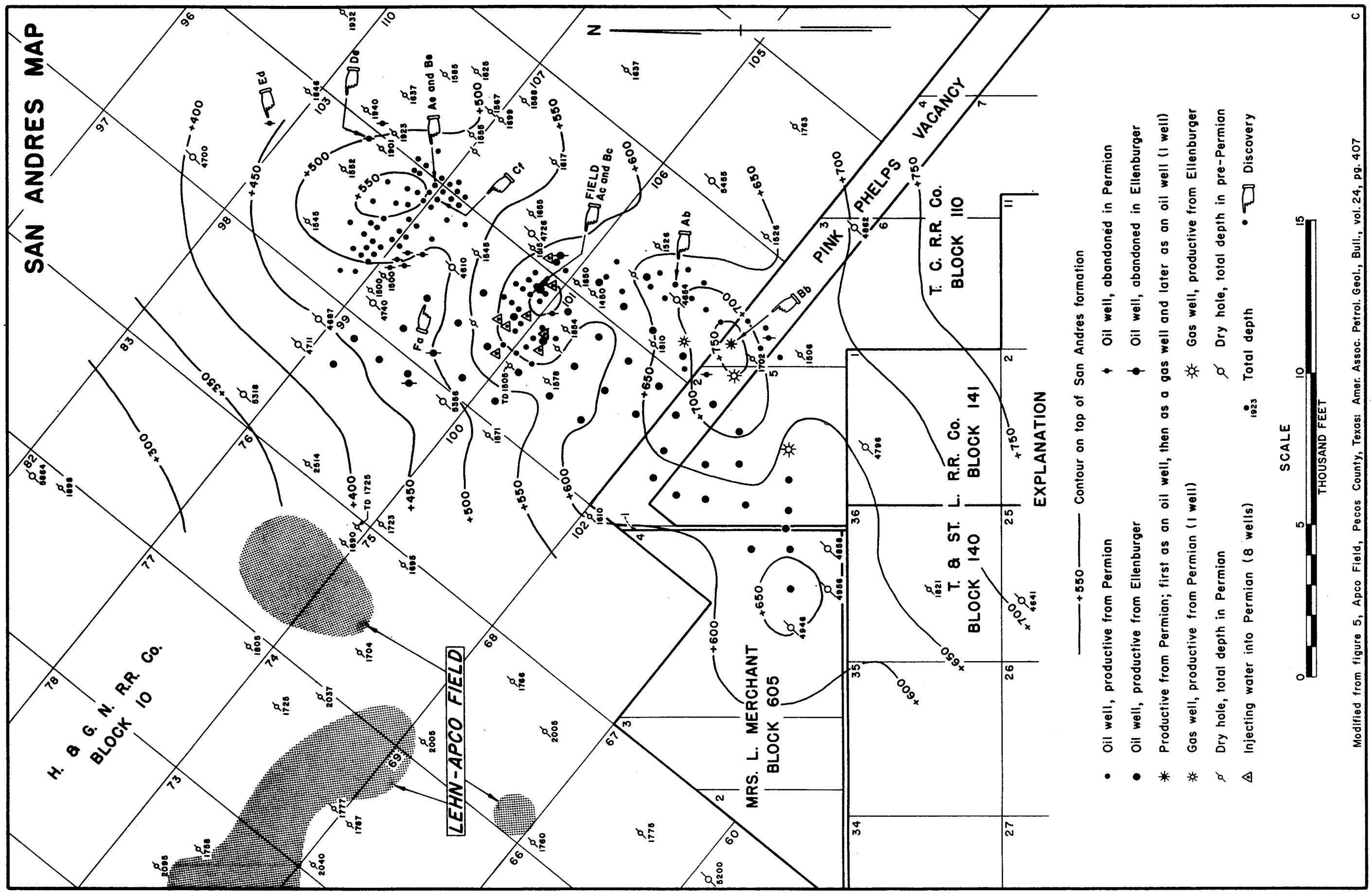
Water production is negligible except that water constitutes about 30% of the gross production of the three wells producing from the Grayburg (Cf) reservoir.

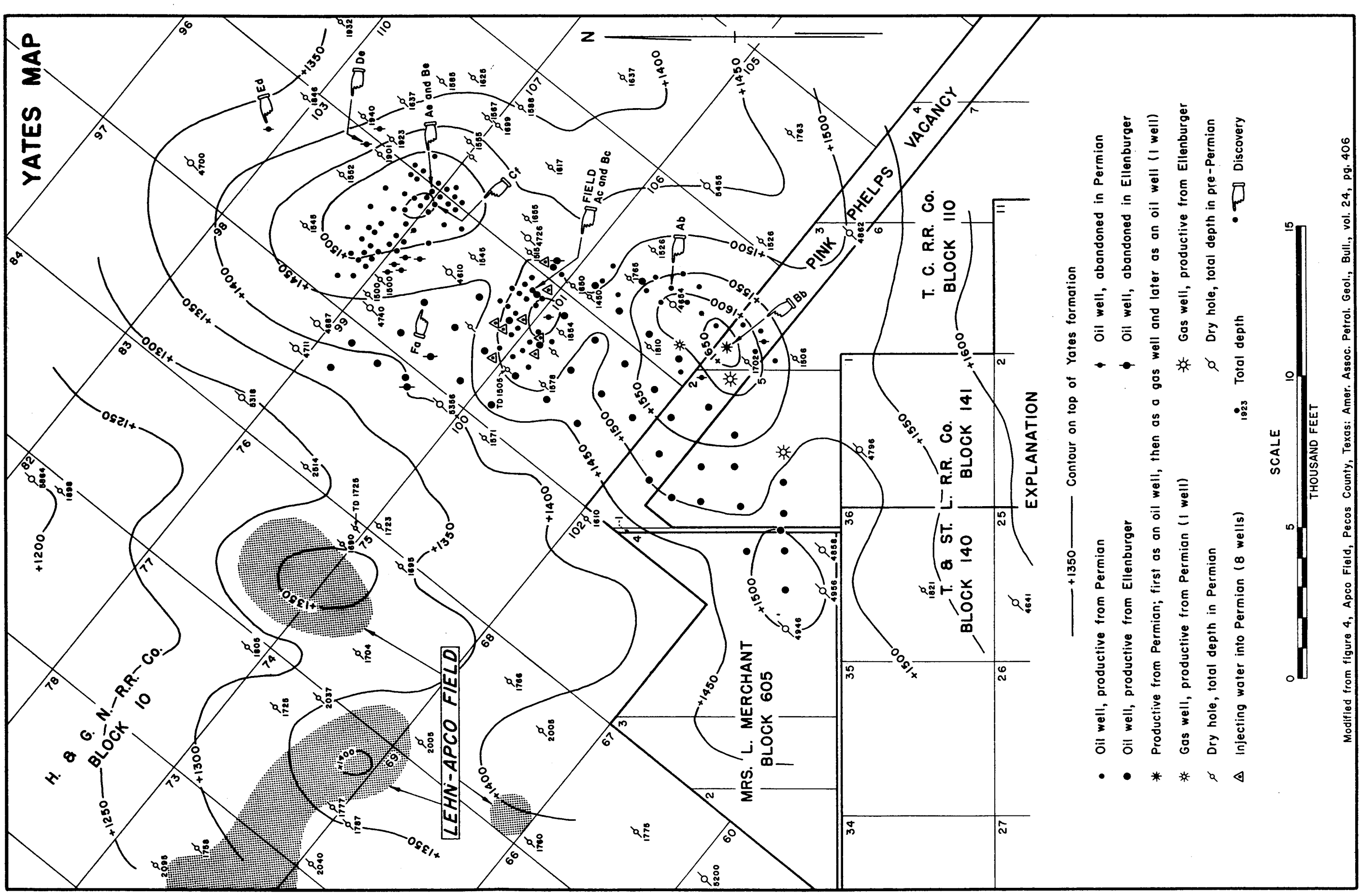
ACID TREATMENT

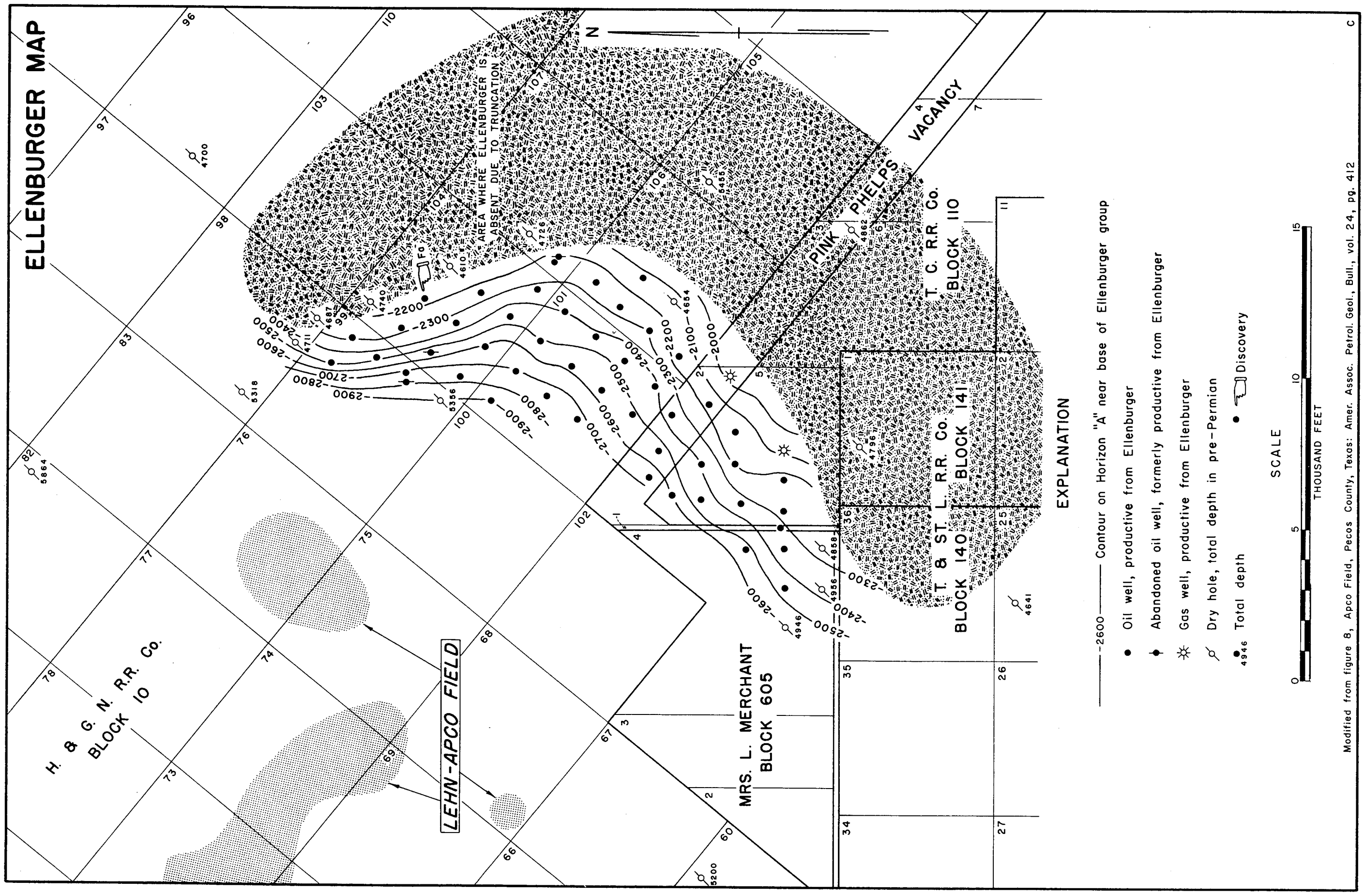
The reservoir rock in each of the Ellenburger wells has been treated with 500 to 9,500 gallons of acid. Data relative to acid treatment of other reservoir rocks are not available.


CROSS SECTIONS
A-A'
B-B'
C-C'
D-D'
E-E'
F-F'
ELEVATION
SEA LEVEL
Top of YATES
Top of SAN ANDRES
Base of PERMIAN
ELLENBURGER
EXPLANATION
FOR ALL CROSS SECTIONS
Detritus
Igneous and metamorphic complex
INSOLUBLE RESIDUE MARKER HORIZONS IN ELLENBURGER GROUP
FLUIDS IN ELLENBURGER GROUP
Gas
Oil
Water
HORIZONTAL SCALE
THOUSAND FEET
Modified from figures 9 and 10, Apco Field, Pecos County, Texas: Amer. Assoc. Petrol. Geol. Bull., vol. 24, pp. 414 and 416

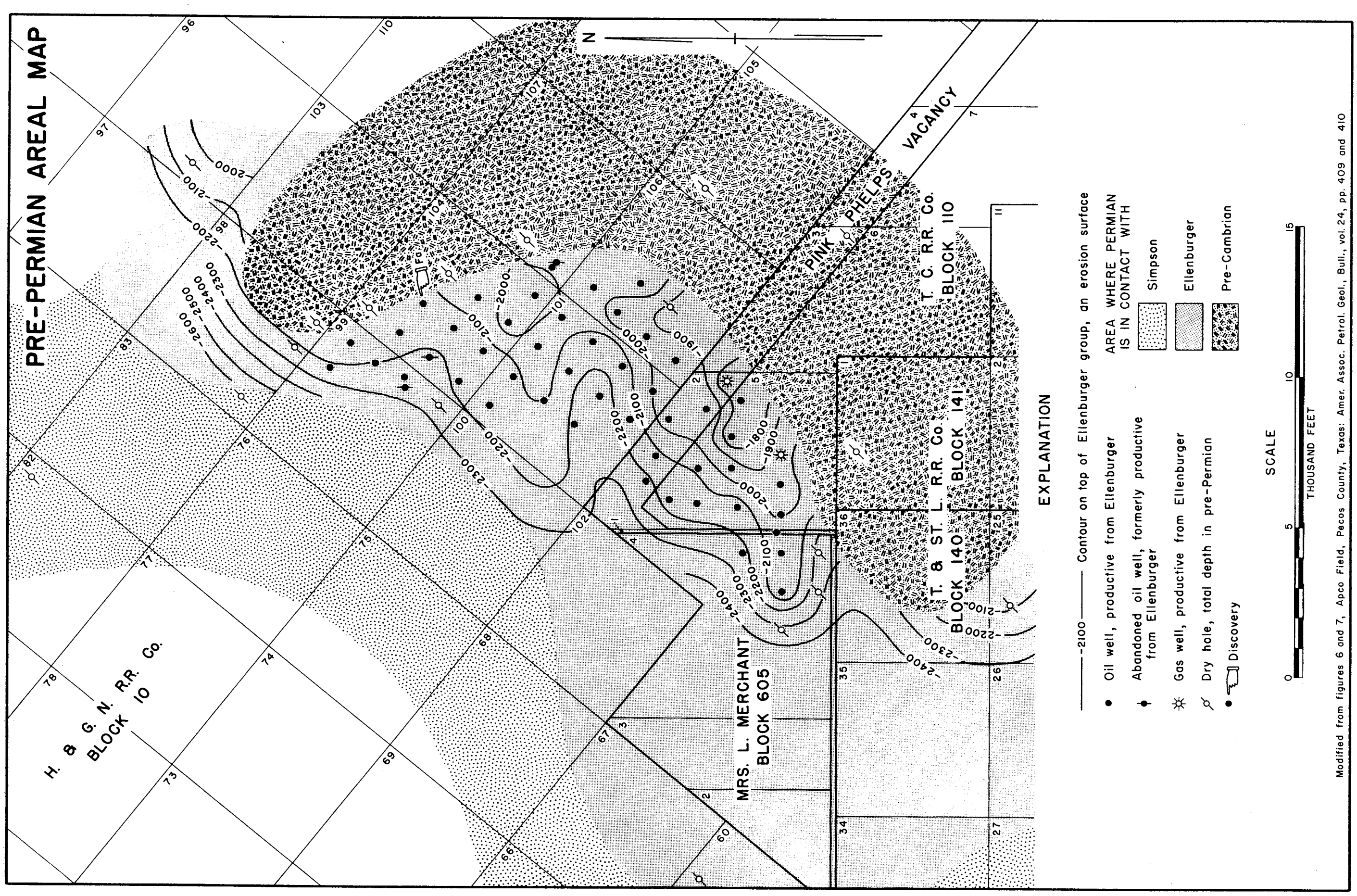

DEVELOPMENT MAP
MASTERSON (3500')
SHEARER (1700')
SHEARER
APCO-WARNER
MASTERSON
FROMME
LEHN-APCO FIELD
H. & G. N. R.R. Co.
BLOCK 10
MRS. L. MERCHANT
BLOCK 605
T. & ST. L. R.R. Co.
BLOCK 140
BLOCK 141
T. C. R.R. Co.
BLOCK 110
PINK PHELPS VACANCY
CLEAR FORK (Ed)
SAN ANDRES (De)
SEVEN RIVERS (Ae)
QUEEN (Be)
GRAYBURG (Cf)
FIELD SEVEN RIVERS QUEEN (Bc)
SEVEN RIVERS (Ac)
SEVEN RIVERS (Ab)
QUEEN (Bb)
ELLENBURGER (Fa)
EXPLANATION
Oil well, productive from Permian
Oil well, productive from Ellenburger
Productive from Permian; first as an oil well, then as a gas well and later as an oil well (1 well)
Gas well, productive from Permian (1 well)
Gas well, productive from Ellenburger
Dry hole, total depth in Permian
Dry hole, total depth in pre-Permian
Injecting water into Permian (8 wells)
Oil well, abandoned in Permian
Oil well, abandoned in Ellenburger
Total depth
Discovery
PRODUCTIVE AREA BOUNDARIES
Apco-Warner
Fromme
Masterson
Masterson (3500')
Shearer
Shearer (1700')
SCALE
THOUSAND FEET


SAN ANDRES MAP
LEHN-APCO FIELD
H. & G. N. R.R. Co. BLOCK 10
MRS. L. MERCHANT BLOCK 605
T. & ST. L. R.R. Co. BLOCK 140
BLOCK 141
T. C. R.R. Co. BLOCK 110
PINK PHELPS VACANCY
EXPLANATION
+550 Contour on top of San Andres formation
Oil well, productive from Permian
Oil well, productive from Ellenburger
Productive from Permian; first as an oil well, then as a gas well and later as an oil well (1 well)
Gas well, productive from Permian (1 well)
Dry hole, total depth in Permian
Injecting water into Permian (8 wells)
Oil well, abandoned in Permian
Oil well, abandoned in Ellenburger
Gas well, productive from Ellenburger
Dry hole, total depth in pre-Permian
Total depth
Discovery
SCALE
THOUSAND FEET
Modified from figure 5, Apco Field, Pecos County, Texas: Amer. Assoc. Petrol. Geol., Bull., vol. 24, pg. 407


YATES MAP
LEHN-APCO FIELD
H. & G. N. R.R. Co. BLOCK 10
MRS. L. MERCHANT BLOCK 605
T. & ST. L. R.R. Co. BLOCK 140
BLOCK 141
T. C. R.R. Co. BLOCK 110
PINK PHELPS VACANCY
EXPLANATION
+1350 Contour on top of Yates formation
Oil well, productive from Permian
Oil well, productive from Ellenburger
Productive from Permian; first as an oil well, then as a gas well and later as an oil well (1 well)
Gas well, productive from Permian (1 well)
Dry hole, total depth in Permian
Injecting water into Permian (8 wells)
Oil well, abandoned in Permian
Oil well, abandoned in Ellenburger
Gas well, productive from Ellenburger
Dry hole, total depth in pre-Permian
Total depth
Discovery
SCALE
THOUSAND FEET
Modified from figure 4, Apco Field, Pecos County, Texas: Amer. Assoc. Petrol. Geol., Bull., vol. 24, pg. 406



Modified from figure 8, Apco Field, Pecos County, Texas: Amer. Assoc. Petrol. Geol., Bull., vol. 24, pg. 412



Modified from figures 6 and 7, Apco Field, Pecos County, Texas: Amer. Assoc. Petrol. Geol., Bull., vol. 24, pp. 409 and 410

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation of oil, feet Top	Bottom	Relief, feet
Seven Rivers:			
Fromme (Ab)	1,269	1,029	240
Masterson (Ac)	1,024	977	47
Shearer (Ae)	1,069	981	88
Queen:			
Fromme (Bb)	995	815	180
Masterson (Bc)	986	936	50
Shearer (Be)	932	841	91
Grayburg:			
Shearer (1700') (Cf)	704	692	12
San Andres:			
Shearer (De) (depleted)	535	510	25
Clear Fork:			
Masterson (3500') (Ed)	-1,123	-1,152	29
Ellenburger:			
Apco-Warner (Fa)	-2,033	-2,300	267

The Ellenburger (Fa) reservoir is the only reservoir containing free gas. Elevation of top of the gas, -1,767 feet; elevation of bottom of gas, -2,033 feet; relief, 266 feet.

CHARACTER OF OIL

	Gravity A.P.I. @ 60°F.
Fromme, (Ab) and (Bb)	27° - 31°
Masterson, (Ac) and (Bc)	21° - 25°
Shearer, (Ae), (Be) and (De)	25° - 36°
Grayburg: Shearer (1700') (Cf)	30°
Clearfork: Masterson (3500') (Ed)	21.9°
Ellenburger: Apco-Warner (Fa)	36° - 43°

For analyses see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 32, 33, 34, 63, 64 and 65.

U. S. Bureau of Mines	Lab. ref.#	38154	40015	46115
Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939) Group 2	Item	63		
Analyses of Crude Oils from Some Fields of Texas. R.I. 3699 (1943)	Item		6	
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944)	Page		3	
Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953)	Item			9

SELECTED REFERENCES

Cole, Taylor (1940) Ordovician development, Apco structure, Pecos County, Texas: Amer. Assoc. Petrol. Geol., Bull., vol. 24, pp. 478-481.

Cole, Taylor (1942) Subsurface study of Ellenburger formation in West Texas: Amer. Assoc. Petrol. Geol., Bull., vol 26, pp. 1398-1409.

Ellison, Samuel P., Jr. (1948) Apco field, Pecos County, Texas: Amer. Assoc. Petrol. Geol., Structure of Typical American Oil Fields, vol. 3, pp. 399-418.

SECONDARY RECOVERY

Water injection into Masterson (Ac) and (Bc) reservoirs was started on November 1, 1954. The project was initiated by injection through the 8 wells indicated on an accompanying map.

PRODUCTION HISTORY

Year	WELLS PRODUCING OIL at end of year Flowing	Pumping	OIL PRODUCTION (barrels) Yearly	Cumulative
Field totals				
1930	?	?	7,964	7,964
1931	?	?	1,883	9,847
1932	?	?	620	10,467
1933	?	?	2,838	13,305
1934	0	3	10,916	24,221
1935	0	5	7,040	31,261
1936	3	11	194,156	225,417
1937	5	15	290,420	515,837
1938	13	23	264,333	780,170
1939	42	25	585,755	1,365,925
1940	45	36	429,047	1,794,972
1941	45	47	386,943	2,181,915
1942	34	61	362,712	2,544,627
1943	46	65	561,367	3,105,994
1944	52	70	852,138	3,958,132
1945	50	76	888,891	4,847,023
1946	46	76	845,402	5,692,425
1947	38	84	808,716	6,501,141
1948	34	88	806,857	7,307,998
1949	29	92	558,175	7,866,173
1950	23	88	537,582	8,403,755
1951	21	98	587,367	8,991,122
1952	18	98	538,148	9,529,270
1953	19	101	520,108	10,049,378
1954	19	101	437,814	10,487,192

PRODUCTION HISTORY (Continued)

Year	WELLS PRODUCING OIL at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Fromme (Ab) and (Bb)				
1939	4	0	9,093	9,093
1940	8	2	28,508	37,601
1941	8	2	34,391	71,992
1942	4	3	22,580	94,572
1943	5	2	16,744	111,316
1944	5	2	10,035	121,351
1945	5	4	12,412	133,763
1946	4	5	11,274	145,037
1947	4	5	10,155	155,192
1948	3	5	8,745	163,937
1949	3	7	8,833	172,770
1950	2	12	12,194	184,964
1951	0	12	16,269	201,233
1952	0	12	12,512	213,745
1953	1	14	21,117	234,862
1954	1	14	17,656	252,518
Masterson (Ac) and (Bc)				
1930	?	?	7,964	7,964
1931	?	?	1,883	9,847
1932	?	?	620	10,467
1933	?	?	2,838	13,305
1934	0	3	10,916	24,221
1935	0	5	7,040	31,261
1936	3	11	194,156	225,417
1937	5	15	290,420	515,837
1938	0	23	192,170	708,007
1939	0	22	90,208	798,215
1940	0	22	65,501	863,716
1941	0	24	59,006	922,722
1942	0	24	46,860	969,582
1943	0	24	46,482	1,016,064
1944	0	24	39,464	1,055,528
1945	0	23	35,501	1,091,029
1946	0	23	33,135	1,124,164
1947	0	22	31,308	1,155,472
1948	0	24	30,356	1,185,828
1949	0	22	30,834	1,216,662
1950	0	20	38,699	1,255,361
1951	0	20	37,655	1,293,016
1952	0	20	34,701	1,327,717
1953	0	17	31,542	1,359,259
1954	0	18	31,243	1,390,502
Masterson (3500') (Ed)				
1943	1	0	21,480	21,480
1944	1	0	28,842	50,322
1945	1	0	16,413	66,735
1946	1	0	2,700	69,435
1947	1	0	1,226	70,661
1948	1	0	412	71,073
1949	0	0	199	71,272
1950-1954	0	0	0	71,272

Year	WELLS PRODUCING OIL at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Shearer (Ae), (Be) and (De)				
1938	13	0	72,163	72,163
1939	35	3	463,570	535,733
1940	30	12	288,653	824,386
1941	27	20	204,218	1,028,604
1942	10	33	182,868	1,211,472
1943	5	38	157,097	1,368,569
1944	5	41	116,447	1,485,016
1945	0	46	84,603	1,569,619
1946	0	43	62,050	1,631,669
1947	0	43	58,299	1,689,968
1948	0	43	52,263	1,742,231
1949	0	41	46,554	1,788,785
1950	0	41	41,340	1,830,125
1951	0	38	35,300	1,865,425
1952	0	38	33,475	1,898,900
1953	0	38	33,628	1,932,528
1954	0	38	31,527	1,964,055
Shearer (1700') (Cf)				
1949	0	2	6,788	6,788
1950	0	2	12,034	18,822
1951	0	3	5,948	24,770
1952	0	3	6,724	31,494
1953	0	3	5,573	37,067
1954	0	3	4,705	41,772
Apco-Warner (Fa)				
1939	3	0	22,884	22,884
1940	7	0	46,385	69,269
1941	10	1	89,328	158,597
1942	20	1	110,404	269,001
1943	35	1	319,564	588,565
1944	41	3	657,350	1,245,915
1945	44	3	739,962	1,985,877
1946	41	5	736,243	2,722,120
1947	33	14	707,728	3,429,848
1948	30	16	715,081	4,144,929
1949	26	20	464,967	4,609,896
1950	21	13	433,315	5,043,211
1951	21	25	492,195	5,535,406
1952	18	25	450,736	5,986,142
1953	18	29	428,248	6,414,390
1954	18	28	352,683	6,767,073

GAS PRODUCTION: The only available records of gas production indicate that 2 wells in Fromme (Ab) and (Bb) produced 40,382 Mcf during 1942; 46,346 Mcf during 1943; 46,519 Mcf during 1944; 67,160 Mcf during 1945; 12,312 Mcf during 1946 and none thereafter. Two wells were completed in Apco-Warner (Fa) as gas wells; we find no record of their having produced any gas.

ARICK FIELD

Hale and Floyd Counties, Texas

B. COOPER HYDE
District Geologist, Houston Oil Co. of Texas, Midland, Texas
March 23, 1955

LOCATION

The Arick field is on the Hale-Floyd county line about 3 miles north of the south end of this common boundary. It is about 2 miles northeast of the town of Petersburg in southeast Hale County. From the standpoint of regional structure, the field is near the apex of the Matador arch.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The discovery was the result of analysis of data afforded by gravity meter, magnetometer and seismograph surveys and by previous drilling operations. The discovery resulted directly from work-over operations on a hole which had been drilled into pre-Cambrian igneous rock and abandoned as dry.

DISCOVERIES

Wichita: December 2, 1948;
General American Oil Co. #2 E.M.Carmichael.
Wolfcamp and Field: April 20, 1948;
General American Oil Co. #1 A.F.Byrd (work-over of hole drilled in 1941 as Humble Oil & Refg. Co. #1 A.F.Byrd).

ELEVATION OF SURFACE

At well locations: Highest, 3,239 ft.; lowest, 3,226 ft.

SURFACE FORMATION

Wind blown sand and caliche of Quaternary age.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is at the base of detrital sediments overlying granodiorite. Within the productive area, the oldest stratigraphic horizon known to have been penetrated is in the Mississippian system about 110 feet below its top. This penetration was in the Wolfcamp discovery well. The accompanying TYPICAL SECTION is based on the log of that well. At its total depth of 6,760 feet, that well had been drilled 15 feet into pre-Cambrian granodiorite.

NATURE OF TRAPS

Wichita and Wolfcamp: The trap in each of the two reservoirs is due primarily to convex folding. It appears likely that termination of reservoir rock against a fault has functioned in a minor way in forming each of the two traps.

PRODUCTIVE AREAS

	Acres
Wichita	40
Wolfcamp	300+
Arick field	300+

THICKNESSES OF RESERVOIR ROCKS

	Wichita	Wolfcamp
Average net productive, feet	28	49

LITHOLOGY OF RESERVOIR ROCKS

Wichita: Dolomite; brown and tan, dense to finely crystalline, slightly oolitic, with intergranular and vuggy porosity.

Wolfcamp: Limestone; tan to white, dense, slightly oolitic, sparingly fossiliferous, with porosity which is largely vuggy with some indications of fracturing.

CONTINUITY OF RESERVOIR ROCKS

Wichita and Wolfcamp: The stratigraphic equivalent of each of the reservoir rocks is identifiable throughout the area of the field. However, as to each, only locally is the degree of porosity and permeability adequate for commercial production.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Feet
Wichita:	
Elevation of highest known oil	-1,505
Elevation of oil-water contact	-1,540
Known relief	35
Wolfcamp:	
Elevation of highest known oil	-2,554
Elevation of oil-water contact	-2,660
Known relief	106

CHARACTER OF OIL

	Wichita	Wolfcamp
Gravity, A.P.I. @ 60° F.	42.0°	42.2°

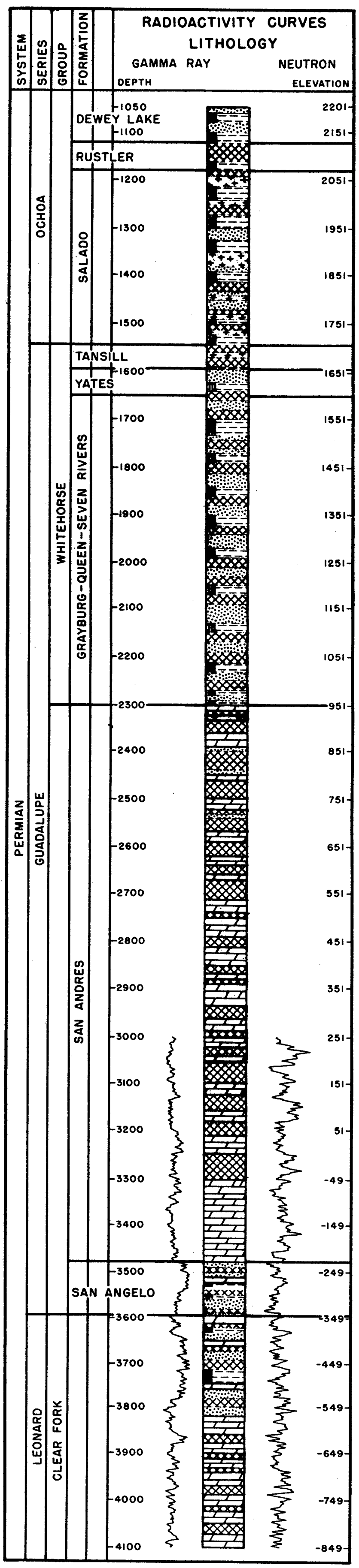
ACID TREATMENT

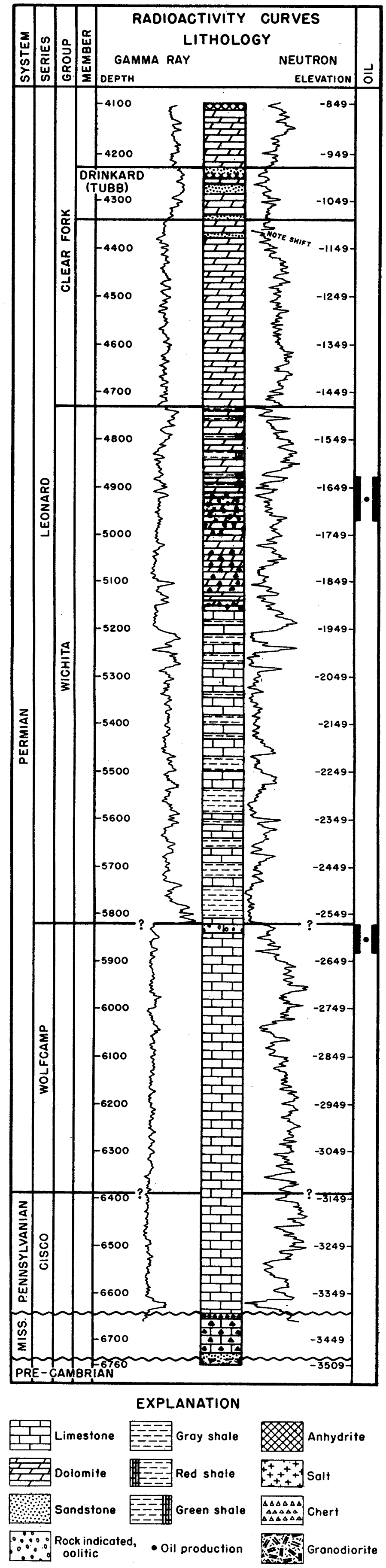
Wichita and Wolfcamp: The reservoir rock in each well has been acidized. The quantity of acid has ranged from 1,500 gallons to 7,500 gallons.

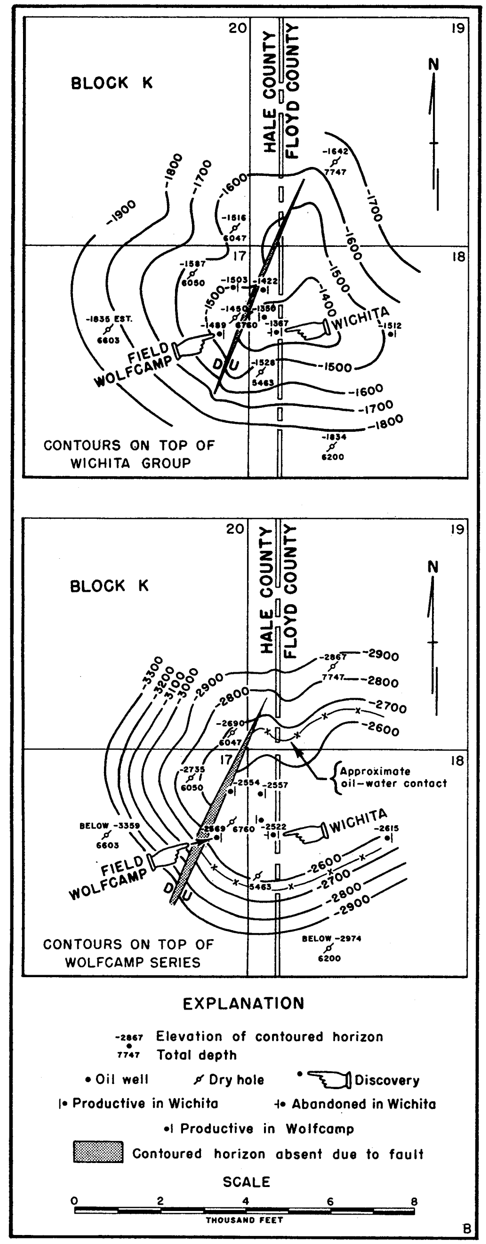
SELECTED REFERENCE

Shepherd, G.Frederick (1949) A Structural Interpretation - Arick Field: The Petroleum Engineer, Nov. 1949, pp. B11 - B16.

TYPICAL SECTION OF ROCKS PENETRATED







PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Field totals:				
1948	1	3	62,339	62,339
1949	3	3	140,342	202,681
1950	1	5	112,066	314,747
1951	1	5	88,083	402,830
1952	2	4	70,849	473,679
1953	0	6	73,896	547,575
1954	0	6	63,591	611,166
Wichita:				
1948	0	1	5,619	5,619
1949	1	1	28,721	34,340
1950	0	1	17,489	51,829
1951	0	1	16,432	68,261
1952	0	1	16,271	84,532
1953	0	1	17,212	101,744
1954	0	1	15,967	117,711
Wolfcamp:				
1948	1	2	56,720	56,720
1949	2	2	111,621	168,341
1950	1	4	94,577	262,918
1951	1	4	71,651	334,569
1952	2	3	54,578	389,147
1953	0	5	56,684	445,831
1954	0	5	47,624	493,455

ARLEDGE FIELD

Coke County, Texas

J. R. KIENE
Geologist, Sinclair Oil & Gas Co., Midland, Texas
July 9, 1954

LOCATION

The Arledge field is in north central Coke County ½ mile south of the northern boundary and is in Sec. 261, Blk. 1-A, H. & T. C. survey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The location of the discovery well was determined on the basis of a surface geological survey supplemented by subsurface data and by seismograph survey.

DISCOVERY

Strawn: January 19, 1948;
Sun Oil Company #1 J. W. Arledge.

ELEVATION OF SURFACE

At well locations: Highest, 2,261 ft.; lowest, 2,239 ft.

SURFACE FORMATIONS

Undifferentiated formations of the Fredericksburg and Trinity groups are exposed on the hills and undifferentiated Tertiary beds occur in the valleys.

OLDEST HORIZON PENETRATED

The oldest horizon penetrated is 10 feet below the top of pre-Cambrian metamorphic rock. This penetration was in Sun Oil Co. #2 J. W. Arledge, the abandoned well located about 1,750 feet northeast of the discovery well. The accompanying TYPICAL SECTION is based on the log of the lower 1,775 feet of penetration by that well.

NATURE OF TRAP

Strawn: The trap appears to be due to decrease of porosity updip on a structural nose.

PRODUCTIVE AREA

Strawn: Gas, 40 acres; oil, 80 acres.

THICKNESS OF RESERVOIR ROCK

Strawn: Net productive, approximate, 35 feet.

LITHOLOGY OF RESERVOIR ROCK

Strawn: Limestone; dark brown, finely crystalline to dense, both intercrystalline and vug type porosity.

CONTINUITY OF RESERVOIR ROCK

Strawn: The reservoir rock appears to be continuous throughout the area of the accompanying map. It was readily identified in each of the wells shown on the map.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Strawn:	Feet
Highest known elevation of gas	-4,311
Lowest known elevation of gas	-4,346
Known relief	35
Highest elevation of oil, estimated	-4,350
Lowest known elevation of oil	-4,364
Relief, estimated	14

CHARACTER OF OIL

Strawn:
Gravity, A.P.I. @ 60° F., 47° Sulphur, 0.2%

WATER PRODUCTION

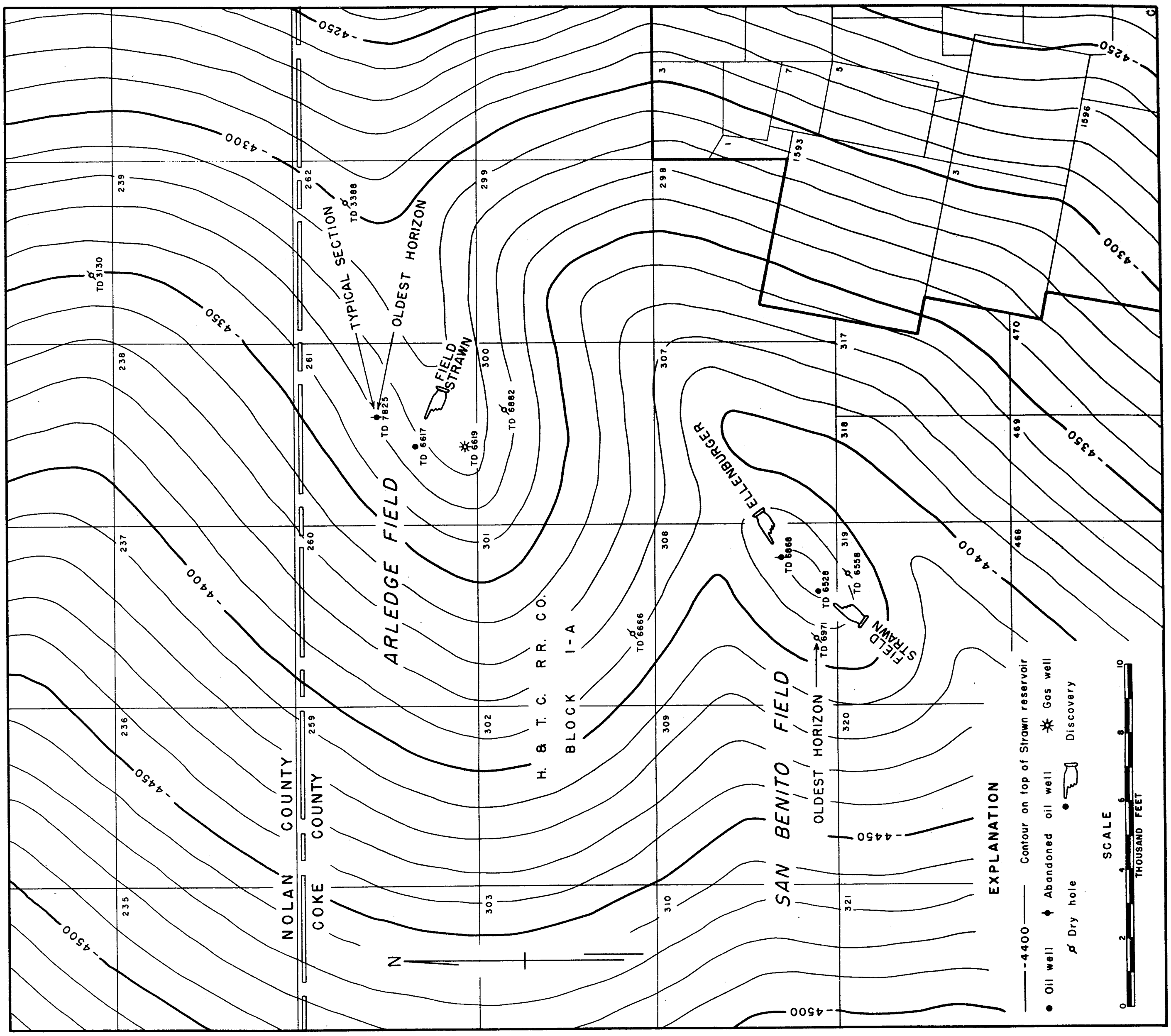
Strawn: Water production is negligible; less than 70 barrels per well per year.

PRODUCTION HISTORY

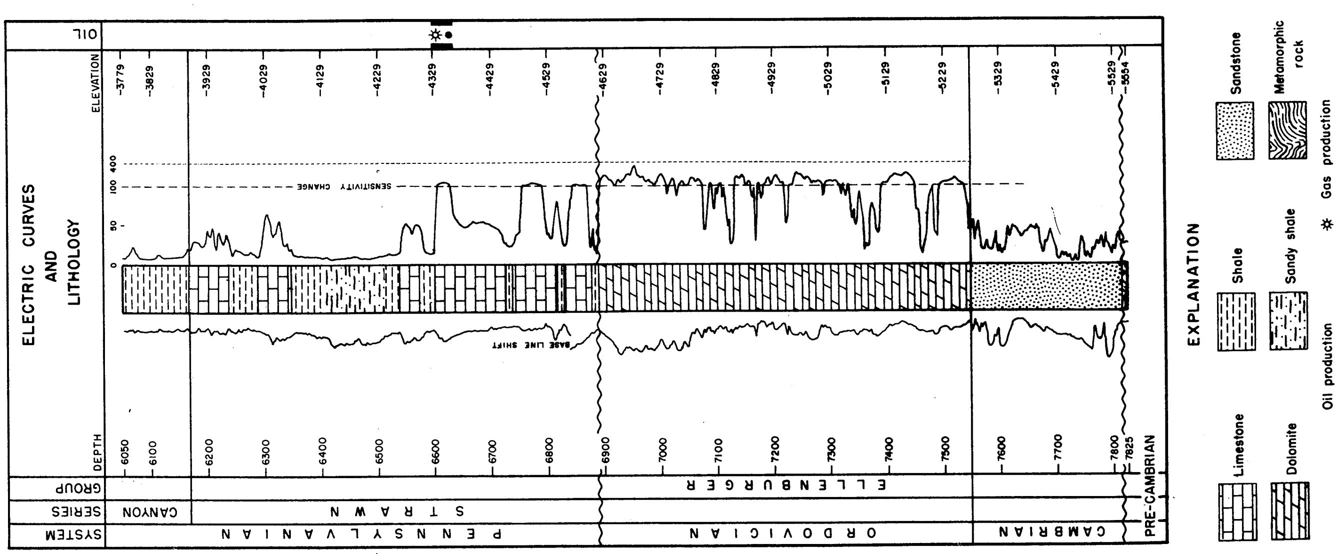
Year	WELLS PRODUCING at end of year: Flowing	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1948	2	15,266	15,266
1949	2	5,947	21,213
1950	2	4,657	25,870
1951	2	4,007	29,877
1952	2	3,640	33,517
1953	2	3,363	36,880

The second of the two oil wells was deepened to test the Cambrian sandstone and was plugged and abandoned on May 18, 1954 after having been drilled to the total depth of 7,825 feet.

GAS PRODUCTION: One of the three wells in the field was completed as a gas well on May 31, 1948. It had a rated capacity of 960 Mcf of gas per day. This well has been shut in since the time of its completion.



TYPICAL SECTION OF ROCKS PENETRATED



BAUGH FIELD
Schleicher County, Texas

EDWARD F. McGEE
Geologist, The Ohio Oil Company, Midland, Texas
June 3, 1953

LOCATION

The Baugh field is in central Schleicher County, 7 miles northeast of Eldorado, county seat. It is about midway between the Hulldale and Page fields.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Mapping of subsurface geological data.

DISCOVERY

Strawn reef: May 27, 1949; The Ohio Oil Co. #1 A. L. Baugh et al. During initial potential test, the well pumped at daily rate of 49.8 barrels of oil and 257 barrels of water through perforations from 5,790 to 5,800 feet. This is the only well which has produced commercially.

Westbrook Oil Corp. #1 A. L. Baugh "A" was completed as a gas well on December 20, 1950 and, if it is a commercial well, it probably should be considered as a discovery well. Although it was completed in Strawn reef limestone, it appears that the reservoir is separate and distinct from that in the producing well. On completion, its potential was at the daily rate of 3,180 Mcf of gas and 14 barrels of condensate. Since the well is shut in with only a small amount of gas having been marketed, further treatment in this report does not appear warranted. No record of the small quantity produced is available.

STRATIGRAPHIC SECTION

The rocks penetrated in this field are quite similar to those penetrated in the Hulldale and Page fields, each of which is to be treated in an accompanying paper. The stratigraphic position of the productive reef limestone is within the Strawn series of the Pennsylvanian system.

CONTINUITY OF RESERVOIR ROCK

Strawn reef: The reef was found in each of the wells shown on the accompanying map. Generally, the upper 20 to 40 feet of the reef yielded nothing on drill-stem test. In wells other than the discovery well, the first fluid encountered was water.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 160 feet below the top of the Ellenburger group. This penetration was in the discovery well.

NATURE OF TRAP

Strawn reef: The trap which caused accumulation of oil and gas appears to be due to variation in degree of porosity and permeability.

THICKNESS OF RESERVOIR ROCK

Strawn reef: Net productive, 10 feet. (The reef has a total thickness of 843 feet at this location).

WATER PRODUCTION

Since the time of its completion, the only productive well has continued to produce about 5 barrels of water with each barrel of oil.

ELEVATION OF SURFACE

At the discovery well: 2,400 feet.

SURFACE FORMATION

Undifferentiated Fredericksburg group, Cretaceous system.

LITHOLOGY OF RESERVOIR ROCK

Strawn reef: Gray, crystalline, porous, fossiliferous limestone.

CHARACTER OF OIL

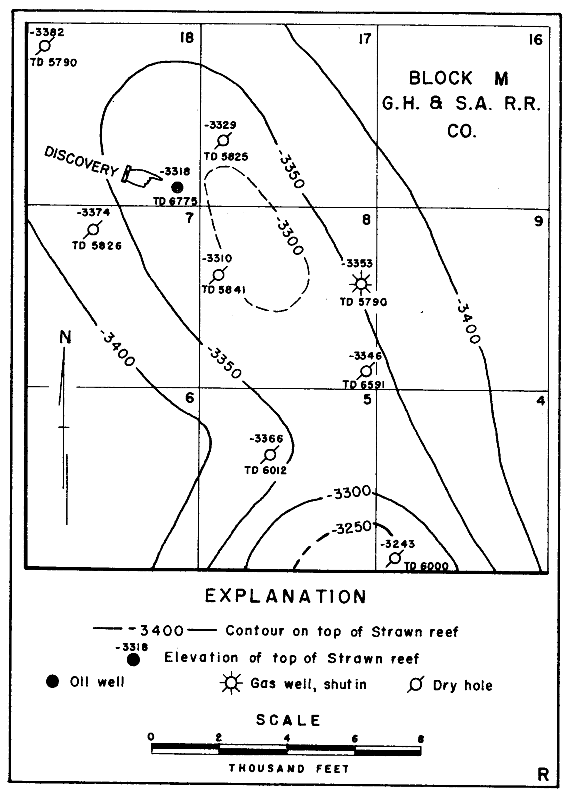
Gravity, A.P.I. @ 60° F.. 39.8°

ACID TREATMENT

The one productive well was treated with 1,000 gallons of acid at depth from 5,790 to 5,800 feet.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year Pumping	OIL PRODUCTION (barrels) Yrly.	OIL PRODUCTION (barrels) Cumu.	GAS PRODUCTION (Mcf, est.) Yrly.	GAS PRODUCTION (Mcf, est.) Cumu.
1949	1	3,955	3,955	4,000	4,000
1950	1	7,947	11,902	8,000	12,000
1951	1	10,580	22,482	19,995	31,995
1952	1	12,794	35,276	25,661	57,656



BEDFORD FIELD
Andrews County, Texas

C. G. COOPER and B. J. FERRIS
Geologists, Shell Oil Co., Midland, Texas
January 1, 1953

LOCATION

The Bedford field is in southwestern Andrews County about 24 miles southwest of the town of Andrews, county seat. It is in the north third of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph.

DISCOVERIES

Devonian: September 30, 1945; Shell Oil Co. and The Texas Co. #1 Ratliff & Bedford.
Fusselman: April 28, 1951; Shell Oil Co. and The Texas Co. #12 Ratliff & Bedford.
Ellenburger: November 1, 1945; Shell Oil Co. and The Texas Co. #1 Ratliff & Bedford.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated within the area of the field is 451 feet below the top of the Ellenburger. This penetration was in the field discovery well, which well discovered production in Devonian and Ellenburger.

NATURE OF TRAPS

The trap in each of the three reservoirs is due to an anticlinal fold.

PRODUCTIVE AREAS

	Acres
Devonian	560
Fusselman	420
Ellenburger	640
Bedford field	640

THICKNESSES OF RESERVOIR ROCKS

Average gross from top to bottom:	Feet
Devonian	400
Fusselman	100
Ellenburger	285

CONTINUITY OF RESERVOIR ROCKS

Each of the reservoir rocks is continuous and is of essentially the same character throughout the area of the field.

LITHOLOGY OF RESERVOIR ROCKS

Devonian: Limestone; white to light gray, compact, fine- to medium-grained, porous, cherty. The upper 20 or 30 feet is commonly sandy; also, the lower portion is siliceous.

Fusselman: Dolomite; white to light gray, medium- to coarse-grained, compact, cherty, glauconitic, calcareous dolomite, with some light gray to brown, fine-grained, compact limestone.

Ellenburger: Dolomite; white to gray and brown, cherty, slightly sandy, rhombic, essentially coarse-grained although grain sizes are variable.

WATER PRODUCTION

Devonian: The first well to produce water from the Devonian was Shell Oil Co. and The Texas Co. #11 Ratliff & Bedford, which was completed with total depth at elevation 6,000 feet below sea level, 80 feet above the elevation of the oil-water contact at time of discovery. A total of 765,000 barrels of oil had been withdrawn from the reservoir before this well first produced water.

Fusselman: Water was first produced from this reservoir by Shell Oil Co. and The Texas Co. #13 Ratliff & Bedford in August 1951.

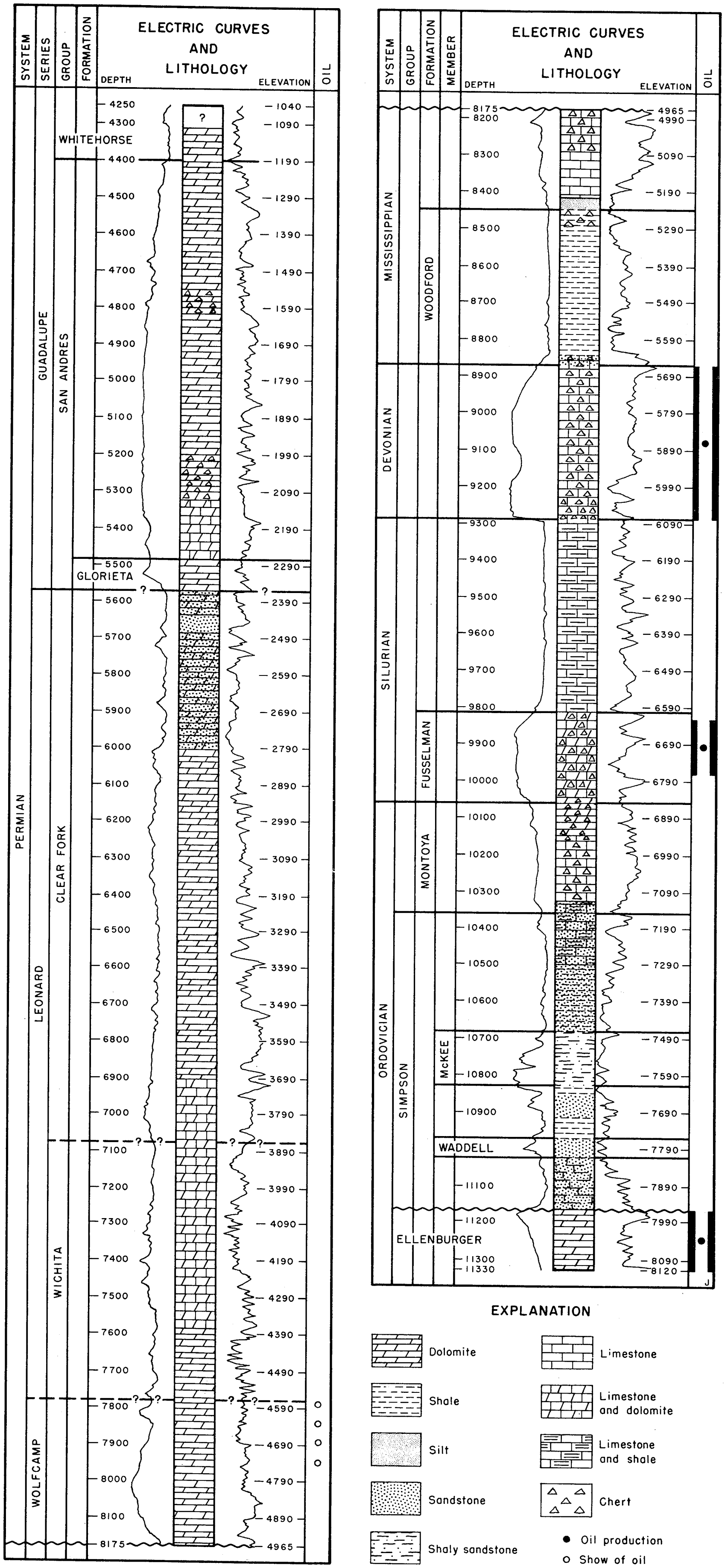
Ellenburger: The first production of water was after a total of 460,000 barrels of oil had been withdrawn from the reservoir, at which time the oil-water contact had risen about 60 feet above its position at time of discovery.

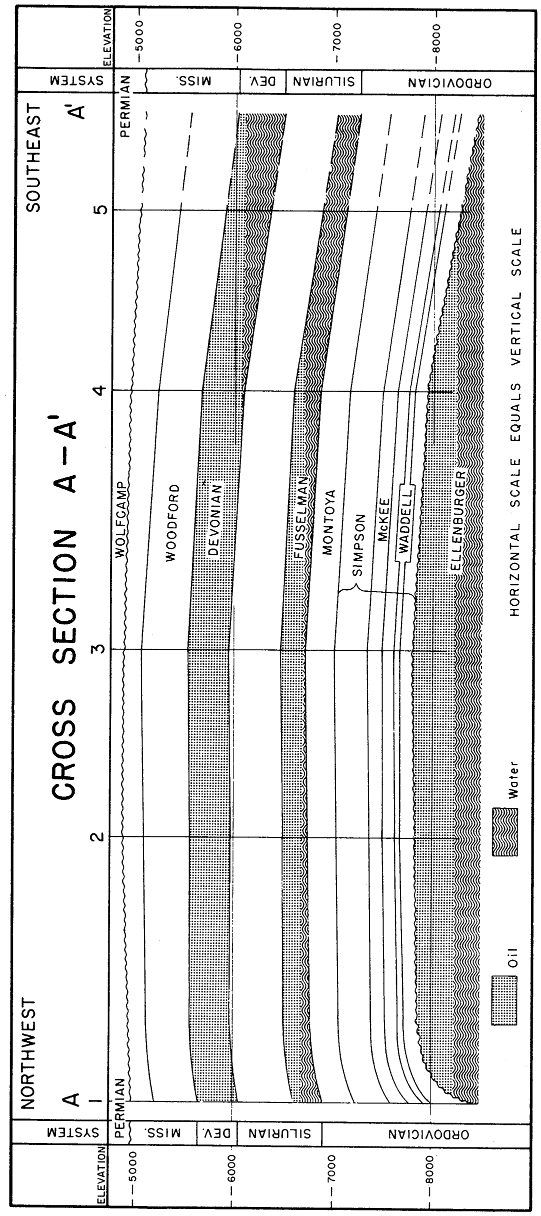
	No. of wells producing water			WATER PRODUCTION (barrels)		
Year	Dev.	Fuss.	Ellen.	Dev.	Fuss.	Ellen.
1948	2		2	26,583		10,834
1949	4		3	45,378		50,819
1950	4		3	50,866		86,768
1951	5	3	3	47,988	12,945	114,098
1952	5	1	4	36,691	7,071	130,902
1953*	6	1	4	45,161	4,447	311,972

WATER ANALYSES

	Milligrams per liter		
Constituent	Devonian	Fusselman	Ellenburger
Calcium	8,325	1,886	2,566
Magnesium	425	406	656
Sodium	39,771	13,926	21,017
Bicarbonate	314	87	412
Carbonate	0	0	0
Sulphate	1,262	3,467	424
Chloride	75,575	23,381	37,422
Totals	125,672	43,153	62,497

TYPICAL SECTION OF ROCKS PENETRATED





ELEVATION AND RELIEF OF PRODUCTIVE ZONES

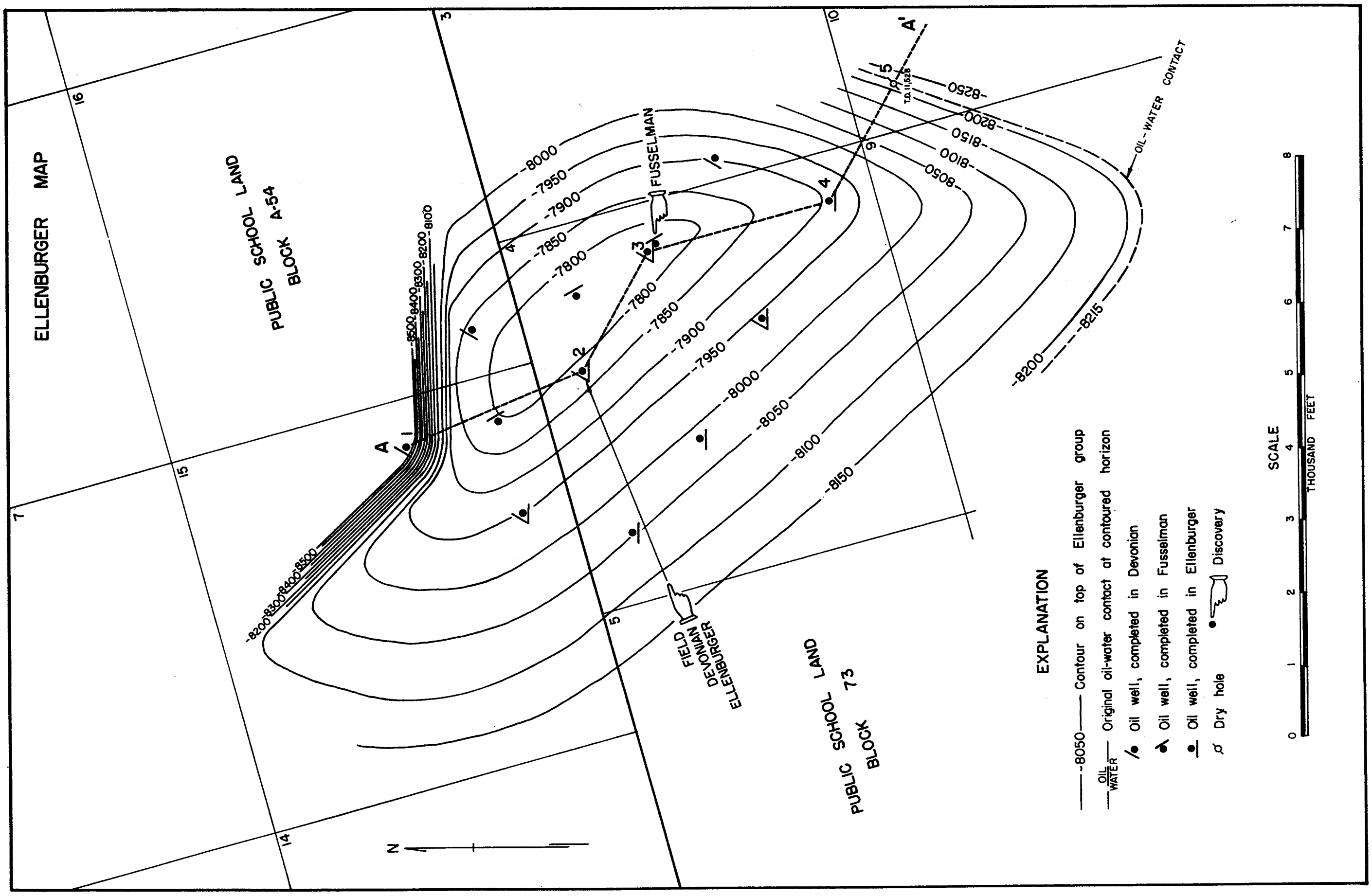
	Devonian	Fusselman	Ellenburger
No free gas			
Elev. of top of oil, feet	-5,540	-6,497	-7,808
Elev. of bottom of oil, feet	-6,080	-6,690±	-8,215
Relief, feet	540	193±	407

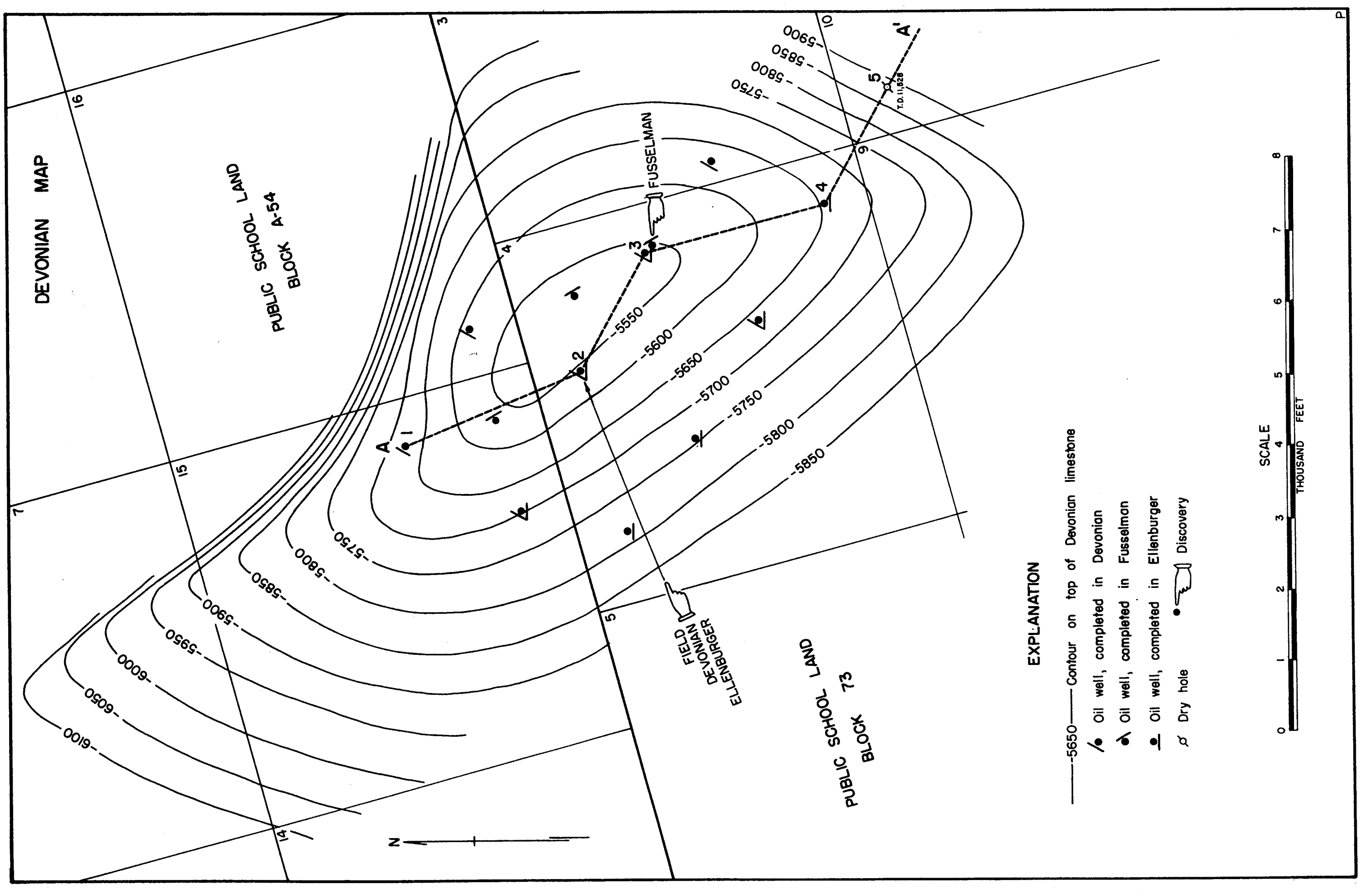
The above figures represent conditions at respective discovery dates.

CHARACTER OF OIL

	Devonian	Fusselman	Ellenburger
Gravity, A.P.I. @ 60° F.	41.7°	39.1°	43.7°
Color	Green	Lt. green	Dark green
Sulphur, by weight	0.65%	0.323%	0.09%

For analyses see:
U. S. Bureau of Mines — Lab. ref. No. 46084 46085
Analyses of Crude Oils from Some West Texas Fields.
R. I. 4959 (1953) — Item 12 11


ELLENBURGER MAP
PUBLIC SCHOOL LAND
BLOCK A-54
PUBLIC SCHOOL LAND
BLOCK 73
FUSSELMAN
FIELD
DEVONIAN
ELLENBURGER
OIL-WATER CONTACT
T.D. 11,828
A
A'
-7800
-7850
-7900
-7950
-8000
-8050
-8100
-8150
-8200
-8215
-8250
EXPLANATION
-8050 Contour on top of Ellenburger group
OIL/WATER Original oil-water contact at contoured horizon
Oil well, completed in Devonian
Oil well, completed in Fusselman
Oil well, completed in Ellenburger
Dry hole
Discovery
SCALE
THOUSAND FEET
0 1 2 3 4 5 6 7 8
N


DEVONIAN MAP
PUBLIC SCHOOL LAND
BLOCK A-54
PUBLIC SCHOOL LAND
BLOCK 73
FUSSELMAN
FIELD
DEVONIAN
ELLENBURGER
T.D. 11,828
A
A'
-5550
-5600
-5650
-5700
-5750
-5800
-5850
-5900
-5950
-6000
-6050
-6100
EXPLANATION
-5650 Contour on top of Devonian limestone
Oil well, completed in Devonian
Oil well, completed in Fusselman
Oil well, completed in Ellenburger
Dry hole
Discovery
SCALE
THOUSAND FEET
0 1 2 3 4 5 6 7 8
N

ELEVATION OF SURFACE

At well locations: Highest, 3,223 ft.; lowest, 3,191 ft.

SURFACE FORMATION

Quaternary sand.

ACID TREATMENT

For each reservoir, acid treatment is a part of regular completion procedure. It has been found practical to treat the reservoir rocks with acid in amounts ranging from 16,000 gallons in 3 stages for the Devonian to as little as a single-stage treatment of 1,000 gallons for the Ellenburger.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)	
	Flowing	Pumping	Gas lift	Yearly	Cumulative	Yearly	Cumulative
Field totals							
1945	2	0	0	11,705	11,705	10,767	10,767
1946	7	0	0	239,138	250,843	177,271	188,038
1947	10	0	0	624,528	875,371	476,106	664,144
1948	13	1	0	1,187,800	2,063,171	665,607	1,329,751
1949	12	2	0	801,330	2,864,501	590,508	1,920,259
1950	12	1	1	708,650	3,573,151	548,618	2,468,877
1951	10	2	1	703,790	4,276,941	480,485	2,949,362
1952	8	6	0	655,474	4,932,415	486,835	3,436,197
1953*	8	6	0	586,108	5,518,523	397,701	3,833,898
Devonian							
1945	1	0	0	9,165	9,165	9,301	9,301
1946	4	0	0	104,102	113,267	106,508	115,809
1947	5	0	0	298,273	411,540	319,194	435,003
1948	7	0	0	525,761	937,301	418,257	853,260
1949	6	1	0	329,700	1,267,001	365,957	1,219,217
1950	6	1	0	275,359	1,542,360	325,765	1,544,982
1951	5	1	0	278,662	1,821,022	287,983	1,832,965
1952	3	3	0	210,597	2,031,619	275,311	2,108,276
1953*	3	3	0	210,452	2,242,071	212,749	2,321,025
Fusselman							
1951	3	0	0	92,285	92,285	31,452	31,452
1952	3	0	0	194,807	287,092	70,633	102,085
1953*	3	0	0	115,929	403,021	49,902	151,987
Ellenburger							
1945	1	0	0	2,540	2,540	1,466	1,466
1946	3	0	0	135,036	137,576	70,763	72,229
1947	5	0	0	326,255	463,831	156,912	229,141
1948	6	1	0	662,039	1,125,870	247,350	476,491
1949	6	1	0	471,630	1,597,500	224,551	701,042
1950	6	0	1	433,291	2,030,791	222,853	923,895
1951	2	1	1	332,843	2,363,634	161,050	1,084,945
1952	2	3	0	250,070	2,613,704	140,891	1,225,836
1953*	2	3	0	259,727	2,873,431	135,050	1,360,886

*1953 data added by amendment.

BLOCK 31 FIELD

Crane County, Texas

J. V. HARDWICK
District Geologist, The British-American Oil Producing Co., Midland, Texas*
March 24, 1953

LOCATION

The Block 31 field is entirely within Block 31, University Land, in east-central Crane County about 7 miles northwest of the town of Crane, county seat. It is on the southeast portion of the Central Basin platform. It is accessible by blacktop roads from Crane and from Odessa.

ELEVATION OF SURFACE

At well locations: Highest, 2,607 feet; lowest, 2,526 feet.

SURFACE FORMATION

Recent or Quaternary sand.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Discovery of this field was due primarily to seismograph work which was initiated because of indications by shallow subsurface data. Refraction surveys were followed by detailed reflection work.

The first deep drilling within the presently productive area was in Gulf Oil Corp. #1 University "F", located near the north end of the field. This test was drilled to the total depth of 10,658 feet and was plugged and abandoned as a dry hole in July of 1941.

In January of 1945, the Atlantic Refining Co. spudded its #1 University A-31 which discovered commercial production in Devonian and in Ellenburger and which was the discovery well of the field. It was completed in November of 1945 as a dual producer with flowing daily potentials of 772 barrels of 47° gravity oil from the Devonian and 408 barrels of oil of the same gravity from the Ellenburger. Commercial oil in each of the three other reservoirs was discovered during later development drilling.

DISCOVERIES

Clear Fork: May 25, 1950;
Beard & Tullous, Inc. #1 University A-31.

Devonian: November 19, 1945;
The Atlantic Refining Co. #1 University A-31.

McKee: December 11, 1948;
The Atlantic Refining Co. #2 University F-31.

Connell: August 8, 1948;
The Atlantic Refining Co. #2 University A-31.

Ellenburger: November 19, 1945;
The Atlantic Refining Co. #1 University A-31.

NATURE OF TRAPS

Clear Fork: The accumulation in this reservoir appears to be due to updip termination of reservoir because of decrease of porosity and permeability. The stratigraphic position of this reservoir has been tested at many places on the general domal fold on which this field is located, but in only one well has the reservoir rock been found sufficiently porous to yield commercial production.

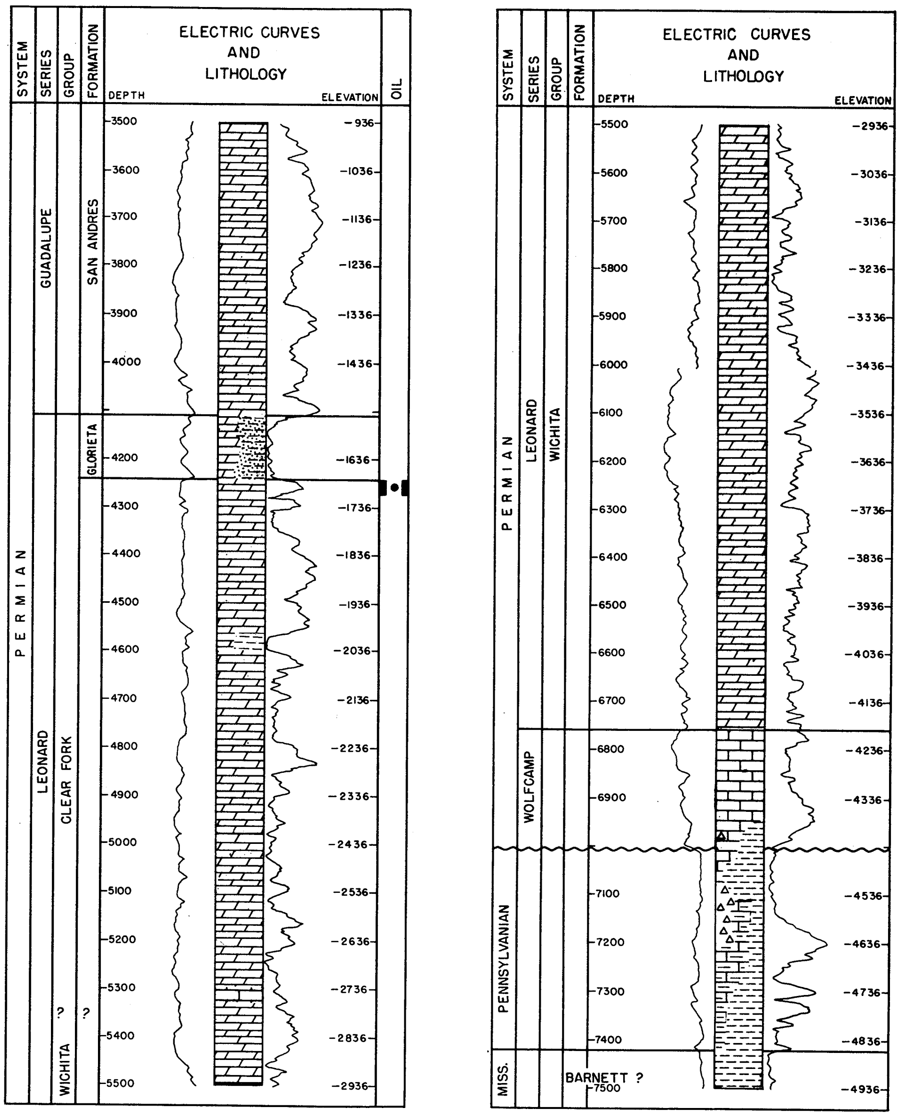
Devonian: The trapping in the main Devonian reservoir appears to be due solely to its convex form at the apex of a domal fold. The minor accumulations in the locally productive zone at the top of the Devonian system appear to have been trapped because of the variations in degree of porosity and permeability.

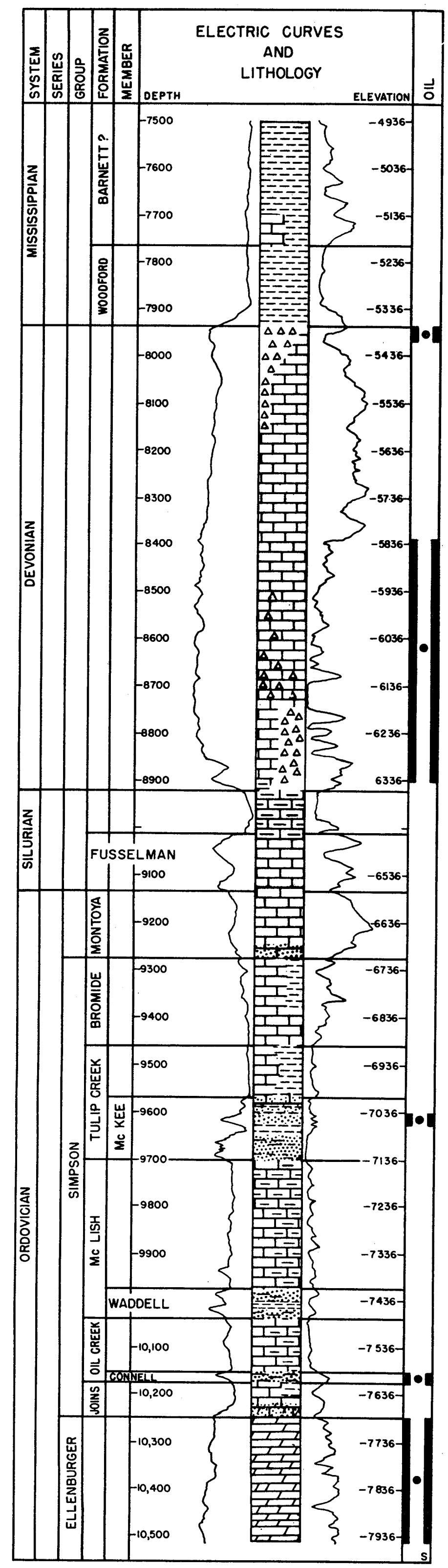
McKee and Connell: The convex form appears to be the dominating factor in occasioning accumulation in each of these two reservoirs. However, porosity and permeability are probably important factors in each reservoir. The McKee is sufficiently permeable to produce only in a restricted area on the crest of the anticline. While the Connell sand is productive over a larger area, it similarly grades into a shaly sand on the flanks of the anticline. Each of these sands was extensively cored and drill-stem tested during development drilling; no interstitial water was yielded. Production in a downdip direction is limited by permeability, at least in the eastern part of the field.

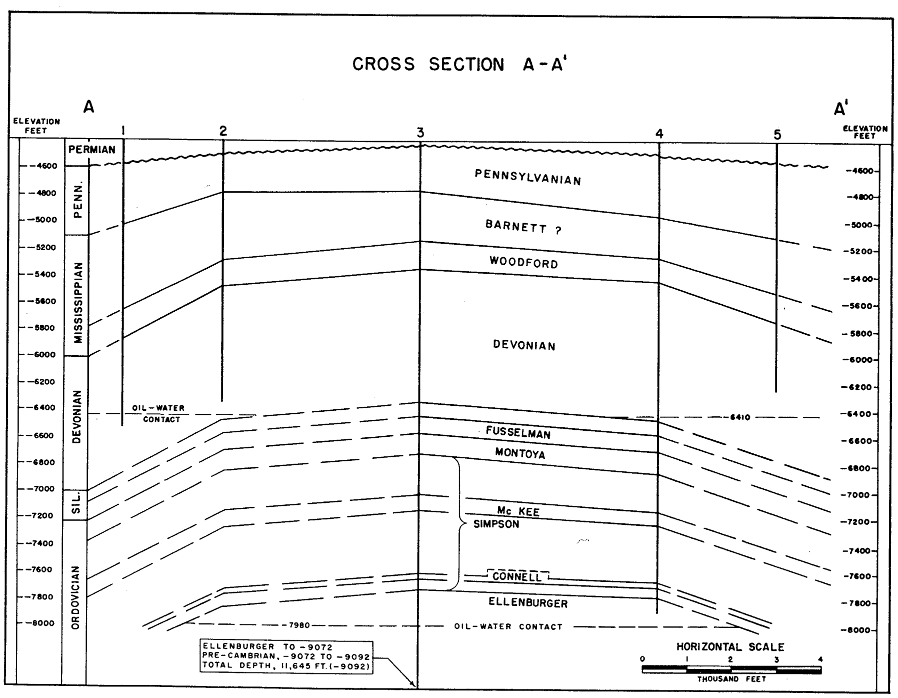
Ellenburger: Convex folding is certainly the dominating factor in forming the trap in the Ellenburger. However, in view of the distribution of the wells completed to date and in view of the relationship of degree of fracturing to productivity, it appears possible that future development may show that low permeability has been a factor locally in forming the trap.

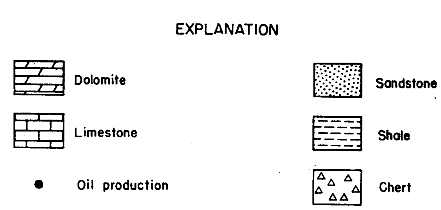
* This paper was compiled while the writer was with The Atlantic Refining Company. He thanks that company for permission to offer this paper for publication.

TYPICAL SECTION OF ROCKS PENETRATED









LITHOLOGY OF RESERVOIR ROCKS

Clear Fork: Dolomite; alternating dense argillaceous dolomite and brown finely crystalline dolomite, quite anhydritic with numerous shale partings and stylolites. The porosity is irregular, generally very low and is of both intercrystalline and vuggy types.

Devonian: Chert, limestone and siliceous limestone. In this field, sediments of the Devonian system consist of three generally distinguishable zones:

(a) The upper zone is 100 to 150 feet thick and consists predominantly of grayish brown opaque chert with varying amounts of gray crystalline limestone with erratic porosity. This zone produces oil only locally where porosity is favorable.

(b) Below the upper cherty zone is 650 to 700 feet of predominantly limestone rocks, fairly pure in the upper portion and quite siliceous in the lower portion, where gray, finely crystalline, siliceous limestone constitutes the principal Devonian producing zone. The porosity is very fine, uniform, intercrystalline and contrasts with the usual fractured, vuggy porosity characteristic of the Devonian on the Central Basin platform.

(c) The lower 200 feet of the Devonian system is dark colored chert in the upper part; it grades into shaly limestone and brown shale near the base. There are thin porous zones of siliceous limestone in this lower cherty zone. These porous zones are quite prolific oil producers wherever above the elevation of the oil-water contact (-6,410 ft.).

As shown on an accompanying map, the boundary of the Devonian productive area does not conform to the structural contours. This is a result of the varying porosity in the upper part of the Devonian rocks. Variations in the distance from the top of the Devonian (contour datum) to the first effective porosity determine the relationship of contours to the boundary of the productive area. The elevation of the Devonian oil-water contact is apparently fairly constant over the field. The upper Devonian reservoir is apparently separated from the principal Devonian producing zone by a series of impermeable beds.

The symbol on the accompanying TYPICAL SECTION indicating reservoir rock from -5,830 to -6,336 is not intended to imply that the rock is productive throughout the whole of that thickness; there are barren streaks within that zone.

McKee: Sandstone. The McKee reservoir rock is a zone of friable, poorly cemented and poorly sorted, rounded to subangular sand grains about 40 feet below the top of the McKee member, which member has a gross thickness averaging about 120 feet and consists predominantly of sand, much of which is shaly and contains numerous streaks of waxy green shale. The reservoir rock is a thin, permeable sandstone of only limited areal extent and which is shaly and asphaltic at locations high up on the flanks of the structure.

Connell: Sandstone; 7 to 12 feet of poorly cemented, friable sandstone consisting of grains of variable size and angularity; shaly at downdip locations. This productive zone is at the top of the Connell member, which has an overall thickness of approximately 25 feet.

Ellenburger: Dolomite; hard, various colors, crystalline with varying degrees of crystallinity. The extreme uppermost part is light tan, finely crystalline. Within the Ellenburger there are distinguishable zones of coarsely crystalline white to tan dolomite, which zones cannot be correlated from well to well, suggesting that they are products of localized secondary crystallization. Porosity is evident in both the finely crystalline and coarsely crystalline dolomite. Oil productivity is independent of the character of crystallization. Production is from fractured zones and openings associated with the fractures.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in pre-Cambrian rocks about 20 feet below the Ellenburger – pre-Cambrian contact. This penetration was at the total depth of 11,645 feet in the Connell discovery well, which is identified as No. 3 on the accompanying cross section.

THICKNESSES OF RESERVOIR ROCKS

	Net productive, feet		
	Min.	Max.	Avg.
Clear Fork	65	65	65
Devonian	50	370	250
McKee	6	10	7
Connell	7	12	9
Ellenburger	30	120	60

CONTINUITY OF RESERVOIR ROCKS

Clear Fork: This zone, as far as is known now, shows possibilities for production from only a very restricted area in the northeast portion of the field, where porosity is locally favorable on the northeastern flank of the Block 31 uplift. The Clear Fork group is continuous over a very large area, but the porous zones within the Clear Fork are of only local extent. Occurrences of oil and gas in the upper portion of the Clear Fork are very widespread but there appears to be no connection between the individual productive reservoirs.

Devonian: The Devonian occurs throughout most of the Permian basin of West Texas and outcrops in the mountains to the west and south. While to the northward it is different in character, grading into dolomite north of Ector County, eastward it has characteristics about the same as in the Block 31 field.

McKee: The McKee reservoir rock extends over only a very small portion of the Block 31 uplift. The McKee member, however, is recognizable over most of the Central Basin platform, but productive reservoirs within it are merely local.

Connell: This reservoir rock is apparently less widely distributed than is the McKee, but is apparently of more uniform lithologic character, particularly in Crane County. The Connell member is hardly recognizable as a lithologic unit in the TXL field in northwestern Ector County, but either produces or has indicated capacity for production in each of five fields in Crane County and in one in northern Pecos County.

Ellenburger: The Ellenburger group is continuous over an enormous area. Its lithologic characteristics are essentially the same over very large areas — predominantly dolomite with some limestone beds which are more prominent toward the Eastern Shelf area of West Texas. It is one of the more important producing zones in West Texas, and produces over a greater area than any other single stratigraphic unit. Its stratigraphic equivalent, the Arbuckle, is a prolific producer in many fields in Oklahoma and Kansas.

PRODUCTIVE AREAS

	Acres
Clear Fork	120
Devonian	5,200
McKee	320
Connell	1,280
Ellenburger	1,720
Block 31 field	5,200

Clear Fork: The estimate of the productive area of this reservoir is no more than a rough guess. The reservoir evidently contains only a very small amount of commercially recoverable oil. Only one well has been completed in it to date.

Devonian and Ellenburger: The estimates for these reservoirs are believed to be quite accurate. Development of each is essentially complete.

McKee and Connell: Coring and drill-stem testing have provided data for reasonably accurate estimates of the productive areas of these reservoirs. Although no well is now producing from either of these reservoirs, neither is regarded as depleted.

CHARACTER OF GAS

No gas analyses are available. The combined field gas is known to be sour. Incidental to pressure maintenance operations, about 16,000 gallons of liquid products are extracted daily from the pressured gas.

The only gas in the reservoirs at respective discovery dates was in solution in the oil.

ACID TREATMENT

Clear Fork: The one well in this reservoir was shot with nitroglycerin and acidized with 4,000 gallons of acid. Results were not good although acid should be beneficial in this reservoir rock even though it is anhydritic throughout most of its thickness.

Devonian: Most wells were completed without acid treatment. During subsequent workovers of several flank wells, treatments with 10,000 gallons of regular 15% acid have resulted in sustained increases in production. Some treatments included the squeezing of 1,000 gallons of mud acid into the reservoir behind the regular acid, but no difference in results was observed.

McKee: Not treated with acid.

Connell: Not treated with acid.

Ellenburger: Some of the wells have been completed without acid treatment while others have been treated with varying amounts of regular 15% acid. The Ellenburger dolomite responds very favorably to acid treatment.

RESERVOIR ENERGY

Clear Fork: The energy operating to expel the oil from the reservoir appears to be that occasioned by gas coming out of solution due to decrease in pressure. The oil was undersaturated at the original reservoir pressure. There are no indications of an effective water drive.

Devonian: Solution gas energy appears to be augmented to a minor extent by water drive. There was no free gas at time of discovery. A program for artificial injection of gas has been initiated and is currently injecting 27,280 Mcf of gas daily at an average pressure of approximately 4,000 psi. Of the total gas injected, 17,500 Mcf per day is produced locally and the remainder is purchased. Gas was being injected into this reservoir through one well at the end of 1949, through two wells at the end of 1950, through four wells at the end of 1951, and through twelve wells at the end of 1952. The injection operation is described in the paper by Carlson cited under SELECTED REFERENCES.

McKee and Connell: Solution gas energy appears to be the only effective reservoir energy in each of these reservoirs. There is no water drive and no gas cap. The oil was considerably undersaturated at the original reservoir pressures.

Ellenburger: There is an effective water drive augmented by energy supplied by gas coming out of solution. The reservoir pressure has declined only slightly.

CHARACTER OF RESERVOIR WATERS

Clear Fork: No data available.

Devonian: Average chloride content: 120,000 parts per million.

McKee: No data available.

Connell: No data available.

Ellenburger: Average chloride content: 50,000 parts per million.

SELECTED REFERENCES

Carlson, Roy F. (1951) Block 31 pressure-maintenance plant believed to be world's highest-pressure gas-injection program: Oil and Gas Journal, April 19, 1951, pp. 154, 157, 220.

Park, Lee B., and McKay, Alexander E. (1948) Geophysical history, Block 31 field, Crane County, Texas: Soc. Explor. Geophysicists, Geophysical Case Histories, vol. 1 - 1948, pp. 389-399.

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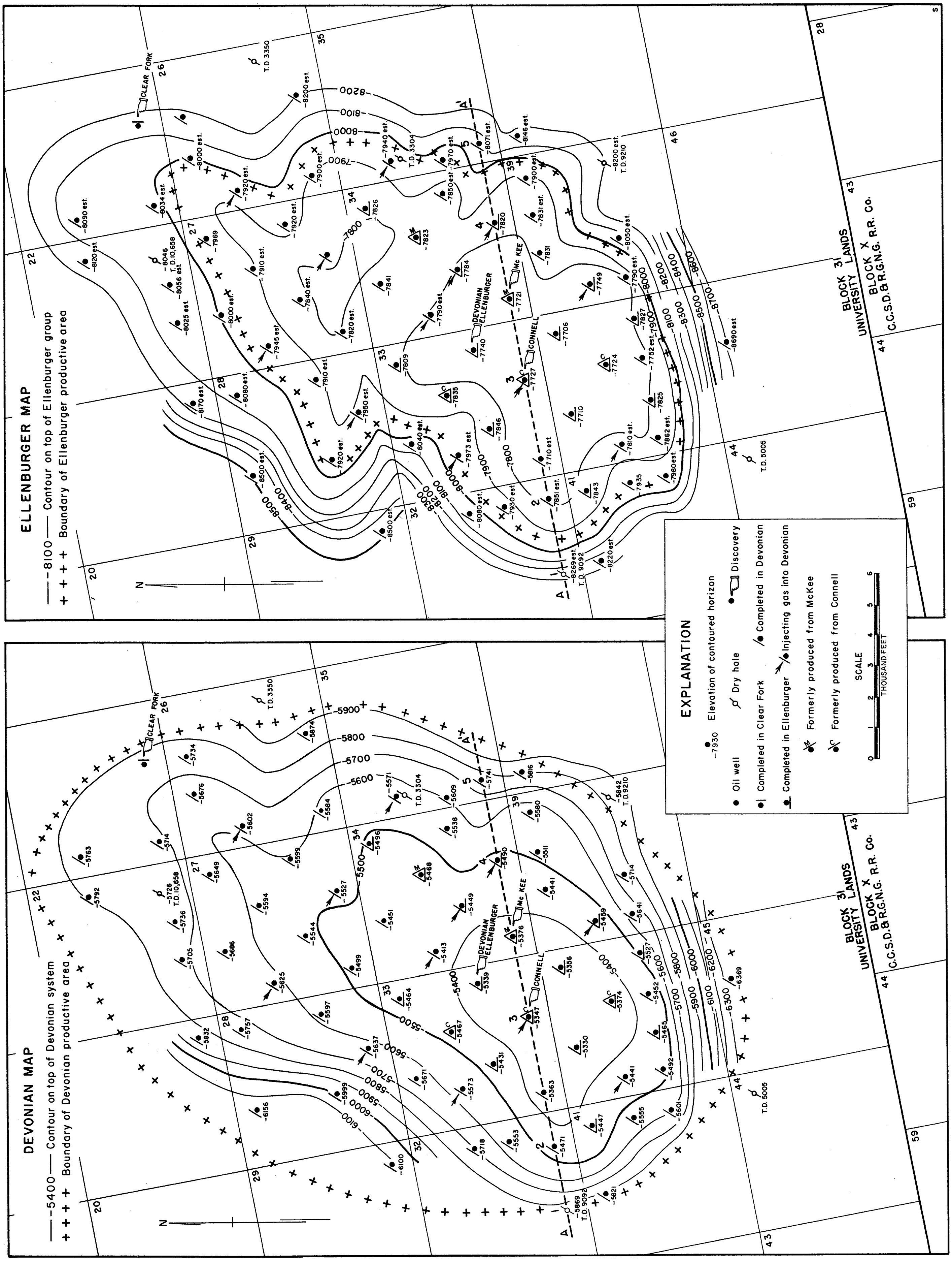

ELLENBURGER MAP
—8100— Contour on top of Ellenburger group
+ + + Boundary of Ellenburger productive area
DEVONIAN MAP
—5400— Contour on top of Devonian system
+ + + Boundary of Devonian productive area
EXPLANATION
-7930 Elevation of contoured horizon
Oil well
Dry hole
Discovery
Completed in Clear Fork
Completed in Devonian
Completed in Ellenburger
Injecting gas into Devonian
Formerly produced from McKee
Formerly produced from Connell
SCALE
THOUSAND FEET
BLOCK 31 UNIVERSITY LANDS
BLOCK X C.C.S.D.&R.G.N.G. R.R. Co.
CLEAR FORK
DEVONIAN ELLENBURGER
Mc KEE
CONNELL

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

No free gas in any reservoir	Clear Fork §	Devonian §§	McKee	Connell	Ellenburger
Highest known elevation of oil, feet*	-1,687	-5,800	-7,066	-7,610	-7,710
Elevation of oil-water contact, feet	Unknown	-6,410	Unknown	Unknown	-7,980
Known oil column, feet	?	610	?	?	270

* Each figure on this line represents the highest elevation at which the top of the reservoir has been penetrated in wells.

§ The Clear Fork has been found capable of commercial production in only one well.

§§ The entries in this column apply to only that part of the Devonian below the top of the blanket porous zone which occurs quite uniformly throughout the field. The erratic porous zone near the top of the Devonian is neglected in this tabulation.

RESERVOIR TEMPERATURE AND PRESSURE and CHARACTER OF OIL

	Clear Fork	Devonian	McKee	Connell	Ellenburger
Pressure, psi.	1,600	4,105	4,100 Est.	4,300	4,178
Temperature, °F.	Not avail.	138	150	160	160
Gravity of oil, A.P.I. @ 60° F.	40	44-48	44	44	42-47
Gas-oil ratio, cu. ft./bbl.	458	1,300	300	576	820

The above data represent conditions at respective discovery dates.

For analyses of oil see: Analyses of Crude Oils from Some West Texas Fields, U. S. Bureau of Mines, R. I. 4959 (1953), Item Nos. 18 and 19.

WATER PRODUCTION

	Devonian			Ellenburger		
	No. of wells	Barrels		No. of wells	Barrels	
Year	producing water	Yearly	Cumulative	producing water	Yearly	Cumulative
1945	?	12	12	?	12	12
1946	4	4,279	4,291	3	4,387	4,399
1947	6	5,940	10,231	3	53,476	57,875
1948	6	9,418	19,649	3	21,084	78,959
1949	7	8,227	27,876	4	23,841	102,800
1950	8	12,690	40,566	5	24,755	127,575
1951	4	13,601	54,167	6	39,151	166,726
1952	2	13,795	67,962	8	221,622	388,348

Clear Fork, McKee and Connell have produced only negligible amounts of water.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year*			OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)	
	Flowing	Pumping	Total	Yearly	Cumulative	Yearly	Cumulative
Field totals							
1945	2	0	2	24,186	24,186	16,655	16,655
1946	26	3	29	893,547	917,733	1,013,472	1,030,127
1947	30	8	38	1,560,210	2,477,943	1,560,610	2,590,737
1948	42	7	49	1,748,005	4,225,948	2,102,911	4,693,648
1949	59	8	67	1,873,859	6,099,807	2,310,799	7,004,447
1950	69	8	77	2,524,930	8,624,737	3,096,276	10,100,723
1951	71	9	80	3,579,989	12,204,726	4,263,934	14,364,657
1952	63	10	73	3,512,347	15,717,073	4,360,149	18,724,806
Clear Fork							
1950	0	1	1	2,158	2,158	0	0
1951	0	1	1	1,584	3,742	0	0
1952	0	1	1	1,265	5,007	0	0
Devonian							
1945	1(1)	0	1	11,984	11,984	8,772	8,772
1946	17(9)	3	20	578,939	590,923	706,808	715,580
1947	19(11)	8	27	1,043,050	1,633,973	1,192,754	1,908,334
1948	34(13)	5	39	1,302,182	2,936,155	1,732,582	3,640,916
1949	47(15)	7	54	1,374,829	4,310,984	1,894,189	5,535,105
1950	54(16)	6	60	2,045,448	6,346,432	2,762,717	8,297,822
1951	57(16)	6	63	2,982,159	9,328,591	3,888,697	12,186,519
1952	49(16)	7	56	3,020,493	12,359,084	4,035,448	16,221,967
McKee §							
1948	2(2)	0	2	2,049	2,049	2,463	2,463
1949	1(1)	0	1	53,610	55,659	41,042	43,505
1950	0	0	0	923	56,582	1,155	44,660
1951	0	0	0	0	56,582	0	44,660
1952	0	0	0	0	56,582	0	44,660
Connell §§							
1948	1(1)	0	1	9,903	9,903	0	0
1949	1(1)	0	1	84,686	94,589	0	0
1950	0	0	0	2,039	96,628	0	0
1951	0	0	0	0	96,628	0	0
1952	0	0	0	0	96,628	0	0
Ellenburger							
1945	1(1)	0	1	12,202	12,202	7,883	7,883
1946	9(9)	0	9	314,608	326,810	306,664	314,547
1947	11(11)	0	11	517,160	843,970	367,856	682,403
1948	8(8)	2(2)	10	433,871	1,277,841	367,866	1,050,269
1949	12(12)	1(1)	13	360,734	1,638,575	375,568	1,425,837
1950	15(15)	1(1)	16	474,362	2,112,937	332,404	1,758,241
1951	14(14)	2(2)	16	596,246	2,709,183	375,237	2,133,478
1952	14(14)	2(2)	16	490,589	3,199,772	324,701	2,458,179

*Under Field totals, a well producing from two reservoirs is counted as two wells. Under the respective reservoir headings, figures in parentheses indicate number of wells producing also from another reservoir.

§The two wells which produced from the McKee were producing also from the Devonian. They could not be operated satisfactorily in this manner. They were recompleted so as to produce dually from Devonian and Ellenburger.

§§Three wells have produced from the Connell. Each was completed so as to produce also from the Devonian. They could not be operated satisfactorily in this manner. They were recompleted so as to produce dually from Devonian and Ellenburger.

BLOCK 47 FIELD

Crockett County, Texas

E. E. LINDEBLAD
Geologist, Continental Oil Co., Midland, Texas
January 1, 1953

LOCATION

The Block 47 field is in northeastern Crockett County, 12 miles northeast of the World field and 5 miles south of the Barnhart field. It comprises portions of sections 8, 9, 13 and 14, Block 47, University Land survey.

METHODS OF EXPLORATION LEADING TO DISCOVERY

It appears that the discovery of this field was the result of having purchased leases at random in a general region indicated as favorable by the results of previous drilling operations. Expiration dates of leases prompted commencement of the test which resulted in discovery. A previous nearby deep test had found showings of oil in the Guadalupe series.

DISCOVERIES

Grayburg: October 24, 1947; Continental Oil Co. #1-A-12 University. Pumped 17 barrels of 32° gravity oil per day with no water; 2-inch tubing. The top of pay was found at the top of the Grayburg formation at depth of 2,110 feet and the well was drilled to total depth of 2,175 feet. The section from top of pay to total depth was shot with 130 quarts of nitroglycerin. On October 10, 1948, the well was plugged and abandoned.

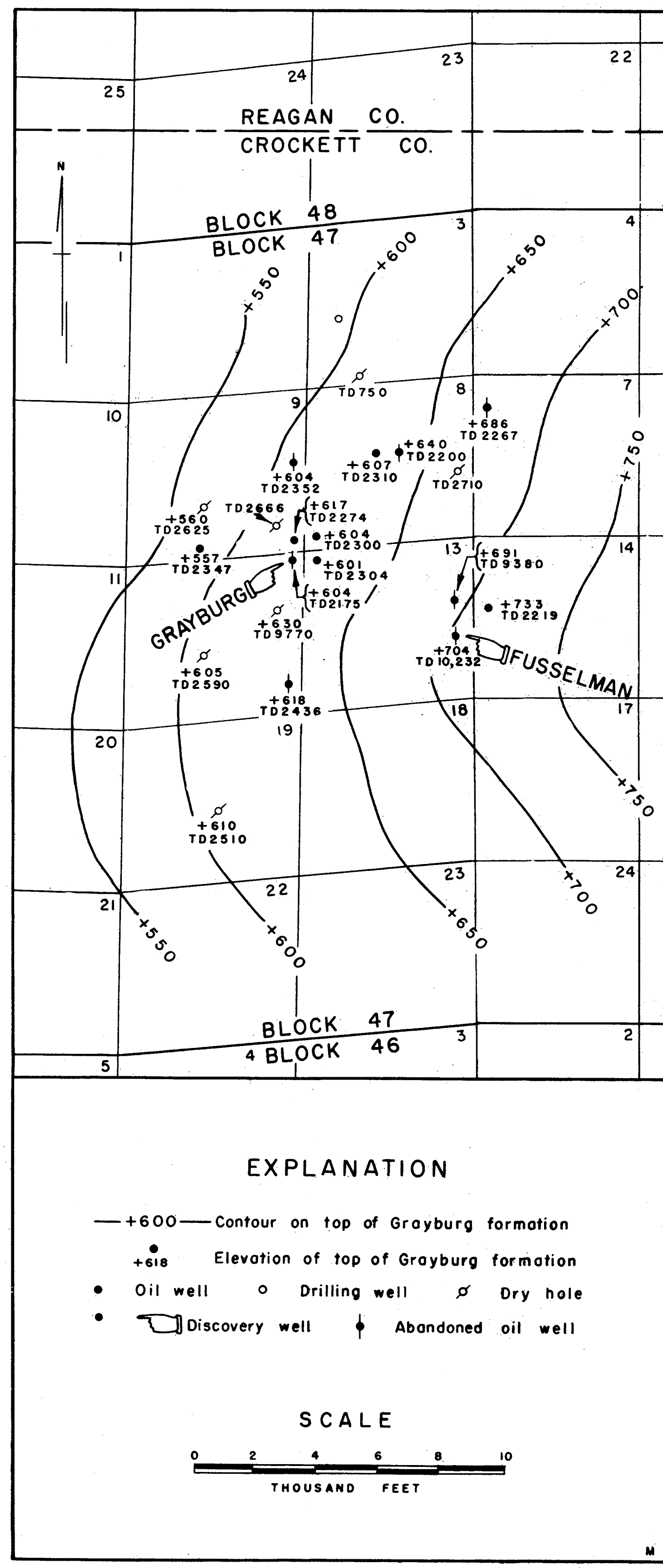
Fusselman: March 28, 1948; Continental Oil Co. #1-A-13 University. Pumped 104 barrels of 45° gravity oil per day; T. D. 10,232 feet; plugged back to 9,408 feet; top of pay at 9,210 feet, 10 feet below top of Fusselman formation; treated with 47,000 gallons of acid. This is the only well which has produced from the Fusselman, and it was plugged and abandoned on October 25, 1948. The Fusselman was tested in the north offset and found non-productive at that location.

ELEVATION OF SURFACE

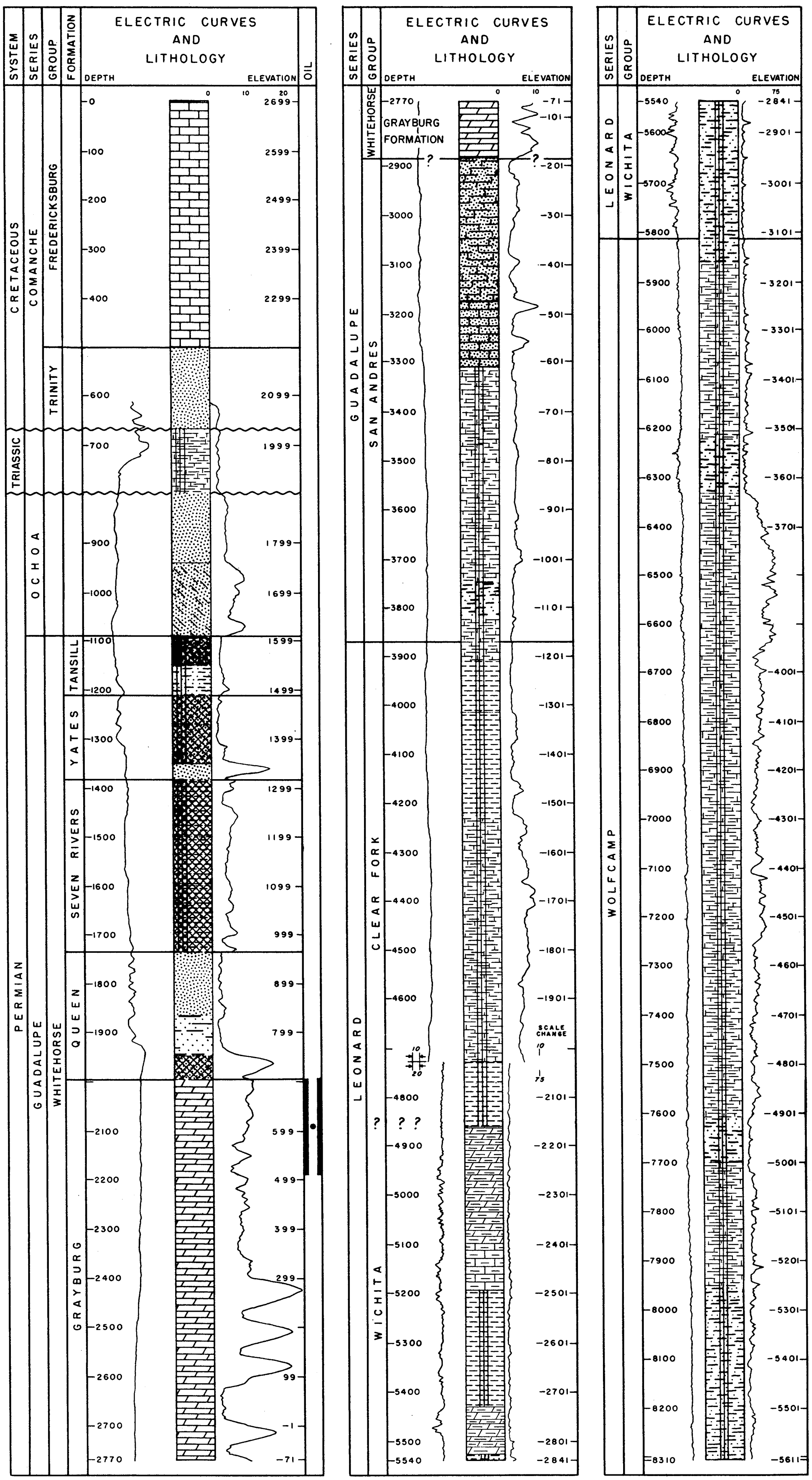
At well locations: Highest, 2,711 ft.; lowest, 2,643 ft.

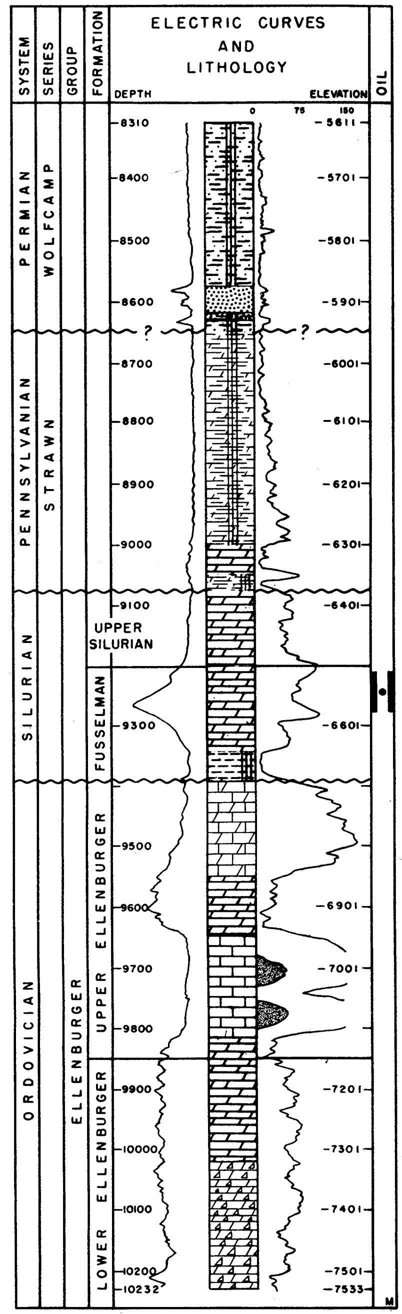
SURFACE FORMATION

Undifferentiated rocks of the Comanche series of the Cretaceous system.

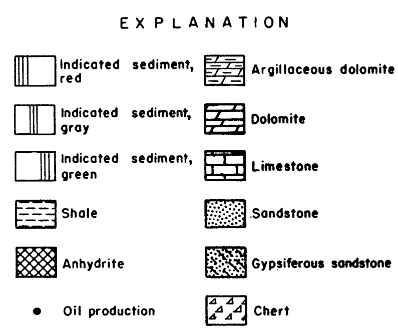


TYPICAL SECTION OF ROCKS PENETRATED





NOTE: This TYPICAL SECTION is based on the log of Continental Oil Co. #1-A-13 University, the Fusselman discovery well. The Grayburg reservoir was non-productive at this location.



OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 838 feet below its top. This penetration was in the Fusselman discovery well, which is the well on which the accompanying TYPICAL SECTION is based.

NATURE OF TRAPS

Grayburg: Variation in degree of porosity.

Fusselman: To date there is insufficient information to determine definitely the nature of the trap-forming factors. Only three wells have been drilled to the Fusselman and only one of those was productive.

PRODUCTIVE AREAS

	Acres
Grayburg	280±
Fusselman (depleted)	40
Block 47 field	280±

THICKNESSES OF RESERVOIR ROCKS

	Grayburg	Fusselman
From top to bottom, feet	195	140
Net productive, feet	15	35

LITHOLOGY OF RESERVOIR ROCKS

Grayburg: Gray, fine to medium grained, crystalline dolomite with some anhydrite inclusions.

Fusselman: Medium to coarse grained, crystalline, fossiliferous, flesh colored dolomite.

CONTINUITY OF RESERVOIR ROCKS

Grayburg: Continuous throughout area of field; degree of porosity is variable.

Fusselman: The reservoir rock was recognized at each of the three locations where wells were drilled to its depth within the area covered by the accompanying map.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Feet
Grayburg:	
Elevation of top of oil	529
Elevation of bottom of oil	489
Relief	40
Fusselman:	
Elevation of top of oil	-6,511
Elevation of bottom of oil	-6,581
Relief	70

CHARACTER OF OIL

	Range	Avg.
Grayburg:		
Gravity, A.P.I. @ 60°F.	35.8° - 32.0°	33.0°
Fusselman:		
Gravity, A.P.I. @ 60°F.		45.0°

WATER PRODUCTION

Little or no water has ever been produced by any well in the field.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: All pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
Grayburg:			
1947	3	334	334
1948	6	10,147	19,481
1949	7	6,886	17,367
1950	6	5,645	23,012
1951	6	6,957	29,969
1952	6	5,680	35,649

The above indicated quantities are less than corresponding quantities reported by the Railroad Commission for the Block 47 field because the Commission figures include the production from the well in Block 49 in the Friend field.

Year	All pumping	Yearly	Cumulative
Fusselman:			
1948	0	2,302	2,302

Only one well has ever produced from the reservoir in the Fusselman formation. That well was completed on March 28, 1948 and plugged and abandoned on October 25, 1948.

BRAHANEY FIELD

Yoakum County, Texas

ARCHIE B. COCKBURN
Geologist, Cabot Carbon Company, Midland, Texas
May 26, 1953

LOCATION

The Brahaney field is in west-central Yoakum County, 3 miles west of the town of Plains, county seat. It is in Secs. 423, 424, 445 and 446 of Block D, John H. Gibson survey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Study of subsurface geological data.

DISCOVERY

San Andres: June 26, 1945; Dunigan Bros. & Brahaney #1 W.S.Hodges. The well was originally drilled to its total depth of 7,717 feet by Skelly Oil Company. It was sold to Dunigan Bros. & Brahaney, who plugged it back to 5,312 feet and completed it, after treating with 14,500 gallons of acid, as a pumper from San Andres with initial potential of 76 barrels of oil per day.

ELEVATION OF SURFACE

Derrick floor: Highest, 3,711 feet; lowest, 3,693 feet.

SURFACE FORMATION

Ogallala formation of Tertiary system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 23 feet below the top of the Devonian limestone. This penetration was in Signal Oil & Gas Co. #1 J.D.Webb, a dry hole at the location in Sec. 423 where total depth of 11,510 feet is indicated on the accompanying maps. The discovery well is the only other well which penetrated below the San Andres formation; at its total depth of 7,717 feet it was near the base of the Clear Fork group.

NATURE OF TRAP

San Andres: Accumulation is in a porosity trap on a southward plunging anticlinal nose.

PRODUCTIVE AREA

San Andres and Field: 360 acres.

THICKNESS OF RESERVOIR ROCK

San Andres: The gross thickness of the productive portion of the San Andres dolomite is 225 feet. The stratigraphic position of the top of the zone sufficiently porous to yield oil varies considerably within the area of the field. The maximum thickness of the gross pay zone in any well is 180 feet. It is estimated that total thickness of net effective pay averages 30 feet.

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomite; light gray to brown, finely crystalline, with scattered chert nodules and thin streaks of dark gray bentonitic shale.

CONTINUITY OF RESERVOIR ROCK

San Andres: The stratigraphic equivalent of the reservoir rock which is productive in this field is probably widespread. However, the high degree of porosity and permeability which occasions commercial production is a local condition.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

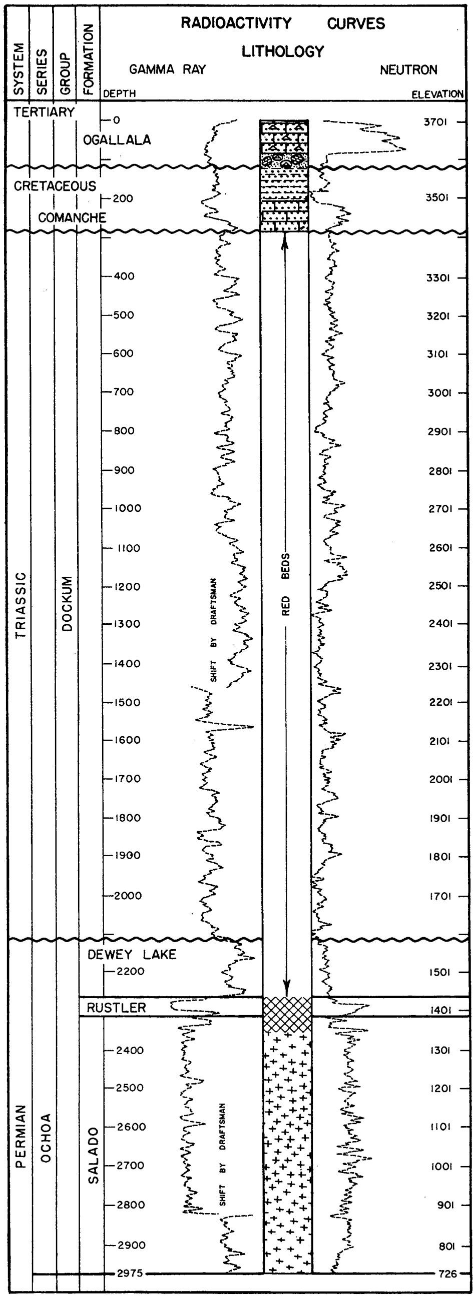
San Andres:	Feet
No free gas cap	
Elevation of top of oil	-1,471
Elevation of bottom of oil, approximate	-1,650
Relief, approximate	179

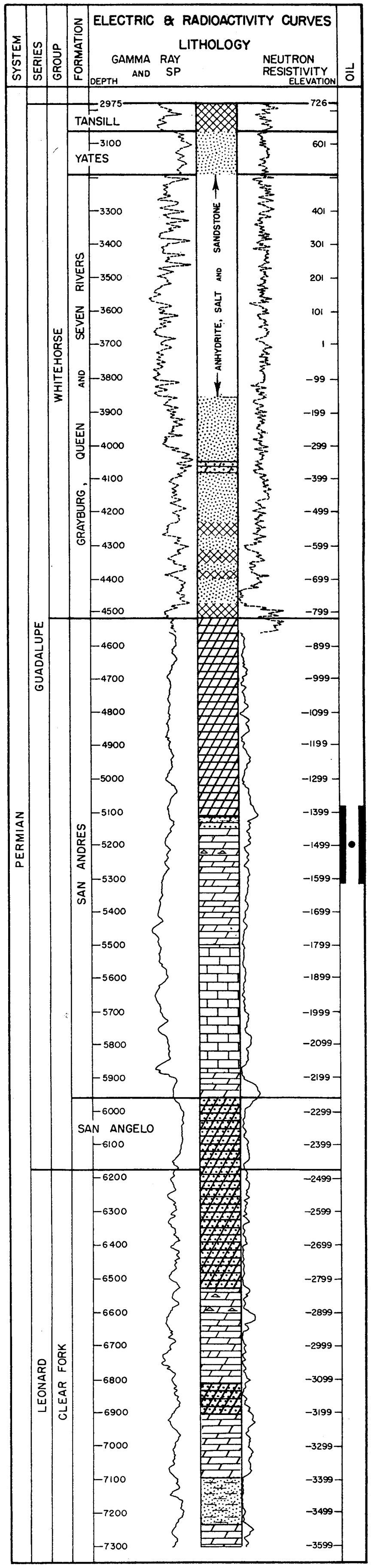
CHARACTER OF OIL

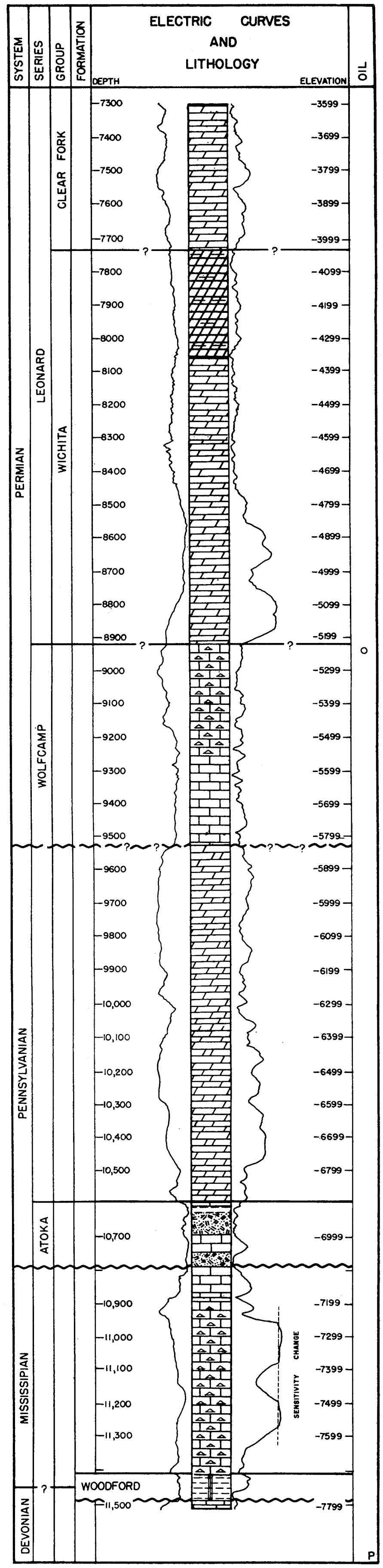
San Andres:

Gravity, A.P.I. @ 60° F., average: 30°
Sulphur: High percentage
Odor: Sour
Color: Brown to black

TYPICAL SECTION OF ROCKS PENETRATED

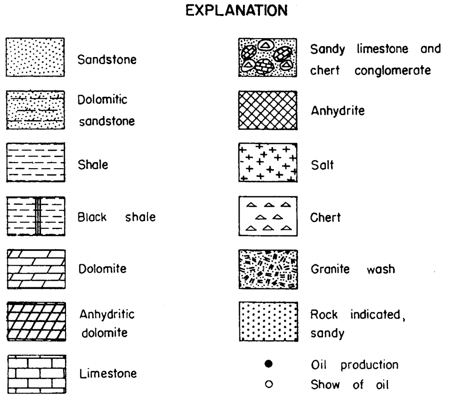






NOTE: This TYPICAL SECTION is based on the log of F. T. Brahaney #1 S. Henard to the depth of 4,565 feet and below that on the log of Signal Oil and Gas Co. #1 J. D. Webb, the deepest well in the field.

EXPLANATION



WATER PRODUCTION

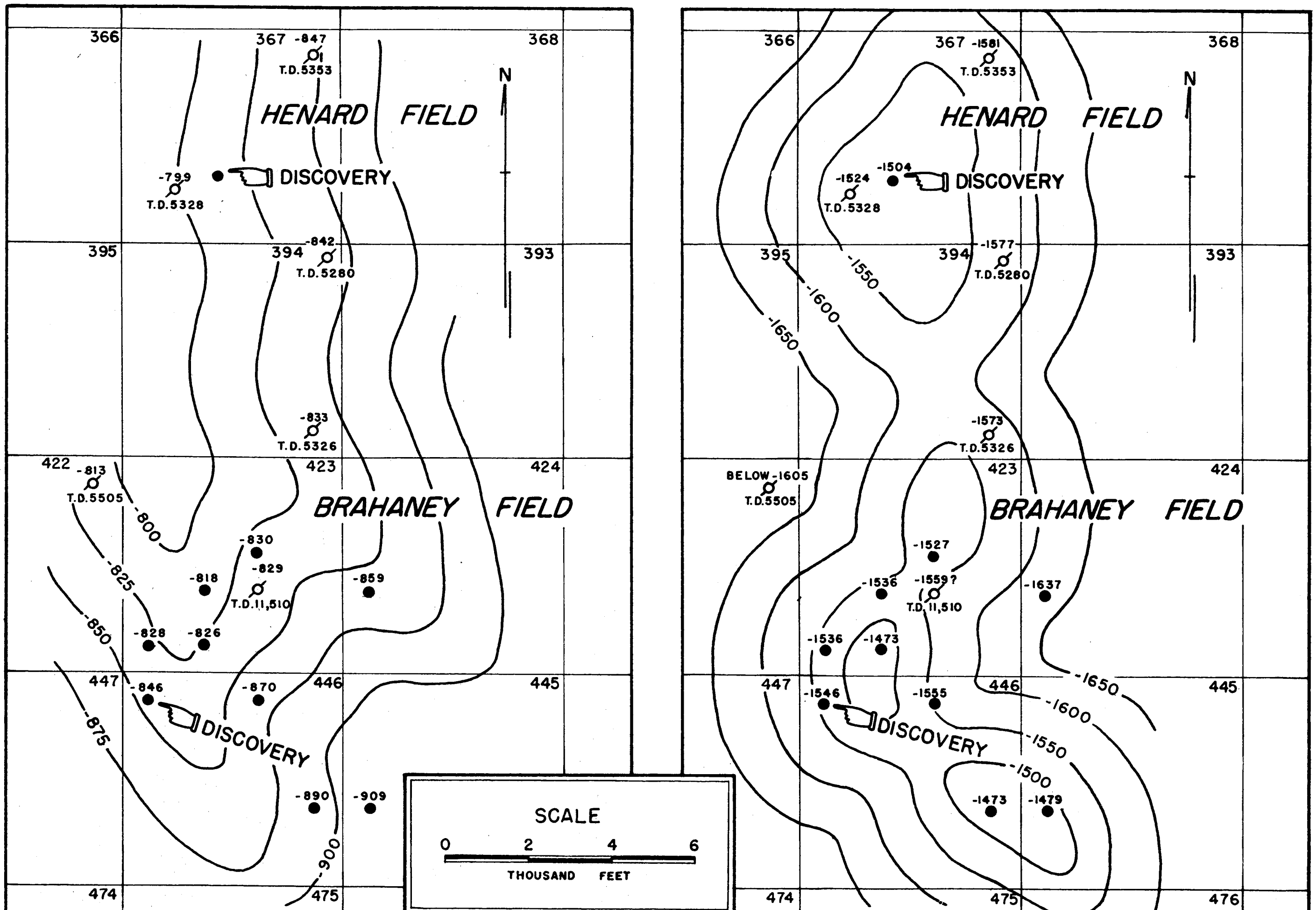
San Andres: Water constitutes an average of 20% of gross liquid produced by most wells initially, but this ratio usually decreases to 10 to 15% within a few weeks. No bottom hole water encroachment is evident at the present time.

ACID TREATMENT

San Andres: Each of the wells was treated with 3,000 to 21,000 gallons of acid. In most cases the treatment resulted in little or no increase in potential. The poor results from acid treatment are believed to be due to effects of the bentonitic shale in the reservoir rock.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1945	0	1	3,385	3,385
1946	0	1	6,027	9,412
1947	0	1	4,876	14,288
1948	0	1	5,577	19,865
1949	0	2	6,448	26,313
1950	0	2	6,970	33,283
1951	0	2	6,250	39,533
1952	1	6	19,765	59,298



EXPLANATION

- 875 Contour on top of San Andres formation

-818 ● Elevation of top of San Andres formation

● Oil Well ⌀ Dry Hole

EXPLANATION

-1550 Contour on top of effective San Andres porosity

-1555 ● Elevation of top of effective San Andres porosity

● Oil Well ⌀ Dry Hole

BREEDLOVE FIELD

Martin County, Texas

JACK D. THORNTON
Geologist, British-American Oil Producing Co., Midland, Texas
July 25, 1953

LOCATION

The Breedlove field is in the east quarter of League 258, Briscoe County School Land survey, in northwest Martin County about 13 miles northwest of the town of Tarzan and about 35 miles north of Midland. It is in the central portion of the Midland basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The location of the discovery well was based on seismograph work which had been conducted as a result of a study of subsurface geological data.

DISCOVERY

Devonian: July 19, 1951; Pan American Production Co. et al #1 F. D. Breedlove. This well was commenced on December 2, 1950, drilled to total depth of 13,053 feet in barren Ellenburger and plugged back to 12,120 feet and completed in Devonian dolomite. During initial potential test, it flowed at rate of 2,341 barrels of 41.3° gravity oil per day.

ELEVATION OF SURFACE

At well locations: Highest, 2,901 ft.; lowest, 2,895 ft.

SURFACE FORMATION

Undifferentiated rocks of the Cenozoic era.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 340 feet below the top of the Ellenburger group. This penetration was in the discovery well. The accompanying TYPICAL SECTION is based on the log of that well.

NATURE OF TRAP

Devonian: The accumulation is at the apex of a convex fold. Low porosity appears to delimit the productive area at the south end of the field.

PRODUCTIVE AREA

Devonian and Field: Estimated, 420 acres. Further development may provide data which would warrant changing this estimate.

THICKNESS OF RESERVOIR ROCK

Devonian:	Min.	Max.	Avg.
Net productive, feet	17	88	46

LITHOLOGY OF RESERVOIR ROCK

Devonian: Dolomite; light gray to colorless, vuggy and crystalized. Many vugs are partially filled with dolomite crystals that appear to be loosely cemented but are tightly held by dolomitic cement; good intercrystalline porosity is left since the small rhombohedral crystals are not surrounded by the cement.

CONTINUITY OF RESERVOIR ROCK

Devonian: The reservoir rock is continuous throughout the area covered by the accompanying map. There is dolomite at the same stratigraphic position throughout most of the Permian basin, but whether the particular bed which is productive in this field is continuous over a large area cannot be determined.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Devonian:	Feet, approx.
No free gas cap	
Elevation of top of oil	-9,167
Elevation of bottom of oil	-9,272
Relief	105

CHARACTER OF OIL

Devonian:
Gravity, A.P.I. @ 60° F.: 40.8° Base: Paraffin
Sulphur: .18% (No hydrogen sulphide)
Viscosity: 60 sec. @ 50° F.; 47 sec. @ 75° F.; 41 sec. @ 100° F.

WATER PRODUCTION

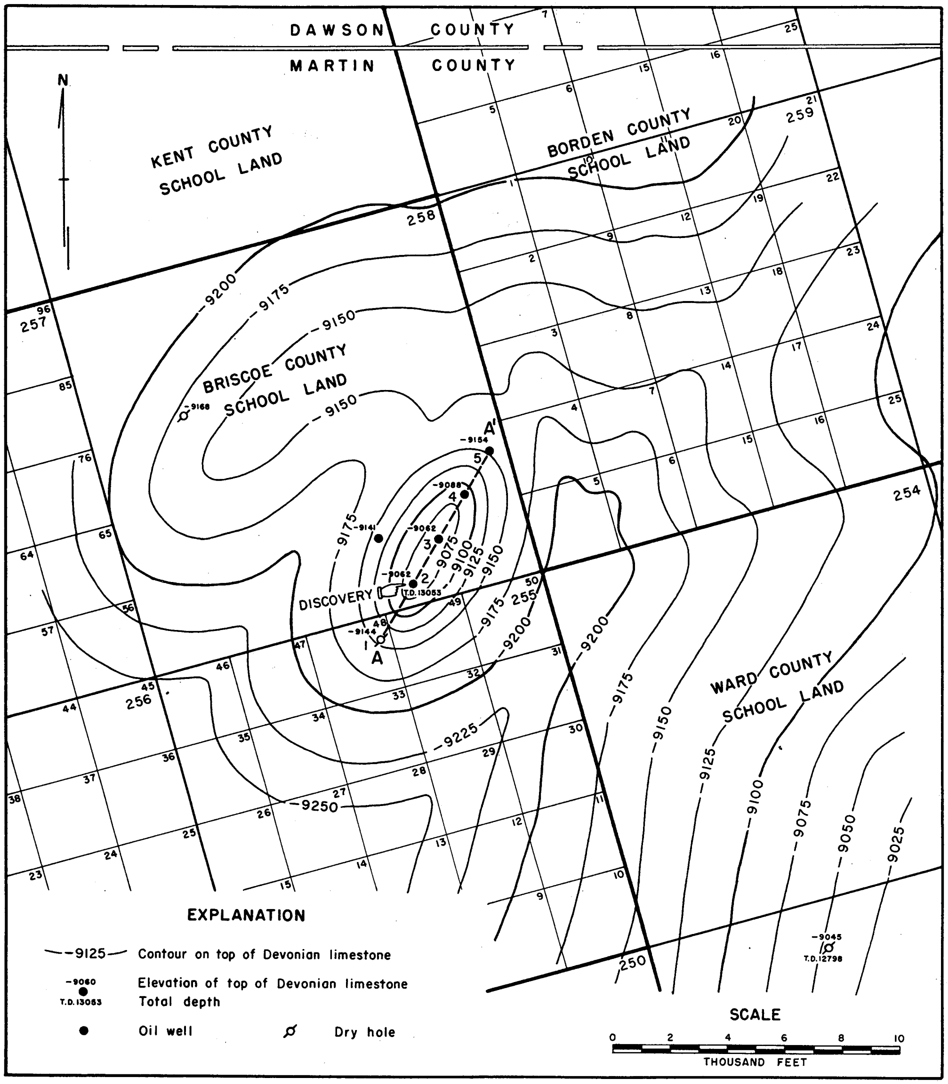
Devonian: No water has been produced to date.

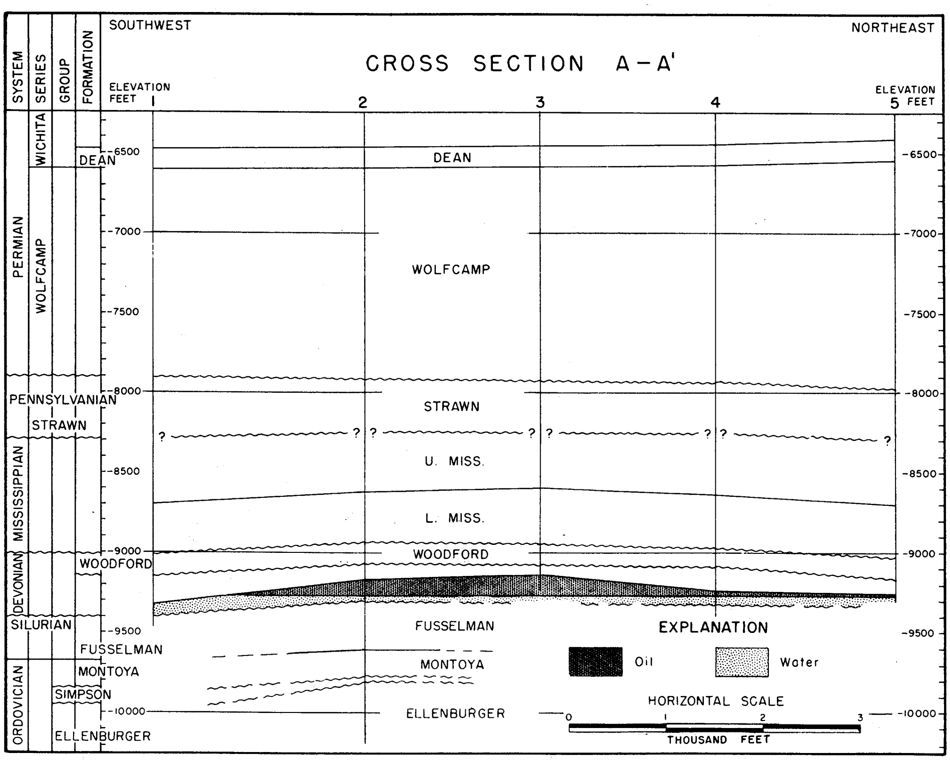
ACID TREATMENT

Usually the wells are treated with 500 gallons of acid in the process of completion. However, one well was treated with 11,000 gallons of acid.

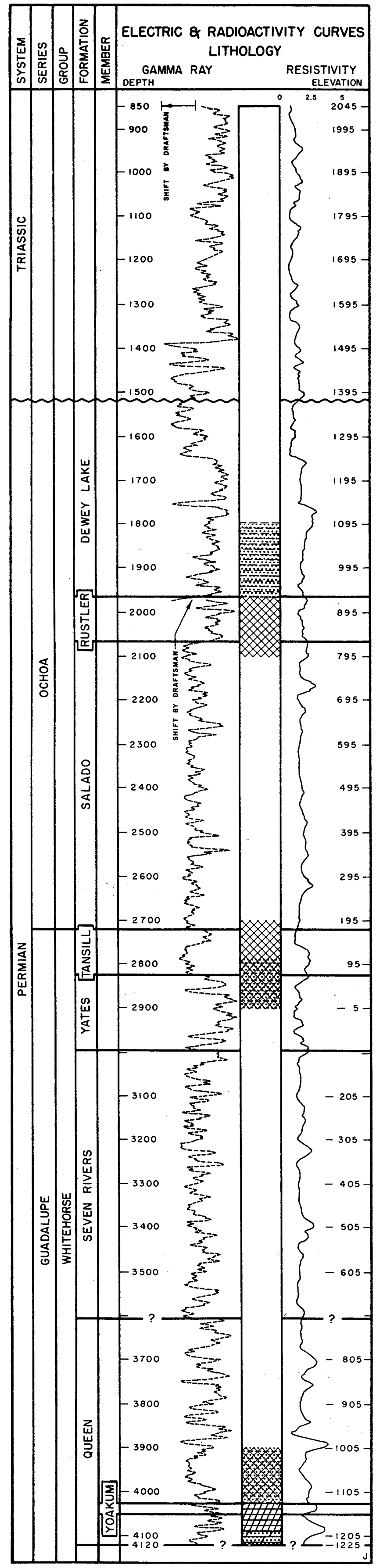
PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1951	1	57,211	57,211
1952	3	301,030	358,241
1953 to 5/1	5	25,215	383,456

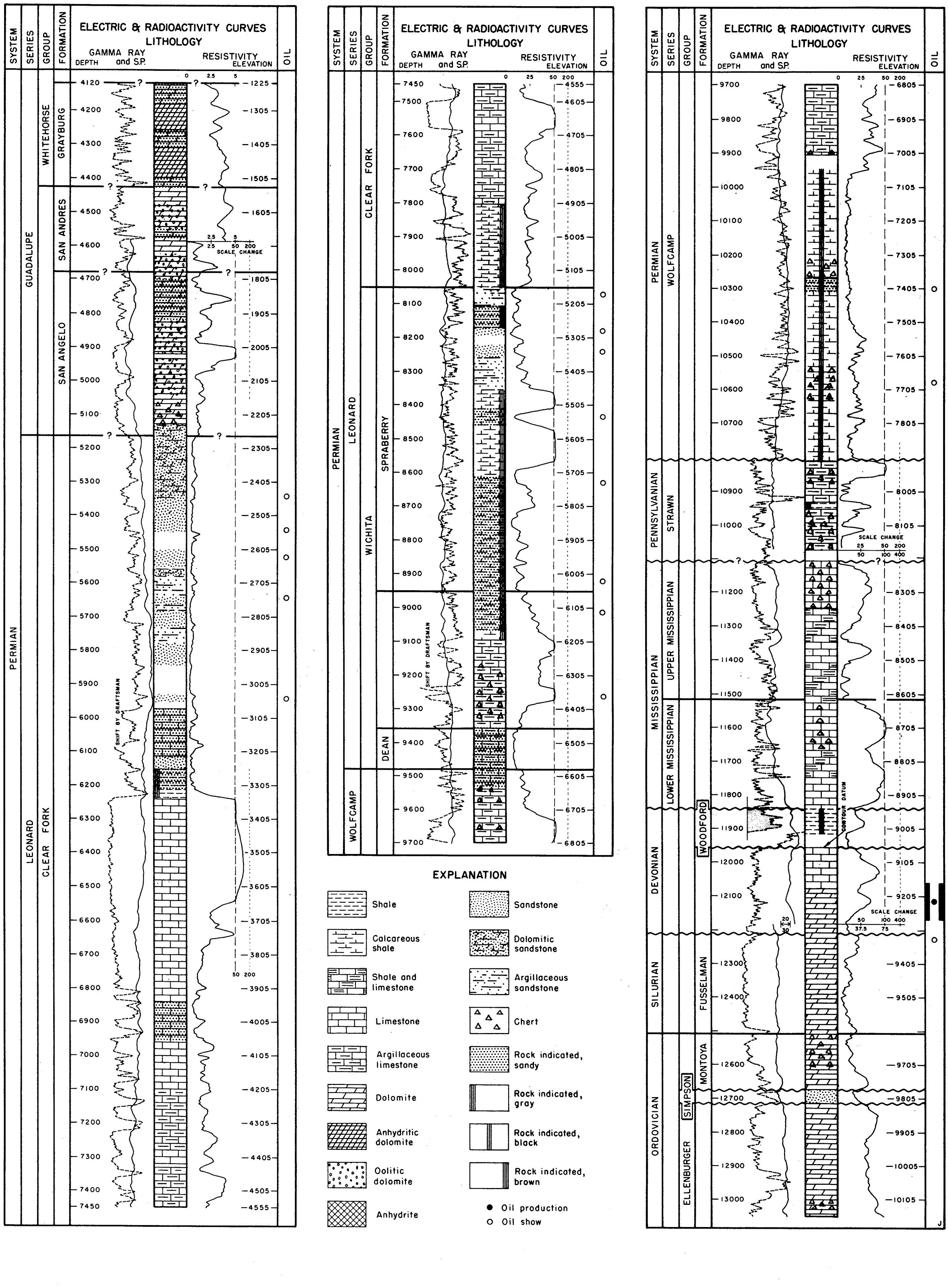




TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED



BRUSHY TOP FIELD

Sutton County, Texas

RICHARD A. LISMAN
Geologist, Vincent & Welch, Inc., Midland, Texas
June 27, 1955

LOCATION

The Brushy Top field is in north central Sutton County, less than a mile from the northern boundary of the county, and 8½ miles north of Sonora, county seat. It is in sections 66 and 67, Block A, H.E. & W.T. R.R. Co. survey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Mapping of subsurface geological data led to the drilling of the discovery well.

DISCOVERY

San Angelo: December 28, 1950; C.L.Norsworthy, Jr., and Lone Star Producing Co. #1 R.M.Thomson.

ELEVATION OF SURFACE

At well locations (derrick floor): Highest, 2,340 feet; lowest, 2,284 feet.

SURFACE FORMATION

Edwards formation of the Fredericksburg group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 537 feet below its top. This penetration was in the discovery well. The accompanying TYPICAL SECTION is based on the log of that well.

NATURE OF TRAP

San Angelo: Lensing out updipward on a small terrace on a monocline.

PRODUCTIVE AREA

San Angelo and Field: 160 acres.

THICKNESS OF RESERVOIR ROCK

San Angelo:

Top to bottom,	86 feet, average
Net productive,	Not yet determined

LITHOLOGY OF RESERVOIR ROCK

San Angelo: Sandstone; gray, white and tan; fine- to medium-grained.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Angelo:	Feet
Elevation of top of oil	1,411
Elevation of bottom of oil	1,325
Relief	86

CHARACTER OF OIL

San Angelo: Gravity, A. P. I. @ 60°F. : 36.4°

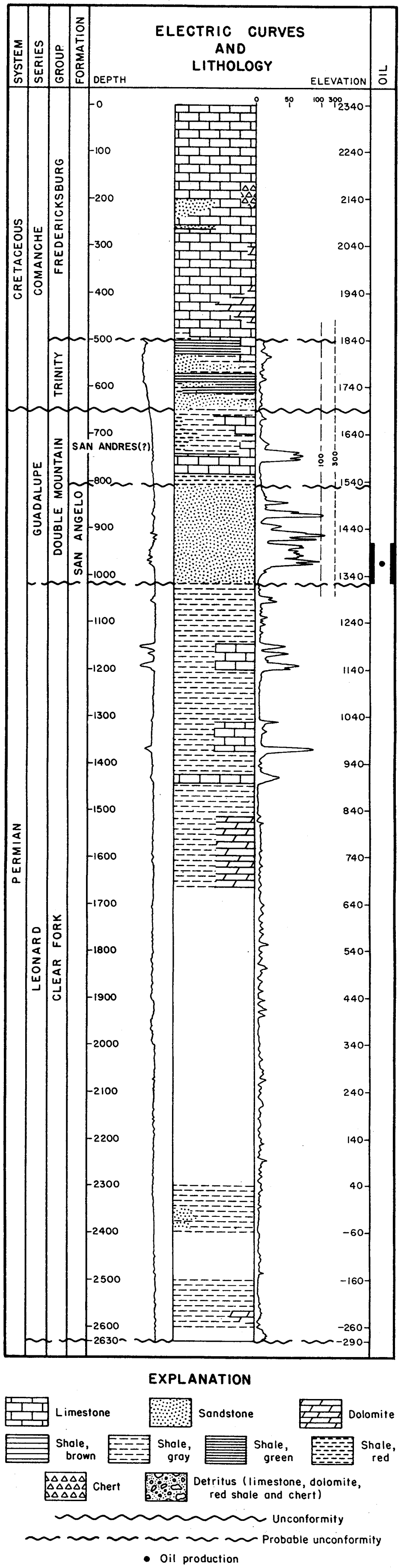
ACID TREATMENT

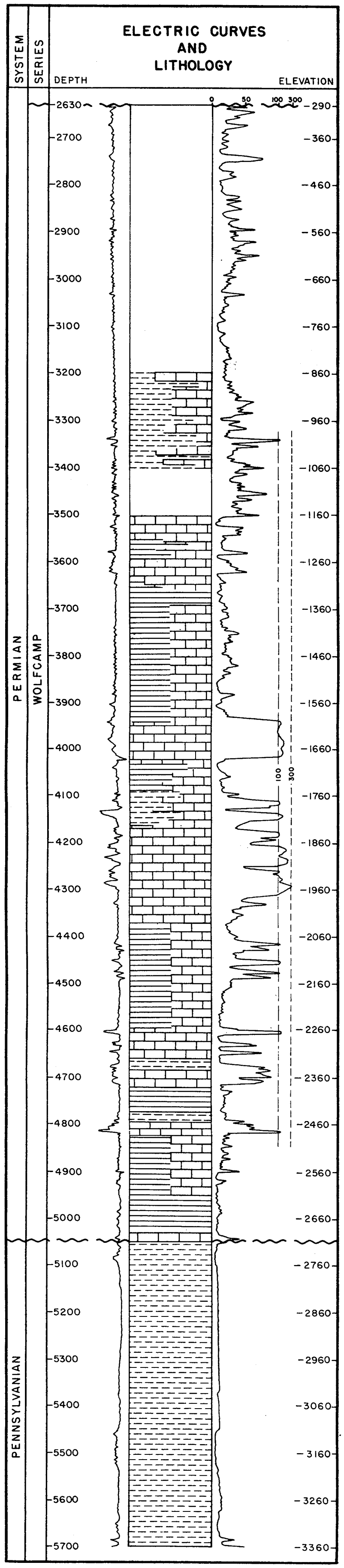
San Angelo: The reservoir rock in the discovery well was treated with 500 gallons of acid; in one well, with 1,000 gallons and in another well, with 3,000 gallons.

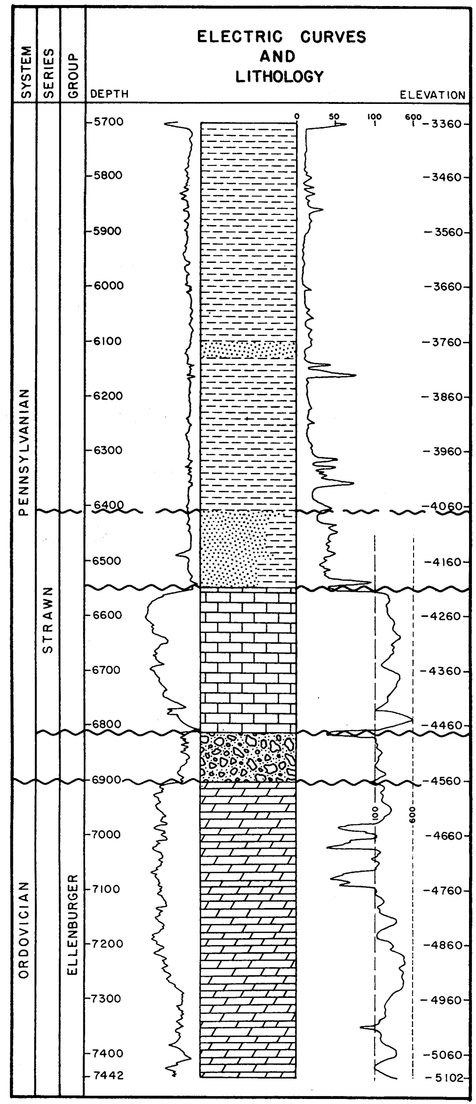
PRODUCTION HISTORY

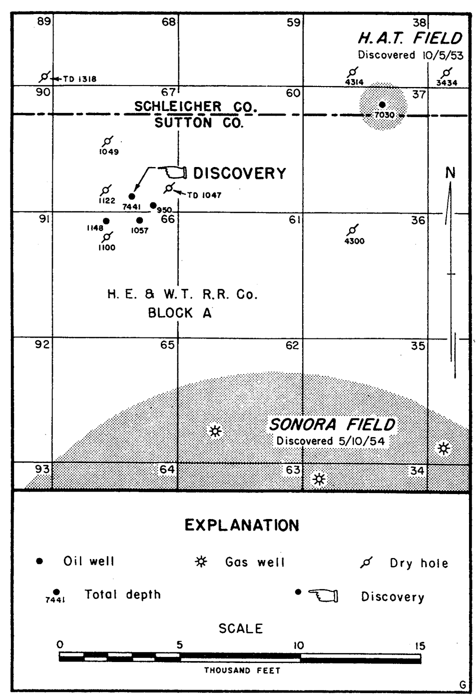
Year	WELLS PRODUCING at end of year — All pumping	OIL PRODUCTION (barrels) — Yearly	Cumulative
1950	1	490	490
1951	4	8,990	9,480
1952	3	5,610	15,090
1953	3	5,527	20,617
1954	2	4,369	24,986

TYPICAL SECTION OF ROCKS PENETRATED









CANNING FIELD

Borden County, Texas

MARVIN T. CARLSEN
Geologist, Standard Oil Co. of Texas, Lubbock, Texas
April 28, 1954

LOCATION

The Canning field (one well) is in southeastern Borden County about 3 miles north of the Von Roeder field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Seismographic surveying.

DISCOVERY

Wolfcamp: August 2, 1950; Vickers Petroleum Co. & Norwood Drilling Co. #1-A J.R. Canning.

ELEVATION OF SURFACE

At discovery well: 2,320 feet.

SURFACE FORMATION

Undifferentiated Dockum group, Triassic system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is 120 feet below the top of the Ellenburger group. This penetration was in the dry hole 1,320 feet north of the producing well. The accompanying TYPICAL SECTION is based on the log of that dry hole.

NATURE OF TRAP

Wolfcamp: The accumulation is at the apex of a local convex fold. It appears likely that the extent of the commercially productive area is determined in part by degree of porosity and permeability. It is possible that southward (updip) decrease of porosity and permeability has functioned as a trap-forming factor.

PRODUCTIVE AREA

Wolfcamp: 40 acres.

THICKNESS OF RESERVOIR ROCK

Wolfcamp:	Feet, estimated
From top to bottom, maximum	90
Net productive, maximum	40 to 60

LITHOLOGY OF RESERVOIR ROCK

Wolfcamp: Tan to dark brown, crystalline, moderately to slightly porous, fossiliferous limestone with brown, fossiliferous chert in variable amounts up to about 15% and with traces of pyrite.

CONTINUITY OF RESERVOIR ROCK

Wolfcamp: The stratigraphic equivalent of the reservoir rock is present throughout most of the northern part of the Midland basin. Its thickness, porosity, permeability and degree of purity vary considerably from county to county. So far as the writer knows, the only other place where this stratigraphic unit produces oil is in eastern Andrews County.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Wolfcamp:	In discovery well
No free gas cap	
Elevation of top of oil, feet	-3,593
Elevation of total depth, feet	-3,611
Known relief of oil, feet	18

The elevation of the oil-water contact has not been determined. Showings of oil in near-by dry holes indicate that the oil column may extend considerably lower than the lowest elevation observed in the productive well. The erratic nature of the porosity leaves doubt that the oil column extends downward to the elevation of the lowest showing in near-by dry holes.

CHARACTER OF OIL

Wolfcamp: Gravity, A.P.I. @ 60° F. 41°

WATER PRODUCTION

None

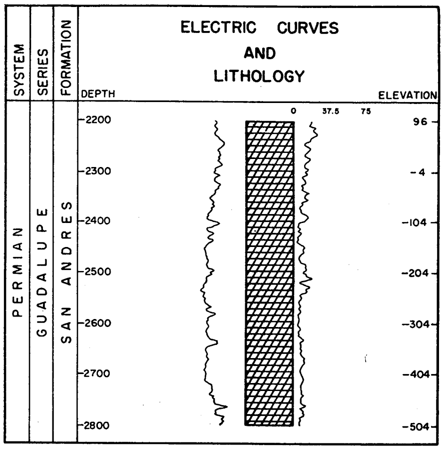
ACID TREATMENT

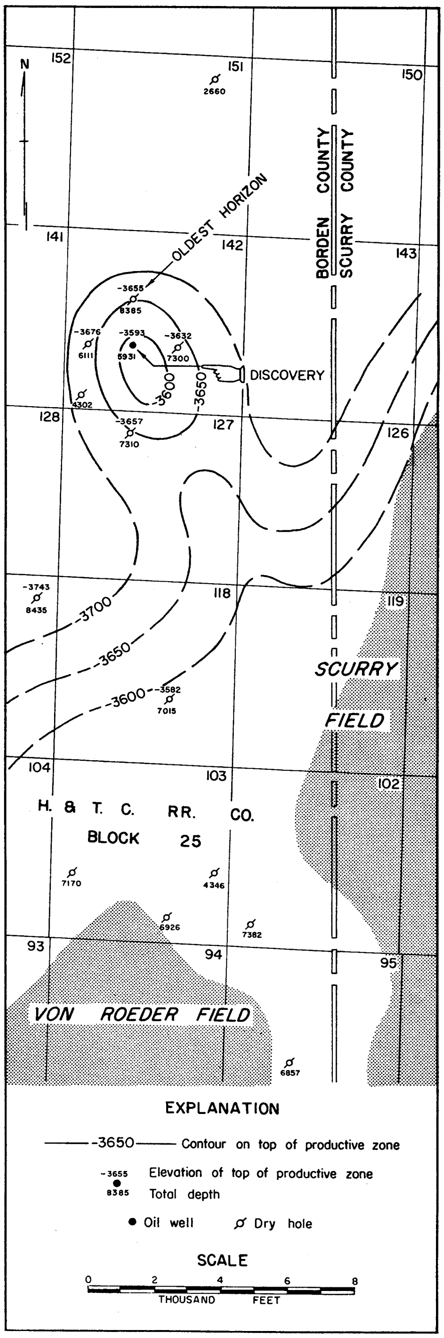
None

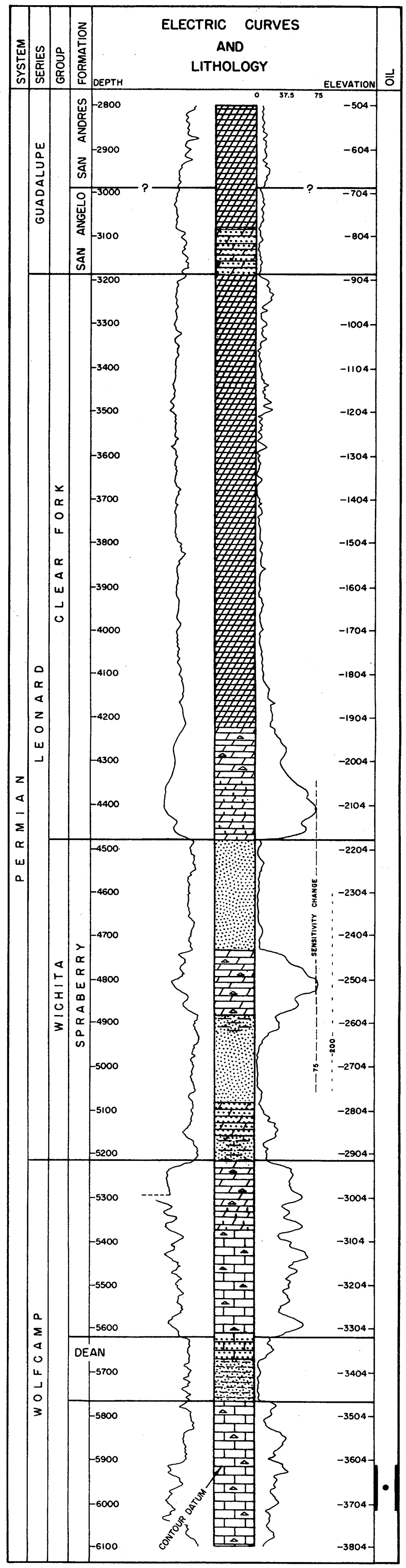
PRODUCTION HISTORY

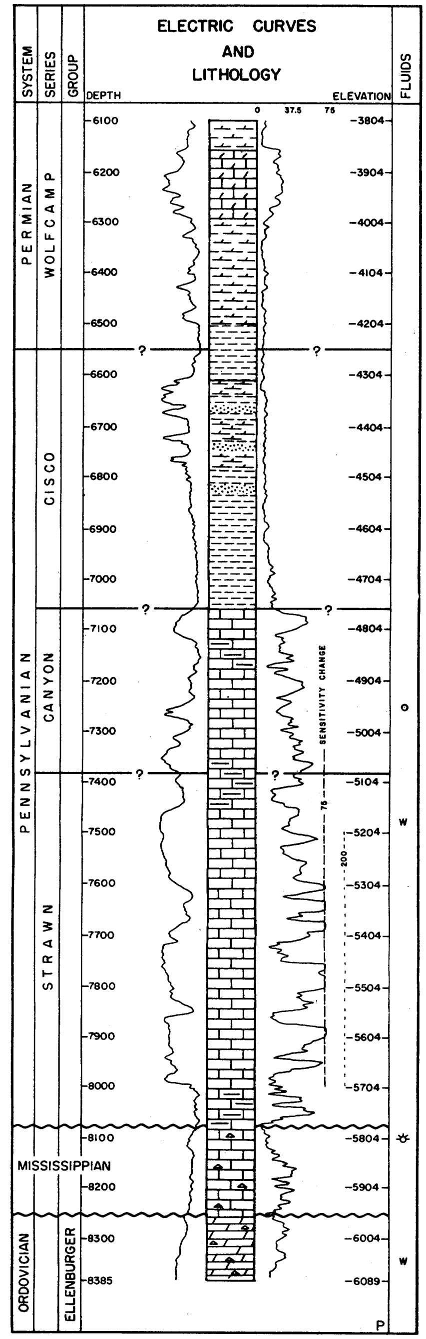
Wolfcamp: The one well produced 20,102 barrels of oil in 1950; 42,221 barrels in 1951; 22,830 barrels in 1952; 19,586 barrels in 1953; total to end of 1953, 104,739 barrels of oil.

TYPICAL SECTION OF ROCKS PENETRATED

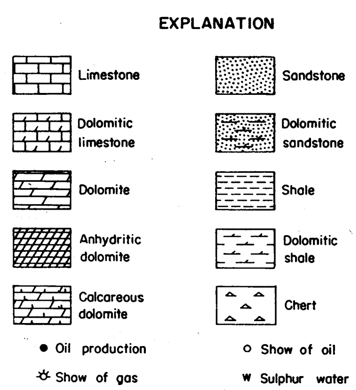








NOTE: The above section is based on the log of Vickers Petroleum Co. & Norwood Drilling Co. #1-B J.R. Canning, the dry hole 1320 feet north of the producing well.



CARTER FIELD

Glasscock County, Texas

JERRY F. SIDES
Geologist, The Superior Oil Company, Midland, Texas
April 7, 1954

LOCATION

The Carter field is in north-central Glasscock County 7 miles north of Garden City, county seat, and 6½ miles south of the western portion of the Howard-Glasscock field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Random drilling.

DISCOVERY

San Andres: October 4, 1936; Floyd C. Dodson & B. A. Duffy #1 Carter Heirs. During potential test, this well produced at rate of 128 barrels of oil per day; actual pumping capacity was estimated as 50 barrels of oil per day. The accompanying TYPICAL SECTION is based on the log of this well.

ELEVATION OF SURFACE

The elevation of the surface is 2,610 feet above sea level at the producing well and is 2,623 feet above sea level at the abandoned well.

SURFACE FORMATION

Undifferentiated formation in the Trinity group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

Each of the two productive wells was drilled only a few feet below the productive zone. The oldest horizon penetrated in the vicinity of the field is about 52 feet below the top of the Ellenburger group. This penetration was in Ralph Lowe #1 Neal-Ballinger, a dry hole in SE cor. Sec. 16, about 2 miles east of the field, at its total depth of 10,336 feet.

NATURE OF TRAP

San Andres: The trap is formed by updip lensing of porous zone on a structural nose.

PRODUCTIVE AREA

San Andres and Field: 40 acres.

THICKNESS OF RESERVOIR ROCK

San Andres:	Feet
From top to bottom	35
Net productive	10

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomite; cream to tan, fine to medium crystalline, scattered pin-point porosity, gray-green shale stringers.

CONTINUITY OF RESERVOIR ROCK

San Andres: The reservoir rock is continuous throughout the area covered by the accompanying map and also throughout a much larger surrounding area. However, the degree of porosity which occasions commercial production is not continuous beyond the immediate vicinity of the two productive wells (one, abandoned).

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Andres:	Feet
No free gas cap	
Elevation of top of oil	-19
Elevation of bottom of oil	-54
Relief	35

CHARACTER OF OIL

Gravity:	28.5° to 33°	Color:	Dark green
Sulphur:	0.67%	Base:	Intermediate

For analysis see:
U. S. Bureau of Mines Lab. ref. No. 38152
Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939) Item 36, Grp. 2

WATER PRODUCTION

San Andres: Water currently constitutes about 90% of the gross production.

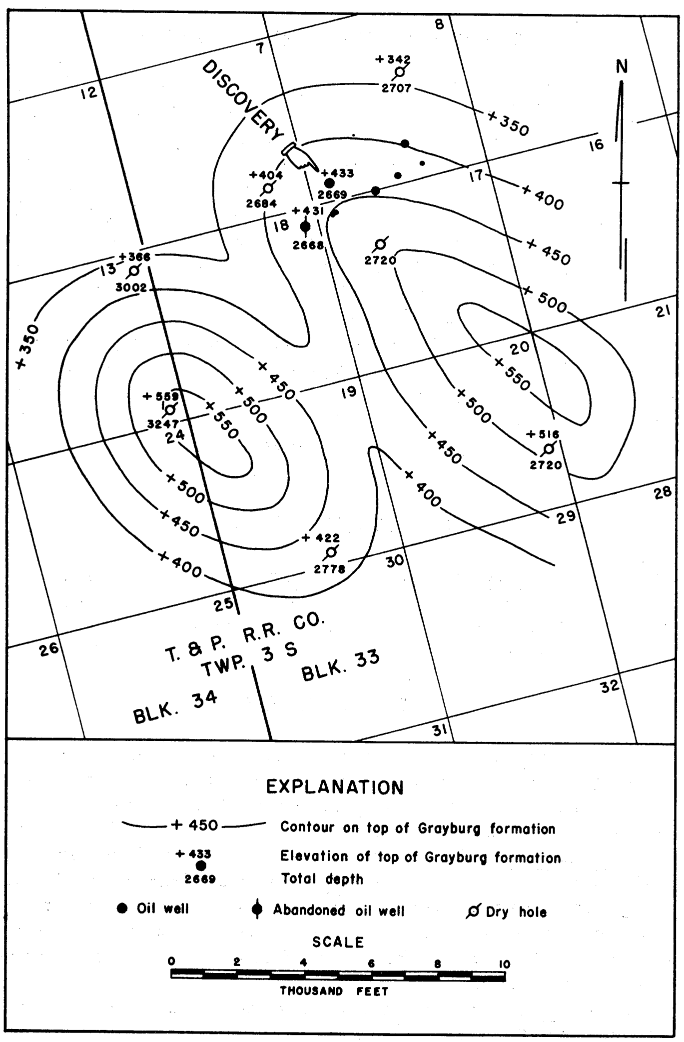
ACID TREATMENT

San Andres: The discovery well was treated with 3,000 gallons of acid.

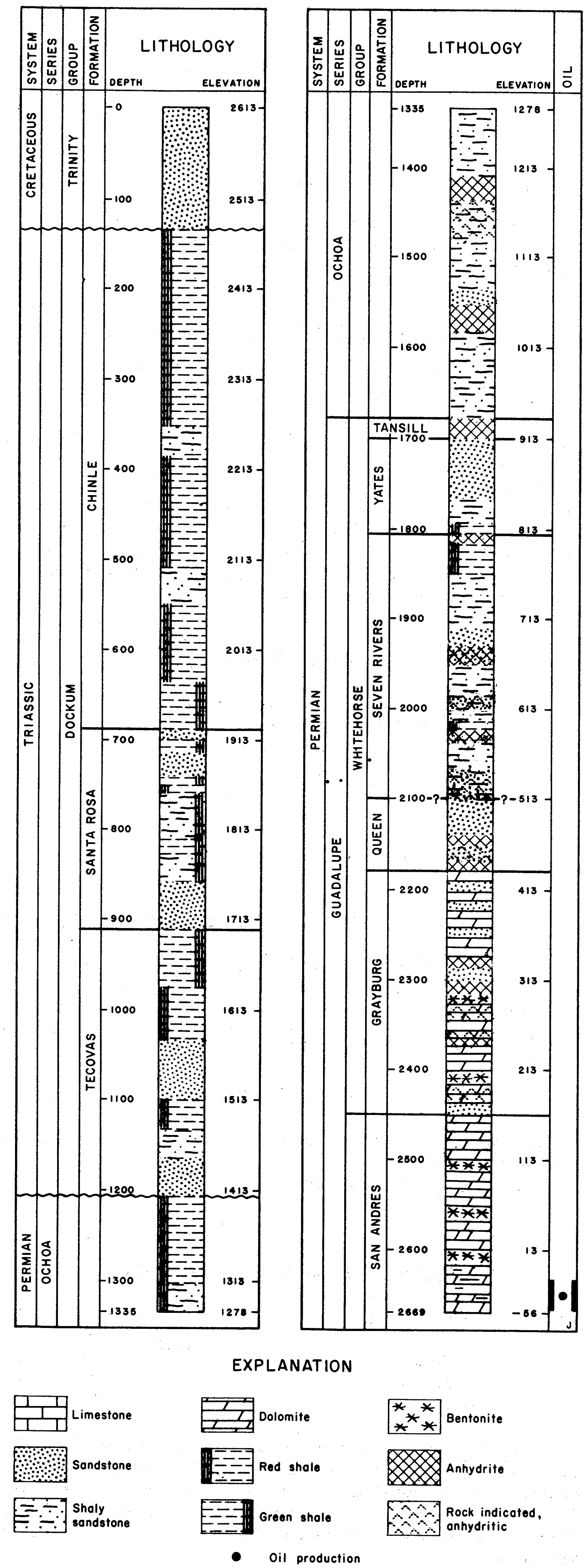
PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1937	2	2,716	2,716
1938	2	6,337	9,053
1939	2	10,021	19,074
1940	1	7,098	26,172
1941	1	5,212	31,384
1942	0	1,937	33,321
1943	0	0	33,321
1944	0	0	33,321
1945	0	0	33,321
1946	0	0	33,321
1947	1	2,643	35,964
1948	1	2,672	38,636
1949	1	2,829	41,465
1950	1	2,701	44,166
1951	1	2,997	47,163
1952	1	2,474	49,637
1953	1	2,136	51,773

The second well was completed in July 1937 and abandoned in October 1940. The discovery well was not operated during the period from July 1942 to April 1947.



TYPICAL SECTION OF ROCKS PENETRATED



C-BAR FIELD

Crane County, Texas

A. M. SCHIEMENZ
Assistant District Geologist, Phillips Petroleum Co., Midland, Texas
October 8, 1953

LOCATION

The C-Bar field is in north-central Crane County approximately 16 miles east of the town of Monahans. It is on the southeast portion of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph work conducted by the Gulf Oil Corporation indicated favorable structural conditions in pre-Permian strata. Gulf staked location for its #1 on the Hattie Connell "A" tract with the intention of drilling to sufficient depth to test the Ellenburger group, and, accordingly, designated the well as #1-E-A Hattie Connell. However, the well was completed as a producer from reservoir rock in the Silurian system and the designation was changed to #1-Si-A Hattie Connell. This well, through discovery of commercial oil in the Fusselman formation of the Silurian system, resulted in the discovery of the C-Bar field.

DISCOVERIES

San Andres: February 24, 1949;
Gulf Oil Corp. #3-SA-G Hattie Connell
Fusselman and Field: January 26, 1948;
Gulf Oil Corp. #1-Si-A Hattie Connell
Connell: September 30, 1948;
Gulf Oil Corp. #1-C-G Hattie Connell
This well was dually completed in the Fusselman and Connell reservoirs.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is 285 feet below the top of the Ellenburger group. That penetration was in the Connell discovery well. The accompanying TYPICAL SECTION is based on the log of that well.

NATURE OF TRAPS

San Andres: Combination of convex fold and termination of favorable porosity.
Fusselman: Convex fold.
Connell: Convex fold.

THICKNESSES OF RESERVOIR ROCKS

From top to bottom, gross	Feet		
	Min.	Max.	Avg.
San Andres	0	100	50
Fusselman	45	55	50
Connell	55	55	55

San Andres: The reservoir in the San Andres formation is about 100 feet thick along the east side of the field and it gradually thins westward to zero at the west limit of the field. The top of the reservoir rock is at varying positions from zero to 100 feet below the top of the San Andres formation.

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomite; fine to medium crystalline, oolitic in part. Porosity is primarily vuggy; some intercrystalline porosity.

Fusselman: Limestone; coarsely crystalline; primarily white with pinkish tint locally; minor amounts of milky white chert throughout. Porosity is intercrystalline generally; vuggy locally.

Connell: Sandstone with a minor amount of dense, tan limestone. The sandstone is clear to light tan with medium to coarse angular to sub-angular grains, mostly unconsolidated. Although this reservoir rock has been tested at only two locations in this field, from a regional standpoint it is known that its lithology is not generally favorable for oil production. Oil shows have been observed in many tests, but there are only few wells completed to produce from this zone. In some places it has been cased off and the wells completed for production from a more prolific zone. Generally, drill-stem testing of the Connell is difficult unless the hole is cased; therefore, it probably has not been adequately tested at all places where it has been penetrated.

CONTINUITY OF RESERVOIR ROCKS

San Andres: The reservoir rock is widespread and produces in several fields in the region. However, in this immediate vicinity, favorable porosity is not continuous westward beyond the boundary of the field. The west boundary is determined by termination of favorable porosity.

Fusselman: Wells have been drilled to the depth of this reservoir at only three locations in the field, so little is known relative to local continuity. It is widespread in the region and, so far as known, is productive wherever structural conditions have afforded a trap.

Connell: Wells have been drilled to the depth of this reservoir at only three locations in the field, so little is known relative to local continuity. It is widespread in the region but, because of its lithologic nature, it is commercially productive in only few places.

CHARACTER OF OIL

Gravity, A. P. I. @ 60° F.	Range	Avg.
San Andres	32.8° to 35.2°	34.0°
Fusselman	35.9° to 39.6°	37.7°
Connell	42.8°	42.8°

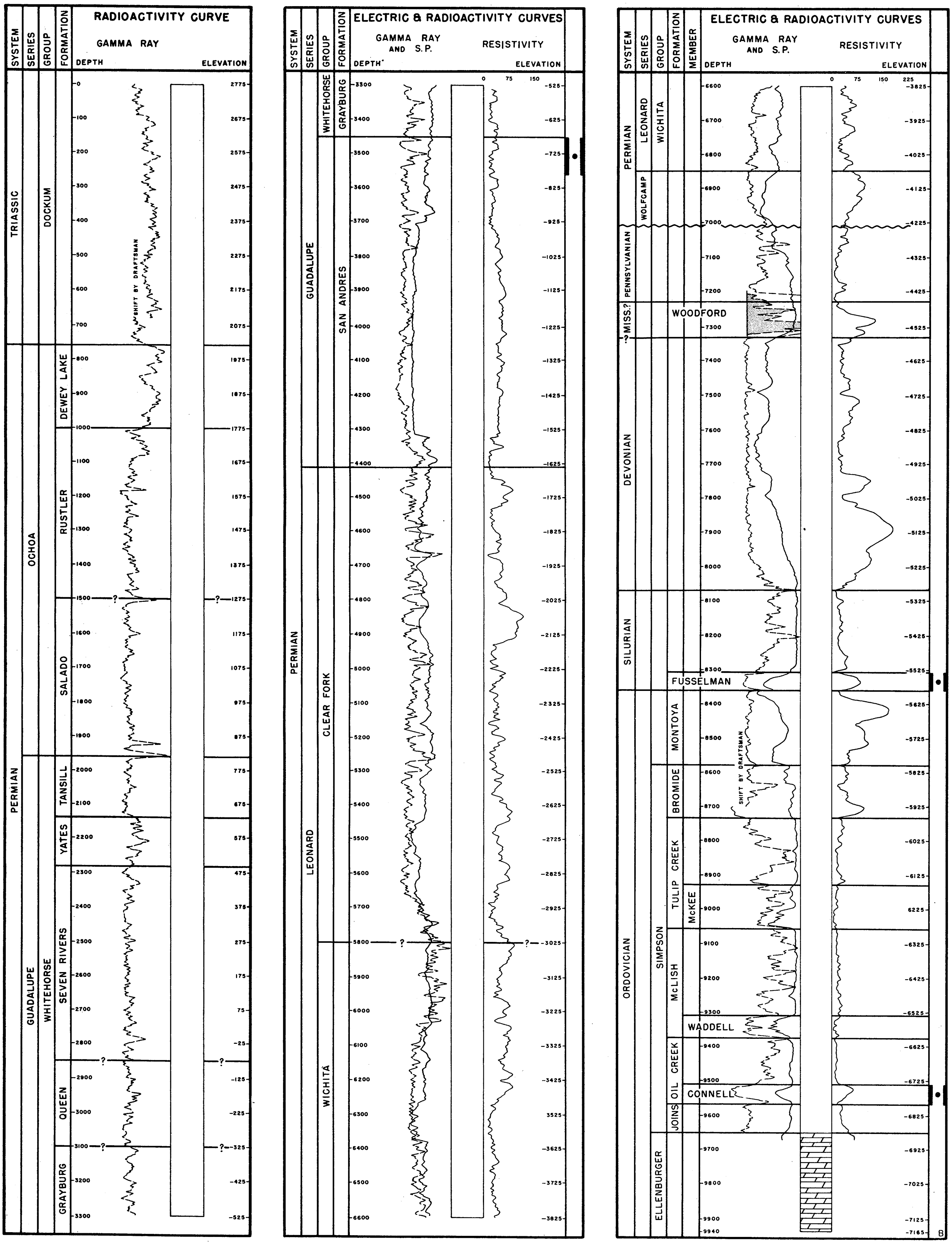
ACID TREATMENT

San Andres: Most wells have been acidized. The quantity of acid used has been 1,000 gallons or more for each treatment. Many of the wells have been shot with nitroglycerin and then acidized.

Fusselman: The discovery well was washed with 200 gallons of mud acid. The only other productive well was completed without acid treatment. Fusselman porosity is such that generally acid is not needed other than to wash out the mud which has been forced into the reservoir in the process of drilling.

Connell: In the only productive well, the reservoir was washed with 200 barrels of mud acid.

TYPICAL SECTION OF ROCKS PENETRATED



ELEVATION OF SURFACE

At well locations: Highest, 2,798 feet; lowest, 2,722 feet.

SURFACE FORMATION

Recent wind-blown sands

PRODUCTIVE AREAS

	Acres
San Andres	1,840
Fusselman	320
Connell	160
C-Bar field	1,840

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	San Andres	Fusselman	Connell
Highest known elev. of oil, ft.	-630	-5,579	-6,735
Lowest known elev. of oil, ft.	-730	-5,624	-6,790
Known relief	100	45	55

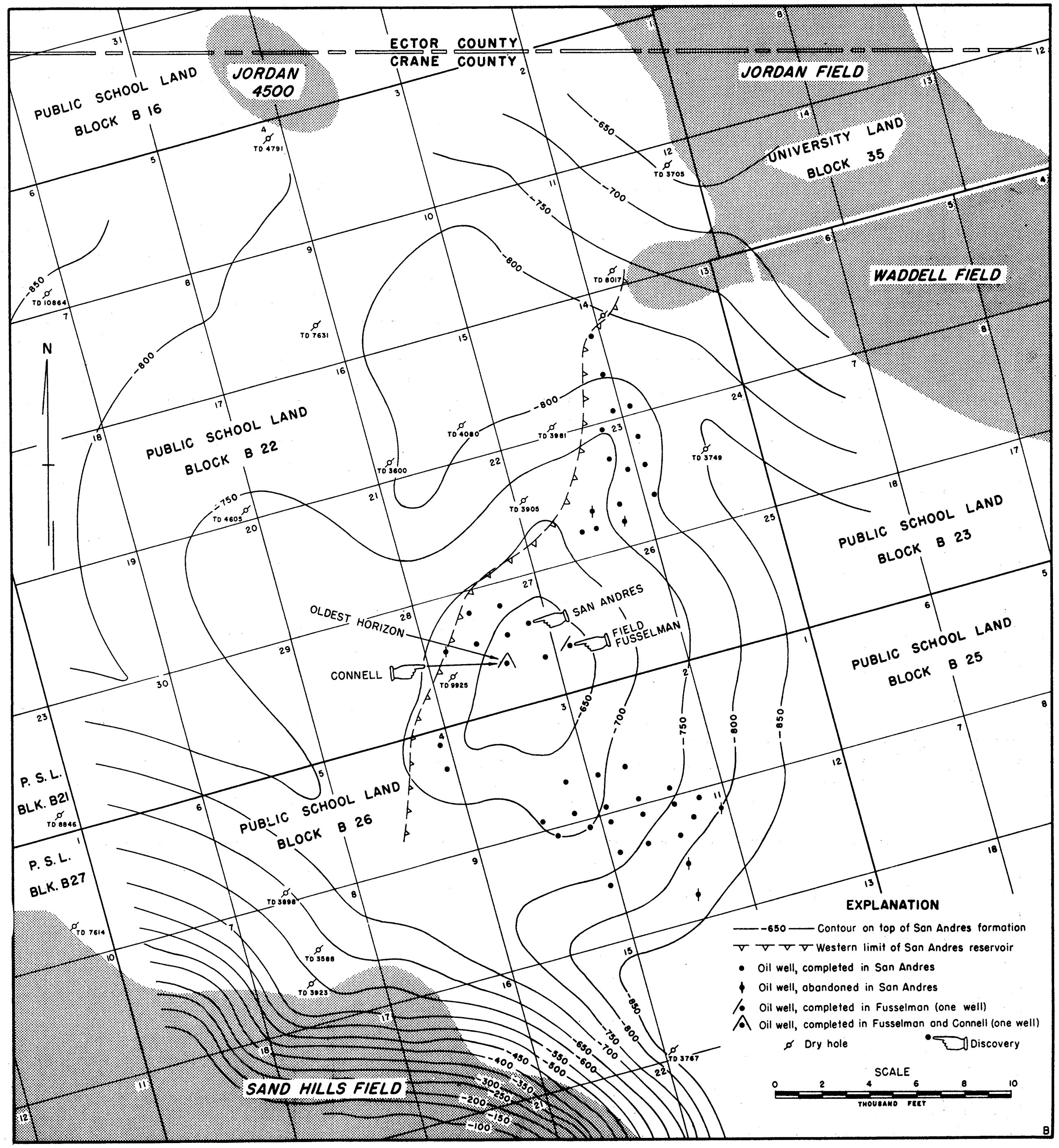
The elevation of the oil-water contact has not been determined in the Fusselman reservoir nor in the Connell reservoir.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)	
	Flow.	Pump.	Total*	Yearly	Cumulative
Field totals					
1948	3	0	2	45,880	45,880
1949	3	2	4	48,794	94,674
1950	4	31	34	176,759	271,433
1951	3	43	46	247,210	518,643
1952	6	36	42	180,781	699,424
1953**	2	40	42	165,699	865,123
1954**	3	39	42	194,114	1,059,237
San Andres					
1949	2	0	2	13,889	13,889
1950	3	29	32	159,239	173,128
1951	1	42	43	222,154	395,282
1952	6	35	41	161,389	556,671
1953**	2	39	41	139,298	695,969
1954**	3	38	41	172,198	868,167
Fusselman					
1948	2	0	2	35,404	35,404
1949	0	2	2	20,672	56,076
1950	0	2	2	6,483	62,559
1951	1	1	2	20,133	82,692
1952	0	1	1	19,392	102,084
1953**	0	1	1	26,401	128,485
1954**	0	1	1	21,916	150,401
Connell*					
1948	1	0	1	10,476	10,476
1949	1	0	1	14,233	24,709
1950	1	0	1	11,037	35,746
1951	0	0	0	4,923	40,669

*Gulf Oil Corp. #1-C-G Hattie Connell was dually completed and produced from both Fusselman and Connell. It was abandoned in Connell in 1951.

**1953 and 1954 data added by amendment.



CHANCELLOR FIELD

Pecos County, Texas

JOSEPH W. LUCKETT, Jr.
District Geologist, The Pure Oil Co., Midland, Texas
March 1, 1954

LOCATION

The Chancellor field is 22 miles west of Fort Stockton. It is in the southern portion of the Delaware basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Mapping of surface exposures of Cretaceous beds and subsequent selective core drilling by The Pure Oil Company led to the drilling of the discovery well.

DISCOVERIES

Lamar limestone: August 24, 1942;
The Pure Oil Co. #1 Paul LeGros
Bell Canyon sandstone and Field: March 24, 1942;
The Pure Oil Co. #1-A G.C. Fraser

ELEVATION OF SURFACE

Elevation of derrick floor at Lamar well, 3,306 feet; at Bell Canyon well, 3,311 feet.

SURFACE FORMATION

Undifferentiated Washita-Fredericksburg limestones.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Bell Canyon formation 920 feet below its top. This penetration was in The Pure Oil Co. #1-A G.C. Fraser, the field discovery well, at its total depth of 6,001 feet.

NATURE OF TRAPS

Lamar limestone: The trap appears to be due primarily to convex folding. The details of the trap are probably controlled by the fractures in the limestone. The fractures probably extend to the underlying Bell Canyon sandstone and have provided channels of migration by which the oil has moved from there into this reservoir.

Bell Canyon sandstone: The trap is at the apex of a convex fold.

PRODUCTIVE AREAS

	Acres
Lamar limestone (1 well)	40
Bell Canyon sandstone (1 well)	40

LITHOLOGY OF RESERVOIR ROCKS

Lamar limestone: A black, silty limestone with porosity afforded by numerous fractures.

Bell Canyon sandstone: A fine-grained, silty, uniform, gray sandstone with thin streaks of black, silty limestone.

CONTINUITY OF RESERVOIR ROCKS

Lamar limestone: This reservoir rock is continuous throughout the region. However, the fractured condition which occasions its being a productive reservoir at this location is a local condition.

Bell Canyon sandstone: This reservoir rock is continuous throughout the region.

THICKNESSES OF RESERVOIR ROCKS

	Feet
Lamar limestone	25
Bell Canyon sandstone	15 to 20

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Lamar limestone: (one well)	Feet
Elevation of top of oil	-1,753
Elevation of total depth	-1,754
Proven relief	1
Bell Canyon sandstone: (one well)	
Elevation of top of oil	-1,771
Elevation of bottom of oil	-1,787
Relief	16

CHARACTER OF OIL

	Lamar	Bell Canyon
Gravity, A.P.I. @ 60° F.	37°	37°
Sulphur indication	Sweet	Sweet
Gas-oil ratio	830:1	753:1

WATER PRODUCTION

The well completed in the Bell Canyon sandstone initially produced some water with its oil production, but the water ratio declined and soon only oil was produced.

COMPLETION TREATMENT

Lamar limestone: The well in this reservoir was completed without treatment of the reservoir rock.

Bell Canyon sandstone: The reservoir rock was shot with 119 quarts of nitroglycerin.

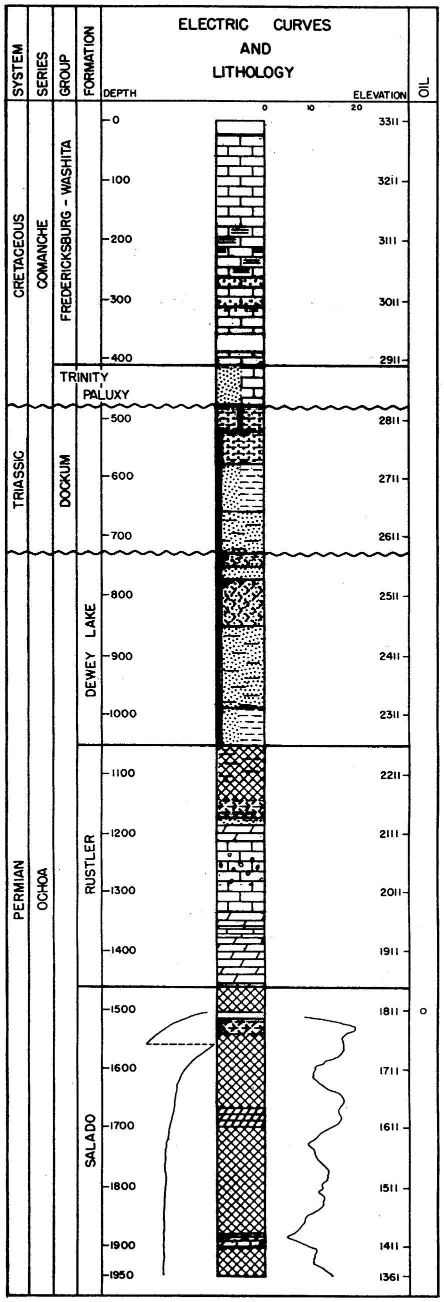
PRODUCTION HISTORY

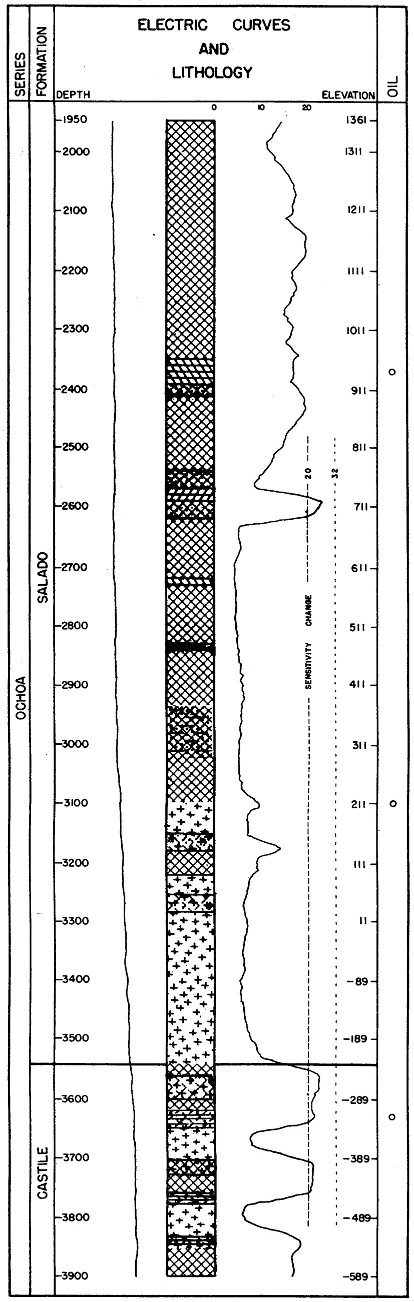
OIL PRODUCTION
(barrels)

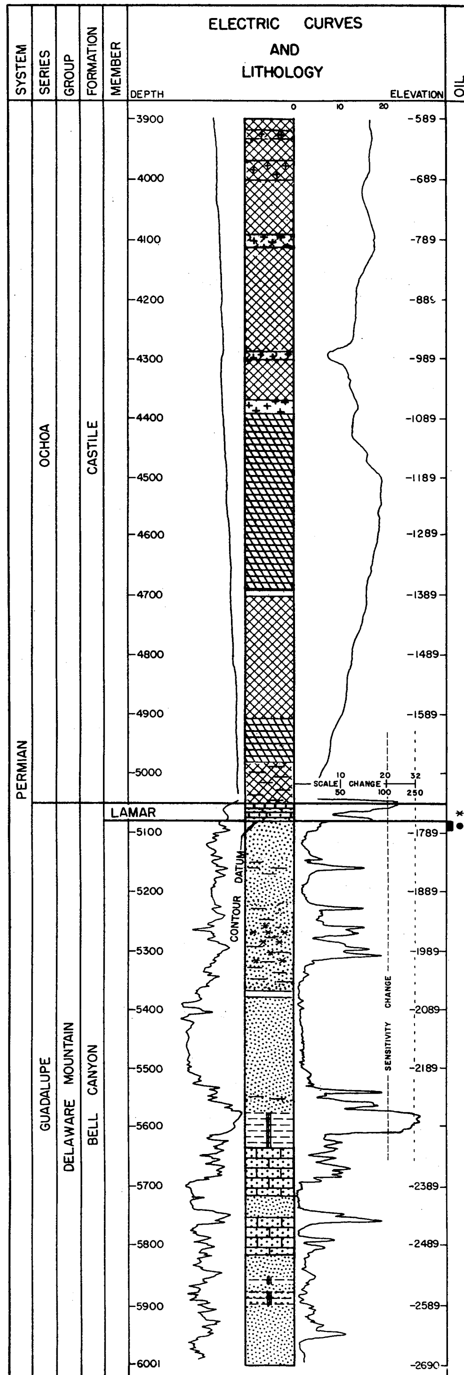
	Lamar	Bell Canyon	Field totals	
Year	Yearly	Yearly	Yearly	Cumulative
1942	5,916	12,438	18,354	18,354
1943	11,250	11,221	22,471	40,825
1944	14,078	7,898	21,976	62,801
1945	14,095	4,607	18,702	81,503
1946	10,048	2,410	12,458	93,961
1947	7,684	1,648	9,332	103,293
1948	7,506	770	8,276	111,569
1949	7,628	1,362	8,990	127,928
1950	6,406	963	7,369	127,928
1951	5,757	0	5,757	133,685
1952	435	0	435	134,120
1953	1,000	0	1,000	135,120
Totals	91,803	43,317	135,120	

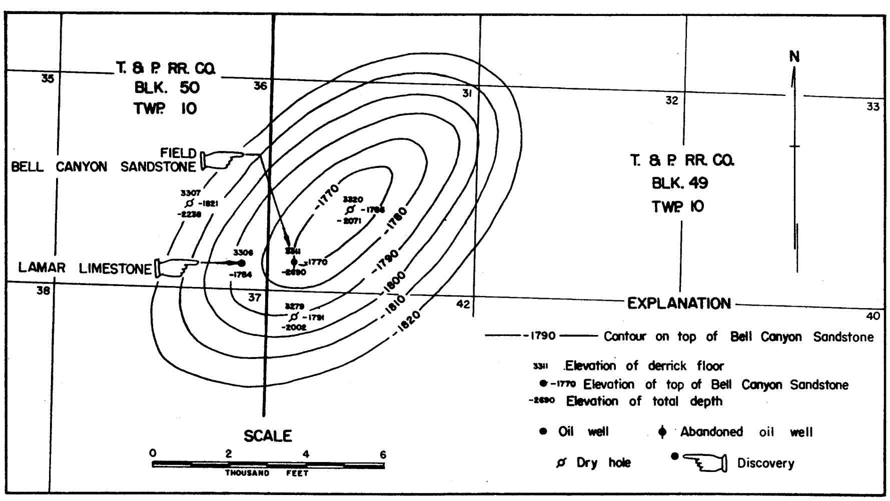
The well completed in the Lamar limestone flowed until in January of 1946; since then its production has been obtained by pumping. The well completed in the Bell Canyon sandstone flowed until in November of 1943; thereafter, until its abandonment in November of 1950, its production was obtained by pumping.

TYPICAL SECTION OF ROCKS PENETRATED

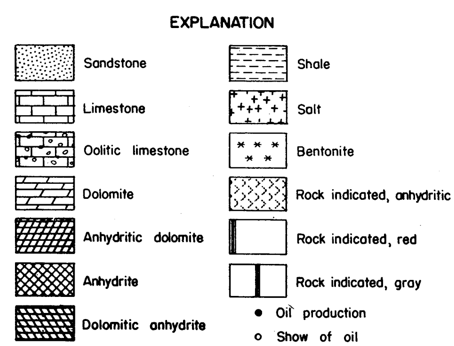








*NOTE: This section is based on the log of the well producing from the Bell Canyon sandstone. The other productive well produces from fractures in the Lamar limestone.



CLAIREMONT FIELD

Kent County, Texas

E. V. STINE and J. L. WALDREP
Geologists, Sunray Oil Corporation, Midland, Texas
January 1, 1954

LOCATION

As indicated on the accompanying map, the Clairemont field is located near the town of Clairemont, county seat of Kent County, Texas.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The discovery of this field was due primarily to the operator having acquired, in consideration of test drilling, a large block of leases in a general region indicated as favorable by the results of previous drilling operations. The first deep test on the block was located about 5 miles northwest of Clairemont on the basis of core drill data and was completed as a dry hole. The operator was obligated to drill another deep test and located that test adjacent to large holdings of another operator who was prompted by core drill data to contribute dry hole money. The core drill data determined the specific location of that test, which became the discovery well.

DISCOVERY

Strawn: April 3, 1950;
General Crude Oil Co. #1-A Percy Jones

ELEVATION OF SURFACE

At well locations: Highest, 2,209 feet; lowest, 2,090 feet.

SURFACE FORMATION

Anhydrite and sands of Whitehorse group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is about 94 feet below the top of the Ellenburger group. This penetration was in Sun Oil Co. #F-1 Bilby Wallace, completed in November 1953 at the location in Sec. 24, Block 98, where the sub-sea elevation of total depth is indicated as -5,287 feet on the accompanying map.

NATURE OF TRAP

Strawn: The accumulation of oil appears to be due to a simple convex trap resulting from reef topography. The strata above and below the reef appear to dip quite regularly westward.

PRODUCTIVE AREA

Strawn: Approximately 720 acres.

THICKNESS OF RESERVOIR ROCK

Strawn:	Feet
From top to bottom	4 to 19
Net productive, average	13

LITHOLOGY OF RESERVOIR ROCK

Strawn: Tan, crystalline, granular in part, coralliferous oolitic limestone with vuggy porosity.

CONTINUITY OF RESERVOIR ROCK

Strawn: The reservoir rock is continuous throughout the area of the field, as is evidenced by the uniformity of reservoir pressures. It is a local reef and probably does not extend far beyond where it has been found in the presently productive wells.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Strawn:	Feet
Elevation of top of oil	-4,562
Elevation of bottom of oil	-4,609
Oil column	47

In the well in the southwest corner of Sec. 10, the oil-water contact is at -4,641 feet. The reservoir which is producing in that well appears to be separate from the reservoir which is producing in all other wells in the field.

CHARACTER OF OIL

Strawn:	
Gravity, A.P.I. @ 60°F.	36.1°
Sulphur	0.49%
Salt	0.004%
Paraffin	2.16%
Viscosity @ 60°F.	59 sec. S. U.
Viscosity @ 100°F.	43 sec. S. U.

The above data are from an analysis of a sample from Sun Oil Co. #1 D.G. Sampson.

For analyses see:
U. S. Bureau of Mines   Lab. ref. No. 50068
Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953) Item 48

WATER PRODUCTION

Strawn: Five of the wells are definitely known to be producing water and there is a possibility that two others are producing some water. Water constitutes about 8% of the total gross fluid produced in the field. The average chloride content of the water is about 100,000 to 110,000 parts per million.

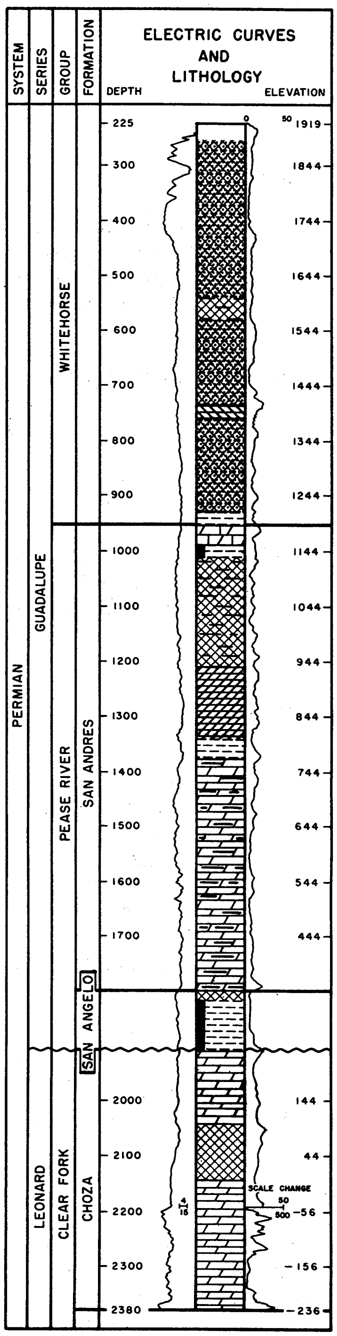
ACID TREATMENT

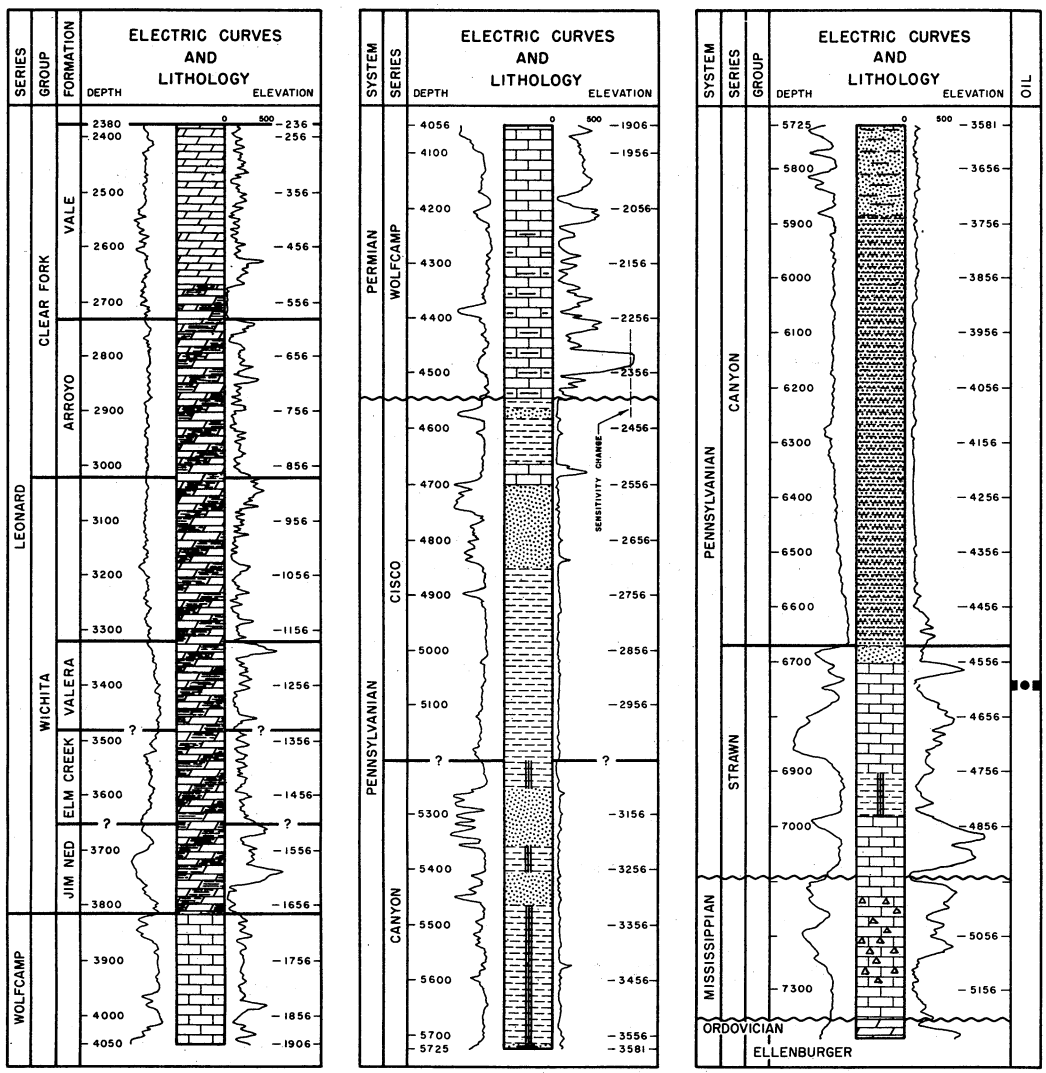
Strawn: Six of the 13 productive wells have been acidized. The quantity of acid used has varied from 500 gallons to 4,000 gallons.

PRODUCTION HISTORY

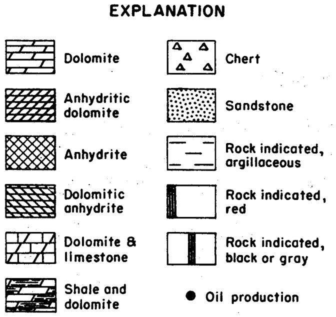
	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1950	3	0	60,535	60,535
1951	7	1	151,459	211,994
1952	9	4	311,644	523,638
1953	7	7	314,075	837,713

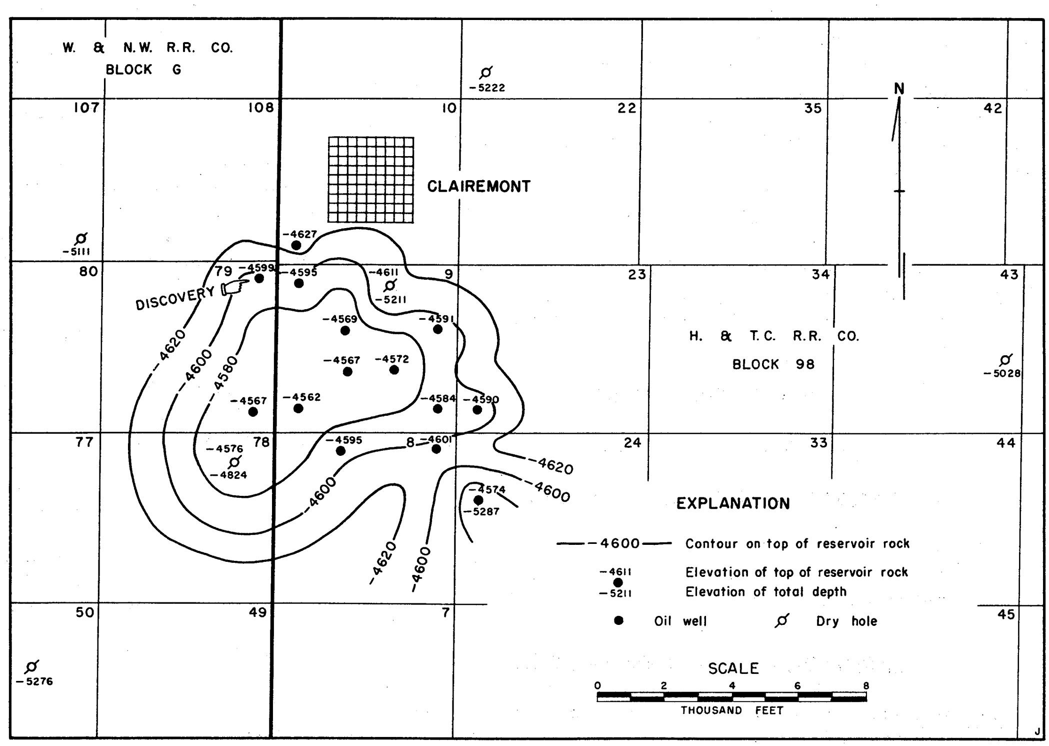
TYPICAL SECTION OF ROCKS PENETRATED





NOTE: This TYPICAL SECTION is based on the log of the discovery well (TD 6752) to the depth of 6740 feet, and, below that depth, with adjusted depths and elevations, on the log of the dry hole in Sec. 9, where actual total depth is 7384 feet (elevation of total depth, 5211).





CLARA COUCH FIELD

Crockett County, Texas

L. E. PATTERSON, Jr.
District Geologist, Cities Service Oil Co., Midland, Texas
June 1, 1953

LOCATION

The Clara Couch field is in west-central Crockett County about 30 miles west of Ozona, county seat. It is near the western margin of the southern portion of the Midland basin.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The location of the test which resulted in the discovery of the field was made on the basis of an interpretation of subsurface geological data which indicated a structural axis through this locality in the shallow Permian beds. The operator intended to locate the test in section 37 on land on which he held an oil and gas lease and which was owned in fee by Clara Couch. When production was discovered, the well was thought to be on Clara Couch land and the field was designated as the Clara Couch field. However, a survey revealed that the well was 167 feet north of the north line of section 37 and was in section 14 on land owned in fee by A. C. Hoover and under lease to Cities Service Oil Co., which company then took over the well on a negotiated basis and has operated it since that time. Although the field was named for Mrs. Clara Couch, there was no production on her land until about 8 months after the completion of the discovery well.

ELEVATION OF SURFACE

At well locations: Highest, 2,771 feet; lowest, 2,294 feet. Tributaries along the east side of the Pecos River which have cut canyons into the Edwards Plateau have produced considerable topographic relief within the area of the field.

VARIATIONS IN THICKNESSES

The younger Permian beds are characterized by marked lateral variations in thickness and lithology. They probably were deposited in a very shallow sea.

There is great variation in the amount of limestone deposited during Pennsylvanian time. It seems likely that during that time this area was a platform area bounded by marginal reefs and across which both reef and lagoonal limestone deposition occurred continuously. Apparently the platform area retreated to the northwest during Pennsylvanian time, and even further to the northwest during early Permian time. To the southeast of this area, the limestone build-up appears to have ended in Strawn or earlier Pennsylvanian time; to the northwest of this area, the build-up probably extended well into Leonard time.

SURFACE FORMATIONS

Undifferentiated Comanche series; mainly of the Washita group but probably with rocks of the Fredericksburg group exposed low in some canyons.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest bed penetrated is in the Ellenburger group 1,504 feet below its top. This penetration was in the Cisco East discovery well at its total depth of 8,264 feet.

DISCOVERIES

Yates: March 29, 1942;
Humble Oil & Refining Co. #B-1 J. W. Owens; now E. J. McCurdy #1-B J. W. Owens.

While gas shows have been reported in many of the cable tool holes, only one additional well has been completed in this reservoir. The two wells were completed as small gas producers. There was no commercial outlet; the only gas produced has been utilized for lease and other local purposes. Since very little information is available and since there appears to be no commercial production discovered to date, there will be no further entries concerning this reservoir.

Upper Queen: May 28, 1944;
E. J. McCurdy #1 W. L. Hobbs

Middle Queen: August 20, 1944;
McCurdy & McElroy #2 W. L. Hobbs

San Andres and Field: August 17, 1941;
R. H. Henderson #1 Clara Couch (on A.C.Hoover land); now Cities Service Oil Co. #1 A.C.Hoover. See explanation in column at left under METHOD OF EXPLORATION.

Wolfcamp: April 19, 1949;
Humble Oil & Refining Co. #1-G J. W. Owens

Cisco East*: May 28, 1947;
Cities Service Oil Co. #1-B J. W. Owens

Cisco West*: October 22, 1949;
Cities Service Oil Co. #1-C J. W. Owens

Canyon*: April 12, 1951;
Cities Service Oil Co. #1-E J. W. Owens

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*Paleontological data available at time of discovery of oil in the eastern of the two Cisco reservoirs suggested that the reservoir rock there is of Wolfcamp age and the reservoir was officially designated by the Railroad Commission of Texas as the "Clara Couch Wolfcamp field." Although Cisco age is now definitely established, this designation continues to be applied by the Railroad Commission, and, as now used, includes not only this reservoir but all reservoirs older than San Andres.

NATURE OF TRAPS

Upper Queen: Updip termination of reservoir due to decrease of porosity and permeability because of change in character of sediments. Sandstone grades into shaly sandstone, sandy shale and shale.

Middle Queen: Updip and lateral termination of reservoir due to lensing of sandstone.

San Andres: Anticlinal folding appears to be the dominating factor in causing the accumulation of oil in this reservoir. Variation in degree of porosity and permeability appears to have contributed to forming the trap. Porosity and permeability are relatively low over the axis of the anticline and updip northward and updip southward from the productive area.

Wolfcamp, Cisco East, Cisco West and Canyon: The traps which occasioned the accumulation in these four reservoirs are due primarily to reef conditions. Both convexity and simple lateral termination of reservoir have contributed to forming the traps. It appears that the traps are due mainly to burial of eroded reef features. It is believed that local structure, as so far revealed, is of less significance to the accumulations in these reservoirs than is the regional stratigraphy of these beds; accordingly, contours on top of the reef-bearing limestone mass, as shown on an accompanying map, are more informative than would be those along a time horizon in the Pennsylvanian sequence. Assuming a platform of limestone deposition with marginal reefs, the portions of the reefs not destroyed by subsequent weathering would be preserved as permeable and porous reservoirs when finally buried, and the general alignment of those reservoirs would approximate the perimeter of the platform to which the reefs were adjacent. As so far developed, the Pennsylvanian reservoirs of this field appear to fit such a concept. Along the length of the ancient marginal reefs, the present reservoirs are probably interrupted where the old tidal channels prevented reef development and where differential erosion, prior to final burial, completely destroyed portions of the reefs and preserved variable thicknesses of other portions.

PRODUCTIVE AREAS

	Acres
Upper Queen	40
Middle Queen	140
San Andres	920
Wolfcamp	40
Cisco East	160
Cisco West	960
Canyon	320
Clara Couch field	2,540

It appears likely that future development will warrant increasing some of the above estimates.

LITHOLOGY OF RESERVOIR ROCKS

Upper Queen and Middle Queen: Sandstone; generally medium- to fine-grained with occasional larger grains. Generally, the grains are subangular, but some are rounded and frosted. Normally the grains are well cemented with siliceous material. The degree of cementation markedly affects the porosity and permeability within short distances. The reservoir rock is interbedded with anhydrite and silty, reddish sandstone and red shales.

San Andres: Dolomite; medium-grained to granular, crystalline dolomite which grades locally into lenses of both coarse-grained and fine-grained material. Generally, the dolomite is sandy, with medium to large sand grains well distributed and locally sufficiently concentrated to form dolomitic sandstone. Oolites occur rarely. The color is generally cream to buff, grading to white and light brown locally. Porosity is generally good, ranging from interstitial to the void spaces of medium-sized vugs. In general in the producing areas, the porosity decreases updip.

Wolfcamp, Cisco East, Cisco West and Canyon: Limestone; ranges in color from white to tan and light brown and in texture from fine-grained to medium-grained. Generally there is an abundance of fossils, primarily foraminifera and crinoids. Porosity consists primarily of vugs. The voids were undoubtedly produced by agents of weathering which attacked the reef prior to final burial. Some vugs associated with individual fossils are evident.

THICKNESSES OF RESERVOIR ROCKS

	Feet		
	Min.	Max.	Avg.
Upper Queen			
From top to bottom	22	35	26
Net effective	15	25	20
Middle Queen			
From top to bottom	14	26	18
Net effective, approximate	10	20	15
San Andres			
From top to bottom	2	115	29
Net effective	2	70	15
Wolfcamp (1 well)			
From top to bottom			40
Net effective			25
Cisco East			
From top to bottom	25	57	33
Net effective	19	50	30
Cisco West			
From top to bottom	24	185	105
Net effective	24	110	67
Canyon (1 well)			
From top to bottom			107
Net effective			45

CONTINUITY OF RESERVOIR ROCKS

Upper Queen and Middle Queen: These reservoirs are local members of a formation which characteristically contains more sandstone than either the overlying Seven Rivers formation or the underlying Grayburg formation. Local productive reservoirs in the Queen formation have been developed in many fields in West Texas and Southeast New Mexico. Some of these reservoirs are at or near the stratigraphic positions of the two local Queen reservoirs in this field and some are at other positions within the formation. It is characteristic of the formation throughout its extent that the proportions of sandstone, anhydrite, dolomite and shale vary markedly within short distances. Most producing sandstone reservoirs in this formation probably occur as lenses. There is no reason to believe that either of the two Queen reservoirs in this field extends much beyond its presently producing area.

San Andres: A dolomite bed with the general lithologic character of the reservoir rock is recognized and appears to be continuous over a broad area in central-western Crockett County, but its characteristics disappear northward, where the granular-type dolomite grades into finer-grained materials and where the distinctive characteristics of the overlying green bentonic shale gradually disappear.

Wolfcamp, Cisco East, Cisco West and Canyon: The continuity of each of these reservoir rocks is limited generally by the boundary of the area of high degree of porosity in preserved portions of buried reefs.

CHARACTER OF GAS

Analyses are not available for gas produced from Yates, Upper Queen, San Andres or Wolfcamp. Following are analyses showing percentage of components of samples from Cisco and Canyon reservoirs.

Components	Cisco East	Cisco West	Canyon
Hydrogen sulphide	Present*	Present*	0.00
Carbon dioxide	2.80	0.75	0.90
Nitrogen	2.96	3.92	2.25
Methane	79.93	76.35	85.58
Ethane	7.76	9.46	6.80
Propane	3.92	4.72	2.74
Iso-butane	0.37	0.58	0.47
Normal butane	1.23	1.47	0.62
Iso-pentane	0.22	0.35	0.17
Normal pentane	0.34	0.38	0.20
Hexanes	0.30	0.48	0.12
Heptane & heavier	0.17	1.53	0.15
Specific gravity	.732	.717	.6617

*The quantity of hydrogen sulphide was not determined because of reaction with material of container in which gas was shipped to laboratory.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

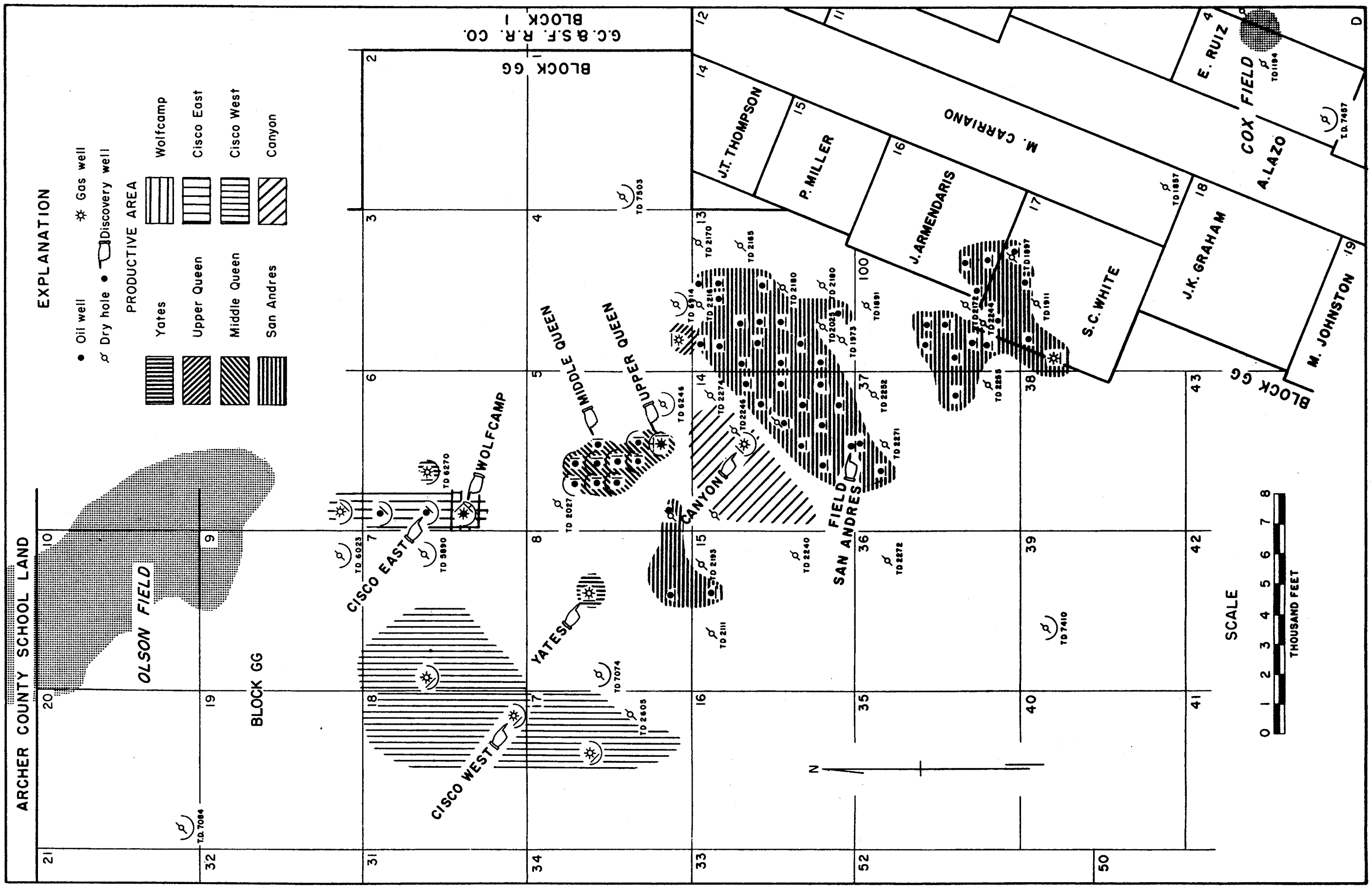
	Feet
Upper Queen: (2 wells)	
Elevation of top of gas	1,150
Elevation of bottom of gas	1,104
Relief	46
Probably no oil in this reservoir	
Middle Queen:	
No free gas cap	
Elevation of top of oil	1,017
Elevation of bottom of oil	942
Relief	75
San Andres:	
No free gas cap	
Elevation of top of oil	645
Elevation of bottom of oil	465
Relief	180

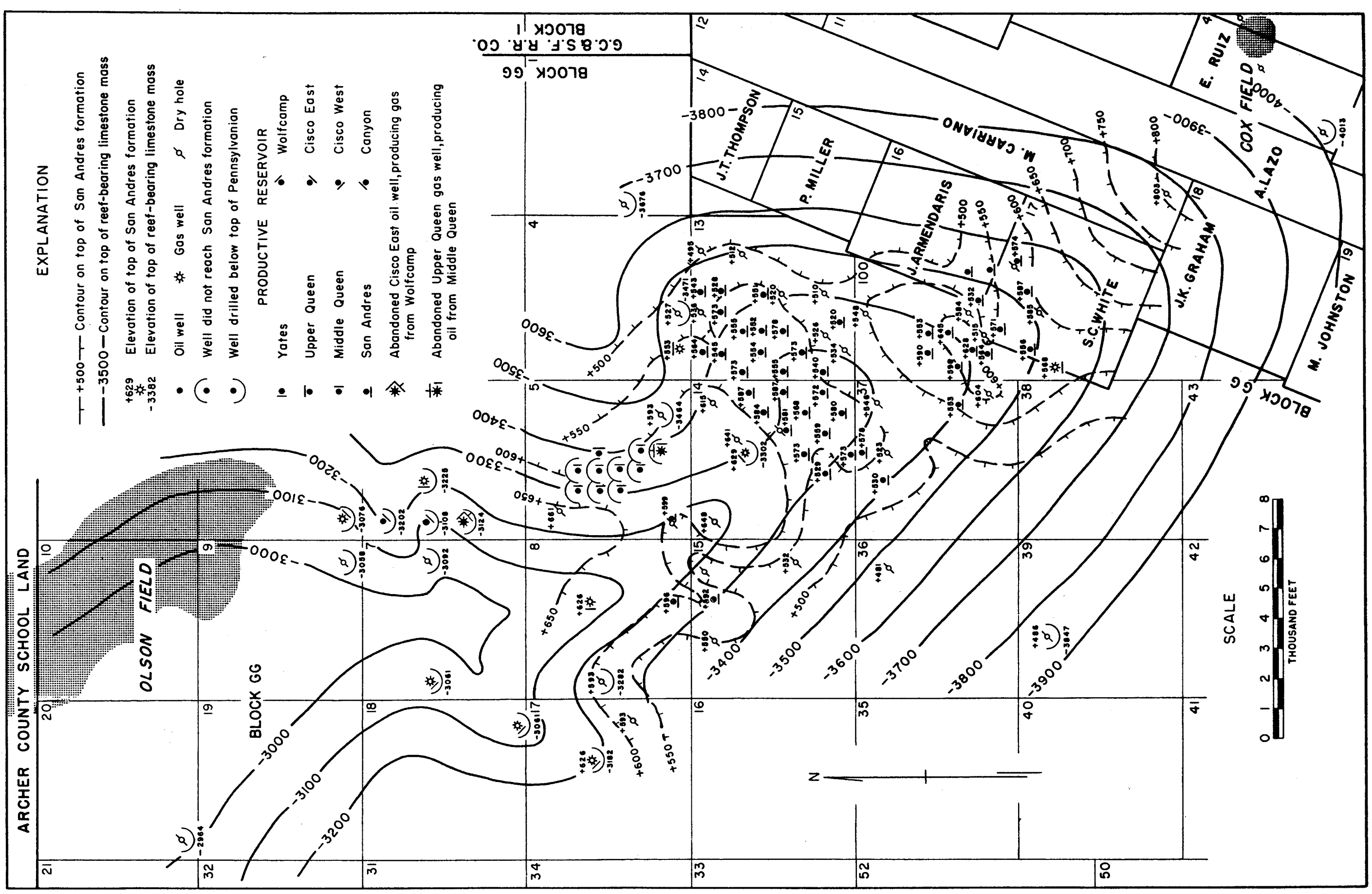
The lowest elevation to which oil is known to extend is 465 feet above sea level. Nonproductive tests in the vicinity of the productive area have encountered water at elevations ranging from 363 feet to 547 feet.

	Feet
Wolfcamp: (1 well)	
Elevation of top of gas	-3,124
Elevation of bottom of gas	-3,164
Relief	40
Probably no oil in this reservoir	
Cisco East:	
Elevation of top of oil	-3,215
Elevation of bottom of oil	-3,289
Relief	74
Cisco West:	
Elevation of top of gas	-3,094
Elevation of bottom of gas	-3,279
Relief	185
Probably no oil in this reservoir	
Canyon: (1 well)	
Elevation of top of gas	-3,419
Elevation of bottom of gas	-3,526
Relief	107

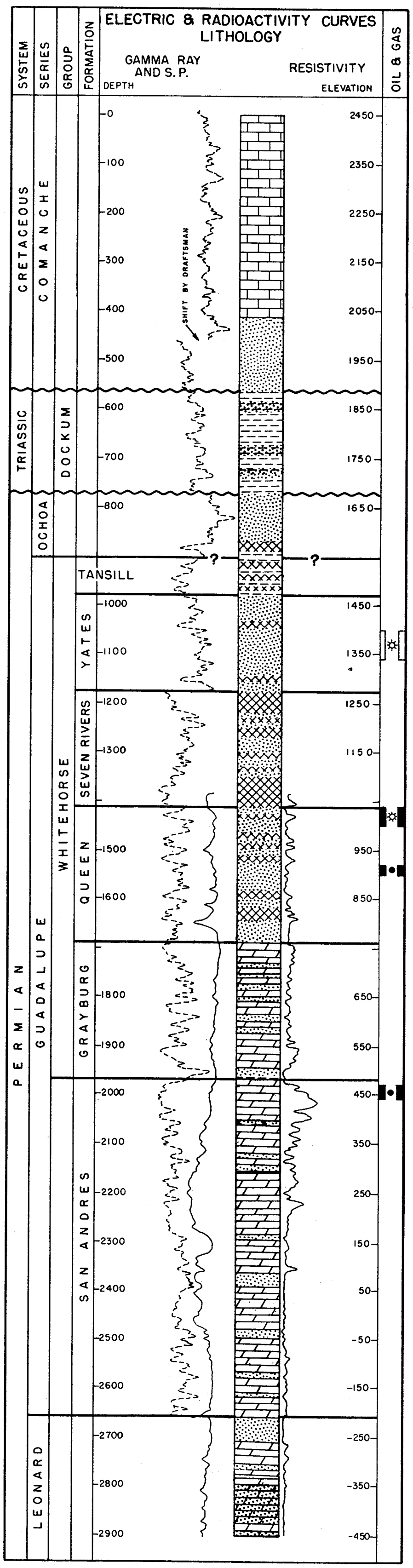
CHARACTER OF OIL

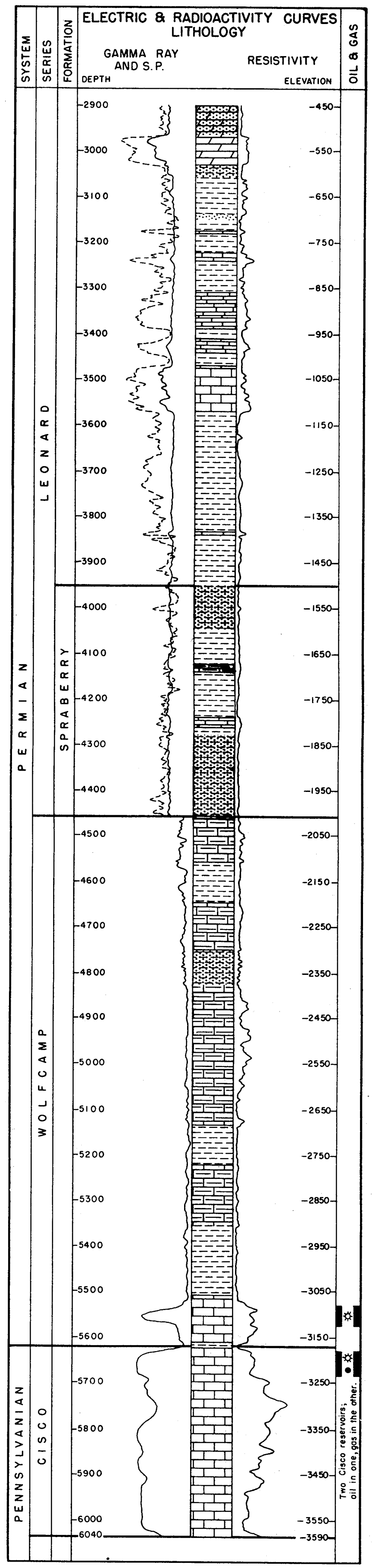
	Middle Queen	San Andres	Cisco East
Gravity, A.P.I. @ 60° F.	31°	25°	39°
Sulphur content	Sour	Sour	Sour
Color	Brown	Black	Dark green

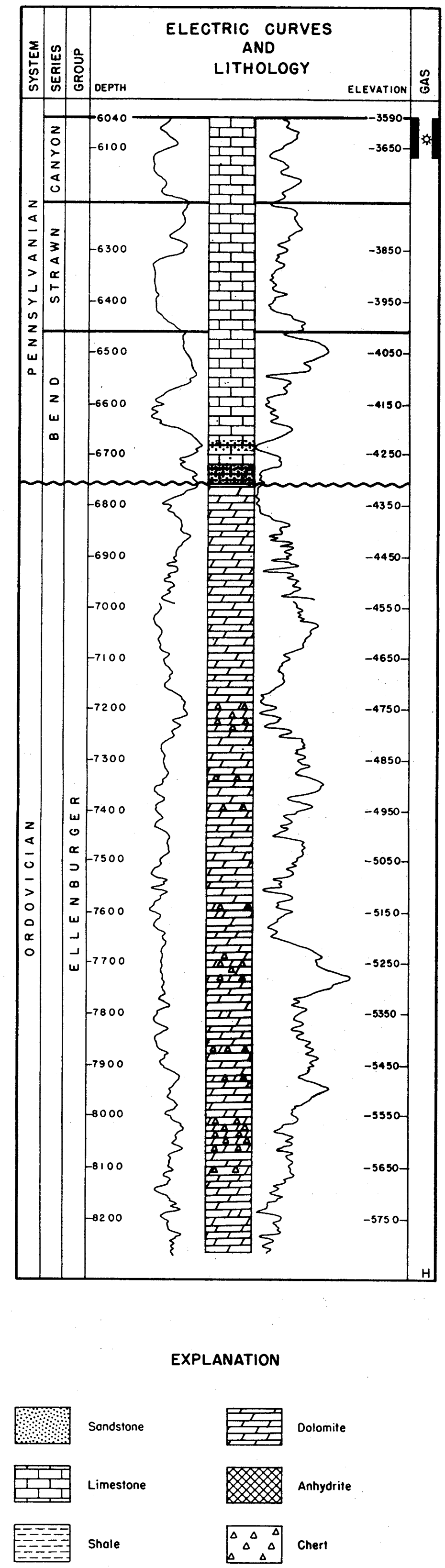

EXPLANATION
Oil well
Gas well
Dry hole
Discovery well
PRODUCTIVE AREA
Yates
Upper Queen
Middle Queen
San Andres
Wolfcamp
Cisco East
Cisco West
Canyon
ARCHER COUNTY SCHOOL LAND
OLSON FIELD
BLOCK GG
G.C.& S.F. R.R. CO. BLOCK I
CISCO EAST
CISCO WEST
WOLFCAMP
MIDDLE QUEEN
UPPER QUEEN
YATES
CANYON
SAN ANDRES FIELD
J.T. THOMPSON
P. MILLER
M. CARRIANO
J. ARMENDARIS
S.C. WHITE
J.K. GRAHAM
M. JOHNSTON
E. RUIZ
A. LAZO
COX FIELD
SCALE
THOUSAND FEET

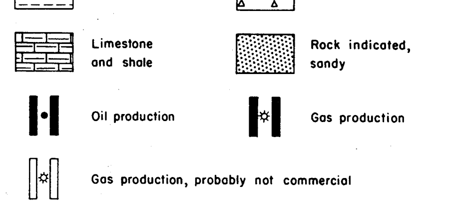

EXPLANATION
+500 Contour on top of San Andres formation
-3500 Contour on top of reef-bearing limestone mass
+629 Elevation of top of San Andres formation
-3382 Elevation of top of reef-bearing limestone mass
Oil well
Gas well
Dry hole
Well did not reach San Andres formation
Well drilled below top of Pennsylvanian
PRODUCTIVE RESERVOIR
Yates
Upper Queen
Middle Queen
San Andres
Wolfcamp
Cisco East
Cisco West
Canyon
Abandoned Cisco East oil well, producing gas from Wolfcamp
Abandoned Upper Queen gas well, producing oil from Middle Queen
ARCHER COUNTY SCHOOL LAND
OLSON FIELD
BLOCK GG
G.C.& S.F. R.R. CO. BLOCK I
J.T. THOMPSON
P. MILLER
M. CARRIANO
J. ARMENDARIS
S.C. WHITE
J.K. GRAHAM
M. JOHNSTON
E. RUIZ
A. LAZO
COX FIELD
SCALE
THOUSAND FEET

TYPICAL SECTION OF ROCKS PENETRATED









NOTE: This TYPICAL SECTION is based on a composite log. It shows all reservoirs which are productive within the area of the field. There is no single location at which all reservoirs are productive.

WATER PRODUCTION

Upper Queen and Middle Queen: No water has been produced from either of these reservoirs. Plans for water flooding Middle Queen for secondary recovery are under consideration.

San Andres: Although only 3 wells produced water during completion tests, many wells now produce various quantities. Generally, water constitutes less than 40% of the gross production of such wells as produce it, but a few wells produce a higher percentage. Remarkably, the water production of most of such wells began abruptly and has continued constantly at essentially the same rate. There seems to be little, if any, water drive in the reservoir.

Wolfcamp: No water has been produced by the lone well completed in this reservoir.

Cisco East and Cisco West: Testing prior to completion has demonstrated the presence of water below the oil and gas columns in both reservoirs. Water has been produced by only one well, that which was abandoned in the Cisco East reservoir and is the Wolfcamp discovery well.

Canyon: No water has been produced by the lone well completed in this reservoir. The well is a gas-condensate well and is shut in because of lack of commercial outlet.

ACID AND OTHER RESERVOIR TREATMENT

Upper Queen: Neither acid nor nitroglycerin has been used in this reservoir.

Middle Queen: Acid has not been used in this reservoir because of absence of calcareous material. Several wells were completed "natural", but most wells have been shot with 25 to 60 quarts of nitroglycerin. Some gas has been injected into this reservoir to improve production of oil.

San Andres: Methods of artificial stimulation are varied; some operators use acid exclusively and others depend largely on nitroglycerin shots. Several wells have been both shot and acidized. Jet perforating has been used alone and also in connection with acid treatment. Acid treatments have ranged from 500 gallons in one stage to 8,000 gallons in four stages; the normal treatment has been with 1,500 gallons in one stage. Nitroglycerin shots have ranged from 40 to 350 quarts; average, about 95 quarts.

Wolfcamp: The single well completed in this reservoir was not acidized or shot.

Cisco East and Cisco West: Most of the wells completed in these reservoirs have been neither acidized nor shot; a few have been acidized with 1,000 to 2,500 gallons in a one-stage treatment.

Canyon: The one well completed in this reservoir was acidized with 1,000 gallons.

PRODUCTION HISTORY

OIL PRODUCTION

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Field totals:				
1941	1	1	986	986
1942	2	5	10,952	11,938
1943	2	6	16,451	28,389
1944	1	10	64,835	93,224
1945	2	14	98,729	191,953
1946	1	19	130,840	322,793
1947	11	28	238,457	561,250
1948	4	39	323,972	885,222
1949	3	44	252,015	1,137,237
1950	2	47	237,917	1,375,154
1951	2	48	232,965	1,608,119
1952	2	47	212,086	1,820,205

PRODUCTION HISTORY (Continued)

OIL PRODUCTION

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Middle Queen:				
1944	1	0	200	200
1945	1	0	4,209	4,409
1946	1	0	4,316	8,725
1947	8	2	47,700	56,425
1948	1	9	22,099	78,524
1949	1	9	13,761	92,285
1950	0	9	11,847	104,132
1951	0	9	8,241	112,373
1952	0	9	5,013	117,386
San Andres:				
1941	1	1	986	986
1942	2	5	10,952	11,938
1943	2	6	16,451	28,389
1944	0	10	64,635	93,024
1945	1	14	94,520	187,544
1946	0	19	126,524	314,068
1947	0	26	157,086	417,154
1948	0	29	231,173	702,327
1949	0	35	204,806	907,133
1950	0	38	195,367	1,102,500
1951	0	39	207,491	1,309,991
1952	0	38	197,308	1,507,299
Cisco East:				
1947	3	0	33,671	33,671
1948	3	0	70,700	104,371
1949	2	0	33,448	137,819
1950	2	0	30,703	168,522
1951	2	0	17,233	185,755
1952	2	0	9,765	195,520

GAS PRODUCTION

Gas production has been limited to supplying gas for local use, particularly including lease and drilling operations. There are no satisfactory records showing quantities produced nor showing the sources from which produced. The records kept by the Railroad Commission are difficult to interpret, particularly as to determining the quantities produced from the respective reservoirs. The following figures have been compiled from Railroad Commission records and appear to represent the reported total gross gas production from all reservoirs.

Year	GAS WELLS PRODUCING at end of year	GAS PRODUCTION (Mcf): Yearly	Cumulative
1942	1	1,448	1,448
1943	1	1,818	3,266
1944	2	1,656	4,922
1945	2	2,333	7,255
1946	2	2,842	10,097
1947	2	3,859	13,956
1948	3	41,092	55,048
1949	3	32,372	87,420
1950	3	37,352	124,772
1951	3	37,345	162,117
1952	4	34,433	196,550

COX FIELD

Crockett County, Texas

J. B. COX
Geologist, Southern Production Co., Inc., Midland, Texas
March 11, 1953

LOCATION

The Cox field is 29 miles west of Ozona and 4 miles north of Ft. Lancaster. It is 2½ miles southeast of the Clara Couch field and 3 miles west of the Lancaster Hill field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Shallow core drilling led directly to the discovery of this field. The discovery well was being drilled for the purpose of obtaining samples of near-surface rocks when it discovered oil.

DISCOVERY

Queen: January 18, 1948; Gulf Oil Corp. #1 H. B. Cox Mineral Fee "C". The well was being drilled for samples of rock when it showed oil from depth of 894-911 feet. It was drilled to total depth of 1,251 feet and then plugged back to 943 feet for completion. Pumped at the rate of 152 barrels of 26.8° gravity oil per day after being shot; GOR, 182:1.

ELEVATION OF SURFACE

At location of discovery well, 2,165 feet; at location of the other productive well, 2,140 feet.

STRATIGRAPHIC SECTION

Readers are referred to accompanying papers on nearby fields. The productive zone is in the Queen formation of the Whitehorse group of the Guadalupe series of the Permian system. The exact position of the productive zone within the Queen formation is not determinable from information available to the writer.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the immediate vicinity of the two productive wells is in the Grayburg formation. This penetration was in the dry hole near the discovery well where the total depth is indicated as 1,373 feet on the accompanying map.

NATURE OF TRAP

Queen: Either convex fold or updip termination of reservoir due to either lensing or change in character of rock.

PRODUCTIVE AREA

Queen and Field: 40 acres.

THICKNESS OF RESERVOIR ROCK

Queen: Net productive, about 6 feet.

LITHOLOGY OF RESERVOIR ROCK

Queen: sandstone; gray to tan, dolomitic, fine grained, thin bedded and lenticular.

CONTINUITY OF RESERVOIR ROCK

Queen: The reservoir rock cannot be correlated beyond the limits of the field. The Queen formation is widespread and contains sandstones which are productive at several places. Whether the sandstone which is productive in this field correlates with productive sandstone elsewhere cannot be determined from information now available.

CHARACTER OF OIL

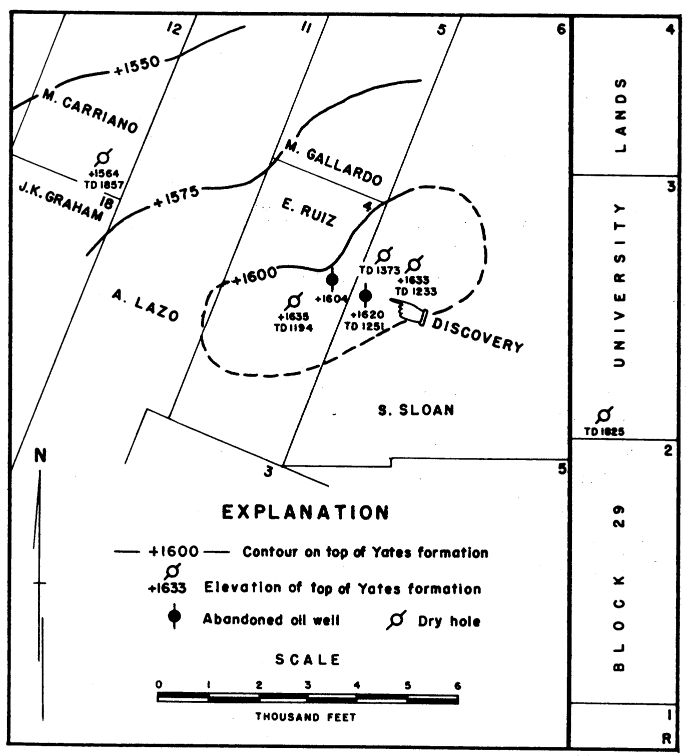
Queen:	Range	Avg.
Gravity, A.P.I. @ 60° F.	23° - 26.8°	25°

WATER PRODUCTION

Queen: No water was ever produced.

PRODUCTION HISTORY

Queen and Field total: Oil was discovered on January 18, 1948 and production was continued until about the end of 1951. The two productive wells were finally abandoned on March 12, 1952 without having produced any oil during 1952. There were 2 wells, both producing by pumping, at the end of each year until operation was no longer profitable at the end of 1951. The production of oil by years was as follows: 1948, 9,929 barrels; 1949, 4,821 barrels; 1950, 1,830 barrels; 1951, 1,120 barrels; total, 17,700 barrels. The production during the last two months of 1951 was 26 barrels during November and 36 barrels during December.



CRAVENS FIELD

Lubbock County, Texas

MARVIN T. CARLSEN
Geologist, Standard Oil Co. of Texas, Lubbock, Texas
April 16, 1954

LOCATION

The Cravens field (two wells, both abandoned) is in north-central Lubbock County $2\frac{1}{2}$ miles northwest of the town of New Deal (formerly called Monroe) and 5 miles south-southwest of the town of Abernathy.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph surveying.

DISCOVERY

Clear Fork: February 28, 1945; Seaboard Oil Co. of Delaware and Stanolind Oil & Gas Co. #1 L. M. Cravens.

ELEVATION OF SURFACE

At discovery well, 3,279 feet; at other well, 3,283 ft.

SURFACE FORMATION

Apparently Ogallala formation of Pliocene series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in either of the two productive wells was penetrated in the discovery well, which apparently was drilled into basal Wolfcamp. The oldest horizon penetrated in the vicinity of the field is 271 feet below the top of the Mississippian system. This penetration was in Standard Oil Co. of Texas #1 G. G. Flinn, located 2.1 miles northwest of the discovery well where the total depth of 11,171 feet is indicated on the accompanying map. The accompanying TYPICAL SECTION is based on the log of that dry hole.

PRODUCTIVE AREA

Clear Fork: Approximately 80 acres.

NATURE OF TRAP

Clear Fork: The trap appears to be due to eastward (updip) decrease of porosity on a westward plunging structural nose.

THICKNESS OF RESERVOIR ROCK

Clear Fork:	Feet
From top to bottom, approximately	90
Net productive, approximately	30

Small fluid recovery during drill-stem tests, zones of rock which yield bleeding oil on cores, layers of dense dolomite, and a relatively low initial potential after considerable acidization, all suggest discontinuous porosity and permeability vertically. Bleeding cores were recovered from the discovery well between the depths of 6,066 feet (-2,787) and 6,148 feet (-2,869).

LITHOLOGY OF RESERVOIR ROCK

Clear Fork: Gray to brown, slightly porous and fossiliferous, fine to medium crystalline dolomite with inclusions of anhydrite and black shale partings.

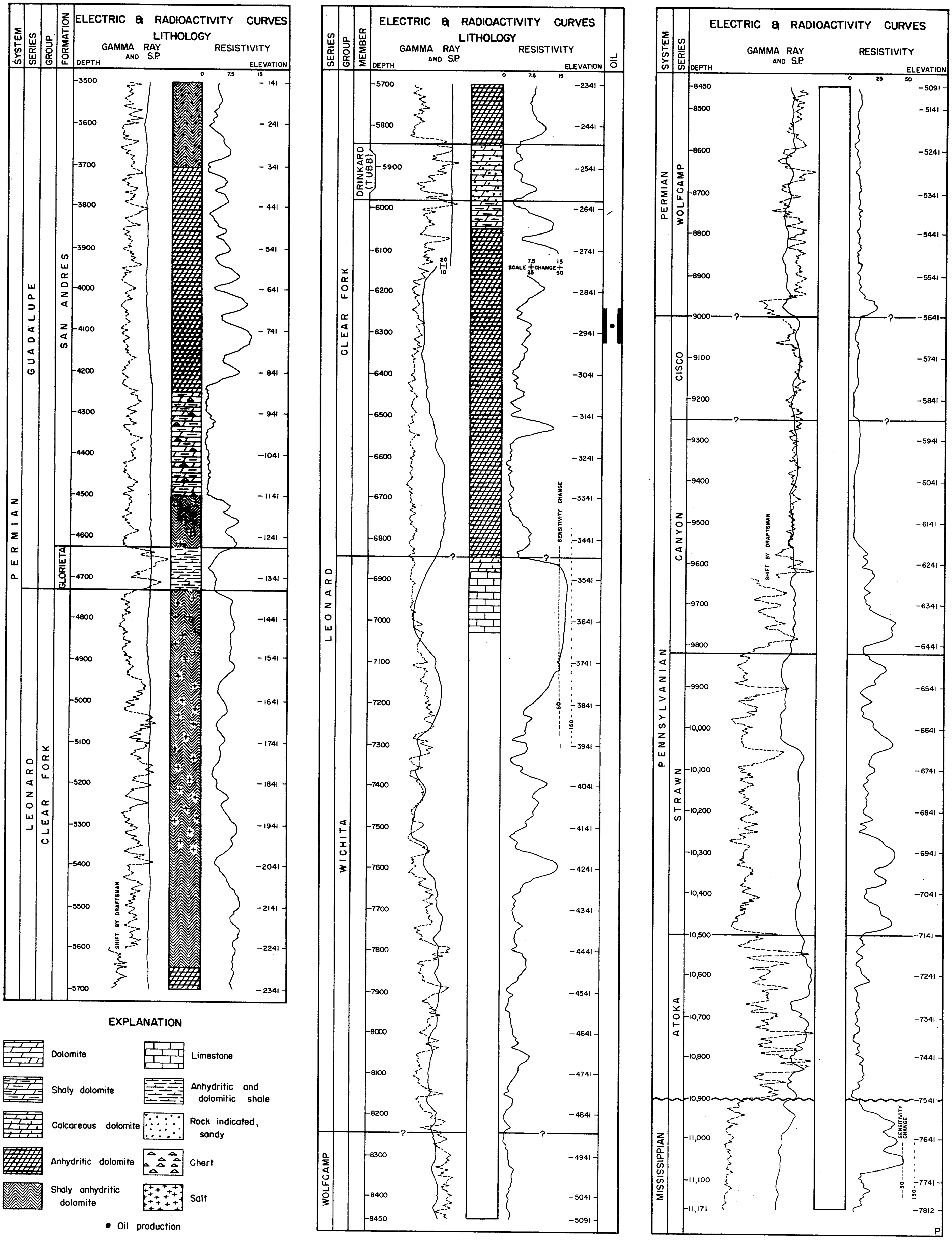
CONTINUITY OF RESERVOIR ROCK

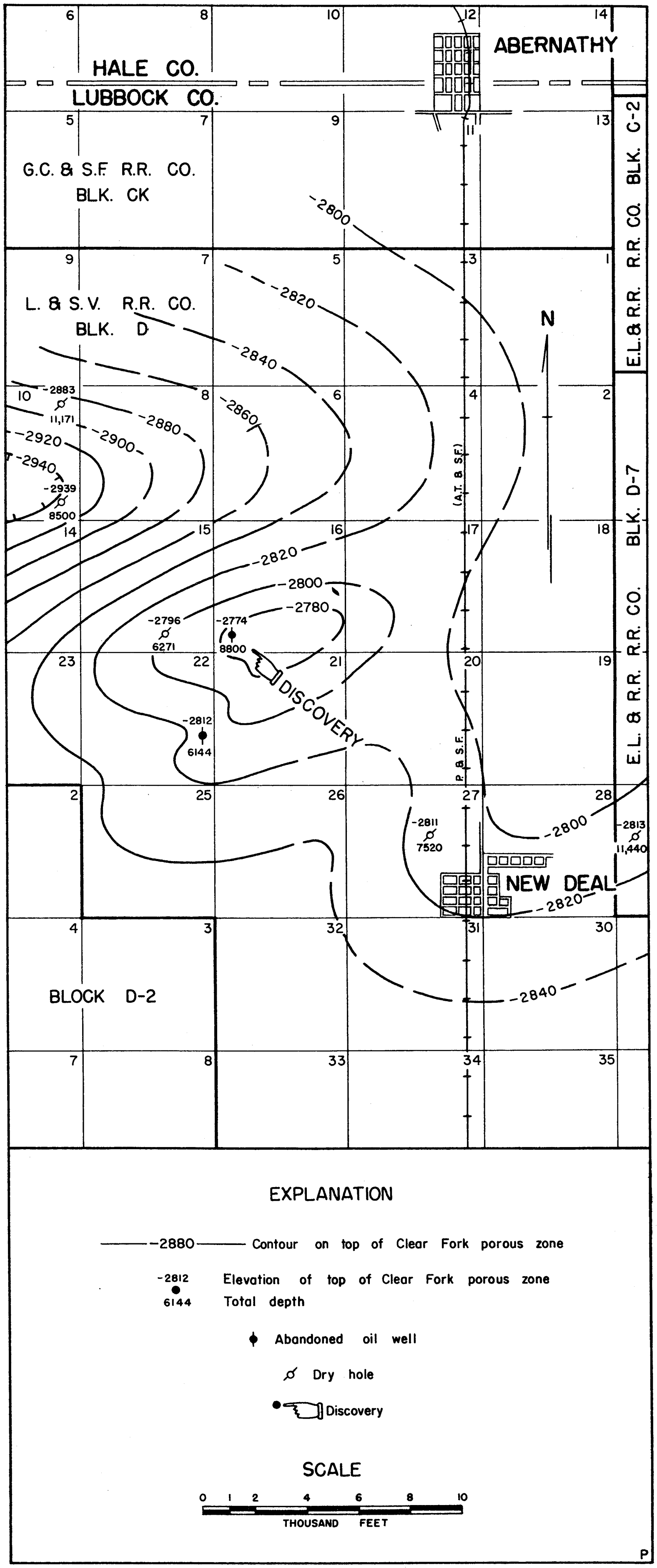
Clear Fork: The stratigraphic equivalent of the productive zone appears to be continuous throughout the area of the accompanying map, but the degree of porosity which occasions commercial production is probably not continuous far beyond the immediate area of the two abandoned wells.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Clear Fork:	Feet
No free gas cap	
Highest known elevation of oil	-2,774
Lowest known elevation of oil	-2,869
Known relief of oil column	95

TYPICAL SECTION OF ROCKS PENETRATED





CHARACTER OF OIL

Clear Fork:	Gravity
Oil produced by	
Seaboard & Stanolind #1 Cravens	27°
Slick & Moorman #1 Cloud	28°

WATER PRODUCTION

Clear Fork: During the initial potential test, the discovery well produced at the daily rate of 136 barrels of oil and 34 barrels of water; i.e., water constituted 20% of gross fluid. During a test two months before abandonment in 1952, water constituted more than 50% of the gross production. Slick & Mooreman #1 Cloud, during its initial potential test, produced at the daily rate of 35 barrels of oil and 82 barrels of water; i.e., water constituted 70% of gross fluid. This well was abandoned in 1951.

ACID TREATMENT

Clear Fork: The discovery well was treated in three stages; first with 1,000 gallons, then with 3,000 gallons and then with 6,000 gallons. The other well was treated with 10,500 gallons in one treatment.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1945	1	4,055	4,055
1946	0	0	4,055
1947	1	1,724	5,779
1948	1	5,850	11,629
1949	2	6,304	18,167
1950	2	6,111	24,278
1951	1	5,106	29,384
1952	0	3,506	32,890

The discovery well was not operated between June 1945 and July 1947; was abandoned on November 19, 1952. The only other well in the field, Slick Oil Co. and Moorman Oil Co. #1 Cloud, was completed on September 9, 1949 and was abandoned in 1951.

CROSSETT FIELD

Crane and Upton Counties, Texas

B. DAVID BUTHMAN
Geologist, The Texas Company, Midland, Texas
July 14, 1954

LOCATION

The Crossett field is located on the common line of Crane and Upton counties about 5 miles west of the town of McCamey and about 25 miles southeast of the town of Crane, the county seat of Crane County. It is about 2½ miles southwest from the nearest portion of the McCamey field. It is one of several fields along the eastern edge of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Interpretation of subsurface data led to the drilling of the exploratory test which became the discovery well of the field and also of the first Devonian production in Texas.

DISCOVERIES

3000-foot: April 11, 1952;
The Texas Company #1-C C.W.Hobbs.
3200-foot: January 16, 1945;
The Texas Company #3-B C.W.Hobbs.
3400-foot: August 25, 1950;
Union Sulphur Co., Inc. #1 R.B.Robbins et al.
5100-foot: March 6, 1950;
The Texas Company #6-B C.W.Hobbs. This well was abandoned in this reservoir and plugged back and completed for production from 3000-foot reservoir on July 23, 1952.
Devonian and Field: August 3, 1944;
The Texas Company #1-A C.W.Hobbs.

SURFACE FORMATION

Undifferentiated Quaternary sand.

ELEVATION OF SURFACE

At well locations: Highest, 2,421 ft.; lowest, 2,328 ft.

PRODUCTIVE AREAS

	Acres
3000-foot (2 wells)	80
3200-foot (2 wells, 1 abandoned)	80
3400-foot (1 well, abandoned)	40
5100-foot (1 well, abandoned)	40
Devonian	840
Crossett field	1,040

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 145 feet below its top. This penetration was in the discovery well of the 3200-foot reservoir.

NATURE OF TRAPS

3000-foot, 3200-foot, 3400-foot and 5100-foot: The trap in each of these reservoirs is due to decrease of porosity and permeability in a sloping reservoir rock. In each of the reservoir rocks, the degrees of porosity and permeability are generally very low and only locally are they adequate for commercial production.

Devonian: The trap is due to erosional truncation of a sloping reservoir rock and sealing by relatively impervious overlying rocks.

LITHOLOGY OF RESERVOIR ROCKS

3000-foot, 3200-foot, and 3400-foot: Dolomite; white to tan with fair to good, fine, vuggy porosity.

5100-foot: Dolomite; generally gray to brown, finely crystalline with slight to fair porosity in the form of fine vugs lined with calcite crystals.

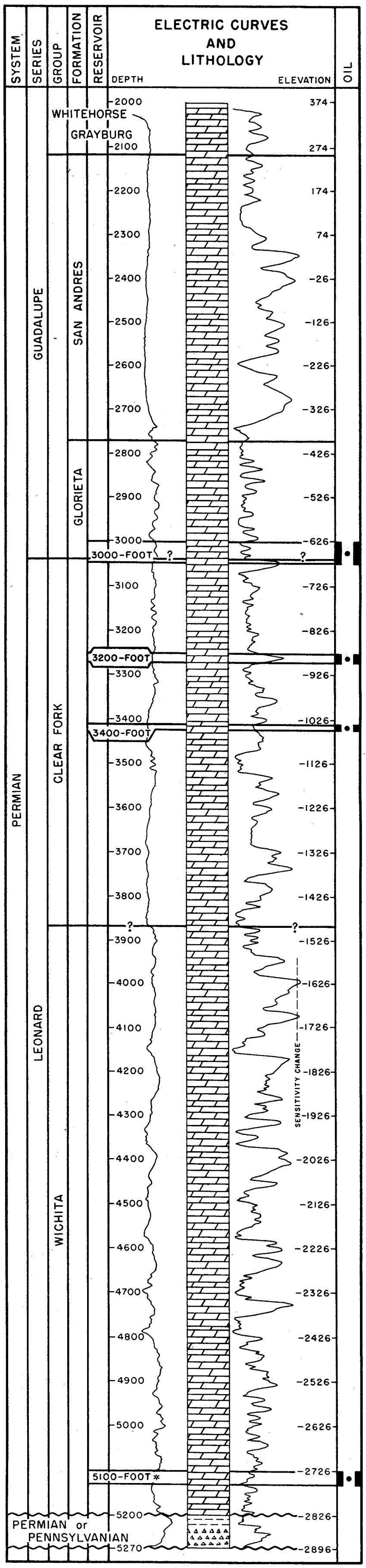
Devonian: Limestone; white to tan, somewhat silicious and containing thin interbedded layers of chert. Cores have shown considerable fracturing.

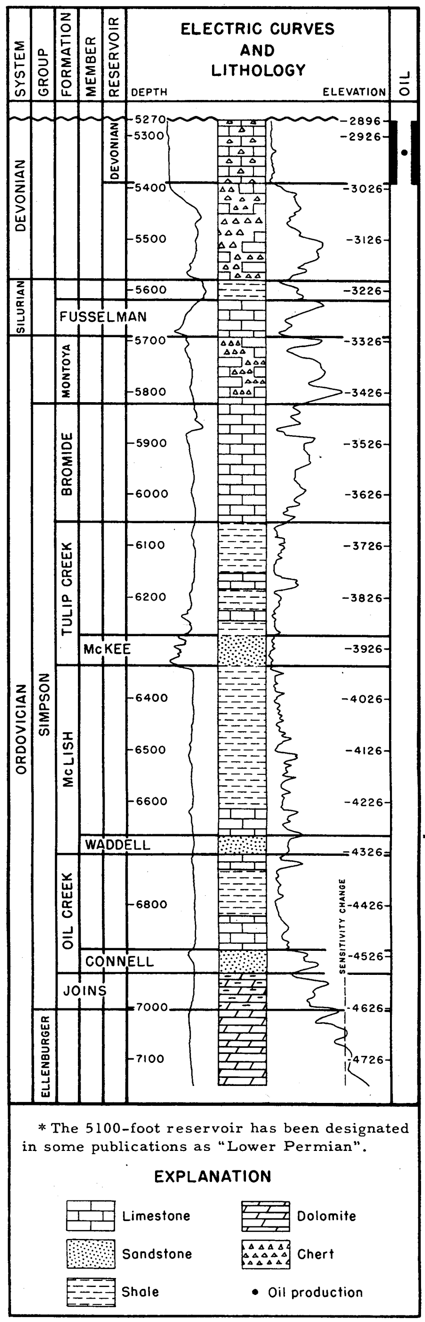
CONTINUITY OF RESERVOIR ROCKS

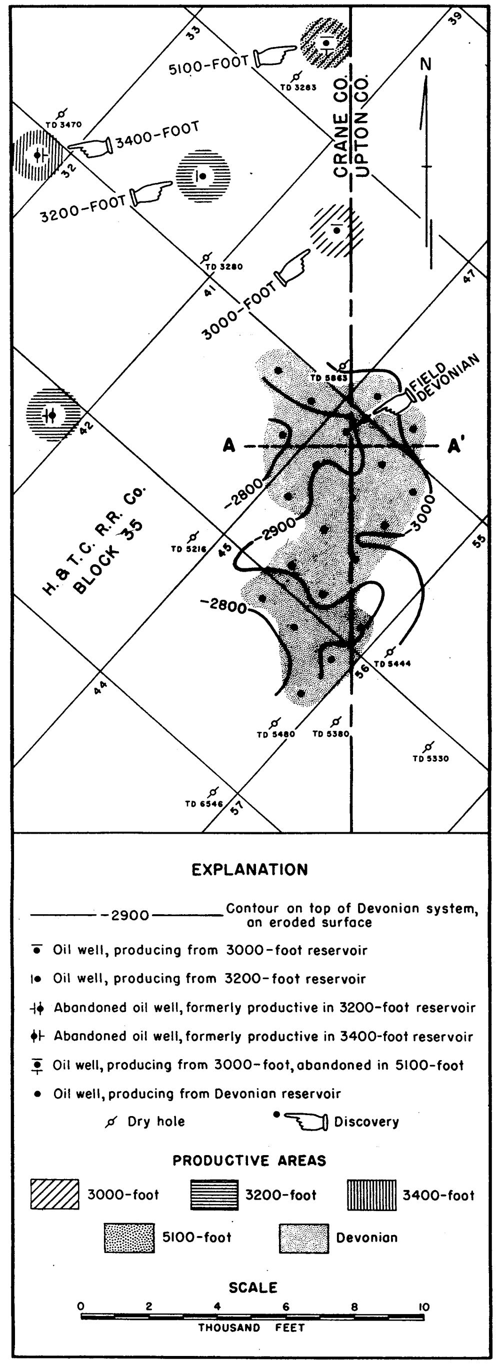
3000-foot, 3200-foot, 3400-foot and 5100-foot: Each of these reservoir rocks is continuous throughout the area of the field and far beyond. However, the degrees of porosity and permeability which occasion commercial production do not appear to be continuous beyond the immediate vicinity of each respective well.

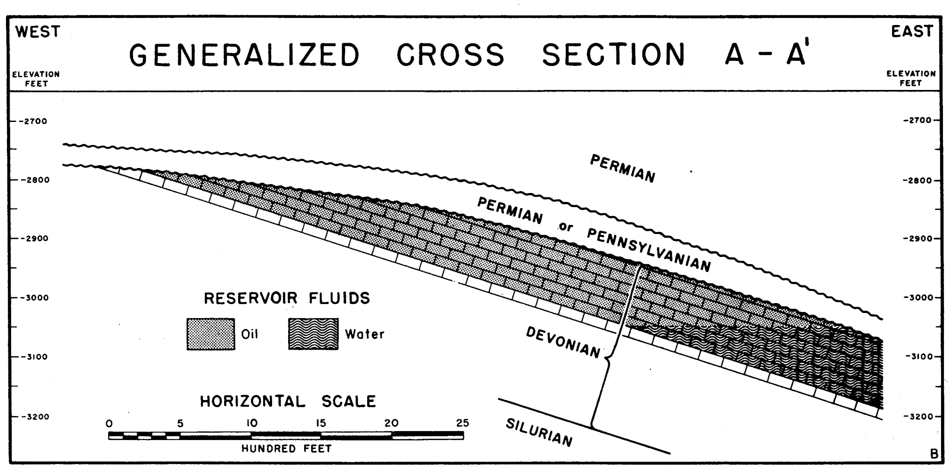
Devonian: Rocks of the Devonian system strike generally north-south and dip eastward. They have been truncated by erosion throughout the area of the field. The reservoir rock, which is at the top of the Devonian system, has been entirely removed throughout the northern portion of the field where the shallower reservoirs have been found productive at scattered locations. Even in the area which produces from the Devonian reservoir, only the bottom portion of the reservoir rock extends throughout the Devonian productive area; the higher portions having been removed by erosion, as indicated on the accompanying cross section.

TYPICAL SECTION OF ROCKS PENETRATED









THICKNESSES OF RESERVOIR ROCKS

From top to bottom, feet	Min.	Max.	Avg.
3000-foot	50	60	55
3200-foot	20	20	20
3400-foot	12	12	12
5100-foot	25	25	25
Devonian	37	135	94

Data are not available for satisfactory estimates of net productive thicknesses.

CHARACTER OF OIL

	Gravity, A.P.I.	Sulphur	Base
3000-foot	41°	Sweet	Mixed
3200-foot	45°	0.5%	Mixed
3400-foot	41°	Sweet	Mixed
5100-foot	44°	Sweet	Mixed
Devonian	45°	0.12%	Mixed

For analysis of Devonian oil see:
U.S. Bureau of Mines Lab.ref.No. 46102
Analyses of Crude Oils from Some
West Texas Fields. R.I. 4959 (1953) Item 21

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation of oil (feet) Top	Elevation of oil (feet) Bottom	Oil column (feet)
3000-foot	-559±	-619±	60±
3200-foot	-813	-833	20
3400-foot	-1,061	-1,073	12
5100-foot	-2,664	-2,689	25
Devonian	-2,790	-3,049	259

The above figures represent conditions as of respective discovery dates.

WATER PRODUCTION

3000-foot and 3200-foot: At time of completion, each well produced a small percentage of water. In general, there has been only a slight increase in the ratio of water to oil, but, in one of the four wells, water increased considerably and the well was abandoned in 1954.

3400-foot and 5100-foot: Excessive water production occasioned the abandonment of the well completed in the 3400-foot reservoir and the recompletion of the well originally completed in the 5100-foot reservoir.

Devonian: Water constituted a small percentage of the gross production of a few of the wells at times of completion. In general, there has been a slight increase in the ratio of water in the production of such wells.

ACID TREATMENT

3000-foot: Each well was washed with 500 gallons of mud acid.

3200-foot: Each well was washed with 4,000 gallons of mud acid.

3400-foot and 5100-foot: Each well was treated with 500 gallons of acid.

Devonian: The normal treatment has been with 500 to 1,000 gallons of acid, but some wells have been completed without acid treatment and the quantity has ranged up to 8,000 gallons used in the treatment of one well.

CHARACTER OF GAS

The only gas production has been incidental to oil production. No analysis of the gas from any reservoir is available, but it is known that the gas from the 3,000-foot reservoir and also that from the Devonian reservoir is sweet and relatively dry.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Field totals				
1944	3	3	32,534	32,534
1945	11	0	164,533	197,067
1946	11	2	116,413	313,480
1947	13	3	155,146	468,626
1948	17	3	213,849	682,475
1949	13	9	150,171	832,646
1950	20	5	177,463	1,010,109
1951	20	5	207,359	1,217,468
1952	20	7	205,504	1,422,972
1953	19	6	209,258	1,632,230
1954*	19	5	170,813	1,803,043
3000-foot				
1952	1	1	19,635	19,635
1953	1	1	33,359	52,994
1954*	1	1	20,930	73,924
3200-foot				
1945	1	0	10,126	10,126
1946	0	1	3,590	13,716
1947	0	1	4,307	18,023
1948	0	2	5,662	23,685
1949	0	2	5,264	28,949
1950	0	2	3,922	32,871
1951	0	2	3,452	36,323
1952	0	2	3,446	39,769
1953	0	2	3,481	43,250
1954*	0	1	3,156	46,406
3400-foot				
1950	1	0	865	865
1951	1	0	1,165	2,030
1952	0	1	28	2,058
1953	0	0	0	2,058
1954*	0	0	0	2,058
5100-foot				
1950	0	1	3,573	3,573
1951	0	1	1,016	4,589
1952	0	1	265	4,854
1953	0	0	0	4,854
1954*	0	0	0	4,854
Devonian				
1944	3	3	32,534	32,534
1945	10	0	154,407	186,941
1946	11	1	112,823	299,764
1947	13	2	150,839	450,603
1948	17	1	208,187	658,790
1949	13	7	144,907	803,697
1950	19	2	169,103	972,800
1951	19	2	201,726	1,174,526
1952	19	2	182,130	1,356,656
1953	18	3	172,418	1,529,074
1954*	18	3	146,727	1,675,801

*1954 data added by amendment.

DIXIELAND FIELD

Reeves County, Texas

JOE R. HORKEY
Geologist, Phillips Petroleum Company, Midland, Texas
January 3, 1953

LOCATION

The Dixieland field is in northeast Reeves County about 2 miles south of the town of Dixieland. It is in sections 12, 13, 17 and 18 of block 2 of H. & G.N. R.R. Co. survey. The field is near the geographical center of the Delaware basin; on the west limb of the asymmetrical basin about 1,500 feet higher than the axis.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Random drilling in the vicinity had discovered shows of oil before the beginning of the exploration which led directly to the discovery of commercial production. In 1922, Dixieland Syndicate in its #1 Bell in Sec. 20 found a particularly promising show, and that show led to the drilling of several other tests in the vicinity. It appears that the operators who drilled the discovery well in 1948 were guided by the data afforded by the several tests previously drilled in the vicinity.

DISCOVERY

Bell Canyon: April 20, 1948; C & B Oil Co. (Cosby and Bectel) #1 Ollie P. Anderson, which is now designated as Indiana Farm Bureau Co-operative Association, Inc., #1 Ollie P. Anderson. On initial potential test, the well flowed at rate of 73 barrels of oil per day; 6/64-inch choke; tubing pressure, 290 psi.; casing pressure, 945 psi.; gravity, 35°, total depth, 3,939 feet; plugged back to 3,906 feet. Within a few weeks, the well was put on pump.

ELEVATION OF SURFACE

At well locations: Highest, 2,787 ft.; lowest, 2,736 ft.

SURFACE FORMATION

Recent Quaternary alluvium and gravels.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Bell Canyon formation 75 feet below the base of the Lamar member. This penetration was in the discovery well. Other wells in the vicinity, but beyond the limits of the field, have been drilled considerably deeper and have demonstrated that the average thickness of the Bell Canyon formation is about 1,200 feet.

NATURE OF TRAP

Bell Canyon: Accumulation of oil appears to have been occasioned by a combination of terracing on an eastward dipping monocline and a decrease in degree of porosity and permeability both updip and along strike.

PRODUCTIVE AREA

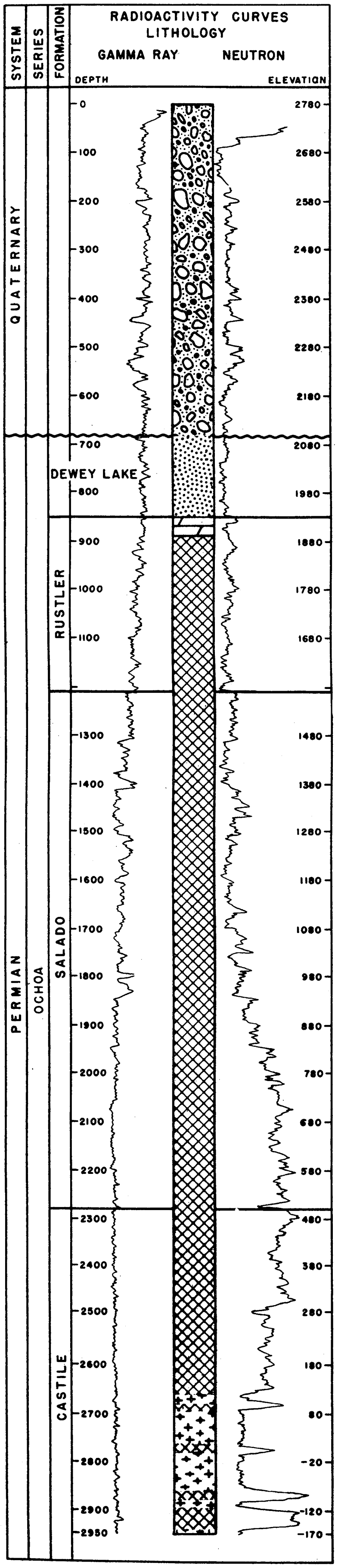
Bell Canyon and Field: About 300 acres proven by development to date.

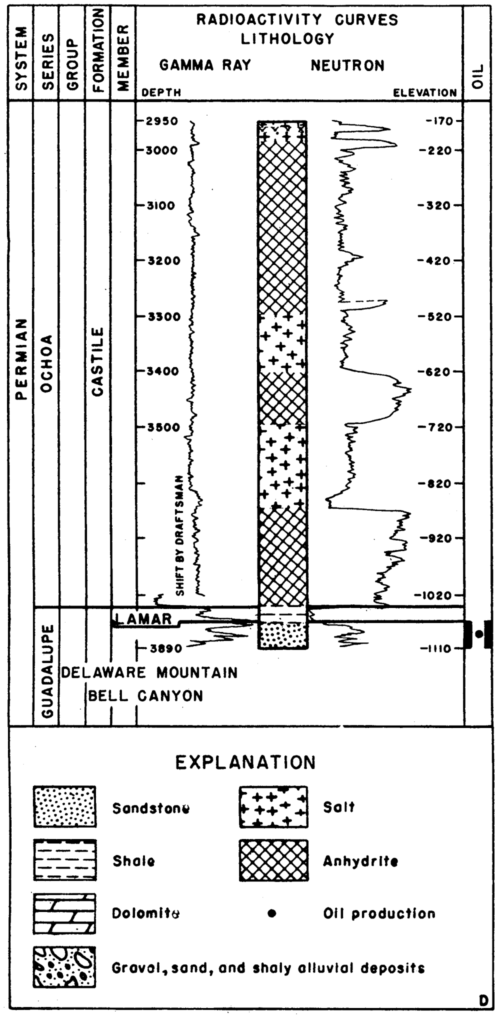
THICKNESS OF RESERVOIR ROCK

Bell Canyon	Feet, average
From top to bottom, gross	60
Net productive	60

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: Very fine-grained, tight, clean to shaly, homogenous sandstone with partings of shale and sandy shale.





CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The reservoir rock is a blanket sandstone occurring throughout the whole of the Delaware basin.

WATER PRODUCTION

Bell Canyon: Only a small amount of water has been produced. Such water as has been produced appears to have been distributed in the reservoir rock with the oil rather than to have occupied a position below any definite oil-water contact.

CHARACTER OF OIL

Bell Canyon:

Gravity, A.P.I. @ 60° F.
Range, 31.9° to 40°
Wtd. Avg., 35°

CHARACTER OF GAS

Bell Canyon: The only gas produced is that which comes out of solution as the oil is produced. Analysis is not available.

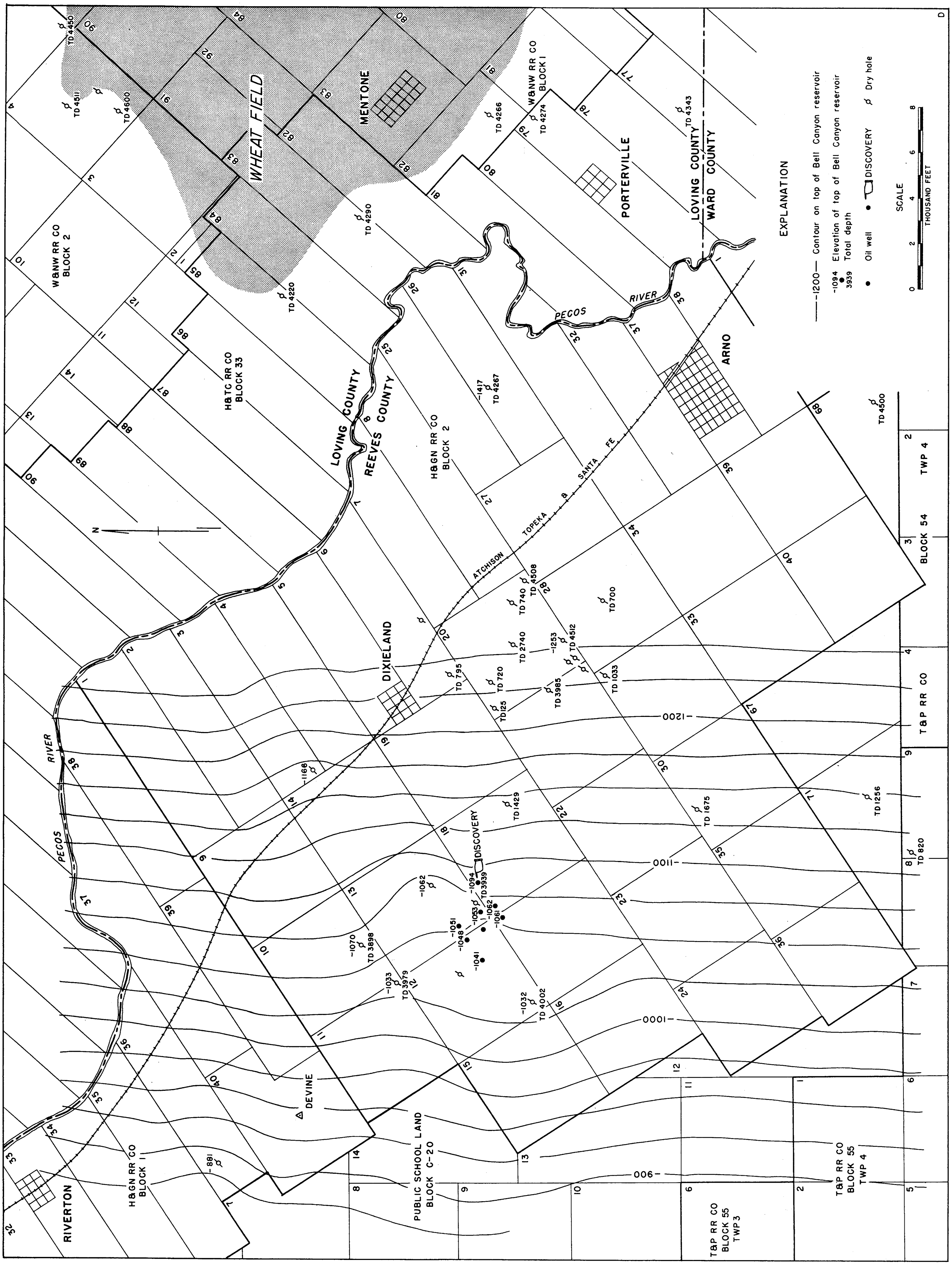
ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet
No free gas cap	
Highest known elevation of oil	-1,041
Lowest known elevation of oil	-1,132
Known relief	91

The above figures represent the extremes in productive wells completed to date. No oil-water contact has been found.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1948	0	3	12,231	12,231
1949	2	3	18,670	30,901
1950	2	3	15,565	46,466
1951	2	6	26,760	73,326
1952	2	6	28,293	101,619



EXPLANATION
—1200— Contour on top of Bell Canyon reservoir
-1094 3939 Elevation of top of Bell Canyon reservoir Total depth
Oil well
DISCOVERY
Dry hole
SCALE
THOUSAND FEET
WHEAT FIELD
MENTONE
PORTERVILLE
LOVING COUNTY
WARD COUNTY
REEVES COUNTY
PECOS RIVER
ARNO
DIXIELAND
DEVINE
RIVERTON
ATCHISON TOPEKA & SANTA FE
W&NW RR CO BLOCK 2
W&NW RR CO BLOCK 1
H&TC RR CO BLOCK 33
H&GN RR CO BLOCK 2
H&GN RR CO BLOCK 1
PUBLIC SCHOOL LAND BLOCK C-20
T&P RR CO BLOCK 54 TWP 4
T&P RR CO BLOCK 55 TWP 4
T&P RR CO BLOCK 55 TWP 3

DOCKREY FIELD

Mitchell County, Texas

E. P. WHEALDON
Geologist, The Superior Oil Co., Midland, Texas
April 9, 1954

LOCATION

The Dockrey field (one well) is in west central Mitchell County approximately 3½ miles southwest of the town of Westbrook.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Drilling to validate expiring lease.

DISCOVERY

Ellenburger: July 8, 1949; The Superior Oil Co. #1 J. R. Dockrey. During potential test, flowed at daily rate of 170 barrels of oil and 62 barrels of water; 11/64-inch choke; 2½-inch tubing set at 7,990 feet; gas-oil ratio of 302:1.

ELEVATION OF SURFACE

At the location of the only well: 2,155 feet.

SURFACE FORMATION

Dockum group of the Triassic system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 20 feet below the top of the Ellenburger.

NATURE OF TRAP

Ellenburger: The trap appears to be due to a small topographic high consisting of truncated, porous Ellenburger dolomite overlain by the non-porous Woodford shale.

PRODUCTIVE AREA

Ellenburger: Approximately 80 acres.

THICKNESS OF RESERVOIR ROCK

Ellenburger:	Feet
Top of Ellenburger to total depth	20
Net productive, approximate	14

LITHOLOGY OF RESERVOIR ROCK

Ellenburger: Dolomite; tan, medium to coarsely granular to crystalline, with fair to good fracture and vug porosity.

CONTINUITY OF RESERVOIR ROCK

Ellenburger: The continuity of the zone which is productive in the one well is not known. Truncation appears to have interrupted continuity in the vicinity of the well.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Ellenburger:	Feet
Elevation of top of oil	-5,819
Elevation of bottom of oil	-5,839
Relief	20

CHARACTER OF OIL

Gravity:	44.3°	Color:	Greenish brown
Odor:	Sour	Base:	Asphalt

WATER PRODUCTION

Ellenburger: Water constitutes about 80% of gross fluid produced.

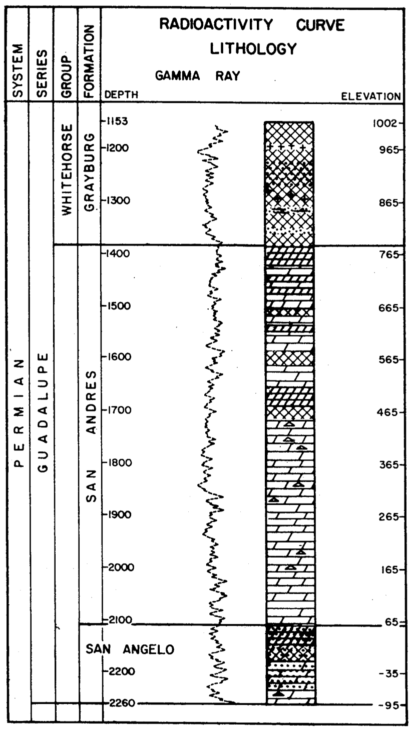
ACID TREATMENT

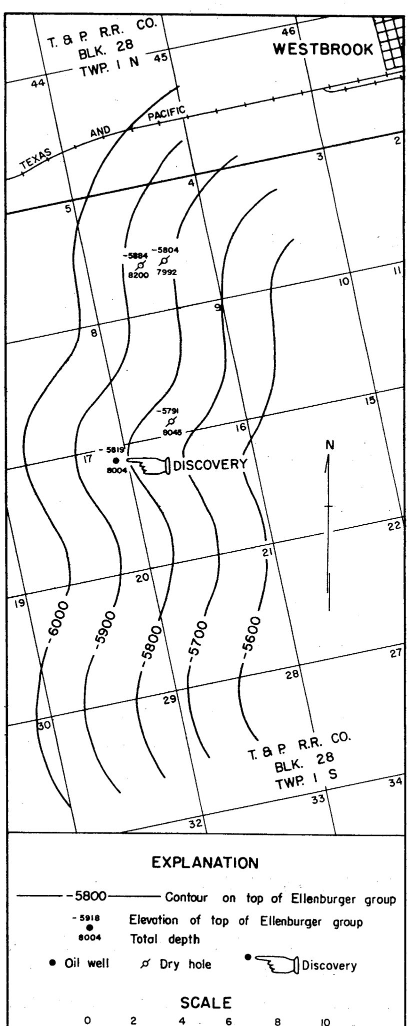
Ellenburger: The section from 7,990 feet to 8,004 feet (total depth) was treated with 1,000 gallons of regular 15% acid.

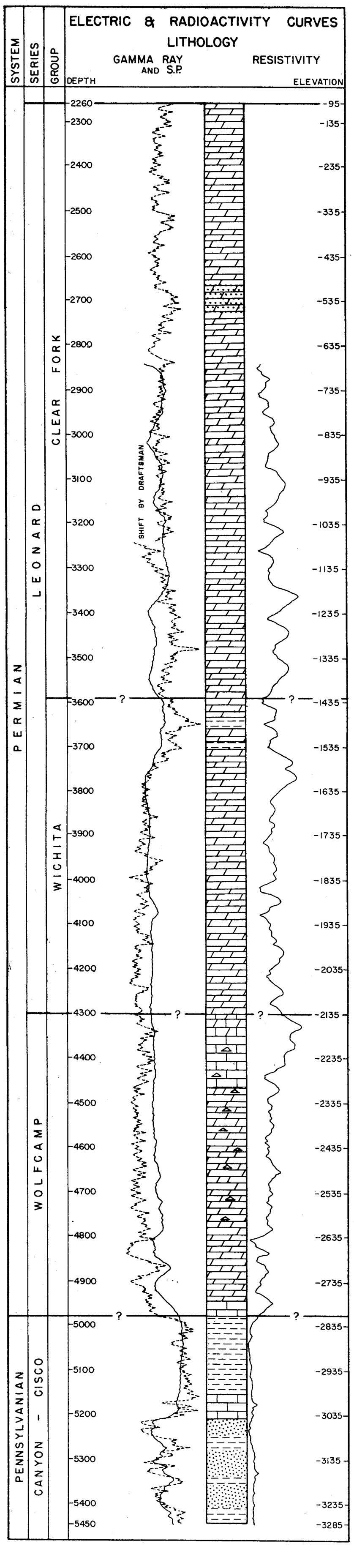
PRODUCTION HISTORY

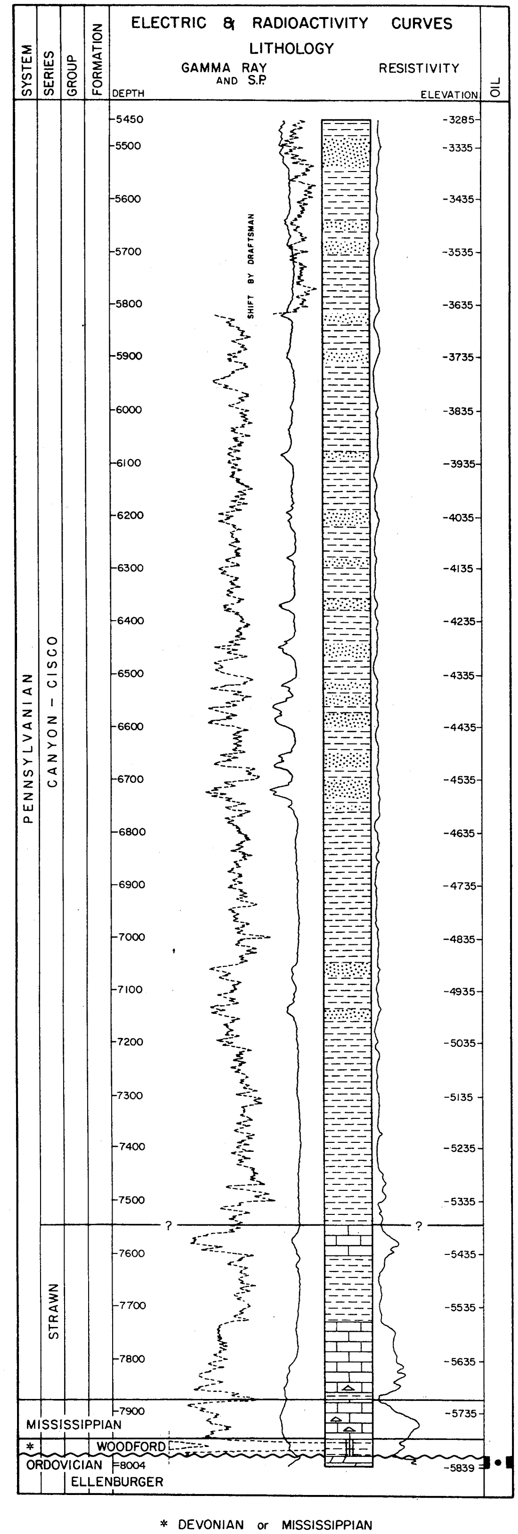
Ellenburger: The one well has produced the following indicated quantities of oil: 1949, 19,066 barrels; 1950, 10,137 barrels; 1951, 12,513 barrels; 1952, 10,592 barrels; 1953, 10,247 barrels; total to end of 1953, 62,555 barrels.

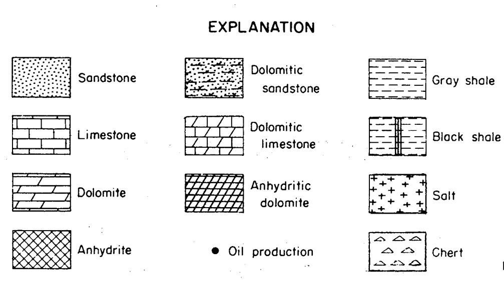
SECTION OF ROCKS PENETRATED











DOLLARHIDE FIELD

Andrews County, Texas, and Lea County, New Mexico

M. H. L. KEENER
Division Development Geologist, The Pure Oil Co., Fort Worth, Texas
March 1, 1957

LOCATION and FIELD NAMES

The Dollarhide field occupies an area partly in Texas and partly in New Mexico. It is largely in southwest Andrews County, Texas, with its nearest well only about 2 miles from the southwest corner of the county. It is about 10 miles east of the town of Jal, New Mexico. It is on the Central Basin platform immediately eastward from the vast belt of almost-continuous productive areas along the west edge of this tectonic feature.

Contrary to the popular belief that the field name was derived from a depressed selling price of cowhides, the field was named for the old Charlie Dollarhide homestead nearby. The area of the field had been a part of the James A. Lynch ranch and that name had been memorialized by using the initials in the naming of the nearest railroad stop, Jal.

In several publications, the New Mexico portion of the field has been designated as the West Dollarhide field. Some publications treat the Dollarhide field as two fields: viz., the Texas Dollarhide field and the New Mexico Dollarhide field. A separate and distinct field not treated in this paper is known as the East Dollarhide field; it is located about 2 miles east of the southernmost part of the Dollarhide field and now has 4 wells, all producing from pre-Permian rocks.

METHODS OF EXPLORATION LEADING TO DISCOVERY

In 1938, Frank S. Perkins #1 E. P. Cowden, located just south of the present extent of the field, was drilled to the depth of 8,012 feet at a location indicated by seismic data to be structurally high. Although this test was completed as a dry hole, it contributed to discovery of the field because it provided paleontological data which indicated the black shales at the total depth to be Woodford in age whereas thick shales at this depth in nearby dry holes are of Pennsylvanian age. Data provided by this and other dry holes indicated structural relief at top of Devonian of about 1,200 feet in the immediate vicinity. This evidence led to the drilling in 1945, at a location one-half mile to the northeast, of the well which became the discovery well of the field and of the Devonian reservoir. Subsequent development has shown Frank S. Perkins #1 E.P. Cowden to have penetrated the top of the Devonian (elevation, -5,259) in a fault wedge at a location where the Devonian reservoir is about 200 feet lower than in a productive well only 500 feet to the northwest.

DISCOVERIES

Queen: April 12, 1952; Skelly Oil Co. #1-H Mexico "O". During potential test this well flowed at rate of 82 barrels of oil per day through perforations from 3,670 feet to 3,788 feet. It had been plugged back to 3,836 feet after having been drilled to the total depth of 6,997 feet.

Leonard: June 23, 1949; Cities Service Oil Co. #1-E E.P. Cowden. During potential test this well flowed at rate of 492 barrels of oil per day on 20/64-inch choke through perforations in 7-inch casing from 6,545 feet to 6,650 feet. The well was also completed at the same time for production from Devonian; it was operated as a dual producer. Although possible commercial production in the Leonard had been indicated at several wells drilled through the Leonard for deeper production, this well is the first which was completed for production from Leonard.

Devonian and Field: June 1, 1945; Magnolia Petroleum Co. and Humble Oil & Refining Co. #1 E.P. Cowden. During potential test after treatment with 1,000 gallons of acid, this well flowed at rate of 244 barrels of oil per day on 3/8-inch choke through perforations from 7,900 feet to 7,960 feet; GOR, 2,186 : 1.

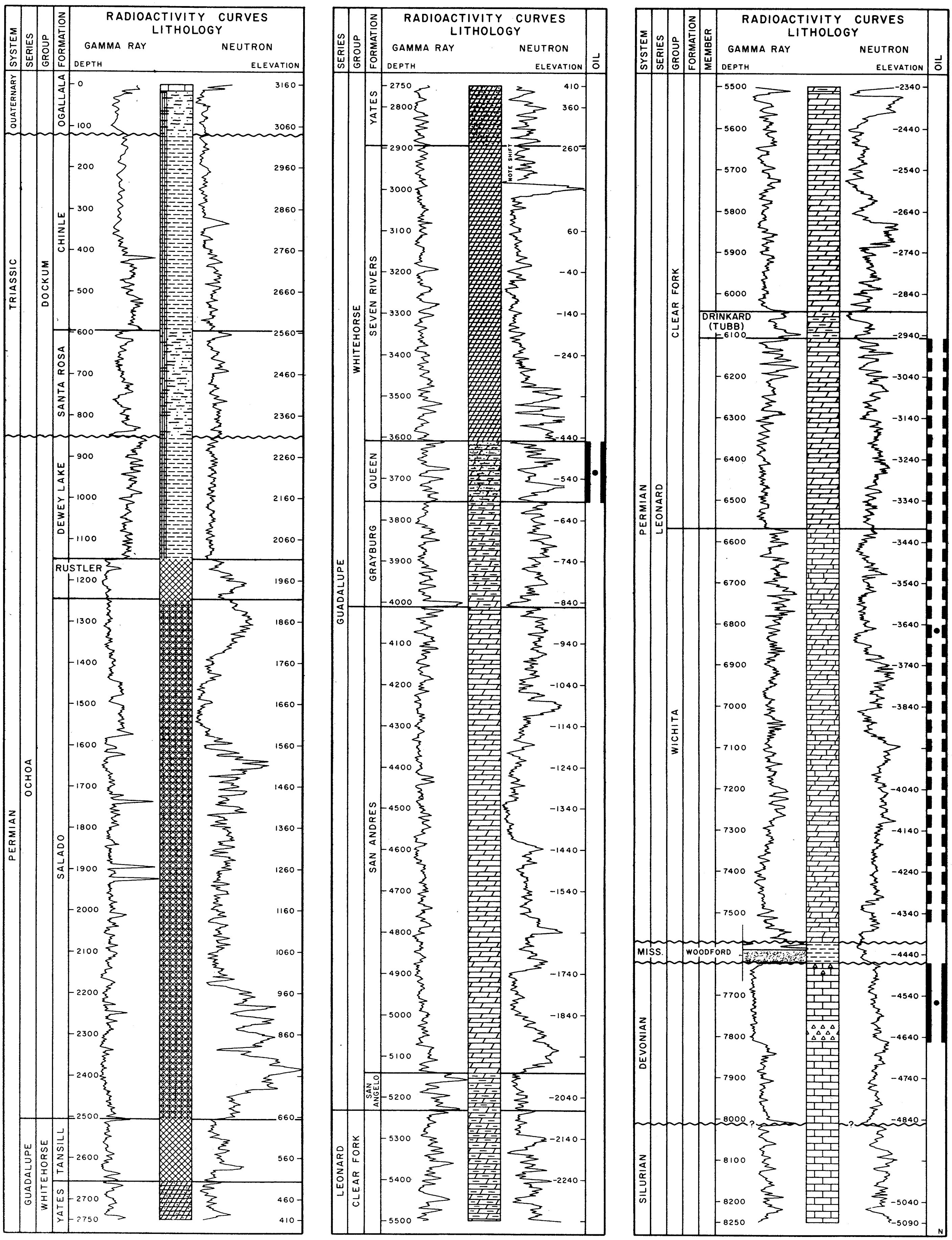
Texas Fusselman-Montoya: January 12, 1947; Magnolia Petroleum Co. #2-B E.P. Cowden. During potential test this well flowed at rate of 535 barrels of oil per day on 3/4-inch choke from 20 feet of open hole just below the top of the Fusselman formation; GOR, 270 : 1.

New Mexico Fusselman-Montoya: February 26, 1952; Skelly Oil Co. #3 Mexico "J". During potential test after treatment with 500 gallons of acid through perforations from 8,710 feet to 8,744 feet, this well flowed oil at rate of 1,996 barrels per day.

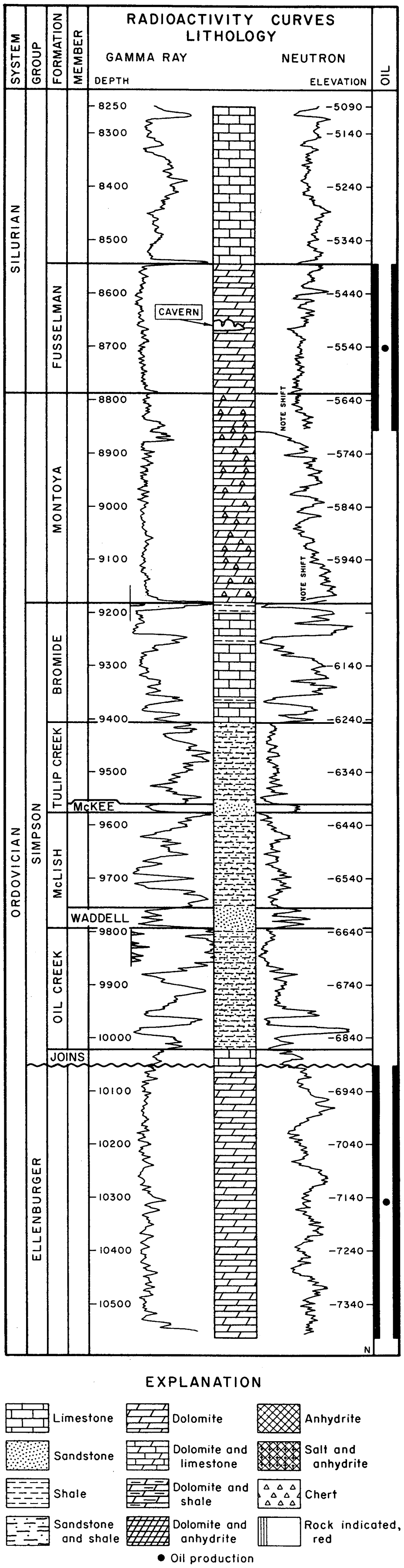
Texas Ellenburger: October 22, 1947; Pure Oil Co. and Humble Oil & Refining Co. #1-E E. P. Cowden "A". During potential test this well flowed at rate of 745 barrels of oil per day on 1/4-inch choke from 165 feet of open hole; GOR, 777 : 1. This well demonstrated that the oil-water contact was at the elevation of about -7,000 feet at discovery date.

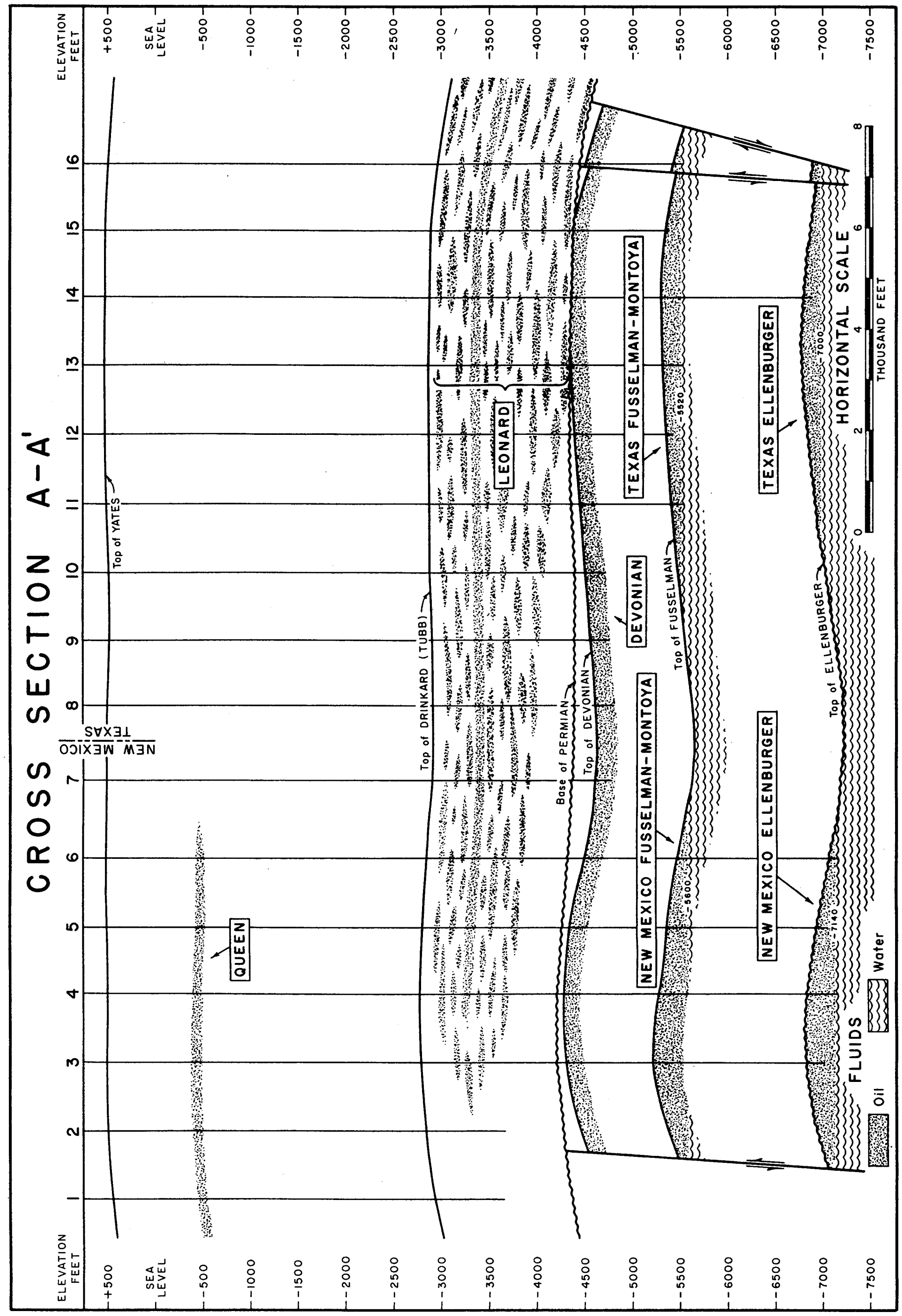
New Mexico Ellenburger: August 24, 1951; Skelly Oil Co. #1 Mexico "J". During potential test this well flowed at rate of 583 barrels of oil per day on 3/4-inch choke through perforations from 10,210 feet to 10,230 feet.

TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED





RESERVOIR PRESSURES

	Datum elevation (feet)	At time of discovery (psi.)	Saturation pressure (psi.)	At indicated recent date Pressure (psi.)	Date
Queen	-550	1,361+	?	689	Nov. 1955
Leonard	-3,400	2,890	2,190	817	Nov. 1956
Devonian	-4,600	3,300	2,830	1,356	Nov. 1956
Texas Fusselman-Montoya	-5,200	3,555	793	2,655	Aug. 1956
New Mexico Fusselman-Montoya	-5,524	3,300*	395	3,062	March 1956
Texas Ellenburger	-6,800	4,295	1,492	2,688	Aug. 1956
New Mexico Ellenburger	-7,080	3,630*	?	2,730	March 1956

* The fact that the discovery pressures in the New Mexico Fusselman-Montoya and in the New Mexico Ellenburger were lower than the discovery pressures in the Texas reservoirs in the same reservoir rocks is attributed to the later discovery dates of the New Mexico reservoirs. The New Mexico discovery pressures, when adjusted for differences in datum elevations, were slightly higher than corresponding pressures at the same dates in the respective Texas reservoirs.

LITHOLOGY OF RESERVOIR ROCKS

Queen: The productive portion of the Queen formation consists of sandstones which are interbedded with anhydritic dolomite and thin beds of red or gray shale. The sandstones are medium grained, with the grains subangular to subrounded; color is typically light gray; the upper part of the reservoir rock commonly contains frosted quartz grains. The foregoing description applies in the northwest part of the field where the Queen formation is commercially productive; southeastward, there is less sand and the formation is not productive.

Leonard: The productive rock consists of scattered layers occurring throughout the section between the base of the Drinkard (Tubb) member of the Clear Fork group and the base of the Permian system, generally a thickness of about 1,400 feet. As indicated on the accompanying TYPICAL SECTION, the Clear Fork portion of this section is dolomite and the Wichita portion is limestone and dolomite. Both portions contain numerous thin shale partings and some anhydrite streaks. The lower 120 feet of the Clear Fork portion is generally favorably porous, but otherwise the distribution of favorable porosity is very irregular and is scattered throughout the dolomite and limestone beds in thin streaks. The zones of favorable porosity are generally regarded as adequately inter-connected to constitute a single reservoir, but the effectiveness of the interconnection is questionable as to some portions of the reservoir. It is difficult to correlate the individual porous layers from well to well, but certain ones, such as the aforementioned 120-foot zone, are recognizable throughout the northern portion of the field and a basal Permian zone is prominent in the southern portion of the field. The porosity of the productive rock averages about 10.4% and the permeability averages about 9.2 millidarcys.

Devonian: This reservoir rock generally consists of (a) an upper member of about 60 feet of white, fine to medium, crystalline limestone and dolomite with varying amounts of gray translucent chert; (b) a middle member of 75 to 100 feet of white, medium crystalline limestone which is somewhat granular near the base and commonly contains considerable glauconite; and (c) a lower member of 20 to 70 feet of chert which normally grades from a light colored opaque chert into a dull brown, earthy, calcareous weathered chert. The porosity of the productive rock averages about 13.5% and the permeability averages about 17 millidarcys.

Fusselman-Montoya, (Texas and New Mexico): The Fusselman portion of this reservoir rock is a white to light buff coarsely crystalline limestone which grades locally into dolomite. It commonly contains glauconite and varying amounts of light colored vitreous opaque chert. The Montoya portion is a coarsely crystalline dolomite with abundant light colored vitreous chert. Good intergranular porosity is present through the entire thickness of the reservoir rock. Cavernous porosity occurs locally. Open caverns, 2 to 16 feet in height, were encountered in 15 wells in the central part of the field, mainly in Sec. 24, Blk. A-52. While the discovered open caverns are mainly in the Fusselman formation, one such cavern is in rock definitely above the Fusselman. Exclusive of the cavernous portion, the productive rock has an average porosity of about 5.8% and an average permeability of about 8.9 millidarcys.

Ellenburger, (Texas and New Mexico): The reservoir rock is gray to brown, medium to coarsely crystalline dolomite containing zones with frosted quartz grains, some chert and small amounts of glauconite and pyrite. The porosity is dominantly of the vuggy and fracture types with visible interstitial porosity limited to some of the coarsely crystalline dolomites. Horizontal and vertical permeability is sufficiently continuous that water drive provides a significant part of the reservoir energy. Analyses of full diameter cores indicate that the porosity averages 2.2% and the permeability averages 4.9 millidarcys.

CHARACTER OF OIL

	Gravity, A. P. I.	Sulphur, %	Base	Color	Volume factor*
Queen	34	?	?	?	?
Leonard	38.1	0.4	Mixed	Green	1.40
Devonian	39.7	0.6	Mixed	Green	1.65
Texas Fusselman-Montoya	44.2	0.4	Asphalt	Black	1.20
New Mexico Fusselman-Montoya	38	?	Asphalt	Black	?
Texas Ellenburger	43	0.2	Mixed	Green	1.29
New Mexico Ellenburger	42	?	Mixed	Green	?

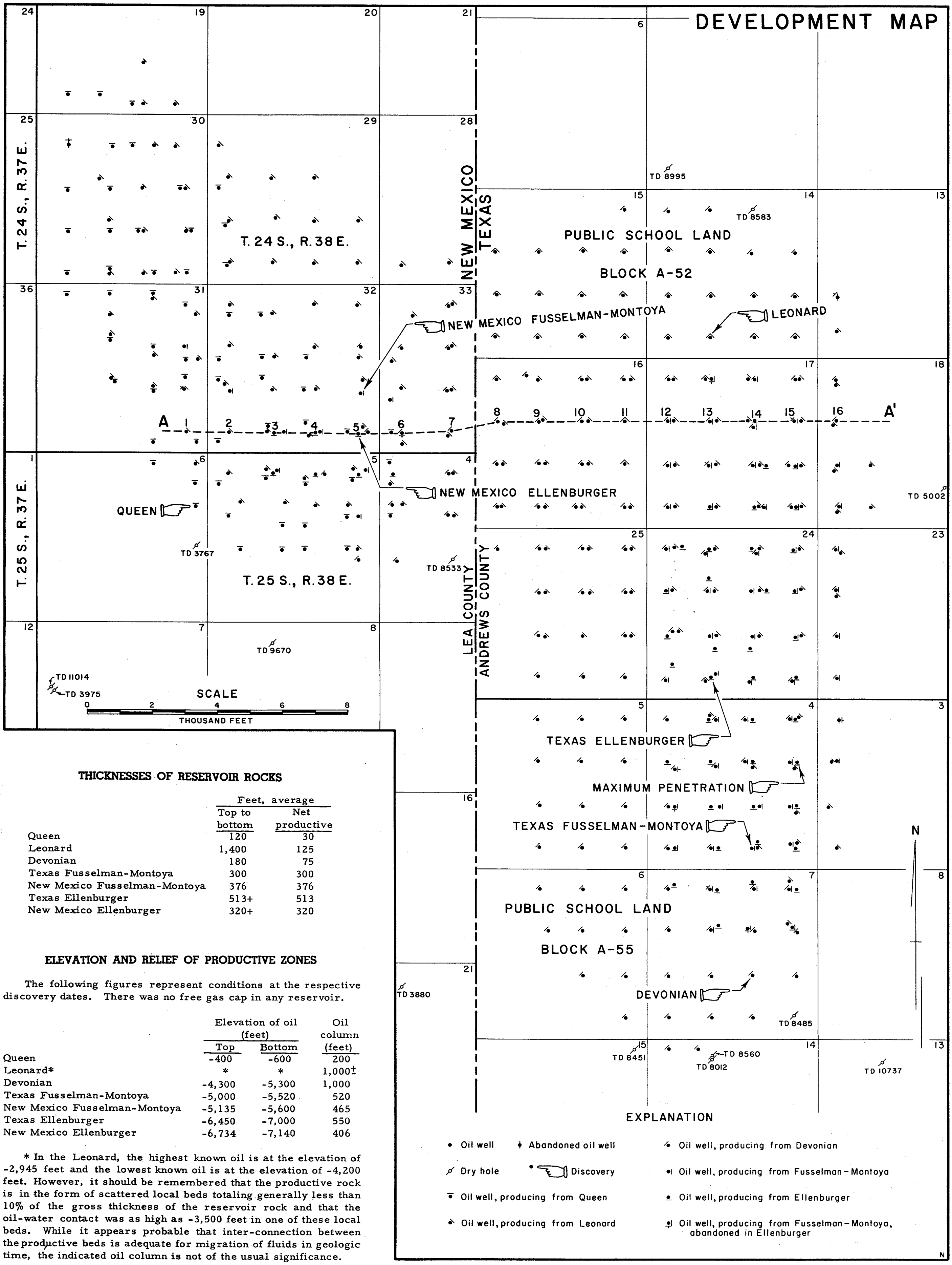
* Volume factor expressed as ratio of volume in reservoir at saturation pressure to volume at surface at atmospheric pressure and temperature of 60° F.

For analysis of sample from the Devonian reservoir see:

U. S. Bureau of Mines — Lab. ref. No. 46092

Analyses of Crude Oils from Some West Texas Fields.

R. I. 4959 (1953) — Item 22



THICKNESSES OF RESERVOIR ROCKS

	Feet, average	
	Top to bottom	Net productive
Queen	120	30
Leonard	1,400	125
Devonian	180	75
Texas Fusselman-Montoya	300	300
New Mexico Fusselman-Montoya	376	376
Texas Ellenburger	513+	513
New Mexico Ellenburger	320+	320

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

The following figures represent conditions at the respective discovery dates. There was no free gas cap in any reservoir.

	Elevation of oil (feet)		Oil column
	Top	Bottom	(feet)
Queen	-400	-600	200
Leonard*	*	*	1,000±
Devonian	-4,300	-5,300	1,000
Texas Fusselman-Montoya	-5,000	-5,520	520
New Mexico Fusselman-Montoya	-5,135	-5,600	465
Texas Ellenburger	-6,450	-7,000	550
New Mexico Ellenburger	-6,734	-7,140	406

* In the Leonard, the highest known oil is at the elevation of -2,945 feet and the lowest known oil is at the elevation of -4,200 feet. However, it should be remembered that the productive rock is in the form of scattered local beds totaling generally less than 10% of the gross thickness of the reservoir rock and that the oil-water contact was as high as -3,500 feet in one of these local beds. While it appears probable that inter-connection between the productive beds is adequate for migration of fluids in geologic time, the indicated oil column is not of the usual significance.

ELEVATION OF SURFACE

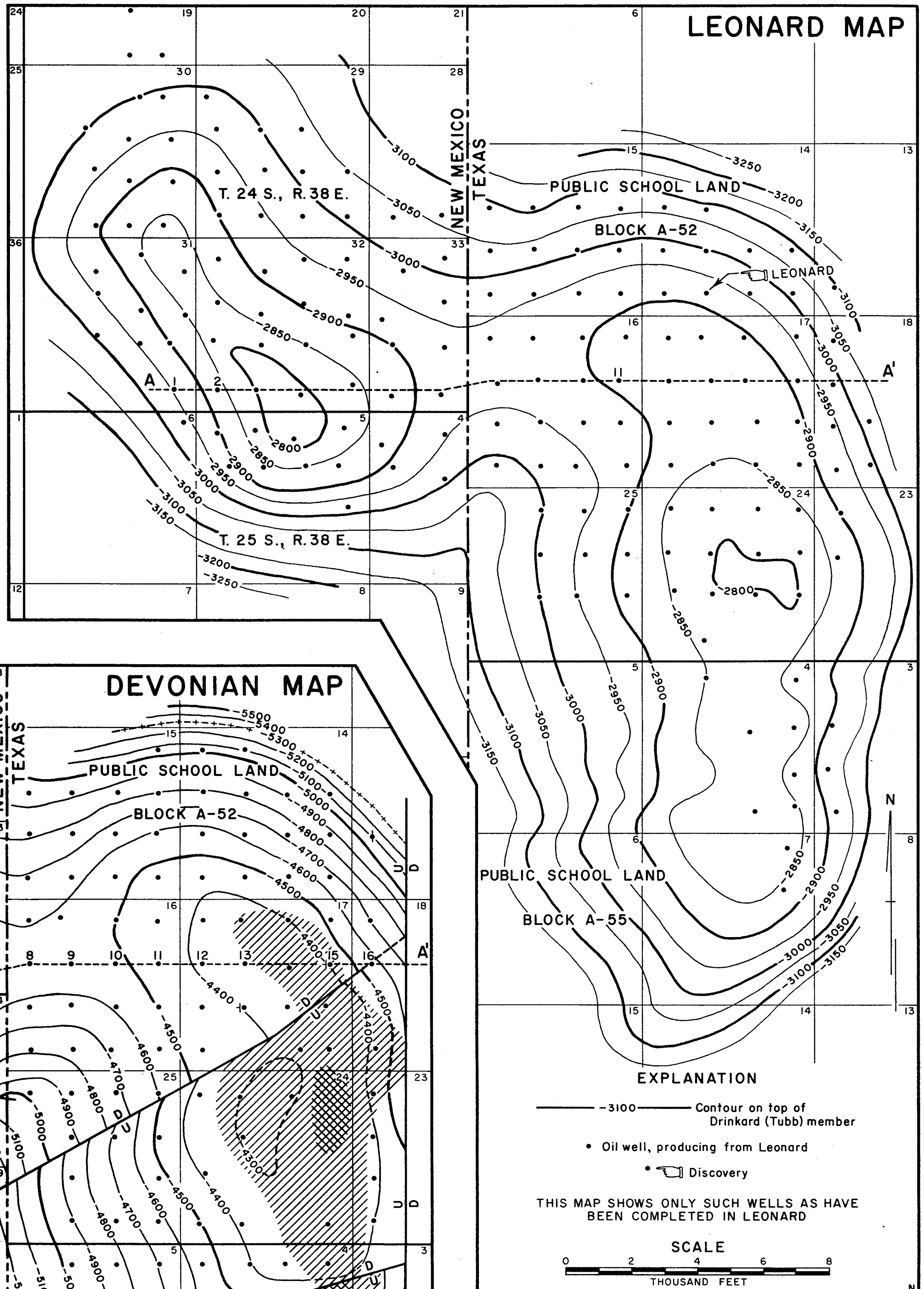
Derrick floor elevations: Highest, 3,200 feet; lowest, 3,110 feet. The higher elevations are at the north end of the field; the surface slopes southward generally.

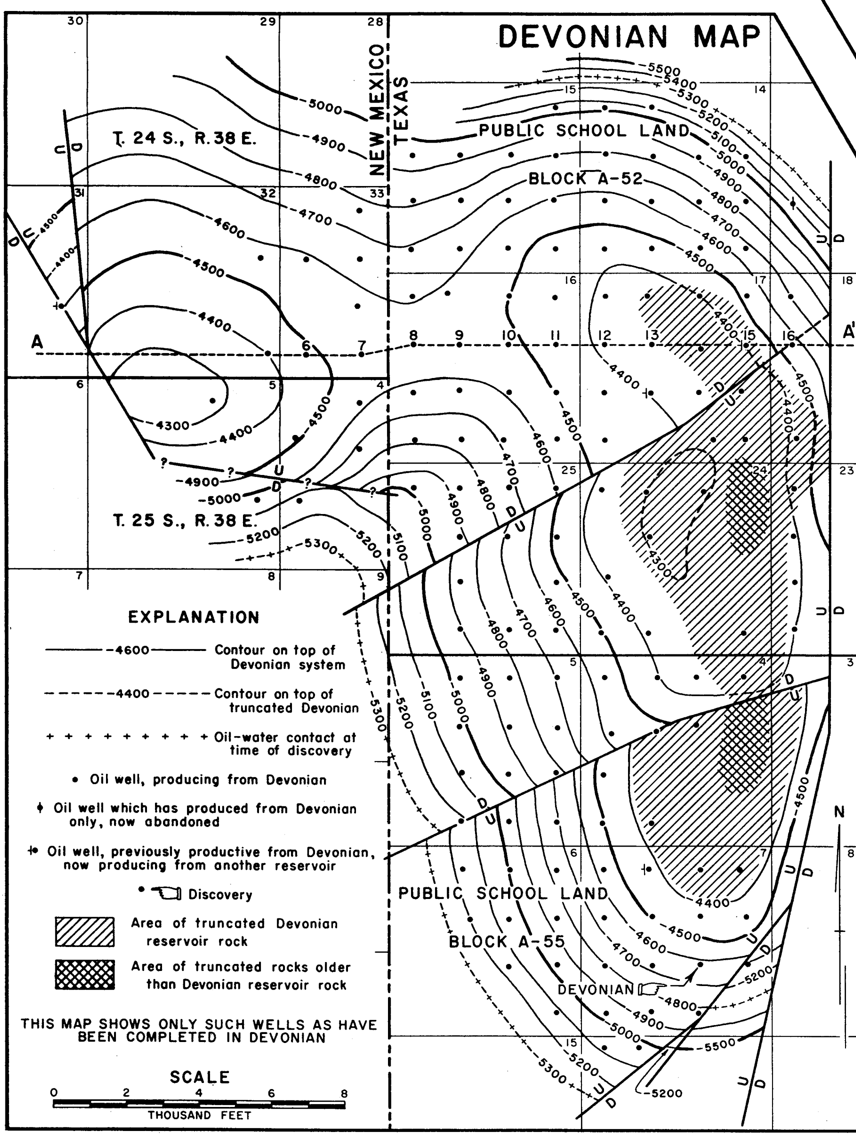
SURFACE FORMATION

Ogallala formation of the Quaternary system overlain generally by Recent wind-blown sands.

PRODUCTIVE AREAS

	Acres
Queen	2,520
Leonard	4,011
Devonian	5,632
Texas Fusselman-Montoya	2,800
New Mexico Fusselman-Montoya	970
Texas Ellenburger	2,555
New Mexico Ellenburger	705
Dollarhide field	9,040





NATURE OF TRAPS

Queen: Convex folding combined with change in character of sediments.

Leonard: Convex fold modified by permeability barriers.

Devonian: The trap is due primarily to convex folding; it is modified by faulting, by truncation and by variation in degree of permeability.

Texas Fusselman-Montoya: Convex fold modified by faulting.

New Mexico Fusselman-Montoya: Convex fold modified slightly by faulting.

Texas Ellenburger and New Mexico Ellenburger: The trap in each of the two reservoirs is due primarily to convex folding but it is modified by faulting and by truncation with sealing by relatively impervious overlying strata.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Ellenburger group. The maximum known penetration of Ellenburger is 513 feet below its eroded top. This penetration was at the total depth of 10,145 feet in Humble Oil & Refining Co. #13 E.P.Cowden, located in Sec. 4 where "MAXIMUM PENETRATION" is entered on the accompanying Development map. Since the top of the Ellenburger is an erosion surface and since exact stratigraphic positions within Ellenburger have not been determined, it is possible that some lesser penetration of Ellenburger actually reached an older horizon than penetrated by the above mentioned well.

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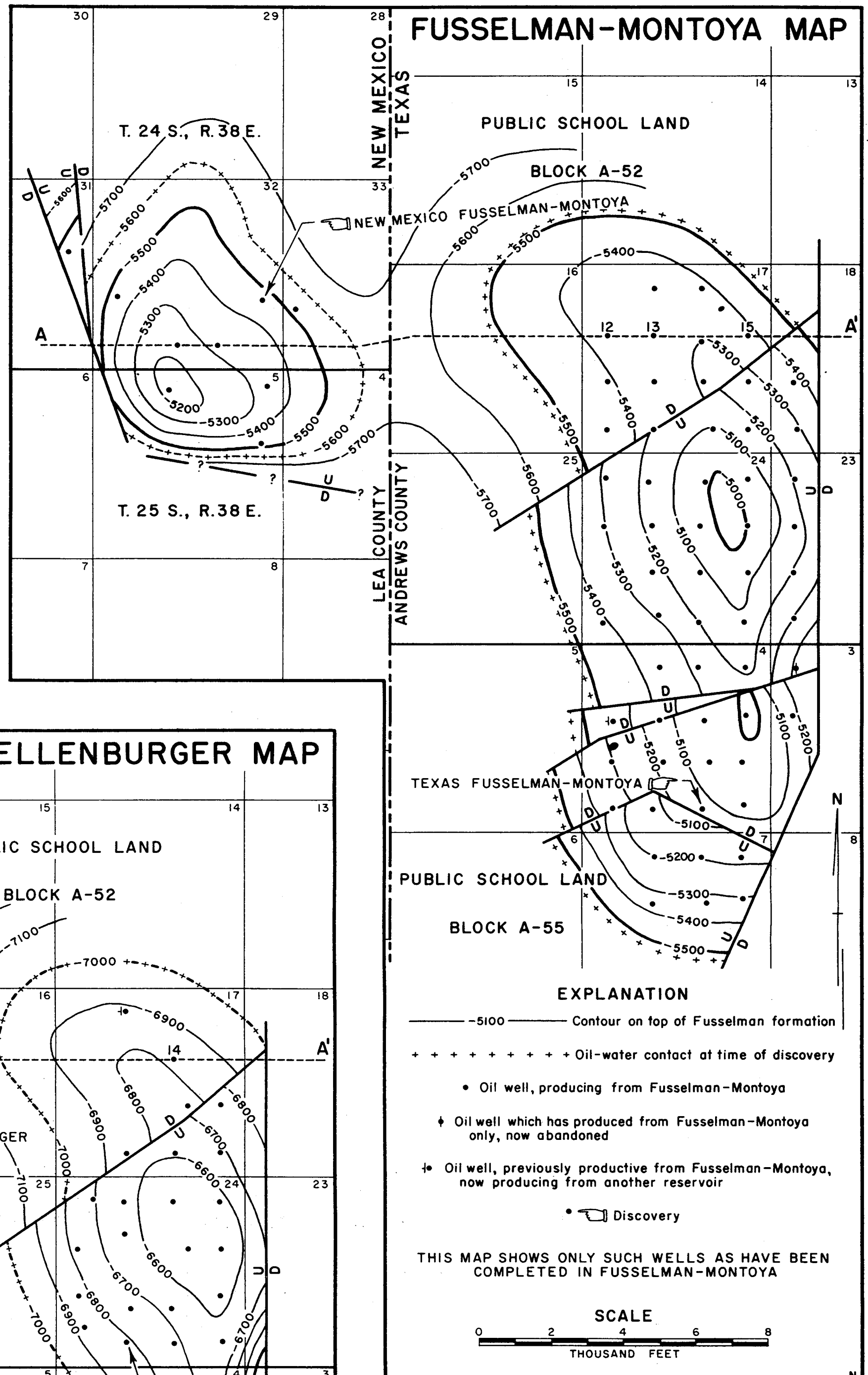
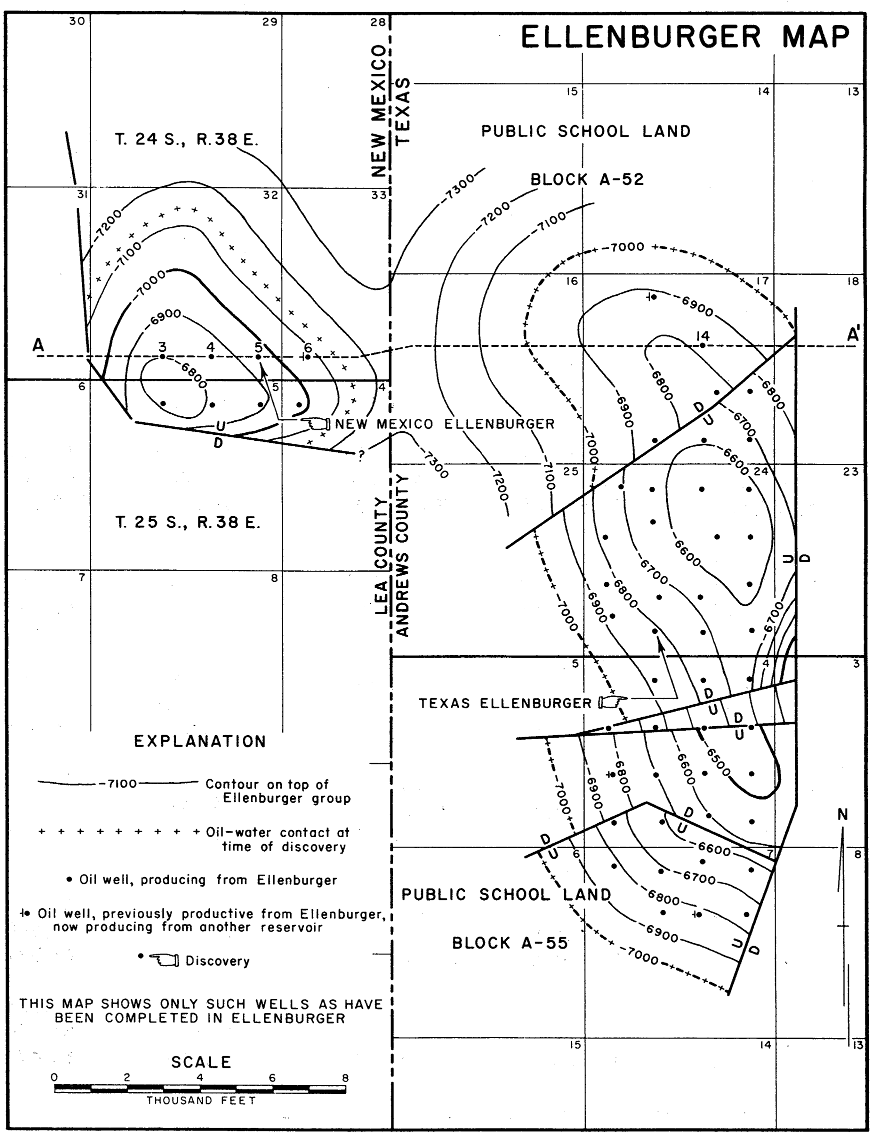




CHARACTER OF GAS

There was no free gas in any reservoir at time of discovery of commercial production. Such gas as has been produced has come out of solution as oil has been produced. The specific gravity and condensate content have averaged about as indicated below.

	Specific gravity	Condensate, gal/Mcf
Queen	?	?
Leonard	0.978	2.58
Devonian	0.957	2.33
Texas Fusselman-Montoya	1.170	3.26
New Mexico Fusselman-Montoya	?	?
Texas Ellenburger	0.989	3.10
New Mexico Ellenburger	?	?

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)		WATER PRODUCTION (barrels)	
	Flowing	Art. Lift	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
Field totals								
1945	1	0	12,093	12,093	26,434	26,434	0	0
1946	6	0	146,864	158,957	244,308	270,742	0	0
1947	27	1	569,239	728,196	659,951	930,693	552	552
1948	85	3	3,550,579	4,278,775	2,449,647	3,380,340	31,285	31,837
1949	165	5	4,537,467	8,816,242	3,177,032	6,557,372	148,891	180,728
1950	227	16	6,315,297	15,131,539	5,462,970	12,020,342	203,364	384,092
1951	267	28	8,173,528	23,305,067	8,680,428	20,700,770	419,747	803,839
1952	313	43	8,095,977	31,401,044	9,601,347	30,302,117	666,518	1,470,357
1953	328	101	10,006,887	41,407,931	16,277,228	46,579,345	1,245,576	2,715,933
1954	333	150	9,956,570	51,364,501	19,867,546	66,446,891	1,638,101	4,354,034
1955	301	191	9,052,301	60,416,802	22,579,607	89,026,498	1,313,549	5,667,583
1956*	277	218	7,971,040	68,387,842	22,582,242	111,608,740	1,531,022	7,198,605
Queen								
1952	6	2	21,337	21,337	8,979	8,979	991	991
1953	36	4	322,681	344,018	207,209	216,188	5,292	6,283
1954	45	14	643,178	987,196	564,576	780,764	16,774	23,057
1955	31	32	619,399	1,606,595	1,544,544	2,325,308	35,222	58,279
1956*	15	48	391,713	1,998,308	1,298,122	3,623,430	28,116	86,395
Leonard, total								
1949	10	0	81,786	81,786	58,265	58,265	0	0
1950	30	1	408,272	490,058	325,060	383,325	1,510	1,510
1951	71	5	1,286,387	1,776,445	1,266,152	1,649,477	17,931	19,441
1952	75	15	1,757,255	3,533,700	1,841,781	3,491,258	50,783	70,224
1953	96	34	2,809,835	6,343,535	4,006,433	7,497,691	57,620	127,844
1954	101	64	3,723,079	10,066,614	7,200,368	14,698,059	107,045	234,889
1955	93	76	3,432,428	13,499,042	9,145,456	23,843,515	95,856	330,745
1956*	95	79	3,005,270	16,504,312	9,138,310	32,981,825	82,414	413,159
Leonard, Texas								
1949	10	0	81,786	81,786	58,265	58,265	0	0
1950	30	1	408,272	490,058	325,060	383,325	1,510	1,510
1951	70	5	1,284,376	1,774,434	1,262,370	1,645,695	17,871	19,381
1952	71	14	1,715,967	3,490,401	1,813,433	3,459,128	49,980	69,361
1953	61	25	2,243,120	5,733,521	3,548,664	7,007,792	49,572	118,933
1954	70	26	2,187,783	7,921,304	5,422,296	12,430,088	47,087	166,020
1955	68	30	1,949,880	9,871,184	6,123,843	18,553,931	32,771	198,791
1956*	64	33	1,410,693	11,281,877	5,537,277	24,091,208	30,095	228,886
Leonard, New Mexico								
1951	1	0	2,011	2,011	3,782	3,782	60	60
1952	4	1	41,288	43,299	28,348	32,130	803	863
1953	35	9	566,715	610,014	457,769	489,899	8,048	8,911
1954	31	38	1,535,296	2,145,310	1,778,072	2,267,971	59,958	68,869
1955	25	46	1,482,548	3,627,858	3,021,613	5,289,584	63,085	131,954
1956	31	46	1,594,577	5,222,435	3,601,033	8,890,617	52,319	184,273
Devonian, total								
1945-51	Same as Devonian, Texas.			7,882,246		13,009,504		29,023
1952	135	9	2,679,417	10,561,663	5,998,817	19,008,321	16,525	45,548
1953	123	22	3,364,019	13,925,682	10,201,863	29,210,184	16,129	61,677
1954	123	23	2,604,923	16,530,605	10,307,204	39,517,388	31,547	93,224
1955	117	29	2,139,990	18,670,595	10,208,562	49,725,950	28,446	121,670
1956*	115	30	1,809,499	20,480,094	10,569,335	60,295,285	30,808	152,478

* Some entries for 1956 are based in part on estimates for last few months.

PRODUCTION HISTORY (Continued)

Year	WELLS PRODUCING at end of year: Flowing	Art. Lift	OIL PRODUCTION (barrels): Yearly	Cumulative	GAS PRODUCTION (Mcf): Yearly	Cumulative	WATER PRODUCTION (barrels): Yearly	Cumulative
Devonian, Texas								
1945	1	0	12,093	12,093	26,434	26,434	0	0
1946	6	0	146,864	158,957	244,308	270,742	0	0
1947	22	0	449,009	607,966	613,276	884,018	552	552
1948	41	1	1,148,266	1,756,232	1,378,688	2,262,706	2,128	2,680
1949	73	1	1,177,209	2,933,441	1,594,402	3,857,108	3,233	5,913
1950	105	5	2,088,408	5,021,849	3,521,731	7,378,839	6,358	12,271
1951	104	22	2,860,397	7,882,246	5,630,665	13,009,504	16,752	29,023
1952	126	9	2,545,163	10,427,409	5,829,723	18,839,227	16,525	45,548
1953	112	22	2,948,830	13,376,239	9,589,920	28,429,147	16,129	61,677
1954	113	22	2,236,693	15,612,932	9,409,697	37,838,844	31,547	93,224
1955	107	26	1,780,134	17,393,066	8,975,596	46,814,440	28,446	121,670
1956*	106	25	1,412,534	18,805,600	8,984,402	55,798,842	30,808	152,478
Devonian, New Mexico								
1952	9	0	134,254	134,254	169,094	169,094	0	0
1953	11	0	415,189	549,443	611,943	781,037	0	0
1954	10	1	368,230	917,673	897,507	1,678,544	0	0
1955	10	3	359,856	1,277,529	1,232,966	2,911,510	0	0
1956	9	5	396,965	1,674,494	1,584,933	4,496,443	0	0
Texas Fusselman-Montoya								
1947	2	1	90,375	90,375	29,866	29,866	0	0
1948	21	2	726,913	817,288	233,380	263,246	8,363	8,363
1949	41	4	1,331,212	2,148,500	448,610	711,856	70,495	78,858
1950	53	4	1,918,961	4,067,461	616,543	1,328,399	53,199	132,057
1951	50	7	2,275,901	6,343,362	761,671	2,090,070	106,822	238,879
1952	49	9	2,044,903	8,388,265	823,325	2,913,395	296,640	535,519
1953	37	19	1,856,818	10,245,083	793,121	3,706,516	369,680	905,199
1954	33	23	1,522,126	11,767,209	712,289	4,418,805	627,357	1,532,556
1955	30	25	1,440,651	13,207,860	758,027	5,176,832	392,352	1,924,908
1956*	25	30	1,405,770	14,613,630	754,898	5,931,730	593,691	2,518,599
New Mexico Fusselman-Montoya								
1952	4	0	132,214	132,214	10,013	10,013	50,314	50,314
1953	4	2	191,923	324,137	61,113	71,126	228,939	279,253
1954	1	6	232,424	556,561	404,288	475,414	192,694	471,947
1955	1	7	235,825	792,386	271,636	747,050	302,828	774,775
1956	1	8	287,540	1,079,926	208,345	955,395	267,179	1,041,954
Texas Ellenburger								
1947	3	0	29,855	29,855	16,809	16,809	0	0
1948	23	0	1,675,400	1,705,255	837,579	854,388	20,794	20,794
1949	41	0	1,947,260	3,652,515	1,075,755	1,930,143	75,163	95,957
1950	39	6	1,899,656	5,552,171	999,636	2,929,779	142,297	238,254
1951	37	11	1,712,900	7,265,071	987,947	3,917,726	277,392	515,646
1952	36	8	1,007,696	8,272,767	698,458	4,616,184	243,636	759,282
1953	25	19	921,177	9,193,944	783,722	5,399,906	427,091	1,186,373
1954	24	20	763,437	9,957,381	550,384	5,950,290	473,709	1,660,082
1955	23	21	749,949	10,707,330	542,464	6,492,754	398,578	2,058,660
1956*	21	21	704,861	11,412,191	511,024	7,003,778	404,627	2,463,287
New Mexico Ellenburger								
1951	4	0	37,943	37,943	33,993	33,993	850	850
1952	8	0	453,155	491,098	219,974	253,967	7,629	8,479
1953	7	1	540,434	1,031,532	223,767	477,734	140,825	149,304
1954	7	0	467,403	1,498,935	128,437	606,171	188,975	338,279
1955	6	1	434,059	1,932,994	108,918	715,089	60,267	398,546
1956	5	2	366,387	2,299,381	102,208	817,297	124,187	522,733

* Some entries for 1956 are based in part on estimates for last few months.

CONTINUITY OF RESERVOIR ROCKS

Queen: The sandstones with favorable porosity and permeability are limited to flank positions on the New Mexico portion of the anticline. Eastward, the sandstones terminate because of facies change.

Leonard: This reservoir rock is continuous throughout the area of the field and throughout a large portion of the Permian basin. However, the individual beds which produce in this field are local and cannot be correlated generally beyond the locations of a few wells.

Devonian: As indicated on the accompanying Devonian map, the continuity of the Devonian reservoir rock is interrupted by faults and by truncation. With these exceptions, the reservoir rock is continuous throughout the area of the field. However, the degree of porosity is quite variable. Where the reservoir rock was exposed to erosional truncation, the nature and degree of porosity was determined largely by weathering.

Fusselman-Montoya (Texas and New Mexico): This reservoir rock is continuous throughout the area of the field except that it is broken by faults as indicated on the accompanying Fusselman-Montoya map. Porosity and permeability are definitely continuous between the two reservoirs and are generally sufficiently continuous that there is an effective water drive in each of the two reservoirs. The consistency of the elevation of the oil-water contact in all segments of the Texas reservoir indicates continuity of lithologic conditions favorable for freedom of migration of reservoir fluids.

Ellenburger (Texas and New Mexico): This reservoir rock is continuous throughout the area of the field except that it is broken by faults as indicated on the accompanying Ellenburger map. Porosity and permeability are continuous between the two reservoirs and are generally sufficiently continuous that, in each of the two reservoirs, there is a partially effective water drive and the elevation of the initial oil-water contact is consistent within all parts of each reservoir (about 140 feet higher in one reservoir than in the other).

WATER PRODUCTION

Queen: Approximately one-half of the wells produce some water. Water now constitutes 10 to 20% of the gross fluid produced by the water-producing wells; as much as 50% of the gross fluid produced by a few wells. The total quantity of water produced from the reservoir has gradually increased until it now amounts to 6.5% of the gross production.

Leonard: As indicated in the following tabulation headed PRODUCTION HISTORY, a small amount of water is produced from this reservoir. Currently, the water amounts to about 2.1% of the gross liquid. The wells along the western edge of the Leonard productive area, either at times of completion or early in their productive lives, have produced water in amounts ranging from a trace to 15% of gross liquid. Tests have indicated that this water is not bottom water; that it is from water-bearing stringers within the gross thickness of the reservoir rock and at elevations above the general elevation of the oil-water contact.

Devonian: Water production has been limited to structurally low wells and a few other wells where it appears that faulting has afforded migration channels. Water encroachment has been negligible; reservoir energy has been essentially all due to expansion of gas released from solution as pressure declines.

Texas Fusselman-Montoya: Water encroachment has been an important factor in reservoir performance. Currently, water constitutes about 21% of the gross liquid produced; from a few individual wells, the water amounts to as much as 45% of gross liquid. Since the time of discovery, the elevation of the oil-water contact has risen generally almost 100 feet (from about -5,520 to about -5,430). Water encroachment within the extensive cavern system mentioned under LITHOLOGY OF RESERVOIR ROCKS has been erratic; water has entered some wells at elevations about 50 feet higher than the general elevation of the oil-water contact; at other wells, even currently, the oil is free of water down to elevations only about 10 feet higher than the elevation of the oil-water contact at time of discovery.

New Mexico Fusselman-Montoya: From soon after discovery, as indicated in the following tabulation presenting PRODUCTION HISTORY, the total quantity of water has been about equal to the total quantity of oil produced from this reservoir. One well, producing more than three barrels of water per barrel of oil, accounts for two-thirds of the water production. Five wells, including the flowing well, are reported to be producing no water.

Texas Ellenburger: Currently, water constitutes about 37% of the gross liquid produced. Of the 44 wells producing from this reservoir, 27 are producing water in varying ratios. Water constitutes more than 60% of the gross production of several individual wells. Although the rise in the elevation of the oil-water contact has been generally uniform throughout the field, coning has occurred at the locations of several wells. Water drive is an important factor of reservoir energy.

New Mexico Ellenburger: Only one well produces water; that well produces 15 barrels of water per barrel of oil. That well is in the extreme southeast corner of the productive area and is near the fault which determines the limit of the productive area. The fault may provide channels for migration of reservoir fluids.

ACID TREATMENT

Queen: Data are not available.

Leonard: Nearly all wells have been treated with acid. The normal procedure is to treat promising portions of the gross thickness selectively, generally with 5,000 to 10,000 gallons of acid, but as much as 20,000 gallons has been used in some such treatments.

Devonian: Acid treatment has been variable largely because the degree of porosity is variable. Where the degree of porosity is high, acid treatment has not been needed. Low porosity has occasioned treatment of many wells with 4,000 to 5,000 gallons of acid. One dry hole surrounded by producers was treated with 26,000 gallons and another dry hole similarly situated was treated with 32,000 gallons, but treatment failed to cause them to produce.

Texas Fusselman-Montoya and New Mexico Fusselman-Montoya: While most wells have been completed without acid treatment, small treatments ranging from 500 to 3,000 gallons have proven beneficial in some wells which showed only low productive capacity when completed naturally. Results were quite variable with the few wells where large quantities were used.

Texas Ellenburger and New Mexico Ellenburger: Small treatments ranging from 500 to 3,000 gallons have proven beneficial in a few wells, but generally the wells have not been treated. The only well treated with a large quantity of acid is located near a fault and where permeability is low; the use of 19,000 gallons of acid resulted in satisfactory completion.

DOSS FIELD

Gaines County, Texas

CHARLES S. NEEL, Jr.
Geologist, Humble Oil & Refining Co., Midland, Texas
June 1, 1954

LOCATION

The Doss field is in southwestern Gaines County about 8 miles southwest of Seminole, county seat. It is on the Central Basin platform near its northeast edge and is one of several fields along a regional anticlinal fold trending northwest-southeast.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Clear Fork and Field: Seismic exploration by Humble Oil & Refining Company in 1935 and early 1936 resulted in the drilling of a dry hole (T.D., 6192) near the northern edge of the area now proven as the productive area of the Doss field. Although this dry hole was not drilled to the depth of the shallowest zone now productive, it did furnish significant subsurface information. Subsequent core drilling and subsurface studies resulted directly in the drilling of the discovery well.

Canyon: Studies of subsurface data and seismograph survey by Ralph Lowe in early 1949 led to the drilling of the Canyon discovery well.

DISCOVERIES

Upper Clear Fork: December 12, 1945; Humble Oil & Refining Co. #1 M.S.Doss. Pumped through perforations from 6,360 to 6,380 feet and from 6,465 to 6,475 feet at daily rate of 187 barrels of 29.2° gravity oil and 47 barrels of salt water; gas-oil ratio, 144 : 1.

Lower Clear Fork and Field: November 7, 1944; Humble Oil & Refining Co. #1 Humble fee. Flowed through perforations from 7,030 to 7,080 feet at daily rate of 201 barrels of 33.6° gravity oil; gas-oil ratio, 517 : 1.

Canyon: July 8, 1949; Ralph Lowe #1 Helen Cunningham (now, Shell Oil Co. and Ralph Lowe #1 Helen Cunningham). Flowed through perforations from 8,850 to 8,950 feet at daily rate of 528 barrels of 47° gravity oil and 143 barrels of water and water emulsion; gas-oil ratio, 301 : 1.

CLEAR FORK RESERVOIRS

Commercial production occurs at several positions in the Clear Fork group. While the production is mainly from two zones, one at the top of the group and the other just below the Drinkard member, there are reservoirs at other positions in the group. In prior publications, there has been general recognition of "Upper Clear Fork" production and "Lower Clear Fork" production. The production from the above mentioned zone at the top of the Clear Fork group has been treated as from "Upper Clear Fork", that from below the Drinkard zone as from "Lower Clear Fork", and that from reservoirs between the Drinkard and the above mentioned zone at the top of the Clear Fork group has been treated variously as from either "Upper Clear Fork" or "Lower Clear Fork", with the result that there is considerable confusion in the records.

The dolomite of the Clear Fork group is characterized by irregular porosity. Commercial production occurs only where the degree of porosity is abnormally high. The vertical distribution and the horizontal distribution of rocks of high porosity are both irregular. Presently available data indicate that there is not sufficient continuity of favorable porosity to permit free migration of reservoir fluids between the several Clear Fork productive zones. Even as to production from a corresponding stratigraphic position, it cannot be assumed that it is from the same reservoir merely because it is from the same stratigraphic position. Most Clear Fork reservoirs are of only local extent although the zones in which they occur are continuous and are of the same general character throughout the region.

The above described conditions have resulted in confusion in correlations and, consequently, confusion in the production records. Since data are not available for determining the relationships of productive rocks in all Clear Fork wells, and since the records are somewhat confused, all production from Clear Fork is reported in the following PRODUCTION HISTORY as coming from a group of reservoirs rather than to endeavor to determine quantities for each reservoir separately. Furthermore, entries under other of the following headings should be considered in view of the above described conditions.

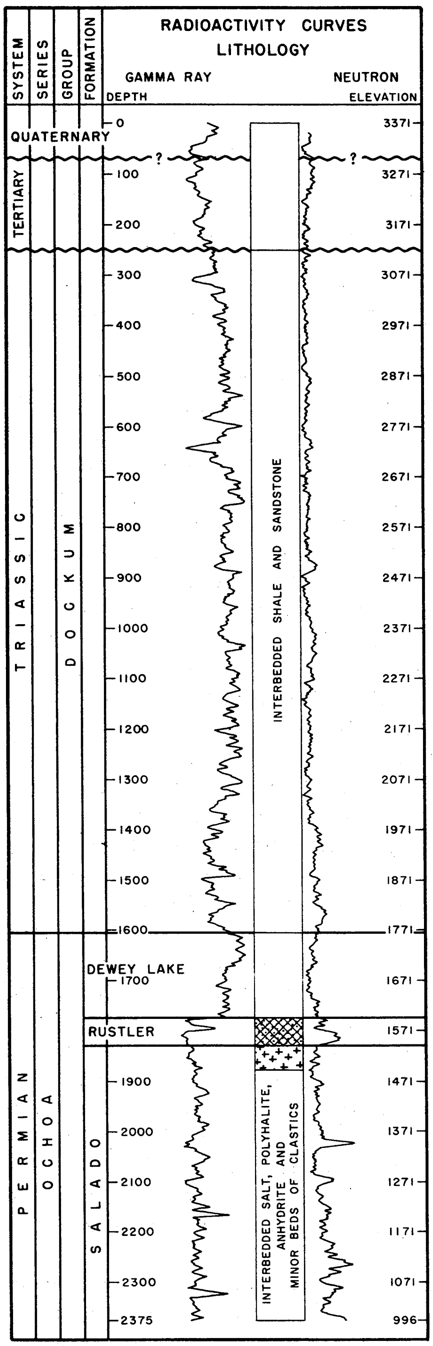
ELEVATION OF SURFACE

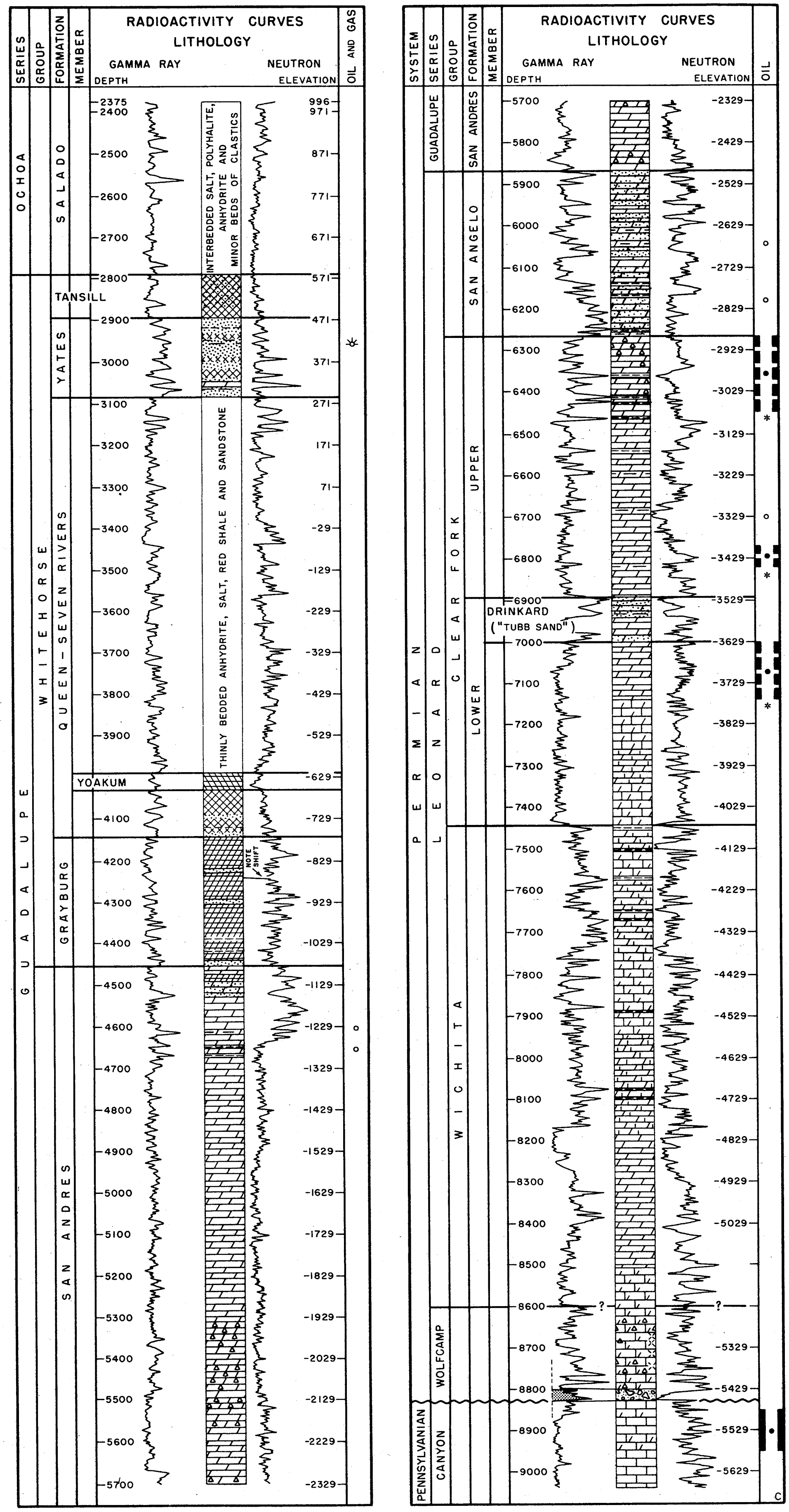
At well locations: Highest, 3,368 ft.; lowest, 3,334 ft.

SURFACE FORMATION

Recent caliche and wind-blown sand.

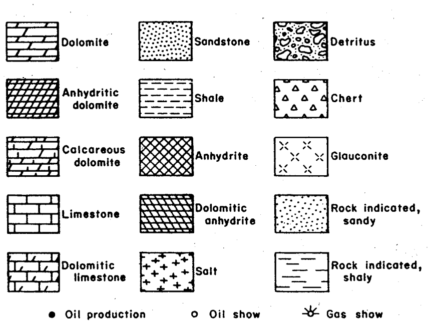
TYPICAL SECTION OF ROCKS PENETRATED





* In the above TYPICAL SECTION, the three most commonly productive zones in the Clear Fork group are indicated by modified reservoir symbols. The three zones are not all productive at any one location.

EXPLANATION



OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 110 feet below its top. This penetration was in the Canyon discovery well at its total depth of 11,881 feet.

NATURE OF TRAPS

Clear Fork reservoirs: Although the known accumulations are along the axis of an anticlinal fold, it appears that the trapping is due largely to variation in degree of porosity and permeability in sloping reservoir rocks. (*)

Canyon: Since the only productive wells are at the crest of a dome, it appears that domal folding is the primary trap-forming factor. However, variation in degree of porosity has definitely limited the productive area and has probably served as a minor factor in forming the trap.

LITHOLOGY OF RESERVOIR ROCKS

Clear Fork: (*) The reservoir rocks in the Clear Fork group are all of the same general character; mainly cream to tan, finely crystalline dolomite. A few thin layers of gray silty dolomite are interbedded with the crystalline dolomite and, limited mainly to the upper 500 feet of the Clear Fork group, there are a few thin beds of dark gray to black lignitic shale. Minor amounts of chert and anhydrite are interspersed in the dolomite. The Drinkard member ("Tubb Sand") is less sandy here than it is generally on the Central Basin platform; here it is composed mostly of dark silty dolomite. The porosity of the reservoir rocks is of the small vug type. Favorable porosity is quite general in the upper 100 feet of the Clear Fork group and in a similar zone immediately below the Drinkard member; at other positions, rocks with favorable porosity are of only local extent and are thin.

Canyon: The reservoir rock in the Canyon group is white to light tan, finely crystalline and chalky limestone with minor amounts of white crystalline dolomite. Thin beds of green shale are interbedded with the limestone. The favorable porosity is of the vug type and is irregularly distributed and has an aggregate thickness of no more than 12 feet at any one of the locations where total thickness has been determined.

THICKNESSES OF RESERVOIR ROCKS

From top to bottom:	Feet Min.	Max.	Avg.
Upper Clear Fork (*)	185	285	200
Lower Clear Fork (*)	315	400	365
Canyon	80	124	110

Net productive: Because of the irregularity of porosity in each reservoir rock, it is not practical to endeavor to determine net thickness.

PRODUCTIVE AREAS

	Acres, approx.
Clear Fork (*)	2,800
Canyon	400
Doss field	2,800

CONTINUITY OF RESERVOIR ROCKS

Clear Fork: (*) The Clear Fork group is continuous throughout most of West Texas; however, the individual reservoirs are each of only local extent.

Canyon: The reservoir rock in the Canyon group is continuous throughout the area of the field and throughout most of western Gaines County. Due mainly to erosion but partly also to lack of deposition, there are no rocks of corresponding age over most of the Central Basin platform nor in the Midland basin. However, a long, narrow tongue of Canyon limestone extends from western Gaines County along the eastern edge of the Central Basin platform as far south as northern Crane County. Although this limestone includes the stratigraphic equivalent of the reservoir rock in the Doss field, it is unlikely that porosity favorable for migration of reservoir fluids is continuous far beyond the proved extent of the field.

ACID TREATMENT

Upper Clear Fork: At time of completion, each well was given a single-stage treatment with 1,000 to 5,000 gallons of acid.

Lower Clear Fork: With only one exception, each well was treated with acid at time of completion. The quantity of acid ranged from 500 to 15,000 gallons. The larger quantities were used in many wells in multi-stage treatments.

Canyon: With only one exception, each well was treated with acid at time of completion. The quantity of acid ranged from 250 to 12,000 gallons. The larger quantities were used generally in multi-stage treatments.

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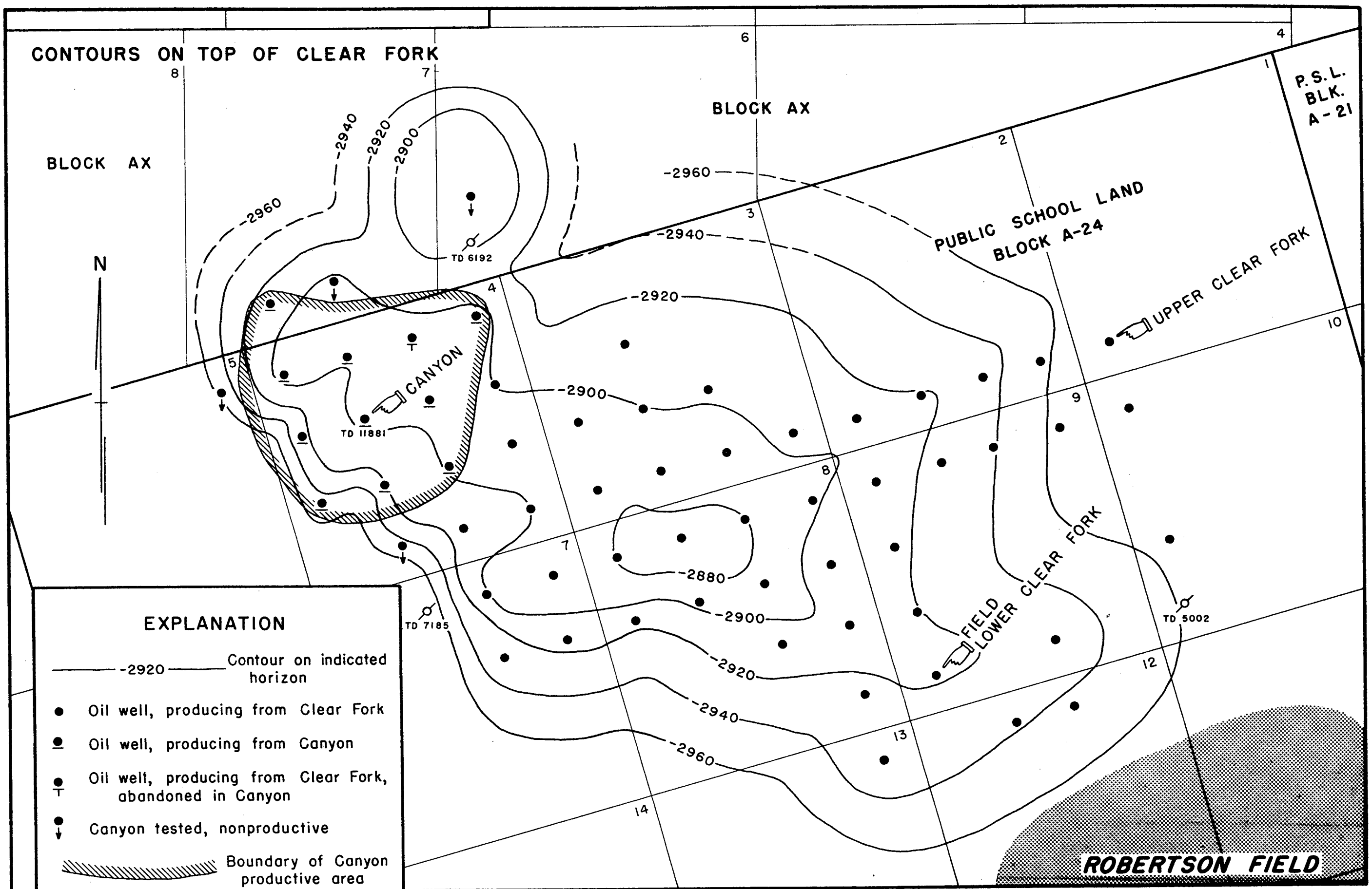
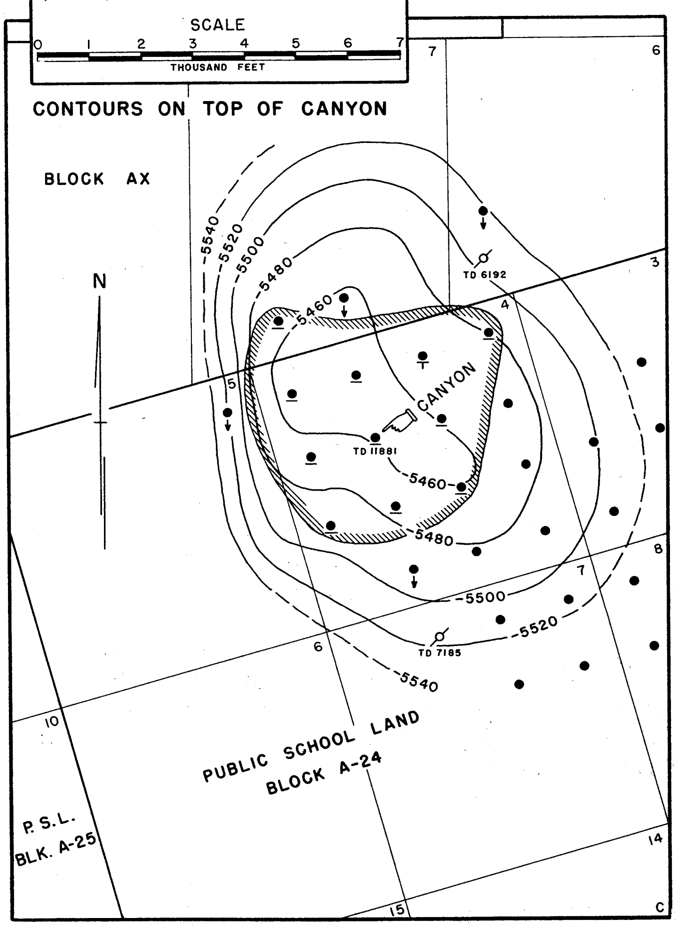
*See entry under the general heading CLEAR FORK RESERVOIRS on first page of this paper.





ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Upper Clear Fork	Lower Clear Fork	Canyon
Elev. of highest known oil, ft.	-2,874	-3,390	-5,487
Elev. of lowest known oil, ft.	-3,240	-3,790	-5,570
Difference, feet	366	400	83

As to reservoirs in the Clear Fork group, it appears unlikely that the above differences represent reliefs of oil columns. In each case, the highest oil and the lowest oil are probably in different reservoirs. (*)

CHARACTER OF OIL and RESERVOIR DATA

	Upper Clear Fork	Lower Clear Fork	Canyon
Original bottom hole pressure, psi.	2,950	2,625	3,500
Elevation of pressure datum, feet	-3,000	-3,700	-5,500
Gravity, A. P. I. @ 60°F.	33.2	38.6	46.0
Saturation pressure, psi.	1,540	?	?
Solution gas-oil ratio, cf/bbl.	695	?	?

CHARACTER OF GAS

	Upper Clear Fork	Lower Clear Fork	Canyon
Sulphur indication	Sour	Sour	Sweet

Orsat analysis of Lower Clear Fork sample	Vol. %
Hydrocarbons or inert	96.4
Hydrogen sulphide	1.8
Carbon dioxide	1.8

*See entry under the general heading CLEAR FORK RESERVOIRS on first page of this paper.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf) §		WATER PRODUCTION (barrels) §§	
	Flowing	Pumping	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
Field totals								
1944	1	0	1,408	1,408	8xx	8xx	3xx	3xx
1945	3	1	46,186	47,594	25,xxx	26,xxx	10,xxx	10,xxx
1946	5	4	126,442	174,036	72,xxx	98,xxx	8,xxx	18,xxx
1947	14	12	273,940	447,976	207,xxx	304,xxx	8,xxx	26,xxx
1948	13	24	496,954	944,930	231,xxx	535,xxx	43,xxx	69,xxx
1949	8	37	439,398	1,384,328	216,xxx	751,xxx	95,xxx	164,xxx
1950	6	44	580,409	1,964,737	211,xxx	962,xxx	74,xxx	238,xxx
1951	3	55	728,664	2,693,401	265,xxx	1,227,xxx	110,xxx	349,xxx
1952	1	56	660,528	3,353,929	292,xxx	1,520,xxx	246,xxx	595,xxx
1953	0	58	550,449	3,904,378	263,xxx	1,782,xxx	12x,xxx	715,xxx
1954 **	0	60	409,865	4,314,243				
1955 **	1	62	470,382	4,784,625				
Clear Fork (*)								
1944	1	0	1,408	1,408	8xx	8xx	3xx	3xx
1945	3	1	46,186	47,594	25,xxx	26,xxx	10,xxx	10,xxx
1946	5	4	126,442	174,036	72,xxx	98,xxx	8,xxx	18,xxx
1947	14	12	273,940	447,976	207,xxx	304,xxx	8,xxx	26,xxx
1948	13	24	496,954	944,930	231,xxx	535,xxx	43,xxx	69,xxx
1949	6	36	376,797	1,321,727	200,xxx	735,xxx	95,xxx	164,xxx
1950	1	42	360,817	1,682,544	156,xxx	891,xxx	74,xxx	238,xxx
1951	1	47	434,555	2,117,099	192,xxx	1,083,xxx	98,xxx	336,xxx
1952	1	46	401,286	2,518,385	227,xxx	1,310,xxx	85,xxx	422,xxx
1953	0	48	371,699	2,890,084	227,xxx	1,537,xxx	53,xxx	475,xxx
1954 **	0	50	318,873	3,208,957				
1955 **	1	52	388,805	3,597,762				
Upper Clear Fork (*)								
1946	0	1	9,670	9,670	3,xxx	3,xxx	4xx	4xx
1947	0	1	11,606	21,276	4,xxx	7,xxx	5xx	1,0xx
1948	0	1	10,697	31,973	5,xxx	12,xxx	7xx	1,7xx
1949	0	1	9,656	41,629	4,xxx	16,xxx	6xx	2,3xx
1950	0	2	14,724	56,353	6,xxx	21,xxx	2,xxx	4,xxx
1951	1	4	32,481	88,834	9,xxx	30,xxx	3,xxx	7,xxx
Lower Clear Fork (*)								
1944	1	0	1,408	1,408	8xx	8xx	3xx	3xx
1945	3	1	46,186	47,594	25,xxx	26,xxx	10,xxx	10,xxx
1946	5	3	116,772	164,366	69,xxx	94,xxx	8,xxx	18,xxx
1947	14	11	262,334	426,700	203,xxx	297,xxx	7,xxx	25,xxx
1948	13	23	486,257	912,957	226,xxx	523,xxx	42,xxx	67,xxx
1949	6	35	367,141	1,280,098	196,xxx	720,xxx	94,xxx	161,xxx
1950	1	40	346,093	1,626,191	151,xxx	870,xxx	72,xxx	234,xxx
1951	0	43	402,074	2,028,265	183,xxx	1,053,xxx	96,xxx	329,xxx
Canyon								
1949	2	1	62,601	62,601	16,xxx	16,xxx	0	0
1950	5	2	219,592	282,193	55,xxx	71,xxx	3xx	3xx
1951	2	8	294,109	576,302	74,xxx	144,xxx	12,xxx	12,xxx
1952	0	10	259,242	835,544	65,xxx	209,xxx	161,xxx	173,xxx
1953	0	10	178,750	1,014,294	36,xxx	245,xxx	7x,xxx	24x,xxx
1954 **	0	10	90,992	1,105,286				
1955 **	0	10	81,577	1,186,863				

§ Quantities of gas have been estimated on the basis of gas-oil ratios.
§§ Quantities of water have been estimated on basis of oil-water ratios.
* See entry under the heading CLEAR FORK RESERVOIRS on first page of this paper.
** Data for 1954 and 1955 added by amendment.

DUNN FIELD

Mitchell County, Texas

MARION R. STEPHENSON
Geologist, American Trading & Production Corp., Midland, Texas
January 25, 1956

LOCATION

The Dunn field (one well, abandoned) is in the northwest corner of Mitchell County within one mile of the common corner of Mitchell, Scurry, Borden and Howard Counties.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of seismic and subsurface geological data led to the discovery of this field.

DISCOVERY

Canyon: October 11, 1949; Standard Oil Co. of Texas #1 B. F. Dunn. Flowed through ½-inch choke at daily rate of 499 barrels of 47° gravity oil and 38 barrels of basic sediment and water from depth of 7,550-7,578 feet. Gas-oil ratio, 1,281 : 1. Total depth, 8,325 feet; plugged back to 7,587 feet. This well, the only well in the field, was abandoned on December 17, 1952.

ELEVATION OF SURFACE

Surface: About 2,239 ft. (derrick floor: 2,249 ft.).

SURFACE FORMATION

Chinle formation of the Dockum group of the Triassic system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 40 feet below its eroded top.

NATURE OF TRAP

Canyon: Domal upper limit of reef-type porosity.

PRODUCTIVE AREA

Canyon and Field: 40 acres

THICKNESS OF RESERVOIR ROCK

Canyon: From top to bottom of productive zone, 37 feet.

LITHOLOGY OF RESERVOIR ROCK

Canyon: Reef limestone; white to tan, fossiliferous, coarsely crystalline.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Canyon:	Feet
Elevation of top of oil	-5,301
Elevation of bottom of oil	-5,338
Relief	37

The above figures represent conditions in the one well at time of discovery.

CHARACTER OF OIL

Canyon:	
Gravity, A. P. I. @ 60° F.,	47°
Sulphur,	0.1%
Gas-oil ratio at time of discovery,	1,281 : 1

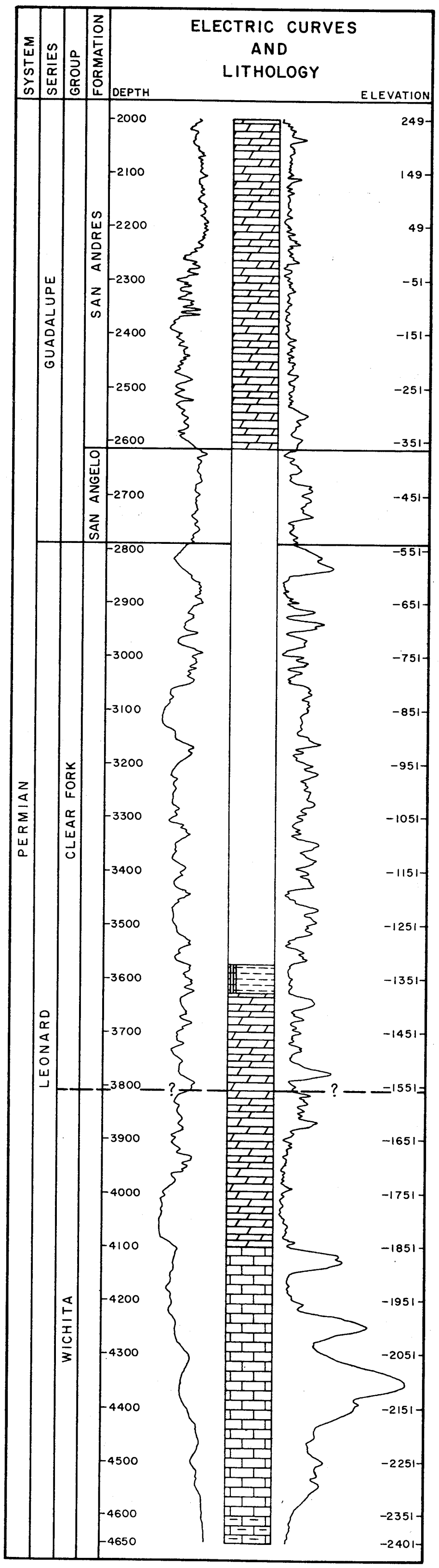
CHARACTER OF GAS

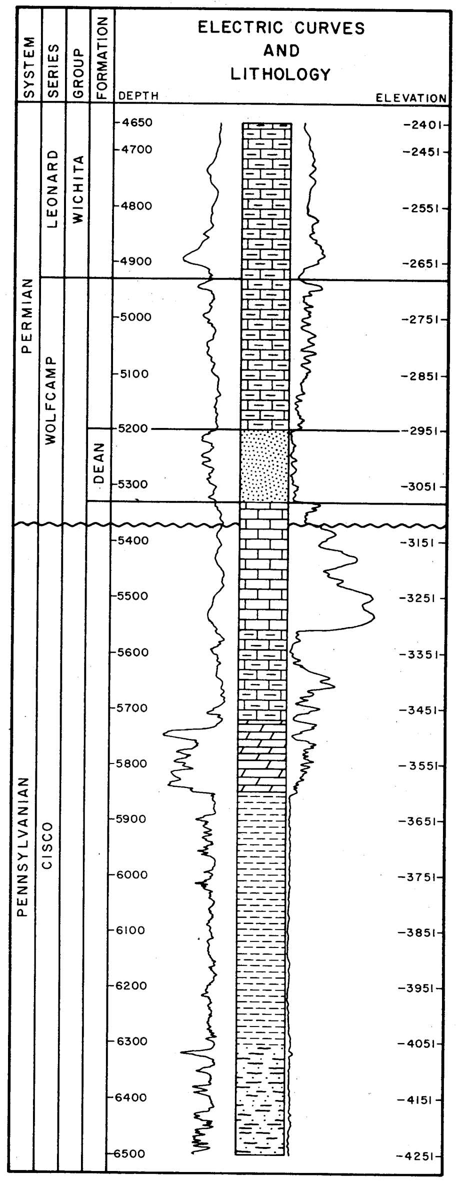
Canyon: No analysis is available; probably none was ever made. Gas was not produced in commercial quantity. At the time of the initial potential test, the gas-oil ratio was 1,280 : 1.

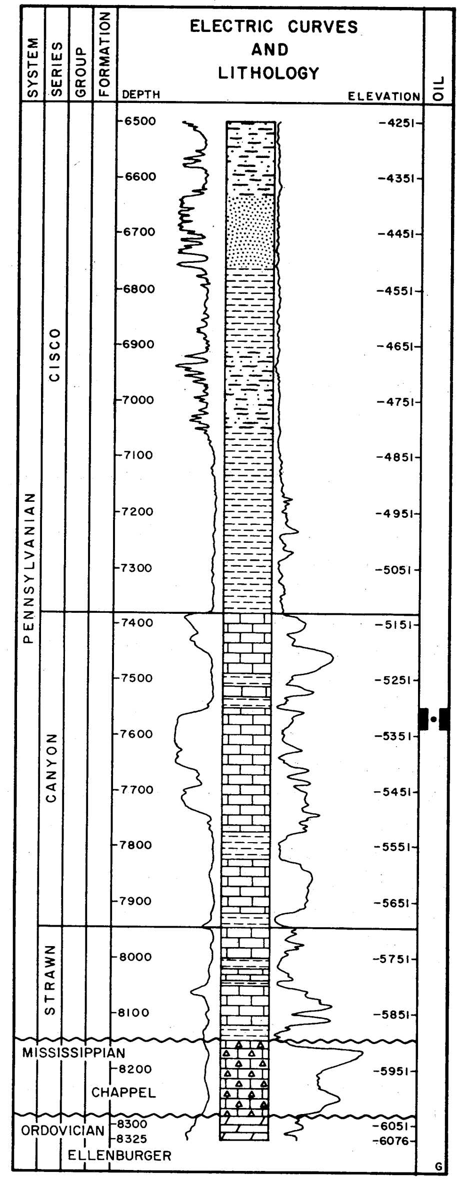
PRODUCTION HISTORY

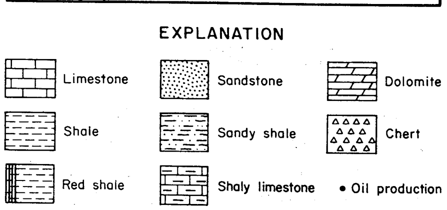
	WELLS PRODUCING	PRODUCTION (barrels)		
		OIL		WATER
	Pumping	Yearly	Cum.	Yearly
1949	1	2,552	2,552	1,629
1950	1	900	3,452	6,002
1951	Shut-in	0	3,452	0
1952	Abnd. 12/17/52	56	3,508	?

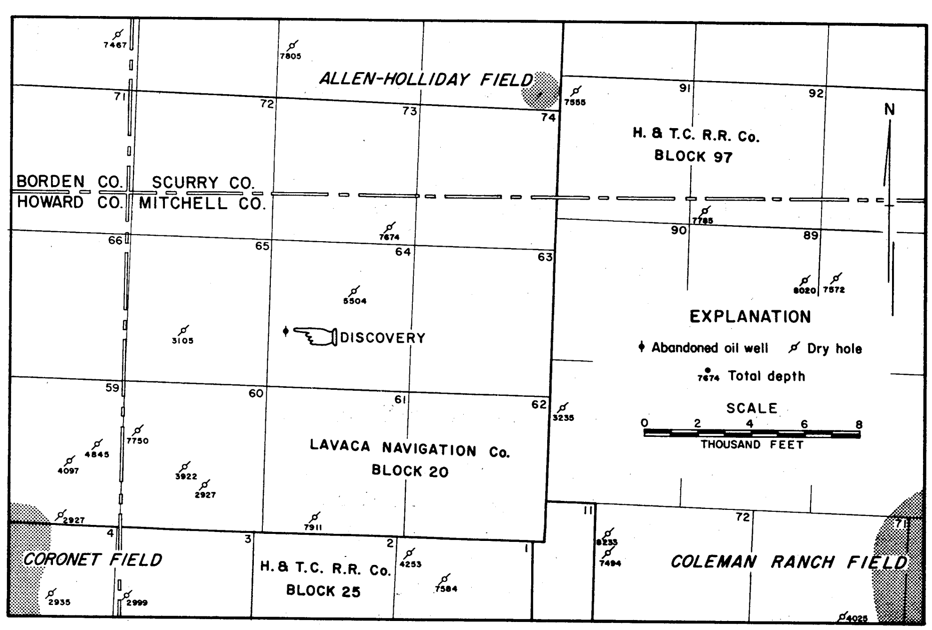
SECTION OF ROCKS PENETRATED











EAST POLAR FIELD

Kent County, Texas

JAMES L. ELKIN, Jr.
Geologist, Humble Oil & Refining Co., Midland, Texas
March 1, 1956

LOCATION

The East Polar field is in southwestern Kent County about 14 miles southwest of the town of Clairemont. It is near the western edge of the Eastern shelf. Its name was derived from the village of Polar, located 3 miles to the west.

NEAR-BY NONCOMMERCIAL PROSPECT

Drilling & Exploration Co. #1 Wilson Connell, located near the northeast corner of Sec. 19, Blk. 5, was completed March 15, 1950 for production from the San Andres formation and was recognized as the discovery well of a new field called the Connell field. It had been drilled to the total depth of 7,931 feet, where it was in Ellenburger, and was plugged back for production from 2,340 to 2,350 feet in the San Andres formation. It pumped at the daily rate of 12 barrels of 33° gravity oil and 68 barrels of water. The northeast diagonal offset was completed April 4, 1950 for production from the San Andres formation and the two wells produced a total of 3,351 barrels of oil before abandonment; 2,702 barrels during 1950 and 649 barrels during 1951.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Surface mapping indicated a structural high in the area. Subsurface studies by Kewanee Oil Company prompted it to purchase leases and to drill.

DISCOVERY

Canyon-Strawn: June 26, 1950; Kewanee Oil Co. #C-1 Wil (fee, Wilson Connell). Flowed 328 barrels of 38.2° gravity oil per day through perforations from 6,853 to 6,870 feet; gas-oil ratio, 394: 1. This well was completed in Canyon limestone. Since its completion, there have been six other productive zones found within the Canyon and Strawn series. The Railroad Commission treats all of these zones as within one reservoir.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is 200 feet below the top of the Ellenburger group. This penetration was in Drilling & Exploration Co. #D-1 Wilson Connell, a dry hole located near the southwest corner of Sec. 5, Blk. 5, where the total depth of 8,010 is indicated on the accompanying map.

NATURE OF TRAP

Canyon-Strawn: The trap is formed by anticlinal folding of the reservoir rock.

PRODUCTIVE AREA

Canyon-Strawn and Field: Development to date indicates a productive area of approximately 480 acres. Further development may occasion some addition to this estimate. Close estimation is precluded by irregular porosity and permeability.

THICKNESSES OF RESERVOIR ROCK

	Feet		
	Minimum	Maximum	Average
Canyon-Strawn	4	66	24

LITHOLOGY OF RESERVOIR ROCK

Canyon-Strawn: The productive rock is fossiliferous bedded light colored limestone distributed in several layers and characterized by irregular permeability. The effective porosity consists primarily of numerous small vugs.

CONTINUITY OF RESERVOIR ROCK

Canyon-Strawn: The reservoir rock is continuous throughout the area of the field; however, porosity and permeability are very irregular.

COMPLETION TREATMENT

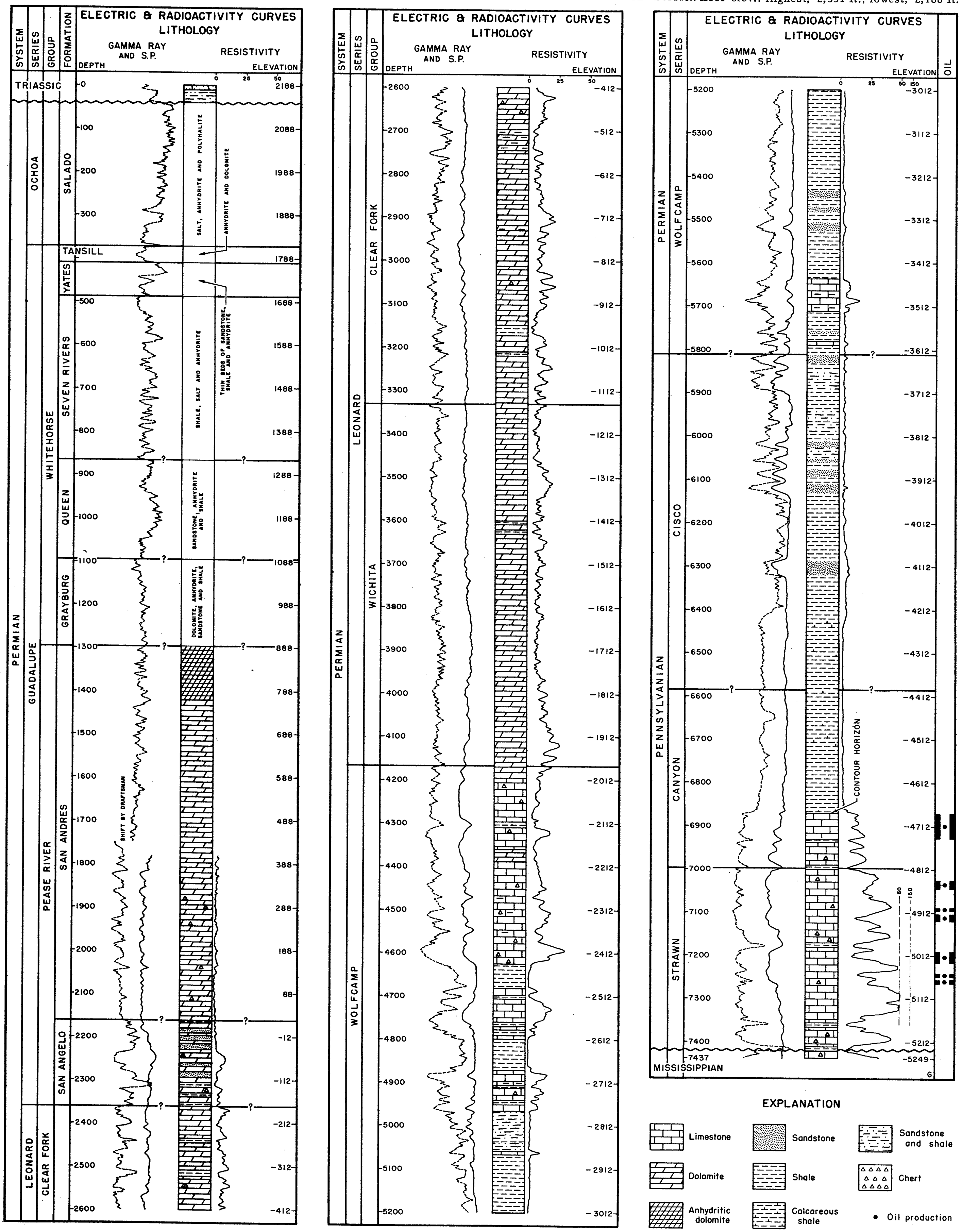
Canyon-Strawn: Nine of the 12 producing wells were acidized; 3 were completed without treatment of the reservoir rock. Quantities of acid ranged from 500 to 10,000 gallons; average, 2,375 gallons. The most recently completed well was given a 3,000-gallon hydraulic fracture treatment.

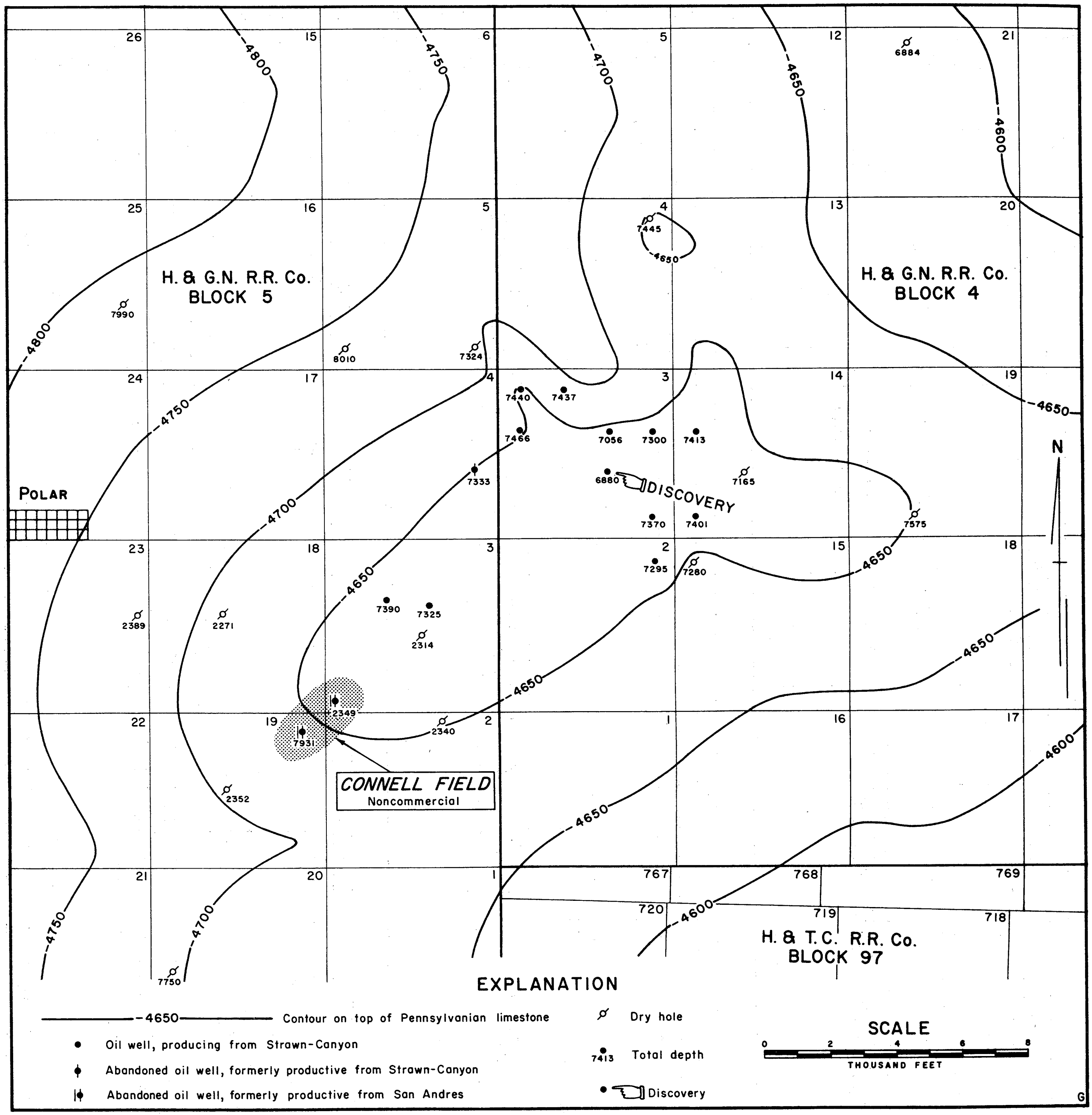
SELECTED REFERENCE

Myers, D. A., Stafford, P. T., and Burnside, R. J. (1956) Geology of the Late Paleozoic Horseshoe Atoll in West Texas: Bureau of Economic Geol., Univ. Texas, Publication 5607, 113pp., 18 plates.

TYPICAL SECTION OF ROCKS PENETRATED

SURFACE FORMATION: Undifferentiated Triassic red shales and sandstones. **ELEVATION OF SURFACE:** Derrick floor elev.: Highest, 2,351 ft.; lowest, 2,188 ft.





ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Canyon-Strawn:	Feet
Highest proved elevation of oil	-4,613
Lowest proved elevation of oil	-5,056

The difference of 443 feet does not represent a continuous oil column.

CHARACTER OF OIL

Canyon-Strawn:

Gravity, A. P. I. @60°F.:	35-39°
Base: Paraffin Odor:	Sweet
Color: Yellowish green	

PRODUCTION HISTORY

Canyon-Strawn:

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		WATER PRODUCTION (barrels)	
	Flow.	Artif.	Yearly	Cumulative	Yearly	Cumulative
1950	1	2	24,418	24,418	0	0
1951	3	6	116,093	140,511	61,xxx	61,xxx
1952	2	10	147,070	287,581	140,xxx	201,xxx
1953	2	10	115,325	402,906	191,xxx	392,xxx
1954	1	11	78,704	481,610	173,xxx	565,xxx
1955	1	11	66,730	548,340	195,xxx	760,xxx

ELKHORN FIELD

Crockett County, Texas

JACKSON B. BROWN
Assistant to the Regional Geologist
Continental Oil Company, Fort Worth, Texas
June 23, 1955

LOCATION

The Elkhorn field is in north-central Crockett County about 15 miles northwest of Ozona, county seat. It is on the Ozona platform, a dominant structural feature in the southern portion of the Permian basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The discovery of this field was the result of studies of surface geology and subsurface geology, including data afforded by refraction seismograph. An inducement for intensive exploration was ownership of leases covering a large area.

DISCOVERY

Ellenburger: June 28, 1951; Continental Oil Co. #1 J.M.Shannon "A". Initial potential capacity was at rate of 2,580 barrels of oil per day.

PRODUCTIVE AREA

Ellenburger and Field: Development to date proves about 2,700 acres as productive and indicates that there may be some additional productive area northward. Except at the north end of the field, the extent of the productive area is quite definitely defined.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Ellenburger group. The maximum known penetration of Ellenburger is 499 feet below its eroded top. This penetration was at the total depth of 7,485 feet in Continental Oil Co. #12 J.M.Shannon "A", located as indicated by entry of "MAXIMUM PENETRATION" on the accompanying map. Since the top of the Ellenburger is an erosion surface and since exact stratigraphic positions within the Ellenburger have not been determined, it is possible that some lesser penetration of Ellenburger actually reached an older horizon than was penetrated in the above mentioned well.

NATURE OF TRAP and STRUCTURE

Ellenburger: Anticlinal folding appears to be the primary trap-forming factor. The trap is due in part also to truncation and sealing by overlying relatively impervious shales and also in part to the down-to-the-east fault on the east limb of the anticline.

While the contours on the accompanying map portray an erosion surface, they serve also to indicate the general structural conditions. There is an anticlinal fold with the axis essentially at the location of the erosional ridge. The eastward and westward dips are slightly greater than the corresponding slopes of the contoured surface. The displacement of beds cut by the fault is not definitely determinable but appears to be in excess of 1,400 feet.

THICKNESSES OF RESERVOIR ROCK

Ellenburger:	Max.	Avg.
From top to bottom, feet	455	232

Net productive thickness cannot be satisfactorily estimated since the reservoir rock consists of highly fractured dolomite.

LITHOLOGY OF RESERVOIR ROCK

Ellenburger: Dolomite; gray to tan, generally finely crystalline, contains numerous vugs and cavities and is highly fractured throughout.

CONTINUITY OF RESERVOIR ROCK

Ellenburger: The reservoir rock is continuous throughout the productive area except that the upper portion has been removed by erosional truncation along the apex of the anticline. The eastward continuity is interrupted by a down-to-the-east fault with throw of several hundred feet.

CHARACTER OF GAS

Ellenburger: There was no free gas cap at time of discovery nor has there been any of importance resulting from operations. The gas production is incidental to oil production as gas comes out of solution with decline in pressure. No analysis of the gas is readily available. Such gas as is produced is processed at the Todd Unit gasoline plant operated by the Continental Oil Company.

WATER PRODUCTION

Ellenburger: Wells located structurally low are now producing considerable amounts of water. A uniform rise in water level is indicated. The average chloride content of the water amounts to 28,971 parts per million.

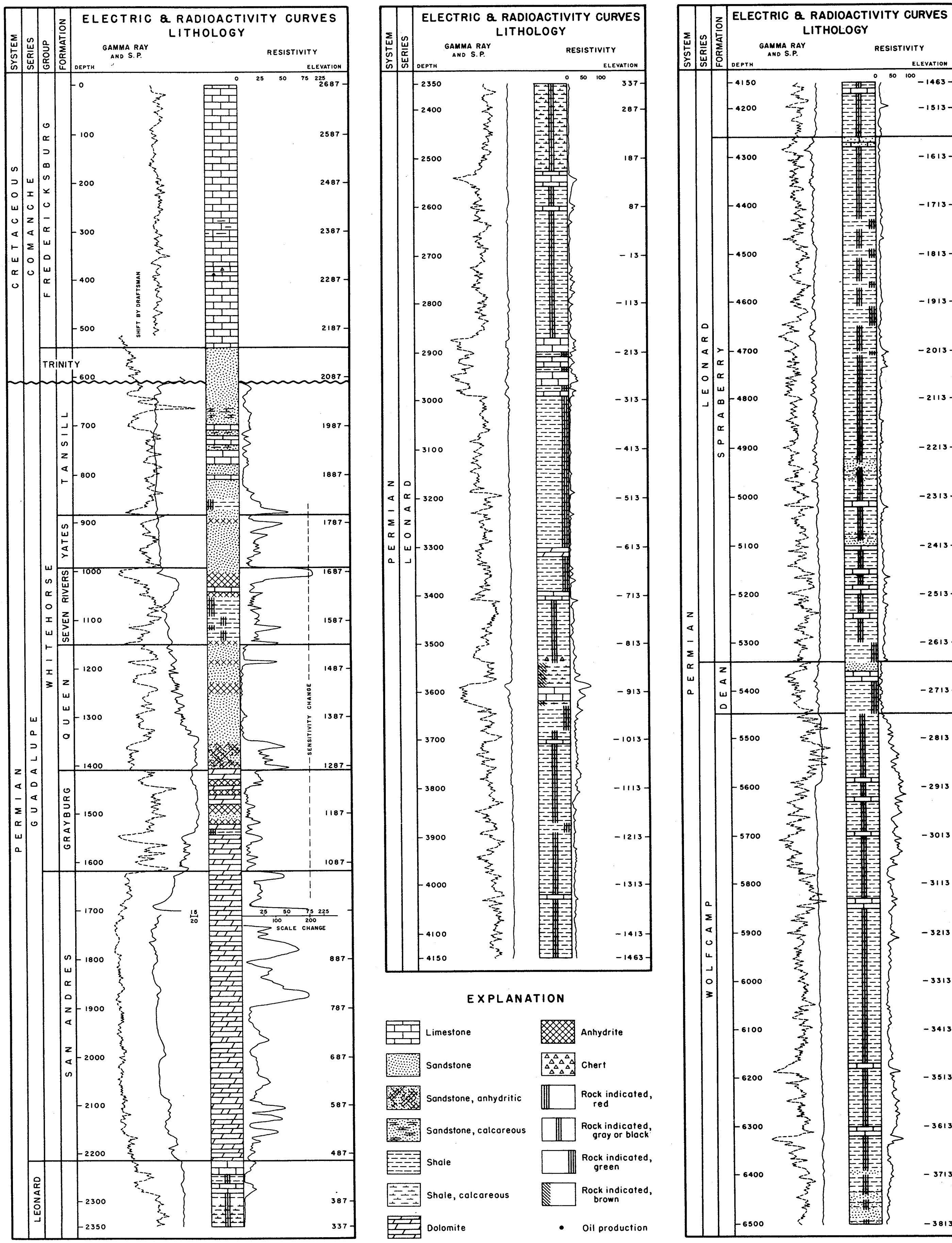
RESERVOIR ENERGY

Ellenburger: Reservoir energy is due to an effective water drive in combination with energy afforded by expansion of gas coming out of solution with decline in pressure.

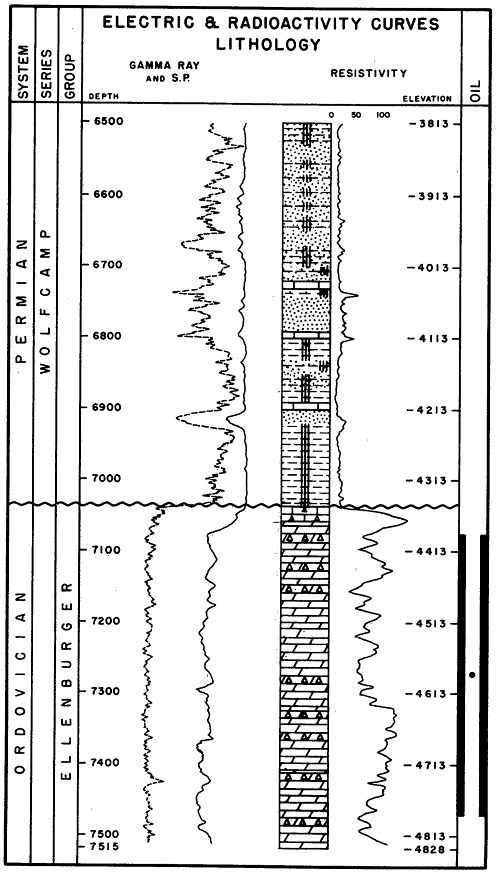
ACID TREATMENT

Ellenburger: Practically every well has been treated with 500 to 1,000 gallons of acid at time of completion.

TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED



ELEVATION OF SURFACE

At well locations: Highest, 2,706 feet; lowest, 2,594 feet.

SURFACE FORMATION

Undifferentiated limestones of the Fredericksburg group.

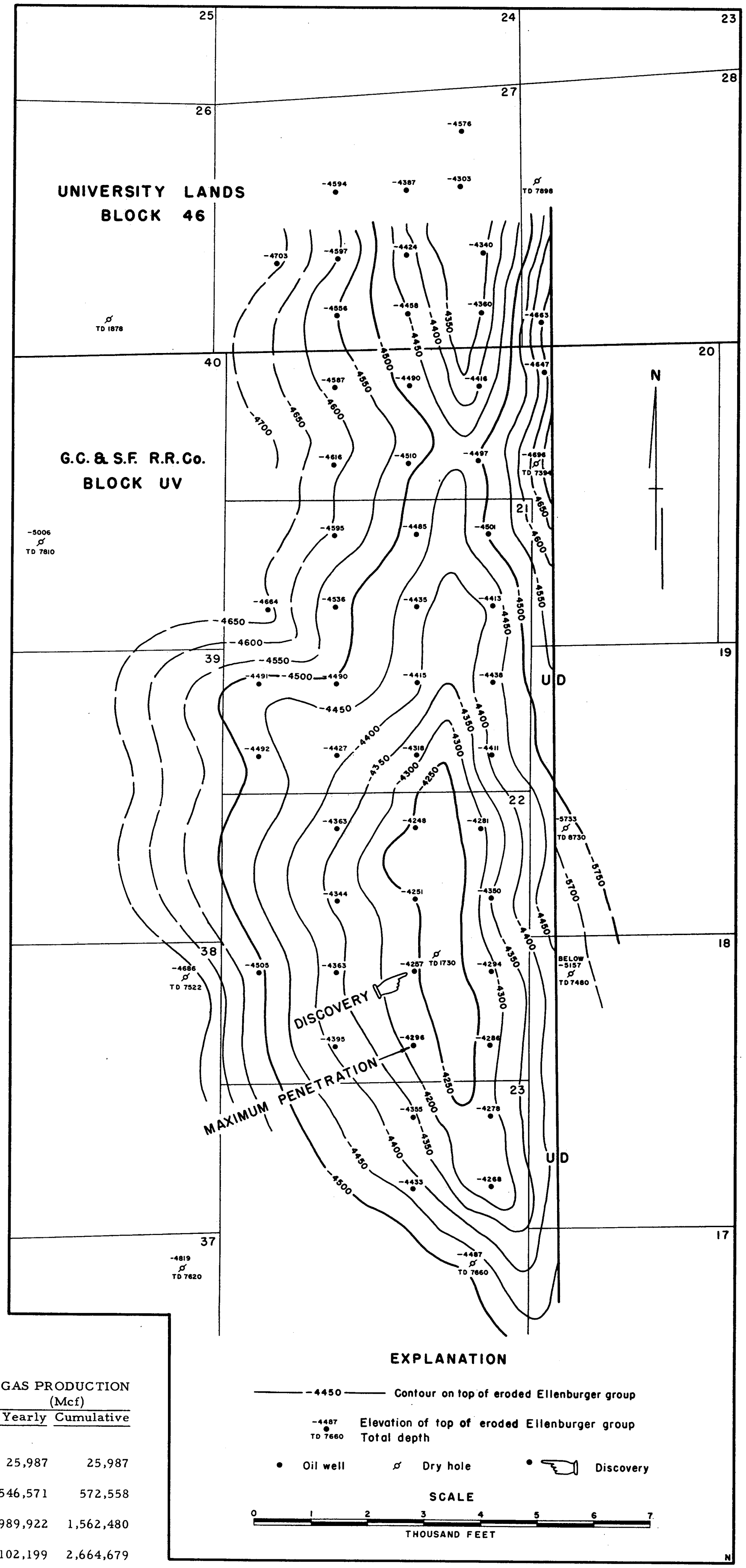
ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Ellenburger:	Feet
Elevation of highest known oil	-4,330
Elevation of oil-water contact at discovery date	-4,785
Relief	455

RESERVOIR TEMPERATURE AND PRESSURE and OIL SAMPLE DATA

Ellenburger:	
Original reservoir temperature, F.,	179°
Original reservoir pressure, psi.,	3,140
Gravity of oil, A.P.I. @ 60° F.,	37°-38°
Bubble point, psi.,	1,714
Solution gas-oil ratio, cf/bbl.,	635
Volume factor, surface : reservoir	1.4119

The above data were determined from bottom-hole samples.



PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flow.	Pump.	Total	OIL PRODUCTION (barrels): Yearly	Cumulative	GAS PRODUCTION (Mcf): Yearly	Cumulative
Ellenburger and Field total							
1951	4	0	4	49,389	49,389	25,987	25,987
1952	26	2	28	861,164	910,553	546,571	572,558
1953	37	11	48	1,550,043	2,460,596	989,922	1,562,480
1954	12	39	51	1,735,746	4,196,342	1,102,199	2,664,679

EMBAR FIELD

Andrews County, Texas

EDWIN VAN DEN BARK
District Geologist, Phillips Petroleum Company, Midland, Texas
January 1, 1954

LOCATION

The Embar field is in Blocks 10 and 11, University Land, in south central Andrews County. It is 18 miles southwest of the town of Andrews, county seat.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The methods of exploration which led directly to discovery were core drilling and gravity surveying. After the completion of a few wells, a reflection seismograph survey was made for the purpose of providing additional data for detailed mapping.

The exploration which led to this discovery was of special importance because this field was the first to produce from the Ordovician north of Crane County. It was the first major Ellenburger field on the Central Basin platform.

DISCOVERIES

Lower Clear Fork: November 4, 1942; Phillips Petroleum Co. #22 University-Andrews. This well had been drilled to a total depth of 6,325 feet, where 5½-inch casing was set. Cement was drilled out to 6,307 feet and the casing was perforated with 160 shots from 6,240 feet to 6,280 feet. Flowed at rate of 259 barrels of 42.3° gravity oil per day through 1/8-inch choke. GOR, 544:1.

Ellenburger and Field: May 14, 1942; Phillips Petroleum Co. #2 University-Andrews. Ellenburger was encountered at depth of 7,746 (-4,500) feet and the well was drilled to total depth of 7,855 feet. Flowed at rate of 1,872 barrels of 44.5° gravity oil per day through 2-inch tubing with ½-inch choke. GOR, 672:1.

OLDEST HORIZON PENETRATED

The oldest horizon penetrated is in pre-Cambrian granite. Pre-Cambrian granite was penetrated in six wells at the crest of the structure.

ELEVATION OF SURFACE

At well locations: Highest, 3,307 ft.; lowest, 3,228 ft.

SURFACE FORMATIONS

Pleistocene windblown sand 0 to 20 feet thick overlying Cretaceous sandstone.

NATURE OF TRAPS

Lower Clear Fork: While the trap appears to be due primarily to domal folding, the commercially productive area does not extend over the apex of the convex fold. Low porosity and permeability certainly determine locally the boundary of the commercially productive area. Probably the trapping at the particular location of the commercial accumulation is due in part to updip and lateral termination of a degree of porosity and permeability adequate for migration of fluids.

Ellenburger: A combination of an anticlinal fold with reservoir terminated locally by two normal faults and also with reservoir terminated around the structural apex by erosional truncation; the truncated surface is overlain by impervious beds of Wolfcamp age.

THICKNESSES OF RESERVOIR ROCKS

Lower Clear Fork: From top to bottom of productive zone is generally about 110 feet.

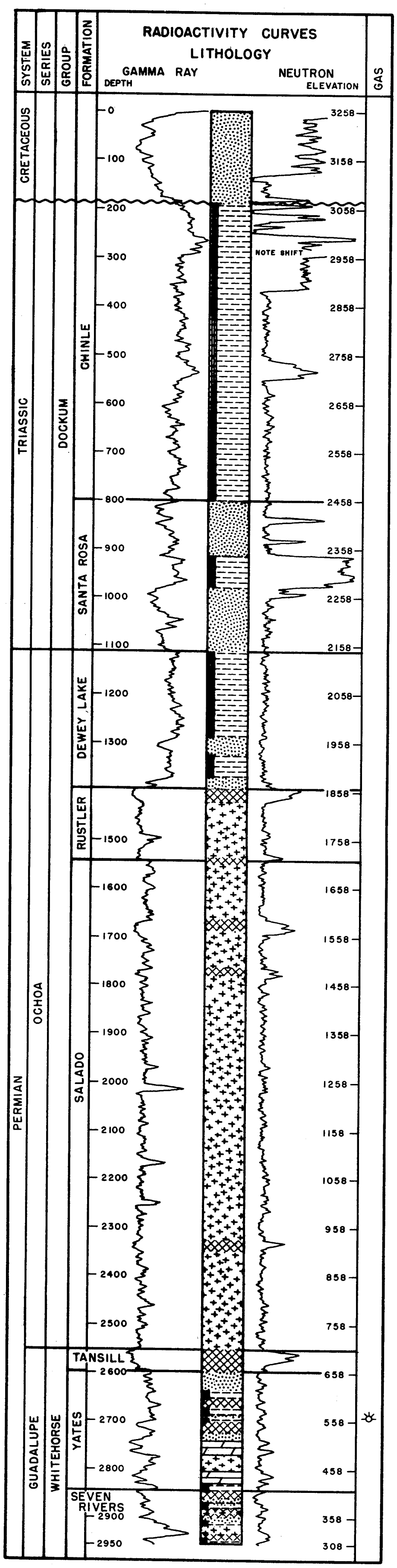
Ellenburger: The thickness of the Ellenburger reservoir rock is quite variable. Throughout an area of about 300 acres at the apex of the structure, there is no Ellenburger; away from that area, the Ellenburger thickens rapidly in all directions. The maximum measured thickness is 710 feet.

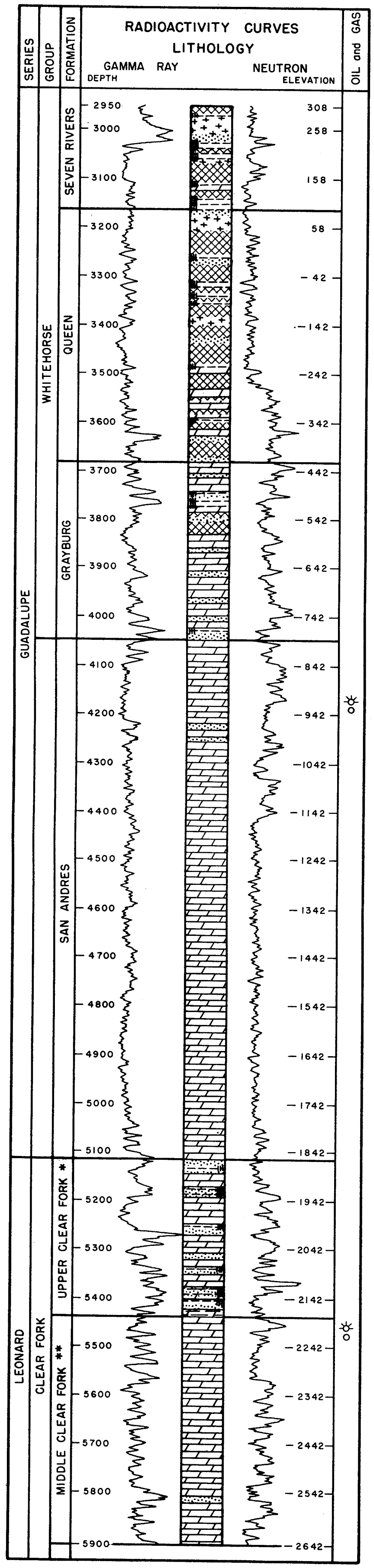
ELEVATION AND RELIEF OF PRODUCTIVE ZONES

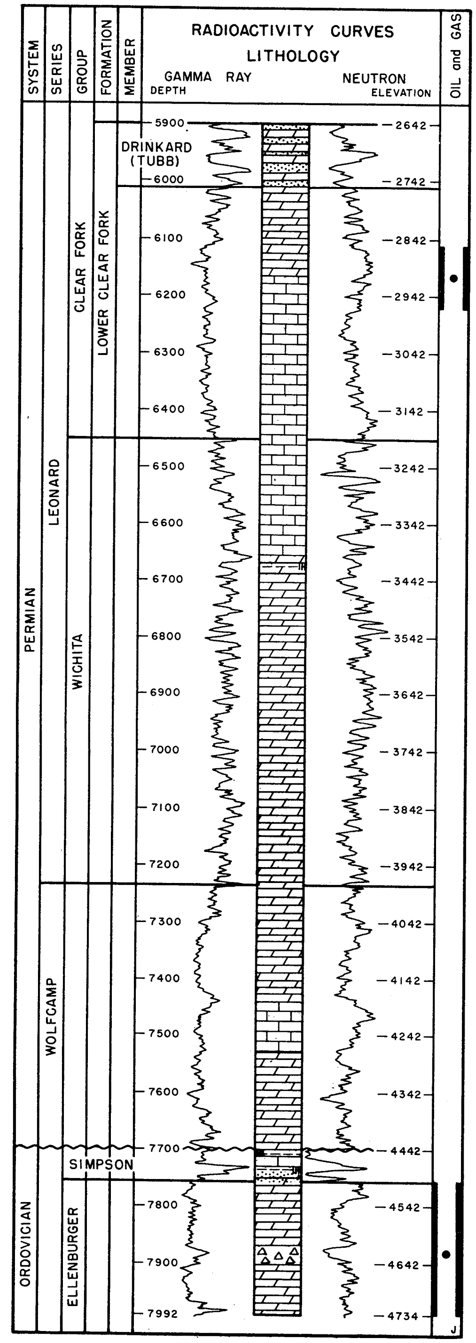
	Lower Clear Fork	Ellenburger
No free gas		
Elevation of top of oil, ft.	-2,700	-4,440
Elevation of bottom of oil, ft.	-3,070	-4,820
Relief, feet	370	380

The above data represent conditions at respective discovery dates.

TYPICAL SECTION OF ROCKS PENETRATED



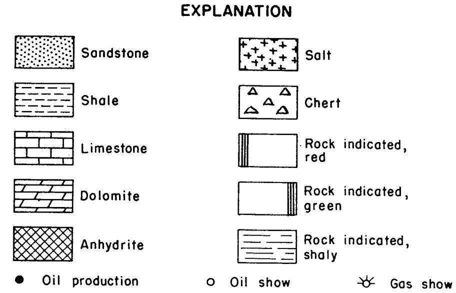


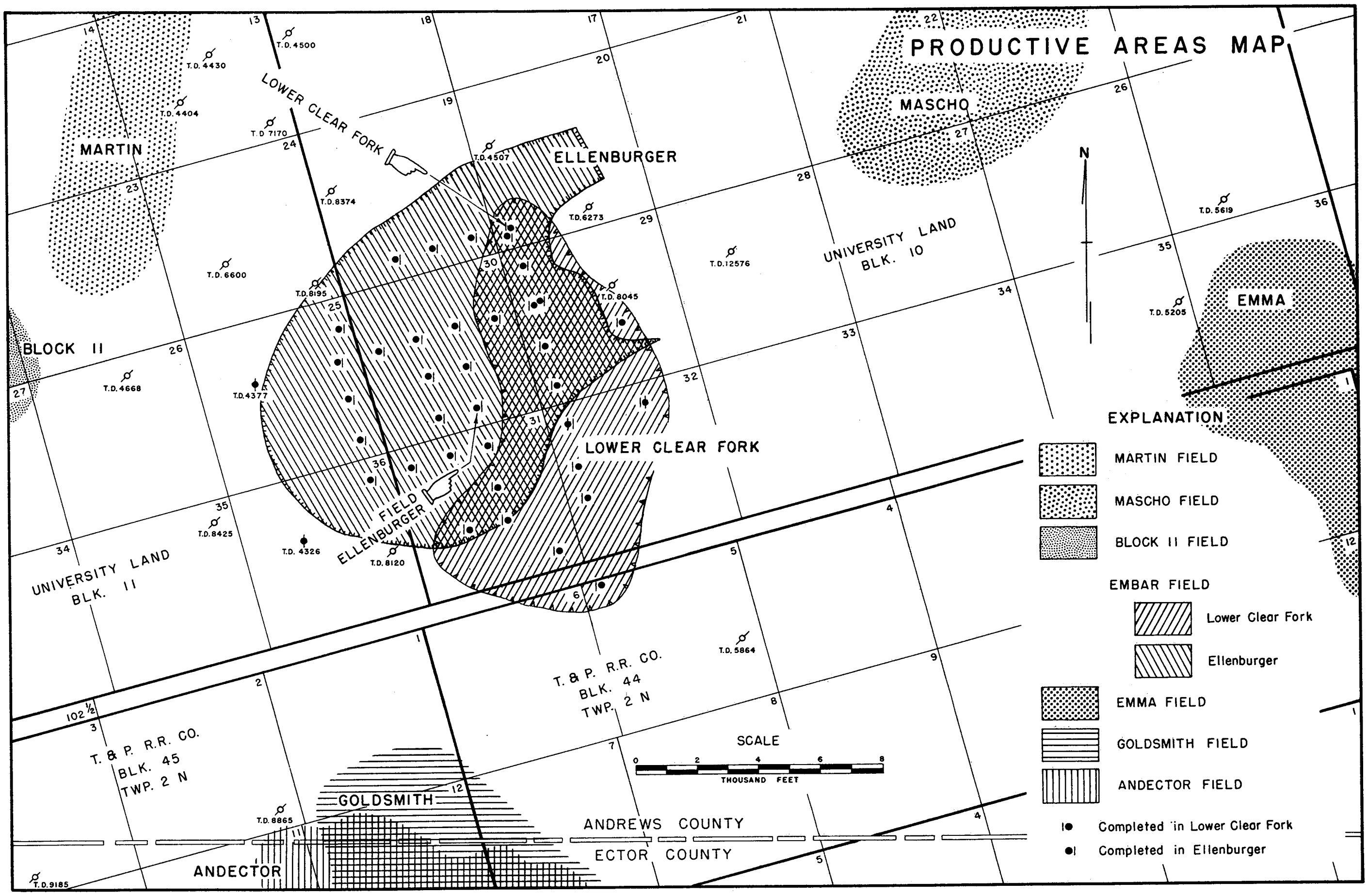


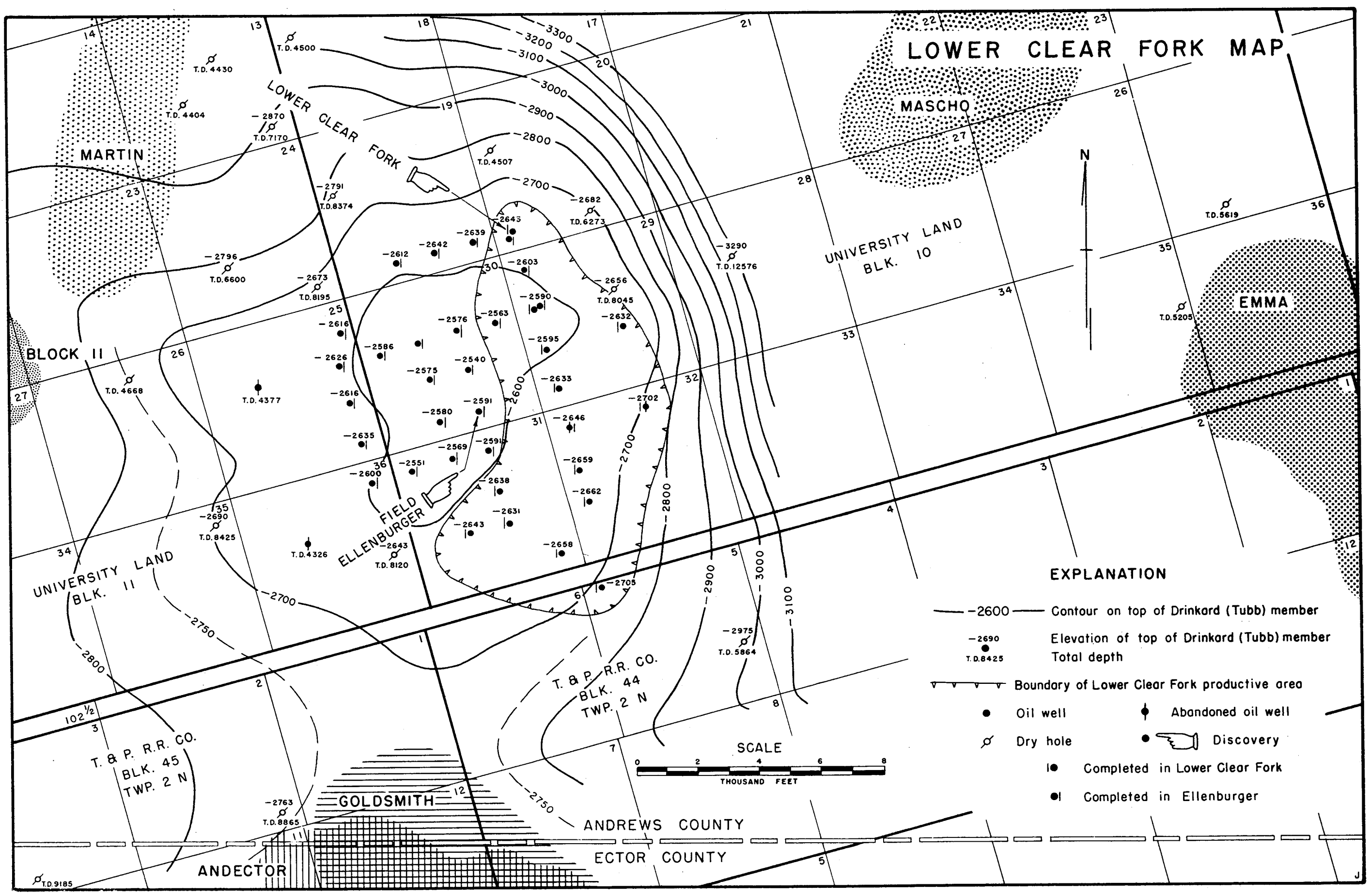
*The section indicated as Upper Clear Fork is commonly called Glorieta. In the opinion of the writer, proper usage of the name Glorieta restricts it to the stratigraphic equivalent of the basal portion of the immediately overlying San Andres formation.

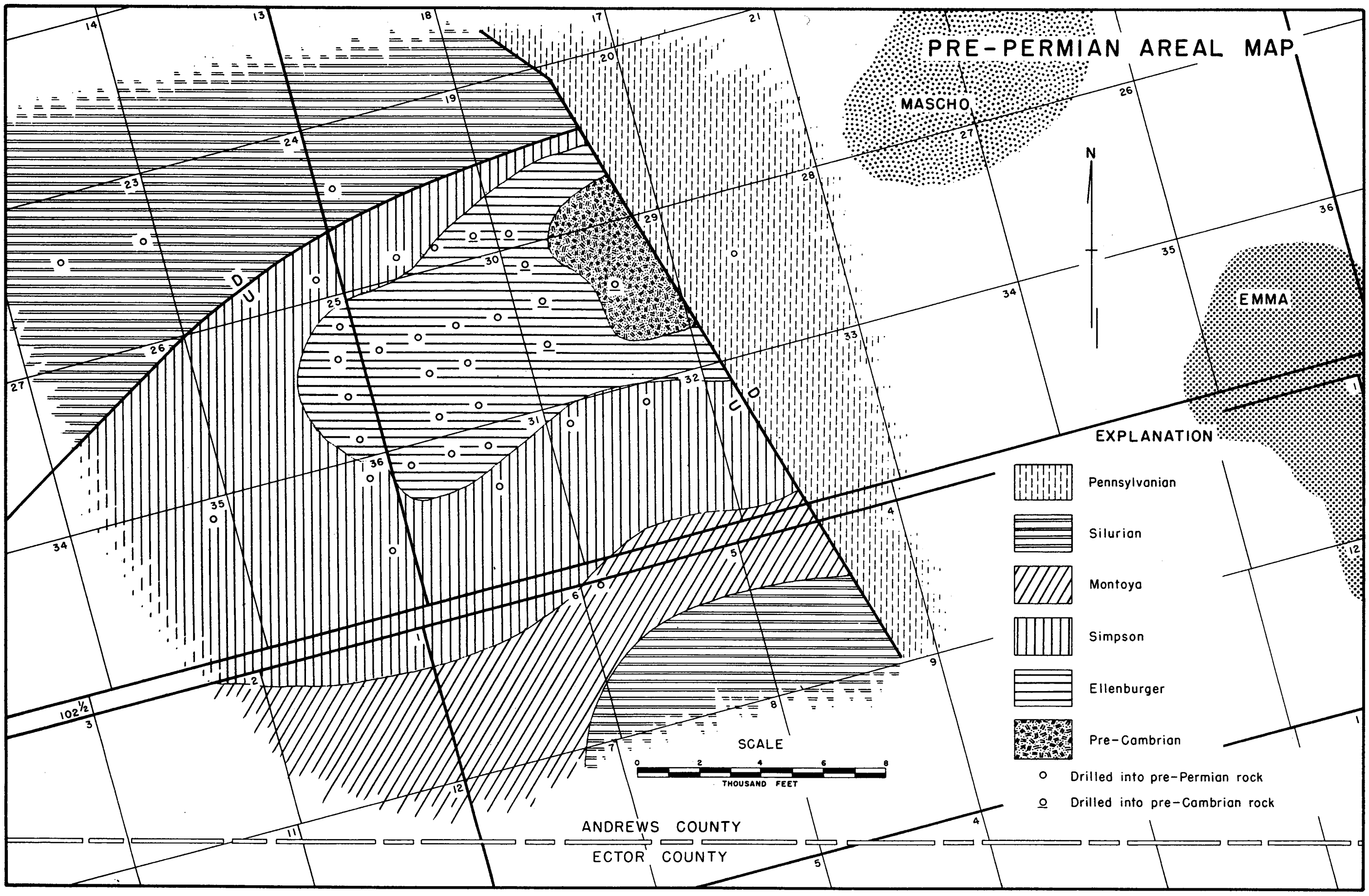
**The section indicated as Middle Clear Fork is commonly called Upper Clear Fork.

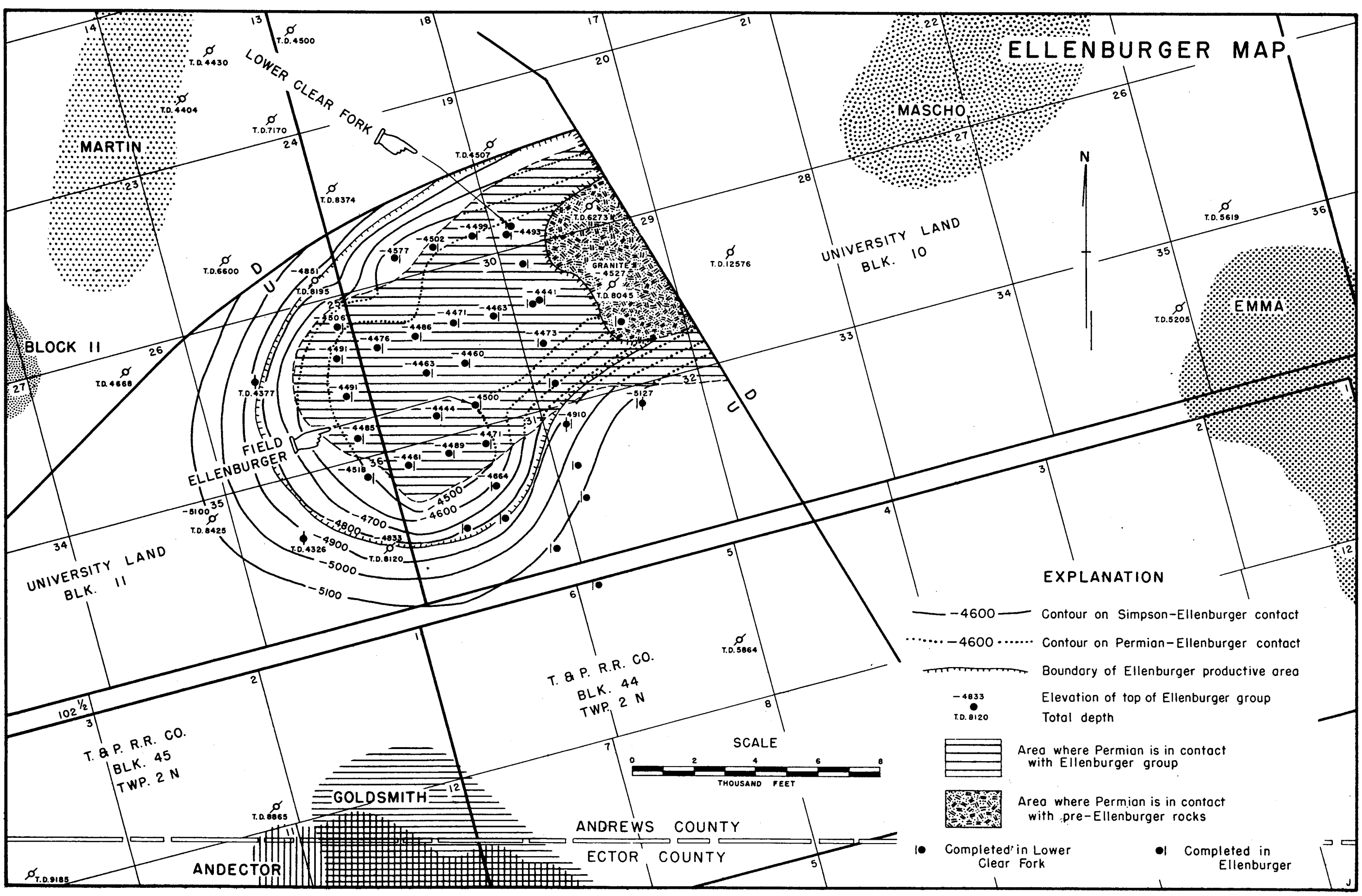
EXPLANATION




PRODUCTIVE AREAS MAP
MARTIN
MASCHO
EMMA
BLOCK 11
LOWER CLEAR FORK
ELLENBURGER
LOWER CLEAR FORK
ELLENBURGER FIELD
UNIVERSITY LAND BLK. 10
UNIVERSITY LAND BLK. 11
T. & P. R.R. CO. BLK. 44 TWP. 2 N
T. & P. R.R. CO. BLK. 45 TWP. 2 N
GOLDSMITH
ANDECTOR
ANDREWS COUNTY
ECTOR COUNTY
SCALE
THOUSAND FEET
EXPLANATION
MARTIN FIELD
MASCHO FIELD
BLOCK 11 FIELD
EMBAR FIELD
Lower Clear Fork
Ellenburger
EMMA FIELD
GOLDSMITH FIELD
ANDECTOR FIELD
Completed in Lower Clear Fork
Completed in Ellenburger


LOWER CLEAR FORK MAP
MARTIN
MASCHO
EMMA
BLOCK 11
LOWER CLEAR FORK
ELLENBURGER FIELD
UNIVERSITY LAND BLK. 10
UNIVERSITY LAND BLK. 11
T. & P. R.R. CO. BLK. 44 TWP. 2 N
T. & P. R.R. CO. BLK. 45 TWP. 2 N
GOLDSMITH
ANDECTOR
ANDREWS COUNTY
ECTOR COUNTY
SCALE
THOUSAND FEET
EXPLANATION
—2600— Contour on top of Drinkard (Tubb) member
Elevation of top of Drinkard (Tubb) member
Total depth
Boundary of Lower Clear Fork productive area
Oil well
Abandoned oil well
Dry hole
Discovery
Completed in Lower Clear Fork
Completed in Ellenburger


PRE-PERMIAN AREAL MAP
MASCHO
EMMA
N
EXPLANATION
Pennsylvanian
Silurian
Montoya
Simpson
Ellenburger
Pre-Cambrian
Drilled into pre-Permian rock
Drilled into pre-Cambrian rock
SCALE
THOUSAND FEET
ANDREWS COUNTY
ECTOR COUNTY


ELLENBURGER MAP
MASCHO
MARTIN
EMMA
BLOCK 11
LOWER CLEAR FORK
ELLENBURGER FIELD
GRANITE
UNIVERSITY LAND BLK. 10
UNIVERSITY LAND BLK. 11
T. & P. R.R. CO. BLK. 44 TWP. 2 N
T. & P. R.R. CO. BLK. 45 TWP. 2 N
GOLDSMITH
ANDECTOR
N
EXPLANATION
—4600— Contour on Simpson-Ellenburger contact
-4600 Contour on Permian-Ellenburger contact
Boundary of Ellenburger productive area
-4833 Elevation of top of Ellenburger group
T.D. 8120 Total depth
Area where Permian is in contact with Ellenburger group
Area where Permian is in contact with pre-Ellenburger rocks
Completed in Lower Clear Fork
Completed in Ellenburger
SCALE
THOUSAND FEET
ANDREWS COUNTY
ECTOR COUNTY

LITHOLOGY OF RESERVOIR ROCKS

Lower Clear Fork: Tan to buff, fine-crystalline dolomite with beds of tan limestone toward the base. Although there is some pinpoint intergranular porosity, the interstitial space is dominantly due to solution cavities and channels.

Ellenburger: Tan, fine- to medium-crystalline dolomite with some persistent beds of white chert. The interstitial space is due to intergranular porosity along with a large number of solution cavities, channels and fractures.

CONTINUITY OF RESERVOIR ROCKS

Lower Clear Fork: This reservoir rock is continuous throughout the area of the field and is correlative with productive reservoirs in a large portion of the Permian basin in West Texas and New Mexico. In Texas it is sometimes referred to as "the Fullerton pay", while in New Mexico it is called "the Drinkard zone". It is productive in the nearby Goldsmith, TXL and Fullerton fields.

Ellenburger: Within the area of the field, the total thickness of this reservoir rock is present in only a narrow band, which almost surrounds the apex of the Embar structure. The Ellenburger was deposited on an eroded surface, with that surface sufficiently high at the apex of the structure that only the uppermost portion of the Ellenburger was deposited there. Post-Simpson erosion removed such Ellenburger as was at the apex and beveled the Ellenburger and overlying Simpson in the surrounding area. The halo of productive Ellenburger is incomplete in that, at the east end, the Ellenburger is non-productive on the downthrown side of the fault. The Ellenburger occurs throughout most of the Permian basin and is productive in many fields, including the nearby Andector, Martin, TXL, Keystone and Dollarhide fields.

PRODUCTIVE AREAS

	Acres
Lower Clear Fork	1,400
Ellenburger	1,800
Embar field	2,900

RESERVOIR ENERGY

Lower Clear Fork: Solution gas drive.

Ellenburger: Water drive. Normal water encroachment has necessitated recompletions in several wells in the upper part of the productive zone.

CHARACTER OF OIL

	Lower Clear Fork	Ellenburger
Gravity, A.P.I. @ 60° F.	42.0°	43.9°
Sulphur	0.65%	.28%
Color	Dk. green	Dk. green
Saybolt viscosity @ 100° F.	39 sec.	36 sec.
Initial boiling point	97°	83°
Conradson carbon residue test of still residue	3.88%	3.32%

For analyses of Ellenburger oil see:

U.S. Bureau of Mines	Lab. ref. No.	43064	46116
Analyses of Crude Oils from Some West Texas Fields, R.I. 3744 (1944)	Page	9	
Analyses of Crude Oils from 283 Important Oil Fields of the United States, R.I. 4289 (1948)	Item	201	
Analyses of Crude Oils from Some West Texas Fields, R.I. 4959 (1953)	Item		23

WATER PRODUCTION

Lower Clear Fork: Very little water has ever been produced from this reservoir. The rate of water production by any well has remained about constant since the completion of the well.

Ellenburger: Normal water encroachment has occurred in this reservoir. Until early in 1951, most of the Ellenburger wells were making water. Recompletions during 1951 have eliminated most of the water production.

ACID TREATMENT

Lower Clear Fork: At completion, each well has been treated with 3,000 to 15,000 gallons of acid.

Ellenburger: The wells completed in the Ellenburger required little or no acid to bring them on production. Usually they were treated with 500 to 2,000 gallons of acid.

SELECTED REFERENCE

Cole, Taylor (1943) Embar field, Andrews County, Texas: Amer. Assoc. Petr. Geol., Bull., vol. 27, p. 538.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf @ 14.65 psi.)	
	Flowing	Pumping	Yearly	Cumulative	Yearly	Cumulative
Field totals						
1942	12	0	115,494	115,494	80,301	80,301
1943	30	0	648,627	764,121	646,265	726,566
1944	34	0	1,255,052	2,019,173	1,030,105	1,756,671
1945	35	3	1,484,049	3,503,222	1,271,959	3,028,630
1946	36	2	1,597,736	5,100,958	1,307,485	4,336,115
1947	35	3	1,807,050	6,908,008	1,364,414 est.	5,700,529
1948	34	3	1,782,429	8,690,437	1,330,000 est.	7,030,529
1949	34	1	1,074,208	9,764,645	994,474	8,025,003
1950	34	1	1,006,907	10,771,552	836,675	8,861,678
1951	35	1	1,246,824	12,018,376	863,716	9,725,394
1952	34	2	1,061,382	13,079,758	810,xxx	10,535,xxx
1953	33	3	1,060,303	14,140,061	892,xxx	11,427,xxx
Lower Clear Fork						
1942	7	0	14,040	14,040	21,450	21,450
1943	12	0	281,348	295,388	429,569	451,019
1944	12	0	279,013	574,401	450,101	901,120
1945	11	3	251,777	826,178	544,266	1,445,386
1946	12	2	244,255	1,070,433	512,520	1,957,906
1947	11	3	228,919	1,299,352	554,414	2,512,320
1948	10	3	172,914	1,472,266	500,000 est.	3,012,320
1949	10	1	118,206	1,590,472	433,565	3,445,885
1950	10	1	97,835	1,688,307	297,010	3,742,895
1951	11	1	132,219	1,820,526	335,998	4,078,893
1952	11	1	127,570	1,948,096	364,xxx	4,443,xxx
1953	11	1	107,361	2,055,457	440,xxx	4,883,xxx
Ellenburger						
1942	5	0	101,454	101,454	58,851	58,851
1943	18	0	367,279	468,733	216,696	275,547
1944	22	0	976,039	1,444,772	580,004	855,551
1945	24	0	1,232,272	2,677,044	727,693	1,583,244
1946	24	0	1,353,481	4,030,525	794,965	2,378,209
1947	24	0	1,578,131	5,608,656	810,000 est.	3,188,209
1948	24	0	1,609,515	7,218,171	830,000 est.	4,018,209
1949	24	0	956,002	8,174,173	560,909	4,579,118
1950	24	0	909,072	9,083,245	539,665	5,118,783
1951	24	0	1,114,605	10,197,850	527,718	5,646,501
1952	23	1	933,812	11,131,662	446,xxx	6,093,xxx
1953	22	2	952,942	12,084,604	452,xxx	6,545,xxx

EMMA FIELD

Andrews County, Texas

J. L. WILLIAMS
Geologist, Phillips Petroleum Co., Midland, Texas

January 22, 1953

LOCATION

The Emma field is in south central Andrews County 12 miles southwest of the town of Andrews. It is in the east central part of the Central Basin platform and is between and in trend with the Mascho and North Cowden fields.

METHODS OF EXPLORATION LEADING TO DISCOVERY

It appears that discovery was the result of mapping of geological data afforded by wells previously drilled in the region and by utilization of data afforded by geophysical surveys.

DISCOVERIES

Upper San Andres: January 10, 1937; Sinclair Prairie Oil Co. #1 Emma Cowden. The initial production of this well is variously reported from 5 to 45 barrels per day by pumping. In its early history it was treated by the Railroad Commission as being in the North Cowden field. It was plugged and abandoned on June 19, 1937, apparently without having produced enough oil to return its cost.

Holt zone: October 27, 1950; Forchall Oil Co. #3 Emma Cowden.

ELEVATION OF SURFACE

Derrick floor: Highest, 3,178 feet; lowest, 3,135 feet.

SURFACE FORMATION

Recent sand.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Holt zone 41 feet below its top. This penetration was in one of only three wells which have been drilled to the depth of the Holt zone within the area of the field. The oldest horizon penetrated in the vicinity of the field is in upper Clear Fork. This penetration was in Stanolind Oil & Gas Co. #1-F University, a dry hole located just north of the field which was drilled to total depth of 5,619 feet.

VARIATIONS IN THICKNESSES

The intervals between certain reliable stratigraphic markers are considerably greater where observed in edge wells than they are in wells at the apex of the anticline. The total thickness of rocks from the top of the Chinle formation to the top of the Rustler formation varies about 100 feet, from about 1,500 feet to about 1,600 feet; interval from top of the Rustler formation to the top of Yates formation varies 70 feet, from 1,090 feet to 1,160 feet; interval from top of Yates formation to top of Grayburg formation varies 60 feet, from 1,160 feet to 1,220 feet; interval from top of Grayburg formation to base of Grayburg formation varies 35 feet, from 230 feet to 265 feet.

NATURE OF TRAPS

Upper San Andres: The trap is due primarily to an anticlinal fold. The fact that profitable production extends farther downdip on the northeast limb than on the southwest limb appears to be due to variation of porosity and permeability within the trap area.

Holt zone: Since the two productive wells are near the apex of the structural high, it appears that the trap is probably due to a convex fold. However, since this reservoir rock failed to yield commercial production at Forchall Oil Co. #1 Holt (T. D. 5,280 feet) where the Holt zone is equally high and almost between the two productive wells, it appears that variation in permeability may be an important trap-forming factor.

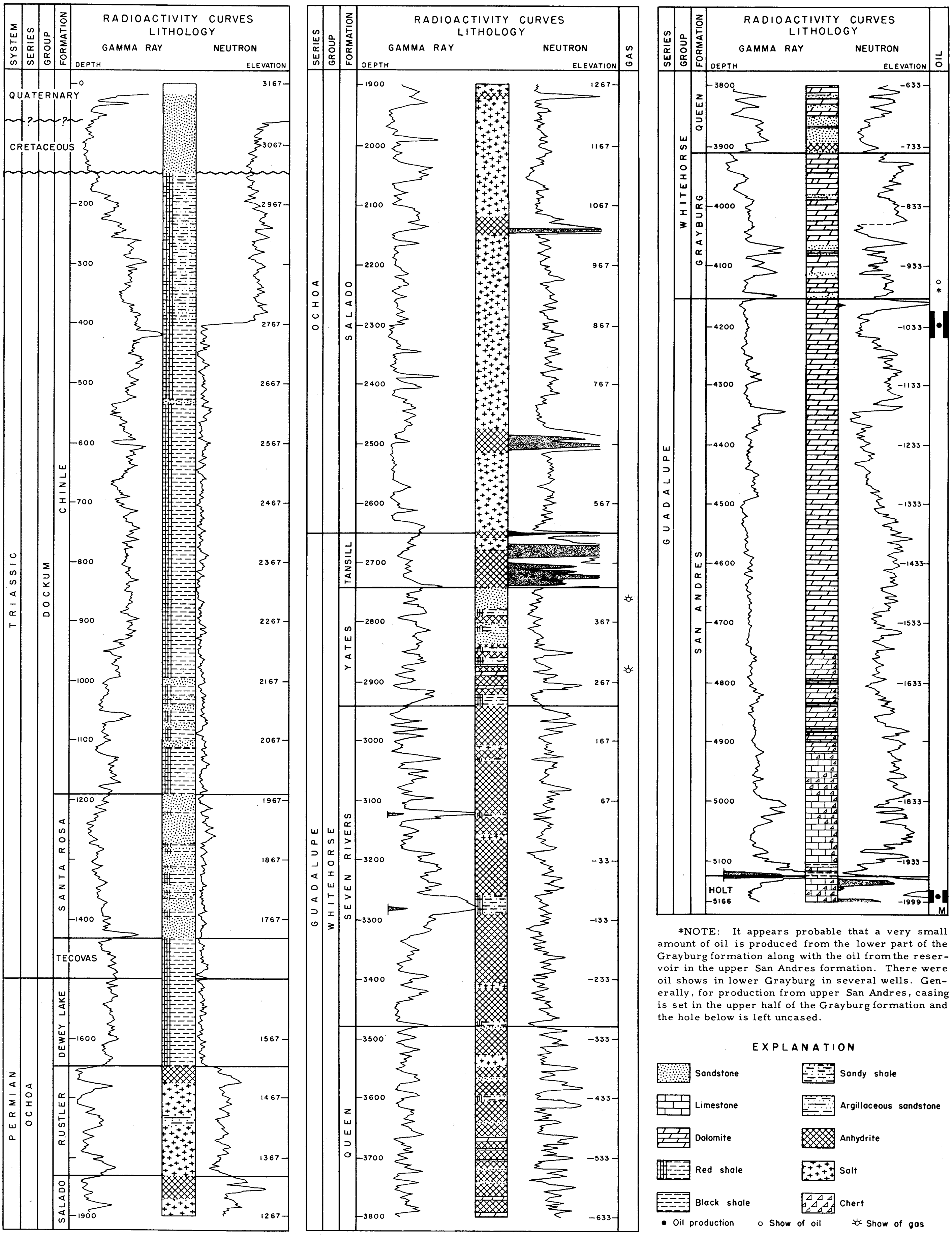
PRODUCTIVE AREAS

	Acres
Upper San Andres	1,500
Holt zone	20
Emma field	1,500

THICKNESSES OF RESERVOIR ROCKS

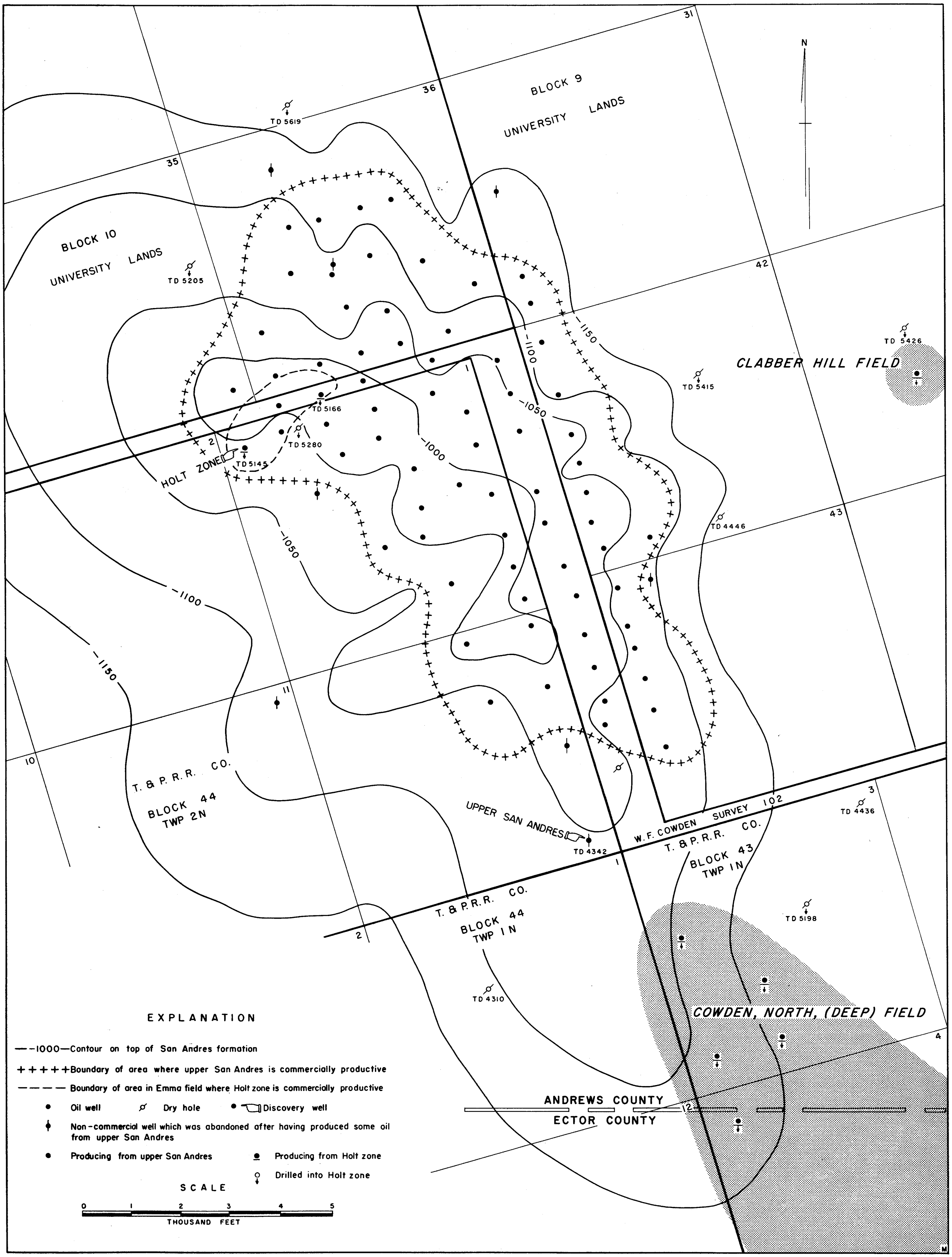
	Feet		
	Min.	Max.	Avg.
Upper San Andres			
From top to bottom	5	180	55
Net productive	5	40	25
Holt zone			
From top to bottom	22	36	29
Net productive	10	10	10

TYPICAL SECTION OF ROCKS PENETRATED



*NOTE: It appears probable that a very small amount of oil is produced from the lower part of the Grayburg formation along with the oil from the reservoir in the upper San Andres formation. There were oil shows in lower Grayburg in several wells. Generally, for production from upper San Andres, casing is set in the upper half of the Grayburg formation and the hole below is left uncased.

EXPLANATION


BLOCK 9
UNIVERSITY LANDS
BLOCK 10
UNIVERSITY LANDS
CLABBER HILL FIELD
HOLT ZONE
UPPER SAN ANDRES
T. & P. R.R. CO.
BLOCK 44
TWP 2N
W. F. COWDEN SURVEY
T. & P. R.R. CO.
BLOCK 43
TWP 1N
T. & P. R.R. CO.
BLOCK 44
TWP 1N
COWDEN, NORTH, (DEEP) FIELD
ANDREWS COUNTY
ECTOR COUNTY
TD 5619
TD 5205
TD 5426
TD 5415
TD 5166
TD 5280
TD 5145
TD 4446
TD 4436
TD 4342
TD 5198
TD 4310
EXPLANATION
—1000— Contour on top of San Andres formation
+ + + + + Boundary of area where upper San Andres is commercially productive
— — — — Boundary of area in Emma field where Holt zone is commercially productive
Oil well
Dry hole
Discovery well
Non-commercial well which was abandoned after having produced some oil from upper San Andres
Producing from upper San Andres
Producing from Holt zone
Drilled into Holt zone
SCALE
0 1 2 3 4 5
THOUSAND FEET

LITHOLOGY OF RESERVOIR ROCKS

Upper San Andres: Light colored, non-sandy, crystalline to dense dolomite. The porosity is of intercrystalline type and is quite variable both vertically and horizontally. The top of the zone which is sufficiently porous to yield oil varies in position from the top to 50 feet below the top of the San Andres formation. The degree of porosity is generally greater on the northeast flank than on the southwest flank of the anticline.

Holt zone: Brown, saccharoidal, very cherty, glauconitic limestone with irregular intercrystalline porosity.

CONTINUITY OF RESERVOIR ROCKS

Upper San Andres: The stratigraphic unit which is productive in this field is continuous throughout the area of the field and probably far beyond. However, the degree of porosity is quite variable within the area of the field and determines the western limit of commercial production.

Holt zone: Only 3 wells have been drilled to the depth of the reservoir rock within the area of the field. While the stratigraphic unit appears to be continuous throughout the area covered by the accompanying map, the degree of porosity is quite irregular.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Upper San Andres:	Feet
No free gas cap	
Elevation of top of oil	-997
Elevation of bottom of oil, approximate	-1,160
Relief, approximate	183
Holt zone:	
No free gas cap	
Elevation of top of oil	-1,955
Elevation of bottom of oil	Unknown*

*Only two wells have produced oil from the reservoir in the Holt zone. In one, the productive zone is from -1,955 feet to -1,957 feet, and, in the other, from -1,955 feet to -1,997 feet. Both wells produce water along with the oil. It is not known whether the water is intermingled with the oil in the reservoir or whether it is below the oil in the reservoir.

WATER PRODUCTION

Upper San Andres: A few wells make very small percentages of water, none make much water, and many make no water. Figures reporting total water production are not available.

Holt zone: Both producing wells make considerable water along with their oil production. Figures representing quantities are not available.

CHARACTER OF OIL

Upper San Andres:	Range	Avg.
Gravity, A.P.I. @ 60° F.	31.2°-35.8°	34°
Sulphur		0.2%

For analyses see:
Railroad Commission of Texas
Analyses of Texas
Crude Oils (1940), pp. 32 and 64

Holt zone:	Range
Gravity, A.P.I. @ 60° F.	29.5°-33.0°

ACID TREATMENT

Upper San Andres: Only a few wells have been completed without acid treatment. The quantity of acid used has ranged from 1,500 gallons to 8,000 gallons; average, about 3,000 gallons, with 5,000 gallons commonly used.

Holt zone: Both wells were acidized; one with 2,000 gallons and the other with 3,500 gallons.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Total	Yearly	Cumulative
Upper San Andres:					
1937	x	x	x	1,731	1,731
1938	x	x	9	60,254	61,985
1939	15	10	25	279,031	341,016
1940	17	20	37	248,415	589,431
1941	30	30	60	360,761	950,192
1942	16	51	67	286,866	1,237,058
1943	9	58	67	380,562	1,617,620
1944	9	63	72	849,353	2,466,973
1945	x	x	76	1,021,225	3,488,198
1946	x	x	76	863,687	4,351,885
1947	3	73	76	762,564	5,114,449
1948	x	x	77	733,683	5,848,132
1949	0	75	75	619,442	6,467,574
1950	1	72	73	568,206	7,035,780
1951	1	72	73	494,326	7,530,106
1952	1	72	73	421,786	7,951,892
Holt zone:					
1950	0	1	1	2,859	2,859
1951	0	2	2	18,110	20,969
1952	0	2	2	22,570	43,539

FLAT ROCK FIELD

Upton County, Texas

PAUL J. BEAVER
Geologist, Cities Service Oil Co., Midland, Texas
February 10, 1953

LOCATION and DEFINITION

The Flat Rock field is in southeast Upton County, with the western boundary of present development 7½ miles east of Rankin. Regionally, the field is in the south-central part of the Midland basin. Its extent has been defined to the north and to the south, but additional drilling to the east and to the west will be necessary to determine the extent in those directions.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Mapping of data pertaining to shallow beds indicated the area as favorable. This mapping was followed by extensive seismograph exploration. The field discovery well was located on the basis of seismograph data and was completed as a producer from Ellenburger at plugged back depth of 10,843 feet. The second well established production from the lower sand member of the Spraberry formation.

DISCOVERIES

Spraberry: July 21, 1951; Cities Service Oil Co. and Continental Oil Co. #1-AM University. Drilled to total depth of 11,097 feet and plugged back to 7,138 feet. During initial potential test, flowed through perforations at 7,088-7,120 feet at the rate of 103 barrels of oil per day through 22/64-inch choke.

Ellenburger and Field: January 23, 1951; Cities Service Oil Co. and Continental Oil Co. #1-AH University. Drilled to total depth of 11,281 feet and plugged back to 10,843 feet. During initial potential test, flowed through perforations at 10,811-10,841 feet at the rate of 2,044.4 barrels of oil per day through 3/4-inch choke. This well produced only 10,163 barrels of oil from the Ellenburger before being plugged back to the Spraberry in October, 1951. An encroaching water cone forced abandonment of Ellenburger.

ELEVATION OF SURFACE

At well locations: Highest, 2,752 ft.; lowest, 2,721 ft.

SURFACE FORMATION

Fredericksburg limestone.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 562 feet below its top. This penetration was in the Ellenburger discovery well. The accompanying TYPICAL SECTION is based on the log of that well.

NATURE OF TRAPS

Spraberry: Simple convex fold.
Ellenburger: Convex fold in combination with a transverse fault.

PRODUCTIVE AREAS

	Acres
Spraberry	640
Ellenburger	240
Flat Rock field	640

It is probable that further development will warrant increase of the above estimates as to each reservoir and as to the field.

THICKNESSES OF RESERVOIR ROCKS

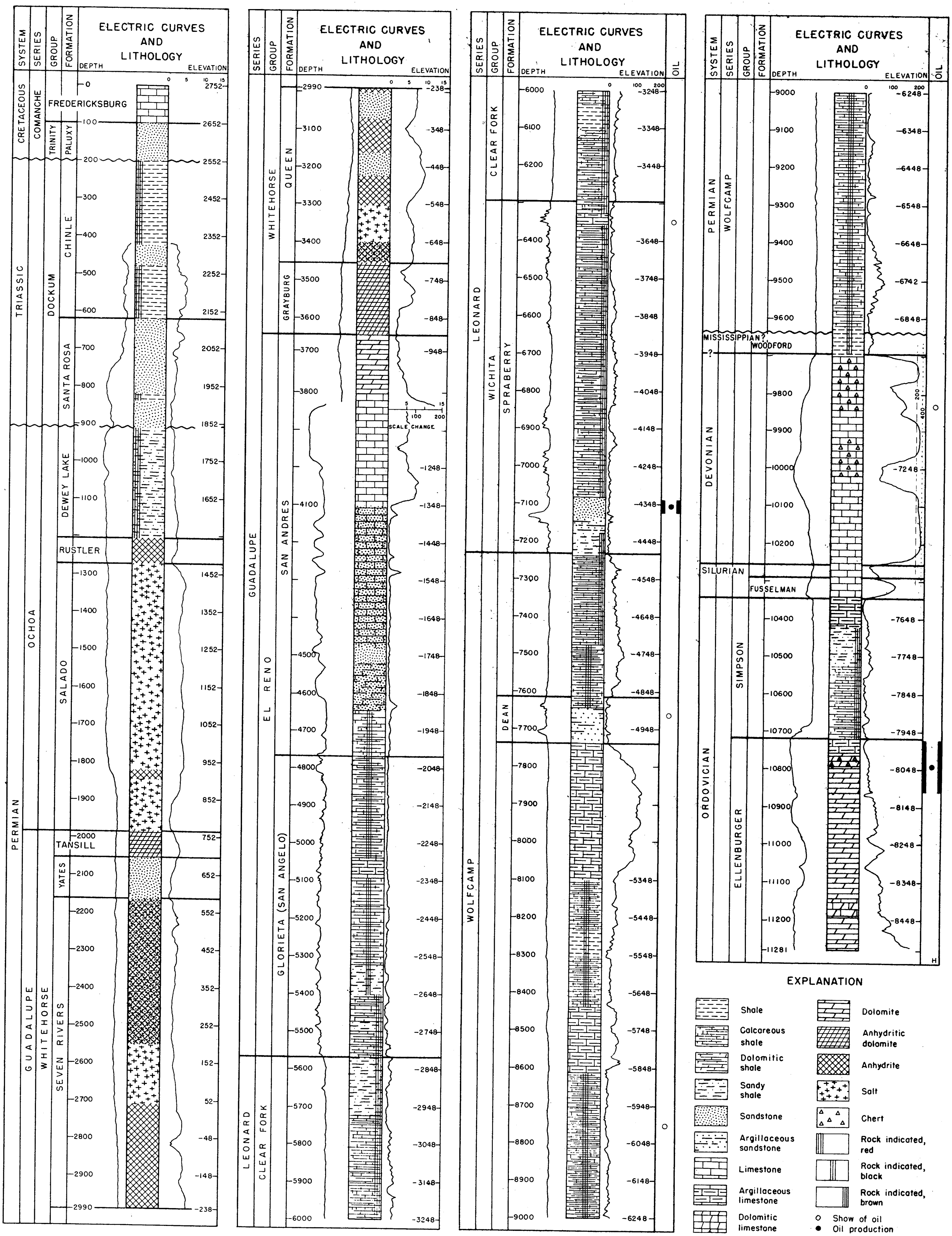
	Min.	Max.	Avg.
Spraberry			
From top to bottom, feet	25	34	28.5
Net productive, feet	12	18	14.8
Ellenburger			
From top to bottom, feet	130	135	133
Net productive:	30% to 40% of gross from top to bottom		

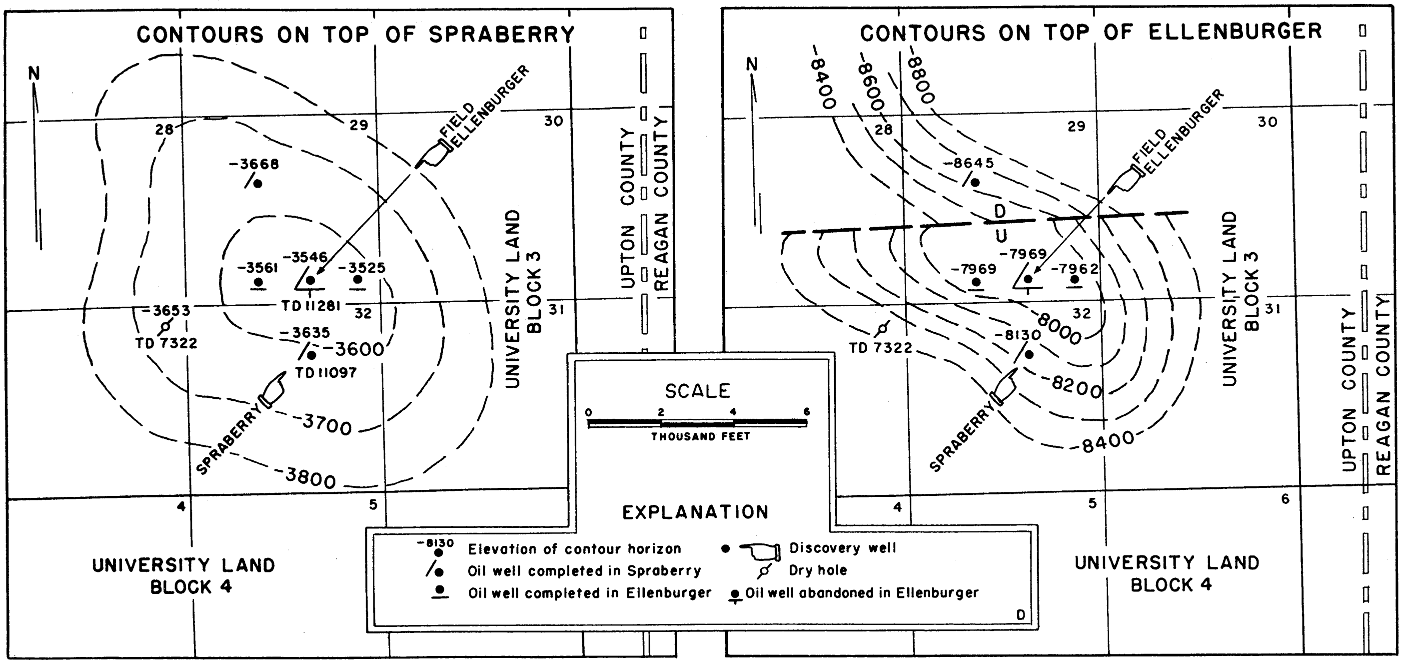
LITHOLOGY OF RESERVOIR ROCKS

Spraberry: Sand; very fine grained, gray, slightly porous, with small amounts of silty material in the pore space.

Ellenburger: Dolomite; medium to coarse crystalline, brown; contains secondary calcite crystals. The Ellenburger is highly fractured throughout and contains many vugs and cavities at the intersection of fractures and along bedding planes. The reservoir is connected from top to bottom by the fracturing, which is vertical. Very little cementation has been noted in cores.

TYPICAL SECTION OF ROCKS PENETRATED





CONTINUITY OF RESERVOIR ROCKS

Spraberry: The productive zone is continuous throughout the area of the field and is of essentially the same character at each location where penetrated within the area of the accompanying maps. It is present throughout the Midland basin and produces oil in many fields.

Ellenburger: The continuity of this reservoir rock is interrupted by an east-west fault with down-throw to the north. The Ellenburger group, of which this reservoir rock is a part, is present throughout the Permian basin and is a prolific producer of oil in many fields.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Spraberry	Ellenburger
No free gas cap		
Elevation of top of oil, feet	-4,363	-7,962
Elevation of bottom of oil, feet	-4,395	-8,097
Relief, feet	32	135

WATER PRODUCTION

Spraberry: No water produced to date.

Ellenburger: Water which could not be shut off entirely because of the vertical fracturing was found at depth of 10,489 feet (-8,097 feet) in the discovery well, which produced 10,163 barrels of oil and 27,646 barrels of water before it was abandoned as an Ellenburger well and completed as a producer from Spraberry. Of the two wells now producing from Ellenburger, one has produced no water; water constituted 84% of the gross production from the other to January 1, 1953.

CHARACTER OF OIL

	Spraberry	Ellenburger
Gravity, A.P.I. @ 60° F.	39°	61°
Sulphur	0.025%	0.05%
Color	Green	Straw
Odor	Sweet	Sweet

COMPLETION TREATMENT

Spraberry: Each well was given a hydraulic fracture treatment (3,000 to 6,000 gallons); some were flushed with kerosene.

Ellenburger: Two wells with good porosity were washed with 500 to 750 gallons of acid; the other Ellenburger producer was treated with a total of 63,300 gallons of acid.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Spraberry				
1951	3	0	20,780	20,780
1952	2	1	52,616	73,396
Ellenburger				
1951	1	0	10,163	10,163
1952	2	0	67,999	78,162

FRIEND FIELD

Reagan County, Texas

E. E. LINDEBLAD
Geologist, Continental Oil Co., Midland, Texas
February 25, 1953

LOCATION and OTHER NAMES

The Friend field is about 6 miles southeast of Big Lake, county seat of Reagan County. It is 3 miles southwest of the Barnhart field and 8 miles northeast of the World field. One of the two wells in the field is in Sec. 1, Georgetown R.R. survey and the other is Sec. 8, Block 49, University Land survey. Although the two wells are about 3 miles apart, they have been considered as in the same field and were so reported on page 970, A.A.P.G. Bull., vol. 32 (June 1948). They have also been treated as in separate fields, the Friend field and the Block 49 field.

For proration purposes, the discovery well mentioned below was treated for awhile as in the World field, as was Moore Exploration Co. #1 M. S. Neal, located about 1½ miles southwest in Sec. 2, D. L. Carver survey, Crockett County, which was also a noncommercial well and which occasioned the use of the designation Moore-Neal as a field name. The Moore-Neal well is also listed on the same page in the above mentioned publication as being in the Friend field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Core drilling and subsurface geology led to the acquisition of leases and to the test drilling which resulted in discovery.

DISCOVERY

Grayburg: January 14, 1947; Moore Exploration Co. #1 W. E. Friend. Pumped 10 barrels per day of 26° oil with no water. Drilled to total depth of 2,582 feet and plugged back to 2,538 feet. The top of the productive zone is at depth of 2,390 feet, 80 feet below the top of the Grayburg formation. The well was plugged and abandoned on August 21, 1949 without having produced enough oil to return its cost.

ELEVATION OF SURFACE

At well locations: Highest, 2,728 ft.; lowest, 2,669 ft.

SURFACE FORMATION

Undifferentiated rocks of the Comanche series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Ellenburger group 150 feet below its top. This penetration was in Continental Oil Company #1 University 3, a dry hole located near the north edge of the area covered by the accompanying map and where the total depth of 9,775 feet is indicated. The accompanying TYPICAL SECTION is based on the log of this dry hole.

NATURE OF TRAP

Grayburg: The trapping of oil appears to be due to variation in degree of porosity and permeability of rock dipping generally westward. It is not known whether there was one accumulation tapped by the two wells or whether there were two separate and distinct accumulations.

PRODUCTIVE AREA

Grayburg and Field: Any estimate of the area which has contributed to the production of the two wells is necessarily quite arbitrary. It seems unlikely that it was in excess of 160 acres.

THICKNESS OF RESERVOIR ROCK

Grayburg:	Feet
From top to bottom	110
Net productive	40

LITHOLOGY OF RESERVOIR ROCK

Grayburg: Dolomite; gray, fine to medium grained, crystalline, occasionally sandy with some minor amounts of chert.

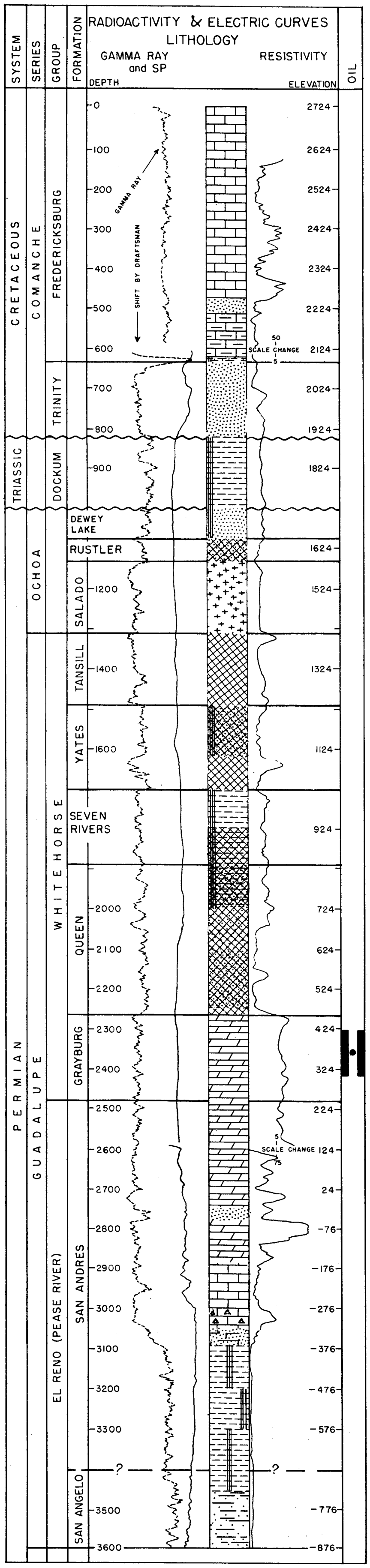
CONTINUITY OF RESERVOIR ROCK

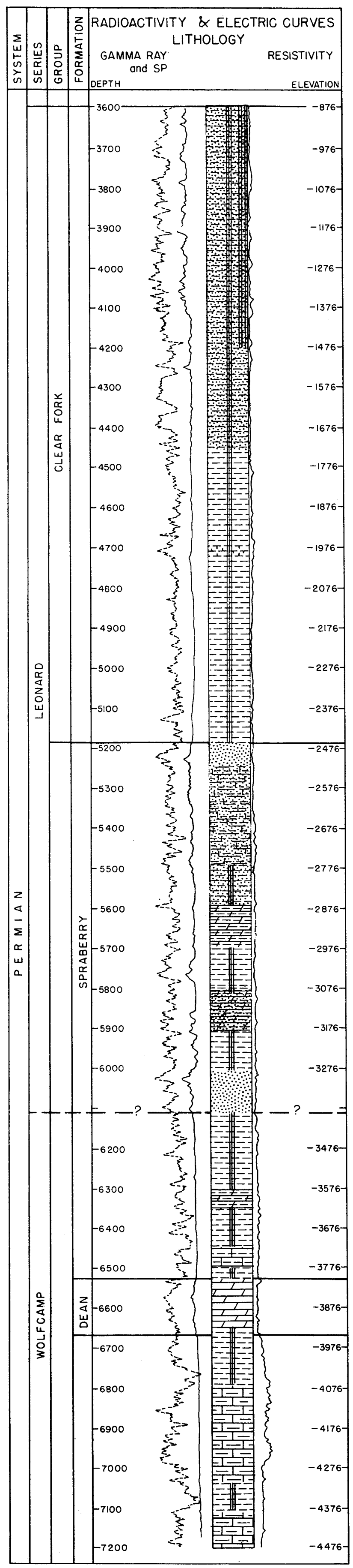
Grayburg: The reservoir rock is continuous throughout the area of the field. The degrees of porosity and permeability are variable.

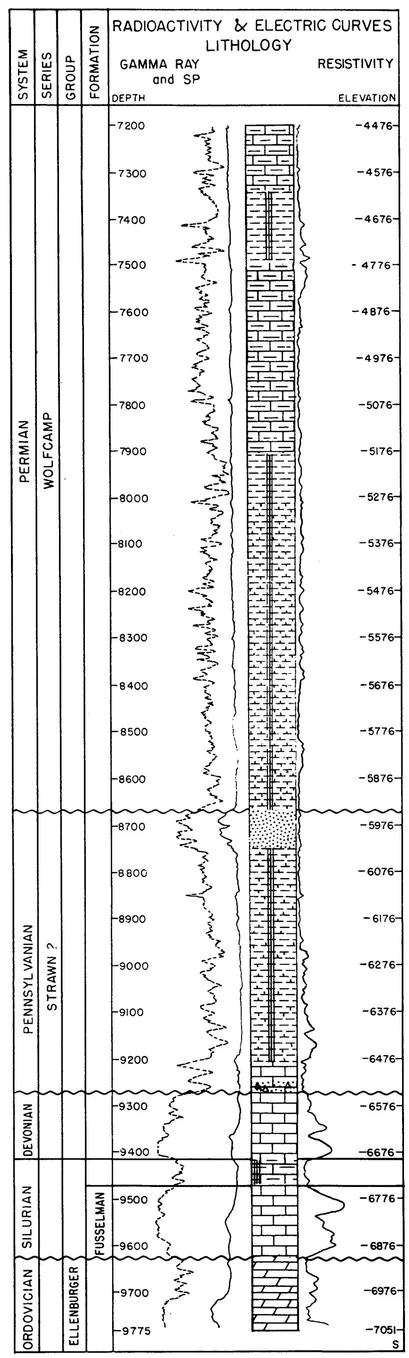
ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Grayburg:	Feet
Highest known elevation of oil	291
Lowest known elevation of oil	181
Apparent relief	110

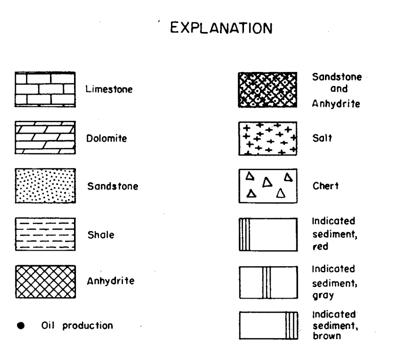
TYPICAL SECTION OF ROCKS PENETRATED

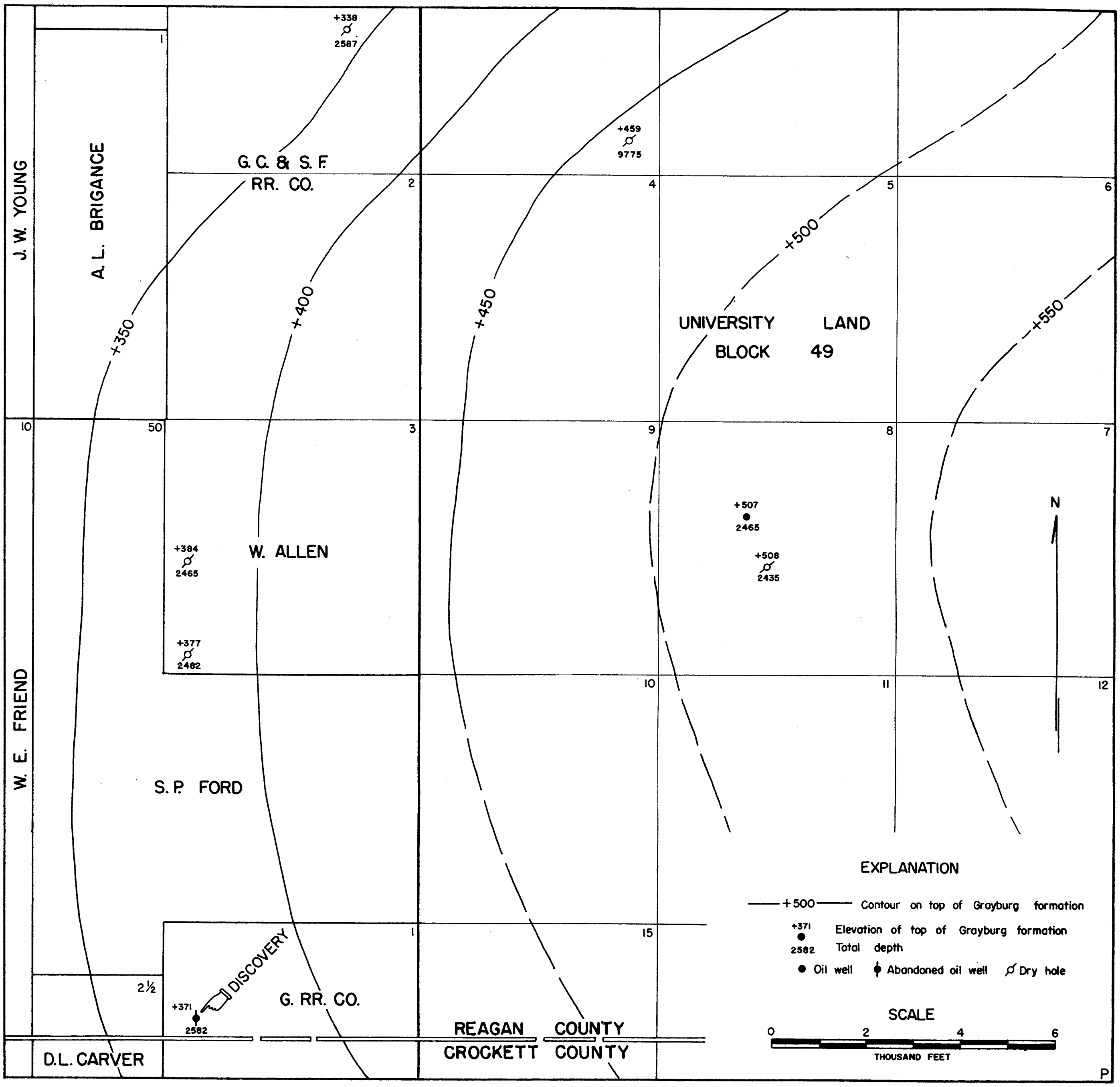






NOTE: This TYPICAL SECTION is based on the log of the deepest test in the vicinity of the field. The stratigraphic position of the productive rock is indicated although no oil or gas was found at the location of this test.





CHARACTER OF OIL

Grayburg:	Range	Avg.
Gravity, A.P.I. @ 60° F.	26° to 32°	29°

WATER PRODUCTION

Grayburg: Little or no water has ever been produced by either of the two wells.

ACID TREATMENT

Grayburg: The productive zone in the discovery well was treated with 3,000 gallons of acid at the time the well was completed as a producer.

PRODUCTION HISTORY

The discovery well was completed on January 14, 1947, and was abandoned on August 21, 1949. The writer finds definite record that it produced 207 barrels during 1949, but finds no record of prior production and has been unable to determine whether any oil was produced from this well prior to 1949.

The only other well which has produced oil in this field was completed as Continental Oil Co. #1-S University B-8, located in Sec. 8, Block 49, University Land survey. The operating control was transferred to Texas Crude Co. and the well designation was changed accordingly. Although the well produced only 90 barrels of oil during 1952 it has not been abandoned. This well produced 217 barrels during 1947, 514 barrels during 1948, 411 barrels during 1949, 368 barrels during 1950, 331 barrels during 1951 and 90 barrels during 1952; a total of 1,931 barrels to the end of 1952. The production was all obtained by pumping.

FUHRMAN-MASCHO FIELD

Andrews County, Texas

W. DAVE HENDERSON, Consulting Geologist, Midland, Texas
and
JOHN M. HILLS, Consulting Geologist, Midland, Texas

January 1, 1956

LOCATION

The Fuhrman – Mascho field is in south central Andrews County 12 miles southwest of Andrews, the county seat of Andrews County, and 30 miles northwest of Odessa, the county seat of Ector County. It is in the eastern portion of the Central Basin platform and forms part of a line of fields a few miles west of the Eastern edge of the platform.

HISTORY and FIELD NAMES

The Fuhrman – Mascho field includes what was formerly designated as the Fuhrman field, the West Fuhrman field and the Mascho field. The first discovery well in the area now designated as the Fuhrman – Mascho field was completed on November 20, 1930. The field which it discovered became known as the Fuhrman field. About 4 miles westward from this discovery well, an exploratory well was completed on February 1, 1941, and was recognized as the discovery well of a field designated as the West Fuhrman field. On May 30, 1942, a successful test about 5 miles southward from the West Fuhrman discovery well was recognized as discovering the Mascho field. Development extended the West Fuhrman field and the Mascho field until they grew together. The use of the name West Fuhrman was discontinued generally when, in May 1943, for regulation purposes, the Railroad Commission consolidated West Fuhrman and Mascho under the name Mascho. Further extensions demonstrated that Mascho and Fuhrman were parts of one and the same field which became known as the Fuhrman – Mascho field. The Railroad Commission consolidated its rules and regulations effective in September 1944, and since then the hyphenated name has been used generally by reporting agencies.

ELEVATION OF SURFACE

The surface slopes from an average elevation of 3,250 feet above sea level at the northwestern side of the field to 3,200 feet at the southeastern side. The general slope is modified by sand dunes which are rarely more than 15 feet high.

NEAR-BY NONCOMMERCIAL PROSPECT

A well which proved to be noncommercial was recognized as the discovery well of a field first designated as the Hunt field, then as the Fuhrman – Mascho Ellenburger field. Placid Oil Co. and Gulf Oil Corp. #1 M. A. Thornberry, located in Sec. 5, Block A-42, near the northwest corner of the area covered by the accompanying map, was completed on July 8, 1946 as a pumping well producing at the daily rate of 33 barrels of 40.2° gravity oil and 729 barrels of water from Ellenburger dolomite at 11,952 to 11,959 feet, the total depth. The top of the Ellenburger is at the depth of 11,941 feet. This was the deepest producing well in the Permian basin up to that time. It produced a total of 3,859 barrels of oil before abandonment; 2,939 barrels during 1946 and 920 barrels during 1947.

SURFACE FORMATIONS

The surface of the western portion of the field is almost entirely covered with gray sand dunes which support a sparse growth of shin oak and occasional patches of mesquite. This gray to yellow surface-sand is from 3 to 15 feet thick depending on the height of the dune. It appears to correlate with the Monahans sand of Huffington and Albritton.* Underlying this gray loose sand and outcropping in the eastern part of the field is a reddish brown indurated sand probably correlative with the Judkins sand of Huffington and Albritton. This formation is generally from 8 to 35 feet thick; in some small areas, it is missing entirely. Underlying the Judkins sand and exposed in limited areas is the sandy caliche of late Tertiary age. The caliche has been quarried for road metal of poor grade in several places in the field. The older formations do not crop out, but are shown in the accompanying TYPICAL SECTION.

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* Huffington, Roy M., and Albritton, Claude C., Jr., (1941) Quaternary Sands on the Southern High Plains of Western Texas: Amer. Jour. Sci., vol. 239, May 1941, pp. 325-328.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 236 feet below its top. This penetration was in Shell Oil Co. and Cities Service Oil Co. #8 E. F. King, located in Sec. 10, Block A-42, at its total depth of 12,668 feet. The accompanying TYPICAL SECTION is based on the log of this well. (P. S.: This well was completed as the Devonian discovery well on 1/10/56.) The Ellenburger had been tested previously in Fuhrman Petroleum Co. #1-E (now #23) W. T. Ford, located in Sec. 16, Block A-43, where the total depth of 12,380 feet is indicated on the accompanying map. This well was drilled 42 feet into Ellenburger, was plugged back to the depth 4,485 feet and was completed in the Grayburg – San Andres reservoir in April, 1953.

PRODUCTIVE AREAS

	Acres
Grayburg – San Andres	14,000
Glorieta	2,300
Fuhrman – Mascho field	14,600

The above figures represent estimates of the areas proven productive by wells completed to date. There are 10 wells currently drilling; 8 are expected to be completed in Grayburg – San Andres and 2 in Glorieta.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Fuhrman sector	Mascho sector
Grayburg – San Andres:		
Elev. of top of gas, feet	-760	-850
Elev. of bottom of gas, feet	-1,030	-1,070
Relief, feet	270	220
Elev. of top of oil, feet	-1,030	-1,070
Elev. of bottom of oil, feet	-1,300	-1,365
Relief, feet	270	295

The above figures represent conditions as of the respective discovery dates. The small original gas cap in the Mascho sector has been largely dissipated. Within the area of the more extensive gas cap (Fuhrman sector) considerable quantities of gas still remain in the reservoir. Due to low vertical permeability of the reservoir rock, there has been little, if any, upward migration of the gas-oil contact.

Glorieta:

Individual beds within the reservoir rock are quite variable. Water occurs locally in some beds at elevations higher than oil in other beds. At some locations, water has been found between oil producing beds. There is no known gas cap. The highest known oil is at the elevation of -2,291 feet and the lowest known oil is at the elevation of -2,694 feet.

DISCOVERIES

Grayburg – San Andres:

Fuhrman: November 20, 1930; Fuhrman Petroleum Corp. #1 W. T. Ford.

West Fuhrman: February 1, 1941; Fuhrman Petroleum Corp. #A-1 Lockhart & Brown.

Mascho: May 30, 1942; Mascho Oil Co. #1 Sun-University.

Glorieta:

Fuhrman: May 13, 1950; Fuhrman Petroleum Corp. #17 W. T. Ford.

Fuhrman, Northwest: July 15, 1954; Signal Oil & Gas Co. #1 E. F. King.

LITHOLOGY OF RESERVOIR ROCKS

Grayburg – San Andres: That portion of this reservoir which is in the Grayburg formation consists mostly of granular, fine-grained, oolitic to crystalline, gray and buff dolomite containing generally some thin, ill-defined streaks of fine-grained sand. That portion in the San Andres formation consists of medium-grained, crystalline, white and gray-to-brown dolomite with fine intergranular porosity. An analysis of a core from one of the better wells shows an average permeability of 14.7 millidarcys, porosity of 13% and connate water content of 23.1% of the pore space.

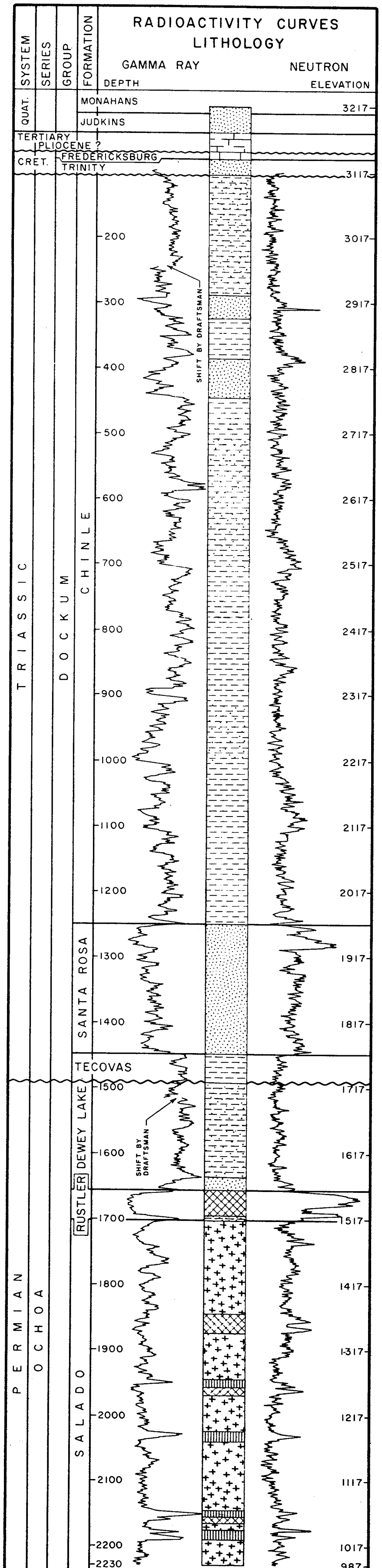
Glorieta: Data are not readily available.

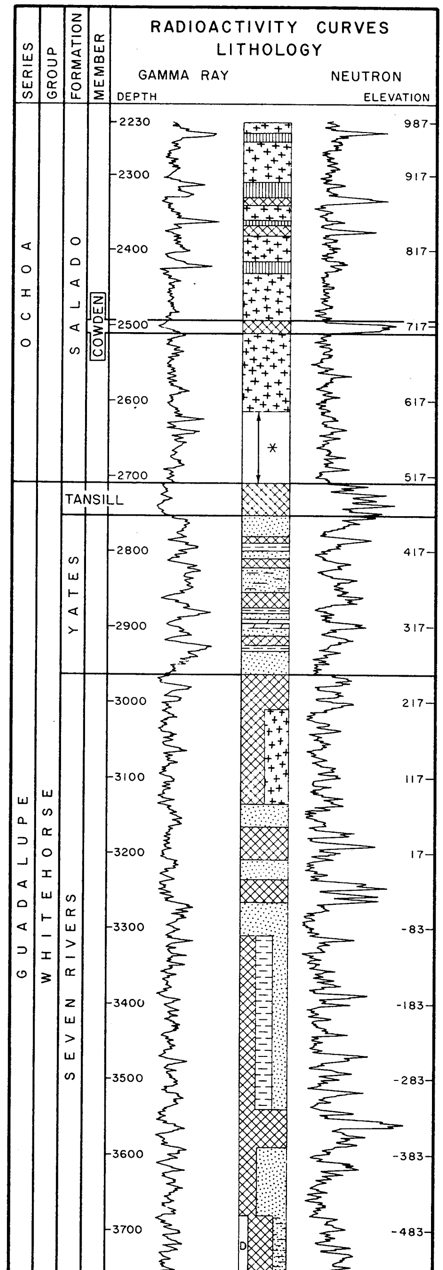
COMPLETION METHODS

Grayburg – San Andres: In the early stages of development, most wells were completed in open hole. During the last two or three years, many operators have drilled to the total depth, cemented casing on bottom, perforated the casing, then acidized and hydraulically fractured through casing perforations. Hydraulic fracturing has been sufficiently beneficial that it has led to the drilling of many new wells. The drilling of new wells, combined with increases due to hydraulic fracturing in old wells, resulted in increasing 1955 production nearly a million barrels over what was expected before the new technique was used.

Glorieta: All wells producing from this reservoir have been completed by hydraulic fracturing through casing perforations.

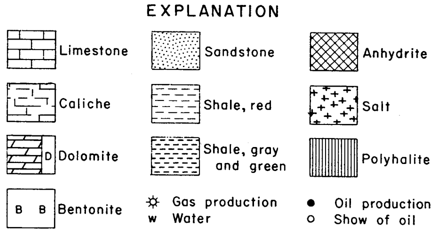
TYPICAL SECTION OF ROCKS PENETRATED





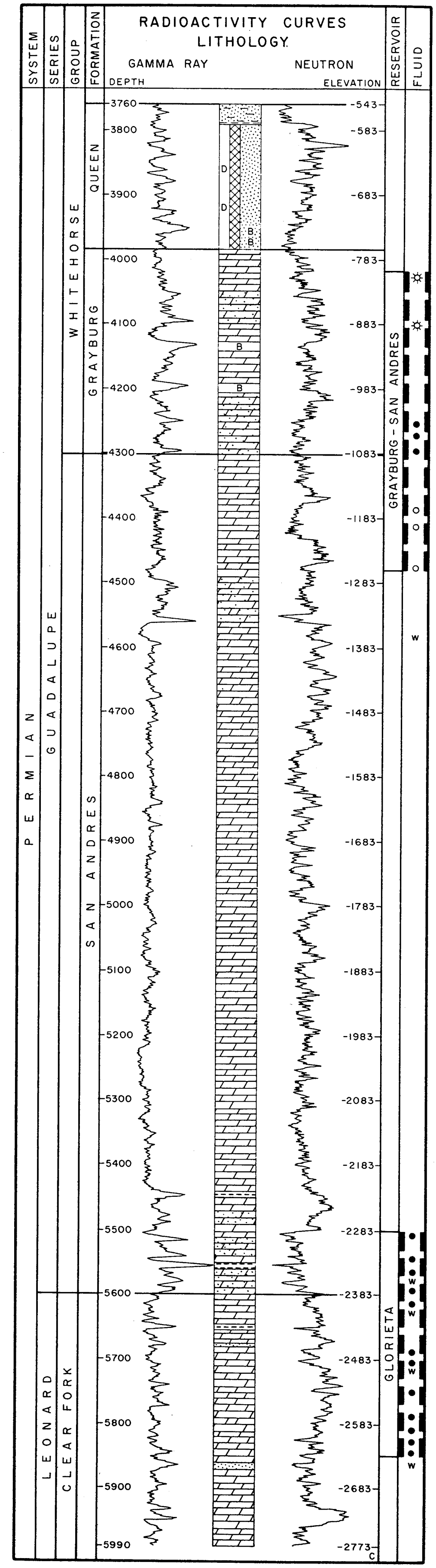
* From 2615 to 2710 feet: anhydrite, 5; polyhalite, 5; salt, 10; polyhalite, 8; anhydrite, 8; sandstone, 7; red shale, 2; salt, 12; anhydrite, 4; sandstone, 12; anhydrite, 6; and salt, 16.

EXPLANATION

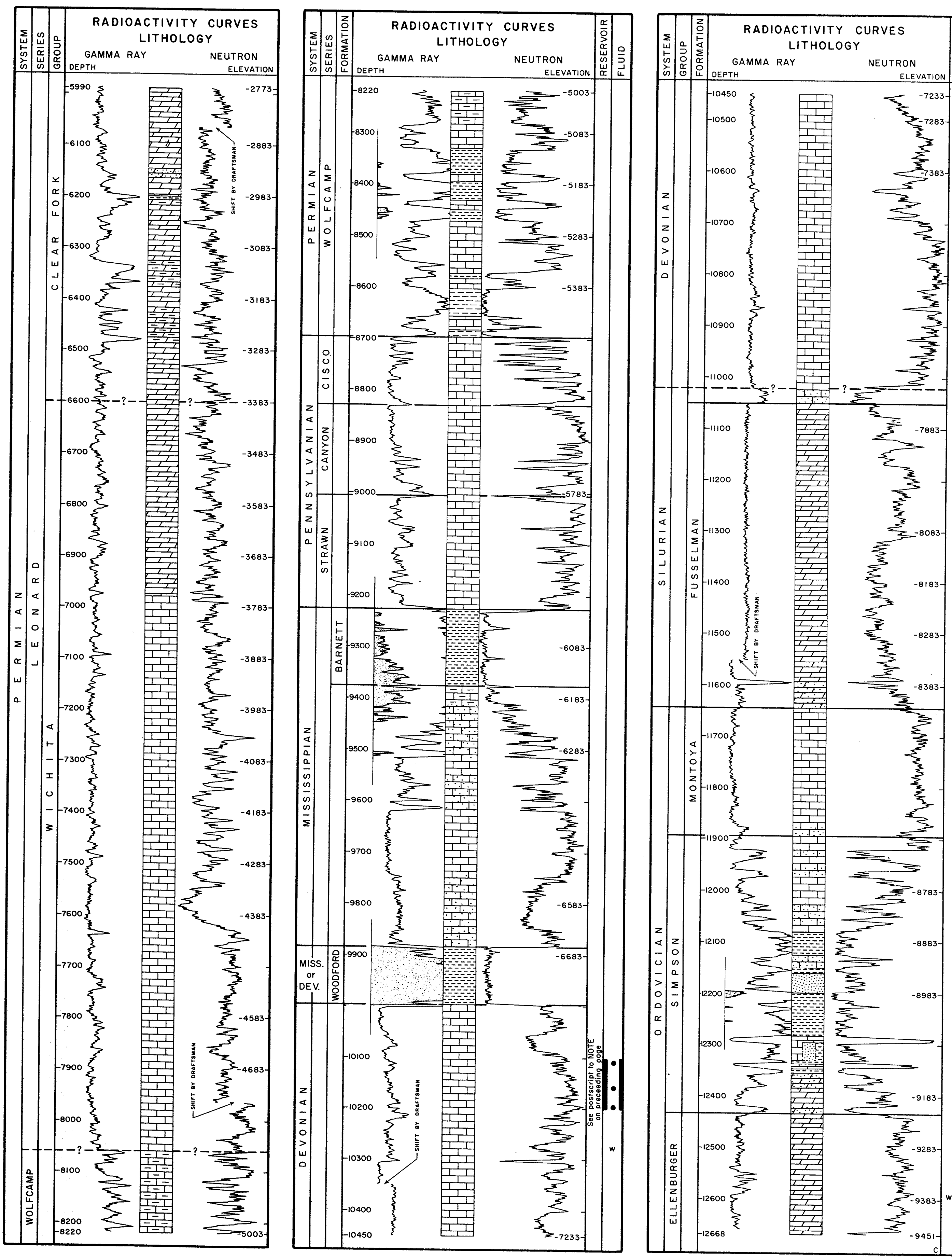


NOTE: This TYPICAL SECTION is based on the log of Shell Oil Co. and Cities Service Oil Co. #8 E. F. King, located in Sec. 10, Block A-42 where its total depth of 12,668 feet is indicated on the accompanying map. The well was drilled to its total depth in December 1955, after having found a good showing of oil in the Devonian.

P. S.: This well was nonproductive in Ellenburger and was plugged back and completed in Devonian on January 10, 1956. Its production to end of 1956 amounted to 47,545 barrels.



TYPICAL SECTION OF ROCKS PENETRATED



WATER PRODUCTION

Grayburg – San Andres: Some water has been produced from the deeper wells, especially in the south, southeast and northeast portions of the field. However, the quantity of water has never been a serious handicap to production from this reservoir. The water has a chloride content of about 35,000 parts per million and it is strongly sulphurous.

Glorieta: Large amounts of water are produced from this reservoir. Water-drive appears to be an important factor of reservoir energy.

NATURE OF TRAPS

Grayburg – San Andres: The accumulation of oil was chiefly influenced by a broad structural uplift along the east side of the Central Basin platform. This uplift has two distinct anticlinal axes, one on the northeast in the original Fuhrman area (now known as the Fuhrman sector) and the other in the southern part of the old West Fuhrman area (now known as the Mascho sector). Variation in degree of porosity probably is also an effective factor in trap-forming; it definitely is an important factor in determining productivity.

Glorieta: The factors which occasioned the accumulation of oil in this reservoir appear to be essentially the same as those which occasioned accumulation in the Grayburg – San Andres reservoir. The Glorieta reservoir is structurally similar to the eastern portion of the Grayburg – San Andres reservoir. As yet, Glorieta production has been developed only in the western portion of the north part of the field. This reservoir consists of lenses of porous dolomite in a sandy and shaly section at the base of the San Andres formation and at the top of the Clear Fork group.

CHARACTER OF GAS

Grayburg – San Andres: Following is an analysis of a typical sample of gas from this reservoir:

Component	%
Methane	73.68
Ethane	17.55
Propane	6.53
Iso-butane	.65
N-butane	1.15
Iso-pentane	.07
N-pentane	.28
Heavier	.09
	100.00

CHARACTER OF OIL

	Gravity A. P. I. @ 60°F	Sulphur
Grayburg – San Andres	28-32°	4.2%
Glorieta	29°	Sour

For analyses of Grayburg – San Andres samples see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 32 and 64

U. S. Bureau of Mines — Laboratory Reference No. 38145
Tabulated Analyses of Texas Crude Oil. T. P. 607 (1939), Group 2 — Item 44
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944) — Page 12
Analyses of Crude Oils from 283 Important Oil Fields of the United States. R. I. 4289 (1948) — Item 205

PRODUCTION HISTORY

	WELLS PRODUCING at end of year: OIL Flow	OIL Pump	GAS	OIL PRODUCTION (barrels) Yearly	Cumulative	GAS PRODUCTION (Mcf) Yearly
Field totals:						
1930-1949	Same as Grayburg – San Andres					
1950	31	251	1	1,375,935	13,417,195	19,433
1951	30	263	2	1,559,607	14,976,802	164,442
1952	27	266	3	1,444,472	16,421,274	150,373
1953	28	283	3	1,483,860	17,905,134	175,899
1954	52	299	3	1,656,921	19,562,055	132,309
1955	74	330	3	2,670,892	22,232,947	180,349
Grayburg – San Andres:						
1930-1938	*				941,902	?
1939	48	6	1	540,387	1,482,289	59,400
1940	47	7	1	504,215	1,986,504	62,400
1941	39	16	1	462,744	2,449,248	66,045
1942	47	29	2	300,366	2,749,614	30,960
1943	77	44	2	443,438	3,193,052	55,229
1944	65	112	1	1,320,043	4,513,095	25,805
1945	66	128	1	1,676,467	6,189,562	37,340
1946	54	143	2	1,497,435	7,686,997	59,588
1947	34	184	1	1,342,612	9,029,609	29,330
1948	33	237	1	1,626,553	10,656,162	28,002
1949	40	243	1	1,385,098	12,041,260	29,928
1950	30	249	1	1,342,305	13,383,565	19,433
1951	30	259	2	1,493,884	14,877,449	164,442
1952	27	260	3	1,386,919	16,264,368	150,373
1953	28	270	3	1,362,382	17,626,750	175,899
1954	52	267	3	1,340,452	18,967,202	132,309
1955	74	288	3	2,215,352	21,182,554	180,349
Glorieta:						
1950	1	2	0	33,630	33,630	0
1951	0	4	0	65,723	99,353	0
1952	0	6	0	57,553	156,906	0
1953	0	13	0	121,478	278,384	0
1954	0	32	0	316,469	594,853	0
1955	0	42	0	455,540	1,050,393	0

* Published records for the years prior to 1939 are confusing because Fuhrman was not consistently recognized as a separate and distinct field. Its production was commonly reported with that of other fields, particularly, Deep Rock and Parker. Although we do not have the figures for each year separately, we believe that the above entry representing cumulative production to the end of 1938 is accurate. It was transcribed from page 337 of TEXAS OIL AND GAS SINCE 1543 by C. A. Warner (1939).

(see FUHRMAN – MASCHO map)

GIB FIELD

Crane County, Texas

ROY HARRIS
District Geologist, Lion Oil Company, Midland, Texas
May 18, 1953

LOCATION

The Gib field is in east central Crane County 3 miles southwest of the town of Crane, county seat. It is 4 miles west of the McElroy field and 4½ miles north of the Crane Cowden field. It is in sections 13, 14 and 24 of Block X, C.C.S.D. & R.G.N.G. R.R. Co. survey.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The field was discovered by the use of seismograph and subsurface geologic studies.

DISCOVERY

Grayburg: January 31, 1948; Lion Oil Co. #1 G. H. (Gib) Cowden. This well was drilled as an unsuccessful Devonian test to a total depth of 8,575 feet and was then plugged back to 2,810 feet. Completion was in a sand and dolomite section of the Grayburg formation through casing perforations from 2,735 to 2,775 feet. During potential test, after treatment with 2,000 gallons of acid, the well pumped at the rate of 19.68 barrels of oil per day.

ELEVATION OF SURFACE

At well locations (derrick floor): Highest, 2,552 feet; lowest, 2,534 feet.

SURFACE FORMATIONS

Quaternary caliche and wind-blown sand.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Devonian system 835 feet below its top. This penetration was in the discovery well. A dry hole three-quarters of a mile south of the field, Humble Oil & Refining Co. #1-B G.H. Cowden, had penetrated about 265 feet of Ellenburger at its total depth of 10,192 feet.

NATURE OF TRAP

Grayburg: Updip decrease of porosity and permeability on an anticlinal nose.

PRODUCTIVE AREA

Grayburg and Field: 120 acres.

THICKNESS OF RESERVOIR ROCK

Grayburg	Min.	Max.	Avg.
From top to bottom, feet			50
Net productive	0	20	11

LITHOLOGY OF RESERVOIR ROCK

Grayburg: The reservoir rock is a fine-grained to medium-fine-grained, loosely cemented, slightly calcareous sandstone and a finely-crystalline, anhydritic, white to gray dolomite containing some vertical fractures.

CONTINUITY OF RESERVOIR ROCK

Grayburg: This porous unit of sandstone and dolomite cannot be correlated beyond the limits of the field. Probably it is of only local extent.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Grayburg:	Feet
No free gas cap	
Elevation of top of oil	-204
Elevation of bottom of oil	-260
Relief	60

CHARACTER OF OIL

Grayburg: Gravity, A.P.I. @ 60° F., avg. 29.6°

WATER PRODUCTION

Grayburg: No water is produced.

COMPLETION TREATMENT

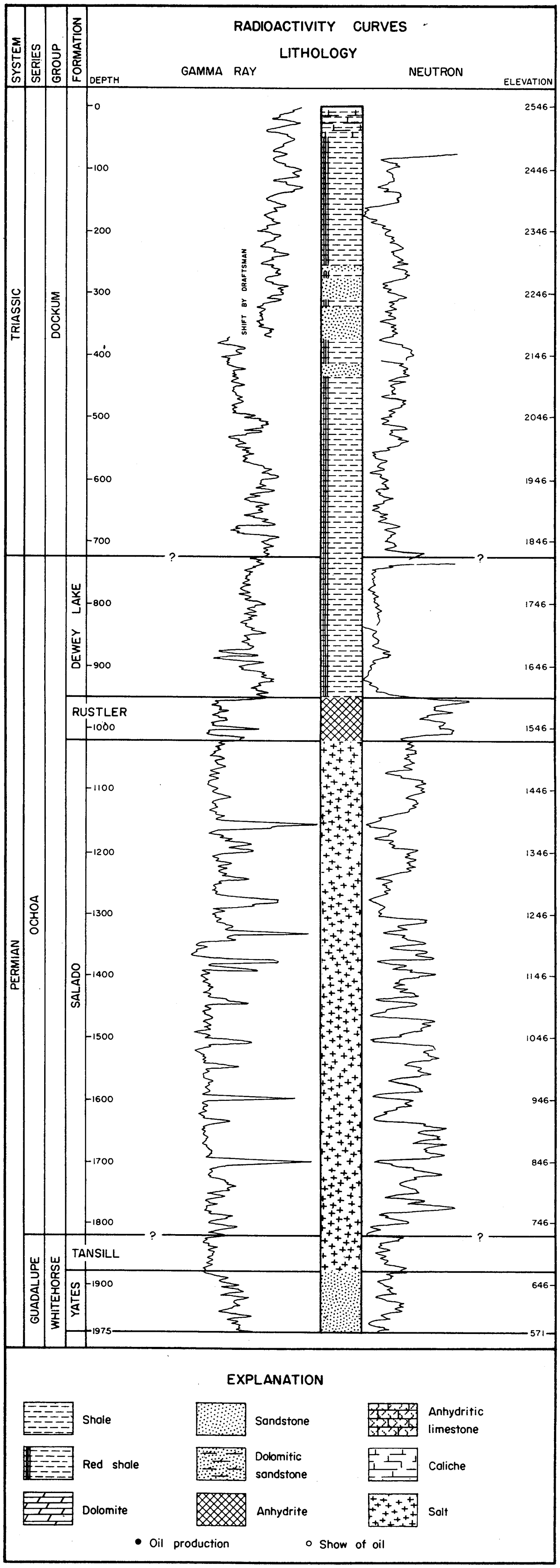
Grayburg: The reservoir rock was shot with nitroglycerin at the time of completion of each well. Two of the wells were also acidized.

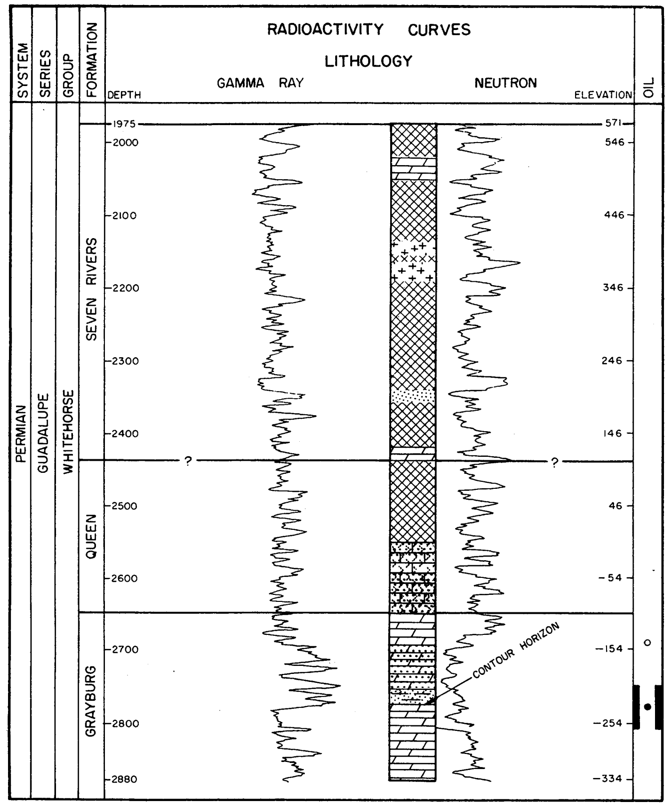
PRODUCTION HISTORY

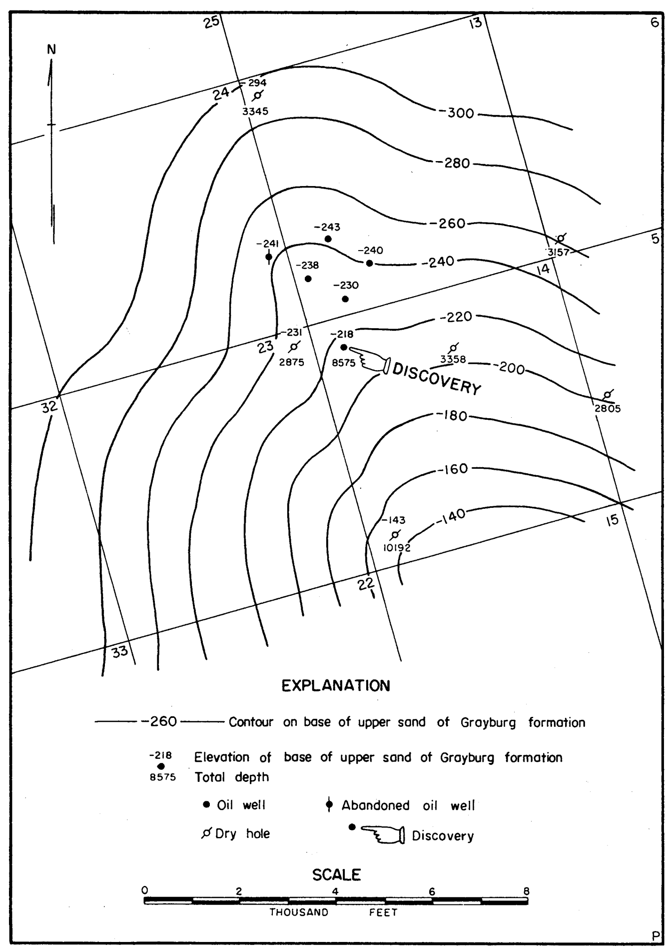
	WELLS PRODUCING at end of year	OIL PRODUCTION (barrels)	
Year	All pumping	Yearly	Cumulative
1947	1	423	423
1948	6	18,872	19,295
1949	5	18,719	38,014
1950	5	12,691	50,705
1951	5	9,110	59,815
1952	5	6,952	66,767
1953*	?	6,038	72,805

*1953 data added by amendment.

TYPICAL SECTION OF ROCKS PENETRATED







GOOD FIELD

Borden County, Texas

CARL S. SCHREINER, Jr.
Geologist, Seaboard Oil Co. of Delaware, Midland, Texas
April 24, 1953

LOCATION

The Good field is in southwestern Borden County about 14 miles southwest of Gail, county seat. It is in blocks 32 and 33, T. 4 N., Texas & Pacific Railroad Co. survey and is in the northeastern part of the T. J. Good ranch.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Regional subsurface studies, core drilling and reflection seismograph.

DISCOVERY

Pennsylvanian reef: April 14, 1949; Seaboard Oil Co. and Pan American Production Co. #1 T. J. Good. The top of the reservoir was found at depth of 7,905 feet and the well was drilled to the total depth of 8,010 feet. Flowed at rate of 488 barrels of oil per day through 1/4-inch choke during initial potential test.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is 60 feet below the top of the Ellenburger group. This penetration was in the dry hole just east of the field at the location where the total depth of 10,200 feet is indicated on the accompanying map. There was no show of oil or gas anywhere in this dry hole.

NATURE OF TRAP

Pennsylvanian reef: The trap is due to a reef limestone build-up overlain by a thick section of compacted black shale. The relief on the top of the limestone is in excess of 500 feet. There is no evidence of structural deformation of the beds below the reef limestone.

PRODUCTIVE AREA

Pennsylvanian reef and Field: 1,940 acres.

THICKNESS OF RESERVOIR ROCK

Pennsylvanian reef: The reservoir rock is in the form of a plano-convex lens. At the location of the highest well, the top of the productive limestone is 489 feet above water level. From the maximum thickness of about 490 feet in the center of the field, the reservoir rock thins in all directions to zero within short distances.

LITHOLOGY OF RESERVOIR ROCK

Pennsylvanian reef: Reef limestone; white to gray, medium crystalline to chalky and containing a few distinguishable fossils. Porosity and permeability are very irregular; there is some indication of fracturing, but generally the porosity is vuggy to pin-point. Productivity is not consistently related to position on reef; some high wells are poor producers and there are a few dry holes which entered the reef limestone far above water level. There are a few local thin black shale beds within the reef limestone.

CONTINUITY OF RESERVOIR ROCK

Pennsylvanian reef: The reservoir rock is continuous throughout the area of the field and only for a very short distance beyond the periphery of the field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Pennsylvanian reef:	Feet
No free gas cap	
Highest known elevation of oil	-5,216
Elevation of oil-water contact	-5,705
Known relief	489

CHARACTER OF OIL

Pennsylvanian reef:	
Gravity, A.P.I. @ 60° F.	43.5°
Sulphur	0.21%
Viscosity, Saybolt universal @ 100° F.	36 sec.
Color	Brownish green

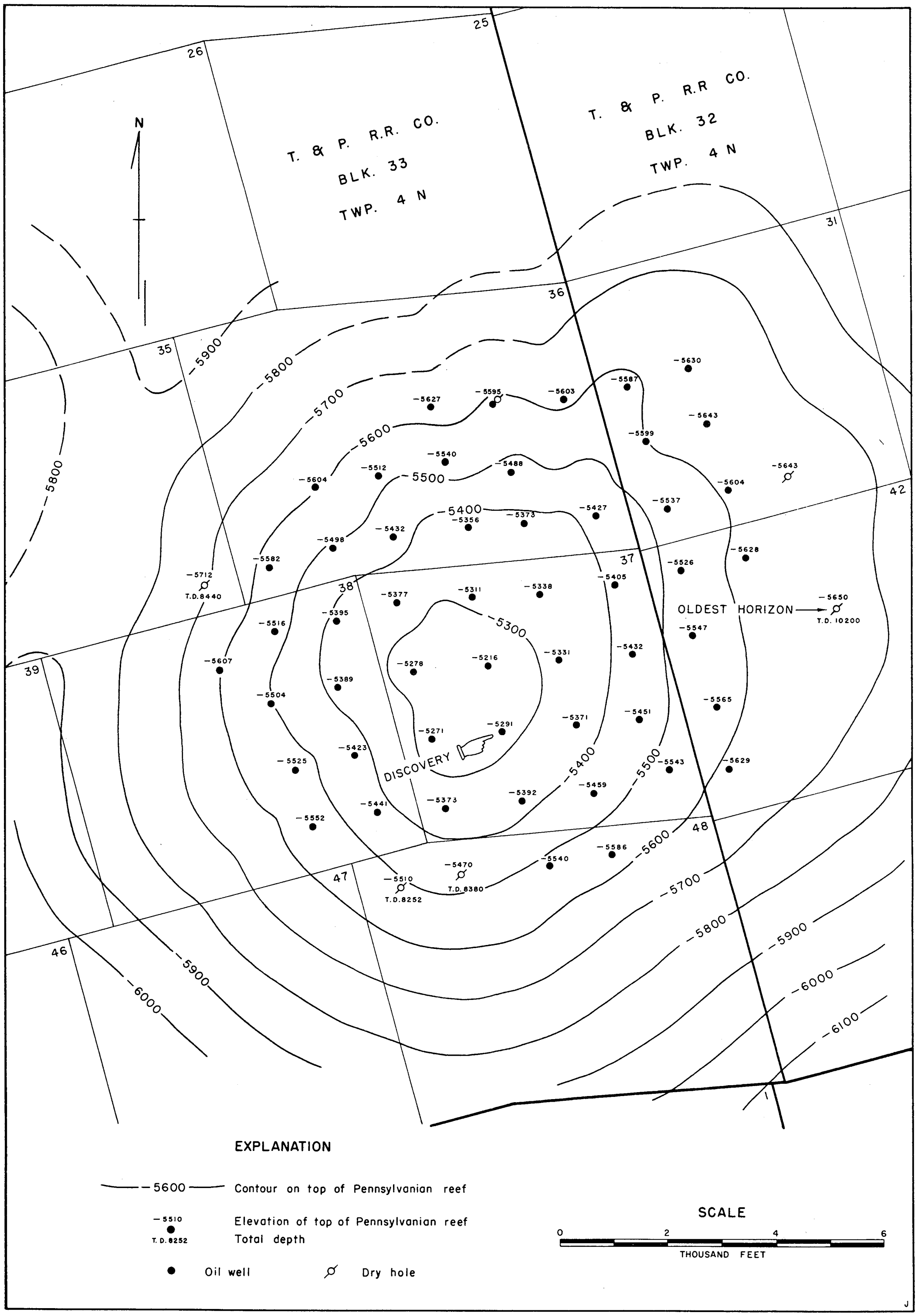
For analysis see:
U. S. Bureau of Mines Lab. ref. No. 50030
Analyses of Crude Oils From Some West Texas Fields.
R. I. 4959 (1953) Item 55

ACID TREATMENT

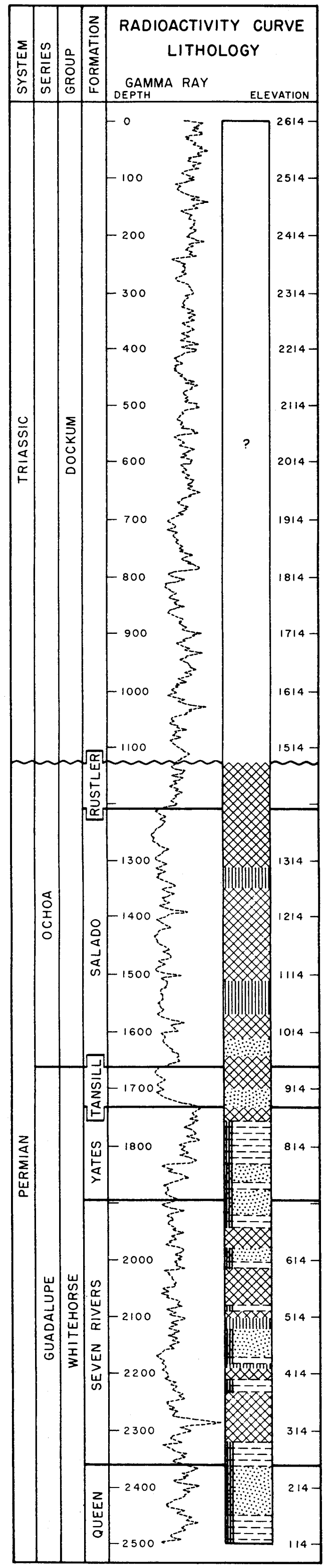
Pennsylvanian reef: The usual completion practice is to set the oil string on top of the reef limestone, and the well generally flows without acid treatment after a couple of runs with a swabbing unit.

SELECTED REFERENCE

Rodan, William B. (1950) Good field, Borden County, Texas: Abilene Geological Society, Geological Contributions - 1950, pp. 15-19 and 4 maps and 2 cross sections.



TYPICAL SECTION OF ROCKS PENETRATED



PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative	GAS PRODUCTION (Mcf): Yearly	Cumulative	WATER PRODUCTION (barrels): Yearly	Cumulative
1949	9	0	203,450	203,450	155,549	155,549	0	0
1950	36	0	1,402,577	1,606,027	1,049,035	1,204,584	2,318	2,318
1951	46	2	2,182,950	3,788,977	1,747,058	2,951,642	103,741	106,059
1952	42	7	1,509,841	5,298,818	1,212,212	4,163,854	261,408	367,467

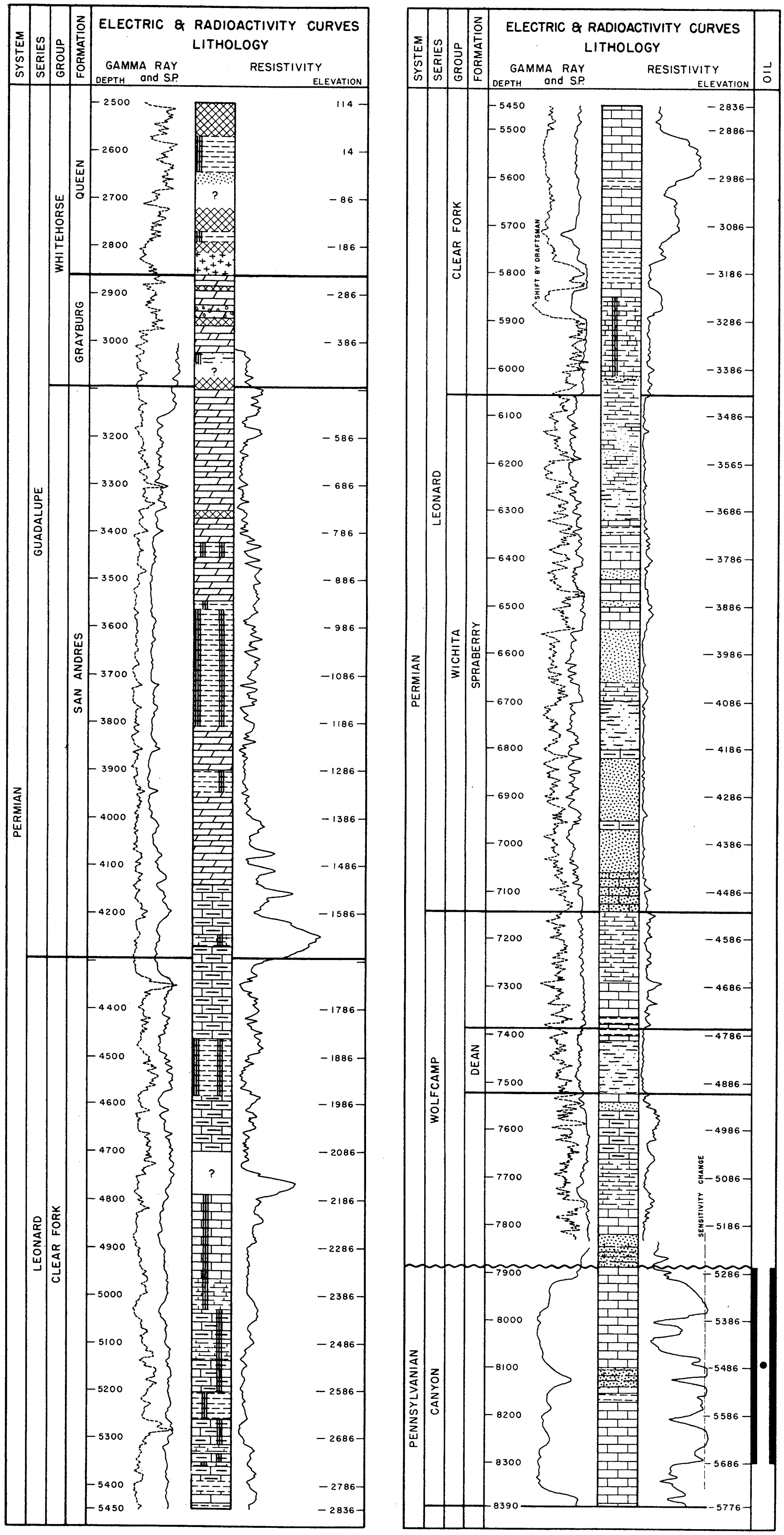
ELEVATION OF SURFACE

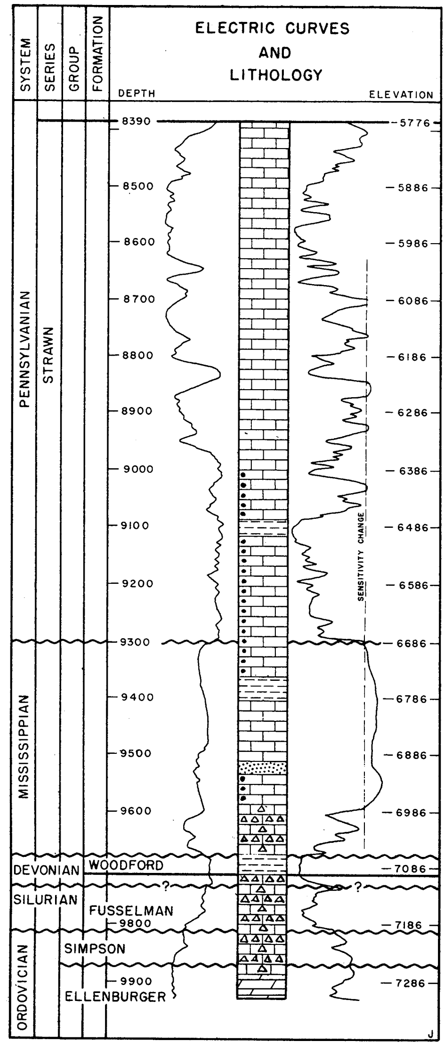
At well locations: Highest, 2,632 feet; lowest, 2,460 feet.

SURFACE FORMATION

Undifferentiated red sand and shales of the Dockum group.

TYPICAL SECTION OF ROCKS PENETRATED

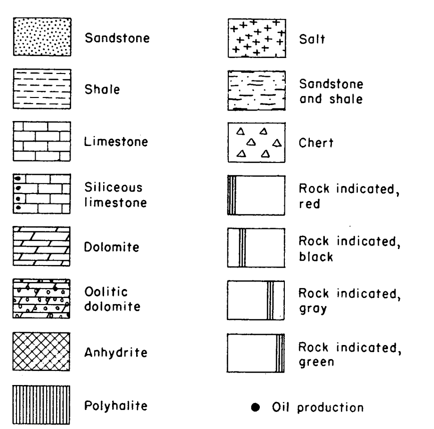




NOTE: The above section is based on the log of the discovery well to the depth of 7,830 feet and below that, with depths and elevations adjusted, on the log of the dry hole where the oldest horizon was penetrated. The stratigraphic position of the reservoir is indicated although there was no production from the rocks at that position at the location where this portion of the above log was made.

The reservoir occupies the upper portion of the reef. While the above symbol in the oil column properly represents the approximate position of the reservoir, it is recognized that there is some evidence that the age of the reef may extend from within Strawn to as late as early Wolfcamp.

EXPLANATION



HARPER FIELD

Ector County, Texas

FRED FORWARD
Geologist, Phillips Petroleum Company, Midland, Texas
April 30, 1952

LOCATION

The Harper field is 10 miles west of Odessa, county seat of Ector County. It is in the midst of several prolific oil fields and is in the approximate center of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Subsurface geology based on the then scanty well data, and using primarily elevations of tops of Rustler and Yates formations, suggested that the Permian beds are structurally high in this area. As a result of the early subsurface studies, Broderick & Calvert #1 E. F. Cowden was spudded on July 13, 1933. This well was completed as a pumping discovery from the San Andres formation on December 1, 1933.

DISCOVERY

San Andres: December 1, 1933;
Broderick & Calvert #1 E. F. Cowden

ELEVATION OF SURFACE

At well locations: Highest, 3,124 ft.; lowest, 3,014 ft.

SURFACE FORMATION

Edwards limestone is at or near the surface throughout the area of the field. A thin veneer of unconsolidated Pleistocene sand covers the limestone over part of the field.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated by any well within the area of the field is in the upper part of the Clear Fork. The oldest horizon penetrated by any well in the vicinity of the field is 37 feet below the top of the Ellenburger group. This penetration was in Cities Service Oil Co. #1 J. E. Parker, a dry hole about a mile west of the field.

NATURE OF TRAP

San Andres: Updip decrease of porosity on a structural nose.

PRODUCTIVE AREA

San Andres and Field: 3,800 acres. The field limits appear to be defined in all directions.

THICKNESS OF RESERVOIR ROCK

San Andres:	Feet
From top to bottom of reservoir rock	180
Net productive	25

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomite; tan, medium crystalline, with most of the porosity in the top 30 feet.

CONTINUITY OF RESERVOIR ROCK

San Andres: The stratigraphic equivalent of the productive dolomite is continuous far beyond the limits of the field. However, sufficiently high porosity to yield oil commercially appears to be limited essentially to the presently productive area.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Andres:	Feet
No free gas	
Highest proven elevation of oil	-881
Lowest proven elevation of oil	-1,260
Proven relief	379

The downdip extent of production is determined by decrease of porosity rather than by oil-water contact. It has not been established that there is a definite oil-water contact in the usual sense.

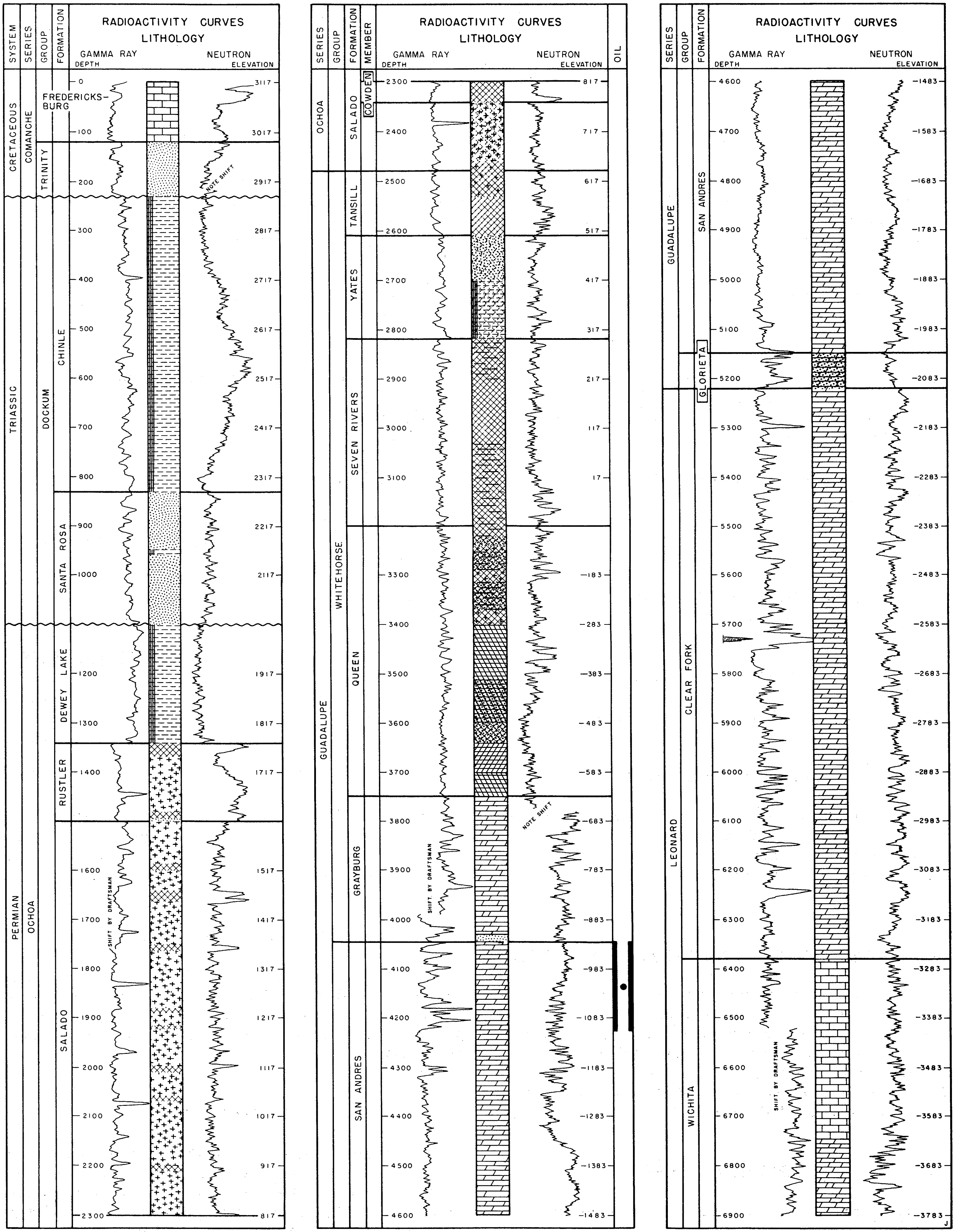
WATER PRODUCTION

San Andres: Only a negligible amount of water has been produced. The discovery well, which is the lowest well structurally with one exception, is producing no water although it has been producing oil 18 years.

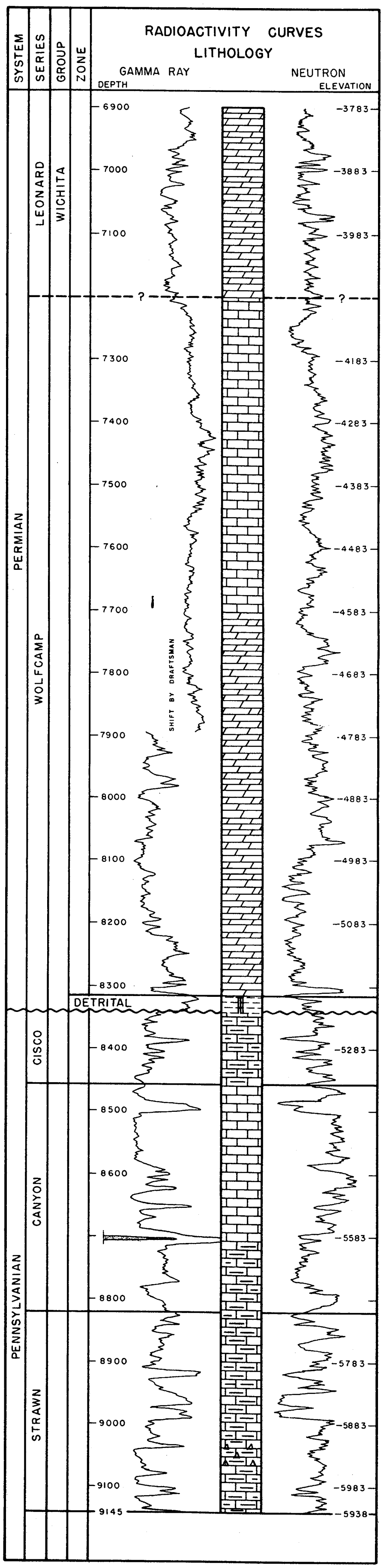
ACID TREATMENT

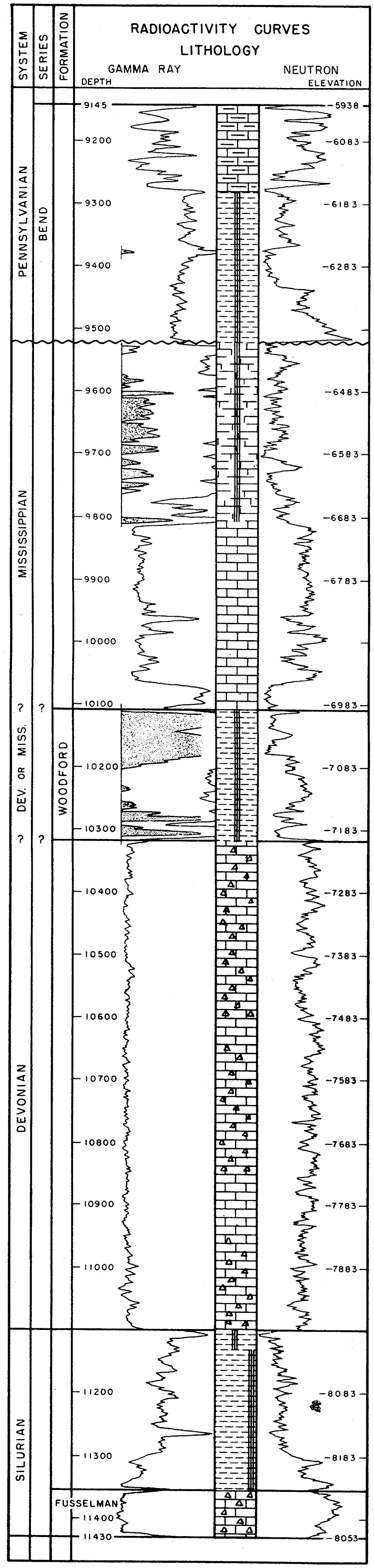
San Andres: Generally at the time of completion of each well, the reservoir rock was shot with 250 to 900 quarts of nitroglycerin. A few wells were treated with 1,500 to 6,000 gallons of acid either before shooting or as the sole treatment.

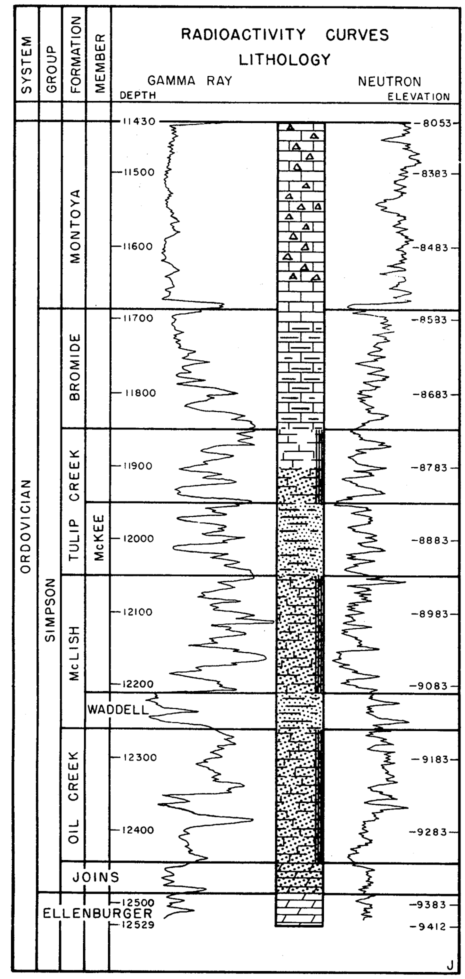
TYPICAL SECTION OF ROCKS PENETRATED



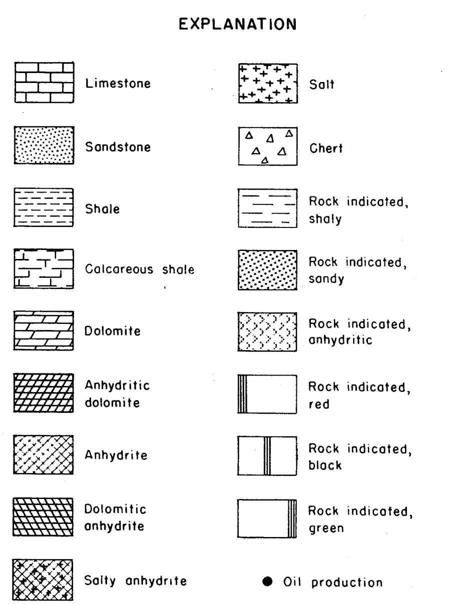
TYPICAL SECTION OF ROCKS PENETRATED

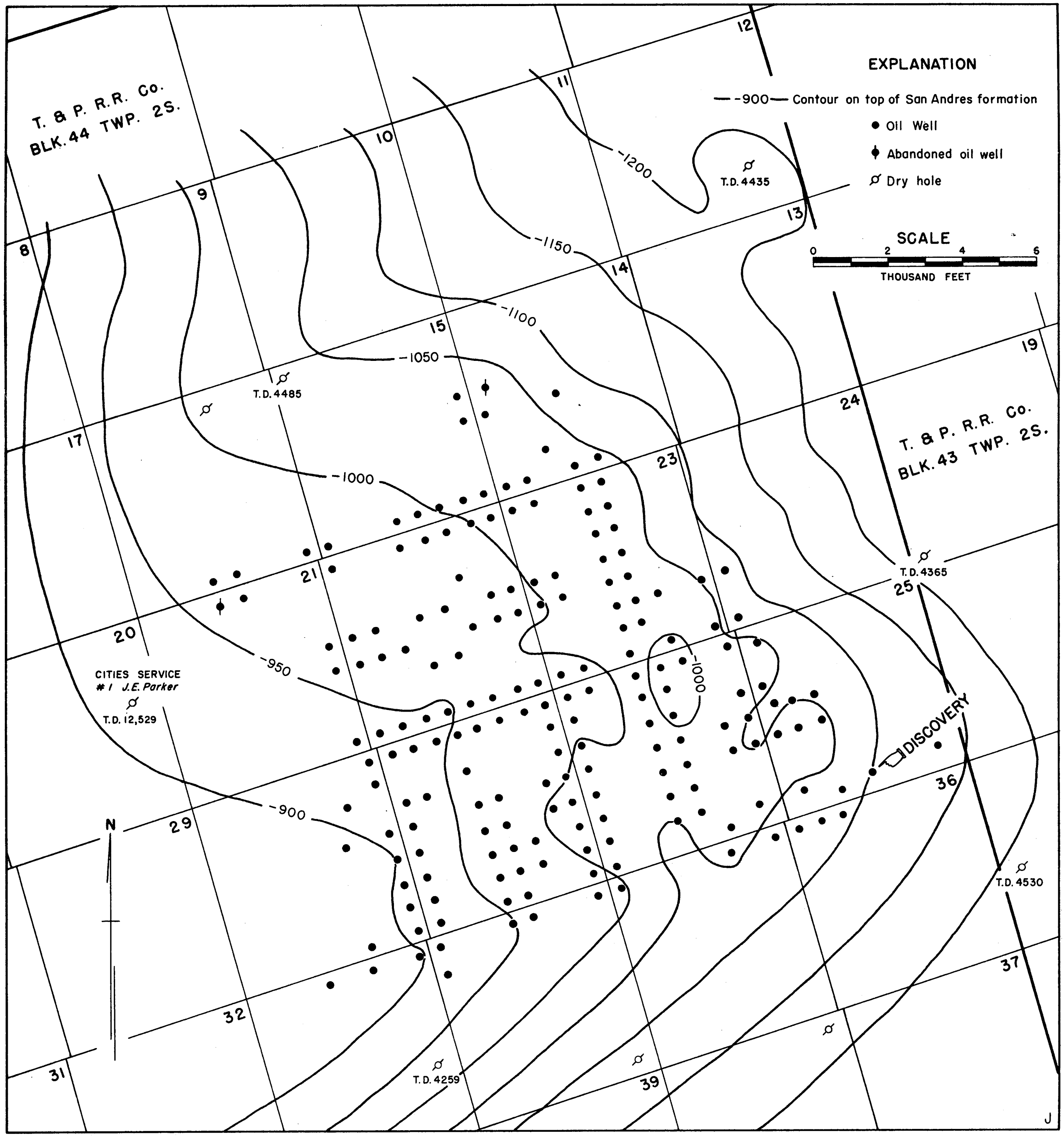






NOTE: This TYPICAL SECTION is based on the log of Cities Service #1 J. E. Parker, a dry hole one mile west of the field. The stratigraphic position of the reservoir rock is indicated although it is not productive at this location.





CHARACTER OF OIL

San Andres:
Gravity, A.P.I.: 36° Sulphur: 1.2%

For analyses see:
Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 32, 63.
U.S. Bureau of Mines Lab.ref.No. 38307 39258
Tabulated Analyses of Texas Crude Oils. T.P. 607 (1939), Group 2, Item 48
Analyses of Crude Oils from Some Fields of Texas. R.I. 3699 (1943), Item 41
Analyses of Crude Oils from Some West Texas Fields. R.I. 3744 (1944), Page 15

DEVELOPMENT AND PRODUCTION HISTORY

Year	NUMBER OF WELLS Completed	Producing at end of year Flow.	Producing at end of year Pump.	OIL PRODUCTION (barrels) Yearly	OIL PRODUCTION (barrels) Cumulative
1933	1		1	6,585	6,585
1934	0		1	24,796	31,381
1935	1		2	33,469	64,850
1936	1	1	2	35,187	100,037
1937	40	?	?	320,070	420,107
1938	134	137	40	2,735,074	3,155,181
1939	1	112	66	1,939,452	5,094,633
1940	6	84	100	1,249,456	6,344,089
1941	0	84	100	1,031,969	7,376,058
1942	0	23	161	603,263	7,979,321
1943	0	22	162	525,442	8,504,763
1944	0	20	164	596,934	9,101,697
1945	0	7	177	472,659	9,574,356
1946	0	11	170	394,281	9,968,637
1947	2	3	181	344,955	10,313,592
1948	0	3	180	316,427	10,630,019
1949	0	3	180	280,151	10,910,170
1950	0	3	181	255,317	11,165,487
1951	0	0	181	230,240	11,395,727
The following data added by amendment.					
1952	0	3	176	212,996	11,608,723
1953	0	3	176	202,160	11,810,883
1954	?	?	?	235,208	12,046,091

HYDRAULIC FRACTURING: Edwin McGhee reports on page 76 of the Oil & Gas Journal of February 7, 1955, that the reservoir rock in 25 wells had been treated by hydraulic fracturing. "In August 1954, when the first well was treated, average production in the field was about 3 bbl. per day. After treatment, the wells have been coming in at as much as 140 bbl. of oil per day. They settle down after several months at rates as high as 70 to 80 bbl. per day."

HARRIS FIELD

Gaines and Andrew Counties, Texas

J. L. WILLIFORD
Geologist, Humble Oil & Refining Company, Midland, Texas
July 30, 1954

LOCATION

The Harris field is 10 miles south of Seminole, county seat of Gaines County. It is on the Central Basin platform near its northeast margin.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Seismograph.

DISCOVERY

San Angelo: October 29, 1949; The Texas Co. #1 E.D.Harris. At the time of completion, the well produced, by pumping, at the daily rate of 41 barrels of 31.9° gravity oil through perforations between 5,965 and 5,980 feet.

ELEVATION OF SURFACE

At well locations: Highest, 3,305 ft.; lowest, 3,255 ft.

SURFACE FORMATION

Wind-blown sand of Recent age and clays and caliche of probable Quaternary age.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Clear Fork group 1,030 feet below its top. This penetration was in the discovery well.

NATURE OF TRAP

San Angelo: The trapping of oil appears to be due to a combination of anticlinal folding and variation in degree of porosity. Porosity pinchout determines the boundary of the productive area except in the vicinity of the discovery well; there, the oil body extends downdip to the oil-water contact.

PRODUCTIVE AREA

San Angelo: Development to date indicates a productive area of 2,480 acres. Futher development may prove that the productive area is slightly greater.

THICKNESS OF RESERVOIR ROCK

San Angelo: The thickness of the productive zone ranges from 6 feet to 55 feet. The area of greatest thickness is on the east flank of the anticline. Near the edge of the productive area, wells have been completed at locations where there is as little as 6 feet of productive rock.

LITHOLOGY OF RESERVOIR ROCK

San Angelo: Tan to light brown, finely crystalline to finely granular dolomite with minor amounts of anhydrite and fine-grained sand. The degree of porosity ranges widely and within short distances.

CONTINUITY OF RESERVOIR ROCK

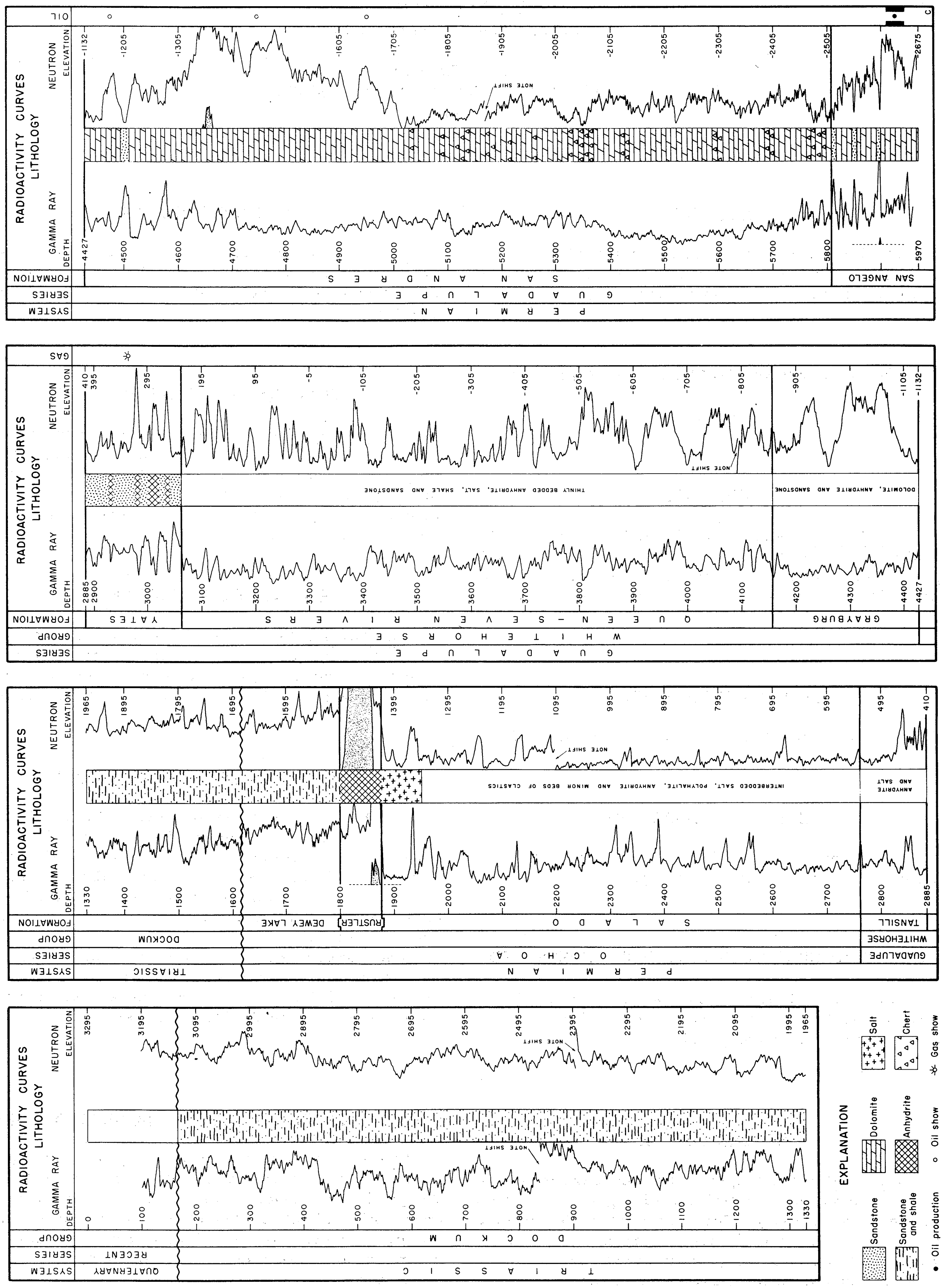
San Angelo: The reservoir rock in the San Angelo formation appears to be continuous throughout the area of the accompanying map and considerably beyond its boundaries. However, the degree of porosity which occasions commercial production is probably not continuous far beyond the presently productive area.

The carbonate and sand facies of the San Angelo formation is continuous over the Central Basin platform and Eastern shelf; a sand and shale basin facies is present in the Midland basin.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Angelo: Due to irregularity of porosity, it is difficult to determine the elevation and relief of the productive zone. The elevation of the highest known oil is about -2,600 feet and the elevation of the oil-water contact is -2,770 feet, but this does not mean that there is a continuous oil body with relief of 170 feet.

TYPICAL SECTION OF ROCKS PENETRATED



CHARACTER OF OIL and RESERVOIR DATA

Pressure at -2,650 ft. at discovery date, approx.	2,400 psi.
Gravity of oil, A.P.I. @ 60°F.	31°
Saturation pressure	340 psi.
Solution gas-oil ratio	159 cf/bbl.

WATER PRODUCTION

San Angelo: Some water has been produced but the quantity has not been enough to be of importance.

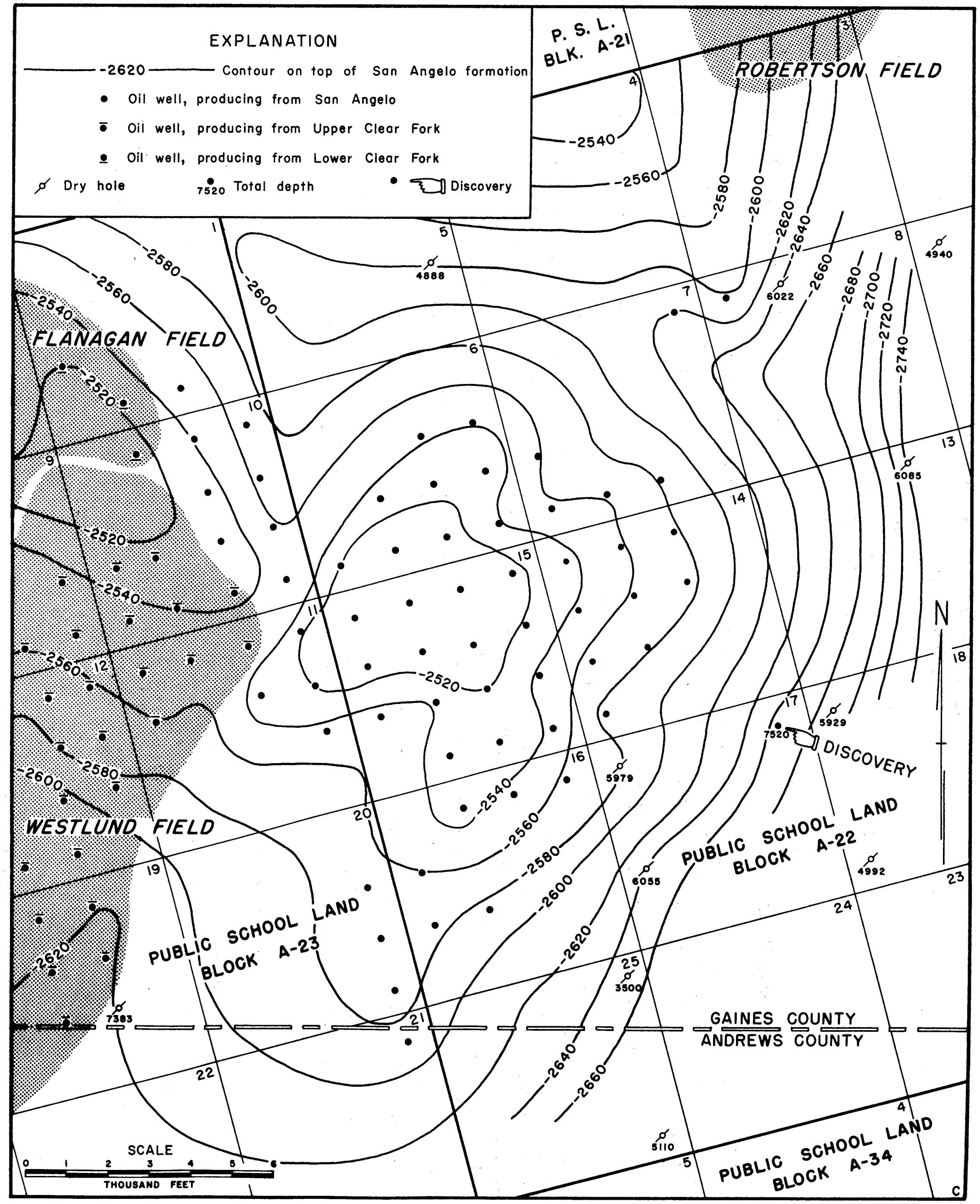
ACID TREATMENT

San Angelo: While the normal treatment is with 4,000 to 6,000 gallons of acid, the quantities have ranged from 500 to 11,500 gallons.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
1949	0	1	2,340	2,340
1950	1	2	38,466	40,806
1951	0	14	172,658	213,464
1952	1	27	450,741	664,205
1953	0	52	610,291	1,274,496
1954*	0	61	580,8xx	1,855,3xx
1955*	0	67	581,5xx	2,436,8xx

*1954 and 1955 data added by amendment.



HENARD FIELD

Yoakum County, Texas

ARCHIE B. COCKBURN
Geologist, Cabot Carbon Company, Midland, Texas
September 25, 1953

LOCATION

The Henard field (one well) is in west-central Yoakum County, 4 miles northwest of the town of Plains, county seat. It is in Sec. 367 of Block D, John H. Gibson survey

MAPS and TYPICAL SECTION

Because of the geographic and geologic relationship with the Brahaney field, certain data pertaining to this field are presented on maps included in the foregoing paper on that field. Furthermore, the data pertaining to stratigraphic section presented in the paper on the Brahaney field apply to this field. The TYPICAL SECTION OF ROCKS PENETRATED presented in that paper is included here by reference.

METHOD OF EXPLORATION LEADING TO DISCOVERY

A study of subsurface geological data, including good shows of oil in two nearby tests, led to the drilling of the discovery well.

DISCOVERY

San Andres: October 28, 1950; Dunigan Bros. & Brahaney #1 Alice Henard. Pumped at rate of 57.7 barrels of oil and 12.6 barrels of water per day from open hole from depth of 5,150 to 5,285 feet after treatment with 4,000 gallons of acid.

ELEVATION OF SURFACE

At the one well: 3,681 feet (derrick floor, 3,691 feet).

SURFACE FORMATION

Ogallala formation of Tertiary system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the one productive well is approximately 750 feet below the top of the San Andres formation. Two miles south, in the Brahaney field, Signal Oil & Gas Co. #1 J.D. Webb penetrated the upper part of the Devonian system.

NATURE OF TRAP

San Andres: While the dominating structural feature is a southward plunging anticlinal nose, it appears that the most important trap-forming factor is the distribution of porosity. As indicated on a map presented in the foregoing paper on the Brahaney field, the top of the zone with relatively high porosity is convex in form.

PRODUCTIVE AREA

San Andres and Field: 40 acres.

THICKNESS OF RESERVOIR ROCK

San Andres:	Feet
From top to bottom	80
Net effective	30

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomite; tan, finely crystalline, slightly fractured, with styolitic partings, thin streaks of dark gray shale, and nodules of blue, fractured chert.

CONTINUITY OF RESERVOIR ROCK

San Andres: The stratigraphic equivalent of the reservoir rock is probably continuous over a large area. However, the degree of porosity and permeability which occasions commercial production is very erratic. While the reservoir rock in the Brahaney field is at the same stratigraphic position, it is not known whether porosity is sufficiently continuous to permit migration of fluids from one field to the other or from a common source to the two fields.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Andres:	Feet
No free gas cap	
Elevation of top of oil	-1,504
Elevation of bottom of oil	-1,636
Relief	132

The elevation of bottom of oil is estimated on the basis of showings in dry holes in the vicinity. Some of these tests produced small amounts of oil but were plugged rather than being completed as marginal producers.

CHARACTER OF OIL

San Andres:

Gravity, A.P.I. @ 60° F.: 32°	Odor: Sour
Sulphur: High percentage	Color: Dark brown to black

WATER PRODUCTION

San Andres: Water initially constituted 18% of gross liquid produced, but the ratio has now decreased to between 3 and 4%.

ACID TREATMENT

San Andres: A treatment with 4,000 gallons of acid resulted in an increase in potential from 15 to 58 barrels of oil per day.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1950	1	1,999	1,999
1951	1	8,388	10,387
1952	1	7,182	17,569

HOMANN FIELD

Gaines County, Texas

DONALD E. CAUSSEY
Geologist, Honolulu Oil Corp., Midland, Texas
May 29, 1953

LOCATION

The Homann field is in Block G, Waxahachie Tap R. R. Co. survey, in central Gaines County about $6\frac{1}{2}$ miles northeast of the town of Seminole, county seat.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Mapping of subsurface data indicated anticlinal structure at the depth of the Yates formation. Seismic surveying confirmed this interpretation.

DISCOVERY

Yates: April 7, 1944; Honolulu Oil Corp. #1 E.B.Homann. This well was drilled to total depth of 5,457 feet and plugged back to 3,513 feet. The top of productive rock is at depth of 3,443 feet. The initial production was at the rate of 5,512 Mcf per day.

ELEVATION OF SURFACE

At well locations: Highest, 3,326 feet; lowest, 3,244 feet.

SURFACE FORMATION

Ogallala formation of Tertiary system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Devonian system about 80 feet below the Woodford shale. This penetration was in the dry hole near the gas well in the southwest corner of Sec. 75 where the total depth of 13,282 is indicated on the accompanying map. The accompanying TYPICAL SECTION is based on the log of this well.

NATURE OF TRAP

Yates: Convex fold, as indicated on accompanying map.

THICKNESSES OF RESERVOIR ROCK

Yates:	Max.	Min.	Avg.
From top to bottom, feet	190	175	182
Net productive, feet	92	58	75

CONTINUITY OF RESERVOIR ROCK

Yates: The stratigraphic equivalent of the productive zone has been recognized at each of the twelve well locations indicated on the accompanying map. However, the degree of porosity and permeability required for commercial production is not continuous throughout the inclusive area. Lack of adequate porosity and permeability appears to be the explanation for the failure of certain test wells, particularly that in Sec. 104, to produce commercial gas. While the reservoir rock appears to be continuous throughout the area of the accompanying map, the condition (high degree of porosity and permeability) which occasions commercial accumulation appears to be quite local.

PRODUCTIVE AREA

Yates: Approximately 2,400 acres.

LITHOLOGY OF RESERVOIR ROCK

Yates: Sandstone; fine- to coarse-grained; grains are sub-rounded and are cemented loosely by varying amounts of salt and shale.

CHARACTER OF GAS

Component	Mol. %	G/Mcf
Carbon dioxide	0.00	
Nitrogen	26.34	
Methane	56.49	
Ethane	9.41	
Propane	4.58	1.256
Iso-butane	0.46	0.150
N-butane	1.22	0.384
Iso-pentane	0.45	0.164
N-pentane	0.28	0.101
Hexane	0.56	0.230
Heptane	0.21	0.097
	100.00	2.382

Specific gravity, calculated from composition,	0.811
Heating value, B.t.u./cf	953
Sulphur content, grains per Mcf	0.3

The above analysis was made by El Paso Natural Gas Co. of a sample secured December 20, 1948 from Honolulu Oil Corp. #1-96 E. B. Homann.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Yates:	Feet
Highest known elevation of gas	-74
Lowest known elevation of gas	-240
Known relief	166

WATER PRODUCTION

None

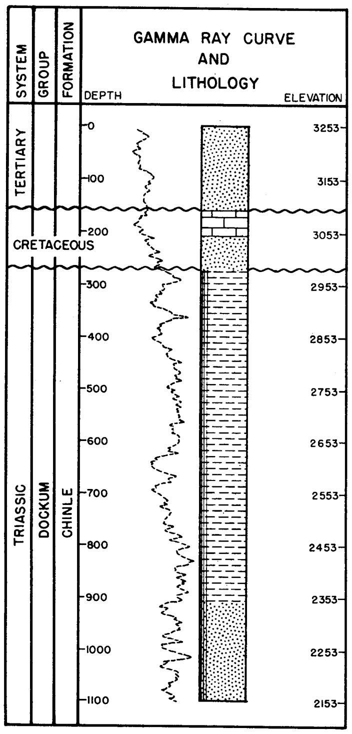
ACID TREATMENT

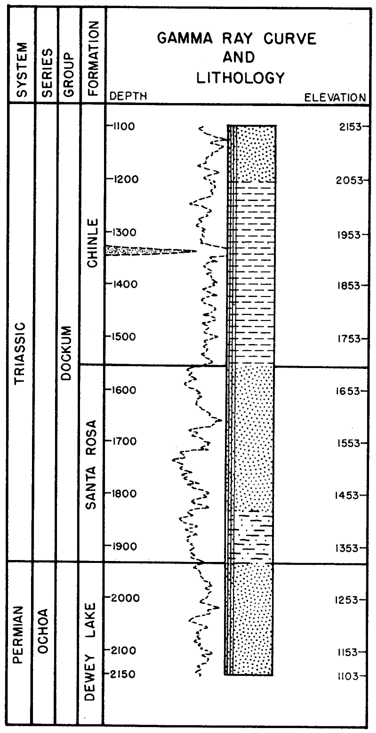
None

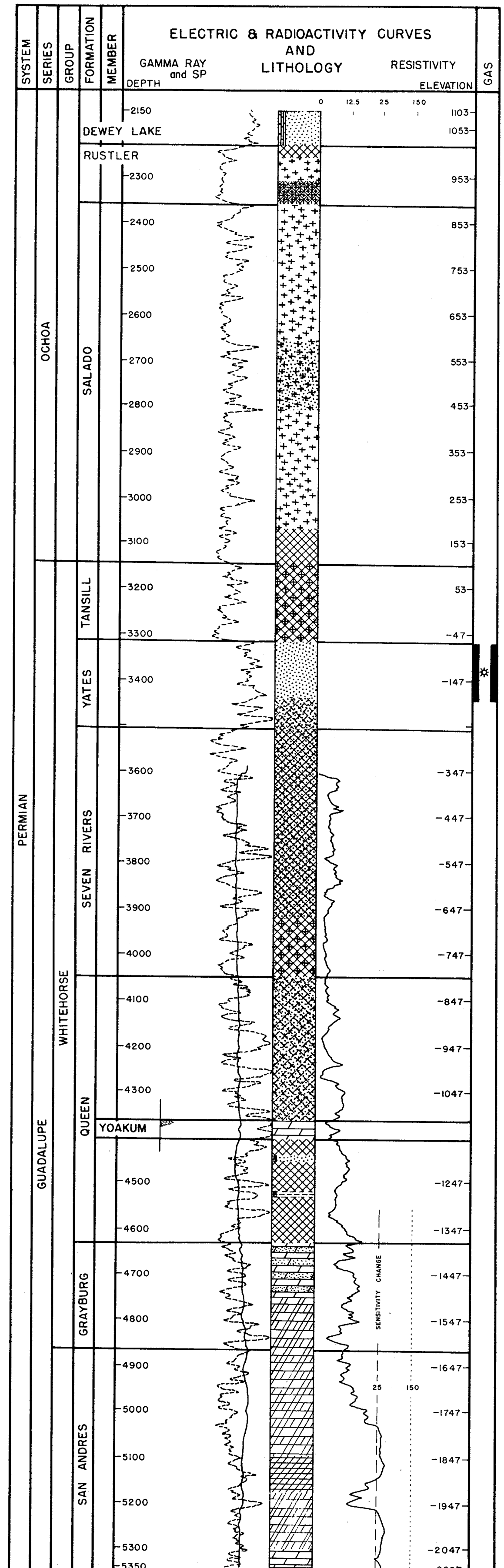
PRODUCTION HISTORY

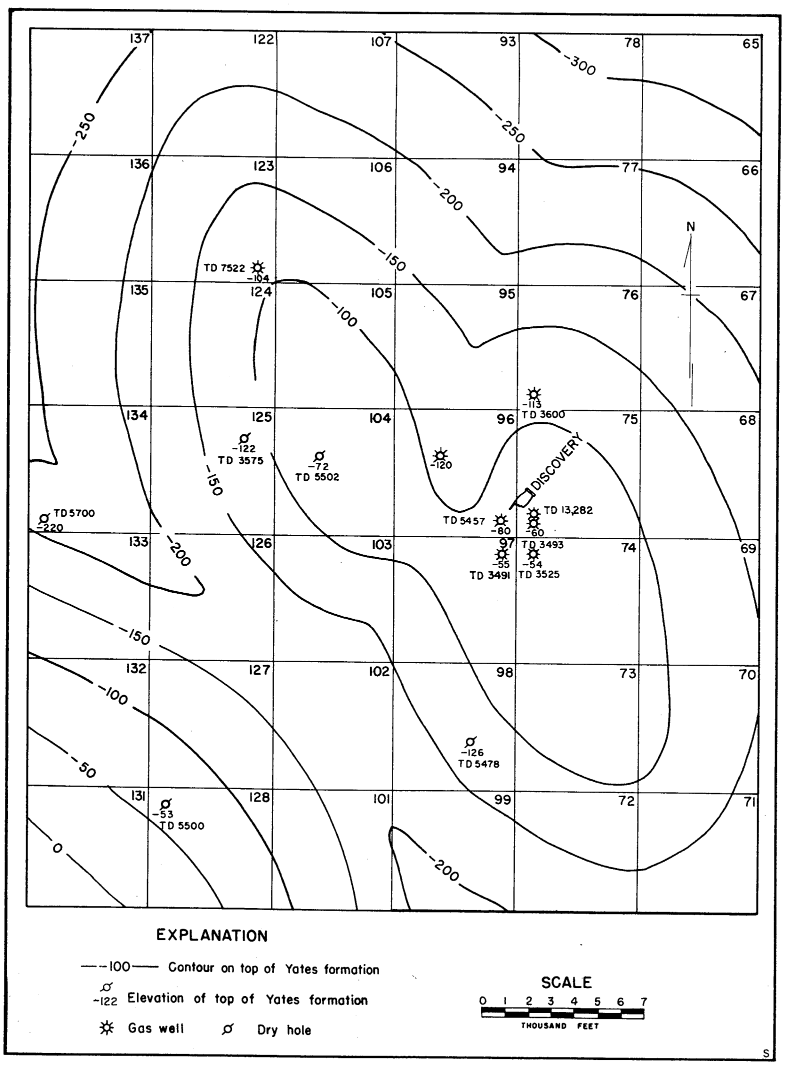
Year	WELLS PRODUCING at end of year	GAS PRODUCTION (Mcf)		CONDENSATE PRODUCTION (barrels)	
	Flowing	Yearly	Cum.	Yearly	Cum.
1946	1	96,007	96,007	1,431	1,431
1947	1	253,478	349,485	3,443	4,874
1948	3	404,881	758,964	4,598	9,472
1949	4	474,612	1,233,576	4,055	13,527
1950	4	510,879	1,744,455	3,930	17,457
1951	4	842,692	2,587,147	4,806	22,263
1952	5	908,526	3,495,673	3,786	26,049

TYPICAL SECTION OF ROCKS PENETRATED

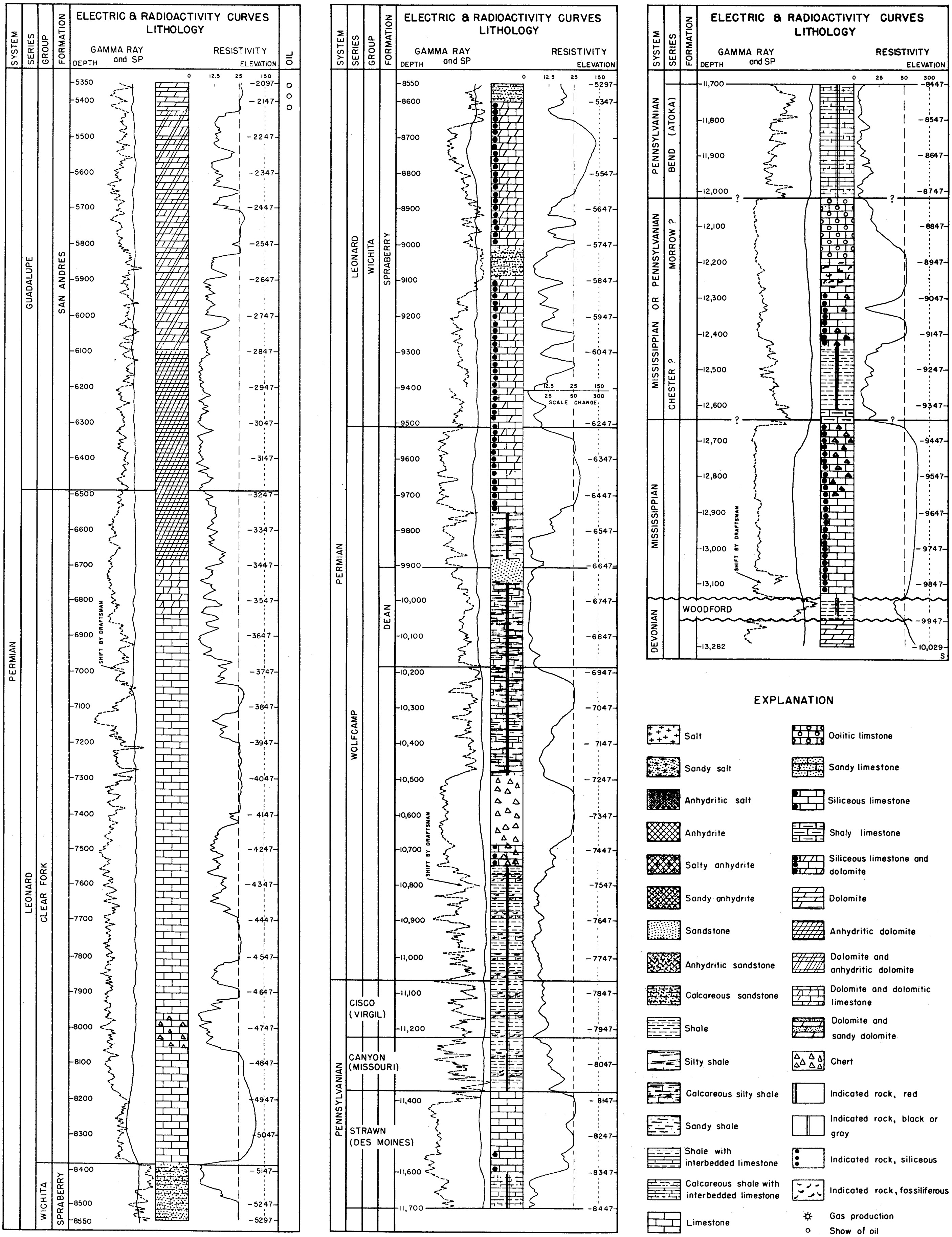








TYPICAL SECTION OF ROCKS PENETRATED



HOOVER FIELD

Crockett County, Texas

D.E.DAUGHERTY, H.J.McCOOL and J.A.BODJO
Geologists, Sinclair Oil and Gas Company, Midland, Texas
May 7, 1954

LOCATION

The Hoover field is in west central Crockett County about 25 miles west and slightly north of the town of Ozona, county seat, and is about 3 miles northeast of the Clara Couch field and 1½ miles southwest of the Simpson field. It is in Secs. 1 and 2, Blk. 1, G.C. & S.F. R.R. Co. survey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Random drilling.

DISCOVERY

Queen: May 18, 1938; W. L. Bradley et al #1 A. C. Hoover. This well was drilled to total depth of 2,173 feet, where sulphur water was encountered. The well was plugged back to 1,440 feet and shot with 110 quarts of nitroglycerin from 1,417 feet to 1,436 feet. Through 2-inch tubing set at 1,438 feet, the well flowed at daily rate of 15 barrels of oil and about 2,000 Mcf of gas. No oil was marketed from this well until the second well in the field was completed in 1941.

ELEVATION OF SURFACE

At well locations: Highest, 2,295 ft.; lowest, 2,249 ft.

SURFACE FORMATION

Undifferentiated Fredericksburg limestone.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 233 feet below the top of the San Andres formation. This penetration was in the discovery well. The accompanying TYPICAL SECTION is based on the log of that well.

NATURE OF TRAP

Queen: Updip lensing on a structural nose.

PRODUCTIVE AREA

Queen and Field: Approximately 80 acres.

THICKNESS OF RESERVOIR ROCK

Queen:	Feet, avg.
From top to bottom	60
Net productive	15

LITHOLOGY OF RESERVOIR ROCK

Queen: Gray-green, medium-grained, loosely cemented sandstone.

CONTINUITY OF RESERVOIR ROCK

Queen: The reservoir rock is a lens which extends only a very short distance beyond the boundary of a small area which includes the four productive wells.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Queen:	Feet
No free gas cap	
Elevation of top of oil	839
Elevation of bottom of oil	779
Relief	60

CHARACTER OF OIL

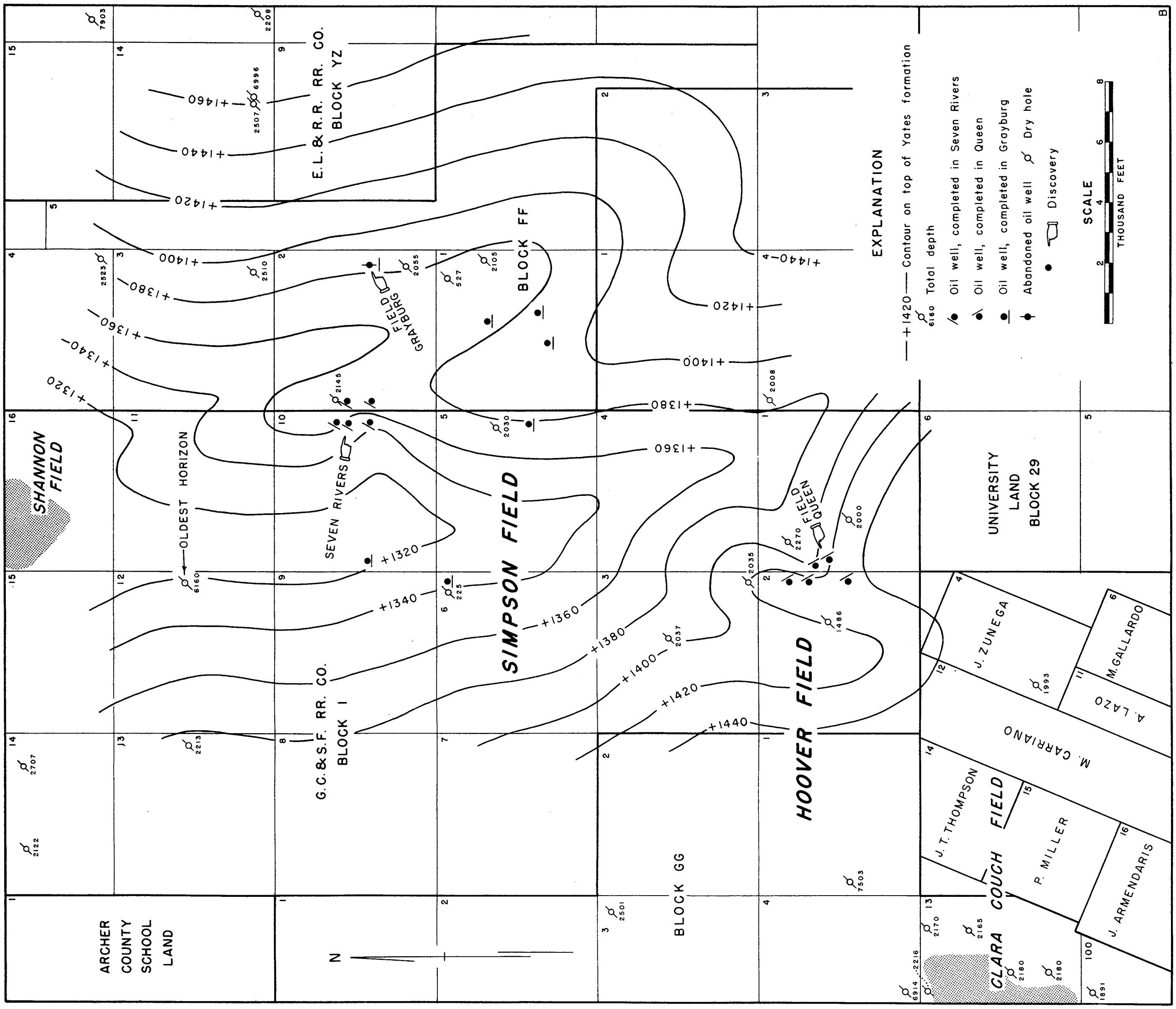
Queen: Gravity, A.P.I. @ 60°F., 25.4°

WATER PRODUCTION

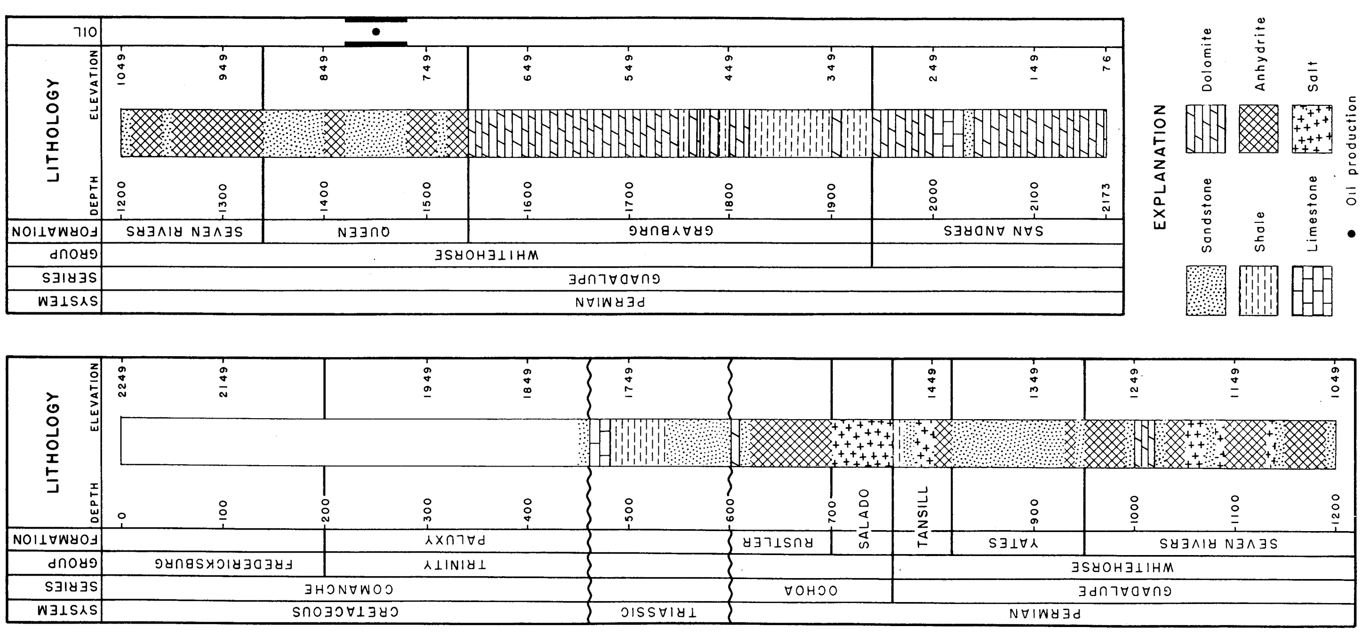
Queen: Very little water has been produced.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
1941	0	2	1,839	1,839
1942	0	2	4,455	6,294
1943	0	1	1,150	7,444
1944	0	1	357	7,801
1945	0	0	0	7,801
1946	0	0	0	7,801
1947	1	1	4,003	11,804
1948	2	2	7,821	19,625
1949	2	2	6,466	26,091
1950	2	2	7,491	33,582
1951	2	2	7,447	41,029
1952	1	3	6,274	47,303
1953	1	4	5,534	52,837



TYPICAL SECTION OF ROCKS PENETRATED



HUDDLE FIELD
Dawson County, Texas

ROLLA E. HARGRAVE
Consulting Geologist, Midland, Texas
March 6, 1953

LOCATION and OTHER NAMES

The Huddle field (one well) is in central Dawson County, 1 mile southwest of Lamesa. Beside being known as the Huddle field, it is also known as the Huddle-Manning field and as the Manning-Huddle field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The discovery well was located on the basis of seismic data. The data were sufficiently indicative of a reef in Pennsylvanian rocks that the well was drilled 174 feet into Pennsylvanian rocks, where a drill stem test recovered salt water. The well was plugged back and completed in the base of the upper Spraberry after a previous test at 7,860 - 7,876 feet had yielded an estimated 4,800 feet of oil into the drill stem.

DISCOVERY

Spraberry: October 17, 1950; Fred M. Manning, Inc. #1 D. Huddle. Drilled to total depth of 9,914 feet and plugged back to 8,026 feet. Flowed at rate of 186 barrels of oil per day after shot of 330 quarts of nitroglycerin at 7,856 - 7,985 feet.

ELEVATION OF SURFACE

At the oil well, 2,960 ft. (derrick floor, 2,972 ft).

SURFACE FORMATION

Caliche of Ogallala formation of Pliocene system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 174 feet below the top of the Cisco series, as indicated on the accompanying TYPICAL SECTION.

NATURE OF TRAP

Spraberry: The factors which occasioned accumulation of oil are not determinable from information afforded by development to date.

PRODUCTIVE AREA

Spraberry and Field: It appears likely that the productive area is on the order of 40 acres.

THICKNESS OF RESERVOIR ROCK

Spraberry: Net productive, 15 feet.

LITHOLOGY OF RESERVOIR ROCK

Spraberry: Gray, fine-grained, porous sandstone.

CONTINUITY OF RESERVOIR ROCK

Spraberry: The reservoir rock is one of several sandstone members in the Spraberry formation. Whether this member correlates with similar members found in other wells is not determinable from available data. In the dry hole offsetting the discovery well to the east, a sandstone which is lithologically similar and is at about the same stratigraphic position yielded oil in quantity almost sufficient to warrant completion as an oil well, but whether it correlates with the productive member is not known.

CHARACTER OF OIL

Spraberry: Gravity, A.P.I. @ 60° F., 38°

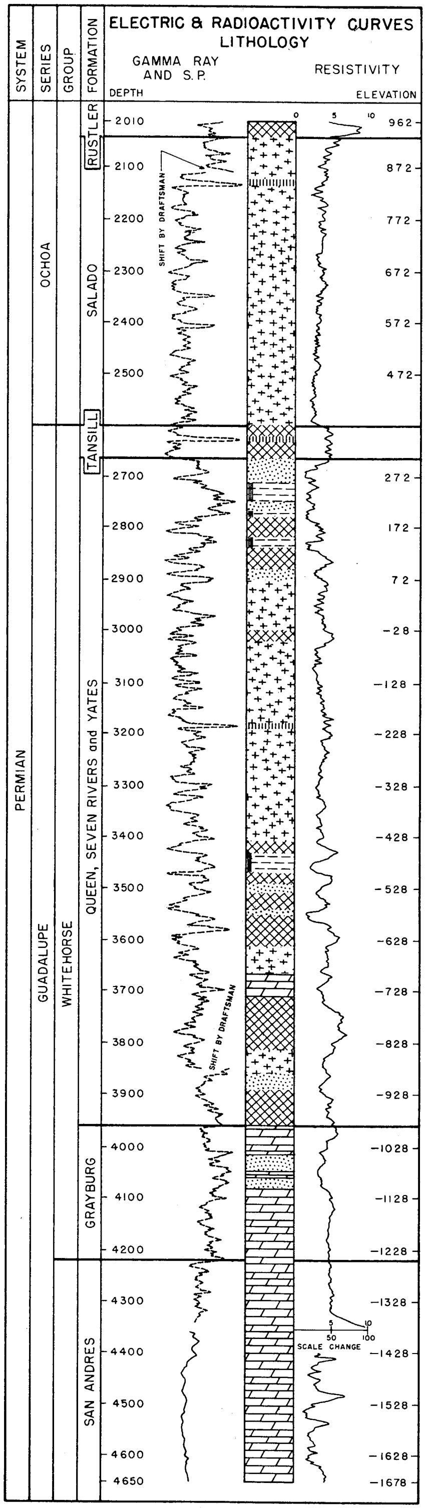
PRODUCTION HISTORY

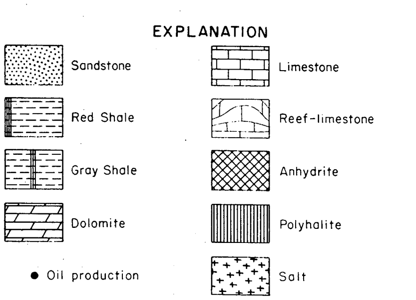
OIL PRODUCTION
(barrels)

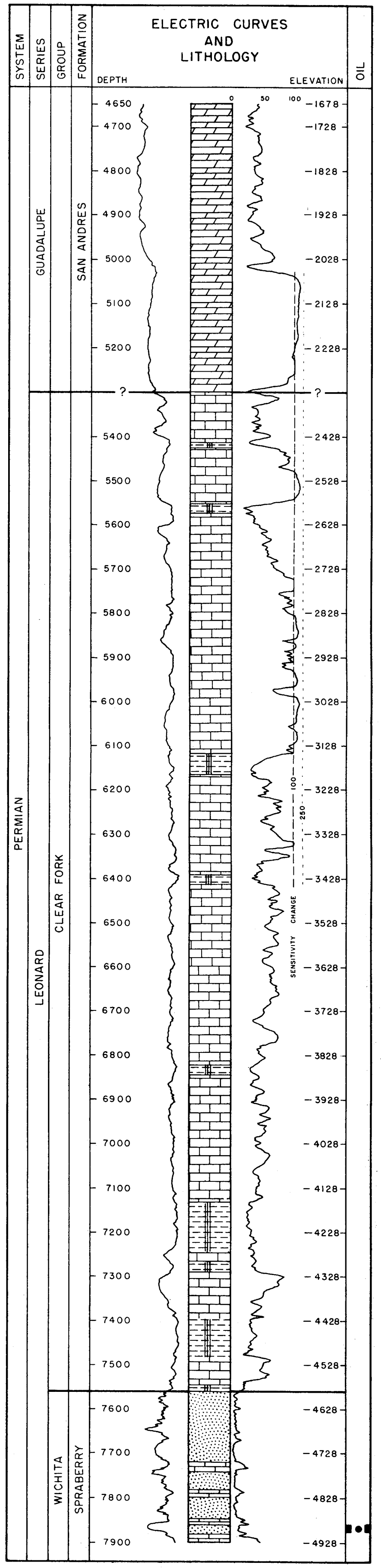
	1950	1951	1952	1953*
January		1,247	2,343	1,924
February		1,166	2,081	1,867
March		2,580	2,195	1,476
April		2,406	1,887	1,797
May		2,380	1,690	1,859
June		2,199	2,030	1,690
July		2,380	2,163	1,979
August		2,303	2,182	1,870
September		2,045	2,063	1,894
October	1,788	2,212	2,051	1,946
November	3,029	1,964	1,734	2,015
December	1,750	2,206	2,014	1,981
Total	6,567	25,088	24,433	22,298

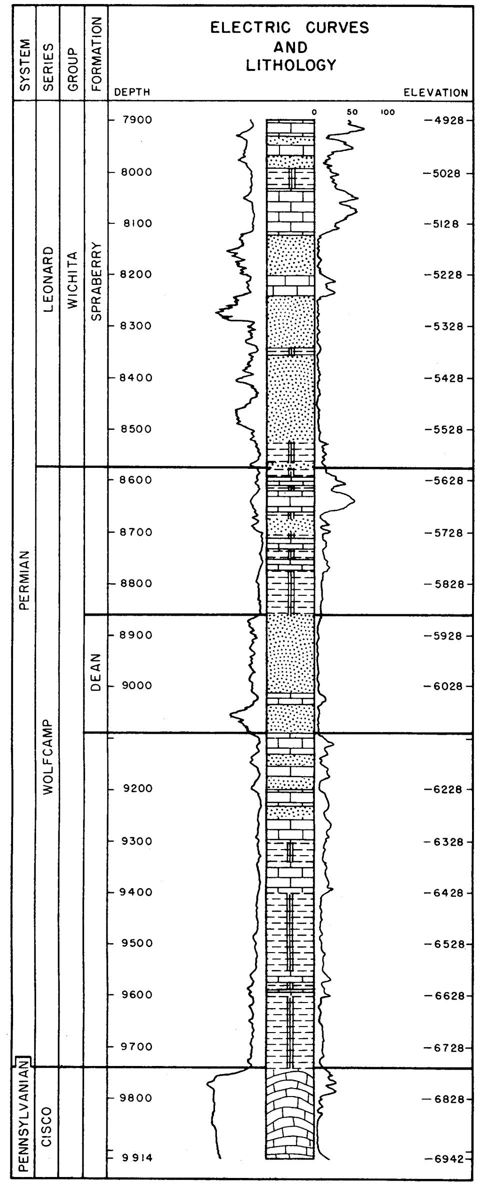
*1953 data added by amendment.

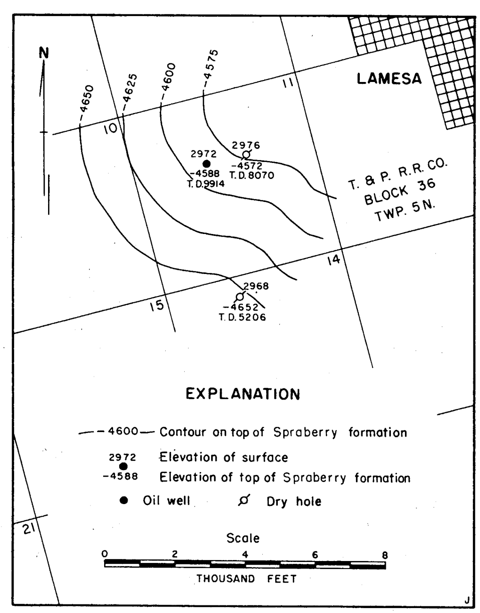
TYPICAL SECTION OF ROCKS PENETRATED











HURDLE FIELD

Upton County, Texas

E. S. HUGHES
Geologist, Gulf Oil Corporation, Fort Worth, Texas
January 1, 1955

LOCATION

The Hurdle field is in southwest Upton County 1½ miles southeast of the McCamey field and 6½ miles east-northeast of the McCamey townsite.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Extension of trend southeastward along the McCamey anticline.

DISCOVERY

Grayburg: June 12, 1936; Brewer & Smith #1 Cordova Union Oil Corp. (now, F.W.Merrick #1 Cordova Union Oil Corp.). The initial pumping capacity was at the rate of 374 barrels of oil per day from a total depth of 2,072.

MAP, LITHOLOGY and STRATIGRAPHIC SECTION

Because of geographic and geologic relationships with the McCamey field, this field is shown on the map in the following paper on that field.

The TYPICAL SECTION and the description of the lithology of the Grayburg reservoir rock in the paper on the McCamey field apply also to this field. The stratigraphic position of the reservoir in this field is the same as that of the Grayburg reservoir in the McCamey field.

ELEVATION OF SURFACE

At well locations: Highest, 2,533 feet; lowest, 2,465 feet.

SURFACE FORMATION

Undifferentiated rocks of the Comanche series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Grayburg formation. On the basis of incomplete records, it appears that the maximum penetration is in the abandoned well in the south part of the field where the total depth of 2,063 feet is indicated on the accompanying map. The oldest horizon penetrated in the vicinity of the field is in the San Andres formation an unknown distance below its top but known to be about 1,055 feet below the top of the Grayburg formation. This penetration is in the dry hole about 0.5 mile west of the field where the total depth of 3,085 feet is indicated on the accompanying map.

NATURE OF TRAP

Grayburg: Since the accumulation is at the apex of an anticlinal fold, it appears that anticlinal folding is the primary trap-forming factor. However, it is likely that variation in degree of porosity has served to some extent as a trap-forming factor.

PRODUCTIVE AREA

Grayburg and Field: Approximately 300 to 350 acres.

THICKNESS OF RESERVOIR ROCK

Grayburg: The gross thickness of the zone containing productive rock is on the order of 40 to 70 feet. Data are not available for estimating the portion of that zone which yields oil.

CHARACTER OF OIL

		Range	Avg.
Grayburg:	Gravity, A.P.I. @ 60° F.,	23° to 28°	25°

WATER PRODUCTION

Grayburg: Since July 1943, water has constituted 0.2% of the gross production of the field.

COMPLETION TREATMENT

Grayburg: Most of the wells were treated with acid at time of completion; quantities used ranged from 1,000 to 3,000 gallons. A few wells were shot with nitroglycerin.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1936	7	19,918	19,918
1937	10	60,758	80,676
1938	18	56,939	137,615
1939	16	37,462	175,077
1940	14	30,031	205,108
1941	12	21,951	227,059
1942	12	16,863	243,922
1943	12	15,170	259,092
1944	12	12,327	271,419
1945	12	11,040	282,459
1946	12	8,852	291,311
1947	12	8,844	300,155
1948	3	13,157	313,312
1949	12	12,484	325,796
1950	12	10,073	335,869
1951	12	8,776	344,645
1952	12	7,621	352,266
1953	12	7,814	360,080
1954	12	7,544	367,624

JONES RANCH FIELD

Gaines and Yoakum Counties, Texas

PERRY L. YAGER
Geologist, British-American Oil Producing Co., Midland, Texas
January 14, 1954

LOCATION

The Jones Ranch field is mainly in the northwest corner of Gaines County with only one well in southwest Yoakum County. It is in Secs. 2, 3 and 6, Block A-6, Public School Land survey and is approximately 27 miles northwest of the town of Seminole. It is on the south extremity of the North Basin platform.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph work led to the discovery of this field.

DISCOVERY

Devonian: November 13, 1945; Amerada Petroleum Corp. #1-A E. H. Jones. Drilled to total depth of 11,635 feet and plugged back to 11,422 feet. During potential test, flowed at rate of 1,375 barrels of oil per day through 1.25-inch choke; gas-oil ratio, 245:1.

OLDEST HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is 31 feet below the top of pre-Cambrian micrgranite. This penetration was in Amerada Petroleum Corp. #2-A E.H. Jones at its total depth of 12,924 feet (-9,227 feet). This well is identified as No. 3 on the accompanying cross section.

The deepest test in the vicinity of the field is Amerada Petroleum Corp. #1-D E.H.Jones, identified as No. 5 on the accompanying cross section. This test was drilled to total depth of 13,025 feet (-9,351 feet) where it was 15 feet below the top of the pre-Cambrian micrgranite. It was plugged and abandoned on December 28, 1946.

NATURE OF TRAP

Devonian: Convex fold.

PRODUCTIVE AREA

Devonian and Field: 640 acres.

THICKNESS OF RESERVOIR ROCK

	Net productive, feet		
	Min.	Max.	Avg.
Devonian:	58	154	77

LITHOLOGY OF RESERVOIR ROCK

Devonian: Predominantly dolomite with limestone stringers. Minor amounts of chert occur in both the dolomite and the limestone. Both dolomite and limestone have vuggy and intercrystalline porosity; degree of porosity is higher in the dolomite.

ACID TREATMENT

Devonian: One well was completed without acid treatment. The other seven wells were each treated with from 500 to 20,000 gallons; average, 5,237 gallons.

CONTINUITY OF RESERVOIR ROCKS

Devonian: The reservoir rock is continuous throughout the area of the field and apparently far beyond the extent of the field. Devonian rocks occur throughout most of the Permian basin and outcrop in the mountains to the west and south. North of Ector County, Devonian limestone grades into dolomite and south of Ector County the silica content increases.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Devonian:	Feet
No free gas cap	
Elevation of top of oil	-7,455
Elevation of bottom of oil	-7,730
Relief	275

CHARACTER OF OIL

Devonian: Gravity, A.P.I. @ 60° F.: 43.6°
Sulphur: 0.16% Odor: Sour
Base: Intermediate Color: Brown

For analysis see:
U. S. Bureau of Mines Lab. ref. No. 46086
Analyses of Crude Oil from Some West Texas Fields.
R. I. 4959 (1953) Item 29

WATER PRODUCTION

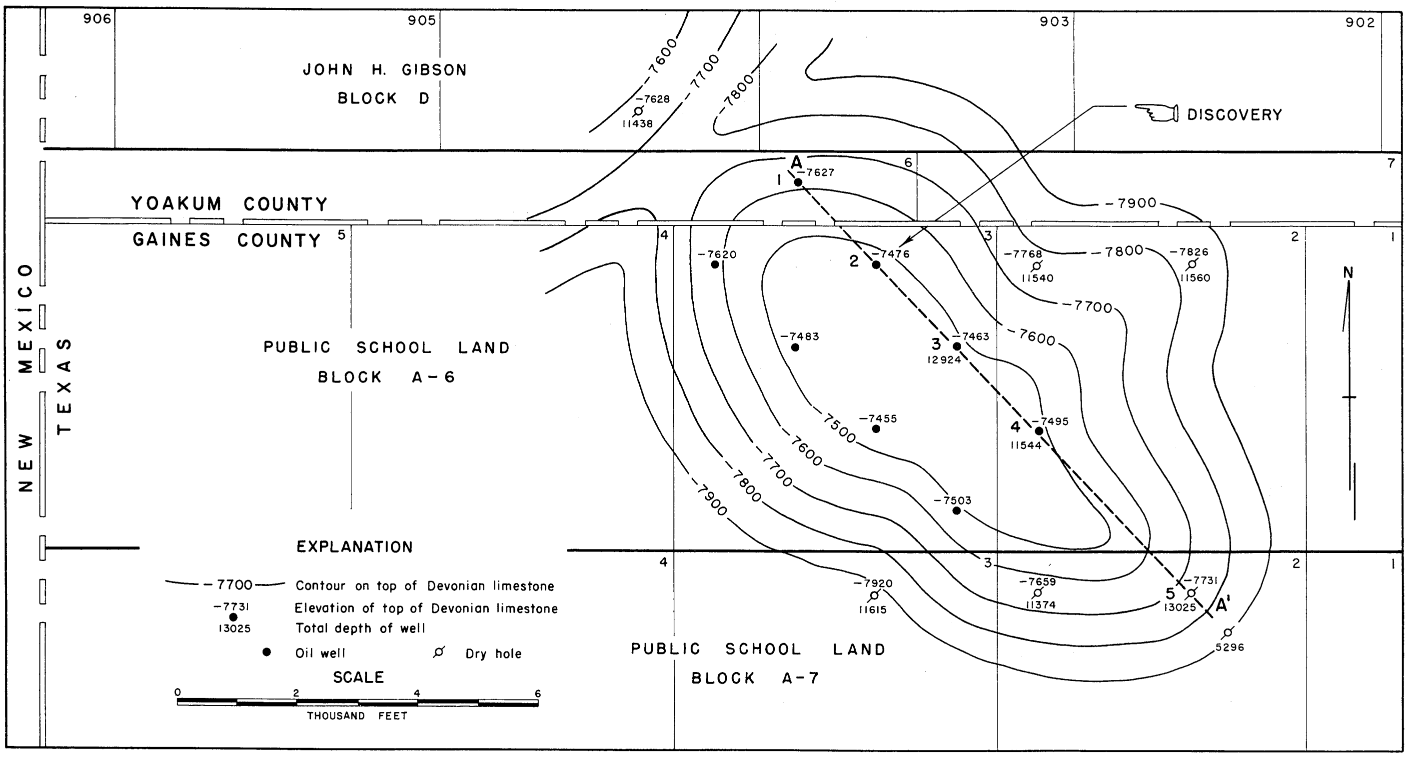
Devonian: During tests in November, water constituted the following indicated percentages of the gross liquid produced by the individual wells: Amerada #1-A Jones, none; Amerada #2-A Jones, 12%; Amerada #1-B Jones, 2%; Amerada #2-B Jones, 3%; Amerada #3-B Jones, 10%; Amerada #1-C Jones, none; Magnolia #1 "3" H&J 82%; Magnolia #2 "3" H&J, 74%. No reasonable explanation is given for the high percentage of water in the production of the two Magnolia wells.

RESERVOIR ENERGY

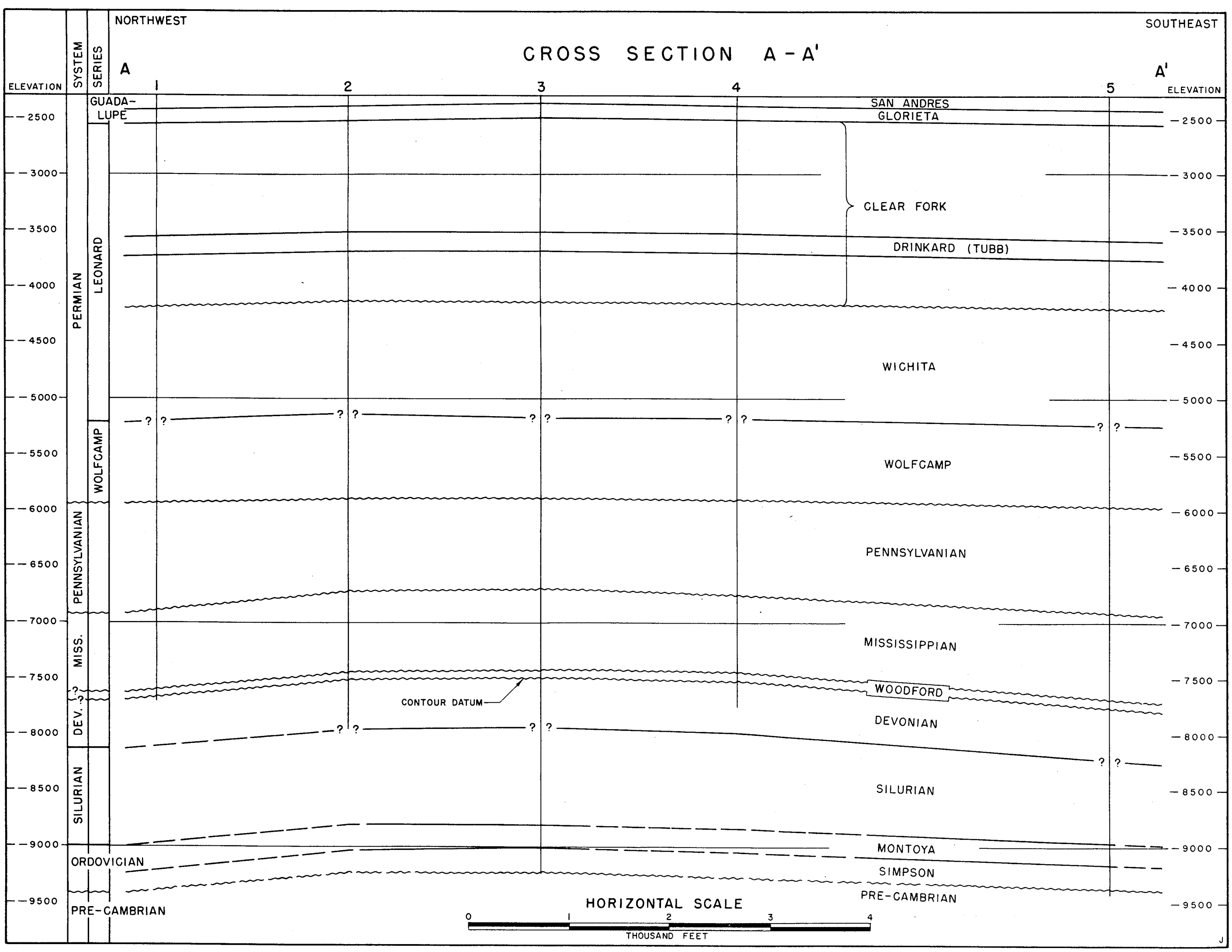
Devonian: Reservoir performance to date indicates an effective water drive.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1945	1	0	19,390	19,390
1946	3	0	185,023	204,413
1947	4	0	272,598	477,011
1948	8	0	507,109	984,120
1949	8	0	457,261	1,441,381
1950	8	0	441,044	1,882,425
1951	7	1	501,129	2,383,554
1952	7	1	469,629	2,853,183
1953	6	2	451,974	3,305,157



JOHN H. GIBSON
BLOCK D
YOAKUM COUNTY
GAINES COUNTY
NEW MEXICO
TEXAS
PUBLIC SCHOOL LAND
BLOCK A-6
PUBLIC SCHOOL LAND
BLOCK A-7
DISCOVERY
EXPLANATION
-7700 Contour on top of Devonian limestone
-7731 Elevation of top of Devonian limestone
13025 Total depth of well
Oil well
Dry hole
SCALE
0 2 4 6
THOUSAND FEET
N

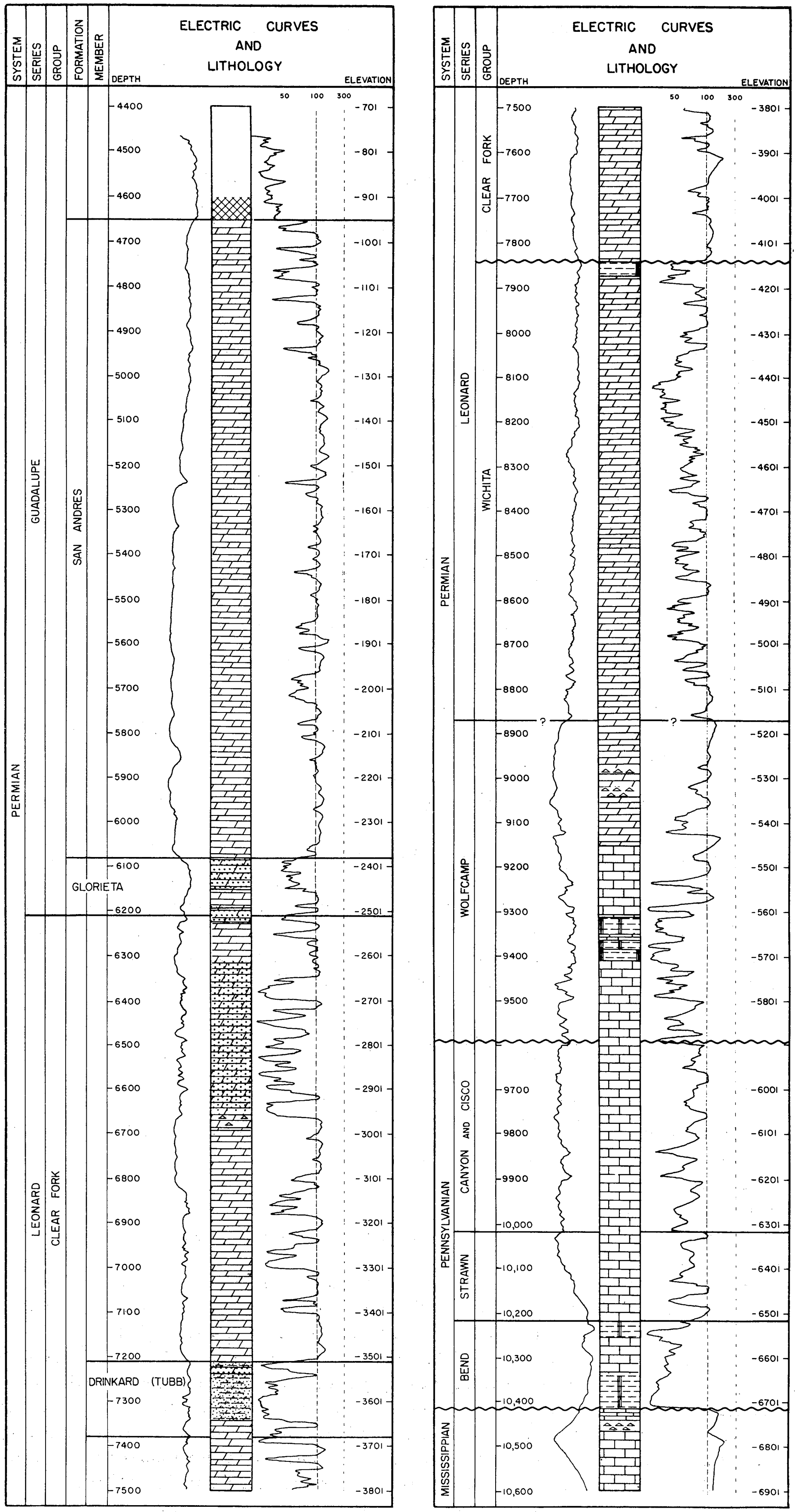


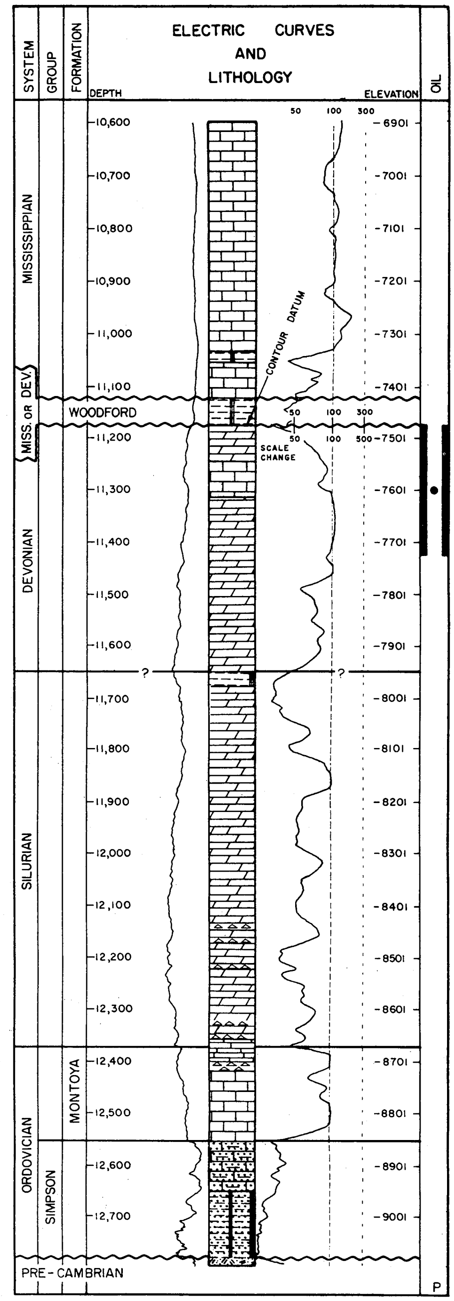
CROSS SECTION A-A'
NORTHWEST
SOUTHEAST
ELEVATION
SYSTEM
SERIES
PERMIAN
PENNSYLVANIAN
MISS.
DEV.
SILURIAN
ORDOVICIAN
PRE-CAMBRIAN
GUADA-LUPE
LEONARD
WOLFCAMP
SAN ANDRES
GLORIETA
CLEAR FORK
DRINKARD (TUBB)
WICHITA
WOLFCAMP
PENNSYLVANIAN
MISSISSIPPIAN
WOODFORD
CONTOUR DATUM
DEVONIAN
SILURIAN
MONTOYA
SIMPSON
PRE-CAMBRIAN
HORIZONTAL SCALE
0 1 2 3 4
THOUSAND FEET

TYPICAL SECTION OF ROCKS PENETRATED

SURFACE FORMATION: Ogallala formation of Pliocene series, Tertiary system.

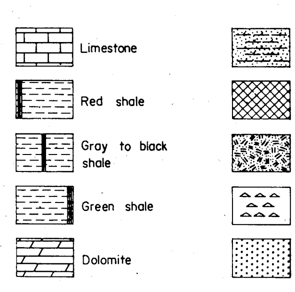
ELEVATION OF SURFACE: Highest, 3,702 feet; lowest, 3,660 feet; average, 3,690 feet.





NOTE: This TYPICAL SECTION is based on the log of Amerada #1-A Jones to the depth of 11,175 feet and below that, with depths and elevations adjusted, on the log of Amerada #1-D Jones.

EXPLANATION



KEYSTONE FIELD

Winkler County, Texas

W. C. OSBORNE
District Geologist, Union Oil & Gas Corp. of Louisiana, Midland, Texas
August 1, 1955

LOCATION

The Keystone field is in north central Winkler County immediately northeast of Kermit, county seat. It is near the southeast corner of New Mexico, as indicated on an accompanying map. It is on the Central Basin platform and occupies an area along the eastern edge of a vast belt of almost-continuous productive areas along the west edge of the platform, the dominant structural feature of the Permian basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Random drilling and trend drilling led to the discovery of the Keystone field. In 1928, several small wells were completed in the near-by Kermit field, and operators then began exploratory drilling on the basis of their various interpretations of trends indicated by prior wells. On May 30, 1929, the first commercial well within the area now known as the Keystone field, M.J. Bashara & Sons #1 Fee, was completed as a gas well in the Yates reservoir. Ten months later, on March 29, 1930, M.J.Bashara & Sons #2 Fee was completed for production of oil from Colby Sand. This discovery of oil led to desultory extension drilling and to deeper drilling, which resulted in the discovery of commercial production in Keystone Lime by Gulf Production Co. #1 Keystone Cattle Co. on July 7, 1935. This discovery gave origin to the designation as Keystone field and occasioned discontinuance of the designation as Bashara field, which designation had been used since Colby Sand discovery. The Keystone Lime discovery well was one of nine tests being drilled in the vicinity simultaneously by Gulf Production Co. under leases which were nearing their date of expiration. This drilling program was prompted by the finding of large gas production on encountering the Keystone Lime at a relatively high elevation in S.W.Richardson et al #1 J.B.Walton located in Sec. 1, Block 3, about ½ mile northwest of where Gulf drilled the Keystone Lime discovery well. As development of the Permian reservoirs proceeded, interest in the possibilities of the pre-Permian rocks increased, and intensive reflection seismograph exploration was conducted by various operators. Deeper drilling then followed and resulted in the discovery of the pre-Permian reservoirs.

ELEVATION OF SURFACE

Surface elevations range from 2,870 feet at the southwest side of the field to 2,990 feet at the northeast side of the field.

DISCOVERIES

Yates Sand: May 30, 1929;
M.J.Bashara & Sons #1 Fee.

Colby Sand: March 29, 1930;
M.J.Bashara & Sons #2 Fee.

Keystone Lime: July 7, 1935;
Gulf Production Co. #1 Keystone Cattle Co.

Holt Lime: September 23, 1943;
Richardson & Bass #4 J.B.Walton.

Devonian: April 9, 1946;
Stanolind Oil & Gas Co. #A-1 Mack Taylor.

Silurian Lime: June 2, 1945;
Sun Oil Co. #2 Keystone Cattle Co.

McKee Sand: January, 1948;
Richardson & Bass #M-58 J.B.Walton. The McKee Sand reservoir was cased off and the well was completed in Waddell Sand and designated as #W-58; completed in 1955 for dual production from McKee Sand and Waddell Sand.

Waddell Sand: January 15, 1948;
Richardson & Bass #W-58 J.B.Walton.

Ellenburger: June 11, 1943;
Amon G. Carter and Pure Oil Co. #C-2 J.B. Walton.

SURFACE FORMATION

Quaternary sand covers the surface. On the west side of the field, westward and southwestward from about the location of a line through the Silurian Lime and Ellenburger discovery wells, the surface is a rolling sandy plain sparsely covered with mesquite and grasses, while on the east side of the field, there are shifting sand dunes with practically no vegetation. This cover of loose Quaternary sand makes travel off of roads extremely difficult and, in many places, practically impossible.

(see WHITEHORSE map)

NATURE OF TRAPS

Yates Sand: Anticlinal folding is the primary trap-forming factor. Variation in degree of porosity and variation in permeability are also important trap-forming factors.

Colby Sand: The productive area is related to the area of a pair of anticlinal domes, but the relationship merely suggests that convex folding may have contributed to trapping the oil. Surely variation in porosity and permeability contributed to trap-forming, but probably not to the extent suggested by the distribution of Colby Sand wells; low porosity and low permeability preclude commercial production at some places where migration and accumulation occurred slowly during geologic time.

Keystone Lime: While anticlinal folding appears to be the primary trap-forming factor, variation in degree of porosity and permeability evidently contributed to forming the trap.

Holt Lime: The trap in the Holt Lime is due to anticlinal folding.

Devonian and Silurian Lime: The trap in each of these reservoirs is due to (a) anticlinal folding, (b) termination of reservoir by faulting and (c) erosional truncation and sealing by overlying relatively impervious beds. The truncated area of Silurian Lime is much less than that of Devonian.

McKee Sand, Waddell Sand and Ellenburger: The trap in each of these reservoirs is due to anticlinal folding and to termination of reservoir by faulting.

THICKNESSES OF RESERVOIR ROCKS

From top to bottom:*	Feet		
	Min.	Max.	Avg.
Yates Sand	11	145	140
Colby Sand	30	180	117
Keystone Lime	144	162	150
Holt Lime	51	66	58
Devonian	30	125	91
Silurian Lime	110	320	175
McKee Sand	105	112	110
Waddell Sand	60	100	80
Ellenburger	73	1,018	650

* The figures include minor partings but are exclusive of the thicknesses of major widespread non-productive beds within the reservoir rocks.

Net productive:

Available data do not afford an adequate basis for estimating net productive thicknesses.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is at the base of the Ellenburger group; i. e., at the base of the sedimentary section. As indicated on an accompanying map, 40 wells have been drilled beyond this horizon and into pre-Cambrian granite.

COMPLETION TREATMENTS

Yates Sand: Both of the current Yates Sand gas wells were completed "natural"; one for production through open-hole and the other for production through perforations.

Colby Sand: A few Colby Sand wells were completed "natural" and a few were completed with light acid treatments; the majority, however, were completed by shooting the open-hole section with 300 to 400 quarts of nitroglycerin.

Keystone Lime: The Keystone Lime wells were completed by shooting the open-hole section with 400 to 500 quarts of nitroglycerin.

Holt Lime: Acid treatment is a part of the regular completion procedure. Quantities of acid have ranged from 500 gallons to 17,500 gallons; the normal quantity is from 3,000 gallons to 10,000 gallons.

Devonian: Acid treatment is a part of the regular completion procedure. Quantities have ranged from 500 gallons to 19,500 gallons; the usual quantity is 5,000 gallons.

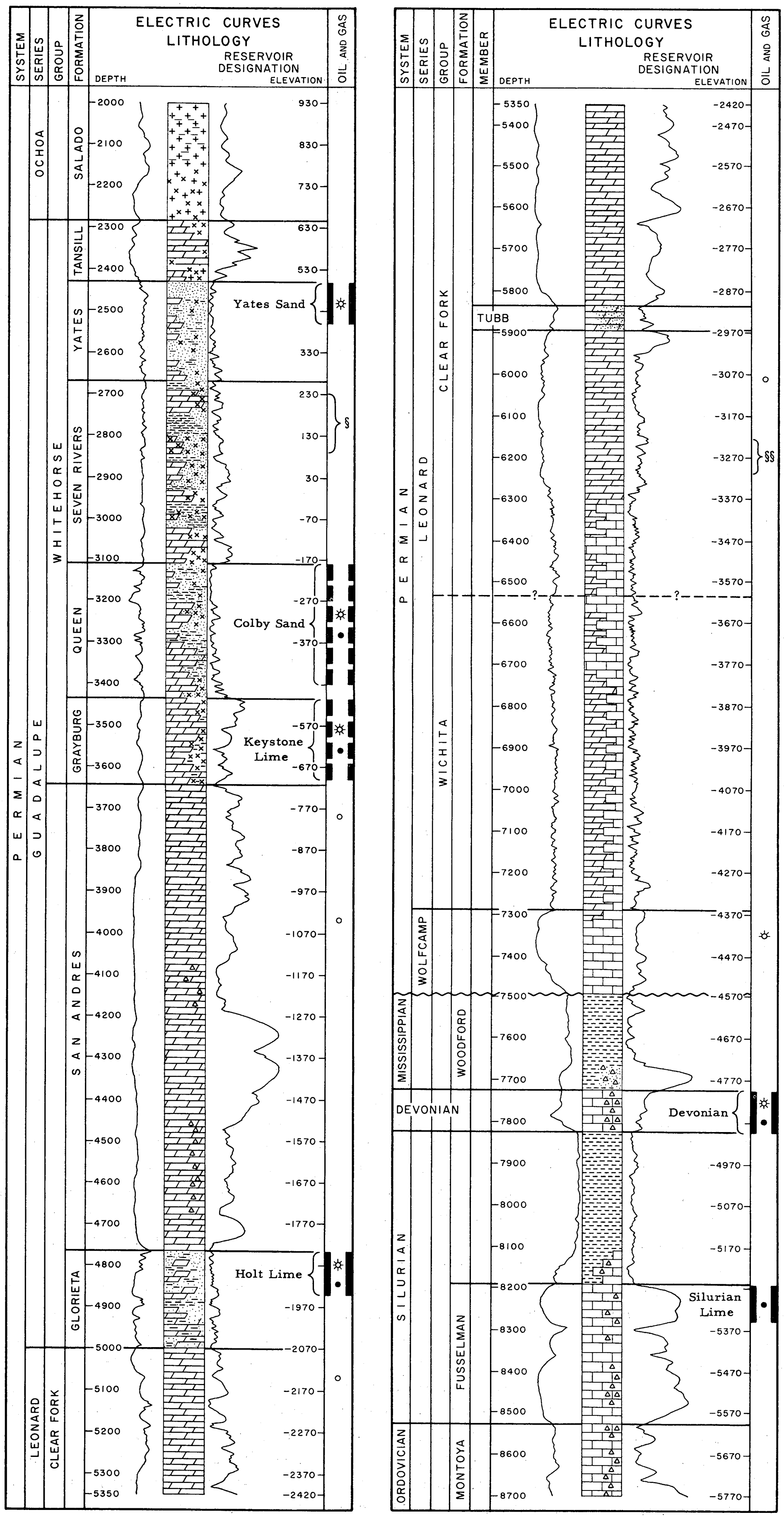
Silurian Lime: Many wells have been completed "natural"; where acid was used, the quantity was small, generally 1,000 gallons to 4,000 gallons.

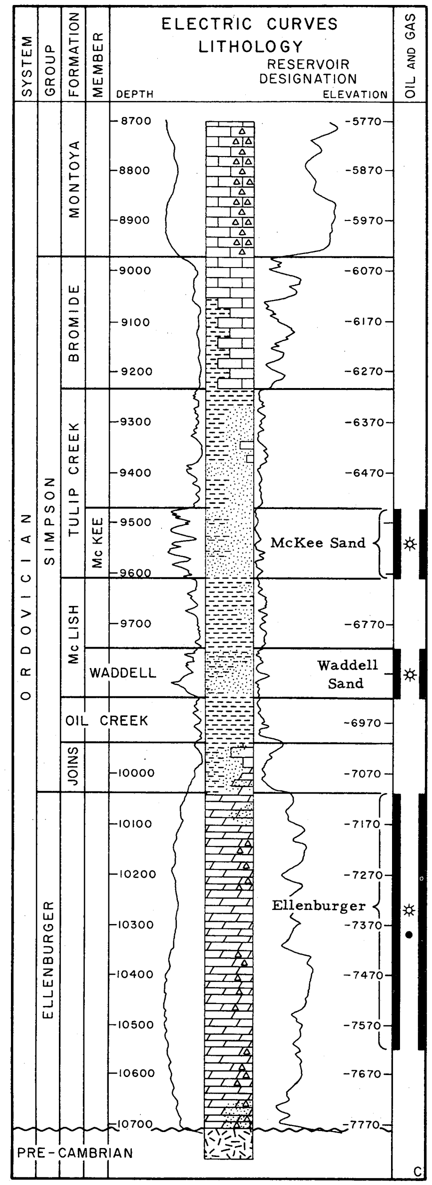
McKee Sand: The discovery well was completed "natural". The standard completion procedure includes a light acid treatment (1,000 - 2,000 gallons) and then hydraulic fracturing with 5,000 to 10,000 gallons of liquid.

Waddell Sand: The regular completion procedure has been to acidize with 2,000 gallons of acid and then to hydraulic fracture with 4,000 gallons of liquid; however, the reservoir rock in one well was shot with 55 quarts of nitroglycerin and then hydraulically fractured with 1,000 gallons of liquid.

Ellenburger: Most of the Ellenburger wells were completed "natural". Such of the wells as have been subjected to artificial stimulation were given a light acid treatment (2,000 - 4,000 gallons).

TYPICAL SECTION OF ROCKS PENETRATED



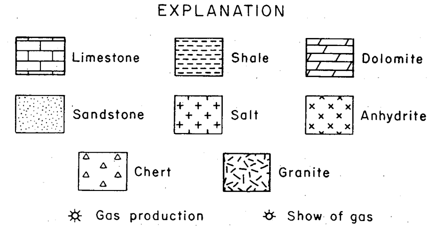


NOTE: The above TYPICAL SECTION is based on a composite of the logs of several wells. This depiction of the complete stratigraphic section results in entering excessive depths and elevations for the lower stratigraphic units.

§ Within the area of the Keystone field, there are several wells which produce oil and gas from a reservoir in the Seven Rivers formation. Such wells are treated by the Railroad Commission, and by reporting agencies generally, as in the Kermit field. That practice is followed in this paper. The area of the Kermit field overlaps with the area of the Keystone field as indicated on the accompanying Whitehorse map.

§§ The single productive zone in the near-by South Keystone field is in the Clear Fork group about 250 feet below the base of the Tubb member.

EXPLANATION



LITHOLOGY OF RESERVOIR ROCKS

Yates Sand: This reservoir rock consists of intermingled beds of sandstone, shale and dolomite with traces of salt at many places. The upper portion is primarily a fine-grained sandstone in which frosted quartz grains commonly occur about 20 feet below the top. The greater portion of the sandstone is red and is highly argillaceous; it varies in color from gray to red, depending on the amount of shale present. The permeability of this reservoir rock has been differentially decreased by differential compaction. Permeability is higher at structurally low locations than it is at structurally high locations. The sandstone grades updip into shales and anhydrite; downdip, it is more calcareous.

Colby Sand: This reservoir rock is comprised of gray to tan, fine- to medium-grained sandstone with varying amounts of dolomite, anhydrite and anhydritic dolomite. Commercial production comes almost exclusively from the sandstone; the dolomite yields some oil locally although generally its permeability is too low for commercial production. A reason for this being one of the better shallow reservoirs is that the sandstone has favorable intergranular porosity with very little cementing material. Differential compaction has affected the permeability of the sandstone so that permeability is higher at structurally low locations than it is at structurally high locations.

Keystone Lime: This reservoir rock is composed chiefly of buff to brown dolomite with small amounts of anhydrite and sand scattered throughout. It includes some cream colored lithographic dolomite which is not productive. The productive dolomite is dense to finely crystalline. The productivity of the reservoir rock is determined by the ratio of productive dolomite to lithographic dolomite, which ratio is quite variable throughout the area of the field. Permeability is higher at structurally low locations than at structurally high locations. The low permeability at high locations has occasioned the abandonment of many wells for production from this reservoir; some of such wells have been re-completed for production from other reservoirs.

Holt Lime: This reservoir rock is comprised of sand, dolomite and sandy dolomite; silty dolomitic sand at the top and grading downward into sandy dolomite and then dolomite. The sand is fine-grained, silty, and is tightly cemented. Its color ranges from gray to tan, depending on the amount of cementing material present. The dolomite is dense to finely crystalline and ranges in color from cream to brown. Most of the oil yielded by this reservoir comes from the dolomite portion of the reservoir rock. The more productive wells are located where the percentage of dolomite is abnormally high.

Devonian: This reservoir rock is composed of limestone, chert and cherty limestone. The limestone varies in texture from granular to coarsely crystalline and, in color, from white to cream or light tan. It is a clean limestone, in general, but near its base it is slightly argillaceous and siliceous. Varying amounts of chert are present throughout the reservoir rock, with the greatest amount near the top. The chert is white to bluish-white, calcareous, and is associated with varying amounts of white crystalline interbedded limestone. Extensive fracturing connects the reservoir from top to bottom and provides favorable porosity and permeability. Vuggy and cavernous porosity has developed along the fracture planes. In a belt around the area where the Devonian has been removed by erosional truncation (indicated on an accompanying map), the porosity and permeability are abnormally low, probably due to cementation of the fracture zones during the time when that portion of the reservoir rock was near the surface.

Silurian Lime: This reservoir rock is a coarsely crystalline limestone, white to light buff with a pink cast in many places. Minor amounts of translucent milky white chert and thin partings of green shale occur throughout. Porosity is of the intercrystalline type commonly associated with coarsely crystalline limestone and dolomite. There is some evidence of fracturing; fracturing, together with resultant vuggy and cavernous porosity, appears to account for the porosity being slightly greater than normal for such limestone. In several local areas, permeability is too low for commercial production, apparently because of cementation in the fracture zones.

McKee Sand: The McKee Sand is a very clean white sandstone, nearly free of shale. Occasionally it has a light green cast due to discoloration by green shale. Grain sizes vary from fine to coarse. Inter-granular porosity is almost intact with only negligible decrease by calcareous cementation.

Waddell Sand: The Waddell Sand is a medium to coarse, rather hard, white sandstone, cemented to some degree by calcareous material and containing a few thin beds of gray and green shale.

Ellenburger: The Ellenburger consists of dolomite with varying amounts of sand, chert and gray shale partings. The sandy phase is in the upper portion; the cherts and gray shales are mainly limited to the lower portion. The dolomite itself ranges from very finely crystalline gray and tan dolomite to fairly coarsely crystalline white and tan dolomite. Porosity and permeability are generally highly favorable, due almost entirely to fracturing which extends from top to bottom of the reservoir. Intergranular porosity is very low and solution porosity such as is common in limestones and dolomites is rare; however, there is some solution porosity although it is not extensive. A few vugs lined with calcite crystals have been found. At locations where the reservoir rock is not fractured, including some structurally high locations, porosity and permeability are too low for commercial production, even after repeated acid treatments.

PRODUCTIVE AREAS

	Acres		
	Productive area	Depleted or inactive	Currently producing
Yates Sand	60	20	40
Colby Sand	7,396	583	6,863
Keystone Lime	2,940	540	2,400
Holt Lime	4,400	120	4,280
Devonian	4,360	840	3,520
Silurian Lime	2,080	160	1,920
McKee Sand	1,640	0	1,640
Waddell Sand	640	320	320
Ellenburger	6,160	820	5,240
Keystone field	14,685	585	14,100

SECONDARY RECOVERY

In July, 1952, a water injection program was begun in the Colby Sand reservoir and is proving to be very successful. As indicated by data presented under PRODUCTION HISTORY, the decline of production was changed to an increasing rate of production. The number of injection wells and the quantities of water injected are reported below:

	INJECTION WELLS at end of year	WATER INJECTED (barrels)	
		Yearly	Cumulative
Colby Sand			
1952	7	1,096,000	1,096,007
1953	31	5,714,072	6,810,079
1954	37	7,674,812	14,484,891

CONTINUITY OF RESERVOIR ROCKS

Yates Sand: The reservoir rock appears to be continuous throughout the area covered by the accompanying Whitehorse map. Although porosity and permeability are too low for commercial production throughout most of that area, it appears likely that permeability adequate for migration, in geologic time, of reservoir fluids (particularly, gas) is continuous throughout that area.

Colby Sand: The reservoir rock is continuous throughout the area covered by the accompanying Whitehorse map. However, porosity and permeability adequate for commercial production are continuous throughout only a portion of that area; the productive area is indicated by the distribution of Colby Sand wells as shown on the Whitehorse map.

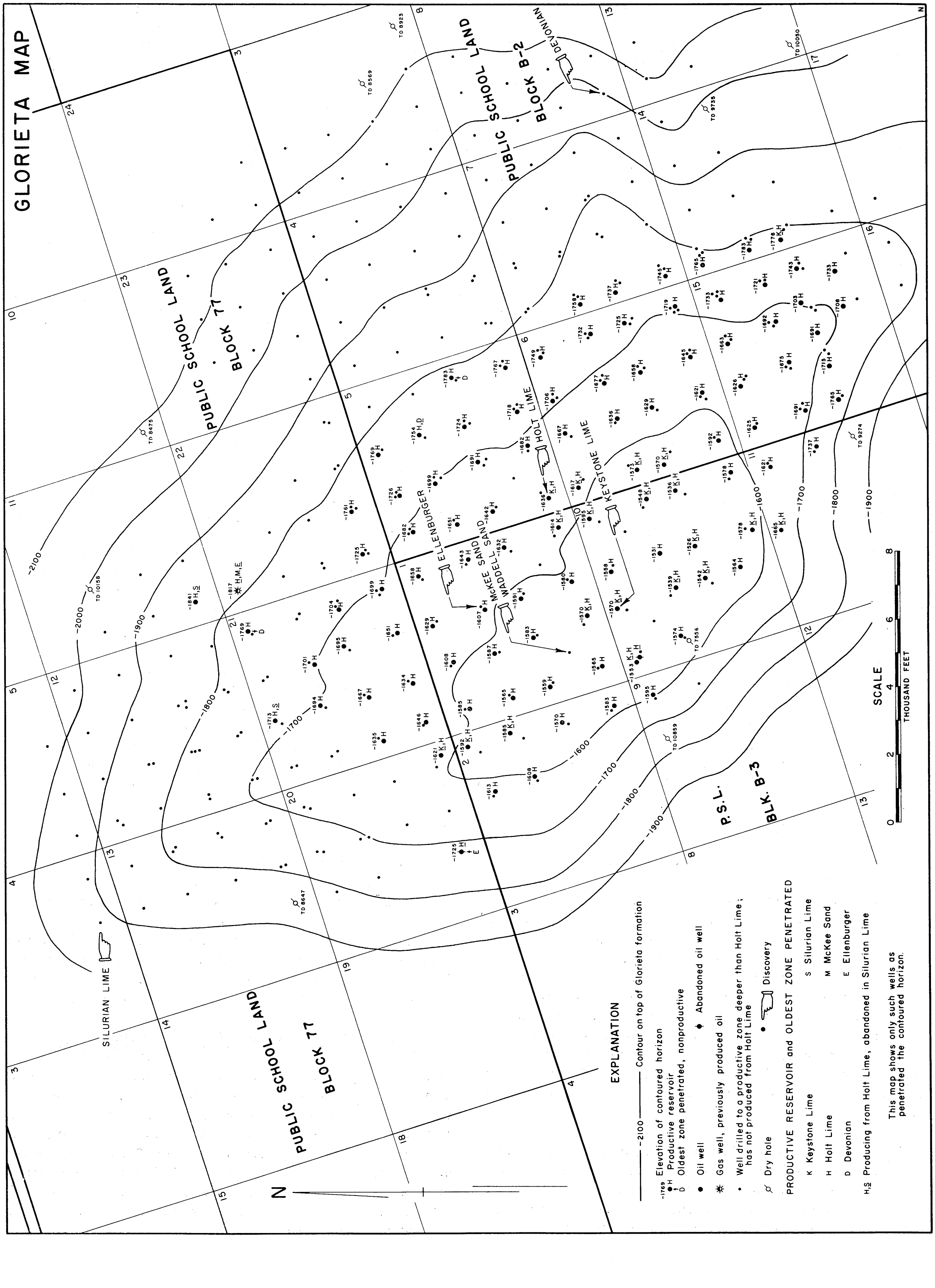
Keystone Lime: The productive area of this reservoir rock is indicated by the distribution of Keystone Lime wells as shown on the accompanying Whitehorse map. The reservoir rock is definitely continuous throughout that area. It is probably continuous throughout a much more extensive area. While rocks at this stratigraphic position are of about the same lithologic character throughout an area considerably larger than that covered by the accompanying Whitehorse map, it is known that westward on the east flank of the Delaware basin, instead of dolomite, there are sandstones and shales at this stratigraphic position. Available data do not afford an adequate basis for estimating the extent of the particular rock unit which is productive in this field.

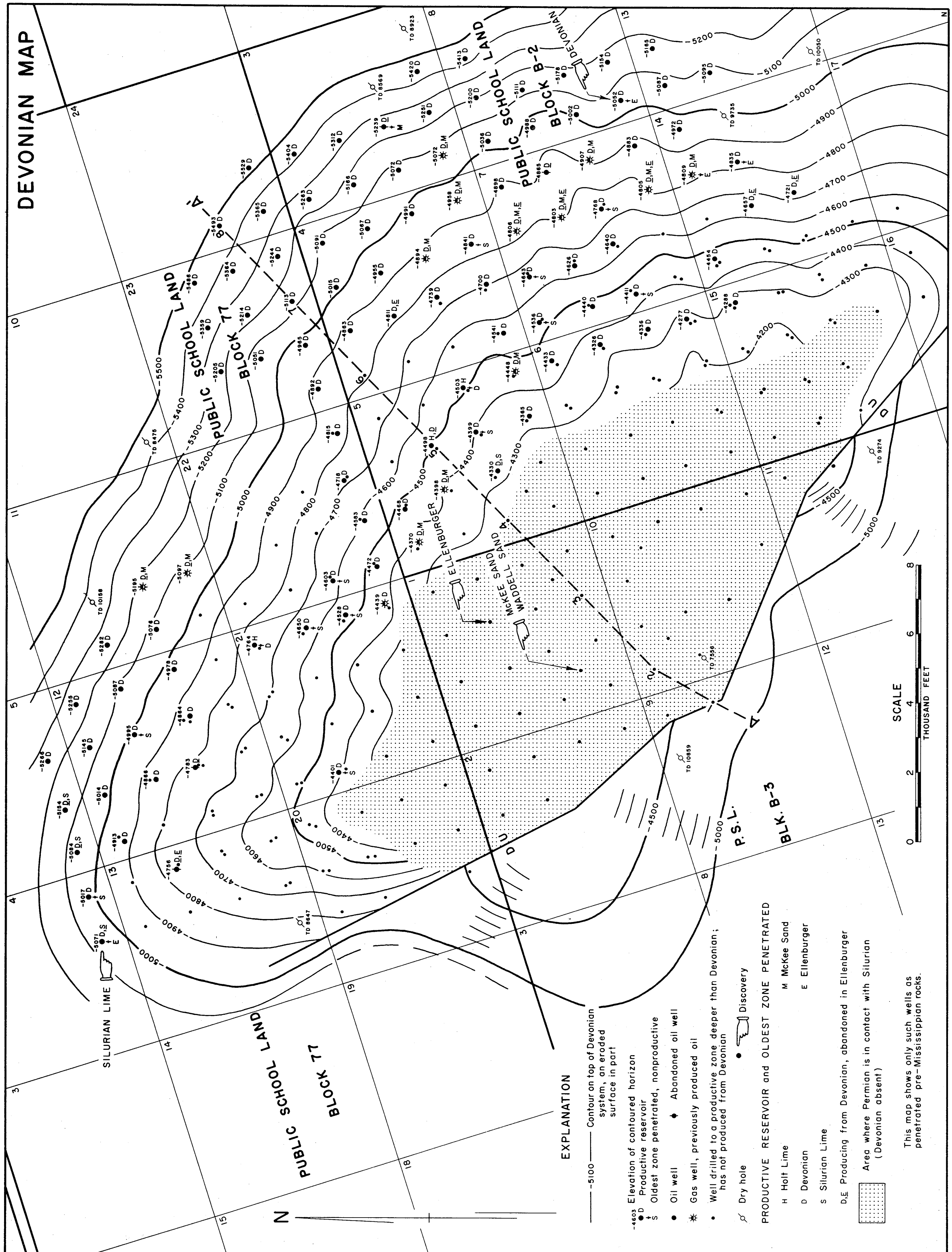
Holt Lime: The productive area of this reservoir rock is indicated by the distribution of Holt Lime wells on the accompanying Glorieta map. It is certainly continuous throughout that area, but its further extent is not determinable from available data. The Glorieta formation, of which Holt Lime is a member, is continuous throughout much of West Texas and Southeastern New Mexico, but the particular rock unit which yields oil in the Keystone field probably does not extend far beyond the productive area. Rocks at this stratigraphic position grade westward into dolomite and eastward into coarser sand with quartz and chert pebbles.

Devonian: The continuity of this reservoir rock is interrupted by a major thrust fault and by erosional truncation, as shown on the accompanying Devonian map and the accompanying cross section; otherwise, the reservoir rock is continuous and of about the same general character throughout the area covered by the accompanying Whitehorse map. Northward, the limestone grades into light-colored dolomite with less chert.

Silurian Lime: The continuity of this reservoir rock is interrupted by a major thrust fault and by erosional truncation in a small area at the apex of the anticlinal fold; otherwise, the reservoir rock is continuous and of about the same general character throughout the area covered by the accompanying Whitehorse map. Northward, the limestone grades into dolomite and the percentage of chert increases.

McKee Sand, Waddell Sand and Ellenburger: The continuity of each of these reservoir rocks is interrupted by a major fault; otherwise each is continuous and of about the same character throughout the area covered by the accompanying Whitehorse map. The stratigraphic equivalent of each is recognized throughout a large portion of West Texas and Southeastern New Mexico, and it is probable that conditions favorable for migration of reservoir fluids are generally continuous in each throughout that region except for minor local areas.


GLORIETA MAP
PUBLIC SCHOOL LAND BLOCK B-2
PUBLIC SCHOOL LAND BLOCK 77
PUBLIC SCHOOL LAND BLOCK 77
P. S. L. BLK. B-3
DEVONIAN
HOLT LIME
KEYSTONE LIME
ELLENBURGER
McKEE SAND
WADDELL SAND
SILURIAN LIME
SCALE
THOUSAND FEET
0 2 4 6 8
N
EXPLANATION
—2100— Contour on top of Glorieta formation
-1769 Elevation of contoured horizon
H Productive reservoir
D Oldest zone penetrated, nonproductive
Oil well
Abandoned oil well
Gas well, previously produced oil
Well drilled to a productive zone deeper than Holt Lime; has not produced from Holt Lime
Dry hole
Discovery
PRODUCTIVE RESERVOIR and OLDEST ZONE PENETRATED
K Keystone Lime
H Holt Lime
D Devonian
S Silurian Lime
M McKee Sand
E Ellenburger
H,S Producing from Holt Lime, abandoned in Silurian Lime
This map shows only such wells as penetrated the contoured horizon.


DEVONIAN MAP
PUBLIC SCHOOL LAND BLOCK 77
PUBLIC SCHOOL LAND BLOCK B-2
P.S.L. BLK. B-3
SILURIAN LIME
DEVONIAN
ELLENBURGER
McKEE SAND
WADDELL SAND
A
A'
SCALE
0 2 4 6 8
THOUSAND FEET
N
EXPLANATION
-5100 Contour on top of Devonian system, an eroded surface in part
-4603 D S Elevation of contoured horizon / Productive reservoir / Oldest zone penetrated, nonproductive
Oil well
Abandoned oil well
Gas well, previously produced oil
Well drilled to a productive zone deeper than Devonian; has not produced from Devonian
Dry hole
Discovery
PRODUCTIVE RESERVOIR and OLDEST ZONE PENETRATED
H Holt Lime
M McKee Sand
D Devonian
E Ellenburger
S Silurian Lime
D,E Producing from Devonian, abandoned in Ellenburger
Area where Permian is in contact with Silurian (Devonian absent)
This map shows only such wells as penetrated pre-Mississippian rocks.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Yates Sand, Colby Sand and Keystone Lime: Irregularities due to variation in porosity and permeability make it impractical to endeavor to estimate elevations of fluids in these reservoirs.

McKee Sand and Waddell Sand: The only hydrocarbon in each of these reservoirs was in gaseous state prior to reduction of pressure occasioned by production. Gas and condensate are produced from each of these reservoirs, but it is not practical to endeavor to estimate the elevations at which these fluids occur in the reservoirs. Available data do not afford an adequate basis for estimating the elevation of either upper or lower extent of gas in either reservoir.

	Holt Lime	Devonian	Silurian Lime	Ellenburger
Elevation of top of gas, feet	-1,526	-4,277	No free	-5,887
Elevation of bottom of gas, feet	-1,735	-4,400**	gas cap	-6,565
Relief, feet	209	123**	indicated	678
Elevation of top of oil, feet	-1,735	-4,400	-4,401	-6,565
Elevation of bottom of oil, feet	-1,800*	-5,500+	various	-7,150§
Relief, feet	65±	1,100+	?	585§

* The elevation of the oil-water contact in the Holt Lime reservoir is irregular; generally it is about -1,800 feet in the upper zone and about -2,100 feet in the lower zone.

** The gas cap in the Devonian reservoir, relatively small at time of Devonian discovery, has enlarged as a result of gas coming out of solution due to decline in pressure as oil has been produced. The gas-oil contact is now at an elevation of about -4,400 feet.

§ The oil-water contact in the Ellenburger reservoir has risen about 150 feet from its position at -7,150 feet at the time of the Ellenburger discovery. Correspondingly, the relief of the oil column is now only about 435 feet.

RESERVOIR ENERGY

Yates Sand: The expulsive force is due to expansion of the gas.

Colby Sand: The expulsive force is due primarily to expansion of gas as it comes out of solution in oil. There are numerous small areas where there is free gas, but there is no extensive gas cap.

Keystone Lime: Gas coming out of solution as pressure declines, combined with an expanding gas cap, provides most of the expulsive force for this reservoir. Water drive is effective, but the influx of water has not been at sufficient rate to maintain reservoir pressure as it was at time of discovery. A few structurally high wells produce gas only.

Holt Lime: The major expulsive force is due to expansion of gas as it comes out of solution in oil; water drive contributes, but the rate of the bottom-hole pressure decline indicates that gas expansion is the major expulsive force.

Devonian: Expansion of gas as it comes out of solution as pressure declines, combined with an expanding gas cap, provides the expulsive force for this reservoir. The enlargement of the gas cap and the lowering of the gas-oil contact resulted in one oil well being re-completed in 1951 as a gas well.

Silurian Lime: Expansion of gas as it comes out of solution provides the expulsive force for this reservoir. There is no free gas cap. No water intrusion has been observed.

McKee Sand and Waddell Sand: The expulsive force in each of these reservoirs is due to the expansion of the gas. The decline in pressure which permits expansion of the gas also results in retrograde condensation.

Ellenburger: An effective water drive accounts for most of the expulsive force. Water has encroached at a fairly uniform rate. The oil-water contact moved up from its position at the elevation of -7,150 feet at time of discovery to about -7,000 feet as of January 1, 1955. Although there was a gas cap, there was no noticeable lowering of the gas-oil contact during the period when reservoir pressure was reduced from the initial pressure to the bubble-point pressure. The bottom-hole pressure was 4,283 psi. at time of discovery and 3,195 psi. on January 1, 1955; it reached the bubble-point pressure (4,230 psi.) during September 1945. These data suggest that water drive has been very effective and that the effect of energy from the gas cap has been minor.

RESERVOIR TEMPERATURE and PRESSURE and OIL SAMPLE DATA

	Yates Sand	Colby Sand	Keystone Lm.	Holt Lime	Devonian	Silurian Lime	McKee Sand	Waddell Sand	Ellenburger
Original reservoir temperature, °F.	90	91	84	92	125	120	140	134	145
Original reservoir pressure, psi.	450	1,393	1,573	2,130	3,338	3,377	4,128	4,128	4,283
Gravity of oil or conds., A.P.I. @ 60° F.	Gas	37	33.2	39.5	36.2	39.7	58.2	62.1	44.2
Sulphur content of oil or condensate, %	Gas	0.78	0.80	0.56	0.44	0.49	Nil	0.05	0.14
Bubble point, psi.	Gas	1,393	1,573	2,130	3,338	3,377	Gas	Gas	4,230
Solution gas-oil ratio, cf/bbl	Gas	485	580	850	655	1,178	Gas	Gas	1,311
Volume factor, surface : reservoir	Gas	1.26	1.37	1.50	1.31	1.61	Gas	Gas	1.68

For oil analyses see:
Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 33 and 63

U. S. Bureau of Mines	Laboratory reference No.	37172 (Permian)	46087 (Ellenburger)	46105 (Silurian)	46108 (Devonian)
Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939) Group 2	Item	60			
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944)	Page	21			
Analyses of Crude Oils from 283 Important Oil Fields of the United States. R. I. 4289 (1948)	Item	222			
Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953)	Item		33	32	31

CHARACTER AND UTILIZATION OF GAS

Gas produced in this field is of a wide range in character. Some gas has been produced from each of the nine reservoirs, three of which (Yates Sand, McKee Sand and Waddell Sand) originally contained gas only and two of which (Holt Lime and Silurian Lime) have produced gas from oil wells only (i.e., as casinghead gas); and, of course, there is a corresponding variation in the character of the gas. Unfortunately, no analysis of any of the gas is available for inclusion in this paper. Only the small quantity of gas which has been produced from the Yates Sand has been classified as dry gas. The gas from the other reservoirs is of various degrees of richness and the sulphur content is various.

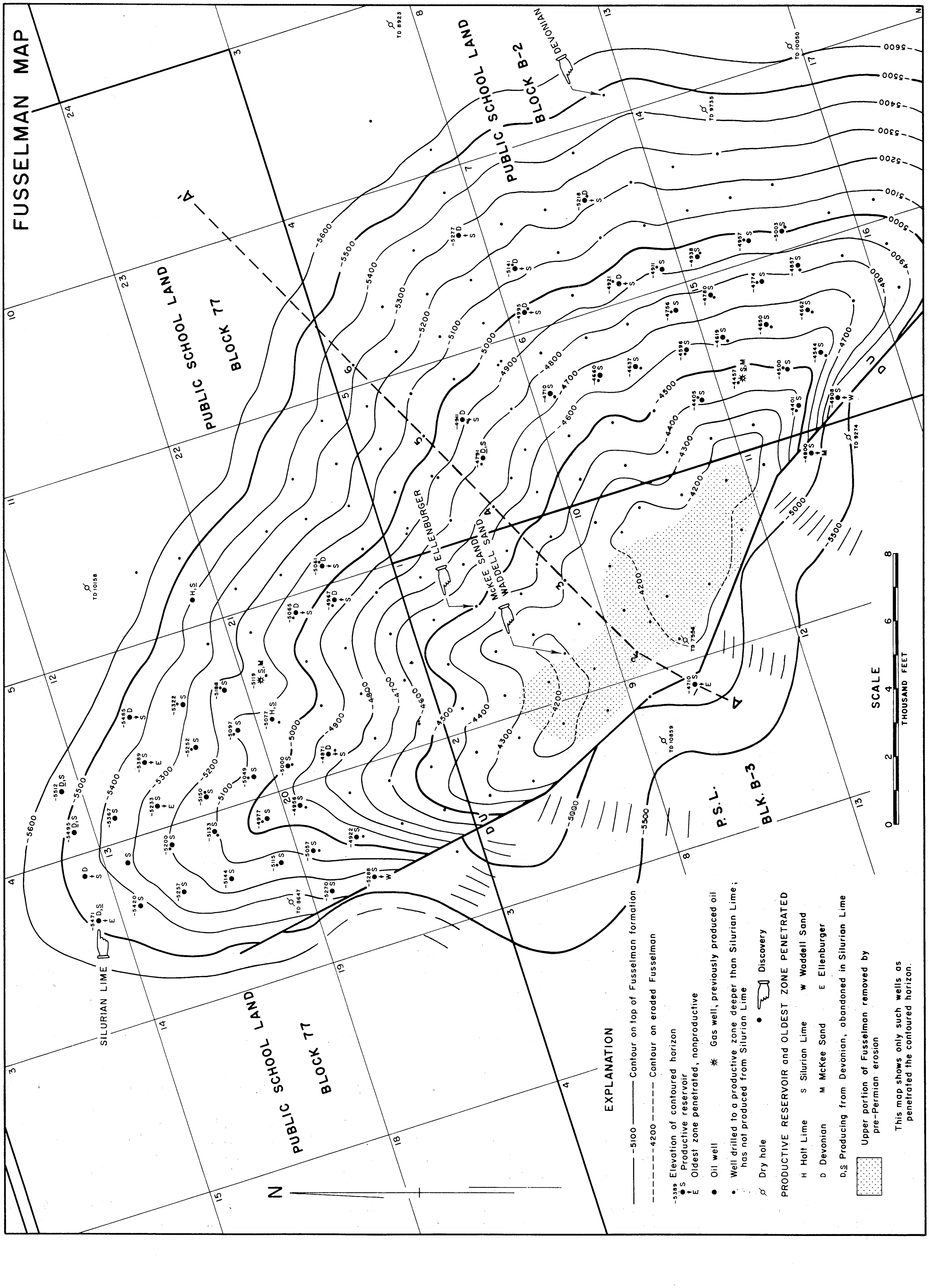
Two gasoline plants and one carbon-black plant are located in the field and process all the gas available for utilization except for small quantities used in drilling and lease operations. Cabot Carbon Company began processing gas through its carbon-black plant in June, 1937, and within the same year it initiated operations at its gasoline plant. In August, 1948, the Sid Richardson Gasoline Corporation commenced operation of its gasoline plant. Except for minor incompleteness, the following tabulation reports the quantities of the principal products (carbon-black and gasoline) of the three plants; data relative to the other products of the plants are not readily available.

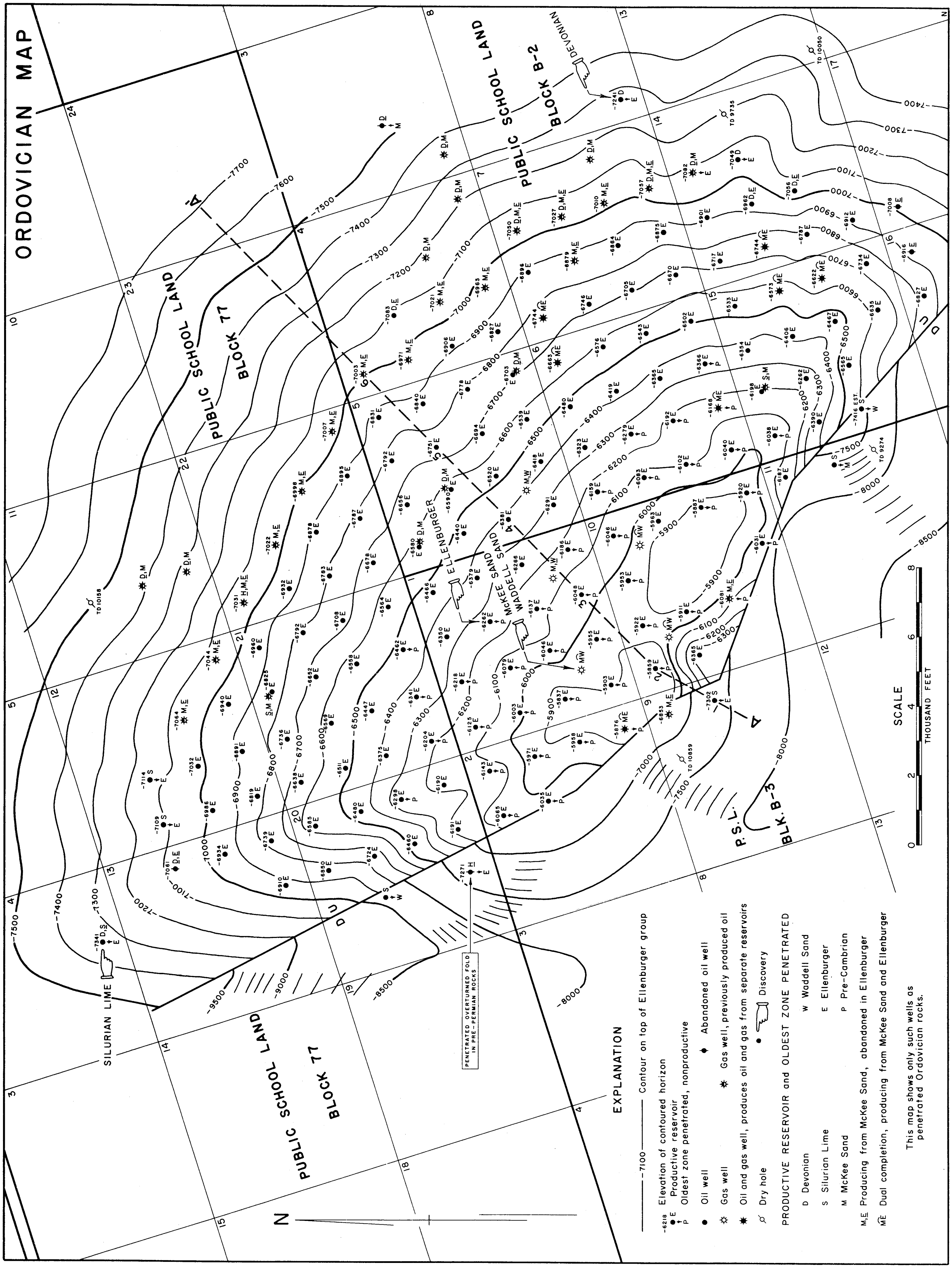
UNDERGROUND STORAGE

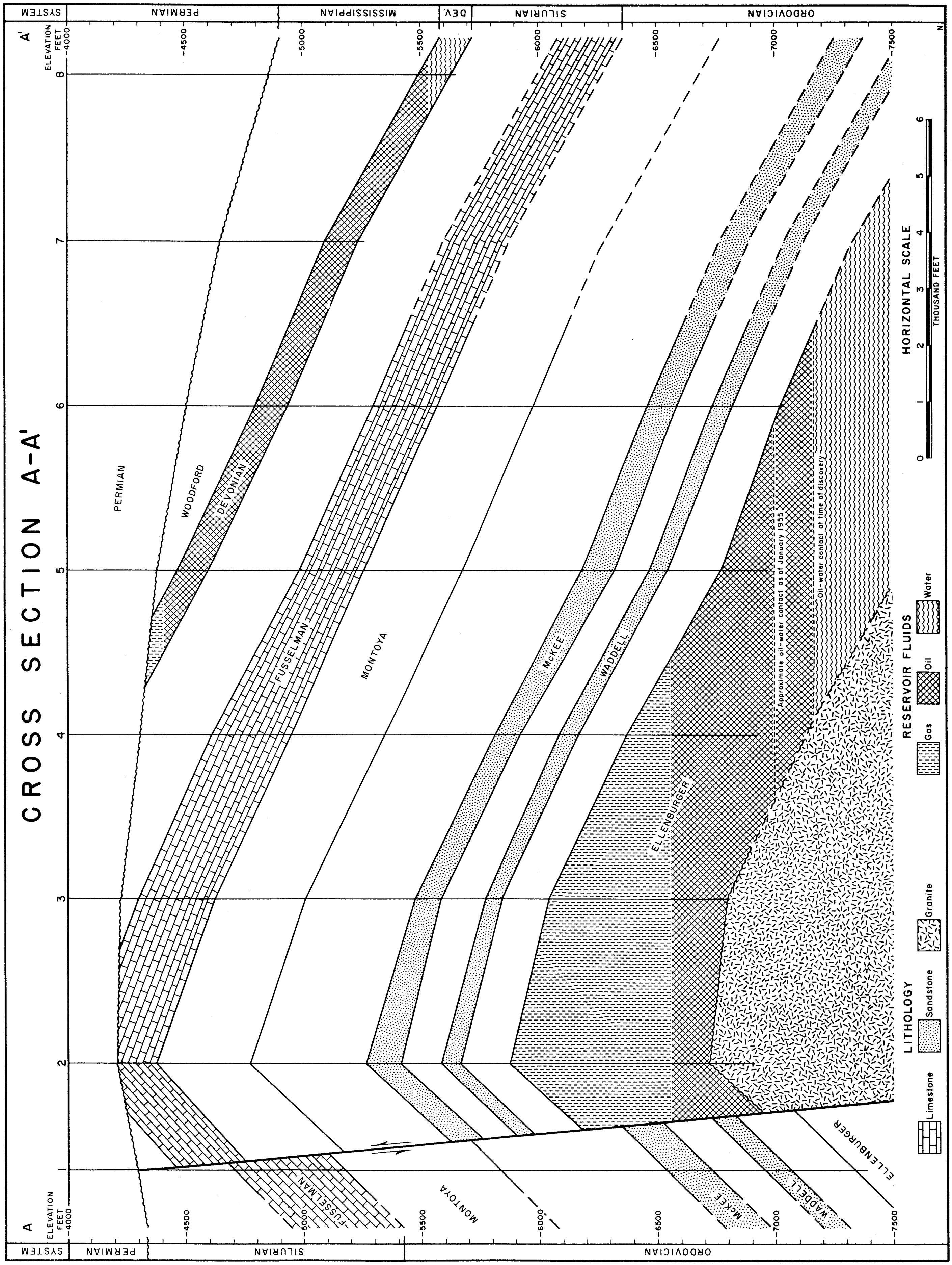
A storage well was drilled near the Sid Richardson gasoline plant in October, 1949. This well, Richardson & Bass #68 J.B. Walton, the first well drilled for underground storage in West Texas, was drilled to the total depth of 822 feet and completed for use in storing liquified petroleum gas in porous dolomite in the Rustler formation, Ochoa series. The storage zone is approximately 10 feet thick, has sufficient closure to prevent escape of the stored products and has excellent porosity and permeability.

OPERATIONS OF GAS PROCESSING PLANTS

	CARBON-BLACK		GASOLINE	
Year	Gas burned (Mcf)	Carbon-black (pounds)	Gas processed (Mcf)	Gasoline (barrels)
1937	?	?	?	?
1938	?	?	?	?
1939	10,509,080	12,581,550	10,663,840	94,718
1940	?	8,354,442	?	137,970
1941	?	17,196,020	?	279,828
1942	?	12,466,078	?	266,306
1943	?	13,328,559	?	235,125
1944	?	11,880,134	?	222,549
1945	11,311,102	16,580,785	?	323,474
1946	?	?	20,826,432	381,911
1947	15,007,442	24,703,846	19,149,725	344,925
1948	15,515,566	25,818,265	22,189,704	441,717
1949	12,810,252	23,762,755	34,948,207	673,385
1950	12,892,117	26,454,050	35,553,747	619,346
1951	13,244,380	26,484,400	40,643,980	609,085
1952	12,075,460	24,482,257	35,818,870	602,697
1953	12,035,419	25,124,880	41,546,928	740,536
1954	11,037,722	24,704,200	44,823,943	686,826


FUSSELMAN MAP
PUBLIC SCHOOL LAND
BLOCK 77
PUBLIC SCHOOL LAND
BLOCK B-2
DEVONIAN
ELLENBURGER
McKEE SAND
WADDELL SAND
SILURIAN LIME
P.S.L.
BLK. B-3
PUBLIC SCHOOL LAND
BLOCK 77
SCALE
THOUSAND FEET
EXPLANATION
-5100 Contour on top of Fusselman formation
-4200 Contour on eroded Fusselman
Elevation of contoured horizon
Productive reservoir
Oldest zone penetrated, nonproductive
Oil well
Gas well, previously produced oil
Well drilled to a productive zone deeper than Silurian Lime; has not produced from Silurian Lime
Dry hole
Discovery
PRODUCTIVE RESERVOIR and OLDEST ZONE PENETRATED
H Holt Lime
S Silurian Lime
W Waddell Sand
D Devonian
M McKee Sand
E Ellenburger
D,S Producing from Devonian, abandoned in Silurian Lime
Upper portion of Fusselman removed by pre-Permian erosion
This map shows only such wells as penetrated the contoured horizon.


ORDOVICIAN MAP
PUBLIC SCHOOL LAND
BLOCK 77
PUBLIC SCHOOL LAND
BLOCK B-2
P.S.L.
BLK. B-3
DEVONIAN
SILURIAN LIME
ELLENBURGER
McKEE SAND
WADDELL SAND
PENETRATED OVERTURNED FOLD IN PRE-PERMIAN ROCKS
SCALE
THOUSAND FEET
EXPLANATION
-7100 Contour on top of Ellenburger group
Elevation of contoured horizon
Productive reservoir
Oldest zone penetrated, nonproductive
Oil well
Abandoned oil well
Gas well
Gas well, previously produced oil
Oil and gas well, produces oil and gas from separate reservoirs
Dry hole
Discovery
PRODUCTIVE RESERVOIR and OLDEST ZONE PENETRATED
D Devonian
W Waddell Sand
S Silurian Lime
E Ellenburger
M McKee Sand
P Pre-Cambrian
M,E Producing from McKee Sand, abandoned in Ellenburger
ME Dual completion, producing from McKee Sand and Ellenburger
This map shows only such wells as penetrated Ordovician rocks.


CROSS SECTION A-A'
SYSTEM
PERMIAN
MISSISSIPPIAN
DEV.
SILURIAN
ORDOVICIAN
A'
ELEVATION FEET
-4000
-4500
-5000
-5500
-6000
-6500
-7000
-7500
A
PERMIAN
WOODFORD
DEVONIAN
FUSSELMAN
MONTOYA
McKEE
WADDELL
ELLENBURGER
Approximate oil-water contact as of January 1955
Oil-water contact at time of discovery
HORIZONTAL SCALE
THOUSAND FEET
RESERVOIR FLUIDS
Gas
Oil
Water
LITHOLOGY
Limestone
Sandstone
Granite

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: OIL Flow.	Pump.	Total	GAS	OIL PRODUCTION (barrels): Yearly	Cumulative	PRODUCTION FROM GAS WELLS: GAS (Mcf) Yearly	Cumulative	LIQUID HYDROCARBONS (barrels) Yearly	Cumulative
Field totals:										
1929	0	0	0	?	0	0	?	?	0	0
1930	?	?	1	?	?	?	?	?	0	0
1931	?	?	2	?	?	?	?	?	0	0
1932	?	?	2	?	?	?	?	?	0	0
1933	?	?	2	?	?	?	?	?	0	0
1934	?	?	3	?	?	5x,xxx	?	?	0	0
1935	?	?	13	?	111,xxx	16x,xxx	?	?	0	0
1936	?	?	35	?	520,xxx	68x,xxx	?	?	0	0
1937	?	?	99	2	1,173,xxx	1,85x,xxx	872,745	872,745	0	0
1938	?	?	157	8	1,207,xxx	3,1xx,xxx	3,101,120	3,973,865	0	0
1939	202	11	213	8	1,451,xxx	4,5xx,xxx	3,110,408	7,084,273	0	0
1940	212	26	238	8	1,649,197	6,2xx,xxx	3,204,991	10,289,264	0	0
1941	248	73	321	5	1,744,733	7,9xx,xxx	198,715	10,487,979	0	0
1942	284	81	365	1	1,703,509	9,6xx,xxx	40,499	10,528,478	0	0
1943	264	105	369	3	1,742,750	11,4xx,xxx	379,295	10,907,773	0	0
1944	272	131	403	7	2,455,799	13,8xx,xxx	971,779	11,879,552	0	0
1945	316	193	509	7	6,805,761	26,6xx,xxx	1,040,180	12,919,732	0	0
1946	440	162	602	5	15,537,577	36,2xx,xxx	457,932	13,377,664	0	0
1947	541	171	712	4 or 5	14,755,717	50,9xx,xxx	76,614	13,454,278	182	182
1948	584	223	807	10 to 13	14,561,195	65,5xx,xxx	206,053	13,660,331	2,576	2,758
1949	545	268	813	9	10,838,968	76,3xx,xxx	3,855,600	17,515,931	83,102	85,860
1950	453	403	856	11 to 14	11,030,217	87,3xx,xxx	1,974,137	19,490,068	25,961	111,821
1951	437	438	875	14 to 17	12,676,832	100,0xx,xxx	1,917,445	21,407,513	21,914	133,735
1952	417	447	864	16 to 21	11,187,152	111,2xx,xxx	2,532,800	23,940,313	11,265	145,000
1953	399	466	865	32 to 37	10,548,662	121,8xx,xxx	6,886,559	30,826,872	208,044	353,044
1954	389	476	865	49 to 54	8,939,781	130,7xx,xxx	15,718,731	46,545,603	398,251	751,295
1955*	381	478	859	56 to 61	8,214,886	138,9xx,xxx	21,857,944	68,403,547	370,426	1,121,721

Yates: See a following page. (Note that the usual presentation in stratigraphic order is not followed.)

Year	WELLS PRODUCING at end of year: OIL Flow.	Pump.	Total	GAS	OIL PRODUCTION (barrels): Yearly	Cumulative	PRODUCTION FROM GAS WELLS: GAS (Mcf) Yearly	Cumulative	LIQUID HYDROCARBONS (barrels) Yearly	Cumulative
Colby Sand:										
1930	?	?	1	0	?	?	0	0	0	0
1931	?	?	2	0	?	?	0	0	0	0
1932	?	?	2	0	?	?	0	0	0	0
1933	?	?	2	0	?	?	0	0	0	0
1934	?	?	3	0	?	5x,xxx	0	0	0	0
1935	?	?	4	0	14,xxx	6x,xxx	0	0	0	0
1936	?	?	11	0	10x,xxx	17x,xxx	0	0	0	0
1937	?	?	48	0	37x,xxx	54x,xxx	0	0	0	0
1938	?	?	91	3	60x,xxx	1,1xx,xxx	546,347	546,347	0	0
1939	128	9	137	3	83x,xxx	2,0xx,xxx	1,011,752	1,558,099	0	0
1940	136	18	154	3	981,798	3,0xx,xxx	1,344,120	2,902,219	0	0
1941	181	49	230	0	1,187,174	4,1xx,xxx	13,643	2,915,862	0	0
1942	204	57	261	0	1,249,523	5,4xx,xxx	0	2,915,862	0	0
1943	192	73	265	0	1,219,785	6,6xx,xxx	0	2,915,862	0	0
1944	186	91	277	0	1,368,637	8,0xx,xxx	0	2,915,862	0	0
1945	183	133	316	0	1,395,928	9,4xx,xxx	0	2,915,862	0	0
1946	203	99	302	0	1,281,062	10,7xx,xxx	0	2,915,862	0	0
1947	211	103	314	1 or 2	1,084,088	11,7xx,xxx	4,002	2,919,864	0	0
1948	198	131	329	2 to 5	1,036,286	12,8xx,xxx	45,309	2,965,173	0	0
1949	163	155	318	0	851,637	13,6xx,xxx	0	2,965,173	0	0
1950	91	257	348	2 to 5	863,710	14,5xx,xxx	30,446	2,995,619	0	0
1951	75	278	353	3 to 6	720,421	15,2xx,xxx	38,303	3,033,922	0	0
1952	65	284	349	4 to 9	607,895	15,8xx,xxx	93,587	3,127,509	0	0
1953	59	300	359	3 to 8	991,660	16,8xx,xxx	76,041	3,203,550	0	0
1954	47	324	371	3 to 8	1,359,668	18,2xx,xxx	42,382	3,245,932	0	0
1955*	44	327	371	3 to 8	1,017,532	19,2xx,xxx	35,759	3,281,691	0	0

* 1955 data added by amendment.

PRODUCTION HISTORY (Continued)

	WELLS PRODUCING at end of year				OIL PRODUCTION (barrels)		PRODUCTION FROM GAS WELLS			
	OIL			GAS			GAS (Mcf)		LIQUID HYDROCARBONS (barrels)	
Year	Flow.	Pump.	Total		Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
Keystone Lime:										
1935	?	?	9	0	97,004	97,004	0	0	0	0
1936	?	?	24	0	418,xxx	515,xxx	0	0	0	0
1937	?	?	51	2	801,xxx	1,316,xxx	872,745	872,745	0	0
1938	?	?	66	4	605,xxx	1,92x,xxx	2,534,300	3,407,045	0	0
1939	74	2	76	4	621,773	2,54x,xxx	2,083,122	5,490,167	0	0
1940	76	8	84	4	667,399	3,21x,xxx	1,824,159	7,314,326	0	0
1941	67	24	91	4	557,559	3,77x,xxx	50,871	7,365,197	0	0
1942	80	24	104	1	453,986	4,22x,xxx	40,499	7,405,696	0	0
1943	70	32	102	2	475,192	4,70x,xxx	329,989	7,735,685	0	0
1944	64	40	104	5	435,191	5,13x,xxx	824,732	8,560,417	0	0
1945	50	60	110	5	400,126	5,53x,xxx	932,568	9,492,985	0	0
1946	52	58	110	4	380,003	5,91x,xxx	430,684	9,923,669	0	0
1947	47	56	103	2	301,947	6,21x,xxx	28,801	9,952,470	182	182
1948	48	65	113	3	301,089	6,52x,xxx	113,874	10,066,344	401	583
1949	41	74	115	4	262,854	6,78x,xxx	276,893	10,343,237	157	740
1950	24	91	115	4	254,492	7,03x,xxx	429,718	10,772,955	164	904
1951	20	98	118	4	238,415	7,27x,xxx	280,232	11,053,187	213	1,117
1952	19	97	116	4	191,219	7,46x,xxx	328,469	11,381,656	224	1,341
1953	19	98	117	4	169,493	7,63x,xxx	380,593	11,762,249	126	1,467
1954	21	96	117	3	157,147	7,89x,xxx	303,306	12,065,555	205	1,672
1955*	21	97	118	3	151,200	7,94x,xxx	232,872	12,298,427	230	1,902

Holt Lime: See following page. (Note that the usual presentation in stratigraphic order is not followed.)

Year	Flow.	Pump.	Total	Gas	Oil Yearly	Oil Cumulative	Gas Yearly	Gas Cumulative	Liquid Yearly	Liquid Cumulative
Devonian:										
1946	6	0	6	0	113,476	113,476	0	0	0	0
1947	32	3	35	0	686,987	800,463	0	0	0	0
1948	61	10	71	0	1,554,756	2,355,219	0	0	0	0
1949	64	15	79	0	1,373,958	3,729,177	0	0	0	0
1950	73	18	91	0	1,430,969	5,160,146	0	0	0	0
1951	80	23	103	1	1,685,600	6,845,746	7,884	7,884	14	14
1952	79	25	104	1	1,301,906	8,147,652	56,244	64,128	69	83
1953	72	27	99	2	915,467	9,063,119	109,027	173,155	36	119
1954	69	21	90	1	644,525	9,707,644	9,317	182,472	5	124
1955*	66	19	85	1	504,713	10,212,357	52,574	235,046	36	160

Silurian Lime: See following page. (Note that the usual presentation in stratigraphic order is not followed.)

Year	Flow.	Pump.	Total	Gas	Oil Yearly	Oil Cumulative	Gas Yearly	Gas Cumulative	Liquid Yearly	Liquid Cumulative
McKee Sand:										
1948-1950	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	1	0	0	30,456	30,456	1,710	1,710
1952	0	0	0	1	0	0	184,745	215,201	1,798	3,508
1953	0	0	0	16	0	0	4,909,792	5,124,993	197,284	200,792
1954	0	0	0	38	0	0	14,447,408	19,572,401	392,497	593,289
1955*	0	0	0	45	0	0	20,626,023	40,198,424	361,981	955,270
Waddell Sand:										
1948	0	0	0	5	0	0	46,870	46,870	2,175	2,175
1949	0	0	0	5	0	0	3,578,707	3,625,577	82,945	85,120
1950	0	0	0	5	0	0	1,513,973	5,139,550	25,797	110,917
1951	0	0	0	5	0	0	1,560,570	6,700,120	19,977	130,894
1952	0	0	0	5	0	0	1,842,259	8,542,379	9,174	140,068
1953	0	0	0	5	0	0	1,345,587	9,887,966	10,598	150,666
1954	0	0	0	3	0	0	879,902	10,767,868	5,544	156,210
1955*	0	0	0	3	0	0	851,380	11,619,248	8,179	164,389

* 1955 data added by amendment.

PRODUCTION HISTORY (Continued)

Year	Wells Producing at end of year: Flow.	Wells Producing at end of year: Pump.	Oil Production (barrels): Yearly	Oil Production (barrels): Cumulative
Holt Lime:				
1943	1	0	6,745	6,745
1944	9	0	191,340	198,085
1945	22	0	441,560	639,645
1946	48	5	1,002,551	1,642,196
1947	71	5	1,779,767	3,421,963
1948	96	5	2,579,900	6,001,863
1949	96	9	1,782,498	7,784,361
1950	93	14	1,370,727	9,155,088
1951	92	15	1,453,774	10,608,862
1952	94	13	1,316,643	11,925,505
1953	92	14	1,222,270	13,147,775
1954	94	13	876,288	14,024,063
1955*	94	12	876,769	14,900,832
Silurian Lime:				
1945	1	0	5,857	5,857
1946	1	0	16,218	22,075
1947	27	4	501,610	523,685
1948	33	8	1,246,266	1,769,951
1949	39	9	1,028,606	2,798,557
1950	37	11	975,471	3,774,028
1951	36	12	1,084,775	4,858,803
1952	34	14	934,677	5,793,480
1953	34	14	853,124	6,646,604
1954	36	12	751,895	7,398,499
1955*	34	14	760,001	8,158,500
Ellenburger:				
1943	1	0	41,028	41,028
1944	13	0	460,631	501,659
1945	60	0	4,562,290	5,063,949
1946	130	0	12,744,267	17,808,216
1947	153	0	10,401,318	28,209,534
1948	148	4	7,842,898	36,052,432
1949	142	6	5,539,415	41,591,847
1950	135	12	6,134,848	47,726,695
1951	134	12	7,493,847	55,220,542
1952	126	14	6,834,812	62,055,354
1953	123	13	6,396,648	68,452,002
1954	122	10	5,150,258	73,602,260
1955*	122	9	4,904,671	78,506,931

Year	Wells Producing at end of year: Gas	Gas Production (Mcf): Yearly	Gas Production (Mcf): Cumulative
Yates Sand: §			
1929-1936	?	?	?
1937	0	0	0
1938	1	20,473	20,473
1939	1	15,534	36,007
1940	1	36,712	72,719
1941	1	134,201	206,920
1942	0	0	206,920
1943	1	49,306	256,226
1944	2	147,047	403,273
1945	2	107,612	510,885
1946	1	27,248	538,133
1947	1	43,811	581,944
1948-1951	0	0	581,944
1952	1	27,496	609,440
1953	2	65,519	674,959
1954	1	36,416	711,375
1955*	1	59,336	770,711

§ For the years prior to 1937, records of the number of wells producing at the end of each year and of the quantity of gas produced are not readily available. All above entries reporting cumulative production omit an unknown quantity of gas produced by the two wells completed in Yates Sand prior to 1937. Four wells in the Keystone field have been completed in Yates Sand. Since 1953, no production has been reported from one of the two wells indicated as currently productive from Yates on the accompanying Whitehorse map.

* 1955 data added by amendment.

WATER PRODUCTION

Estimates of quantities of water produced are not available. The operators do not keep records of observations which would afford a basis for making such estimates. It is known, however, that some wells producing from each of eight of the nine reservoirs have produced some water. No water is known to have been produced by either of the two wells indicated as Yates Sand wells on the accompanying Whitehorse map nor from the Yates Sand reservoir by any of the few wells which have produced only temporarily from this reservoir. Only a few of the McKee Sand wells and the Waddell Sand wells have produced any water; the quantities of water produced by these gas wells have been negligible. There is a wide range in water production of wells producing oil from Colby Sand, Keystone Lime, Holt Lime, Devonian, Silurian Lime and Ellenburger. Analyses indicate that the average chloride content of such water as has been produced from each reservoir was as follows:

	Parts per million
Colby Sand	82,400
Keystone Lime	50,200
Holt Lime	81,600
Devonian	100,000
Silurian Lime	138,000
McKee Sand	91,680
Waddell Sand	No analysis
Ellenburger	65,600

LANCASTER HILL FIELD

Crockett County, Texas

CHARLES R. GRICE
Consulting Geologist, Midland, Texas
June 1, 1953

LOCATION

The Lancaster Hill field is in west central Crockett County, about 5 miles northeast of the site of the ruins of Fort Lancaster and about 25 miles west of the town of Ozona, county seat. It is in Secs. 14 and 15 of Block 29, University Lands survey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The discovery of this field resulted directly from core drill exploration conducted by Gulf Oil Corporation during 1947 and 1948. The discovery well was being drilled for the purpose of obtaining samples of near-surface rocks when it discovered oil.

DISCOVERY

Grayburg: April 10, 1947; Gulf Oil Corp. #1-R University. The top of the productive rock was found at depth of 1,667 feet (1,004 feet above sea level) and the well was drilled to total depth of 1,685 feet. During initial potential test, the well pumped 108 barrels of 33.3° gravity oil in 24 hours through 2-inch tubing set 1,682 feet; gas-oil ratio, 591 to 1. Surface elevation, 2,671 feet.

ELEVATION OF SURFACE

At well locations: Highest, 2,700 ft.; lowest, 2,417 ft.

SURFACE FORMATION

Undifferentiated Cretaceous.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is 661 feet below the top of the Ellenburger group. This penetration was in the dry hole in Sec. 10 where the total depth of 8,626 feet is indicated on the accompanying map.

NATURE OF TRAP and STRUCTURE

Grayburg: The oil accumulation is due to updip decrease of porosity on a structural nose. There are indications of the possibility of structural closure immediately west of the field, but it appears that within the area of such indicated closure the degree of porosity is too low for commercial production.

PRODUCTIVE AREA

Grayburg and Field: Estimated 120 to 160 acres.

THICKNESS OF RESERVOIR ROCK

Grayburg:	Feet Min.	Feet Max.	Feet Avg.
Gross, top to bottom	10	18	15

LITHOLOGY OF RESERVOIR ROCK

Grayburg: Buff to tan, medium crystalline, anhydritic dolomite alternating with thin medium-grained sand and anhydrite stringers.

CONTINUITY OF RESERVOIR ROCK

Grayburg: The reservoir rock appears to be continuous throughout the area covered by the accompanying map. However, the degree of porosity adequate for commercial production appears to be limited to the immediate vicinity of the productive wells.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Grayburg:	Feet
Elevation of top of oil	1,004
Elevation of bottom of oil	976
Relief	28

CHARACTER OF OIL

Gravity: 33.3° Base: Asphalt Color: Black

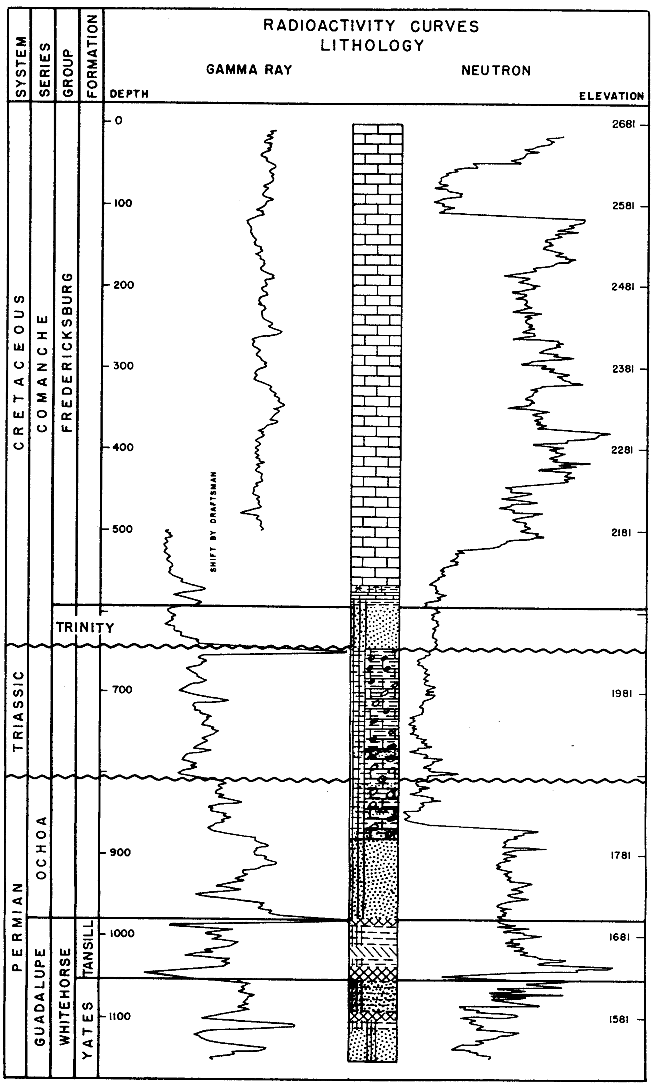
WATER PRODUCTION

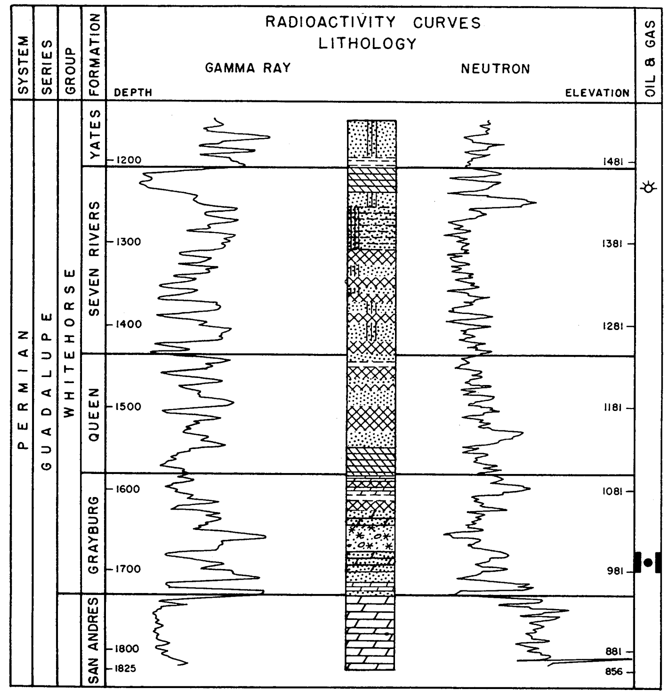
Grayburg: It is known that some water is produced with the oil, but details are not available.

PRODUCTION HISTORY

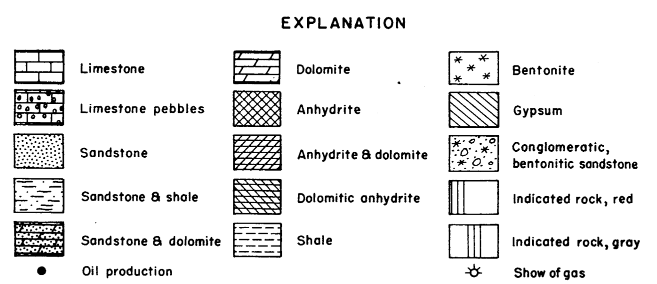
Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1947	3	13,479	13,479
1948	3	10,607	24,086
1949	3	3,136	27,222
1950	2	1,891	29,113
1951	2	2,672	31,785
1952	3	3,372	35,157
1953, Jan. & Feb.	3	701	35,858

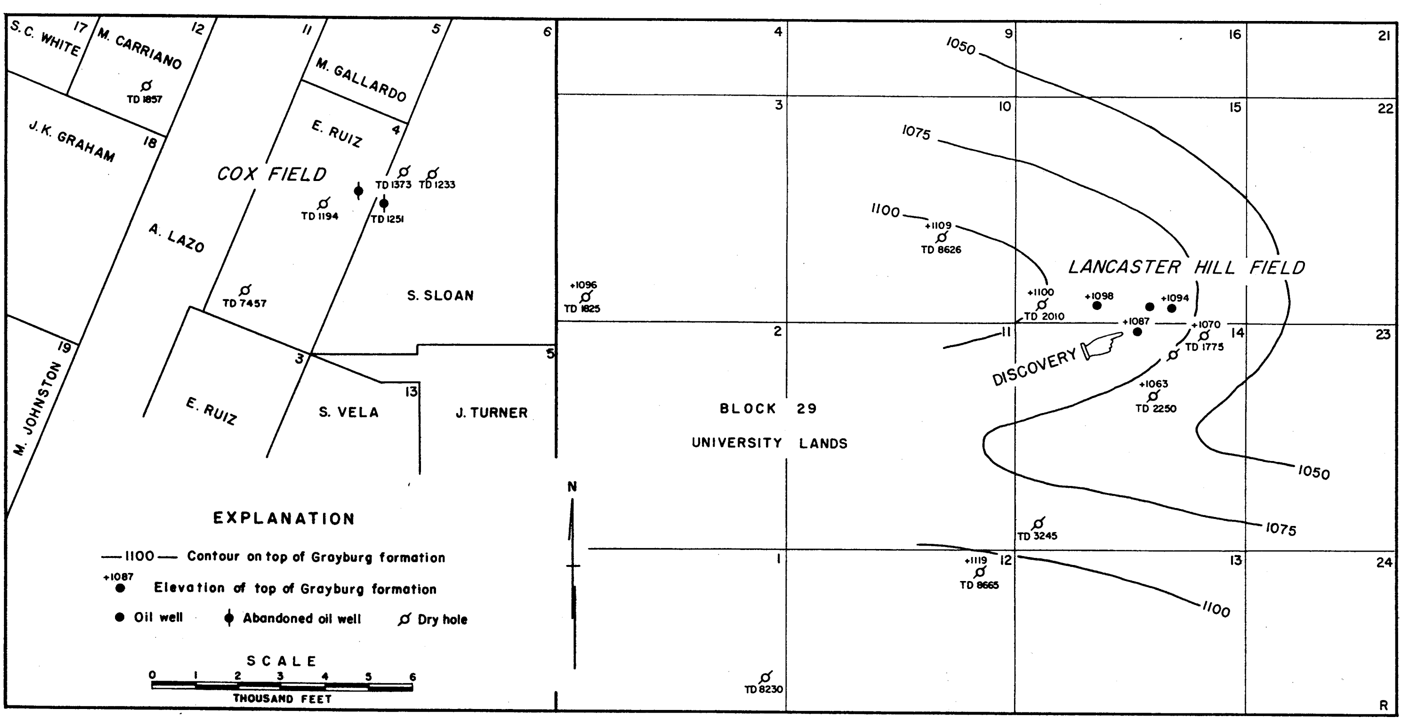
TYPICAL SECTION OF ROCKS PENETRATED





NOTE: This TYPICAL SECTION is based on the log of A. R. McElreath #1 University, a dry hole about two miles west of the field. Although there was no production at this location, the position of the productive reservoir is indicated by the customary symbol.





LEE HARRISON FIELD

Lubbock County, Texas

WILLIAM H. CARTER
District Geologist, Midstates Oil Corporation, Midland, Texas
November 22, 1955

LOCATION and OTHER NAMES

The Lee Harrison field is in central Lubbock County about 3 miles east of the city of Lubbock. It is about a mile northwest of the Fort Worth & Denver railway and immediately southeast of U. S. Highway 62, which is parallel to the railway through the area covered by the accompanying map.

Throughout the several years when there was only one well in the field it was generally known as the Lubbock field. In some publications, the field was first designated as the Nairn field, but this name was soon superseded by the more widely used name. Following the completion of the second well on October 9, 1948, the field was given its present name in memory of the late Lee Harrison of Lubbock, who drilled the discovery well. Effective February 1, 1949, the Railroad Commission changed its official designation from Lubbock field to Lee Harrison field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph.

DISCOVERY

Clear Fork: August 20, 1941; Lee C. Harrison et al #1 W.G.Nairn Estate. After treatment with 2,000 gallons of acid, the well produced by pumping through casing perforations from 4,885 to 5,002 feet at the daily rate of 160 barrels of oil and 8 barrels of water; gas-oil ratio, 300 : 1. The well was temporarily abandoned in October of 1945 after having produced a total of 11,527 barrels of oil; production was started again in June of 1947.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Bend shale of Lower Pennsylvanian age. This penetration was in Texas & Pacific Coal & Oil Co. #1 F. W. Austin, a dry hole located near the northwest corner of the area covered by the accompanying map (TD 10,030).

NATURE OF TRAP

Clear Fork: The accumulation of oil is due partly to a convex fold and partly to variation in degree of porosity and permeability.

ELEVATION OF SURFACE

At well locations (derrick floor): Highest, 3,208 feet; lowest, 3,198 feet.

SURFACE FORMATION

The surface formation is sandy loam of the Ogallala formation of the Pliocene series.

THICKNESSES OF RESERVOIR ROCK

Clear Fork:	Feet		
	Min.	Max.	Avg.
From top to bottom	90	132	115
Net productive	?	?	45

LITHOLOGY OF RESERVOIR ROCK

Clear Fork: Dolomite; tan, brown or gray; intermittently finely granular and finely porous; locally oolitic and locally cherty; low permeability; contains a few partings of dense gray dolomite and also of shale.

CHARACTER OF OIL

Clear Fork:

Gravity, A.P.I. @ 60°F.: 23.6° - 28° ; avg., 25°.
Base: Asphalt — Color: Black

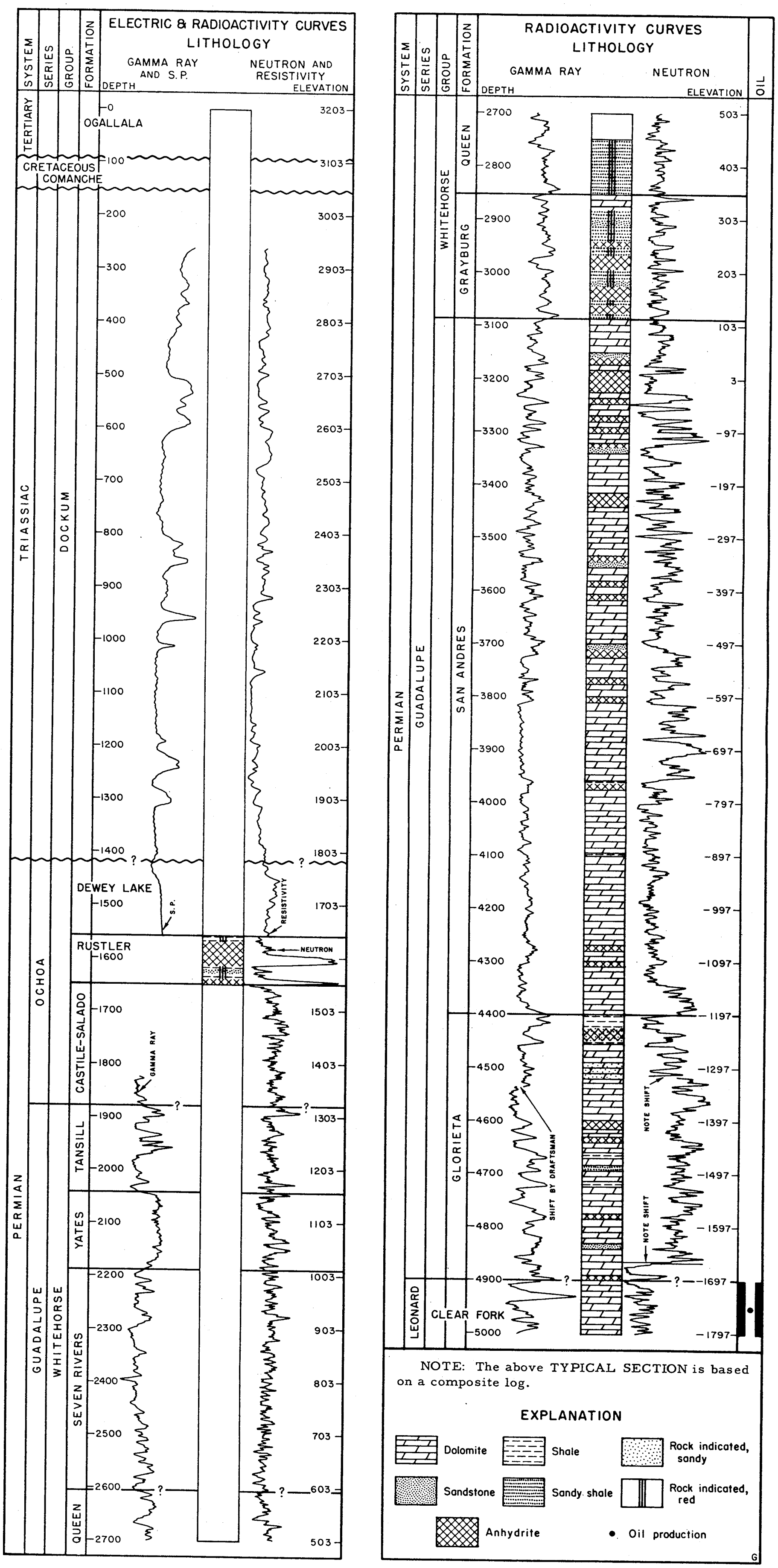
WATER PRODUCTION

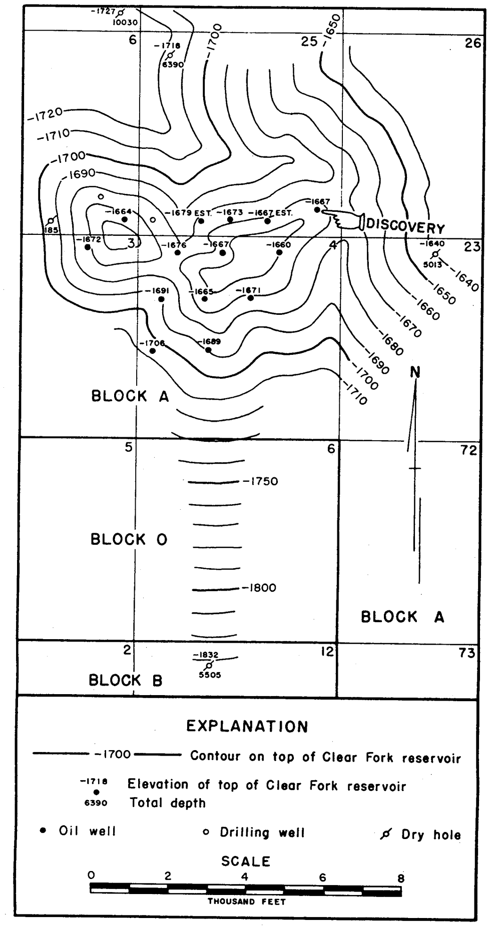
Clear Fork: Water constitutes a material portion of the gross production of each well; the range is about 3% to about 75%.

ACID TREATMENT

Clear Fork: Each well was treated with acid during completion operations. The quantity of acid used during each treatment ranged from 2,000 gallons to 19,000 gallons. The large quantities were occasioned by the low permeability of the reservoir rock.

TYPICAL SECTION OF ROCKS PENETRATED





PRODUCTIVE AREA

Clear Fork and Field: 560 acres.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Clear Fork:	Feet
No free gas cap	
Highest known oil	-1,664
Lowest known oil	-1,829
Known relief	165

PRODUCTION HISTORY

	WELLS PRODUCING at end of year — All pumping	OIL PRODUCTION (barrels) Yearly	Cumulative
Clear Fork:			
1941	1	1,764	1,764
1942	1	2,353	4,117
1943	1	1,467	5,584
1944	1	3,520	9,104
1945	1	2,425	11,529
1946	0	0	11,529
1947	1	1,489	13,018
1948	2	4,506	17,524
1949	6	41,186	58,710
1950	10	63,281	121,991
1951	10	49,889	171,880
1952	10	44,641	216,521
1953	10	40,073	256,594
1954	12	41,928	298,522
1955*	14	90,360	388,882

*1955 data added by amendment.

Operation of the discovery well was suspended temporarily from time to time until after the second well was completed late in 1948. No production was reported for the period from October 1945 to June 1947.

LEHN-APCO FIELD

Pecos County, Texas

JAMES P. MURPHY and JAKE W. HODGES
Geologists, Sinclair Oil & Gas Company, Midland, Texas and Roswell, New Mexico, respectively
October 1, 1955

LOCATION and DEFINITION

The Lehn-Apco field is in north-central Pecos County about 5 miles southwest of the town of Buenavista. It is on the Central Basin platform near its southwestern edge.

The Lehn-Apco field is in the midst of an area spotted closely with oil and gas fields. The random distribution, the lean production and the generally small extent of the continuously productive areas have contributed to confusion in applying field names and in keeping records of development and operation. Certain parts of this field are about as closely related to certain parts of near-by fields as they are to other parts of this field. The definition of the field is not determined as much by geologic facts as it is by geography and history. For the purposes of this paper, the Lehn-Apco field is defined as including all of the productive area within the area of the accompanying map except a portion of the area of the Apco field at the southeast corner and also portions of the areas of the Lehn-Apco North field and the Pecos-Shearer field, both in the north-central portion of the area covered by the accompanying map. This definition coincides with the current definition of the Lehn-Apco (1600') field of the Railroad Commission except that the productive portion of Sec. 46 at the northwest end of the field is treated by the Commission as in the Pecos Valley (Low Gravity) field and, furthermore, our definition includes the Commission's Lehn-Apco (Ellenburger) field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Interpretation of subsurface geological data.

ELEVATION OF SURFACE

At well locations: Highest, 2,490 ft.; lowest, 2,400 ft.

PRODUCTIVE AREAS

	Acres
Seven Rivers	80
Queen-Grayburg	2,100
Ellenburger	40
Lehn-Apco field	2,220

HISTORY and FIELD NAMES

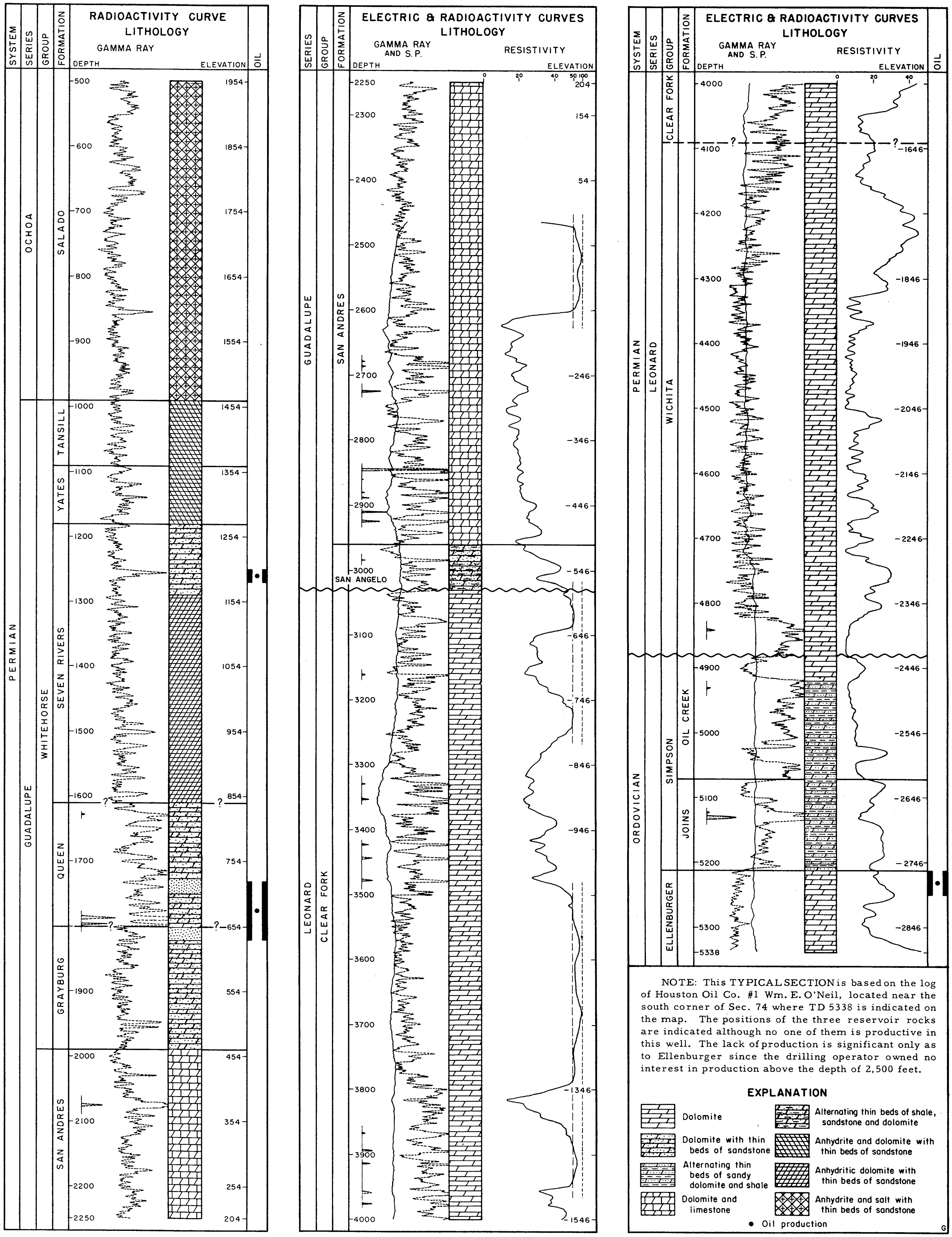
The first commercial well within the area of the Lehn-Apco field was completed on July 20, 1939, at a location near the east corner of Sec. 71 and indicated on the accompanying map by a discovery symbol. Under the name of Lehn field, development spread to include portions of Secs. 47, 48, 69, 70, 71, 72, 73 and 74. On October 22, 1943, E.R. Lloyd #1 Mrs. E.C.Powell (now, Burke Royalty Co. #1 E.C.Powell) was completed in Sec. 76 and was recognized as a discovery well. Development spread into Sec. 75 and the name Apco 1600' field was applied to the producing area in Secs. 75 and 76. On May 20, 1944, Debs Patillo #1 Iowa Realty Trust (now, Burke Royalty Co. #1 Iowa Realty Trust), located in Sec. 61, was completed as a producer in the Seven Rivers formation. Although the producing zone is considerably higher than the producing zone in the wells then in the Lehn field, this well and two additional wells subsequently completed in the same reservoir were added to the Lehn field schedules and treated as if they were producing from the same reservoir as other Lehn wells. For purposes of regulation, the Lehn field was consolidated with the Apco 1600' field on October 1, 1945, under the name Lehn-Apco 1600' field. Wells located 3 to 5 miles north of the herein defined Lehn-Apco field subsequently were completed and treated as in this field. The first of such wells was completed on March 6, 1946; there were 20 such wells on April 1, 1949, when they were removed from the Lehn-Apco 1600' field schedules and set up as in the Lehn-Apco 1600' North field.

As wells were completed in Sec. 47, near the northwest end of the field, they were added to either the Lehn schedule or the Lehn-Apco 1600' schedule, whichever was effective at the time. However, only a short distance westward, in Sec. 46, there were previously completed wells which were carried on the schedules for the Pecos Valley (Low Gravity) field. Now that the productive area is continuous, for the purposes of this paper, the wells in Sec. 46 are considered as in the Lehn-Apco field although they are currently treated by the Railroad Commission as in the Pecos Valley (Low Gravity) field, the main portion of which occupies an area beginning 2 miles westward.

SURFACE FORMATION

Quaternary sands.

TYPICAL SECTION OF ROCKS PENETRATED



NOTE: This TYPICAL SECTION is based on the log of Houston Oil Co. #1 Wm. E. O'Neil, located near the south corner of Sec. 74 where TD 5338 is indicated on the map. The positions of the three reservoir rocks are indicated although no one of them is productive in this well. The lack of production is significant only as to Ellenburger since the drilling operator owned no interest in production above the depth of 2,500 feet.

RESERVOIRS

Oil in commercial quantities has been found in three stratigraphic zones; one is in the Seven Rivers formation, one is partly in the Queen formation and partly in the Grayburg formation, and the other is in the Ellenburger group. For the purposes of this paper, each of these productive zones is treated as a stratigraphic unit designated as the reservoir rock.

The Seven Rivers reservoir rock has produced in only three wells. It appears that those three wells have produced from one and the same reservoir.

The Queen-Grayburg reservoir rock has been the source of all production except the minor amount produced by the three above mentioned wells and the small amount produced in 1955 by the one Ellenburger well. The Queen-Grayburg reservoir rock consists of interbedded dolomite, shale and sandstone with a small amount of anhydrite. The major portion of the production is from sandstones in the basal portion of the Queen formation. While the accompanying TYPICAL SECTION indicates a productive sandstone at each the top and the bottom of the productive section, it is not to be understood that such relationship is consistent. The sandstones are lenticular, are at various positions in the zone and are not subject to definite correlation except locally. Migration of fluids through the zone has not been sufficiently free that all production should be considered as from one reservoir. Not only is there lack of communication across strata, but, also, there is lack of continuity of adequate porosity and permeability in correlative beds to permit migration of fluids along strata at present temperatures and pressures. There are probably several distinct reservoirs in the Queen-Grayburg productive zone within the area of this field. Since it is not practical to determine the extent of each reservoir separately, the following data have been compiled to apply to the several reservoirs collectively.

The Ellenburger reservoir has been found productive in only one well to date.

DISCOVERIES

Seven Rivers: May 20, 1944; Debs Pattillo #1 Iowa Realty Trust (now, Burke Royalty Co. #1 Iowa Realty Trust).

Queen-Grayburg and Field: July 20, 1939; H.L.Cain #1 M.M.Lehn (later, W.E.Kenney #1 M.M.Lehn; now, Burke Royalty Co. #1 Masterson Lehn "A").

Queen-Grayburg: Apco 1600': October 22, 1943; E.R. Lloyd #1 Mrs. E.C.Powell (later, Major Drilling Co. #1 Mrs. E.C.Powell; now, Burke Royalty Co. #1 E.C.Powell). This well is at considerable distance from any previously completed well; it was recognized as a discovery well at time of completion and it led to the designation of Apco 1600' field. This well and other wells in Sec. 76 along with those in the north half of Sec. 75 are producing from a reservoir which appears to be separated from other reservoirs by lack of permeability adequate for migration of fluids.

Ellenburger: Jan. 17, 1955; Vega Oil Corp. #1 J.B. Rayner

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Ellenburger group 281 feet below its top. This penetration was in W.R.Weaver #1 Iowa Realty Trust, completed as a dry hole on 11/24/54 and located near the west corner of Sec. 73, Block 10, where the total depth of 5,786 feet is indicated on the accompanying map. Pre-Cambrian rocks have been penetrated by several wells located immediately east and southeast of the area covered by the accompanying map.

NATURE OF TRAPS

Seven Rivers: Updip termination of favorable porosity in a sloping reservoir rock.

Queen-Grayburg: Each of the traps in this zone is due to updip termination of favorable porosity in a sloping reservoir rock. Most of the traps are formed in part because of the termination of favorable porosity being in a curved position on a structural nose.

Ellenburger: Available data are inadequate for determining nature of trap.

THICKNESSES OF RESERVOIR ROCKS

Net productive, average, approx.	Feet
Seven Rivers	12
Queen-Grayburg	20
Ellenburger	10

LITHOLOGY OF RESERVOIR ROCKS

Seven Rivers: Interbedded sandstones, shales and dolomite containing some anhydrite.

Queen-Grayburg: Interbedded sandstones, shales and dolomite containing some anhydrite. The sandstone in that portion of the reservoir rock in the Queen formation is fine grained and is white to gray in color. For additional description, see preceding entry under RESERVOIRS.

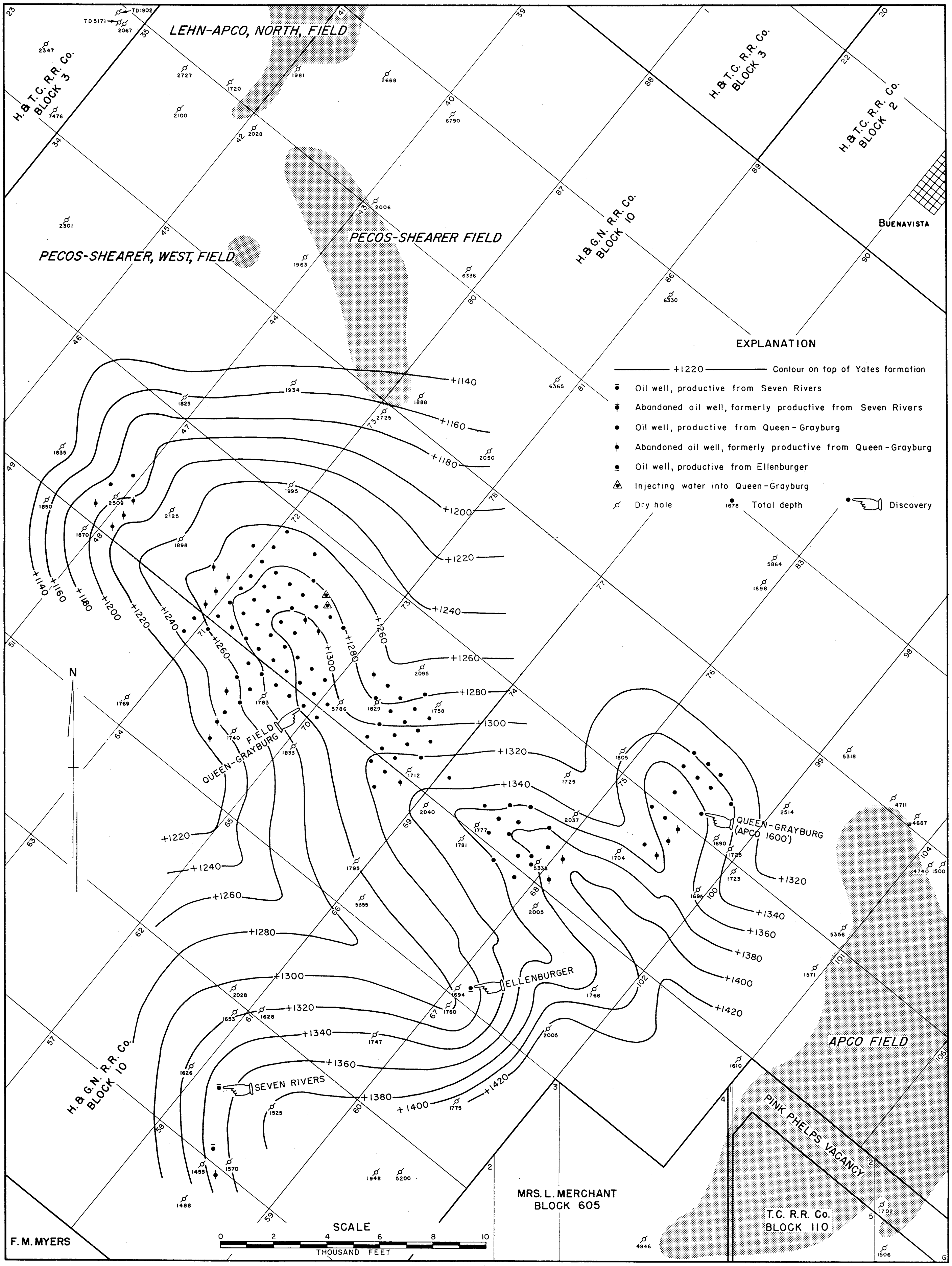
Ellenburger: Fine- to medium-grained, tan to dark gray, crystalline dolomite.

CONTINUITY OF RESERVOIR ROCKS

Seven Rivers: The productive member of the Seven Rivers formation is not subject to positive correlation beyond the immediate vicinity of the three wells where it is productive.

Queen-Grayburg: The zone which is locally productive is continuous throughout the area covered by the accompanying map. However, as reported above under RESERVOIRS, the individual productive lenses are of only local extent.

Ellenburger: Available data do not afford a basis for determination of continuity of this reservoir rock.


LEHN-APCO, NORTH, FIELD
PECOS-SHEARER FIELD
PECOS-SHEARER, WEST, FIELD
APCO FIELD
H. & T. C. R.R. Co. BLOCK 3
H. & T. C. R.R. Co. BLOCK 2
H. & G. N. R.R. Co. BLOCK 10
BUENAVISTA
MRS. L. MERCHANT BLOCK 605
T.C. R.R. Co. BLOCK 110
PINK PHELPS VACANCY
QUEEN-GRAYBURG FIELD
QUEEN-GRAYBURG (APCO 1600')
ELLENBURGER
SEVEN RIVERS
EXPLANATION
+1220 Contour on top of Yates formation
Oil well, productive from Seven Rivers
Abandoned oil well, formerly productive from Seven Rivers
Oil well, productive from Queen-Grayburg
Abandoned oil well, formerly productive from Queen-Grayburg
Oil well, productive from Ellenburger
Injecting water into Queen-Grayburg
Dry hole
1678 Total depth
Discovery
N
SCALE
0 2 4 6 8 10
THOUSAND FEET
F. M. MYERS

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Seven Rivers:	Feet
Elevation of top of oil, approx.	1,300
Elevation of bottom of oil, approx.	1,262
Relief, approx.	38

Queen-Grayburg:	
Highest proven elevation of oil, approx.	835
Lowest proven elevation of oil, approx.	721

The difference of approximately 114 feet does not represent relief of oil in single reservoir. There are several distinct reservoirs in this stratigraphic unit and these figures merely represent the extreme elevations of oil in the several reservoirs.

Ellenburger: (one well)	
Elevation of top of oil	-4,772
Elevation of bottom of oil	-4,800
Relief	38

CHARACTER OF OIL

	Gravity, A. P. I. @ 60°F.		
	Max.	Min.	Avg.
Seven Rivers	?	?	?
Queen-Grayburg	36.6°	26°	34°
Ellenburger	35.5°	35.5°	35.5°

WATER PRODUCTION

Seven Rivers and Queen-Grayburg: Wells in these reservoirs initially produced very little water. Data relative to present water production are not available.

Ellenburger: The one well initially pumped at the rate of 15 barrels of oil and 18 barrels of salt water daily.

COMPLETION TREATMENT

Seven Rivers and Queen-Grayburg: The majority of the wells in these reservoirs were each shot with from 40 to 150 quarts of nitroglycerin.

Ellenburger: The reservoir rock in the one productive well was treated with 1,000 gallons of regular acid.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
Field totals				
1939	13	0	23,572	23,572
1940	34	1	133,195	156,767
1941	44	3	134,871	291,638
1942	27	23	91,714	383,352
1943	19	34	83,369	466,721
1944	28	38	97,688	564,409
1945	28	45	101,233	665,642
1946	25	51	81,xxx	747,xxx
1947	20	56	59,xxx	806,xxx
1948	13	60	51,xxx	857,xxx
1949	22	51	53,xxx	910,xxx
1950	24	66	85,407	995,xxx
1951	20	71	67,822	1,063,xxx
1952	22	63	55,343	1,118,xxx
1953	22	62	52,801	1,171,xxx
1954	26	64	71,979	1,243,xxx
Seven Rivers				
1944	2	0	1,1xx	1,1xx
1945	2	1	1,7xx	2,8xx
1946	2	1	2,5xx	5,3xx
1947	1	1	1,7xx	7,0xx
1948	1	1	1,7xx	8,7xx
1949	1	1	1,6xx	10,3xx
1950	1	1	1,6xx	11,9xx
1951	1	1	1,4xx	13,3xx
1952	1	1	1,8xx	15,1xx
1953	0	2	1,5xx	16,6xx
1954	0	2	9xx	17,5xx
Queen-Grayburg				
1939	13	0	23,572	23,572
1940	34	1	133,195	156,767
1941	44	3	134,871	291,638
1942	27	23	91,714	383,352
1943	19	34	83,369	466,721
1944	26	28	96,6xx	563,3xx
1945	26	44	99,5xx	662,8xx
1946	23	50	83,xxx	746,xxx
1947	19	55	57,xxx	803,xxx
1948	12	59	49,xxx	852,xxx
1949	21	50	51,xxx	903,xxx
1950	23	65	83,8xx	987,xxx
1951	19	70	66,4xx	1,053,xxx
1952	21	62	53,5xx	1,107,xxx
1953	22	60	51,3xx	1,158,xxx
1954	26	62	71,1xx	1,229,xxx
Ellenburger				
1955 (to Oct.)	0	1	1,072	1,072

The above figures do not include such wells as are in section 46 nor the production from those wells. Under Field totals and under Queen-Grayburg, the correct number of wells is 1 to 3 greater than above indicated and the correct quantities of oil are greater by the amounts produced by such well or wells in section 46 as were producing. Since the respective times of their completion, those wells have been reported as in the Pecos Valley (Low Gravity) field.

LION FIELD
Ward County, Texas

C. K. HOLLOWAY
Geologist, Lion Oil Company, Midland, Texas
January 21, 1954

LOCATION

The Lion field is in central Ward County about 4 miles west of the town of Pyote.

METHOD OF EXPLORATION LEADING TO DISCOVERY

This field was discovered as a result of subsurface geologic studies.

DISCOVERIES

Bell Canyon gas sand: March 17, 1945;
Lion Oil Company #B-4 University
Bell Canyon oil sand and Field: October 3, 1944;
Lion Oil Company #B-1 University

ELEVATION OF SURFACE

At well locations (derrick floor): Highest, 2,675 feet; lowest, 2,649 feet.

SURFACE FORMATION

Wind-blown sands of Quaternary age.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Bell Canyon formation 1,545 feet below its top. This penetration was in Lion Oil Co. #B-7 University at its total depth of 6,490 feet.

NATURE OF TRAPS

Bell Canyon gas sand and Bell Canyon oil sand: Some structural closure is indicated in each of the two reservoirs. However, accumulation appears to be controlled by lenticularity of sandstones in the uppermost twenty feet of the Bell Canyon formation.

THICKNESSES OF RESERVOIR ROCKS

Bell Canyon gas sand: Net productive, average, about 10 feet.

Bell Canyon oil sand: Net productive, average, about 10 feet.

PRODUCTIVE AREA

Bell Canyon and Field: Total proven for gas and oil, 360 acres.

LITHOLOGY OF RESERVOIR ROCKS

Bell Canyon gas sand: Very fine-grained, tight sandstone.

Bell Canyon oil sand: Fine-grained sandstone containing thin shale laminae.

The two reservoirs are separated by a thin zone of relatively impermeable sandstone or, as at Lion Oil Co. #7-B University, by a thin limestone.

CONTINUITY OF RESERVOIR ROCKS

Throughout the Delaware basin, there are sandstones at the stratigraphic positions of the reservoir rocks, but the particular lenses of sandstone which produce in this field may not extend far beyond the presently proven productive area of this field.

CHARACTER OF OIL

Gravity, A.P.I. @ 60° F.	37.1°
Sulphur indication	Sweet

CHARACTER OF GAS

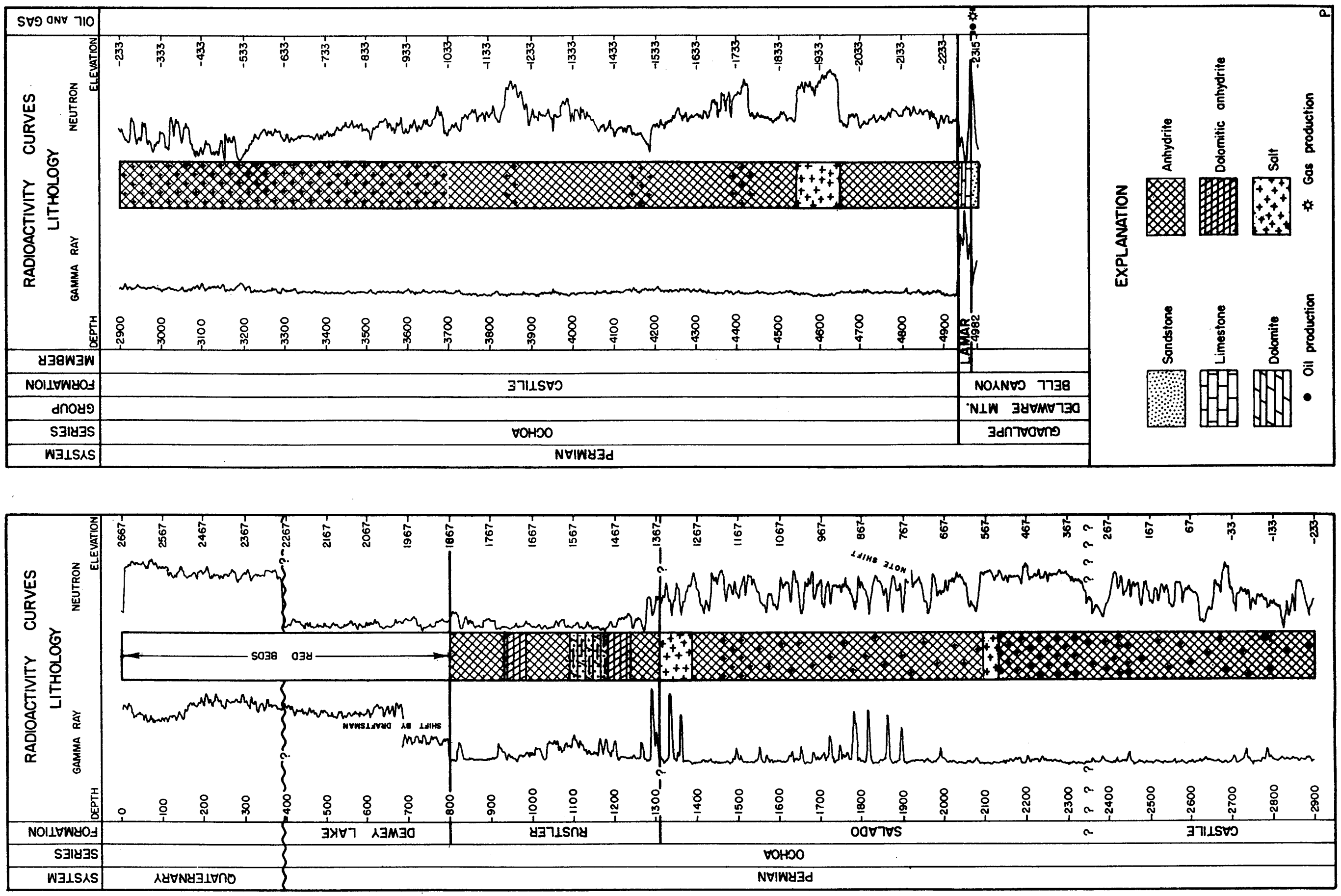
The sulphur content is sufficiently low that the gas is satisfactory for domestic usage. As the gas is produced at the two productive gas wells, a small amount of condensate is yielded at the surface.

WATER PRODUCTION

The current daily production of well #B-1 is 10 barrels of oil and 5 barrels of water; of well #B-7, 7 barrels of oil and 2 barrels of water. Wells #B-2, #B-3 and #B-5 each produced salt water prior to abandonment.

COMPLETION TREATMENT

In wells #B-1, #B-2, #B-3 and #B-8, the reservoir rock was shot with nitroglycerin. In well #B-7, the reservoir rock was treated with 1,000 gallons of acid. There was no treatment of the reservoir rock in either of the gas wells, #B-4 and #B-6.



TYPICAL SECTION OF ROCKS PENETRATED

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

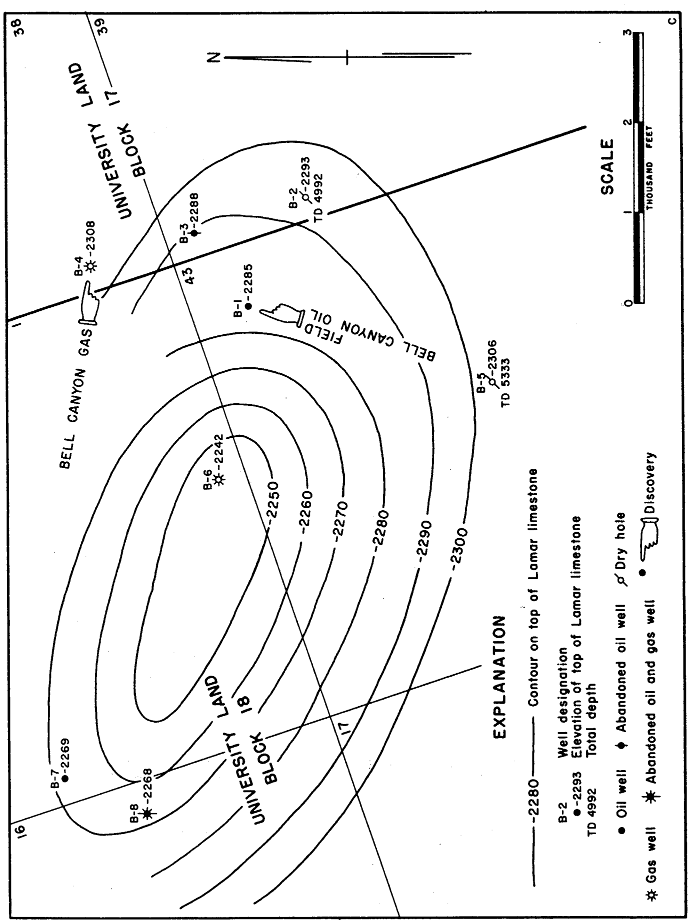
	Wells B-1	B-3	B-4	B-6	B-7	B-8 *
Elevation of top of gas, feet	No	No	-2,344	-2,287	-2,305?	-2,298
Elevation of bottom of gas, feet	free	free	-2,345	-2,288	-2,310?	-2,308
Relief, feet	gas	gas	1	1	5?	10
Elevation of top of oil, feet	-2,324	-2,323	No	No	-2,310	-2,298
Elevation of bottom of oil, feet	-2,339	-2,337	oil	oil	-2,321	-2,308
Relief, feet	15	14			11	10

*Well #B-8, now abandoned, was first classified as an oil well and then later as a gas well after the oil was depleted.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Oil	Gas	OIL PRODUCTION (barrels)*: Yearly	Cumulative	GAS PRODUCTION (Mcf): Yearly	Cumulative
1944	1	0	4,459	4,459	None	None
1945	2	1	13,404	17,863	?	?
1946	2	2	8,311	26,174	145,926	145,926
1947	2	2	15,120	41,294	846,445	992,371
1948	3	2	23,184	64,478	518,998	1,511,369
1949	3	2	17,354	81,832	87,335	1,598,704
1950	3	2	12,774	94,606	446,133	2,044,837
1951	3	2	11,118	105,724	576,331	2,621,168
1952	3	2	9,459	115,183	878,788	3,499,956
1953	2	2	6,550	121,733	297,627	3,797,583

*Condensate constitutes about 6% of the indicated quantities.



MARTIN FIELD

Andrews County, Texas

R. N. WATSON* and FELIX P. BENTZ**

April 15, 1952

LOCATION and OTHER NAME

The Martin field is in southwestern Andrews County about 13 miles southwest of the town of Andrews, county seat. It is one of the prolific fields on the eastern side of the Central Basin platform.

From the time of its discovery in 1940 until after the completion of the Wichita reservoir discovery on the N. H. Martin land in 1945, this field was known as the West Andrews field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Subsurface mapping and interpretation of trends in the San Andres formation led to the drilling of the field discovery well. After the development of the San Andres reservoir had extended over a large portion of the presently productive area, The Atlantic Refining Co., Humble Oil & Refining Co., Sun Oil Co. and others each conducted separate detailed seismic surveys in search for traps in deeper sediments. These seismic surveys were followed by discoveries in deeper reservoirs as indicated below.

DISCOVERIES

San Andres and Field: June 28, 1940; The Atlantic Refining Co. #1 University Block 11. Initial potential: pumped 172 barrels of 37.1° gravity oil per day; GOR, 192 : 1; depth 4,350-4,475 feet.

Wichita: March 24, 1945; Sun Oil Co. #1 N. H. Martin. Initial potential: flowed 301 barrels of 36° gravity oil per day through $\frac{1}{4}$-inch choke; GOR, 837 : 1; depth, 6,850-7,035 feet.

McKee: November 10, 1945; Humble Oil & Refining Co. #1 J. E. Parker. Initial potential: flowed 578 barrels of 42.3° gravity oil per day through $\frac{1}{2}$-inch choke; GOR, 630 : 1; depth 8,690-8,790 feet.

Ellenburger: January 3, 1946; Humble Oil & Refining Co. #2 J. E. Parker. Initial potential: flowed 1,594 barrels of 42.3° gravity oil per day through $\frac{1}{2}$-inch choke; GOR, 128 : 1; depth, 8,850-8,865 feet.

*District Geologist, The Atlantic Refining Company, Midland, Texas

**Geologist, Union Oil Company of California, Abilene, Texas

ELEVATION OF SURFACE

The highest surface elevation within the area of the field is 3,311 feet; the lowest, 3,267 feet.

SURFACE FORMATION

The area of the field is covered with windblown sand dunes which overlie the Ogallala formation of the Pliocene series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is in Ellenburger dolomite 480 feet below the top of the Ellenburger group. This penetration was in Humble Oil & Refining Co. #11 J. E. Parker, which is at location No. 4 on the accompanying cross section.

NATURE OF TRAPS

San Andres: The trapping of oil in the San Andres is due to convex folding. Oil productivity depends upon porosity and permeability.

Wichita: The accumulation of oil is due to updip termination of the reservoir because of decrease of porosity. This updip termination is on the east and south limbs of an anticlinal fold.

McKee and Ellenburger: The trap in each of these two reservoirs is due primarily to convex folding, with termination against faults effective as a minor trap-forming factor.

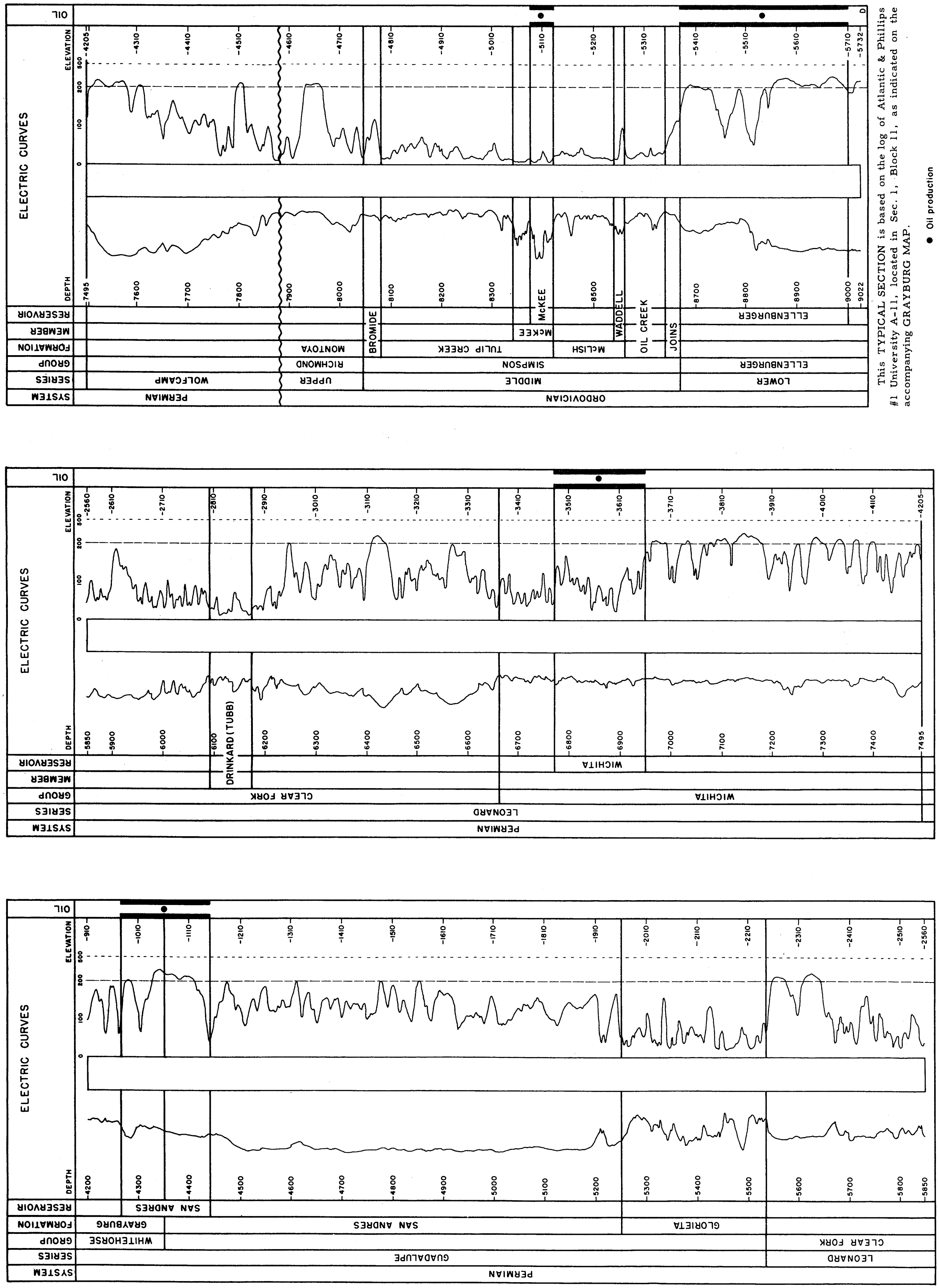
PRODUCTIVE AREAS

	Acres proven
San Andres	2,220
Wichita	640
McKee	2,020
Ellenburger	1,720
Martin field	3,740

The productive areas of San Andres and Wichita are probably much larger than proven by development to date. However, estimates predicting small ultimate yields have discouraged further development.

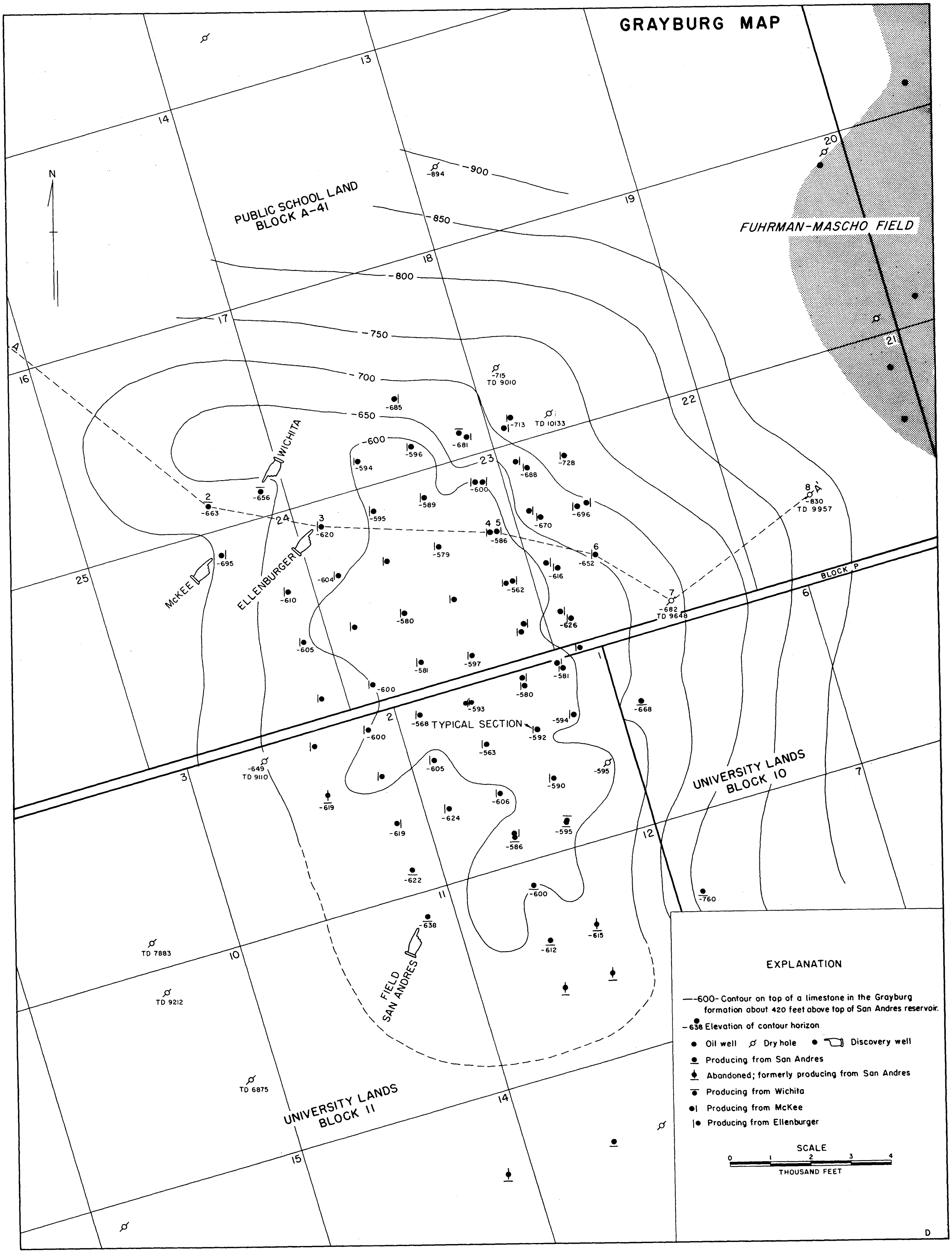
The productive areas of McKee and Ellenburger are well defined by faults to the north and to the east and by the water level to the south and to the west.

TYPICAL SECTION OF ROCKS PENETRATED



This TYPICAL SECTION is based on the log of Atlantic & Phillips #1 University A-11, located in Sec. 1, Block 11, as indicated on the accompanying GRAYBURG MAP.

● Oil production


GRAYBURG MAP
PUBLIC SCHOOL LAND
BLOCK A-41
FUHRMAN-MASCHO FIELD
UNIVERSITY LANDS
BLOCK 10
UNIVERSITY LANDS
BLOCK 11
BLOCK P
WICHITA
ELLENBURGER
McKEE
SAN ANDRES FIELD
TYPICAL SECTION
EXPLANATION
-600- Contour on top of a limestone in the Grayburg formation about 420 feet above top of San Andres reservoir.
-638 Elevation of contour horizon
Oil well
Dry hole
Discovery well
Producing from San Andres
Abandoned; formerly producing from San Andres
Producing from Wichita
Producing from McKee
Producing from Ellenburger
SCALE
0 1 2 3 4
THOUSAND FEET
D

THICKNESSES OF RESERVOIR ROCKS

From top to bottom, feet	Min.	Max.
San Andres	100	120
Wichita	90	160
McKee	20	30
Ellenburger	20	445

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomite; tan to brown, finely crystalline dolomite with shreds of organic matter and grading to a white or buff, medium crystalline to saccharoidal dolomite, rarely anhydrite-bearing; locally, gray, sandy or oolitic. Where anhydrite does not fill the space between the dolomite crystals, the interstitial space constitutes effective porosity. The San Andres is only rarely vuggy.

Wichita: Dolomite; white to tan, ranging from dense, near lithographic, to fine- and medium-crystalline. The porosity is intercrystalline.

McKee: Mainly quartz sand, the sand consisting of medium to coarse quartz grains, generally well-rounded and frosted. The upper part of the sand is commonly shaly; locally glauconitic and tightly cemented. The lower part of the sand is loose and friable and has high porosity. There are thin beds of green, fine-grained pyritic shale commonly containing sand grains and locally containing sandy limestone laminae.

Ellenburger: Dolomite; white to tan or gray with texture ranging from near lithographic, very finely crystalline, to coarsely crystalline, saccharoidal. The uppermost part commonly contains coarse sand grains; stringers of sandy dolomite occur lower in the section. A small amount of white chert, locally including brown oolites, is generally distributed throughout the entire thickness. The porosity is intercrystalline to vuggy with large fractures common.

ELEVATIONS OF TOPS OF RESERVOIRS IN WELLS

	Feet		
	Highest	Lowest	Relief
San Andres	-981	-1,057	76
Wichita	-3,464	-3,488	*
McKee	-4,825	-5,370	545
Ellenburger	-5,171	-5,676	505

*Both the highest elevation and the lowest elevation were observed in edge wells.

The excess of the McKee relief over the Ellenburger relief is not to be interpreted as indicating greater structural relief on the McKee. The difference is due merely to the fact that completed wells provided opportunity for measurement further down-dip on the McKee.

CONTINUITY OF RESERVOIR ROCKS

San Andres: The San Andres dolomite is one of the most widespread producing zones on the Central Basin platform. It is commercially productive where there are traps and where the absence of anhydrite permits sufficient porosity and permeability.

Wichita: The Wichita dolomite is extensively distributed throughout the Central Basin platform. It is a major oil reservoir in the Fullerton field, ten miles to the north. Although it is presently productive in only three wells in the Martin field, it has been found capable of commercial production in numerous wells completed in deeper zones.

McKee: The degree of pre-Permian erosion is an important factor in determining the distribution of the McKee sand. However, within the area of the Martin field, this sand has not been eroded. It is continuous throughout the area of the field. Locally, its continuity is interrupted by faults at the east and north limits of the field. Regionally, changes in facies, as well as erosion, are important in determining distribution. It is absent over a wide part of the Northern Shelf area of Texas and New Mexico and over some of the uplifts on the Central Basin platform. It is commercially productive in several fields in a broad area; confined principally to anticlinal structures on the Central Basin platform

Ellenburger: The Ellenburger is of essentially uniform lithologic character over a very extensive area. It is a prolific producer in many fields in North and West Texas, and its equivalent, the Arbuckle, is productive in Oklahoma and Kansas.

CHARACTER OF OIL

	San Andres	Wichita	McKee	Ellenburger
Gravity, A.P.I.	37-38°	35°	41°	44°

WATER PRODUCTION

San Andres, Wichita and McKee: Negligible; definite data not available.

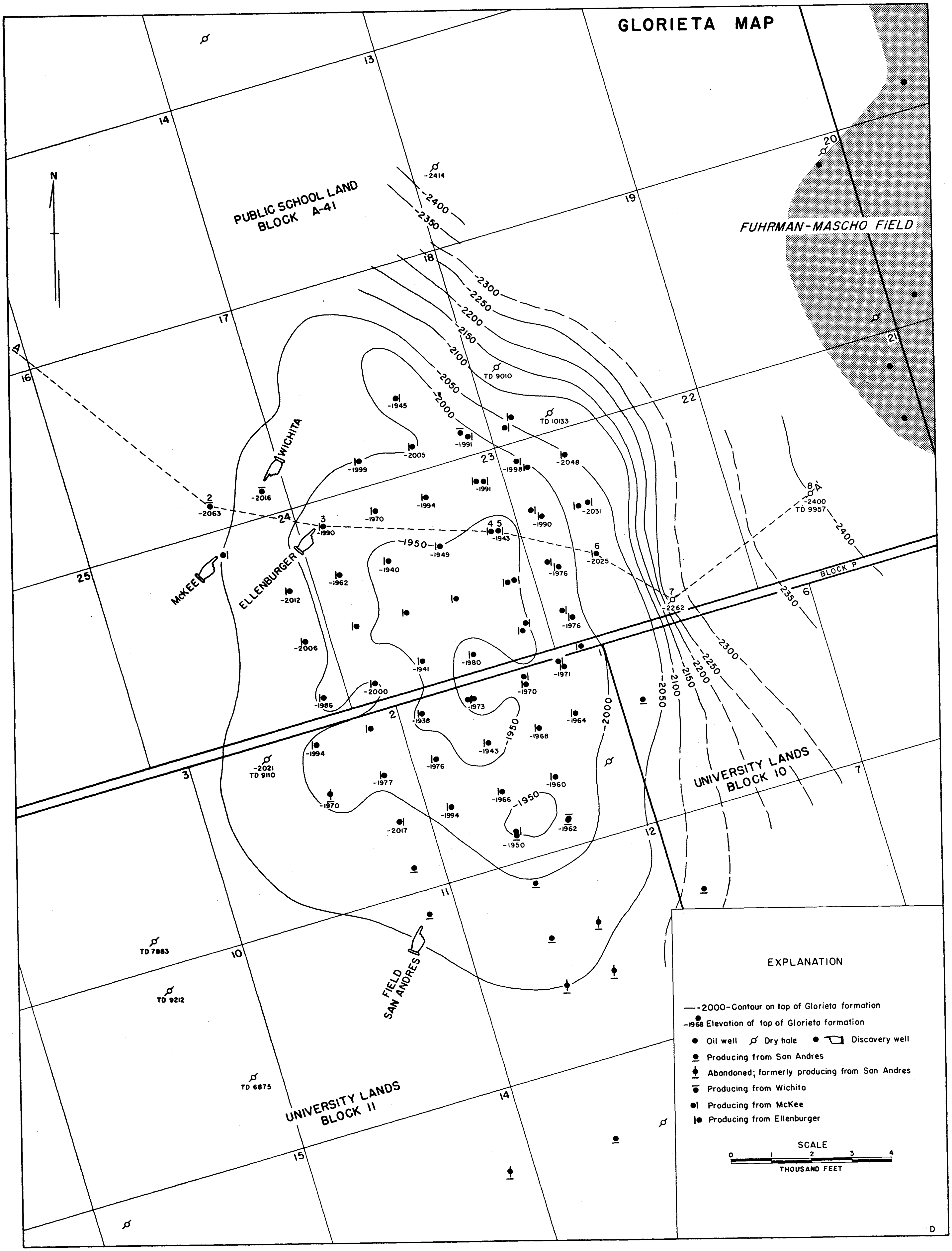
Ellenburger: Cumulative water production to June 1, 1951, amounted to 1,546,505 barrels or 15.5% of the gross fluid produced. The water contains considerable sulphur.

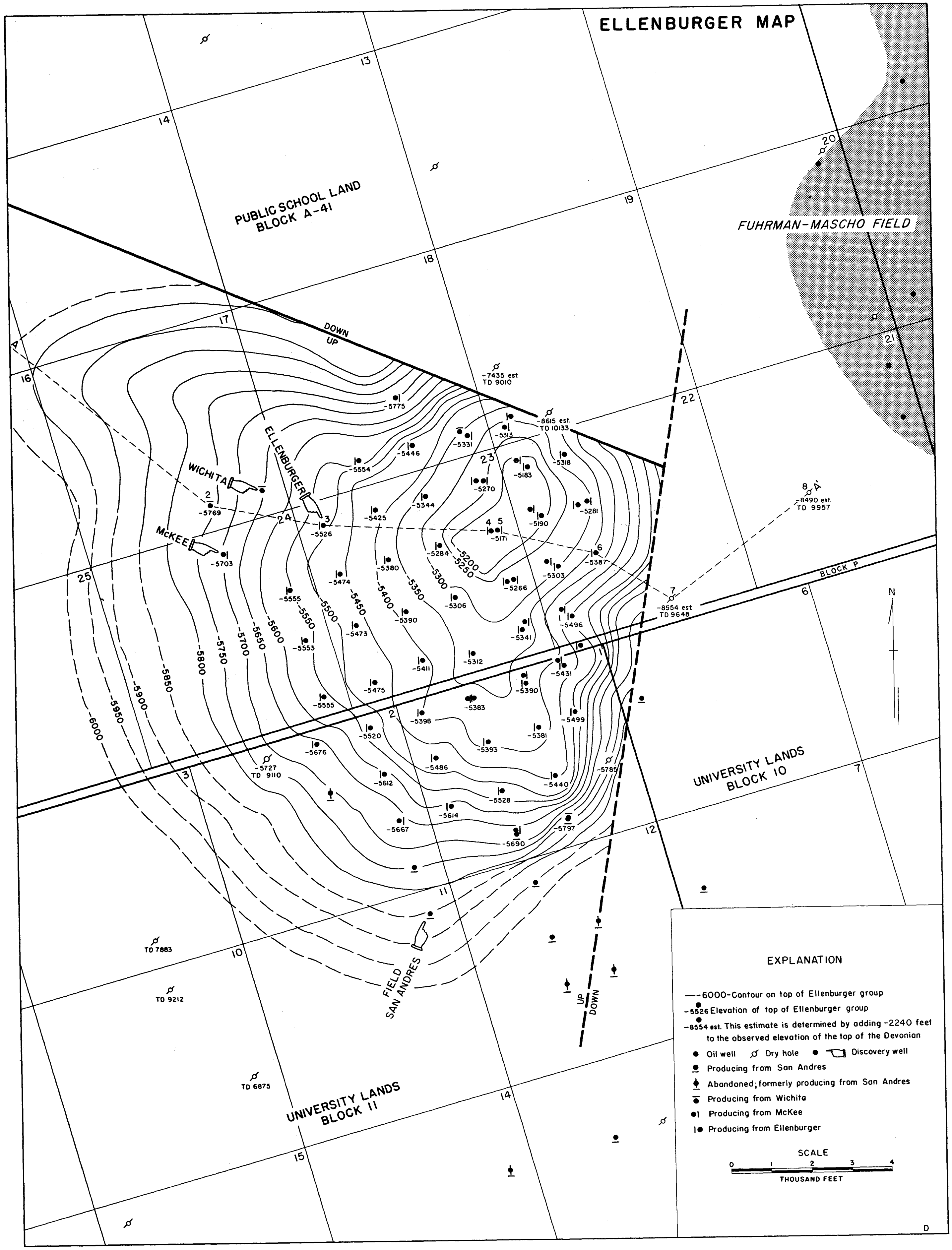
ACID TREATMENT

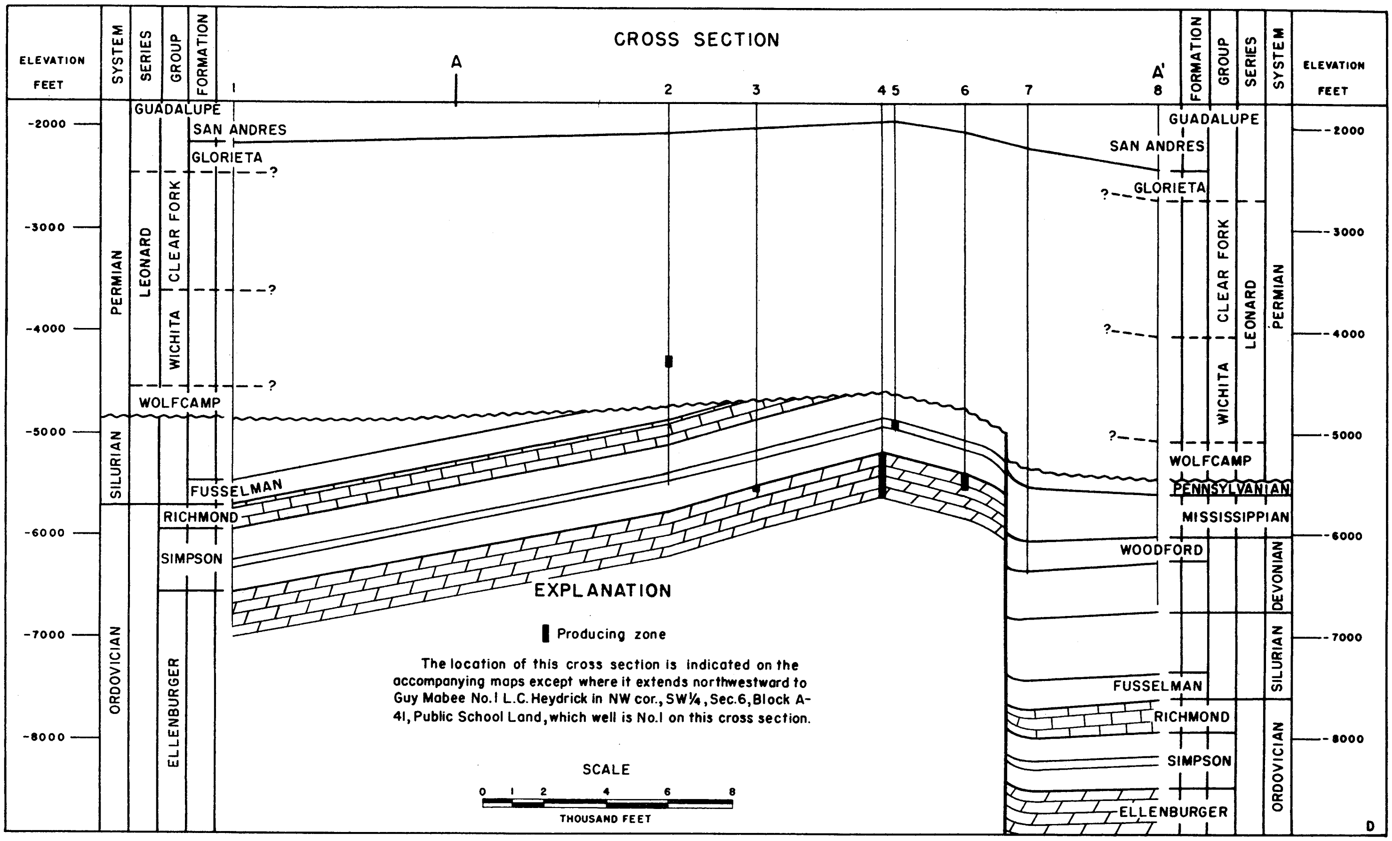
San Andres and Wichita: Generally before being placed on production, each well is acidized with 5,000 to 20,000 gallons.

McKee: Not acidized.

Ellenburger: Most of the Ellenburger wells are completed without acidization; however, treatment with only a 500-gallon acid wash appears to be necessary for proper completion of some wells.


GLORIETA MAP
FUHRMAN-MASCHO FIELD
PUBLIC SCHOOL LAND BLOCK A-41
UNIVERSITY LANDS BLOCK 10
UNIVERSITY LANDS BLOCK 11
BLOCK P
WICHITA
McKEE
ELLENBURGER
FIELD SAN ANDRES
N
A
A'
EXPLANATION
-2000- Contour on top of Glorieta formation
-1968 Elevation of top of Glorieta formation
Oil well
Dry hole
Discovery well
Producing from San Andres
Abandoned; formerly producing from San Andres
Producing from Wichita
Producing from McKee
Producing from Ellenburger
SCALE
0 1 2 3 4
THOUSAND FEET


ELLENBURGER MAP
PUBLIC SCHOOL LAND
BLOCK A-41
FUHRMAN-MASCHO FIELD
UNIVERSITY LANDS
BLOCK 10
UNIVERSITY LANDS
BLOCK 11
BLOCK P
WICHITA
McKEE
ELLENBURGER
SAN ANDRES
FIELD
DOWN
UP
-7435 est.
TD 9010
-8615 est.
TD 10133
-8490 est.
TD 9957
-8554 est.
TD 9648
-5727
TD 9110
TD 7883
TD 9212
TD 6875
EXPLANATION
-6000- Contour on top of Ellenburger group
-5526 Elevation of top of Ellenburger group
-8554 est. This estimate is determined by adding -2240 feet to the observed elevation of the top of the Devonian
Oil well
Dry hole
Discovery well
Producing from San Andres
Abandoned; formerly producing from San Andres
Producing from Wichita
Producing from McKee
Producing from Ellenburger
SCALE
0 1 2 3 4
THOUSAND FEET
D



PRODUCTION HISTORY

Field totals

Year	Wells* Oil	Oil production (barrels) Yearly	Cumulative
1940	3	4,553	4,553
1941	7	18,369	22,922
1942	22	45,107	68,029
1943	9	42,327	110,356
1944	18	23,507	133,863
1945	19	70,919	204,782
1946	27	301,024	505,806
1947	38	825,474	1,331,280
1948	65	2,353,832	3,685,112
1949	79	2,638,776	6,323,888
1950	79	2,637,342	8,961,230
1951	79	3,306,296	12,267,526
1952**	77	2,852,101	15,119,627

San Andres

Year	Wells* Oil	Oil production (barrels) Yearly	Cumulative
1940	3	4,553	4,553
1941	7	18,369	22,922
1942	22	45,107	68,029
1943	9	42,327	110,356
1944	18	23,507	133,863
1945	17	30,006	163,869
1946	16	24,987	188,856
1947	16	21,899	210,755
1948	15	19,656	230,411
1949	13	19,074	249,485

San Andres (Continued)

Year	Wells* Oil	Oil production (barrels) Yearly	Cumulative
1950	14	20,446	269,931
1951	13	29,751	299,682
1952**	11	24,656	324,388

Wichita

Year	Wells* Oil	Oil production (barrels) Yearly	Cumulative
1945	1	30,833	30,833
1946	2	35,520	66,353
1947	2	24,757	91,110
1948	2	17,599	108,709
1949	2	15,701	124,410
1950	3	15,438	139,848
1951	3	15,953	155,801
1952**	3	16,328	172,129

McKee

Year	Wells* Oil	Oil production (barrels) Yearly	Cumulative
1945	1	10,080	10,080
1946	2	70,616	80,696
1947	2	70,192	150,888
1948	10	177,094	327,982
1949	19	400,972	728,954
1950	17	366,700	1,095,654
1951	18	278,859	1,374,513
1952**	18	208,600	1,583,113

Ellenburger

Year	Wells* Oil	Oil production (barrels) Yearly	Cumulative
1946	7	169,901	169,901
1947	18	708,626	878,527
1948	38	2,139,483	3,018,010
1949	45	2,203,029	5,221,039
1950	45	2,234,758	7,455,797
1951	45	2,981,733	10,437,530
1952**	45	2,602,517	13,040,047

*Number of wells producing at end of year.

**1952 data added by amendment.

Development of the Ellenburger followed rapidly after The Atlantic Refining Co. completed a stepout 1½ miles southeast of the Ellenburger discovery well. McKee sand development has been largely subsequent to Ellenburger development as most of the McKee wells have been drilled as twins to previously completed Ellenburger producers.

MARVIN FIELD

Sterling County, Texas

R. L. THARP and C. F. SKRABACZ
Geologists, Anderson-Prichard Oil Corp., Midland, Texas
January 30, 1953

LOCATION

The Marvin field is in south-central Sterling County about 8 miles south of Sterling City, county seat. The two presently productive wells are in the southwest quarter of Section 12, Block 15, H. & T. C. R. R. Co. Survey. The field is on the western edge of the Eastern platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Seismic data indicated a structural high on pre-Permian strata.

DISCOVERY

Wolfcamp: May 10, 1948; Anderson-Prichard Oil Corporation and Vickers Petroleum Company #1 M. F. Foster.

ELEVATION OF SURFACE

The surface at the discovery well is 2,470 feet above sea level; at Humble Oil & Refining Co. #1 R. T. Foster (abandoned oil well), 2,524 feet above sea level.

SURFACE FORMATION

The only formation exposed within the area of the field is limestone of the Fredericksburg group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

About thirty feet below top of Ellenburger. This penetration was in the discovery well.

NATURE OF TRAP

Wolfcamp: It appears that a convex fold forms the trap. However, as indicated on the accompanying map, closure is not proven.

PRODUCTIVE AREA

Wolfcamp and Field: 80 acres. Future development may warrant increasing this estimate.

THICKNESS OF RESERVOIR ROCK

Wolfcamp: The net productive thickness of the reservoir rock is about 30 feet in the discovery well and about 20 feet in the other currently producing well.

LITHOLOGY OF RESERVOIR ROCK

Wolfcamp: White, oolitic and fossiliferous limestone. This limestone is interbedded in a brown, argillaceous limestone.

CONTINUITY OF RESERVOIR ROCK

Wolfcamp: The limestone member which is productive cannot be proven to be continuous beyond the wells where its elevation is indicated on the accompanying map. This member was not recognized in the most eastern well on the map.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Wolfcamp:	Feet
No free gas	
Elevation of top of oil	-1,783
Elevation of bottom of oil	-1,823
Relief of oil column	40

CHARACTER OF OIL

Wolfcamp:

Gravity, A.P.I. @ 60° F.	28°
Base,	Paraffinic

WATER PRODUCTION

Wolfcamp: Each well has produced only a very small amount of water.

ACID TREATMENT

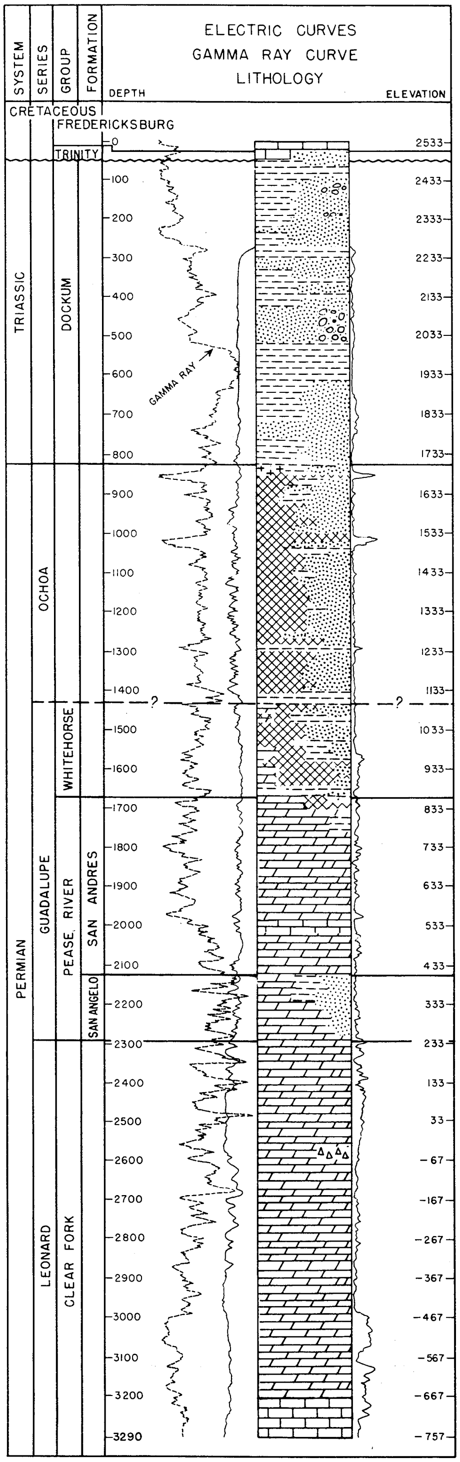
Wolfcamp: Each of the two presently productive wells was treated with 1,000 gallons of acid through perforations.

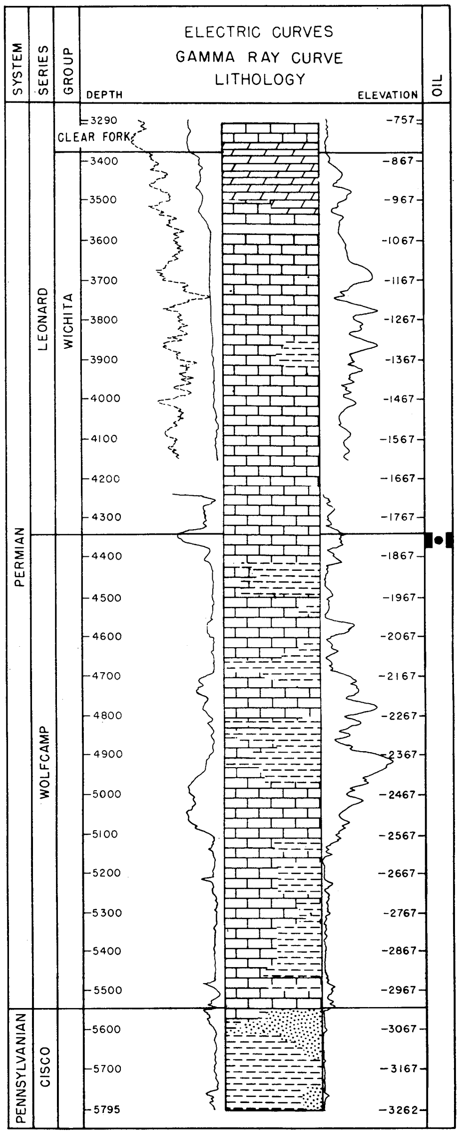
PRODUCTION HISTORY

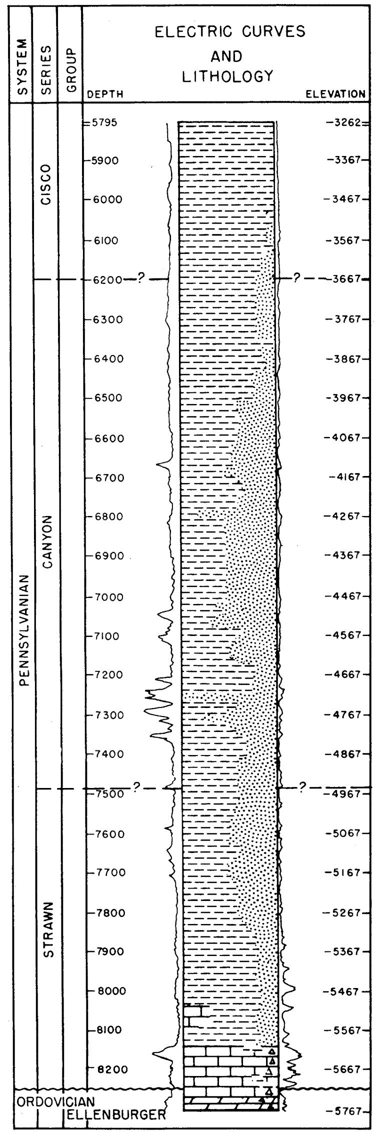
Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1948	2	10,820	10,820
1949	2	33,402	44,222
1950	2	34,315	78,537
1951	2	31,793	110,330
1952	2	14,205	124,535

Although three wells have been completed in the field, nearly all of the production has been by two wells. Humble Oil & Refining Co. #1 R. T. Foster was completed Nov. 3, 1948, and was abandoned in 1949 after having produced only little oil.

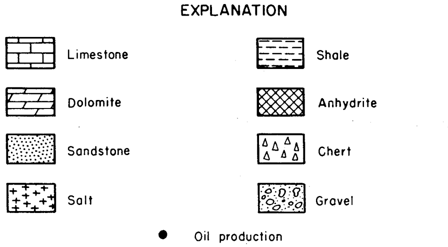
TYPICAL SECTION OF ROCKS PENETRATED

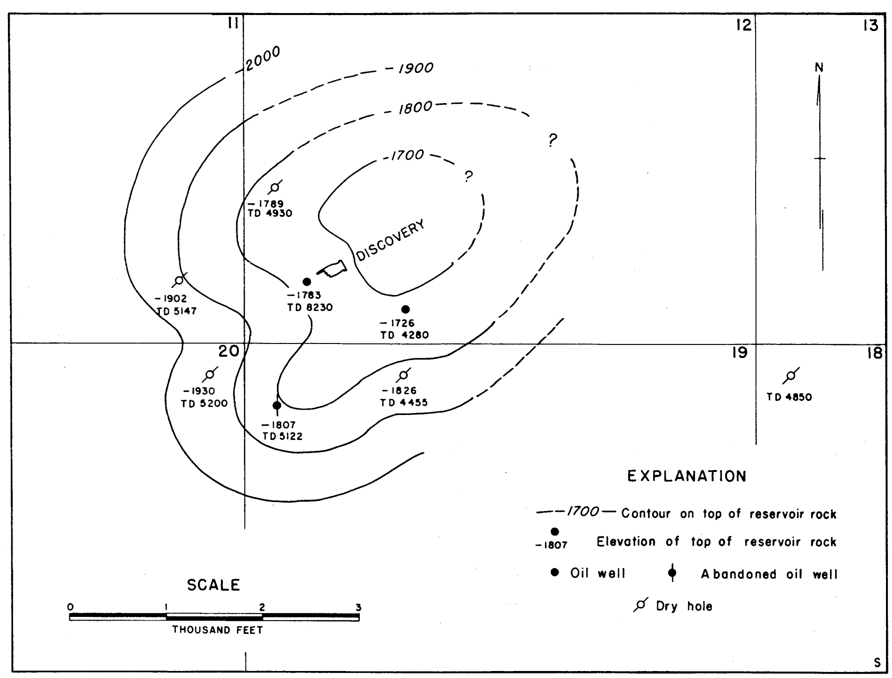






NOTE: Above the depth of 4200 feet this TYPICAL SECTION is based on the log of Humble Oil and Refg. Co. #1 R. T. Foster (abandoned oil well in Sec. 19) and below the depth of 4200 feet, it is based on the log of the discovery well with adjusted depths and elevations.





MASON FIELD

Loving County, Texas

GORDON S. KNOX
Geologist, Phillips Petroleum Co., Midland, Texas
January 4, 1953

LOCATION

The Mason field is in northwestern Loving County 3 miles south of the Texas — New Mexico border and 9 miles northeast of the hamlet of Orla in Reeves County. It is in Secs. 8, 17, 20 and 21 of Block 55, T. & P. R.R. Co. Survey. It is in the central part of the Delaware basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

On November 20, 1934, O. M. Mason and associates acquired a block of oil and gas leases covering an area which now includes the Mason field. They later organized the Loving County Oil Company, which drilled the discovery well. The writer does not know the nature of the information which induced the Loving County Oil Company to locate the discovery well where it did. Subsurface geology is given credit for the northward extension of the field.

DISCOVERY

Bell Canyon: March 3, 1937;
Loving County Oil Company #2 Mrs. Minnie Kyle.

ELEVATION OF SURFACE

At well locations: Highest, 3,101 ft.; lowest, 3,030 ft.

SURFACE FORMATION

Quaternary gravels and alluvium.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Bell Canyon formation about 382 feet below the base of the Lamar member. This penetration was in Argo Oil Corp. #1-C TXL at its total depth of 4,274 feet. This well is located near the northwest edge of the field.

NATURE OF TRAP

Bell Canyon: Accumulation of oil appears to be due to differential porosities and permeabilities in a sloping reservoir rock.

PRODUCTIVE AREA

Bell Canyon and Field: 800 acres.

THICKNESS OF RESERVOIR ROCK

Bell Canyon: The productive rock is limited to a zone about 7 feet thick, the top of which is about 20 to 30 feet below the base of the Lamar member. It is a portion of a sandstone several hundred feet thick.

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: Very fine grained, gray, tightly cemented to soft, porous sandstone with a few thin black shale partings.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The reservoir rock is a portion of a thick blanket sandstone which contains some interbedded shale and which is continuous as a remarkably homogenous sandstone throughout the Delaware basin. The continuity of the locally productive portion cannot be proven beyond the extent of the field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet
No free gas cap	
Elevation of top of oil	-841
Elevation of bottom of oil	-912
Relief	71

WATER PRODUCTION

Bell Canyon: From the time of first production, a small amount of water has been produced with the oil by most of the wells, regardless of structural position. No encroachment of water has been observed.

CHARACTER OF OIL

Bell Canyon:

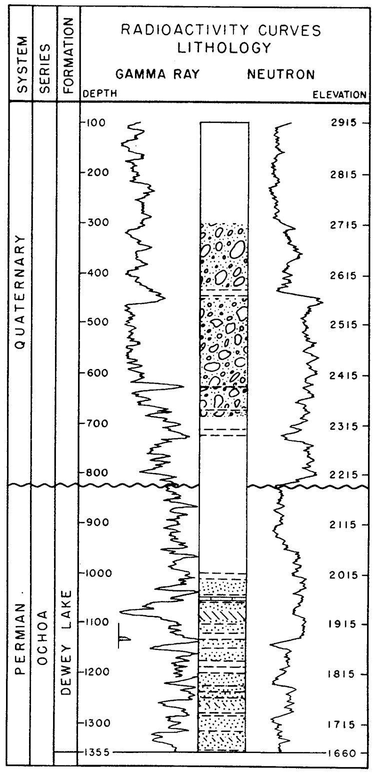
Gravity, A.P.I. @ 60° F., average,	40.9°
Sulphur,	0.12%
Base,	Intermediate

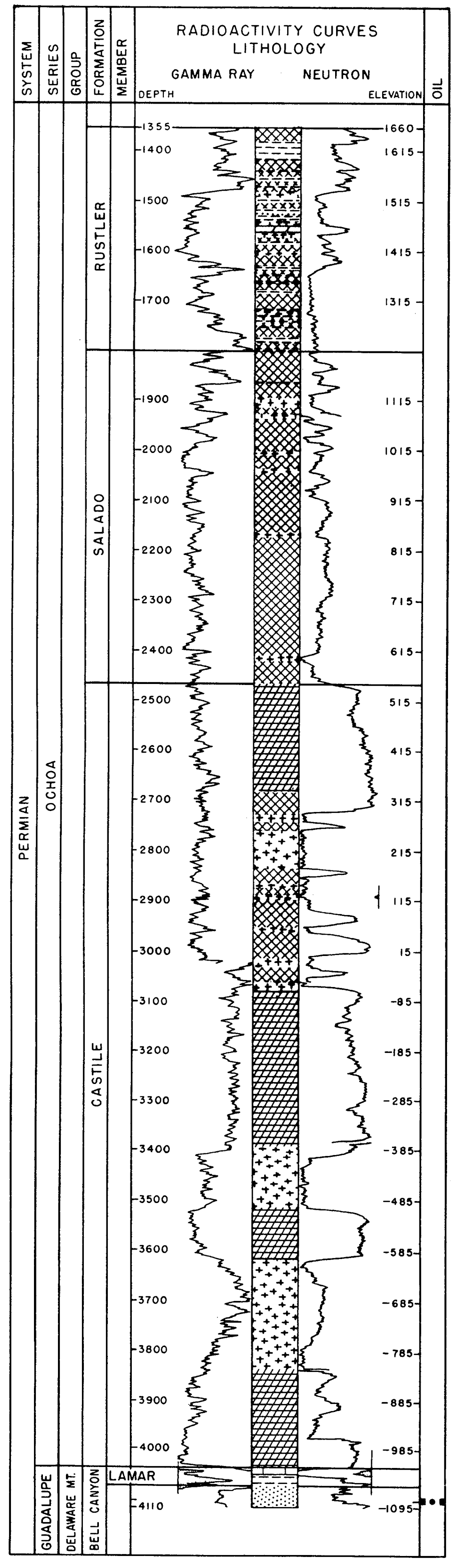
For analyses see:
Railroad Commission of Texas
Analyses of Texas Crude Oils (1940) pp. 33 and 65
U. S. Bureau of Mines Lab. ref. No. 38142
Tabulated analyses of Texas Crude Oils,
T. P. 607 (1939) Item 62, Group 2

PRODUCTION HISTORY

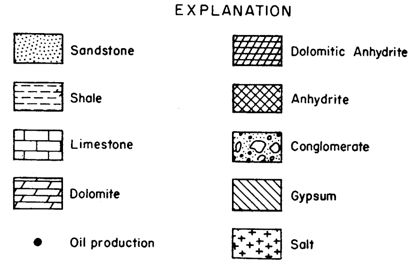
Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
1937	5	0	84,892	84,892
1938	7	0	121,329	206,221
1939	7	2	89,014	295,235
1940	7	2	79,540	374,775
1941	7	2	62,536	437,311
1942	6	3	58,913	496,224
1943	6	3	54,832	551,056
1944	6	3	49,717	600,773
1945	6	3	50,871	651,644
1946	5	4	49,557	701,201
1947	3	6	54,238	755,439
1948	3	6	56,867	812,306
1949	2	7	59,192	871,498
1950	9	7	90,449	961,947
1951	7	9	63,316	1,025,263
1952	7	11	65,486	1,090,749

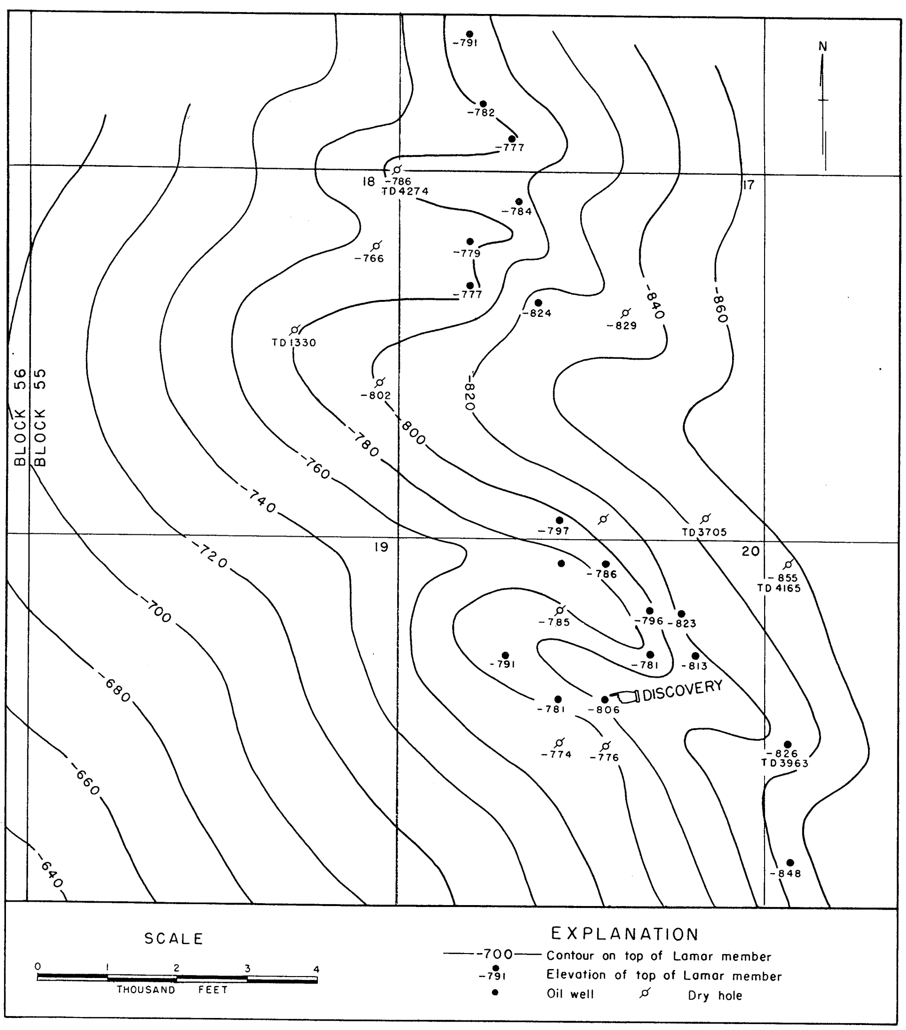
TYPICAL SECTION OF ROCKS PENETRATED





EXPLANATION





McCAMEY FIELD

Upton and Crane Counties, Texas

E. S. HUGHES
Geologist, Gulf Oil Corporation, Fort Worth, Texas
July 15, 1954

LOCATION and FIELD NAMES

The McCamey field is mainly in southwestern Upton County. It occupies an area almost 15 miles long in a northwest-southeast direction, with the northwest end extending into southeastern Crane County. At the nearest point, it is about $1\frac{1}{2}$ miles northward from the town of McCamey. It is one of several fields along the eastern edge of the Central Basin platform.

The area treated herein includes the area treated in some publications as the Herrington field (4 producing wells) in Sec. 4, Blk. $3\frac{1}{2}$, C.C.S.D. & R.G.N.G. survey and Sec. 16, Blk. 3, M.K.&T. survey. The northwestern end of the McCamey field has been called the Taylor area in some publications and the name McCamey-Taylor was commonly applied to the entire field during several years.

The map presented as a part of this paper serves also for the accompanying paper on the Hurdle field and for the accompanying paper on the Webb Ray field. The map indicates the area of the Crossett field and a part of the area of the Crane-Cowden field, both of which fields are treated in other papers in this volume. The map also indicates the location of Buffalo Oil Co. #1 King Ranch Oil & Lignite Co., which was completed June 7, 1953, as the discovery well in a new field designated by the Railroad Commission as the South McCamey (Wichita) field; also, the location of Brown & Thorp and John Parker #1-A J.W.Robbins, which was completed February 13, 1953, as the discovery well in a new field designated by the Railroad Commission as the Webb Ray Southeast (San Andres) field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The mapping of surface exposures, which reveal a gentle anticlinal fold, led to the discovery of the field.

ELEVATION OF SURFACE

At well locations: Highest, 3,121 ft.; lowest, 2,421 ft.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 223 feet below its top. This penetration was at the total depth of 8,653 feet in Sinclair Oil & Gas Co. #5-A J.F.Lane, located in the southeastern part of the field at the location indicated as No. 2 on the line A-A' on the accompanying map.

SURFACE FORMATIONS

Rocks exposed at the surface are mainly of the Comanche series of the Cretaceous system. The northeast portion of the field is situated on King Mountain, a large mesa capped by rocks of the Fredericksburg group with rocks of the Trinity group exposed along the slopes. Recent Quaternary deposits fill the lowlands. To the north and northwest of the field, red beds of the Dockum group of the Triassic system are exposed at the surface.

DISCOVERIES

Grayburg: September 25, 1925; George B. McCamey, J.P. Johnson and Marland Oil Co. #1 M.L.Baker (now, Reno Oil Co. #1 M.L.Baker). The initial production was at the rate of 70 barrels of oil per day from a total depth of 2,193 feet. This well was soon sold to Republic Production Co. and was deepened to the total depth of 2,350 feet and plugged back to 2,267 feet after encountering sulphur water. It was re-completed on March 13, 1926, with a potential pumping capacity of 60 barrels of fluid, 30 to 40% of which was water; gravity of the oil was 33.0° A.P.I.

Fusselman: November 25, 1943; Texas Pacific Coal & Oil Co. #52-A J.F.Lane. This well was formerly a producer from the reservoir in the Grayburg formation and was deepened to 8,358 feet and tested water in the Ellenburger. It was then plugged back and perforated for production from Fusselman. Through perforations at 7,125-7,160 feet and 7,190-7,200 feet, it flowed 44° gravity oil at rate of 398 barrels per day; gas-oil ratio, 1,732:1. A steady increase in gas-oil ratio led to early classification of the well as a gas-condensate well. The rate of production of condensate quickly declined to 50 barrels per day, then to 13 barrels per day and the well was shut-in within a short time. The writer has been unable to find any record of the quantities of fluids produced. The only other well completed in this reservoir is the Ellenburger discovery well, which produces gas and condensate from this reservoir.

Ellenburger: May 19, 1948; Texas Pacific Coal & Oil Co. #62-A J.F.Lane. During initial potential test, flowed at rate of 54 barrels of 43.1° gravity oil and 37 barrels of sulphur water per day through perforations at 8,070-8,130 feet; gas-oil ratio, 1,025:1. This well is the only dually completed well in the field; it produced oil from the Ellenburger and gas and condensate from the Fusselman for about eighteen months before excessive water production forced abandonment in the Ellenburger.

NATURE OF TRAPS

Grayburg: The trap is due primarily to anticlinal folding. Variation in degree of porosity and permeability has functioned as a secondary trap-forming factor.

Fusselman and Ellenburger: The trap in each of these reservoir rocks is due to a small, prominent anticline or dome with approximately 650 feet of structural closure.

THICKNESSES OF RESERVOIR ROCKS

	From top to bottom, feet		
	Min.	Max.	Wt. avg.
Grayburg, estimated	20	105	85
Fusselman	75	110	93
Ellenburger	74	90	82

Data are not available for satisfactory estimates of net productive thicknesses.

CONTINUITY OF RESERVOIR ROCKS

Grayburg: The reservoir rock in the Grayburg formation is certainly continuous throughout the area of the field and probably throughout a large portion of the area of Central Basin platform. Its top is an important datum horizon in the eastern half of that platform.

Fusselman and Ellenburger: The Fusselman and Ellenburger reservoir rocks have been found in each of the 9 wells which have been drilled to sufficient depth to test the Ellenburger; no additional wells have penetrated Fusselman. It appears likely that these reservoir rocks are continuous throughout the area of the accompanying map. However, there is a possibility that the Fusselman is truncated locally along the axis of the dominant anticline.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Feet
Grayburg:	
No free gas cap	
Elevation of top of oil	638
Elevation of bottom of oil	378
Relief	260
Fusselman:	
Elevation of top of gas	-4,399
Elevation of bottom of oil	-4,602
Relief	203
Most of the productive relief is occupied by gas.	
Ellenburger:	
No free gas cap	
Elevation of top of oil	-5,352
Elevation of bottom of oil	-5,564
Relief	212

PRODUCTIVE AREAS

	Acres
Grayburg	20,000
Fusselman	160
Ellenburger	160
McCamey field	20,000

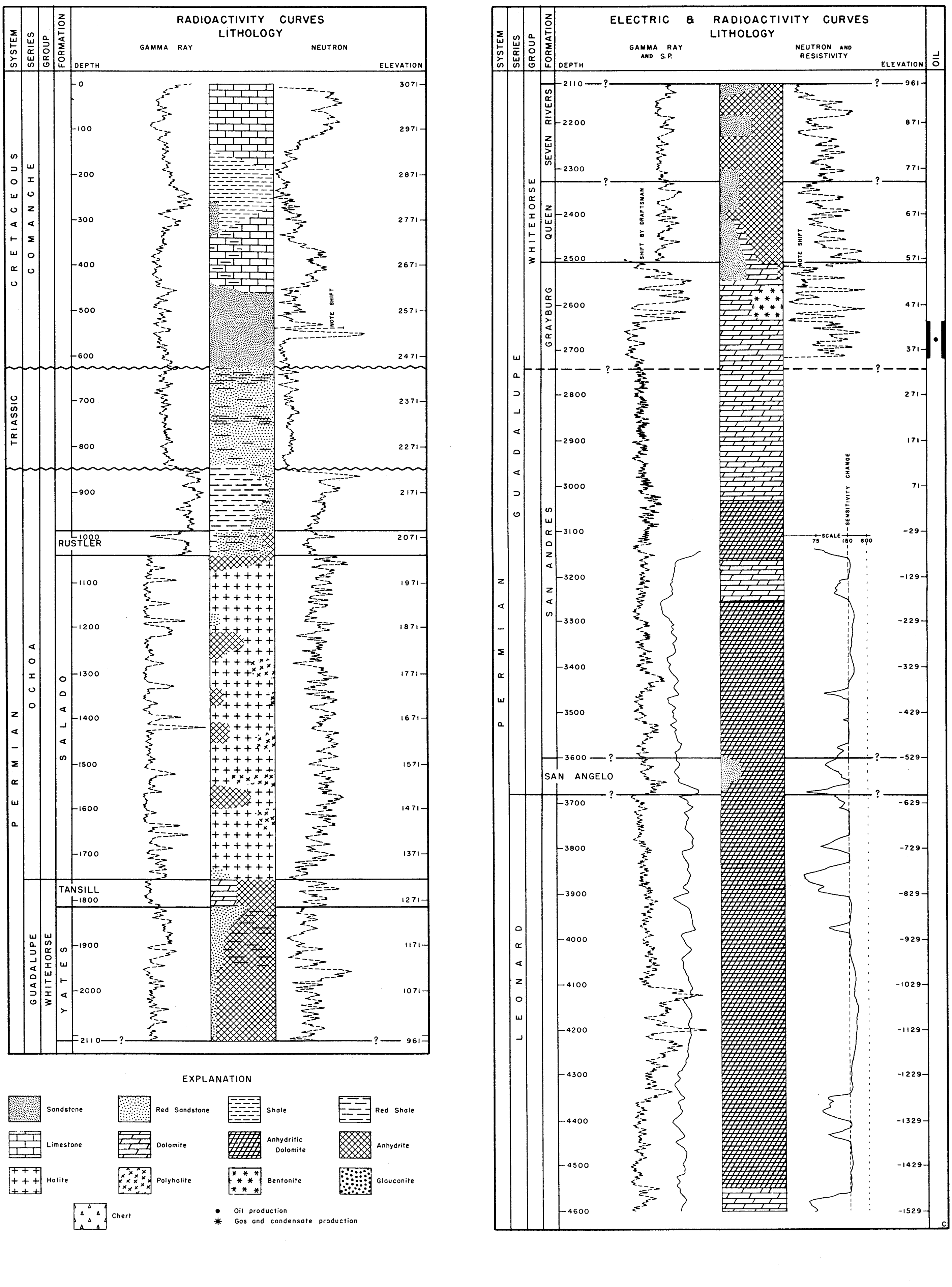
LITHOLOGY OF RESERVOIR ROCKS

Grayburg: The reservoir rock in the Grayburg formation consists of three members, each with distinctive lithology. The upper member, locally 10 to 20 feet thick, is predominantly a finely crystalline, tan to brown dolomite with medium to large, dark brown dolomite rhombs. The brown color is due to oil which is thoroughly disseminated throughout the dolomite. This member is one of the most persistent and widespread stratigraphic units in the Guadalupe series; its top is an important datum horizon throughout the eastern half of the Central Basin platform. The middle member, approximately 100 feet thick, is predominantly clastic and is characterized by a gray-green fine- to medium-grained well cemented sandstone, a gray fine-grained calcareous argillaceous sandstone, and light green bentonitic shale. The upper 10 to 40 feet contains varying amounts of white granular to massive anhydrite. The highest oolitic zone in the reservoir rock occurs about 60 to 70 feet below the top of the middle member. Commercial oil production is yielded by this middle member wherever the sandstone is of sufficient thickness and with a sufficiently high degree of porosity. The lower member is the principal productive portion of the Grayburg reservoir rock. It is dolomite with one to three producing zones, generally two, where porosity is adequate for commercial production. The top of the highest porous zone in the lower member is 130 to 180 feet below the top of the reservoir rock and the top of the lowest porous zone is approximately 200 to 225 feet below that datum. In general, the vertical permeability of the lower member is of low order. The effective porosity is of the secondary solution type.

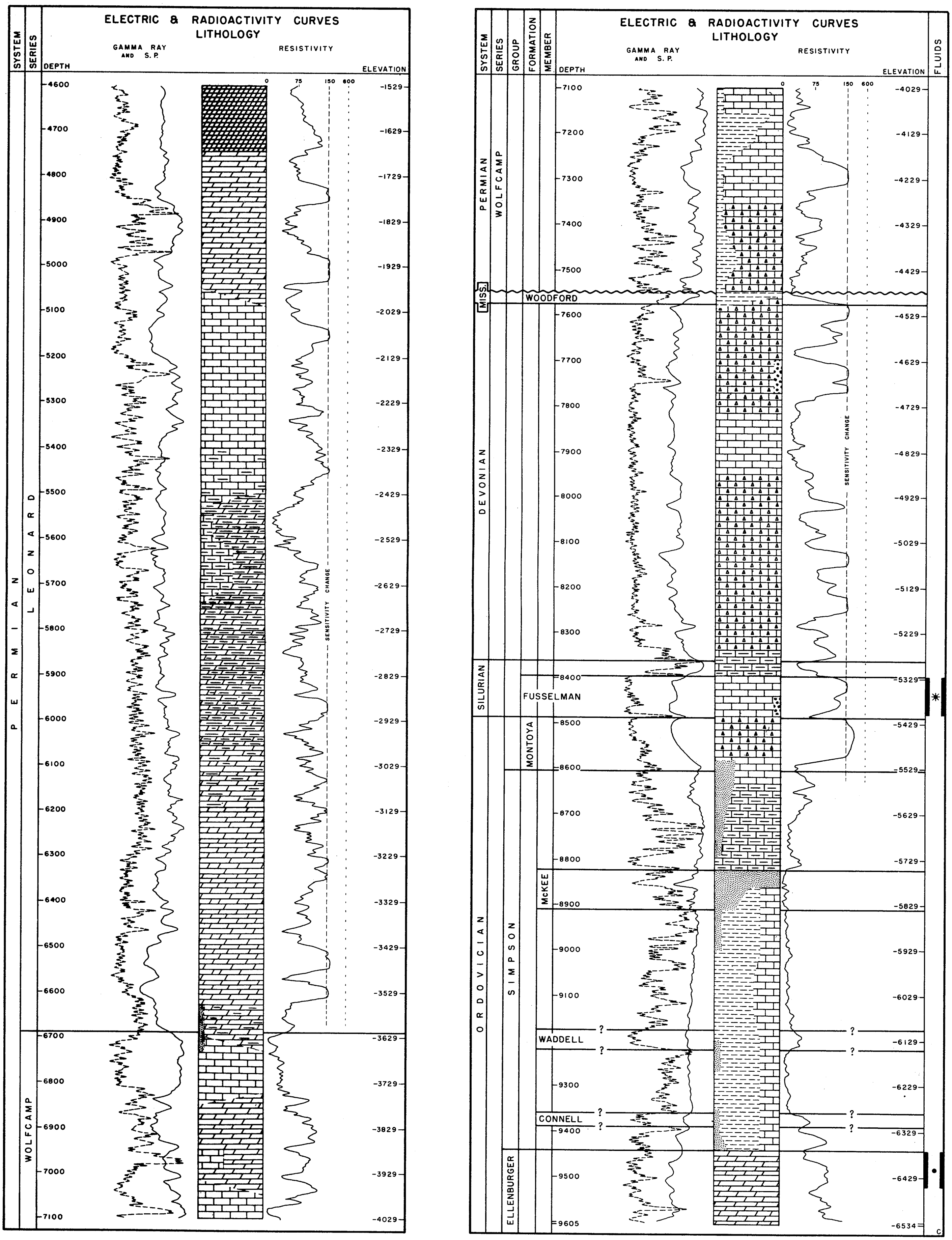
Fusselman: The reservoir rock in the Fusselman formation is a white to pink, coarsely crystalline, crinoidal to chalky limestone. Varying amounts of gray to brown, vitreous chert are scattered throughout its thickness and a very thin zone of medium to coarse, oolitic limestone occurs at the base. The rock is uniformly porous throughout with the exception that the degree of porosity is higher in the basal portion. Intercrystalline porosity, fossil-cast porosity and secondary solution cavities constitute the effective pore space.

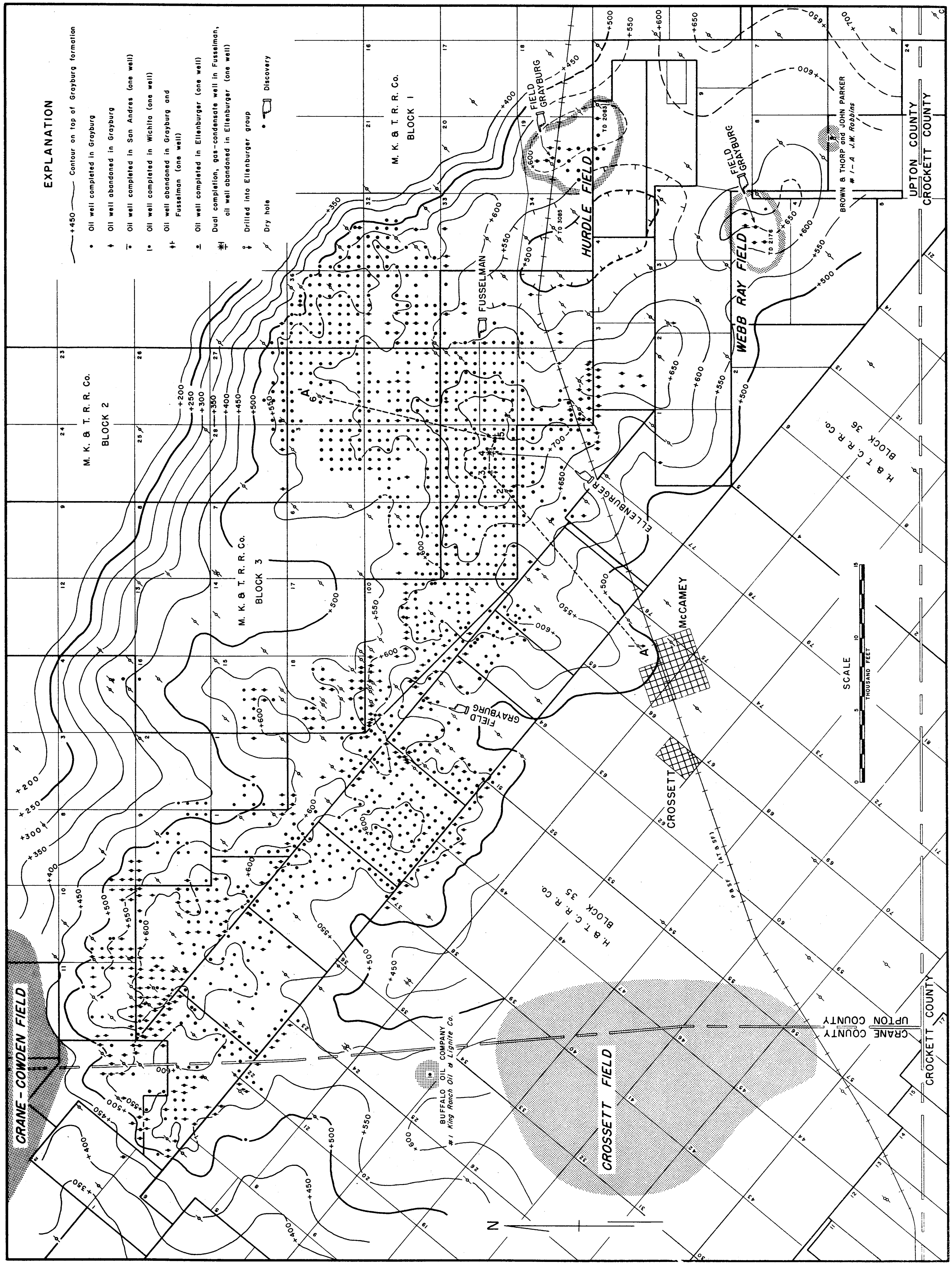
Ellenburger: The reservoir rock, which is approximately the upper 70 to 80 feet of the Ellenburger group, is predominantly gray to brown finely crystalline fractured dolomite containing a few thin gray shale partings. The effective porosity is due to fracturing and to secondary solution cavities.

TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED




EXPLANATION
+450 Contour on top of Grayburg formation
Oil well completed in Grayburg
Oil well abandoned in Grayburg
Oil well completed in San Andres (one well)
Oil well completed in Wichita (one well)
Oil well abandoned in Grayburg and Fusselman (one well)
Oil well completed in Ellenburger (one well)
Dual completion, gas-condensate well in Fusselman, oil well abandoned in Ellenburger (one well)
Drilled into Ellenburger group
Dry hole
Discovery
M. K. & T. R. R. Co. BLOCK 1
M. K. & T. R. R. Co. BLOCK 2
M. K. & T. R. R. Co. BLOCK 3
H. & T. C. R. R. Co. BLOCK 35
H. & T. C. R. R. Co. BLOCK 36
GRAYBURG FIELD
HURDLE FIELD
WEBB RAY FIELD
FUSSELMAN
ELLENBURGER
McCAMEY
CROSSETT
CROSSETT FIELD
CRANE-COWDEN FIELD
BROWN & THORP and JOHN PARKER
1-A J.W. Robbins
BUFFALO OIL COMPANY
#1 King Ranch Oil & Lignite Co.
UPTON COUNTY
CROCKETT COUNTY
CRANE COUNTY
SCALE
THOUSAND FEET
N

CHARACTER OF GAS

Fusselman: Following is an analysis made by Texas Pacific Coal & Oil Co. of a sample of gas from Texas Pacific Coal & Oil Co. #62-A J.F.Lane, the only gas well in the field; a dual completion, formerly with oil production from Ellenburger. During the Fusselman potential test at time of completion, this well produced condensate of 58° gravity at rate of 17 barrels per day; gas-liquid ratio, 126,771:1.

Component	Mol. %
Carbon dioxide	0.10
Nitrogen	2.52
Methane	69.40
Ethane	14.44
Propane	7.31
Iso-butane	0.66
N-butane	2.73
Iso-pentane	0.32
N-pentane	0.58
Hexanes	0.81
Heptanes	1.13
Total	100.00

Specific gravity @ 58° F.	0.76
Sulphur indication	Sweet

RESERVOIR ENERGY

Grayburg: Expulsion of oil from the reservoir is due to expansion of gas coming out of solution as pressure declines and also to water drive. Depletion has advanced to the stage where water drive is now the more important of the two types of reservoir energy.

Fusselman: The reservoir energy is of gas-expansion type.

Ellenburger: There is an effective water drive in this reservoir. Texas Pacific Coal & Oil Co. #62-A J.F.Lane was abandoned in this reservoir because of water encroachment.

WATER PRODUCTION

Grayburg: Throughout the field, water constitutes a large percentage of the gross production. During April 1953 about 80% of the gross production of most wells was water. For analysis of the water see:

Berger, W.R. and Fash, R.H. (1934) Relation of water analyses to structure and porosity in the West Texas Permian basin: Amer. Assoc. Petr. Geol., Problems of Petroleum Geology, pp. 869-889.

Fusselman: No water production.

Ellenburger: During October 1954 water constituted about 15% of the gross production of the one Ellenburger well. Excessive water production forced abandonment of Ellenburger production in the Ellenburger discovery well after operating about eighteen months.

ACID TREATMENT

Grayburg: Most of the recent completions have included acid treatment; a few wells have been completed "natural" and others have been shot with nitroglycerin. Generally, each well is treated with 1,000 to 3,000 gallons of acid, but the quantities have ranged upward to as much as 10,000 gallons.

Fusselman: Both of the wells completed in the Fusselman reservoir were treated with acid. Texas Pacific Coal & Oil Co. #52-A J.F.Lane was treated with 12,000 gallons in four stages; 1,000 gallons, 8,000 gallons, 2,000 gallons, and 1,000 gallons. Texas Pacific Coal & Oil Co. #62-A J.F.Lane, the presently producing gas well, was treated with 4,500 gallons.

Ellenburger: Both of the wells completed in the Ellenburger reservoir were treated with acid; Texas Pacific Coal & Oil Co. #62-A J.F.Lane, with 13,000 gallons and Texas Pacific Coal & Oil Co. #63-A J.F.Lane with 4,000 gallons.

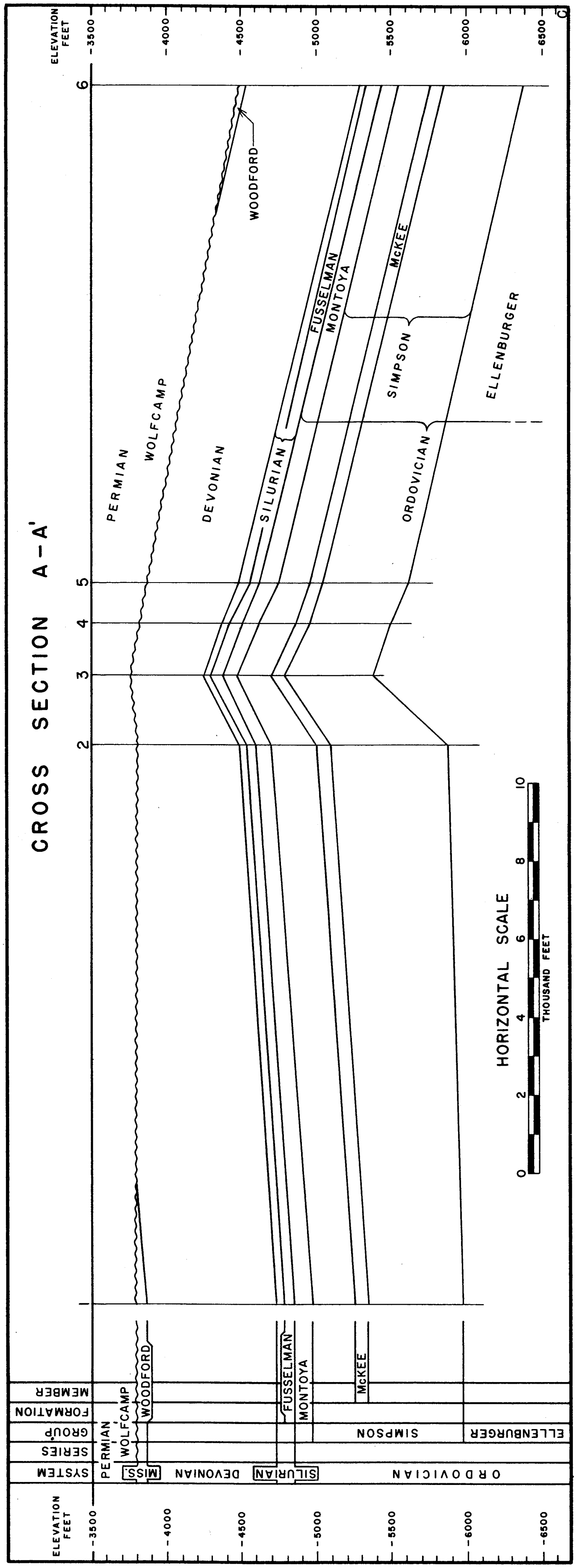
CHARACTER OF OIL

	Grayburg	Fusselman	Ellenburger
Gravity, A.P.I. @ 60° F.	28°	44°	46°
Sulphur, %	2.23	0.58	0.35

For analyses of samples from the Grayburg reservoir see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 32 and 61

U.S. Bureau of Mines	Laboratory reference No.	26178	26265	27593	27863	27864
Analyses of Crude Oils from the West Texas District. R.I. 2849 (1927)	Page				14	15
Tabulated Analyses of Texas Crude Oils. R.I. 3252 (1934) Group 2	Item	40	41	42	43	44
Tabulated Analyses of Texas Crude Oils. T.P. 607 (1939) Group 2	Item	64	65	66	67	68
Analyses of Crude Oils from Some West Texas Fields. R.I. 3744 (1944)	Page					23
Analyses of Crude Oils from 283 Important Oil Fields of the United States. R.I. 4289 (1948)	Item					231



PRODUCTION HISTORY

Grayburg:

Year	WELLS PRODUCING at end of year: Flow	Pump	OIL PRODUCTION (barrels): Yearly	Cumulative
1926	?	?	1,617,158	1,617,158
1927	?	?	6,663,444	8,280,602
1928	?	?	4,293,927	12,574,529
1929	?	?	3,195,374	15,769,903
1930	?	?	2,601,478	18,371,381
1931	?	?	2,298,062	20,669,443
1932	0	253	1,356,887	22,026,330
1933	0	260	1,291,329	23,317,659
1934	6	300	1,328,093	24,645,752
1935	6	296	1,961,719	26,607,471
1936	5	543	3,124,153	29,731,624
1937	0	717	4,586,953	34,318,577
1938	3	838	5,683,217	40,001,794
1939	1	881	5,180,729	45,182,523
1940	2	869	4,226,117	49,408,640
1941	2	854	4,156,649	53,565,289
1942	13	841	3,264,274	56,829,563
1943	0	832	3,211,799	60,041,362
1944	1	811	3,350,671	63,392,033
1945	9	836	3,224,725	66,616,758
1946	3	855	3,303,437	69,920,195
1947	1	869	3,352,054	73,272,249
1948	1	899	3,408,193	76,680,442
1949	0	872	3,046,635	79,727,077
1950	0	895	3,586,829	83,313,906
1951	0	925	3,382,231	86,696,137
1952	3	936	3,029,043	89,725,180
1953	2	961	2,786,500	92,511,680
1954*	0	953	2,396,245	94,907,925

Fusselman: One well, Texas Pacific Coal & Oil Co. #62-A J.F.Lane, has flowed gas and condensate since May, 1948. Another well, the discovery well, produced oil during a short period and then some gas and condensate. While the writer has been unable to determine quantities of fluids produced by that well, it is apparent that the quantities were small.

Year	CONDENSATE PRODUCTION (barrels): Yearly	Cumulative	GAS PRODUCTION (Mcf): Yearly	Cumulative
1948	5,904	5,904	122,730	122,730
1949	6,361	12,265	124,437	247,167
1950	4,871	17,136	99,376	346,543
1951	3,680	20,816	103,949	450,492
1952	4,409	25,225	123,597	574,089
1953	4,085	29,310	106,201	680,290
1954*	2,984	32,294	115,458	795,748

Ellenburger:

Year	WELLS PRODUCING at end of year: Flow	Pump	OIL PRODUCTION (barrels): Yearly	Cumulative
1948	2	0	7,659	7,659
1949	2	0	29,346	37,005
1950	1	0	23,309	60,314
1951	1	0	17,858	78,172
1952	1	0	10,200	88,372
1953	1	0	8,097	96,469
1954*	1	0	6,642	103,111

*1954 data added by amendment.

McCUTCHEN FIELD

Coke County, Texas

J. B. JORDAN
Exploitation Geologist, Union Oil Co. of Calif., Midland, Texas
June 1, 1954

LOCATION

The McCutchen field is 3 miles east of the town of Robert Lee, county seat of Coke County.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Geophysical exploration led to the location of the well which discovered the field. That well is the discovery well of the McCutchen pool. The West McCutchen pool was discovered by a well which was located on the basis of subsurface geological data.

DISCOVERIES

Graham:
- McCutchen pool: July 17, 1950;
  - Union Oil Co. of Calif. #1-B Daisy McCutchen.
- West McCutchen pool: January 17, 1951;
  - Union Oil Co. of Calif. #3 Jim McCutchen.

ELEVATION OF SURFACE

Derrick floor: Highest, 1,978 ft.; lowest, 1,909 feet.

SURFACE FORMATION

San Angelo formation at base of Guadalupe series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 395 feet below the top of the Ellenburger. This penetration was in the McCutchen pool discovery well. The accompanying TYPICAL SECTION is based on the log of that well.

NATURE OF TRAPS

Graham: Each of the two traps is formed by draping of the overlying shale over a thick, relatively local, sand body and by lateral updip gradation of the sand to shale.

PRODUCTIVE AREAS

Graham	Acres
McCutchen pool	296
West McCutchen pool	80
McCutchen field	376

THICKNESSES OF RESERVOIR ROCK

Graham:	Net productive, feet		
	Min.	Max.	Avg.
McCutchen pool	8	30	18
West McCutchen pool	15	21	18

LITHOLOGY OF RESERVOIR ROCK

Graham: The reservoir rock consists of fine to coarse sand with some shale and chert pebbles and interbedded thin shale streaks. In the southwest part of the McCutchen pool, there are some conglomerate zones within the reservoir rock.

CONTINUITY OF RESERVOIR ROCK

Graham: The reservoir rock grades laterally into shale in all directions. The exact extent of sand is not known. However, at the location of the dry hole near the north edge of the area covered by the accompanying map, the reservoir rock is very shaly and, at a location only a mile further north, sand is completely absent. There is no sand at a location $3\frac{1}{2}$ miles to the northwest. Pure limestone occupies the corresponding stratigraphic position at a location 4 miles to the east. Southward, the zone grades from predominantly sand to predominantly shale at a distance of about 7 miles.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Graham:	McCutchen	West McCutchen
Elevation of top of oil, ft.	-2,003	-2,056
Elevation of bottom of oil, ft.	-2,049	-2,077
Relief	46	21

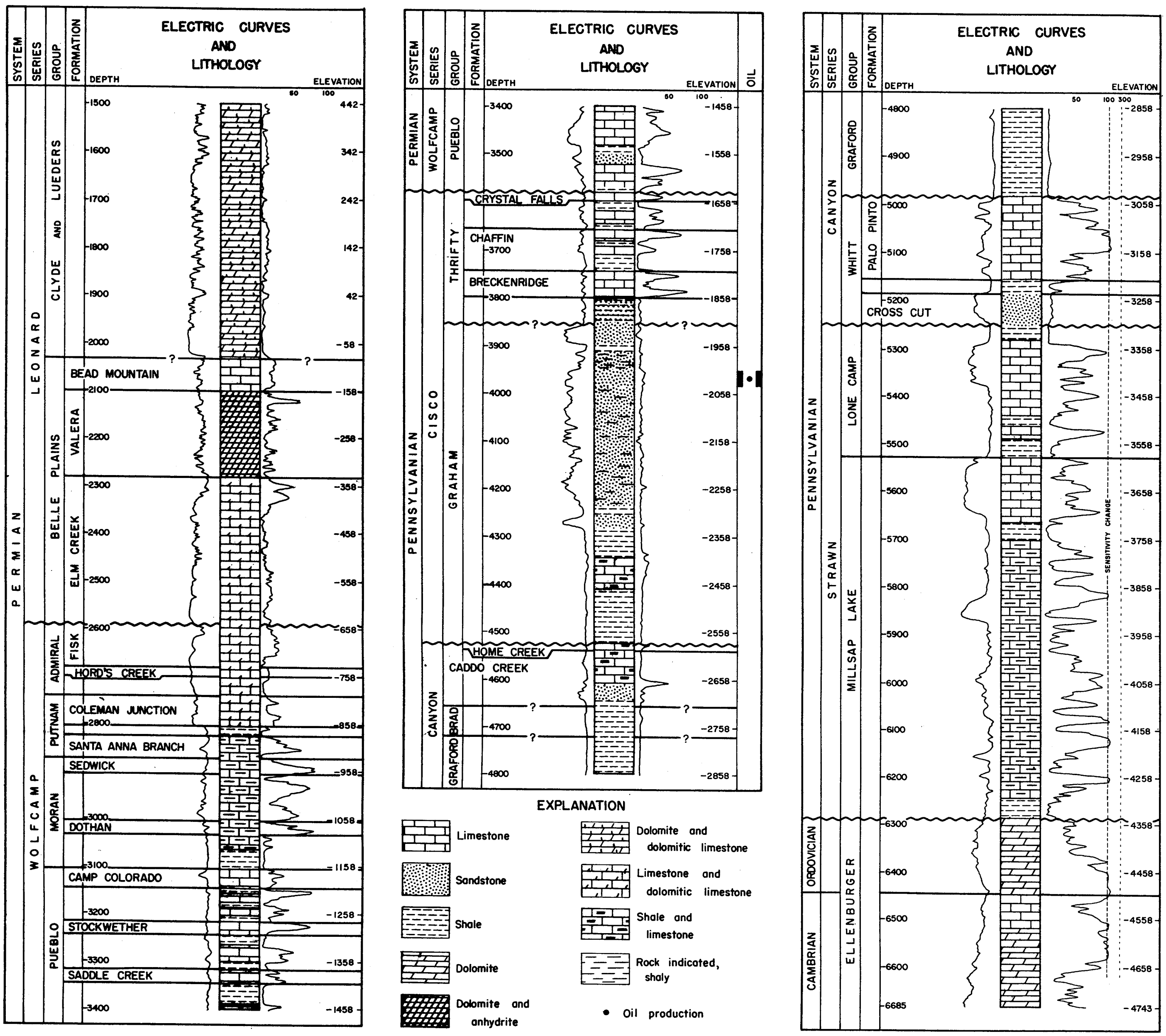
CHARACTER OF OIL

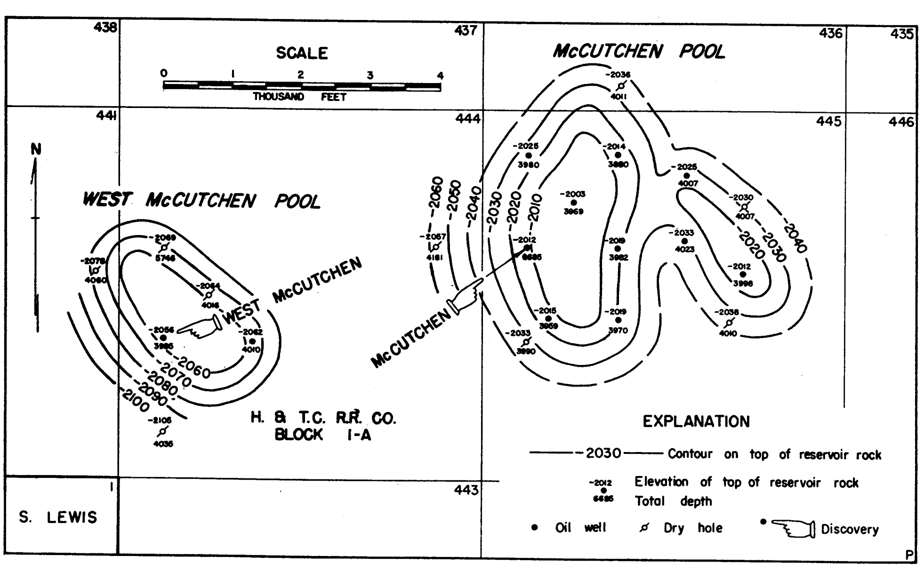
Graham:
- Gravity, A.P.I. @ 60°F.: 46°
- Sulphur: 0.15%
- Color: Yellow

WATER PRODUCTION

Graham: None of the wells produced water initially but as oil was withdrawn some of the edge wells started producing small amounts of water.

TYPICAL SECTION OF ROCKS PENETRATED





PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Pumping	Oil production (barrels): Yearly	Cumulative
Graham: Field totals				
1950	5	0	36,958	36,958
1951	2	9	161,256	198,214
1952	3	9	178,371	376,585
1953	?	?	144,008	520,593
Graham: McCutchen pool				
1950	5	0	36,958	36,958
1951	2	7	145,799	182,757
1952	3	7	172,320	355,077
1953	?	?	140,661	495,738
Graham: West McCutchen pool				
1951	0	2	15,457	15,457
1952	0	2	6,051	21,508
1953	0	2	3,347	24,855

McELROY FIELD

Crane and Upton Counties, Texas

A. B. McINNIS and F. H. HARTMAN
Geologists, Gulf Oil Corporation, Fort Worth, Texas
November 15, 1955

LOCATION and FIELD NAMES

The McElroy field is in northeastern Crane County and west-central Upton County. It is elongated in a northwest-southeast direction with the central portion occupying an area along the Crane-Upton County line immediately east of the town of Crane. It is in the midst of several fields on the eastern edge of the Central Basin platform. It is continuous with the Dune field; separated merely by an arbitrary line. Presently known conditions of nature indicate that the adjacent portion of the Dune field would be more appropriately considered as a part of the McElroy field than as a part of the Dune field. Adoption of the more nearly natural boundary does not appear practical for the purposes of this paper.

During early development, three portions of the McElroy field were treated as individual fields: namely, Church-Fields field, Gulf-McElroy field and McClintic field. Extension and merging of productive areas led to designations by various combinations of these names and, finally, to general recognition that the three units should be treated as one field and to general adoption of the use of the one name with its present significance. The Railroad Commission consolidated its rules and records effective March 1, 1941.

The first well drilled in the northeast quarter of Sec. 3, Blk. X, C.C.S.D. & R.G.N.G. survey was treated during several years as in a separate field, the South Crane field, and that name has been used in many publications. George F. Getty #1 Hallie C. Day, located 330 feet south of the north line and 990 feet west of the east line of said section, was completed in the Grayburg formation on June 24, 1948, and its oil production of 1,883 barrels during 1948, 319 barrels during 1949 and 163 barrels during 1951 (total, 2,365 barrels) was reported as from the South Crane field. The well was temporarily abandoned and produced no more oil until after a workover which was completed on March 14, 1955, when it was designated as E. Q. Echols #1 Hallie C. Day and was treated as in the McElroy field. It is now designated as R. L. Dameron #1 Hallie C. Day and treated as in the McElroy field. Other wells in the immediate vicinity have been treated generally by administrative authorities and in petroleum publications as in the McElroy field. In this paper, the production of said first well, along with the production of the subsequent wells, is treated as in the McElroy field.

DISCOVERIES

Grayburg: Church-Fields: April 19, 1926; Church & Fields #1 University (later, Magnolia Petroleum Co. #1 University). Completed with open hole from 3,028 to 3,040 feet; estimated potential, 190 barrels of oil per day.

Grayburg: Gulf-McElroy: July 22, 1926; Gulf Production Co. #1 J. T. McElroy. Completed with open hole from 2,675 to 2,750 feet (later deepened to 2,917 feet); estimated potential, 500 barrels of oil per day.

Grayburg: McClintic: November 28, 1928; Keck Investment Co. #1 H. L. McClintic (later, Mabee Petroleum Corp. #1 H. L. McClintic). Top of reservoir, 2,890 feet; total depth, 2,944 feet; shot with 400 quarts of nitroglycerin from 2,874 to 2,934 feet; swabbed 140 barrels of oil during first day after shot.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Trend drilling in conjunction with interpretation of a limited amount of surface geological data led to the drilling of Church & Fields #1 University, which was the first discovery well within the present area of the field.

ELEVATION OF SURFACE

The surface generally is about 2,625 feet above sea level; the highest elevation is about 2,800 feet and the lowest is about 2,550 feet.

SURFACE FORMATIONS

Quaternary sand and caliche cover the surface within the area of the field. Rocks of the Fredericksburg and Trinity groups are exposed in mesas east and southeast of the field.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 400 feet below its top. This penetration was in Gulf Production Co. #103 J. T. McElroy, located in Sec. 197, Blk. F, where the total depth of 12,786 feet is indicated on the accompanying map. There were several shows of oil below the Grayburg formation, but no commercial production. The well was plugged back and completed in the Grayburg reservoir. At the time this well was drilled to its total depth (May 25, 1935), it was the deepest well in the world. As reported in the two papers cited below under SELECTED REFERENCES, this well established several records and provided considerable technical information.

LITHOLOGY OF RESERVOIR ROCK

Grayburg:

The upper portion of the reservoir rock is only locally commercially productive. This member is sandy, gray to tan, anhydritic, bentonitic (green), shaly dolomite. The average thickness is about 100 feet. It yields oil and gas locally from thin oolitic zones where porosity is favorable. The porosity is primary and is oolitic and intergranular. This sandy upper portion of the reservoir rock is generally recognized by its fine, angular, even-grained texture. It is immediately below a widespread brown dolomite zone, generally about 15 feet thick, which is the first widely correlative carbonate rock below the evaporite series.

The above described sandy upper portion of the reservoir rock immediately overlies the main productive zone, which is oolitic, anhydritic, fossiliferous dolomite. The oolites are spherical and nearly uniform in size; about 1/32-inch in diameter. Fragments of fusulinids are common. This main productive zone, 10 to 100 feet thick, is the main source of production in the McElroy field. It is relatively homogeneous and, due to its oolitic and granular dolomitic texture, is an excellent reservoir rock. It has both primary and secondary porosity; the primary porosity is of the oolitic and inter-crystalline types and the secondary porosity is of the solution vug and fossil cast types.

NATURE OF TRAP

Grayburg: The trap is due primarily to anticlinal folding. Variation in degree of porosity and permeability has functioned as a secondary trap-forming factor.

THICKNESSES OF RESERVOIR ROCK

	Feet		
Grayburg:	Min.	Max.	Avg.
Top to bottom	100	400	225

Data are not available for determining net thicknesses of productive rock.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Grayburg:	Feet
No free gas cap	
Elev. of top of oil	-198
Elev. of bottom of oil, approx.	-600
Relief, approx.	402

The above figures represent conditions at time of discovery.

CHARACTER OF GAS

Component	Mol. %
Hydrogen sulphide	21.6
Methane	34.5
Ethane	26.55
Propane	12.97
Butane	3.41
Pentane	.70
Hexane	.20
	99.93

CHARACTER OF OIL

Gravity, A.P.I. @60°F.: 31 - 33°
Sulphur: 2.5% Base: Intermediate
Color: Greenish- and brownish-black

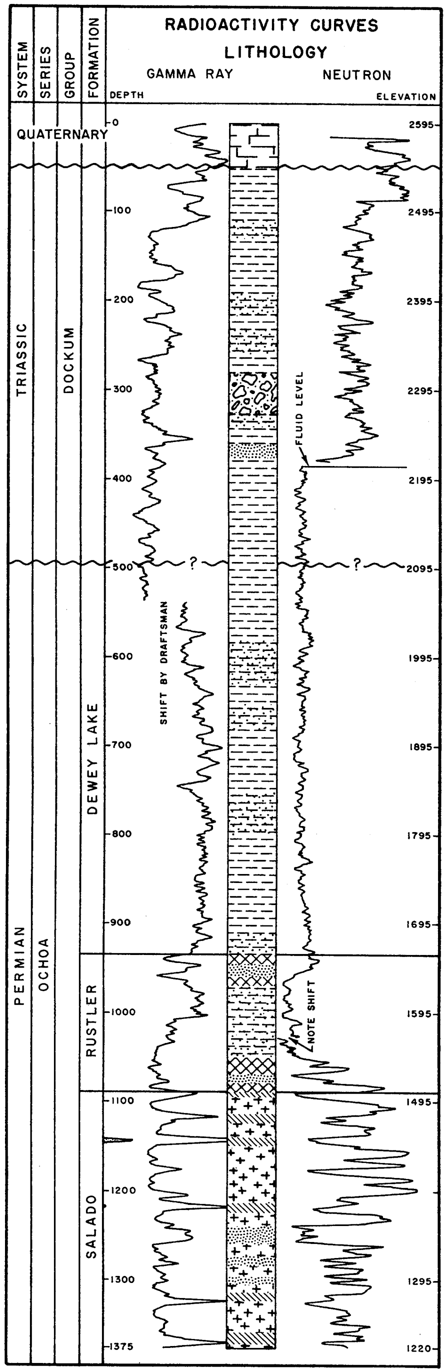
Component	Mol. %
Hydrogen sulphide	5.99
Methane	8.98
Ethane	6.92
Propane	5.67
Butane	4.37
Pentane	3.74
Hexane	4.49
Heptane and heavier	60.34
	100.50

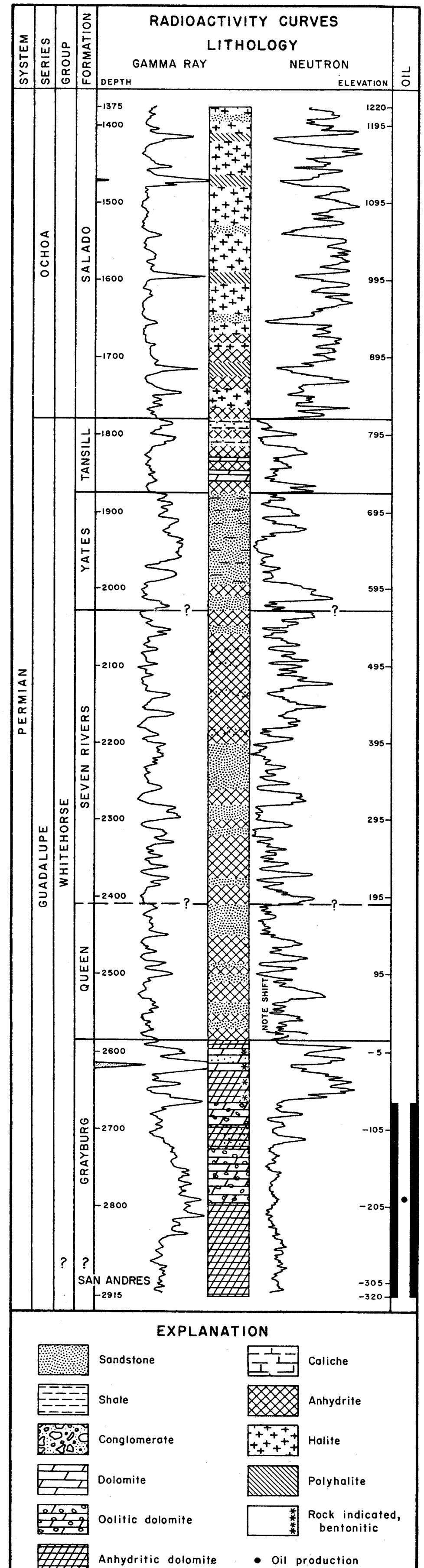
For other analyses see:

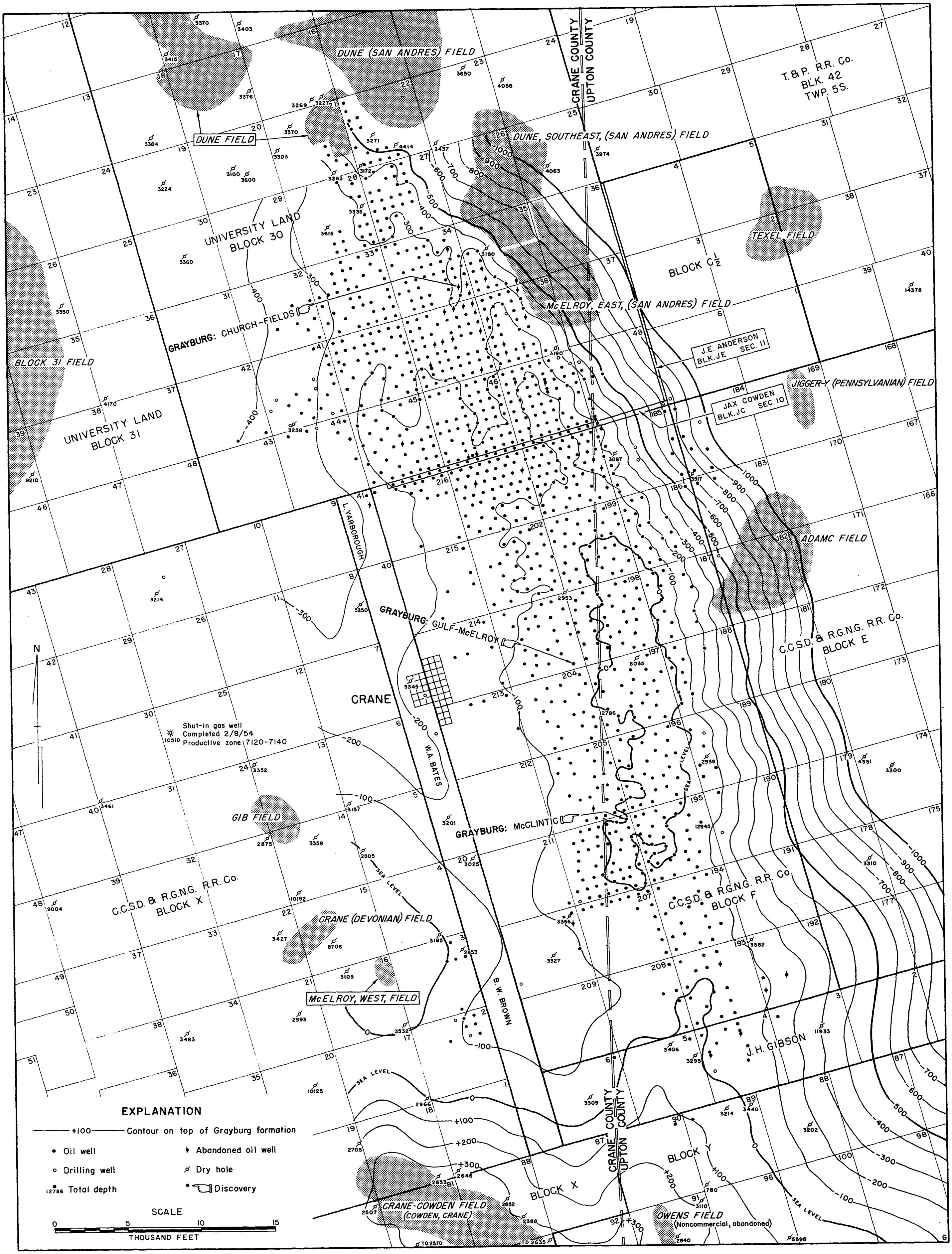
Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 32 and 62.

U. S. Bureau of Mines	Lab. ref. No.	27860	27861	27862	30343	43112
Analyses of Crude Oils from the West Texas District. R. I. 2849 (1927)	Page	11	12	13		
Tabulated Analyses of Texas Crude Oils. R. I. 3252 (1934)	Group 2, Item	19	46	47	20	
Petroleum Engineering Report, Big Spring Field and Other Fields in West Texas and Southeastern New Mexico. R. I. 3316 (1936)	Page		144			
Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939)	Group 2, Item	37	38	39	40	
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944)	Page					24
Analyses of Crude Oils from 283 Important Oil Fields of the United States. R. I. 4289 (1948)	Item					232

TYPICAL SECTION OF ROCKS PENETRATED






DUNE (SAN ANDRES) FIELD
DUNE FIELD
DUNE, SOUTHEAST, (SAN ANDRES) FIELD
CRANE COUNTY
UPTON COUNTY
T. & P. R.R. Co.
BLK. 42
TWP. 5S.
TEXEL FIELD
BLOCK C 1/2
UNIVERSITY LAND
BLOCK 30
GRAYBURG: CHURCH-FIELDS
McELROY, EAST, (SAN ANDRES) FIELD
J.E. ANDERSON
BLK. JE SEC. 11
JAX COWDEN
BLK. JC SEC. 10
JIGGER-Y (PENNSYLVANIAN) FIELD
BLOCK 31 FIELD
UNIVERSITY LAND
BLOCK 31
ADAMC FIELD
L. YARBOROUGH
GRAYBURG: GULF-McELROY
C.C.S.D. & R.G.N.G. R.R. Co.
BLOCK E
CRANE
Shut-in gas well
Completed 2/8/54
Productive zone 7120-7140
W.A. BATES
SEA LEVEL
GIB FIELD
GRAYBURG: McCLINTIC
C.C.S.D. & R.G.N.G. R.R. Co.
BLOCK X
C.C.S.D. & R.G.N.G. R.R. Co.
BLOCK F
CRANE (DEVONIAN) FIELD
McELROY, WEST, FIELD
B. W. BROWN
J. H. GIBSON
BLOCK Y
BLOCK X
CRANE-COWDEN FIELD
(COWDEN, CRANE)
OWENS FIELD
(Noncommercial, abandoned)
N
EXPLANATION
+100 Contour on top of Grayburg formation
Oil well
Abandoned oil well
Drilling well
Dry hole
12786 Total depth
Discovery
SCALE
0 5 10 15
THOUSAND FEET

PRODUCTIVE AREA

Grayburg and Field: Approximately 21,000 acres.

CONTINUITY OF RESERVOIR ROCK

Grayburg: The reservoir rock is continuous throughout the area of the field.

WATER PRODUCTION

Grayburg: As indicated by figures in a column in the following PRODUCTION HISTORY, water production constituted less than 2% of the total fluid production during the first 16 years, less than 10% during the next 5 years, and more than 12% but less than 20% during the last 7 years. It is estimated that water production through 1955 totals about 14,000,000 barrels, or about 5.6% of the gross quantity of fluids removed from the reservoir. Following is an analysis of a typical sample of the water. The sample was taken 9/27/55 from the flow line of Gulf Oil Corp. #55 J. T. McElroy, which is located in Sec. 200, Blk. F, and which was completed on 10/22/28 at the total depth of 2,990 feet for production from 2,800 - 2,990 feet.

ANALYSIS

Salinity: Primary, 76.42%; Secondary, 15.88%
Alkalinity: Primary, 0.00%; Secondary, 15.88%
Specific gravity: 1.0133 pH: 6.98
Resistivity @24°C.: 0.412 ohmmeters.

Radical	Parts/ million	Reaction coeff.	Reaction value	Reaction value, %
Na	5,985	0.0435	260.36	38.21
Ca	1,160	0.0499	57.88	8.50
Mg	273	0.0822	22.44	3.29
OH	0	0.0588	0.00	0.00
CO_3	0	0.0333	0.00	0.00
HCO_3	1,598	0.0164	26.21	3.85
SO_4	3,100	0.0208	64.48	9.46
Cl	8,865	0.0282	249.99	36.69
H_2S	754		0.00	0.00
Total	21,735		681.36	100.00

Hypothetical recombination	Parts per million
$Ca(HCO_3)_2$	2,124
$CaSO_4$	2,154
$MgSO_4$	1,344
$NaSO_4$	735
NaCl	14,616

COMPLETION TREATMENT

Grayburg: Acidizing has played a subordinate role in both workovers and initial completions. The general completion practice has been to shoot the reservoir rock with 100 to 300 quarts of nitroglycerin. Large volume, high injection rate, sand-oil fracture treatments have recently replaced shooting during both workovers and initial completions. Generally, a fracture treatment consists of injecting 15,000 gallons of refined oil containing 20,000 pounds of sand down the 7-inch casing with injection rates ranging between 15 and 40 barrels per minute, followed by an overflush of approximately 175 barrels of crude oil.

RESERVOIR ENERGY

Grayburg: Oil expulsion is due to expansion of gas as it comes out of solution because of declining pressure. The reservoir behavior is characterized by lack of free gas cap, low rate of water influx, increasing gas-oil ratios and decreasing bottom-hole pressures.

SELECTED REFERENCES

Carpenter, C. B., and Hill, H. B. (1936) Church-Fields, McElroy oil field; in Petroleum Engineering Report, Big Spring and other fields in West Texas and Southeastern New Mexico: U. S. Bureau of Mines, R. I. 3316, pp. 136-149.

West Texas Oil Scouts (1936) Church-Fields-McElroy; in chapter re West Texas - Year 1935: National Oil Scouts Assoc., Year Book - 1936, pp. 218-219. Presents detailed data afforded by the then deepest well in the world.

PRODUCTION HISTORY

Grayburg

Year	WELLS PRODUCING at end of year: Flow.	Artif.	Total	OIL PRODUCTION (barrels): Yearly	Cumulative	WATER (% of total liquid; est.)
1926	?	?	19	427,020	427,020	Neg.
1927	?	?	221	23,421,270	23,848,290	Neg.
1928	?	?	255	21,456,390	45,304,680	Neg.
1929	?	?	282	13,841,477	59,146,157	0.02
1930	?	?	320	11,564,274	70,710,431	0.05
1931	?	?	335	6,341,942	77,052,373	0.04
1932	?	?	344	5,648,998	82,701,371	0.03
1933	?	?	345	4,646,597	87,347,968	0.03
1934	?	?	351	4,500,160	91,848,128	0.04
1935	65	312	377	4,062,666	95,910,794	0.05
1936	86	328	414	4,474,135	100,384,929	0.07
1937	130	290	420	4,520,758	104,905,687	0.08
1938	129	344	473	3,657,959	108,563,646	1.24
1939	176	317	493	3,696,244	112,259,890	1.07
1940	212	313	525	5,063,915	117,323,805	1.01
1941	154	428	582	4,797,089	122,120,894	1.05
1942	108	487	595	4,910,238	127,031,132	1.51
1943	79	523	602	6,147,530	133,178,662	2.32
1944	87	529	616	10,458,736	143,637,398	4.47
1945	115	538	653	10,932,952	154,570,350	5.00
1946	83	586	669	9,812,707	164,383,057	6.10
1947	67	666	733	10,381,131	174,764,188	6.50
1948	48	761	809	10,627,787	185,391,975	9.10
1949	30	824	854	8,135,442	193,527,417	12.10
1950	27	876	903	7,495,252	201,022,669	14.91
1951	14	907	921	8,412,540	209,435,209	15.86
1952	9	915	924	7,442,090	216,877,299	15.70
1953	11	898	909	7,165,838	224,043,137	18.90
1954	11	946	957	6,679,230	230,722,367	19.78
1955*	33	1,033	1,066	6,827,197	237,549,564	16.85

* 1955 data added by amendment.

GAS PRODUCTION: Incidental to oil production, some gas has been produced throughout the history of the field, but since the gas was sour and had very little value, records of gas production are too fragmental to warrant entry here.

McKEE FIELD

Crane County, Texas

BARBARA M. CREAGER
Geologist, Humble Oil & Refining Co., Midland, Texas
February 1, 1956

LOCATION and FIELD NAME

The McKee field is in southwestern Crane County one mile north of the Pecos River. It is in the approximate center of the southern portion of the Central Basin platform.

The field name was derived from the name of the McKee sandstone, which was the first zone found productive in the field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Study of subsurface geological data led to the exploratory drilling which resulted in the discovery of commercial production in the McKee sandstone. The nearest McKee production at that time was in the Abell field about two miles to the southwest.

A leak in the casing in the third well in the field prompted workover operations during which it was found that oil was flowing from the Tubb Dolomite. This well was then completed as the Tubb Dolomite discovery well.

DISCOVERIES

Tubb Dolomite: January 9, 1950; Magnolia Petroleum Co. #3 D.K.Glenn. After having produced from the McKee sandstone for six years, this well was plugged back to 4,136 feet and completed for production from the Tubb Dolomite member, where its daily initial flowing potential was at the rate of 124 barrels of 35.8° gravity oil through perforations from 4,050 to 4,075 feet; GOR, 1,317 : 1.

McKee: September 5, 1942; Magnolia Petroleum Co. #1 D.K.Glenn. The daily initial flowing potential was at the rate of 225 barrels of 43.2° gravity oil from open hole from 6,125 to 6,185 feet. This well has been plugged and abandoned and the only other wells (two) which have produced from McKee have been abandoned in this reservoir and are now producing from Tubb Dolomite.

ELEVATION OF SURFACE

At well locations: Highest, 2,461 ft.; lowest, 2,419 ft.

SURFACE FORMATION

Undifferentiated Quaternary sand.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is 249 feet below the top of the Ellenburger. This penetration was at the total depth of 7,204 feet in Magnolia Petroleum Co. #1 N.M.Tucker, a dry hole just east of the field.

NATURE OF TRAPS

Tubb Dolomite: The trap is due to variation in degree of porosity and permeability on a north-south trending anticline.

McKee: Anticlinal folding appears to be the primary trap-forming factor.

PRODUCTIVE AREAS

Tubb Dolomite	600 acres
McKee (depleted)	120 acres
McKee field	625 acres

THICKNESSES OF RESERVOIR ROCKS

From top to bottom:	Feet		
	Min.	Max.	Avg.
Tubb Dolomite	15	85	43
McKee	10	60	37

Net thicknesses: Available data do not warrant estimates of net productive thicknesses.

LITHOLOGY OF RESERVOIR ROCKS

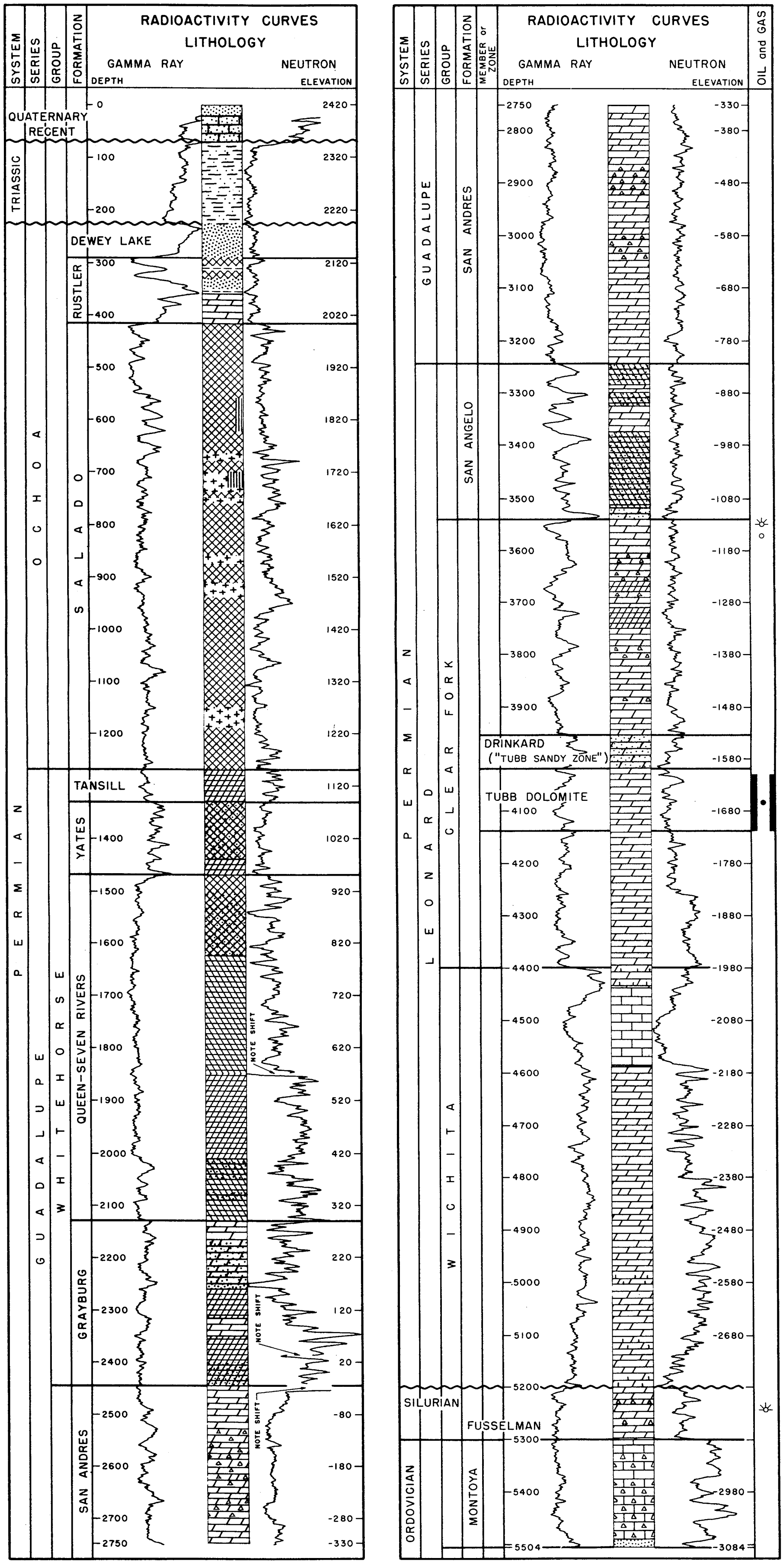
Tubb Dolomite: Gray to brown, slightly shaly, dense to crystalline dolomite with pinpoint to vuggy lenticular porosity and a small amount of fracturing.

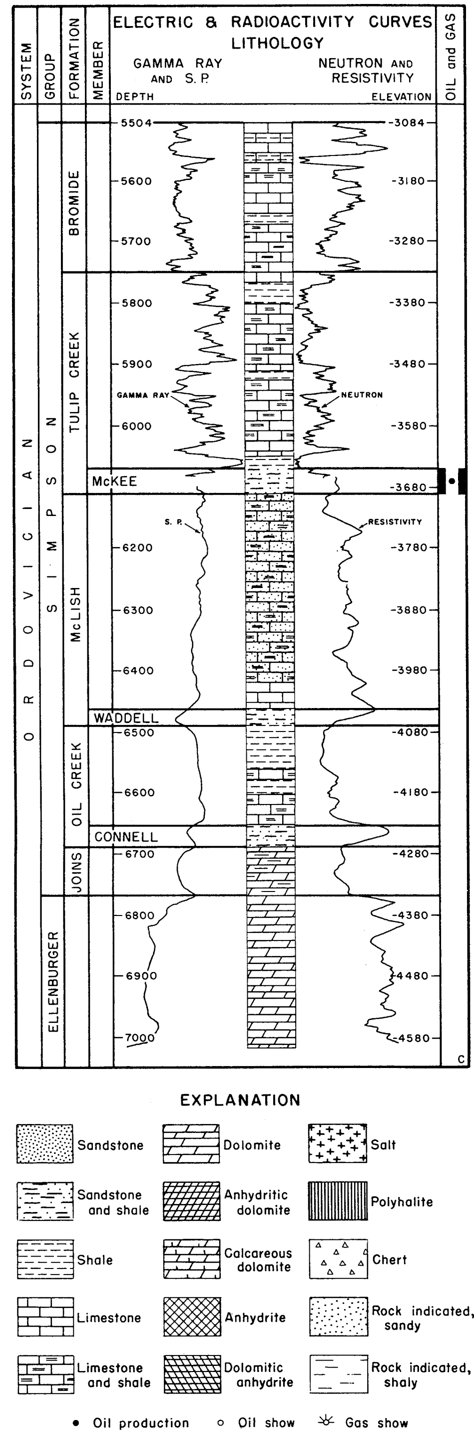
McKee: Fine- to medium-grained, white to green, loosely consolidated sandstone with scattered shale partings.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Tubb Dolomite	McKee
Highest known elev. of oil, ft.	-1,614	-3,660
Lowest known elev. of oil, ft.	-1,718	-3,749
Known relief, ft.	104	89

TYPICAL SECTION OF ROCKS PENETRATED





CHARACTER OF OIL

	Tubb Dolomite	McKee
Gravity, A.P.I. @ 60°F.	37.5°	39.6°
Sulphur, % by weight	1.16	0.22
Base	Intermediate	
Viscosity at 100°F., Saybolt sec.	42	44
Odor	Sour	Sour
Color	Brownish-green	Brownish-black

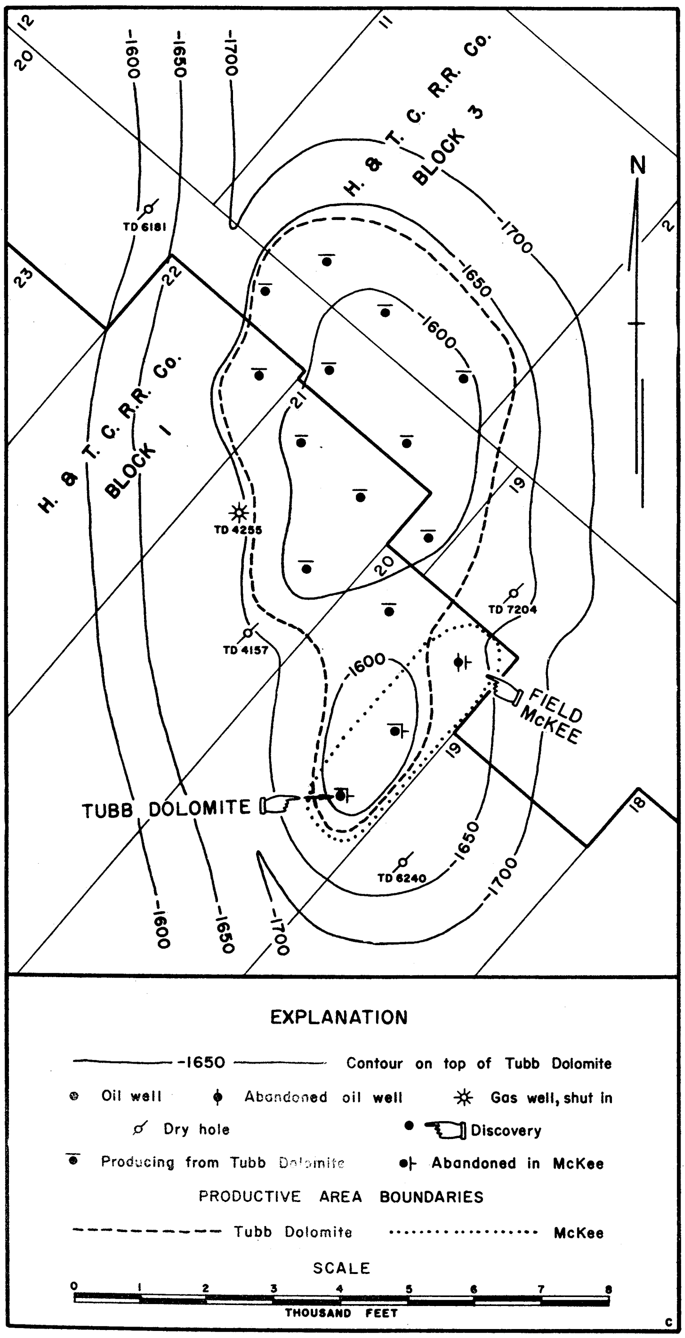
For analyses of McKee oil see:

U.S. Bureau of Mines Lab. ref. No. 46097
Analyses of Crude Oils from Some West Texas Fields. R.I.4959 (1953) Item 38

CONTINUITY OF RESERVOIR ROCKS

Tubb Dolomite: The reservoir rock in the Clear Fork group is continuous throughout the area of the field and throughout a large portion of the Central Basin platform. However, generally the degree of porosity and permeability are not adequate for commercial production. A reservoir rock at the same stratigraphic position is productive in the South Sand Hills field, 3 miles north, and in the Sand Hills field, 7 miles north, and also in several other fields on the Central Basin platform. Within the area of the McKee field, the top of the porous zone is from 15 to 130 feet below the base of the Drinkard member, which is characterized by being sandy.

McKee: The reservoir rock is continuous over most of the southern portion of the Central Basin platform except in areas of extreme pre-Permian erosion and except in local areas where continuity is interrupted by faulting.



WATER PRODUCTION

Tubb Dolomite: Water production has increased gradually since the time of discovery. Water now constitutes less than 15% of the gross liquid production.

McKee: No water was produced at time of discovery. No record of water subsequently produced is available.

ACID TREATMENT

Tubb Dolomite: Of the 14 wells completed in this reservoir, 13 were acidized; one was completed "natural". Quantities of acid ranged from 250 gallons to 9,000 gallons; average, 1,750 gallons.

McKee: Of the 3 wells completed in this reservoir, 1 was acidized; 2 were completed "natural".

RESERVOIR ENERGY

Tubb Dolomite: The reservoir energy is due primarily, if not wholly, to expansion of gas as it comes out of solution in the oil due to decline in pressure. There appears to have been some free gas present at time of discovery, but whether it was in this reservoir or in a lens slightly higher is not determinable. The gas-oil ratio has increased from 1,317 : 1 at time of discovery to the present ratio of 5,989 : 1.

McKee: The reservoir energy was due to expansion of gas which came out of solution as pressure declined.

DEVELOPMENT AND PRODUCTION HISTORY

	NUMBER OF WELLS			OIL PRODUCTION (barrels)	
	Completed during year	Producing oil at end of year Flow	Pump	Yearly	Cumulative
Tubb Dolomite					
1950	3	2	1	14,656	14,656
1951	3	4	2	32,176	46,832
1952	5	9	2	94,435	141,267
1953	3	9	5	100,704	241,971
1954	0	8	6	70,965	312,936
1955	0	7	6	68,529	381,465
McKee					
1942	1	1	0	8,768	8,768
1943	2	1	2	34,618	43,386
1944	0	0	3	41,797	85,183
1945	0	0	3	19,253	104,436
1946	0	0	3	11,600	116,036
1947	0	0	2	9,609	125,645
1948	0	0	2	7,218	132,863
1949	0	0	2	5,289	138,152
1950	0	0	1	8,670	146,822
1951	0	0	1	1,393	148,215
1952	0	0	0	435	148,650
1953-55	0	0	0	0	148,650

MIDWAY LANE FIELD

Crockett County, Texas

JOHN M. SWEET
Geologist, The Atlantic Refining Co., Midland, Texas
March 15, 1953

LOCATION

The Midway Lane field is in northeast Crockett County, about 14 miles north northwest of Ozona, county seat.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Refraction seismograph surveys were conducted in the general area by The Atlantic Refining Co. and Sinclair Oil & Gas Co. On the basis of these surveys, the two companies collaborated in the selection of the location of the exploratory test which became the field discovery well.

DISCOVERIES

Queen: August 22, 1950; Sinclair Oil & Gas Co. and The Atlantic Refining Co. #7 University 67.

Ellenburger and Field: July 31, 1947; Sinclair Oil & Gas Co. and The Atlantic Refining Co. #1 University 66.

ELEVATION OF SURFACE

Derrick floor elevations: Highest, 2,683 feet; lowest, 2,642 feet.

SURFACE FORMATION

Undifferentiated limestones of Fredericksburg group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 20 feet below the top of the Riley formation. This penetration was in the well in the southeast corner of Sec. 21, Block 46, University Lands survey. Below the depth of 7,600 feet, the accompanying TYPICAL SECTION is based on the log of that well. It is the only well in the field which penetrated pre-Ellenburger rocks.

NATURE OF TRAPS

Queen: Low relief anticlinal fold.

Ellenburger: Anticlinal fold with irregularities as indicated on an accompanying map. Fracturing influences productiveness within the anticlinal trap. The vertical distribution of productive rock within the Ellenburger is variable due to the distribution of fractures.

PRODUCTIVE AREAS

	Acres
Queen	90
Ellenburger	1,400
Midway Lane field	1,405

It appears likely that further development will warrant increase of the above estimate for the Queen reservoir. It is not likely that there will be any further development of the Ellenburger reservoir.

THICKNESSES OF RESERVOIR ROCKS

	Net productive, feet		
	Min.	Max.	Avg.
Queen	7	20 est.	13 est.
Ellenburger	55	75	65

LITHOLOGY OF RESERVOIR ROCKS

Queen: Sandstone; gray to white, fine to medium grained, soft to unconsolidated. There are a few local anhydrite partings less than 5 feet thick.

Ellenburger: Dolomite; white to tan, fine to coarsely crystalline, hard, with vuggy, interstitial and fracture porosity, porcelaneous chert and large round sand grains.

CONTINUITY OF RESERVOIR ROCKS

Queen: This reservoir rock has been readily recognized at the location of every productive well and dry hole within the area of the accompanying map. It is continuous for many miles in all directions from the field. Throughout such indicated area, porosity and permeability are favorable for migration of reservoir fluids.

Ellenburger: With reservoir rock defined to include all of that portion of the section which yields, or has yielded, commercial oil and/or gas within the area of the field, it is entirely accurate to say that the reservoir rock is continuous throughout the area of the accompanying map. However, the stratigraphic position of the productive zone is quite variable within the section included in this definition. A zone which is prolific at one location may be nonproductive nearby because of low permeability; but another zone may be productive there. The degree of permeability is dependent upon fractures, and fracturing is quite irregular.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Queen	Ellenburger
Elevation of top of oil, feet	1,737	-4,832
Elevation of bottom of oil, feet	1,516	-4,980
Relief, feet	221	148

In the Ellenburger discovery well, there was a column of 122 feet of free gas above the oil. Testing of other Ellenburger wells has not been adequate for determination of extent of free gas above the oil. So far as known, there is no free gas cap in the Queen reservoir.

CHARACTER OF OIL

	Queen	Ellenburger
Gravity, A.P.I. @ 60° F.	30°	50.2°
Sulphur	?	.18%
Base	?	Intermediate
Color	Black	Red-green
Viscosity @ 100° F.	?	33 sec.

WATER PRODUCTION

Queen: Three wells produced small amounts of water during initial production tests. At the date of the last available records (July, 1952), water constituted 14% of the gross liquid produced from this reservoir.

Ellenburger: The encroachment of salt water occurred very rapidly. Water was first produced in May, 1948, when 0.26% was recorded. From then the water percentage increased at a steady rate up until the time of the last available records (January, 1953), when water constituted 79% of gross production.

ACID TREATMENT

Queen: This reservoir has been acidized in two wells; in one well, with 1,000 gallons of acid and, in the other, with 150 gallons of acid.

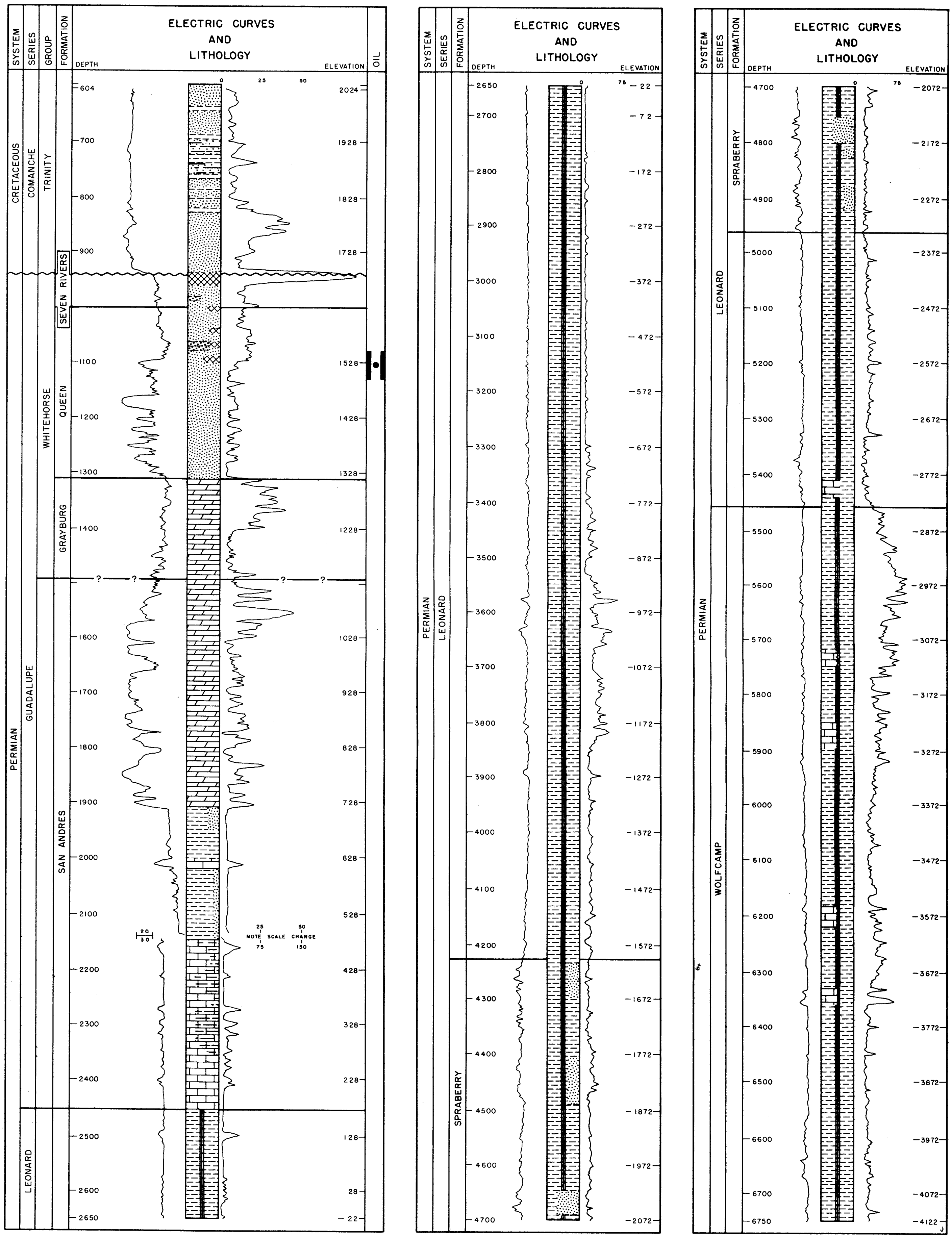
Ellenburger: This reservoir has been acidized in most wells where it is productive. Only 500 gallons of acid were used in treating each of more than half of the wells acidized; varying amounts up to 9,500 gallons of acid were used in treating each of the others.

PRODUCTION HISTORY

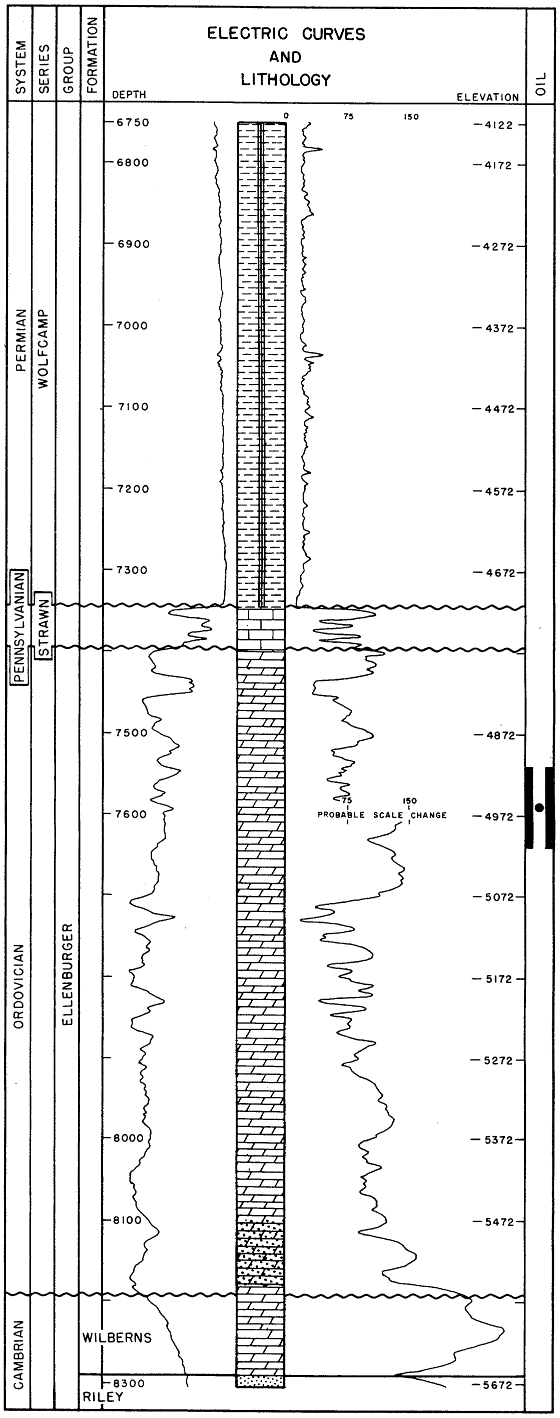
Year	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)*	
	Flowing	Pumping	Yearly	Cumulative	Yearly	Cumulative
Queen						
1950	2	0	2,874	2,874		
1951	0	7	24,977	27,851		
1952	0	6	25,761	53,612		
Ellenburger						
1947	0	0	44,781	44,781	100,774	100,774
1948	29	0	1,270,252	1,315,033	2,408,775	2,509,549
1949	25	10	1,310,137	2,625,170	5,792,099	8,301,648
1950	17	14	666,567	3,291,737	6,162,052	14,463,700
1951	15	13	402,016	3,693,753	6,440,718	20,904,418
1952	16	10	191,021	3,884,774	4,973,884	25,888,302

*GAS PRODUCTION: The above figures represent net gas production; i.e., the difference between the amount produced and the amount returned to the reservoir. A pressure maintenance plant was installed in 1949 and has been operated solely to maintain pressure. The gas is not processed before being returned to the reservoir.

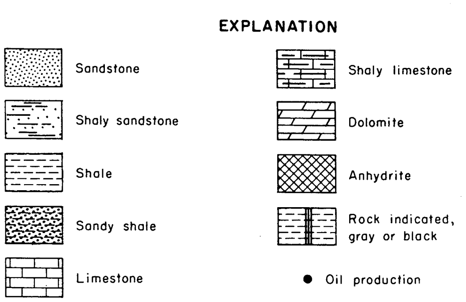
TYPICAL SECTION OF ROCKS PENETRATED

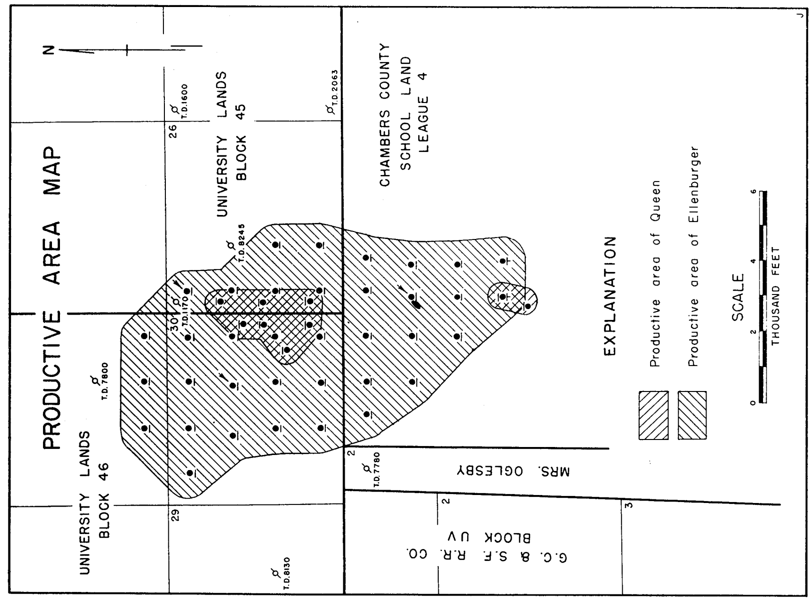


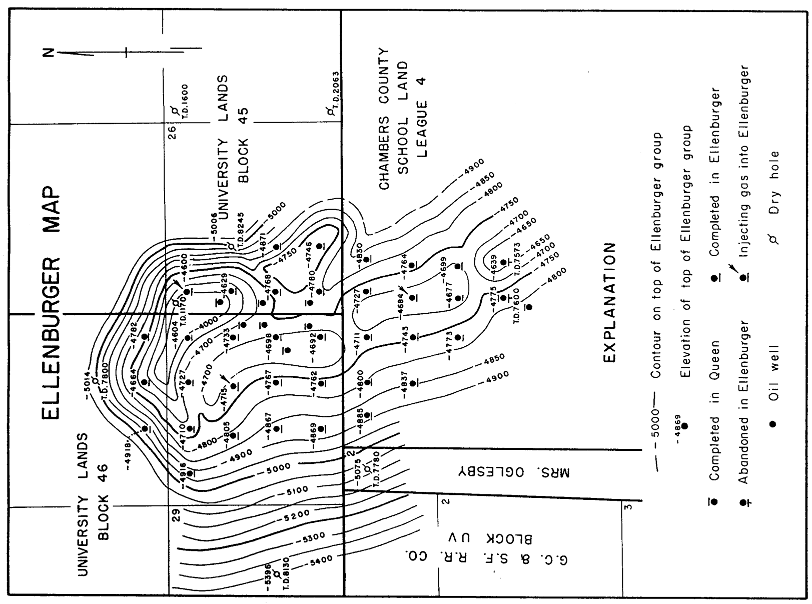
TYPICAL SECTION OF ROCKS PENETRATED

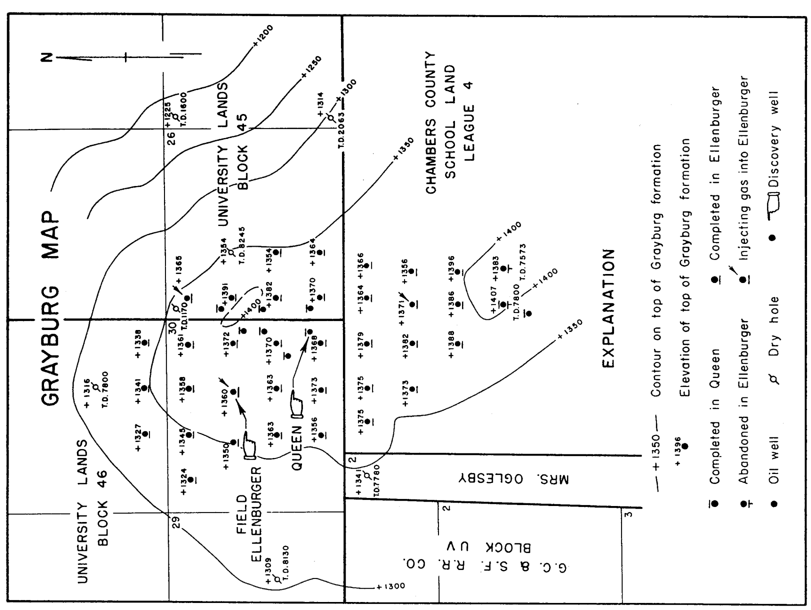


NOTE: To the depth of 7,600 feet this TYPICAL SECTION is based on the log of Sinclair and Atlantic #2 University 66, the north offset to the Ellenburger discovery well; below 7,600 feet, on the log of Sinclair and Atlantic #3 University 62, the well in the southeast corner of Sec. 21, Block 46.









MIERS FIELD

Sutton County, Texas

JOE M. NICHOLS
Geologist, Stanolind Oil & Gas Co., Midland, Texas
February 10, 1955

LOCATION and OTHER NAMES

The Miers field is in southeastern Sutton County about 20 miles southeast of Sonora, county seat. It is in the general area of the juncture of the Eastern shelf to the northeast, the Midland basin to the northwest and the Kerr basin to the south. Physiographically, the location of the field is within the area of the Edwards Plateau.

During its early history this field was commonly known as the Wilson field and as the Shell-Wilson field. However, since the time of the first marketed production in 1949, it has been more generally designated as the Miers field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Refraction seismograph.

DISCOVERIES

Canyon: July 18, 1952; Phillips Petroleum Co. #1 Libb "A" (fee, Libb Wallace). Initial open flow capacity, 13,000 Mcf of gas per day through perforations from depth of 3,976 - 4,018 feet. This is the only well completed in this reservoir.

Strawn and Field: May 5, 1946; Shell Oil Co. #1 Duke Wilson et al. Initial open flow capacity, 9,200 Mcf of gas per day through perforations from depths of 4,195 - 4,215 and 4,220 - 4,245 feet.

OLDEST HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is at the base of the Riley formation, Cambrian system. The Riley formation unconformably overlies pre-Cambrian granite.

The oldest horizon penetrated is in the pre-Cambrian granite. Granite has been penetrated in two wells. The greater penetration was 169 feet and was in Shell Oil Company #3 W.A.Miers (total depth, 5,009 feet) located in Sec. 53, Blk. 14, about 3,200 feet southeast of the Canyon discovery well and identified as No. 4 on the line of the accompanying cross section. The other penetration of granite was in the Canyon discovery well, which, at its total depth of 5,489 feet, was drilled 23 feet into pre-Cambrian granite.

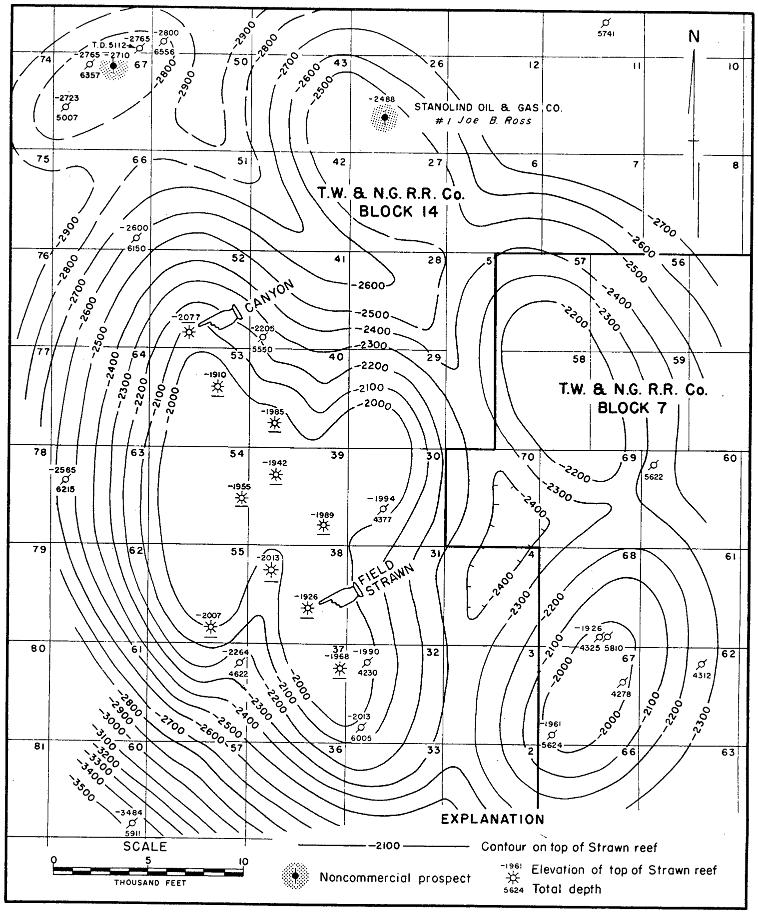
NEAR-BY NONCOMMERCIAL PROSPECTS

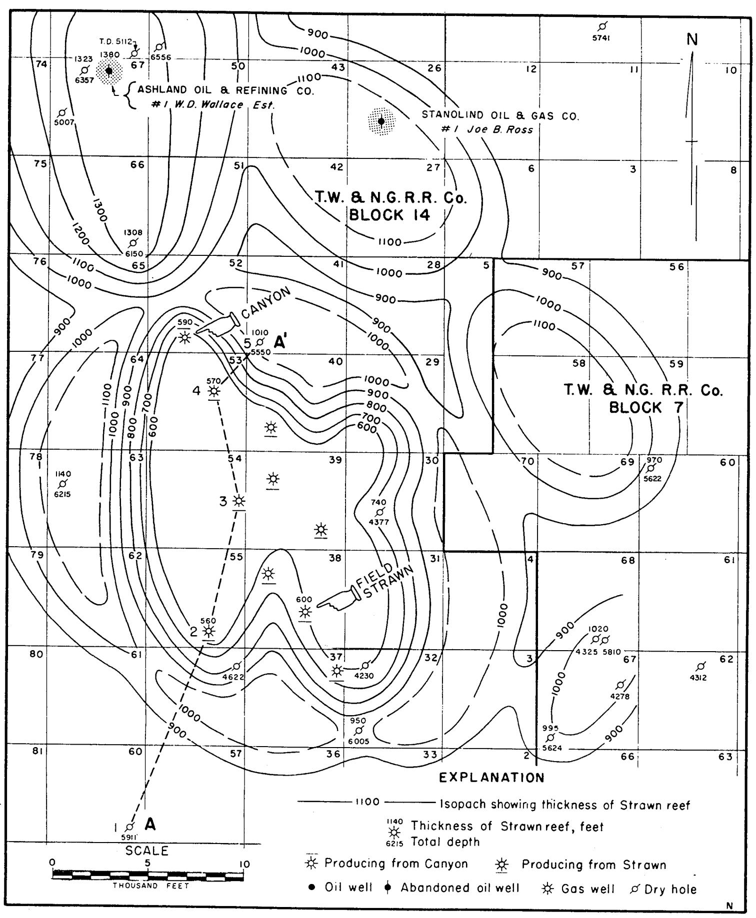
The location of the well which prompted the designation of Wallace field is near the northwest corner of the area covered by the accompanying maps. Ashland Oil & Refining Co. #1 W.D.Wallace Est. was completed on August 24, 1953, in Strawn limestone with an initial daily flowing potential of 87 barrels of 33.2° gravity oil and 11 barrels of water through perforations between 5,006 and 5,026 feet. It was generally recognized as a discovery well and was so treated in several publications. Oil production decreased and water production increased so that operation soon became unprofitable. Operation was suspended in November of 1953 and the well was later plugged and abandoned after having produced only 2,292 barrels of oil. Subsequent to the completion of that well, the Strawn limestone was found nonproductive in four dry holes in the immediate vicinity.

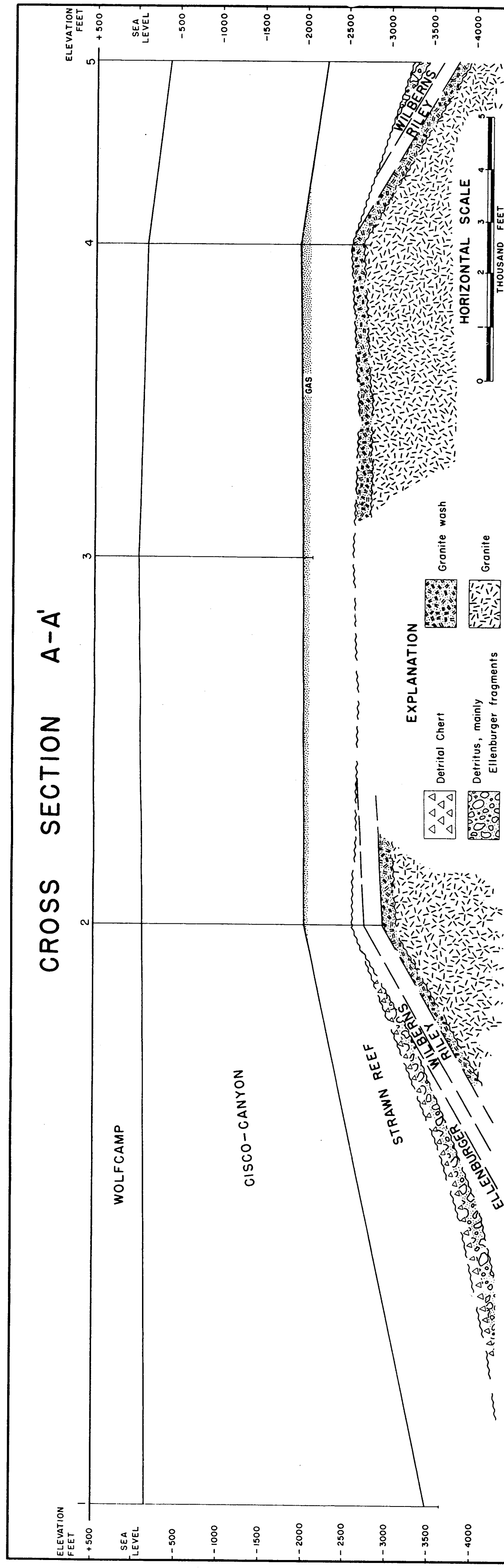
Another near-by noncommercial prospect occasioned erroneous recognition in some publications as a field discovery and was designated by the Railroad Commission as the Son Ross field. Stanolind Oil & Gas Co. #1 Joe B. Ross, located in Sec. 26, Block 14, was completed for production from a zone in the Canyon series. After having been drilled to the total depth of 4,950 feet by Lockhart & Nichols, the well was acquired by Stanolind Oil & Gas Co. with the hope that further testing might result in profitable production from zones which had made good shows of oil. The new operator set 5½-inch casing at 4,755 feet and then, after two unsuccessful attempts at completion, perforated with 120 shots from 4,450 to 4,470 feet and then applied hydraulic fracturing treatment with use of 3,000 gallons of fluid. The zone from 4,450 to 4,462 feet was later re-perforated with 48 shots and given hydraulic fracturing treatment with an additional 12,000 gallons of fluid. On August 19, 1954, the well was completed for production. It indicated initial potential of 7.56 barrels of 29° gravity oil per day; gas-oil ratio, 11,750 : 1. On February 9, 1955, the well was plugged and abandoned after having produced a total of only 311 barrels of oil.

ELEVATION OF SURFACE

At well locations (derrick floor): Highest, 2,305 feet; lowest, 2,186 feet.


STANOLIND OIL & GAS CO.
#1 Joe B. Ross
T.W. & N.G. R.R. Co.
BLOCK 14
T.W. & N.G. R.R. Co.
BLOCK 7
CANYON
FIELD
STRAWN
N
SCALE
THOUSAND FEET
EXPLANATION
-2100 Contour on top of Strawn reef
Noncommercial prospect
-1961 Elevation of top of Strawn reef
5624 Total depth


ASHLAND OIL & REFINING CO.
#1 W.D. Wallace Est.
STANOLIND OIL & GAS CO.
#1 Joe B. Ross
T.W. & N.G. R.R. Co.
BLOCK 14
T.W. & N.G. R.R. Co.
BLOCK 7
CANYON
FIELD
STRAWN
A
A'
N
SCALE
THOUSAND FEET
EXPLANATION
1100 Isopach showing thickness of Strawn reef
1140 Thickness of Strawn reef, feet
6215 Total depth
Producing from Canyon
Producing from Strawn
Oil well
Abandoned oil well
Gas well
Dry hole


CROSS SECTION A-A'
ELEVATION FEET
SEA LEVEL
WOLFCAMP
CISCO-CANYON
STRAWN REEF
GAS
WILBERNS
RILEY
ELLENBURGER
HORIZONTAL SCALE
THOUSAND FEET
EXPLANATION
Granite wash
Granite
Detrital Chert
Detritus, mainly Ellenburger fragments

SURFACE FORMATIONS

The rocks at the surface consist of limestones of the Washita and Fredericksburg groups and also of caliche of Recent, Quaternary, age. Certain of these limestones form prominent escarpments throughout the area covered by the accompanying map.

VARIATIONS IN THICKNESSES

The accompanying isopachous map shows the variations in thicknesses of the Strawn reef. Within the map area, thicknesses range from less than 600 feet to nearly 1,400 feet. The reef is less than 600 feet thick over the apex of the granite knob over which the Miers field is located. The reef was deposited on an eroded surface of truncated older rocks, including pre-Cambrian granite, so that thicknesses of the remaining portions of each of the pre-Strawn stratigraphic units range from zero to complete normal thickness.

NATURE OF TRAPS

Canyon: Updip decrease of porosity.

Strawn: Convex upper limit of reef limestone which is covered by relatively impervious shale.

THICKNESSES OF RESERVOIR ROCKS

Canyon: The interval from the top to the bottom of the reservoir rock in the one productive well is 60 feet. Within this total thickness, there is a net thickness of 41 feet of porous sandstone which yields gas into the bore-hole.

Strawn: The characteristics of the Strawn reservoir rock are such that its upper and lower limits cannot be correlated with precision throughout the area of the field; therefore, its range of thickness is not accurately determinable. In the eight productive wells, the gross interval from the top of the productive rock to the gas-water contact ranges from 31 to 124 feet. It appears probable that the maximum thickness of the reservoir rock, from top to bottom, is only slightly greater than the thickness indicated by the larger of these figures. Data are not available for estimating net thicknesses of rocks which yield gas and condensate into the bore-holes.

ACID TREATMENT

Canyon: The one well was not treated with acid.

Strawn: With one exception, all wells have been completed without acid treatment.

LITHOLOGY OF RESERVOIR ROCKS

Canyon: Sandstone; medium to large grains of clear quartz in a white to gray cement; friable; large spots of green glauconite are common.

Strawn: Limestone; brown to tan, fine- to medium-grained crystalline, fossiliferous; porosity is mainly due to vugs of fine to medium size.

CONTINUITY OF RESERVOIR ROCKS

Canyon: The reservoir rock in the one productive well cannot be correlated with any particular stratum in any other well. The reservoir rock appears to be a local lens of sandstone, merely one of such as are common in this portion of the Canyon series.

Strawn: The reservoir rock is at the apex of a reef. The reef appears to be continuous far beyond the present extent of the field, but it is doubtful whether conditions favorable for migration of reservoir fluids are continuous in any direction more than a few miles beyond the present extent of the field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Canyon: (One well)	Feet
Elevation of top of gas	-1,741
Elevation of bottom of gas	-1,801
Known relief of gas	60
No oil known	

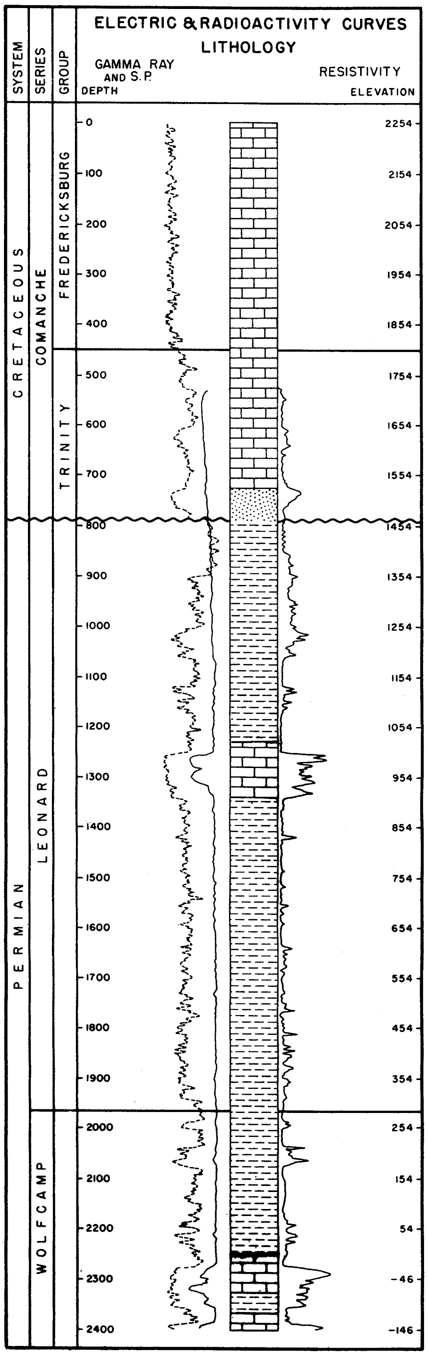
Strawn:	
Highest known elevation of gas	-1,926
Elev. of gas-water contact, approx.	-2,050
Known relief of gas, approx.	124
No oil in this reservoir	

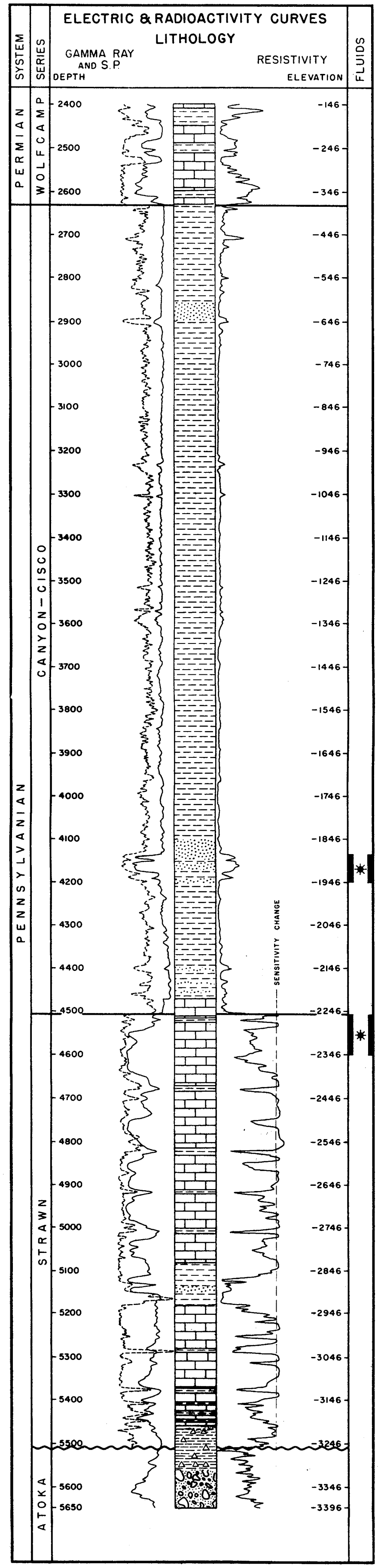
The elevation of the gas-water contact in the Strawn reservoir has not been determined definitely. It appears that at the time of discovery of commercial production in this reservoir, the gas-water contact was within 20 feet either above or below the indicated elevation of -2,050 feet.

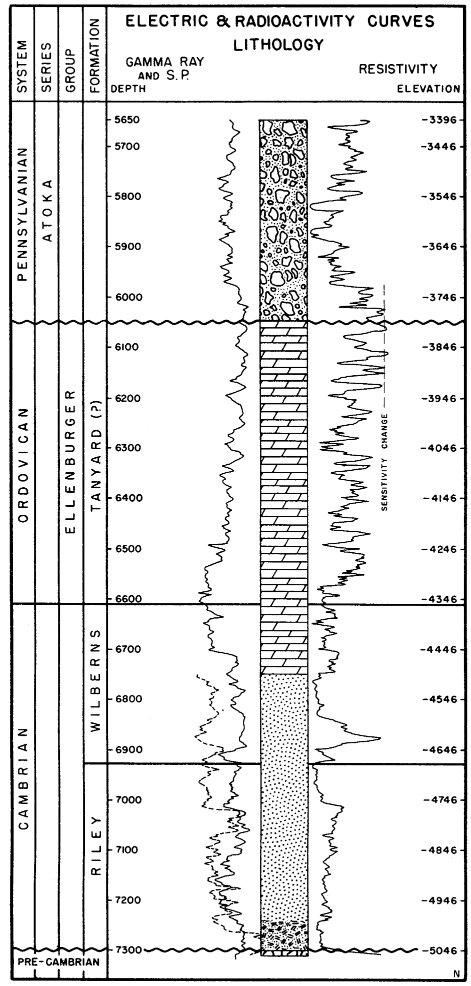
CHARACTER OF GAS

Canyon and Strawn: The gas in each reservoir is sweet and is rich in heavy hydrocarbons which condense when reservoir pressure is decreased. The production of gas is accompanied by production of considerable condensate. The weighted average gravity of the condensate is 48° A.P.I. @ 60° F. The stripped gas is of quality satisfactory for domestic utilization.

TYPICAL SECTION OF ROCKS PENETRATED



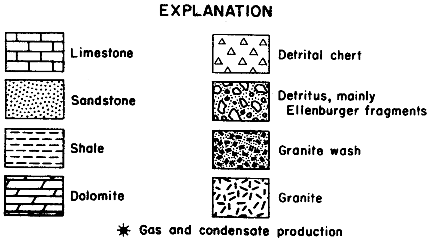




This TYPICAL SECTION is based on a composite log compiled from the logs of three wells.

STRATIGRAPHIC NOMENCLATURE: Because of this field being located in a transition zone between two geologic provinces, correlations within Pennsylvanian and Permian are very difficult. Data which will become available through additional development may occasion some revision of the above nomenclature.

EXPLANATION



PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year	GAS PRODUCTION (Mcf) Yearly	Cumulative
Field totals			
1949	1	9,147	9,147
1950	0	0	9,147
1951	0	0	9,147
1952	2	83,740	92,887
1953	9	3,724,910	3,817,797
1954	8	3,532,934	7,350,731
Canyon			
1953	1	120,969	120,969
1954	1	656,586	777,555
Strawn			
1949	1	9,147	9,147
1950	0	0	9,147
1951	0	9,147	9,147
1952	2	83,740	92,887
1953	8	3,603,941	3,696,828
1954	7	2,876,348	6,573,176

GAS PRODUCTION: Until February 1953, there was no market for the gas except for local consumption. A pipe line connecting with San Angelo was completed in February 1953, and since then the field has supplied gas to that line for marketing in San Angelo. At no time has the market demand been equal to the capacity of the field. Had market been available for greater quantities of gas, more wells would have been drilled.

CONDENSATE PRODUCTION: The only records of condensate production indicate that the production from Canyon amounted to 208 barrels during 1953 and 937 barrels during 1954; from Strawn, 2,490 barrels during 1953 and 1,250 barrels during 1954.

MONAHANS FIELD

Ward and Winkler Counties, Texas

C. G. COOPER and B. J. FERRIS
Geologists, Shell Oil Company, Midland, Texas
January 1, 1953

LOCATION

The Monahans field is in northeastern Ward County and southeastern Winkler County about 2½ miles north of Monahans, the county seat of Ward County. It is in Secs. 22, 23, 37, 38, 39, 43, 44, 45 and 46, Blk. A, Gunter & Munson, Maddox Bros. & Anderson survey. It is in the central portion of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph.

DISCOVERIES

Clear Fork: August 11, 1945;
Shell Oil Co. #6 Sealy-Smith Foundation
Tubb: November 11, 1942;
Shell Oil Co. #2 Sealy-Smith Foundation
Ellenburger and Field: August 7, 1942;
Shell Oil Co. #1 Sealy-Smith Foundation

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is 463 feet below the top of the Ellenburger. This penetration was in the Ellenburger discovery well at its total depth of 10,545 feet.

NATURE OF TRAPS

Clear Fork: Anticline with porosity and permeability pinchout in southeast direction, particularly in crestal area.

Tubb: Anticline.

Ellenburger: Anticline.

PRODUCTIVE AREAS

	Acres
Clear Fork	2,120
Tubb	40
Ellenburger	2,000
Monahans field	2,600

THICKNESSES OF RESERVOIR ROCKS

Average gross from top to bottom:	Feet
Clear Fork	245
Tubb	30*
Ellenburger	281

*This estimate of average gross thickness includes only the oil bearing zone. The higher beds which are sufficiently porous to yield gas at the locations of two wells are above and separate from the commercially productive Tubb reservoir.

LITHOLOGY OF RESERVOIR ROCKS

Clear Fork: Limestone; light gray to light brown, fine-grained, compact dolomitic. Locally it is finely saccharoidal and it is also locally cherty and anhydritic. Porosity and permeability decrease toward the southeast; decrease to such degree that the Clear Fork is not productive in the southeast part of the field even at its highest structural position.

Tubb: Limestone; medium to light brown, finely compact, finely saccharoidal, porous, dolomitic limestone containing minor quantities of chert and anhydrite.

Ellenburger: Dolomite; white to light gray and brown, generally dense, locally banded. Grain sizes vary, but in general, the dolomite is of a fine texture. Where productive it is characterized by fractures and by vugs, which are commonly up to ½-inch in diameter and are lined with calcite crystals.

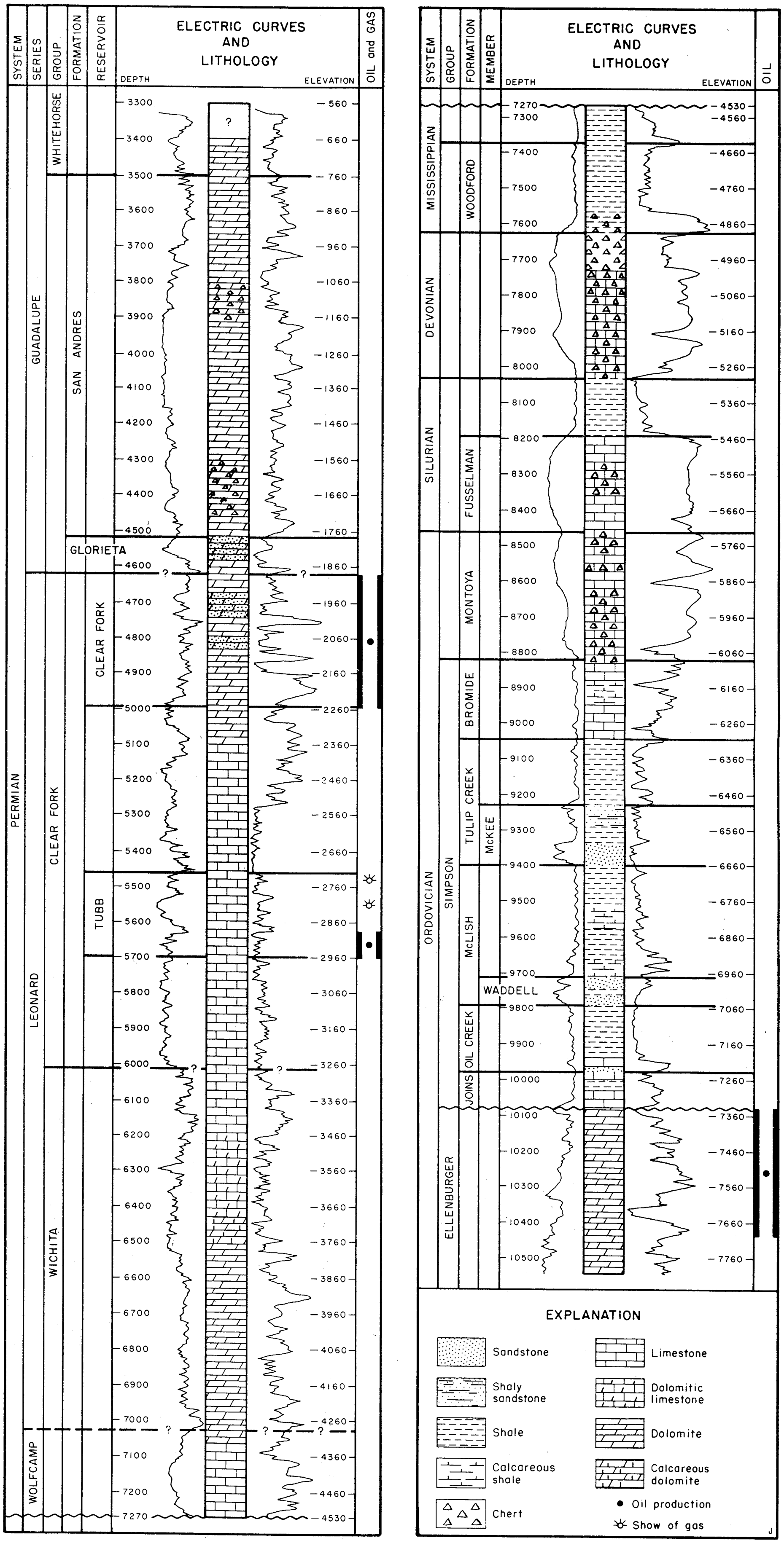
CONTINUITY OF RESERVOIR ROCKS

Each of the reservoir rocks is continuous and is of essentially the same character throughout the area of the field except that the porosity and permeability of Clear Fork decrease toward the southeast.

ACID TREATMENT

All three reservoirs have been given acid treatments. The amounts have varied from 500 gallons for a one-stage treatment of Ellenburger to as much as 10,000 gallons during a three- to five-stage treatment of Clear Fork.

TYPICAL SECTION OF ROCKS PENETRATED



ELEVATION OF SURFACE

At well locations: Highest, 2,753 ft.; lowest, 2,680 ft.

SURFACE FORMATION

Pleistocene and Recent alluvium and sand dunes.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation, feet		Relief
	Top of oil	Bottom of oil	feet
Clear Fork	-1,957	-2,150 to -2,180	193 to 223
Tubb	-2,807	-2,932	125
Ellenburger	-7,326	-7,700	374

The above data represent conditions at respective discovery dates.

There is no free gas cap in any of the oil reservoirs. In two wells near the apex of the anticline, free gas was found in a locally porous zone about 50 feet above the Tubb productive reservoir. The gas-bearing rock appears to be separated from the oil-bearing rock by impervious beds.

CHARACTER OF OIL

	Clear Fork	Tubb	Ellenburger
Gravity, A.P.I. @ 60° F.	36.0°	35.7°	46.9°
Color	Green	Lt. green	Lt. green
Sulphur, by weight	1.6%	0.8%	0.17%

For analysis of sample from Ellenburger see:
U. S. Bureau of Mines Lab. ref. No. 46079
Analyses of Crude Oils from Some West Texas Fields
R. I. 4959 (1953) Item 40

WATER PRODUCTION

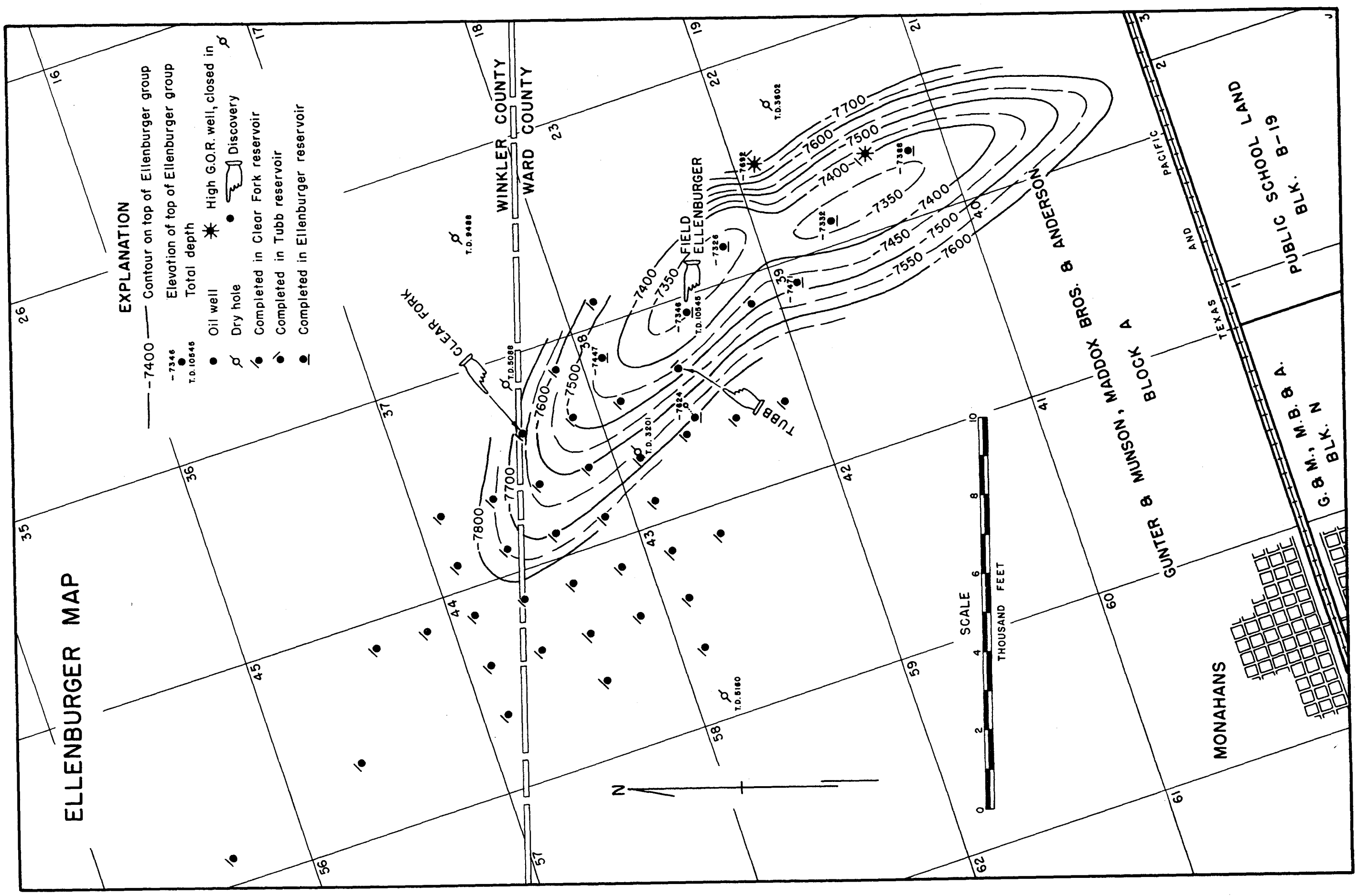
Clear Fork: Only occasional, very small amounts of water have been produced from the reservoir.

Tubb: The discovery well started making water in February 1945, after having produced 31,500 barrels of oil since its completion on November 11, 1942. The only other well which has ever produced from this reservoir has been shut down since 1949 because of high gas-oil ratio.

Year	No. of wells producing water		WATER PRODUCTION (barrels)	
	Tubb	Ellenburger	Tubb	Ellenburger
1944		1		26,299
1945	1	2	1,075	26,259
1946	1	2	1,353	33,420
1947	1	5	1,952	86,392
1948	2	5	2,886	254,290
1949	2	5	3,627	119,218
1950	2	5	2,284	239,950
1951	1	4	2,446	457,695
1952	1	5	1,403	221,274
1953	1	4	6,150	222,422

WATER ANALYSES

Constituent	Milligrams per liter		
	Clear Fork	Tubb	Ellenburger
Calcium	7,746	5,741	3,375
Magnesium	1,472	692	516
Sodium	45,192	60,440	29,843
Bicarbonate	36	395	1,236
Carbonate	0	0	0
Sulphate	2,807	1,371	2,454
Chloride	85,564	104,168	50,960
Totals	142,817	172,807	88,384


ELLENBURGER MAP
EXPLANATION
—7400— Contour on top of Ellenburger group
Elevation of top of Ellenburger group
Total depth
Oil well
Dry hole
Completed in Clear Fork reservoir
Completed in Tubb reservoir
Completed in Ellenburger reservoir
High G.O.R. well, closed in
Discovery
WINKLER COUNTY
WARD COUNTY
CLEAR FORK
TUBB
ELLENBURGER FIELD
GUNTER & MUNSON, MADDOX BROS. & ANDERSON
BLOCK A
PUBLIC SCHOOL LAND
BLK. B-19
G. & M., M.B. & A.
BLK. N
TEXAS AND PACIFIC
MONAHANS
SCALE
THOUSAND FEET
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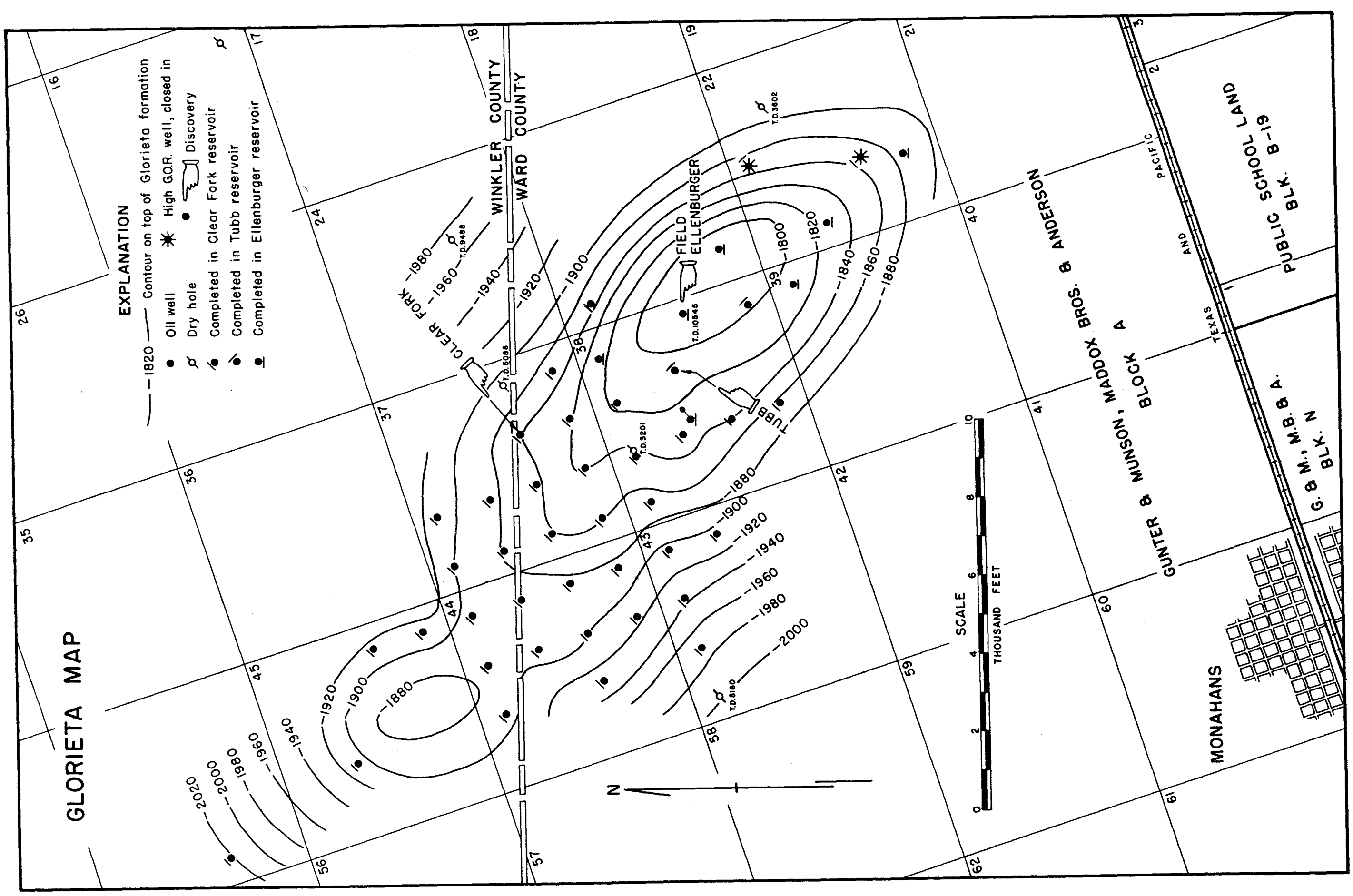

GLORIETA MAP
EXPLANATION
—1820— Contour on top of Glorieta formation
Oil well
Dry hole
Completed in Clear Fork reservoir
Completed in Tubb reservoir
Completed in Ellenburger reservoir
High G.O.R. well, closed in
Discovery
WINKLER COUNTY
WARD COUNTY
CLEAR FORK
TUBB
ELLENBURGER FIELD
GUNTER & MUNSON, MADDOX BROS. & ANDERSON
BLOCK A
PUBLIC SCHOOL LAND
BLK. B-19
G. & M., M.B. & A.
BLK. N
TEXAS AND PACIFIC
MONAHANS
SCALE
THOUSAND FEET
N

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)	
	Flowing	Pumping	Gas lift	Yearly	Cumulative	Yearly	Cumulative
Field totals							
1942	2	0	0	63,628	63,628	65,905	65,905
1943	2	0	0	77,441	141,069	116,862	182,767
1944	5	0	0	152,261	293,330	217,835	400,602
1945	8	0	0	307,317	600,647	516,619	917,221
1946	16	0	0	532,759	1,133,406	855,084	1,772,305
1947	31	0	0	1,165,817	2,299,223	1,694,418	3,466,723
1948	40	3	2	1,202,075	3,501,298	2,362,174	5,828,897
1949	40	3	1	661,415	4,162,713	1,399,666	7,228,563
1950	38	3	1	550,706	4,713,419	1,539,344	8,767,907
1951	31	10	1	515,337	5,228,756	1,557,459	10,325,366
1952	25	17	1	395,169	5,623,925	1,090,453	11,415,819
1953*	25	18	2	404,056	6,027,981	1,161,006	12,576,825
Clear Fork							
1945	2	0	0	21,076	21,076	19,440	19,440
1946	9	0	0	133,130	154,206	201,541	220,981
1947	23	0	0	413,169	567,375	554,381	775,362
1948	33	3	0	587,960	1,155,335	1,307,052	2,082,414
1949	33	3	0	340,038	1,495,373	912,294	2,994,708
1950	32	3	0	253,743	1,749,116	875,562	3,870,270
1951	26	9	0	220,824	1,969,940	872,500	4,742,770
1952	22	14	0	170,755	2,140,695	626,112	5,368,882
1953*	22	17	0	203,154	2,343,849	668,263	6,037,145
Tubb							
1942	1	0	0	5,830	5,830	7,507	7,507
1943	1	0	0	10,749	16,579	7,883	15,390
1944	1	0	0	13,004	29,583	10,459	25,849
1945	1	0	0	13,084	42,667	9,497	35,346
1946	1	0	0	12,424	55,091	11,617	46,963
1947	2	0	0	35,126	90,217	41,611	88,574
1948	2	0	0	38,804	129,021	172,149	260,723
1949	2	0	0	19,790	148,811	84,207	344,930
1950	1	0	0	17,638	166,449	45,545	390,475
1951	0	1	0	17,945	184,394	13,280	403,755
1952	0	1	0	14,701	199,095	17,870	421,625
1953*	0	1	0	14,375	213,470	27,526	449,151
Ellenburger							
1942	1	0	0	57,798	57,798	58,398	58,398
1943	1	0	0	66,692	124,490	108,979	167,377
1944	4	0	0	139,257	263,747	207,376	374,753
1945	5	0	0	273,157	536,904	487,682	862,435
1946	6	0	0	387,205	924,109	641,926	1,504,361
1947	6	0	0	717,522	1,641,631	1,098,426	2,602,787
1948	5	0	2	575,311	2,216,942	882,973	3,485,760
1949	5	0	1	301,587	2,518,529	403,165	3,888,925
1950	5	0	1	279,325	2,797,854	618,237	4,507,162
1951	5	0	1	276,568	3,074,422	671,679	5,178,841
1952	3	2	1	209,713	3,284,135	446,471	5,625,312
1953*	3	0	2	186,527	3,470,662	465,217	6,090,529

*1953 data added by amendment.

MONROE FIELD

Ward County, Texas

R. L. THARP and BOOKER McDEARMON
Geologists, Anderson-Prichard Oil Corporation, Midland, Texas
January 6, 1953

LOCATION

The Monroe field is in the northwest part of Ward County; approximately 8 miles north of the town of Pecos. It is in the Delaware basin and is approximately 20 miles west of the western edge of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

It is believed that random drilling led to the discovery of the field. There were encouraging shows of oil in several wells drilled earlier in the region.

DISCOVERY

Bell Canyon: November, 1930; John F. Shipley et al #1 Lee Monroe. Shipley owned the block of leases on which the well was drilled and he contracted with H.A.Harman for the drilling of the well. After the well was drilled to depth of approximately 4,500 feet, finances for deeper drilling were provided by D. Harold Byrd, Jack Frost and Harman. After the well was completed as a producer, Byrd, Frost and Harman formed Plains Production Company and delivered to that company their interests in this well along with certain other properties. Operation of the well was then by Plains Production Company which operated the well until July 1, 1952, when that company was succeeded by Three States Natural Gas Company, the present operator.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Bell Canyon formation about 70 feet below the base of the Lamar member. This penetration was in the dry hole which offsets the discovery well to the northwest.

ELEVATION OF SURFACE

At well locations: Highest, 2,672 ft.; lowest, 2,642 ft.

NATURE OF TRAP

Bell Canyon: Differential porosity and permeability of the reservoir rock. The structure is similar to that in the Wheat field, where small noses are superimposed upon the main terrace according to data presented in the paper cited under SELECTED REFERENCE.

PRODUCTIVE AREA

Bell Canyon and Field: More than 440 acres. The boundary of the productive area has not yet been determined. Further development may extend the field northward, eastward and southward.

THICKNESS OF RESERVOIR ROCK

Bell Canyon: Net productive, 5 to 10 feet.

LITHOLOGY OF RESERVOIR ROCK

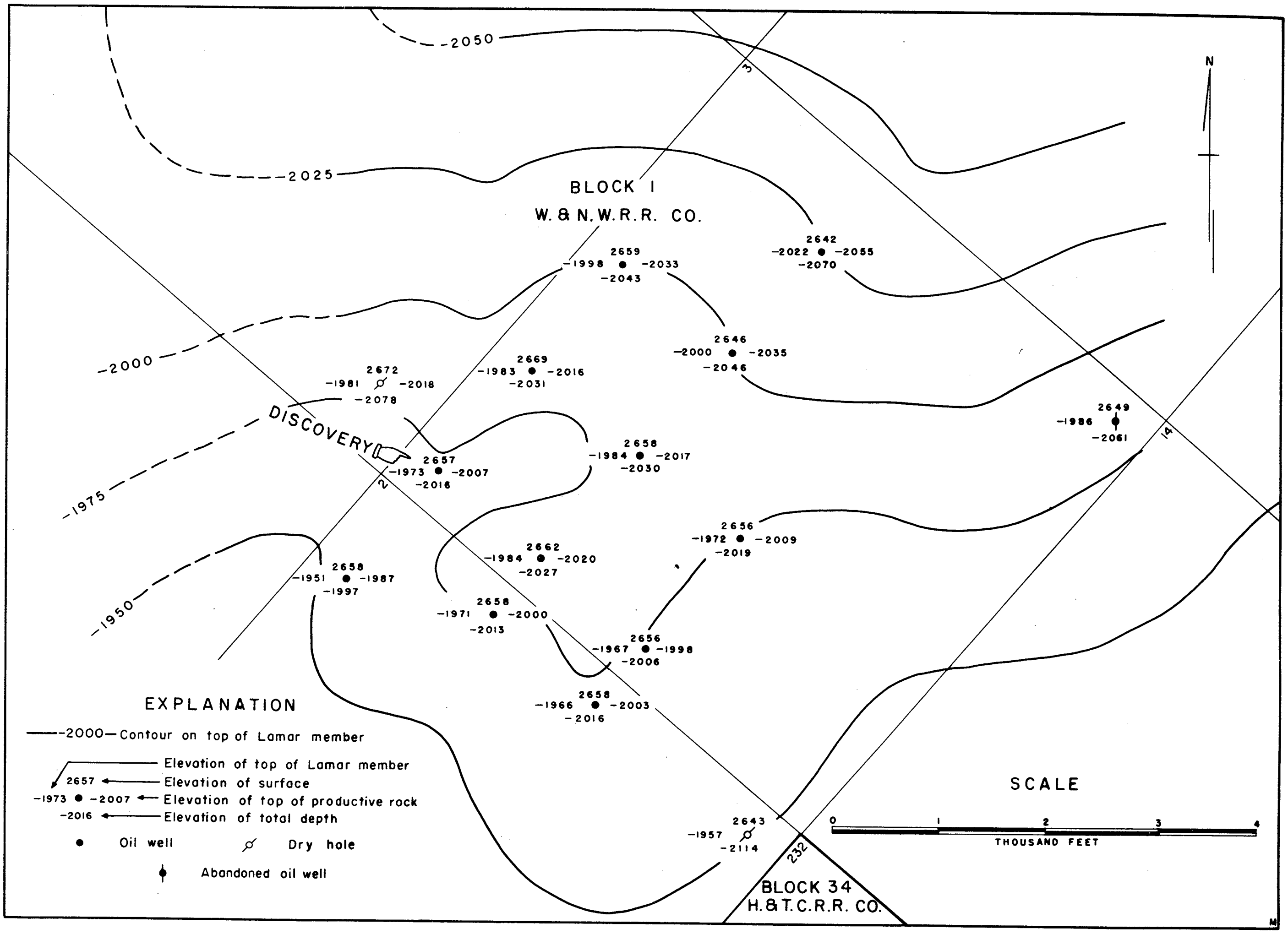
Bell Canyon: Soft sandstone with thin black shale partings.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The sandstone member which is productive in this field is found throughout the entire Delaware basin. Within the area covered by the accompanying map, there is continuously a zone which is sufficiently porous to yield oil wherever tested except at the locations of the two dry holes indicated on the map.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet
Highest known elevation of oil	-1,987
Lowest known elevation of oil	-2,055
Known relief	68



CHARACTER OF OIL

Bell Canyon:

Gravity, A.P.I. @ 60° F.,	32° to 34°
Sulphur,	0.14%
Base,	Intermediate

For analyses see:

U. S. Bureau of Mines Lab. ref. No. 32208

Tabulated Analyses of Texas Crude Oils. R. I. 3252 (1934) Item 1, Grp. 2

Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939) Item 70, Grp. 2

WATER PRODUCTION

Bell Canyon: Only one well, Anderson-Prichard Oil Corp. #1-E Monroe, is making water. This well is at a lower structural position than any other well in the field. It is at the location where top of Bell Canyon formation is indicated as at the elevation of -2,022 feet on the accompanying map.

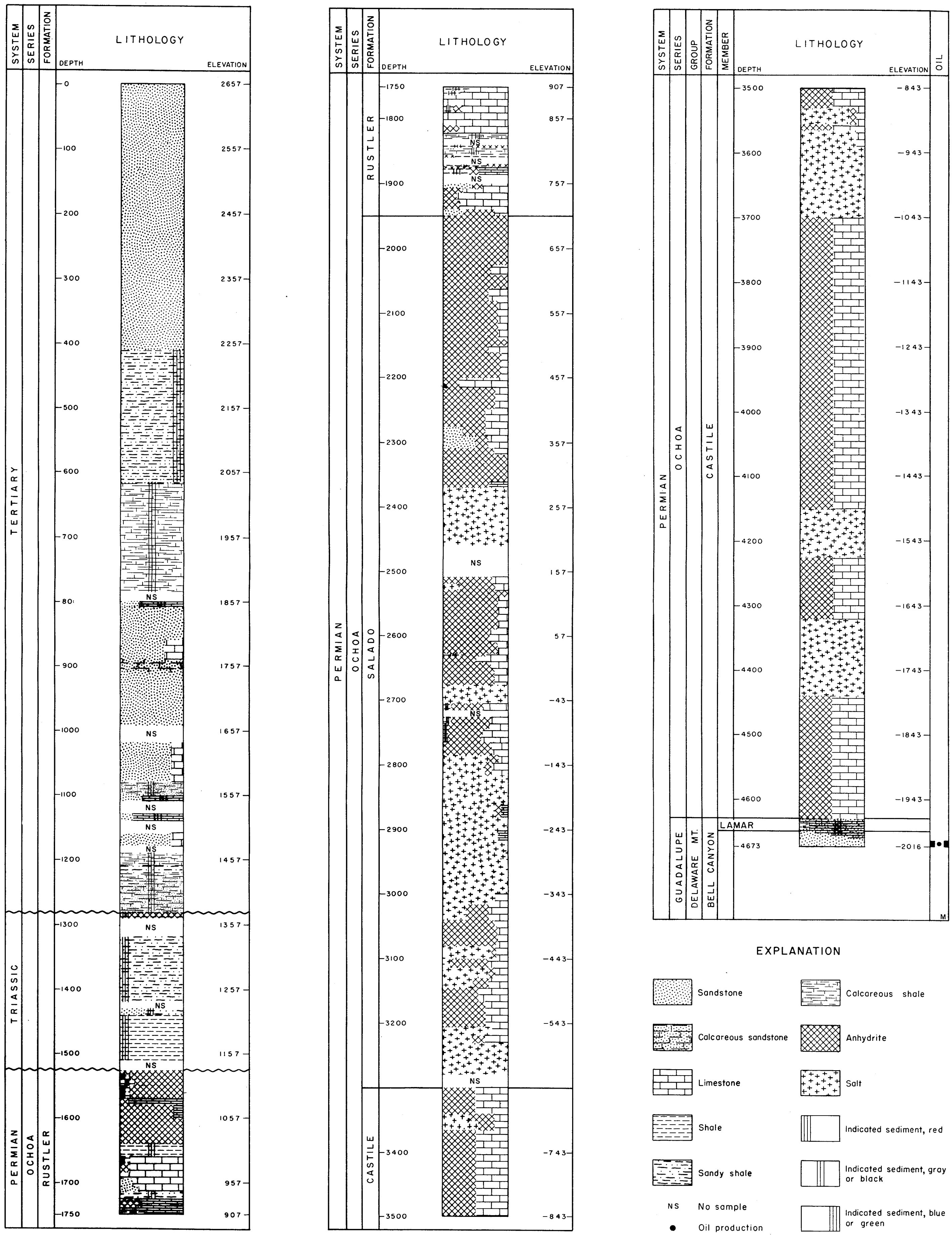
SELECTED REFERENCE

Adams, J. E. (1936) Oil pool of open reservoir type: Amer. Assoc. Petrol. Geol., Bull., vol. 20, pp. 780-796.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
1931	1	0	2,350	2,350
1932	1	0	?	?
1933	1	0	?	14,834
1934	1	0	3,733	18,567
1935	1	0	8,275	26,842
1936	1	0	9,155	35,997
1937	1	0	8,850	44,847
1938	1	0	8,266	53,113
1939	2	0	6,344	59,457
1940	1	0	6,726	66,183
1941	2	0	8,690	74,873
1942	1	0	5,953	80,826
1943	1	0	5,709	86,535
1944	1	0	6,123	92,658
1945	1	0	5,804	98,462
1946	1	0	5,630	104,092
1947	1	0	5,911	110,003
1948	1	0	6,008	116,011
1949	2	0	7,302	123,313
1950	9	1	65,925	189,238
1951	9	1	64,780	254,018
1952	11	1	56,804	310,822

TYPICAL SECTION OF ROCKS PENETRATED



NELSON FIELD

Andrews County, Texas

C. G. COOPER and B. J. FERRIS
Geologists, Shell Oil Company, Midland, Texas
January 1, 1954

LOCATION and OTHER NAME

The Nelson field is in west-central Andrews County about 28 miles west of the town of Andrews, county seat. It is in the northern part of the Central Basin platform.

The north end of the field was designated as the Freund field during a few months after the completion of the first well in that area, the Humble Oil & Refining Co. #2 H.O.Sims et al., located in NE cor., Sec. 25, Blk. A-39, Public School Land. This well was completed on November 27, 1946, with potential production at rate of 704 barrels per day from the Ellenburger.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph.

DISCOVERIES

Wichita: December 21, 1948;
Humble Oil & Refining Co. #3 H.O.Sims
Ellenburger and Field: June 10, 1946;
Shell Oil Co. #1 A. Nelson

ELEVATION OF SURFACE

At well locations: Highest, 3,385 ft.; lowest, 3,326 ft.

SURFACE FORMATION

Quaternary sand.

OLDEST ZONE PENETRATED

Pre-Cambrian granite.

NATURE OF TRAPS

Wichita: Updip decrease of porosity and permeability.
Ellenburger: Anticline.

LITHOLOGY OF RESERVOIR ROCKS

Wichita: Light gray to light brown, finely saccharoidal, slightly cherty dolomite with some white to gray, compact limestone. This zone has yielded commercial production in a local area restricted so far to the northwest part of the field. Throughout other parts of the area of the field, apparently due to low porosity and permeability, this zone has either failed on tests to yield significant amounts of oil or has failed to make shows of oil sufficiently encouraging to warrant testing. Generally, throughout the area of the field, the rock at this stratigraphic position is dense, nonporous limestone.

Ellenburger: White to light brown, cherty, slightly sandy dolomite, commonly coarse-grained, but occasionally showing a fine saccharoidal texture. The reservoir is overlain by a variable thickness of dense limestone.

CONTINUITY OF RESERVOIR ROCKS

Wichita: The reservoir rock is continuous throughout the area of the field but the degree of porosity which occasions its being productive is limited, so far as now known, to a local area.

Ellenburger: This reservoir rock is continuous and is of fairly uniform lithologic nature throughout the area of the field. However, on the northwest closure, a gradation to limestone has resulted in the rock being sufficiently dense that there are erratic accumulation conditions with dry holes at favorable structural positions.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

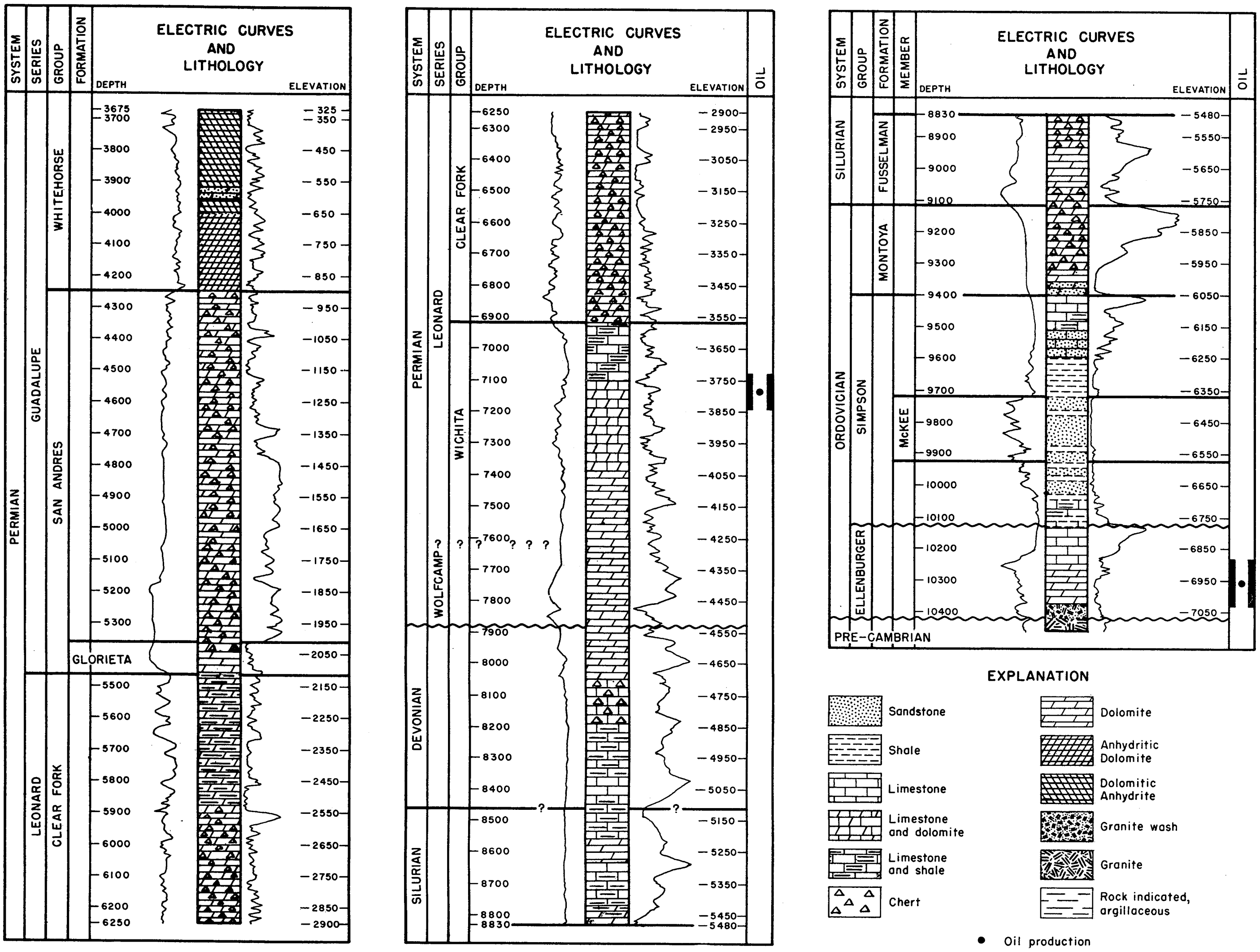
	Wichita	Ellenburger
No free gas		
Elev. of top of oil, feet	-3,783	-6,807
Elev. of bottom of oil, feet	-4,008	-7,251
Relief, feet	225	444

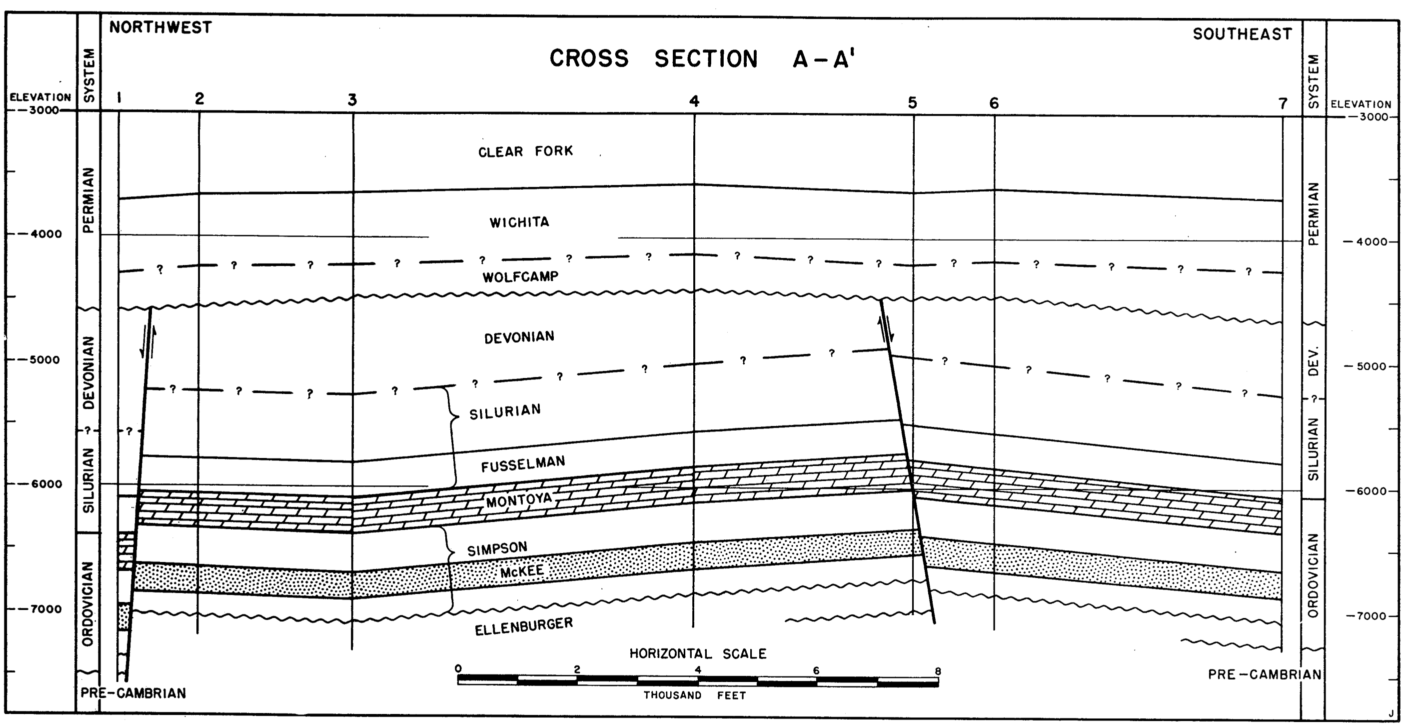
ACID TREATMENT

Wichita: Acidization has varied from a single treatment of 1,000 gallons to a total of 13,000 gallons of acid in five stages.

Ellenburger: Acidization has varied from single treatments of 1,000 gallons to a total of 8,000 gallons given in three stages.

TYPICAL SECTION OF ROCKS PENETRATED





PRODUCTIVE AREAS

	Acres
Wichita	600±
Ellenburger	1,200
Nelson field	1,520

CHARACTER OF OIL

	Wichita	Ellenburger
Gravity, A.P.I. @ 60° F.	36.1°	43.0°
Color	Green	Dark green
Sulphur, by weight	0.63%	0.14%

For analyses of sample from Ellenburger see:

U. S. Bureau of Mines Lab. ref. No. 46089
Analyses of Crude Oils from
Some West Texas Fields.
R. I. 4959 (1953) Item 41

THICKNESSES OF RESERVOIR ROCKS

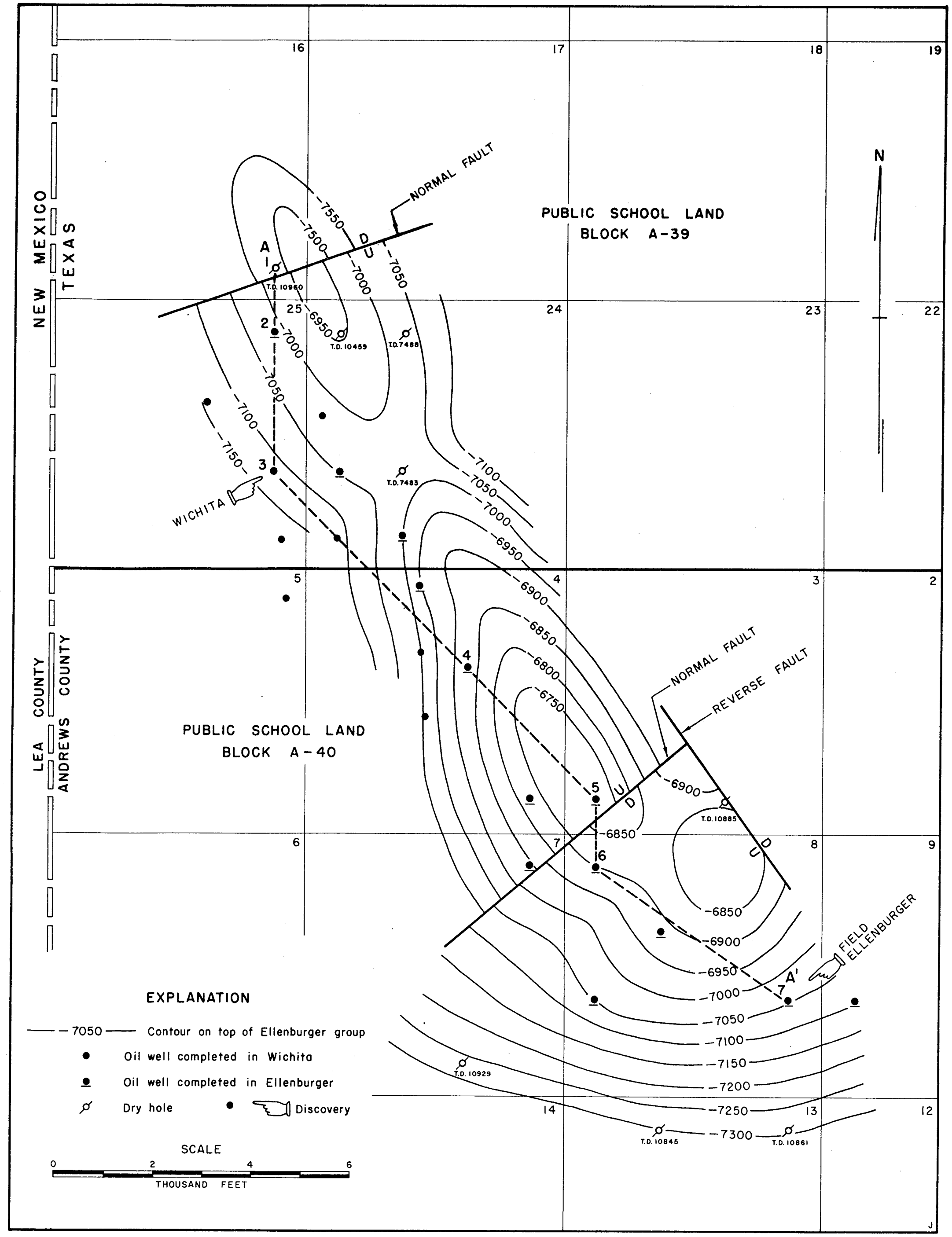
Top to bottom, avg. gross	Feet
Wichita	225
Ellenburger	160

WATER PRODUCTION

Year	No. of wells producing water: Wichita	No. of wells producing water: Ellenburger	Water production (barrels): Wichita	Water production (barrels): Ellenburger
1947		1		1,859
1948		2		18,485
1949	1	2	3,887	21,481
1950	1	2	1,344	20,480
1951	1	2	1,612	28,445
1952	1	2	4,317	13,082
1953	3	4	?	54,170

PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Wells producing at end of year: Pumping	Oil production (barrels): Yearly	Oil production (barrels): Cumulative	Gas production (Mcf): Yearly	Gas production (Mcf): Cumulative
Field totals						
1946	1	0	51,677	51,677	18,780	18,780
1947	2	2	216,055	267,732	68,607	87,387
1948	1	5	285,847	553,579	88,719	176,106
1949	0	8	279,470	833,049	59,110	235,216
1950	0	8	259,257	1,092,306	73,725	308,941
1951	0	10	325,536	1,417,842	117,986	426,927
1952	0	14	431,697	1,849,539	203,932	630,859
1953	4	17	527,513	2,402,955	257,995	888,854
Wichita						
1949	0	1	13,770	13,770	13,522	13,522
1950	0	1	12,133	25,903	14,378	27,900
1951	0	1	10,747	36,650	8,952	36,852
1952	0	1	21,583	58,233	17,978	54,830
1953	4	4	56,392	114,625	51,316	106,146
Ellenburger						
1946	1	0	51,677	51,677	18,780	18,780
1947	2	2	216,055	267,732	68,607	87,387
1948	1	5	285,847	553,579	88,719	176,106
1949	0	7	265,700	819,279	45,588	221,694
1950	0	7	247,124	1,066,403	59,347	281,041
1951	0	9	314,789	1,407,095	109,034	390,075
1952	0	13	410,114	1,817,209	185,954	576,029
1953	0	13	471,121	2,288,330	206,679	782,708



NORTH GAIL FIELD

Borden County, Texas

BILL C. OGDEN
Geologist, Union Oil & Gas Corp. of Louisiana, Midland, Texas
January 25, 1956

LOCATION

The North Gail field (one well, now abandoned) is in northwest Borden County 11 miles northwest of Gail, county seat, and 4 miles southeast of the common corner of Lynn and Garza Counties on the north boundary of Borden County.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Seismic work led to the drilling of the discovery well.

DISCOVERY

Spraberry: March 29, 1949; H. L. Hunt #B-1 Clayton & Johnson. Pumped through perforations from 5,730-5,745 feet at daily rate of 40 barrels of 37.5° gravity oil and 15 barrels of salt water. Gas-oil ratio, 400 : 1. Total depth 8,237 feet; plugged back to 5,760 feet.

ELEVATION OF SURFACE

Derrick floor: 2,626 feet

SURFACE FORMATION

Chinle formation of Dockum group of Triassic system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated, as indicated on the accompanying SECTION OF ROCKS PENETRATED, is in the Strawn series 114 feet below its top. The oldest horizon penetrated in the vicinity of the field is in the Ellenburger group 319 feet below its top. This penetration was in H. L. Hunt #B-3 Clayton & Johnson located in Sec. 16 where the total depth of 9,294 feet is indicated on the accompanying map.

NATURE OF TRAP

Spraberry: The trap appears to be due to updip and lateral decrease of porosity in a sloping reservoir rock. Porosity of the reservoir rock decreases with increase of shale content.

PRODUCTIVE AREA

Spraberry and Field: 40 acres

THICKNESS OF RESERVOIR ROCK

Spraberry: From top to bottom of productive zone, 20 ft.

LITHOLOGY OF RESERVOIR ROCK

Spraberry: Gray to white-and-tan, very-fine-grained, dense, calcareous, silty sandstone with some fractures.

CONTINUITY OF RESERVOIR ROCK

Spraberry: The reservoir rock appears to be continuous throughout the area of the accompanying map and considerably beyond. It is at or near the same stratigraphic position of reservoir rocks in several fields in the Midland basin in a north-south belt from southern Lynn County to southeastern Upton County and southwestern Reagan County. Whether conditions throughout the area of said belt are favorable for migration of reservoir fluids is not determinable from data now available.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Spraberry:	Feet
Elevation of top of oil	-3,104
Elevation of bottom of oil	-3,124
Relief	20

The above figures represent conditions in the one well at time of discovery.

CHARACTER OF OIL

Spraberry:	
Gravity, A. P. I. @ 60° F.,	37.5°
Sulphur,	0.27%
Gas-oil ratio at time of discovery,	400:1

WATER PRODUCTION

Spraberry: During the initial potential test, water constituted 23% of the gross production. Records of subsequent water production are not available.

ACID TREATMENT

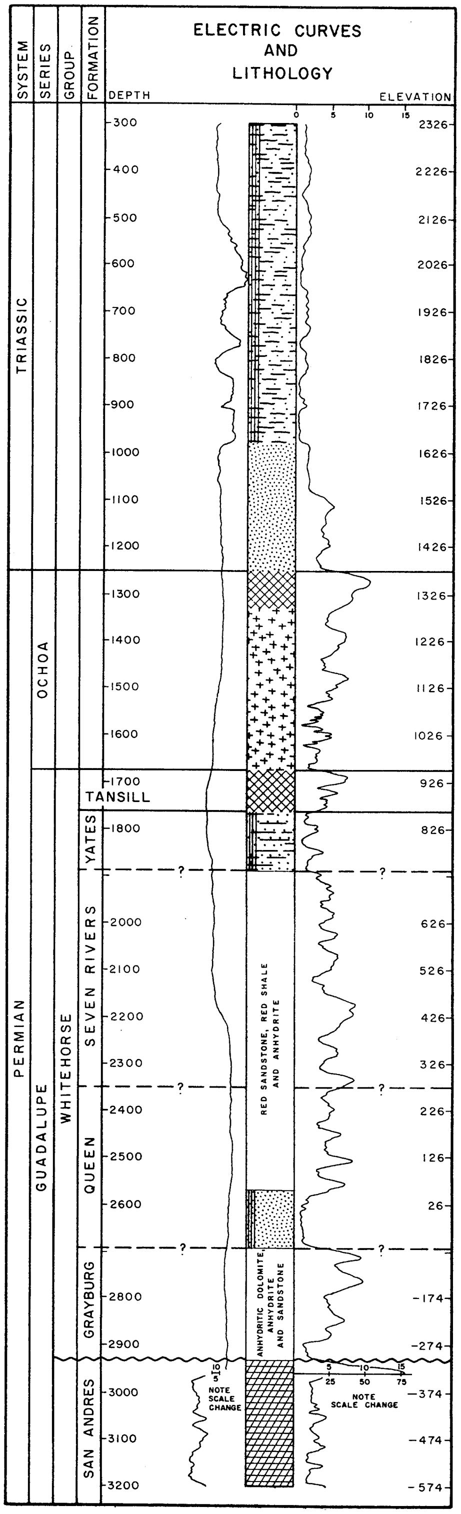
Spraberry: The reservoir rock in the one well was treated with 500 gallons of acid.

PRODUCTION HISTORY

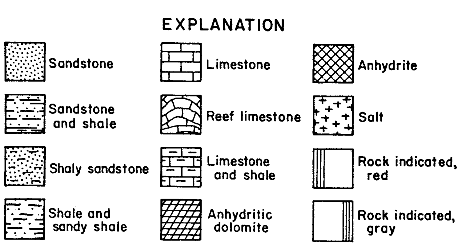
	WELLS PRODUCING	OIL PRODUCTION (barrels)	
	Pumping	Yearly	Cumulative
Spraberry:			
1949	1	1,980	1,980
1950	1	767	2,747
1951	1	373	3,120
1952	*	109	3,229

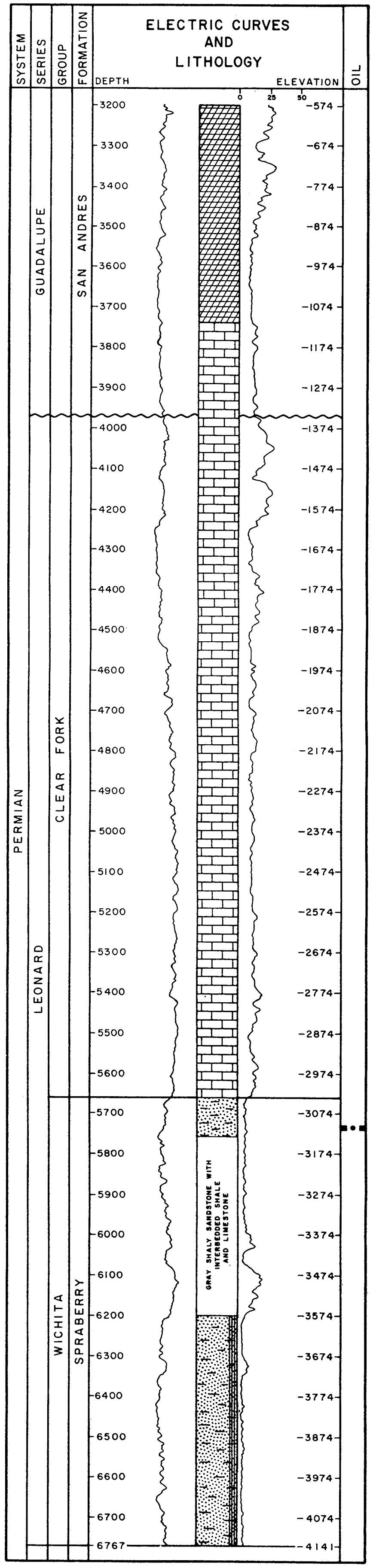
*The well has not produced since April 1952.

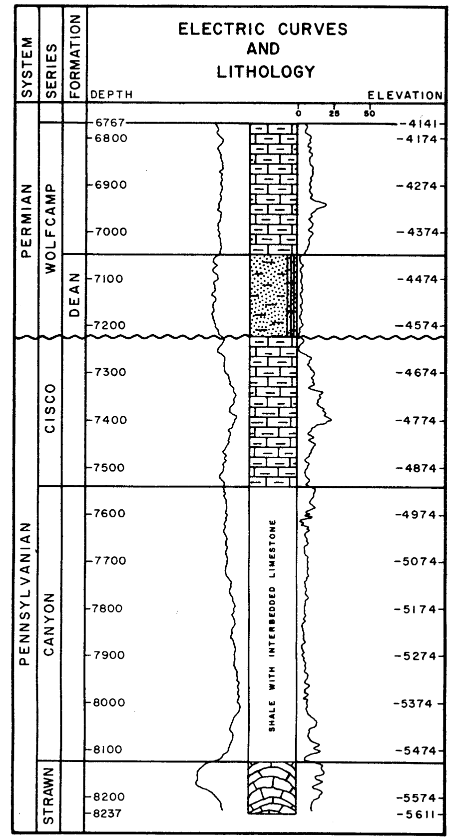
SECTION OF ROCKS PENETRATED

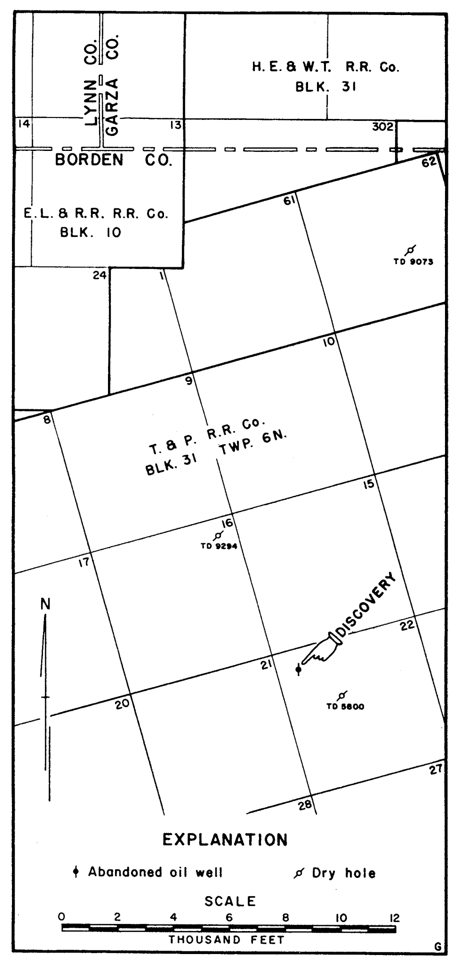


NOTE: Slight shows of oil were found from the depth of 6,422 feet to the depth of 8,146 feet.









NORTH GOLDSMITH FIELD

Ector County, Texas

EDWIN VAN DEN BARK
District Geologist, Phillips Petroleum Co., Midland, Texas
November 28, 1953

LOCATION and OTHER NAME

The North Goldsmith field is in the extreme northwest corner of Ector County about 30 miles northwest of Odessa, county seat. It is one of many multi-pay fields on the Central Basin platform. It was known as the Cummins field until in 1940 when the present name was officially established.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Interpretation of subsurface data led to the discovery of this field. The production of both the first well and the second well was such that there was doubt through several years whether commercial production had been discovered. The first well, C. J. Davidson and Atlantic Refining Co. #1 H. E. Cummins was completed in the San Andres reservoir on August 20, 1934, when initial potential test indicated a daily capacity of 35 barrels of oil and 1,500 Mcf of gas. However, during subsequent operations the well produced very little oil; has been operated intermittently as a gas well. On November 5, 1936, the second well, Grisham-Hunter Corp. #1 R. B. Cowden was completed with capacity of 10 barrels of oil per day from San Andres at depth of 4,265 feet to 4,430 feet. The location of this second well, now abandoned, is 1½ miles north of the gas well and may be identified on accompanying maps as the abandoned oil well twinned by a Devonian producer. Further development did not follow until 1940, when there were additional wells drilled to develop San Andres production. The field produced from only the San Andres reservoir until in 1946 when commercial production was discovered in the Devonian reservoir and in the Fusselman reservoir.

DISCOVERIES

San Andres: August 20, 1934; C. J. Davidson and Atlantic Refining Co. #1 H. E. Cummins

Devonian: April 21, 1946; Stanolind Oil & Gas Co. #1 Grisham-Hunter Corp. (now designated as Stanolind Oil & Gas Co. #1-A R. B. Cowden)

Fusselman: October 10, 1946; Phillips Petroleum Co. #1 Bum

ELEVATION OF SURFACE

At well locations: Highest, 3,325 feet; lowest, 3,280 feet.

SURFACE FORMATION

Sandstone of probable Trinity age. In the upper part of this sandstone, to depths varying up to 50 feet, there is a secondary deposit of caliche.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated in the vicinity of the field is in Ellenburger dolomite about 95 feet below the top of the Ellenburger formation. This penetration was in Stanolind Oil & Gas Co. #1 J. M. Williamson, a dry hole just west of the field.

NATURE OF TRAPS

San Andres: Updip decrease of porosity and permeability on a northwest plunging structural nose.

Devonian and Fusselman: Each of these reservoirs is terminated updip by truncation.

The North Goldsmith field is on the west limb of a general structural high on which the nearby Andector field is located. For an understanding of the structural and stratigraphic relationship of the reservoirs in this field, please see the map and cross sections in the accompanying paper on the Andector field.

PRODUCTIVE AREAS

	Acres
San Andres	400
Devonian	400+
Fusselman	600+

The San Andres productive area is fairly well defined. The limits of the Devonian and Fusselman productive areas have not yet been determined.

THICKNESSES OF RESERVOIR ROCKS

	Feet		
	Min.	Max.	Avg.
San Andres			
From top to bottom	60	200	150
Net productive	30	60	50
Devonian			
From top to bottom			40
Net productive			20
Fusselman			
From top to bottom			50
Net productive			20

LITHOLOGY OF RESERVOIR ROCKS

San Andres: The reservoir rock is a brown dolomite, aphanitic to finely crystalline with a few oolitic layers. Porosity occurs as zones of fine-grade pores separated by impervious beds.

Devonian: The reservoir rock is a light gray to white chert, smooth to very finely granular. Reservoir space is furnished by fractures and by zones of finely porous chert.

Fusselman: The reservoir rock is a white calcareous chert and white cherty crystalline limestone. Porosity occurs in thin zones scattered through the Fusselman formation but most conspicuously at the top.

CONTINUITY OF RESERVOIR ROCKS

San Andres: This upper San Andres reservoir rock extends throughout and far beyond the field, and is, in fact, practically the same unit which produces in the nearby Goldsmith field. The two fields, however, are separated by an area in which the porous layers are either of non-commercial grade or have been elevated so high that they contain only gas.

Devonian: This thin unit rises monoclinally to the east and is terminated by truncation a short distance east of the producing wells. However, northward along strike the reservoir rock can be traced a considerable distance into the Block 11 and Three Bar fields where the same unit of the Devonian is productive under similar geological conditions.

Fusselman: This reservoir rock has the same attitude as the Devonian reservoir and in a similar manner is terminated by truncation to the east of the producing wells.

RESERVOIR ENERGY

San Andres and Devonian: The energy operating to expel the oil from each of these reservoirs appears to be that occasioned by gas coming out of solution due to decrease in pressure.

Fusselman: An effective water drive serves to expel the oil from the reservoir.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	San Andres	Devonian	Fusselman
Highest known elevation of oil, feet	-976*	-4,586	-4,718
Lowest known elevation of oil, feet	-1,180+	-4,755	-4,978
Known relief, feet	204	169	260

*Above this elevation, all porous zones in the upper part of the San Andres formation throughout the Goldsmith-North Goldsmith-Andector structural high contain gas.

CHARACTER OF OIL

	San Andres	Devonian	Fusselman
Gravity, A.P.I. @ 60° F.	37°	43°	36.2°

WATER PRODUCTION

San Andres and Devonian: There is a small quantity of water produced by certain wells in each of these two reservoirs.

Fusselman: This reservoir has produced a considerable amount of water.

ACID TREATMENT

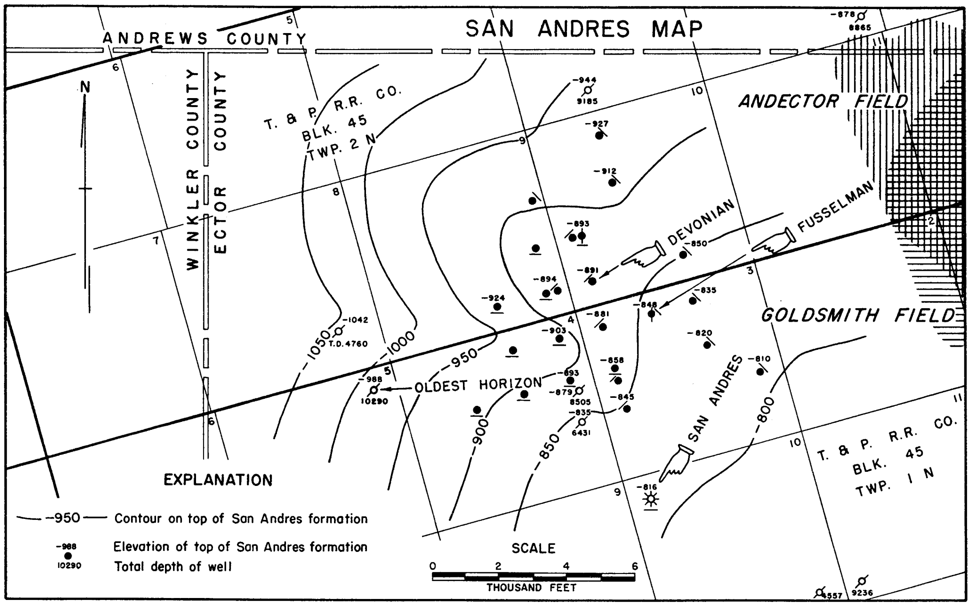
All wells have been treated with acid either at time of initial completion or at time of recompletion. The quantities of acid used have ranged from 300 gallons to 5,000 gallons.

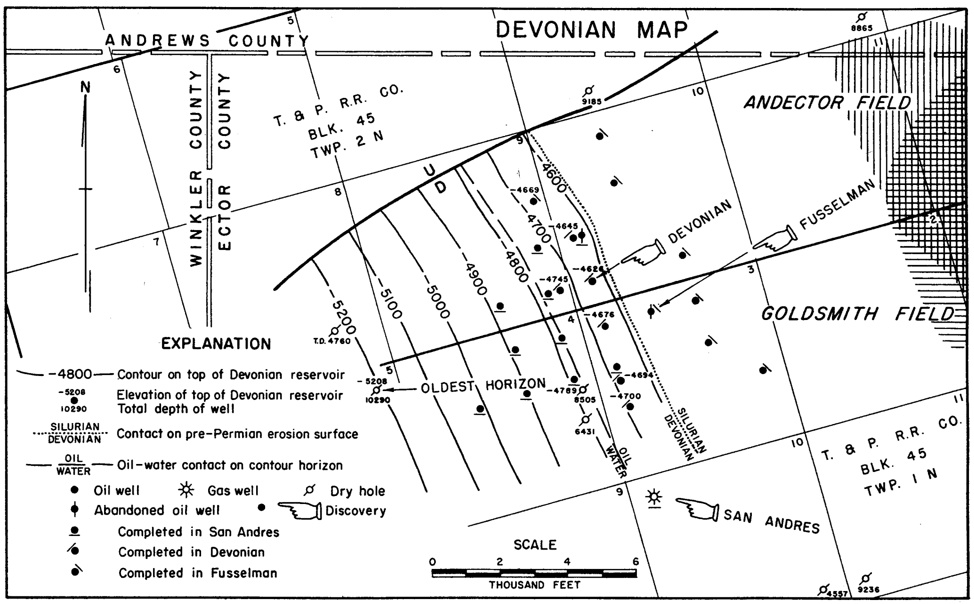
PRODUCTION HISTORY

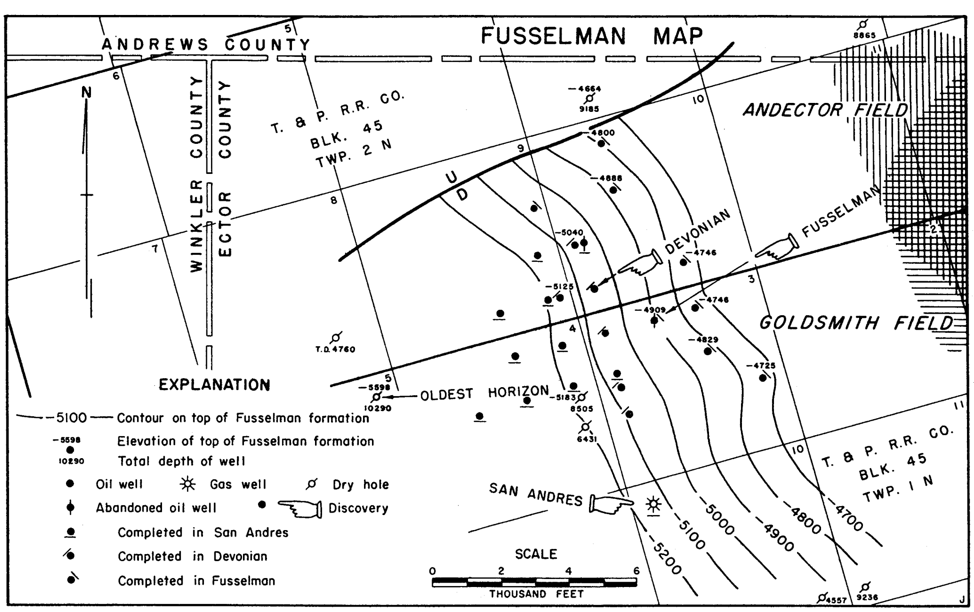
Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Field totals				
1936	1	0	2,400*	
1937	1	0	2,000*	4,400*
1938	1	0	1,500*	5,900
1939	1	0	1,000*	6,900
1940	5	0	12,443	19,343
1941	9	1	49,711	69,054
1942	6	8	32,628	101,682
1943	7	3	27,930	129,612
1944	7	2	24,393	154,005
1945	7	2	21,274	175,279
1946	11	2	111,564	286,843
1947	11	6	262,718	549,561
1948	8	9	324,948	874,509
1949	5	12	197,777	1,072,286
1950	7	12	164,458	1,236,744
1951	12	7	166,384	1,403,128
1952	11	9	150,942	1,554,070*
San Andres				
1936	1	0	2,400*	
1937	1	0	2,000*	4,400*
1938	1	0	1,500*	5,900
1939	1	0	1,000*	6,900
1940	5	0	12,443	19,343
1941	9	1	49,711	69,054
1942	6	8	32,628	101,682
1943	7	3	27,930	129,612
1944	7	2	24,393	154,005
1945	7	2	21,274	175,279
1946	7	2	23,961	199,240
1947	5	4	26,814	226,054
1948	1	8	26,493	252,547
1949	1	8	19,318	271,865
1950	1	8	18,276	290,141
1951	6	3	19,857	309,998
1952	6	3	17,879	327,877*
Devonian				
1946	3	0	77,587	77,587
1947	3	2	173,167	250,754
1948	3	1	148,151	398,905
1949	3	1	88,174	487,079
1950	3	1	78,675	565,754
1951	3	1	86,920	652,674
1952	4	1	88,057	740,731
Fusselman				
1946	1	0	10,016	10,016
1947	3	0	62,737	72,753
1948	4	0	150,304	223,057
1949	1	3	90,285	313,342
1950	3	3	67,507	380,849
1951	3	3	59,607	440,456
1952	1	5	45,006	485,462

*The above figures reporting quantities produced from San Andres during 1936, 1937, 1938 and 1939 are merely estimates. These estimates represent portions of all cumulative quantities for San Andres and Field.

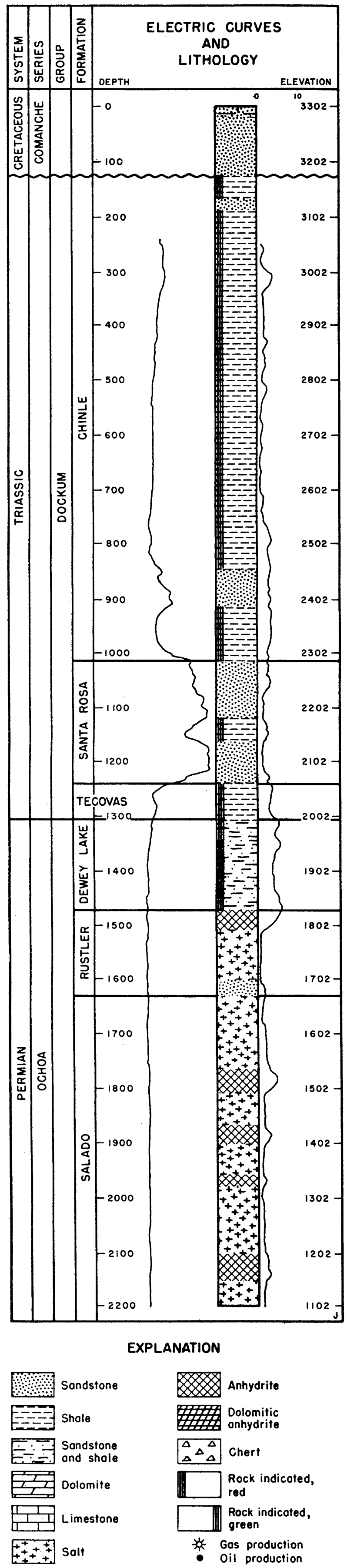
GAS PRODUCTION: The single gas well, which produces from the San Andres, had produced prior to January 1, 1953, slightly over 1,000,000 Mcf of gas.







TYPICAL SECTION OF ROCKS PENETRATED



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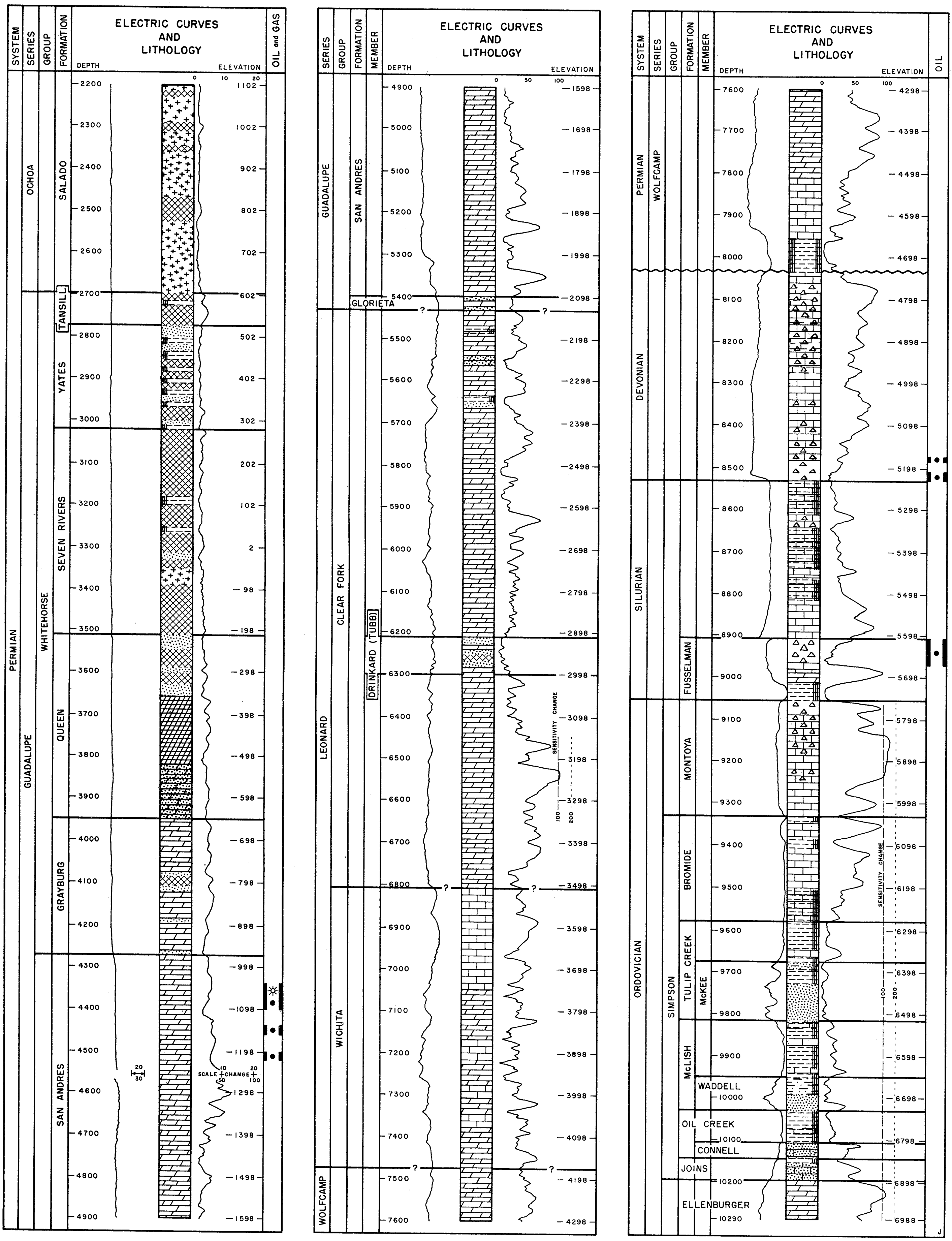


NORTH POLAR FIELD

Kent and Garza Counties, Texas

JOHN E. SCHERER
Geologist, Union Oil & Gas Corp. of Louisiana, Midland, Texas
January 25, 1956

LOCATION

The North Polar field consists of two offsetting wells, one in Kent County and the other in Garza County, about 8 miles north of the south boundaries of these counties. It is about 5 miles northwest of the town of Polar in Kent County.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of seismic and subsurface geological data led to the discovery of this field.

DISCOVERY

Ellenburger: October 15, 1950; Star Oil Co. and Moore-Cook # A-1 Blanche Young. Flowed through 3/4-inch choke at daily rate of 1,477 barrels of 41.2° gravity oil from depth of 7,780-7,822 feet. Gas-oil ratio, 960:1. Total depth, 7,822 feet.

ELEVATION OF SURFACE

Elevation of ground: 2,312 feet at the discovery well and 2,291 feet at the other well.

SURFACE FORMATION

Chinle formation of Dockum group of Triassic system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 42 feet below its eroded top. This penetration was in the discovery well at its total depth of 7,822 feet.

NATURE OF TRAP

Ellenburger: The trap appears to be due to updip and lateral decrease of porosity in a sloping reservoir rock. The degree of porosity is locally high because of differential solution at an erosion surface.

PRODUCTIVE AREA

Ellenburger and Field: 80 acres

THICKNESS OF RESERVOIR ROCK

Ellenburger: The reservoir rock is at least 42 feet thick, as the total Ellenburger penetration in the discovery well yielded oil and only oil. The total thickness is probably not much greater than 42 feet because the oil-water contact is at an elevation only 6 feet below the total depth of the discovery well; as to upper extent, it is unlikely that there is much productive rock stratigraphically higher than that at the top of the productive section in the discovery well.

LITHOLOGY OF RESERVOIR ROCK

Ellenburger: Predominantly brown-to-gray microcrystalline dolomite with small amount of white chert.

CONTINUITY OF RESERVOIR ROCK

Ellenburger: The Ellenburger dolomite is continuous throughout most of West Texas and, although it is truncated at many places and to various degrees, there is almost everywhere a zone at the top which is sufficiently porous to permit free migration of reservoir fluids. The condition of low porosity which affords a trap at this location is very local. Most Ellenburger reservoirs are in anticlinal traps rather than being limited by change in degree of porosity.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Ellenburger:	Feet
Elevation of highest known oil	-5,458
Elevation of oil-water contact	-5,506
Known relief	48

The highest known oil is at the top of the productive section in the discovery well. The elevation of the oil-water contact is established by its position in the other well, where water was yielded 15 feet below the top of the reservoir. The oil body may extend slightly higher than -5,458 feet at some near-by undrilled location, but it is unlikely that it extends much higher.

CHARACTER OF OIL

Ellenburger: Gravity, A. P. I. @ 60° F., 41.2°

CHARACTER OF GAS

Ellenburger: No analysis is available; probably none was ever made. This field has not produced gas in commercial quantity. At time of completion, the gas-oil ratio in the discovery well was 960 : 1; in the other well, 512 : 1.

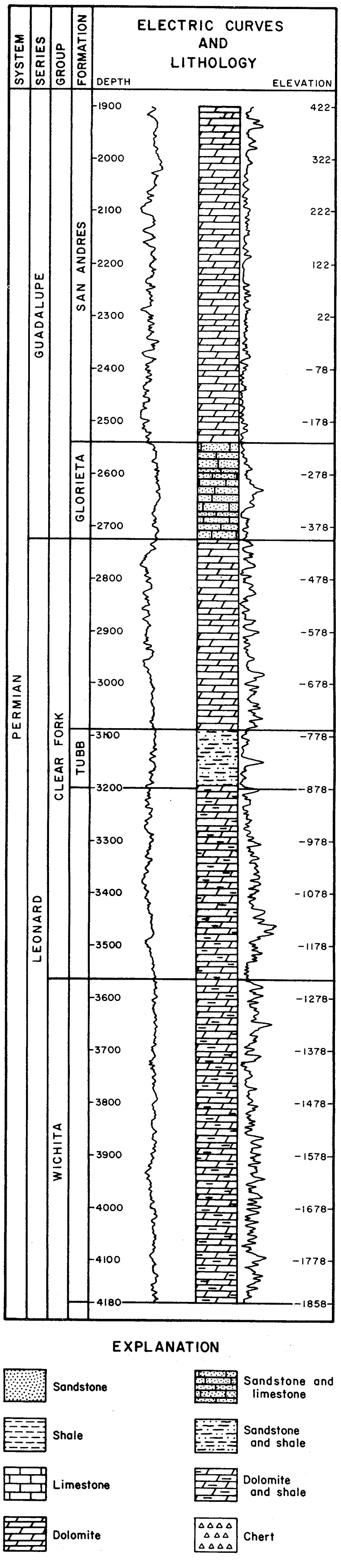
WATER PRODUCTION

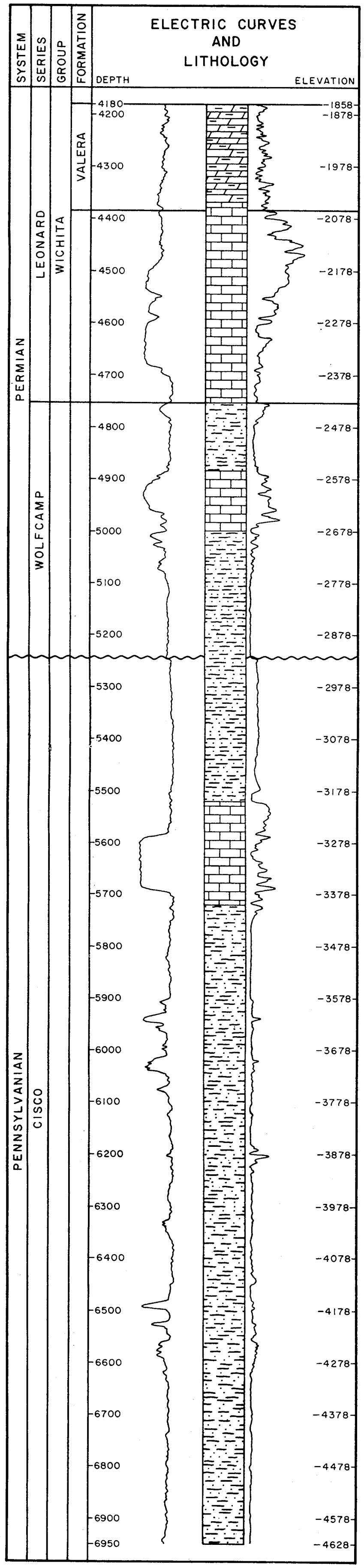
Ellenburger: No records of water production have been kept. At time of completion, the gross production of the second well was 5% water.

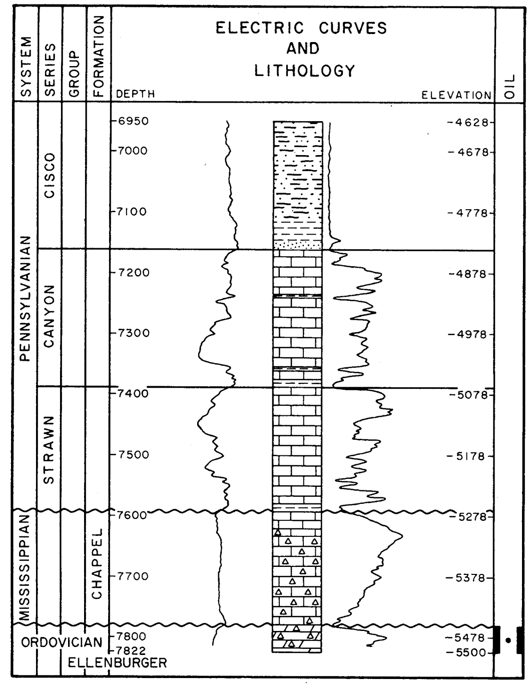
ACID TREATMENT

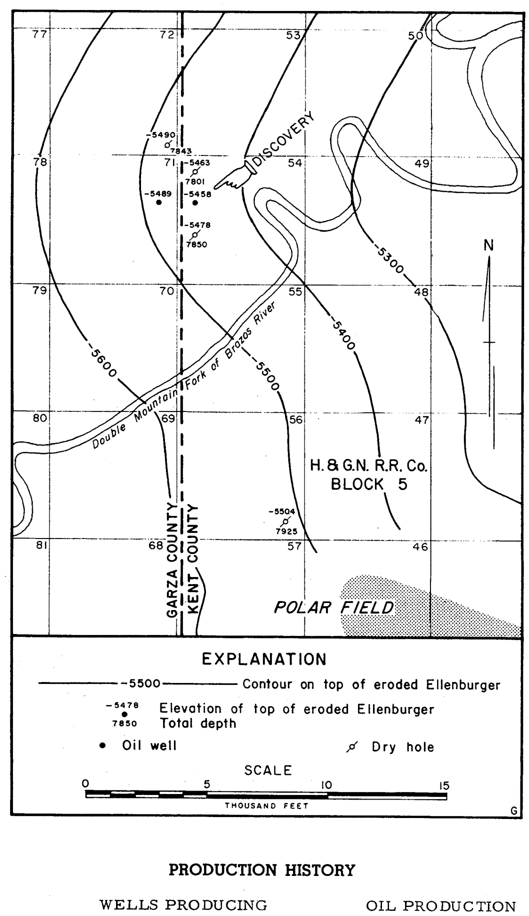
Ellenburger: In the discovery well, at time of completion, the reservoir rock was treated with 1,000 gallons of acid. The other well was completed "natural".

TYPICAL SECTION OF ROCKS PENETRATED









PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
1950	1	0	13,324	13,324
1951	1	1	55,482	68,806
1952	0	2	38,875	107,681
1953	0	2	33,598	141,279
1954	0	2	27,039	168,318
1955	0	2	25,471	193,789

NORTHWEST BLOCK 31 FIELD

Crane County, Texas

JOHN FUSZEK
Geologist, The Atlantic Refining Company, Midland, Texas
April 8, 1953

LOCATION

The single well comprising the Northwest Block 31 field is located 1,980 feet from the south and east lines of Sec. 6, Block 31, University Lands survey, in the north central portion of Crane County about 10 miles northwest of Crane, county seat. It is about 2 miles west of the south end of the University Waddell field and about 3½ miles northwest of the Block 31 field. It is near the eastern edge of the Central Basin platform.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph work led to the drilling of the discovery well by The Atlantic Refining Company. Stanolind Oil & Gas Company acquired a half-interest in the well prior to its completion.

DISCOVERY

Connell: November 25, 1950; The Atlantic Refining Co. #1-LL University Block 31. Drilled to total depth of 11,915 feet and plugged back to 11,520 feet. On initial production test, flowed at rate of 262 barrels of oil per day through perforations from 11,470 to 11,510 feet. It was temporarily abandoned in February, 1953.

ELEVATION OF SURFACE

Derrick floor elevation at well location: 2,645 feet.

STRATIGRAPHIC SECTION

The rocks penetrated in the one well in this field are similar to those penetrated in the Block 31 field and reported in the TYPICAL SECTION in the accompanying paper on that field. However, the only zone which is productive in this well is in the Connell member of the Oil Creek formation. The top of the Connell member is at the depth of 11,465 feet and the top of the zone which yielded oil is at 11,470 feet.

SURFACE FORMATION

Recent and Quaternary sands.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is 345 feet below the top of the Ellenburger group.

PRODUCTIVE AREA

Connell and Field: Approximately 40 acres.

THICKNESS OF RESERVOIR ROCK

Connell: There is about 6 feet of net productive sand in the Connell member, which member is about 35 feet thick at this location.

LITHOLOGY OF RESERVOIR ROCK

Connell: Sandstone; light colored, medium- to coarse-grained, loosely cemented, slightly calcareous. The sand grains vary from subangular to well-rounded.

CONTINUITY OF RESERVOIR ROCK

Connell: While the continuity of the reservoir rock cannot be positively determined, that rock appears to be a blanket sandstone. It is a portion of the Connell member of the Oil Creek formation, which member has been found at widely distributed locations and is best developed on the southern portion of the Central Basin platform, with commercial production limited, up to now, to fields in Crane and northern Pecos counties.

CHARACTER OF OIL

Gravity:	46.6° @ 76° F.	Sulphur:	0.1%
Base:	Paraffinic	Color:	Green

WATER PRODUCTION

The amount of water produced was negligible.

PRODUCTION HISTORY

Year	OIL PRODUCTION (barrels) Yearly	Cumulative	GAS PRODUCTION (Mcf) Yearly	Cumulative
1950	5,000	5,000	4,957	4,957
1951	12,163	17,163	10,792	15,749
1952	3,139	20,302	2,680	18,429
1953	56	20,358	35	18,464

The only well in the field made its entire production by flowing and was temporarily abandoned in February, 1953.

OATES FIELD

Pecos County, Texas

DONALD R. RANEY
Geologist, The Pure Oil Co., Fort Worth, Texas
June 19, 1955

LOCATION

The Oates field is in western Pecos County about 20 miles southwest of Fort Stockton.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Surface mapping of Cretaceous beds led The Pure Oil Company in 1930 to drill to the depth of 5,000 feet to test the Delaware Mountain sandstone. In 1947, this hole was deepened to 11,805 feet. The discovery well was drilled as a water supply well for the deepening operations.

DISCOVERY

Rustler: April 10, 1947; The Pure Oil Co. #1-B J.S. Oates. Initial production was at the daily rate of 39 barrels of oil and 501 barrels of water.

ELEVATION OF SURFACE

At well locations: Highest, 3,617 feet; lowest, 3,479 feet.

SURFACE FORMATIONS

Undifferentiated limestones in the Fredericksburg group and sandstones of the Paluxy formation, Trinity group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Pennsylvanian system 1,580 feet below its top. This penetration was in The Pure Oil Co. #1 C.B.Harrison, located about 1,700 feet northeast of the discovery well where the total depth of 11,805 feet is indicated on the accompanying map. The accompanying TYPICAL SECTION is based on the log of this dry hole.

NATURE OF TRAP

Rustler: Closed anticline.

PRODUCTIVE AREA

Rustler and Field: About 320 acres proved productive. The extent of the productive area is not completely defined, particularly to the north and northwest.

THICKNESS OF RESERVOIR ROCK

Rustler: From top to bottom, approximately 10 feet.

CONTINUITY OF RESERVOIR ROCK

Rustler: The reservoir rock appears to be continuous throughout the area of the field and considerably beyond. The dolomite member of the Rustler formation is continuous throughout most of the Delaware basin.

LITHOLOGY OF RESERVOIR ROCK

Rustler: Light gray to buff calcareous sandy dolomite.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

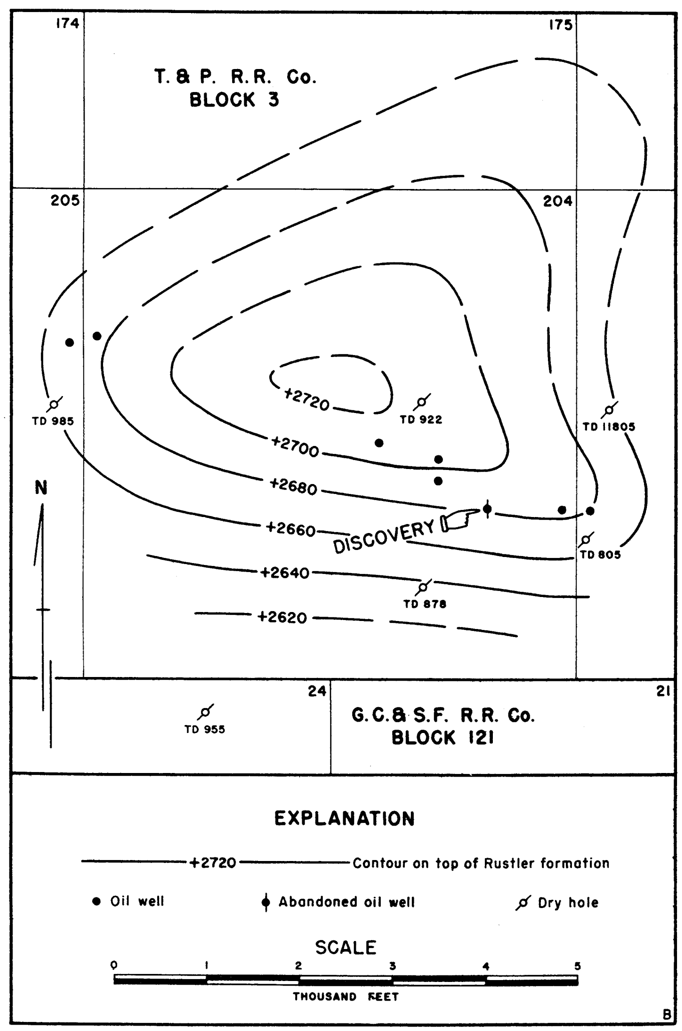
Rustler:	Feet
Elevation of top of oil	2,706
Elevation of bottom of oil	2,660
Relief	46

CHARACTER OF OIL

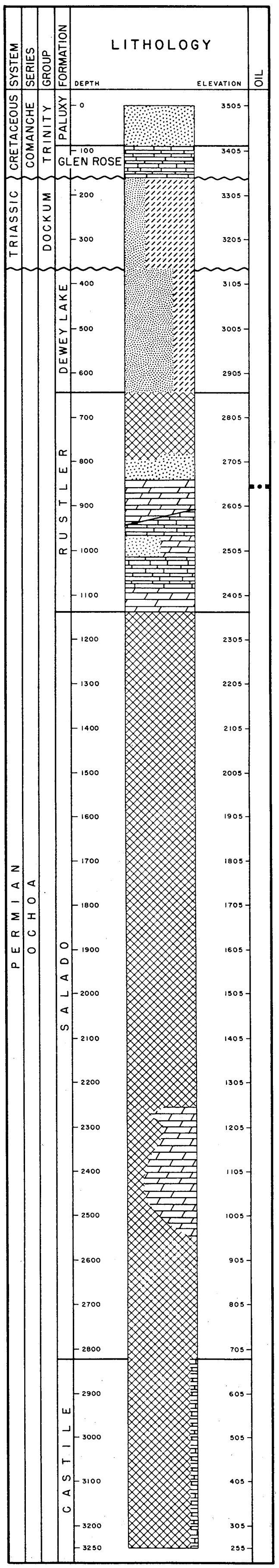
Rustler: Gravity, A.P.I. @ 60°F., 18.6°

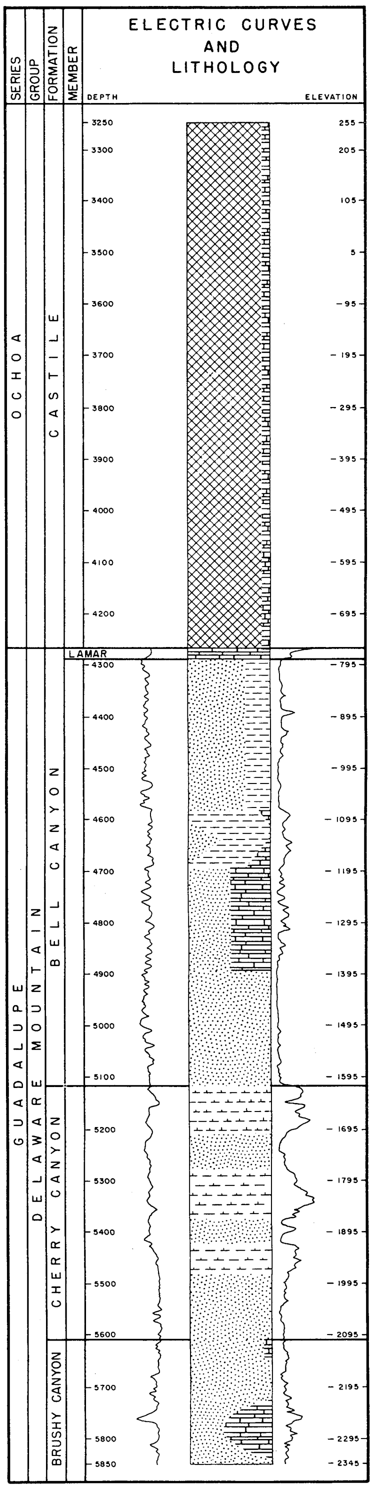
WATER PRODUCTION

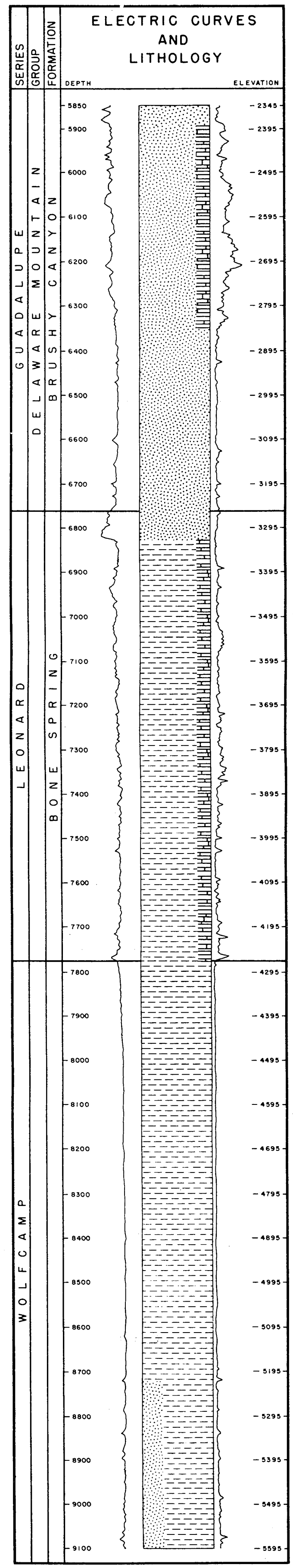
Rustler: A considerable amount of water is produced with the oil. Several of the wells produced some water at time of completion.

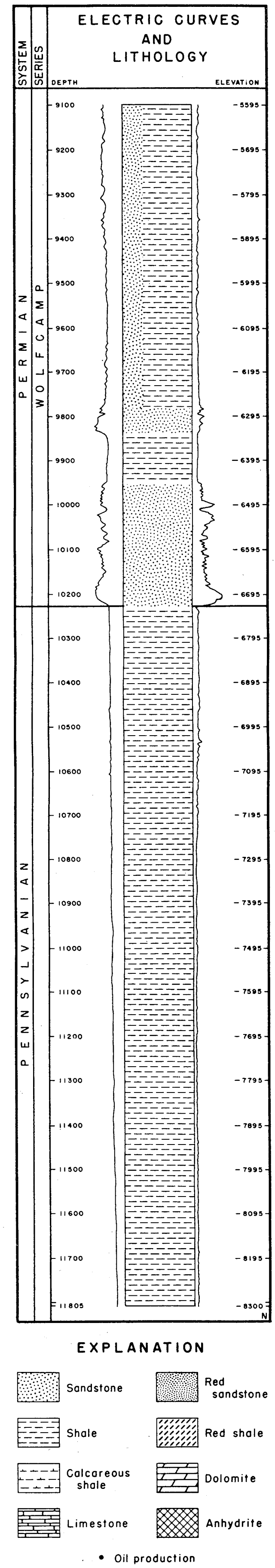


TYPICAL SECTION OF ROCKS PENETRATED









PRODUCTION HISTORY

Year	NO. OF WELLS at end of year Pumping	OIL PRODUCTION (barrels) Yearly	Cumulative
1947	1	3,403	3,403
1948	2	9,393	12,796
1949	3	5,888	18,684
1950	5	22,580	41,264
1951	5	34,449	75,713
1952	7	29,281	104,994
1953	7	28,464	133,458
1954	7	24,110	157,568

O'DONNELL FIELD

Lynn County, Texas

E. C. RISLEY
Geologist, Continental Oil Co., Midland, Texas
February 1, 1953

LOCATION

The O'Donnell field is near the southeast corner of Lynn County, about 15 miles southeast of the town of Tahoka and about 13 miles northeast of the town of O'Donnell. The three presently productive wells are all in Sec. 431, Block 9, East Line & Red River R.R. Co. survey.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Seismograph surveying by Magnolia Petroleum Co. led to the drilling of the field discovery well.

DISCOVERIES

Strawn and Field: May 20, 1950;
Magnolia Petroleum Co. #1 Garza Land & Cattle Co.
Mississippian: October 8, 1950;
Humble Oil & Refining Co. #1 W. C. Dulin
Ellenburger: November 1, 1952;
Round Top Oil Co. #1 Garza Land & Cattle Co.

SURFACE FORMATION

Ogallala formation of Pliocene system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 68 feet below the top of the Ellenburger group.

NATURE OF TRAPS

The known elevations on each reservoir prove at least a nose, as indicated by the accompanying maps. Further development may prove that the traps are due to structural nosing in combination with updip decrease in permeability.

PRODUCTIVE AREAS

	Acres
Strawn	40
Mississippian	120
Ellenburger	40
O'Donnell field	120

THICKNESSES OF RESERVOIR ROCKS

	Strawn	Miss.	Ellenburger
From top to bottom, feet	15	46 - 58	16
Net productive, feet	15	22	16

LITHOLOGY OF RESERVOIR ROCKS

Strawn: Limestone; gray to brown or black, fossiliferous, finely crystalline to dense, with a minor amount of vuggy porosity throughout its thickness. Fracturing is apparent toward the base of the productive reservoir rock.

Mississippian: Limestone; gray to tan, finely crystalline, containing gray to white vitreous chert and also some interstitial porosity locally. Apparently, there is a wide divergence in permeability. Toward the bottom, fractures increase permeability.

Ellenburger: Dolomite; gray, generally dense, containing blue chert inclusions; good porosity locally; fracturing increases permeability.

CONTINUITY OF RESERVOIR ROCKS

Each of the three reservoirs appears to be continuous throughout the area of the field and beyond to include the immediately adjacent area tested by two dry holes. Within this small area, however, there is considerable variation in porosity and permeability of each of the three reservoir rocks. The degree of fracturing is quite variable and may determine the boundaries of productive areas. Each of the three reservoirs is at a stratigraphic position corresponding to the stratigraphic position of productive reservoirs elsewhere in the Permian basin. However, it is highly conjectural whether conditions favorable for migration of reservoir fluids are continuous from any reservoir in this field to any reservoir in any other field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Elevation of oil, feet	Strawn	Miss.	Ellenburger
Highest known	-5,695	-6,063	-6,395
Lowest known	-5,710	-6,157	-6,411
Known relief, feet	15	94	16

CHARACTER OF OIL

	Strawn	Miss.	Ellenburger
Gravity, A.P.I. @ 60° F.	42.2°	37.2° avg. (33.9 - 40.5)	42.2°
Odor	Sweet	Sweet	Sweet

WATER PRODUCTION

	Barrels		
	Strawn	Miss.	Ellenburger
1950	0	152	0
1951	2,529	163	0
1952	11,611	1,266	*

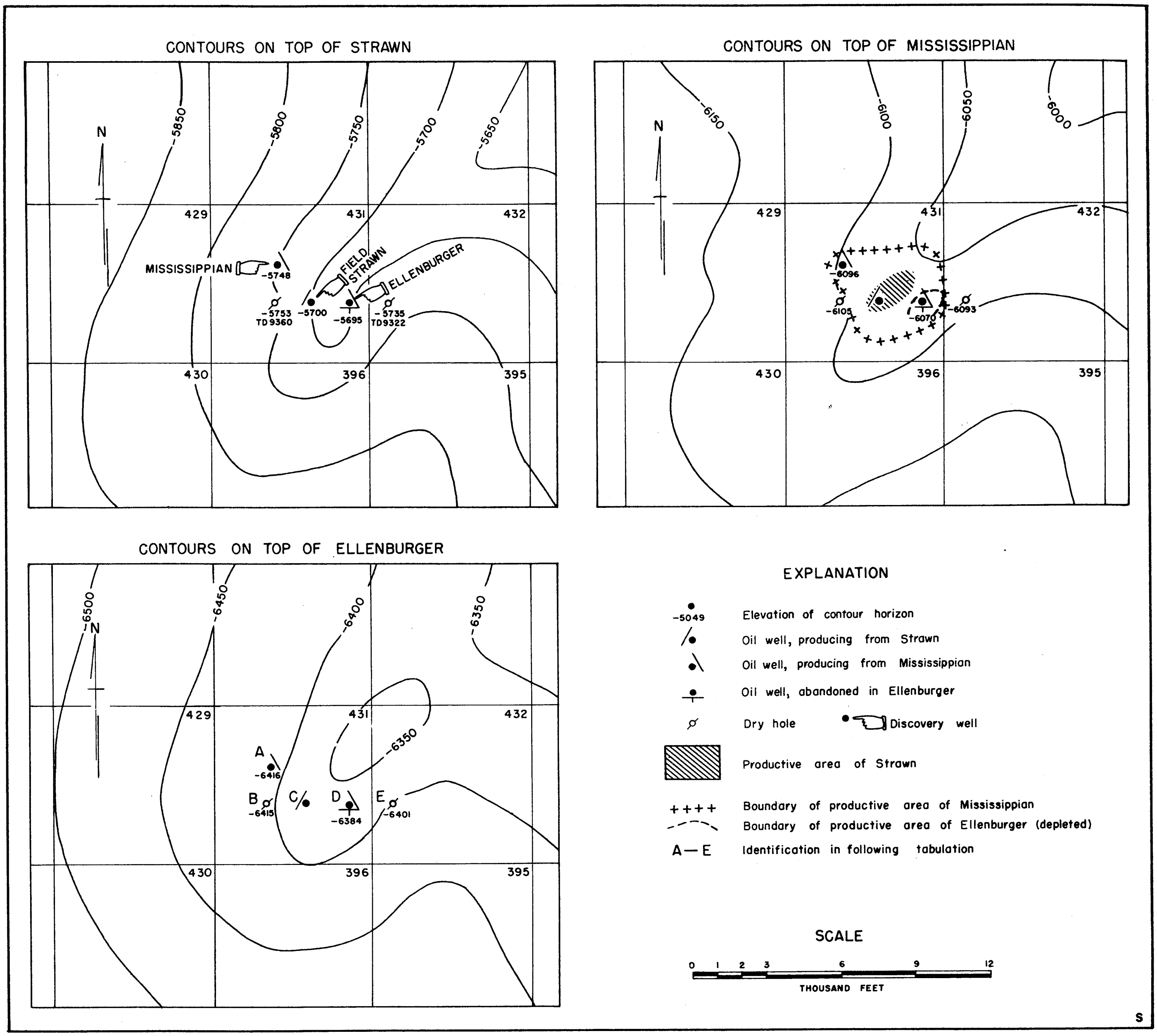
*Some water was produced from Ellenburger during December; amount, unknown.

ACID TREATMENT

Strawn: The one well completed in the Strawn reservoir was washed with 250 gallons of wash acid and then treated with 500 gallons of regular acid.

Mississippian: In the Mississippian discovery well, this reservoir was treated four times with acid during the course of completion; with 3,000 gallons during each of three treatments and then with 5,000 gallons during the fourth treatment. In the other Mississippian producer, this reservoir was washed with 1,000 gallons of acid and then treated with 2,500 gallons of acid at the time of completion in this reservoir in February, 1953, after the well had been plugged back from Ellenburger.

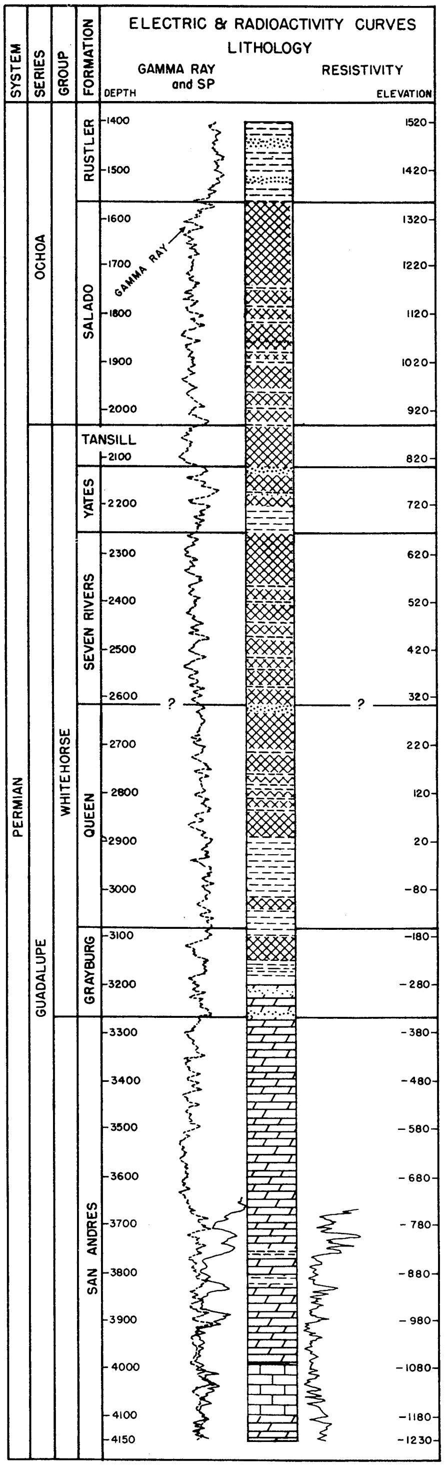
Ellenburger: The one well which was completed in this reservoir was washed with 5,000 gallons of acid at the time of that completion. Subsequently the Ellenburger was plugged off and the well was completed in the Mississippian.



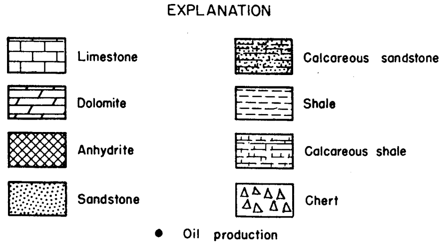
ELEVATIONS AT INDICATED LOCATIONS

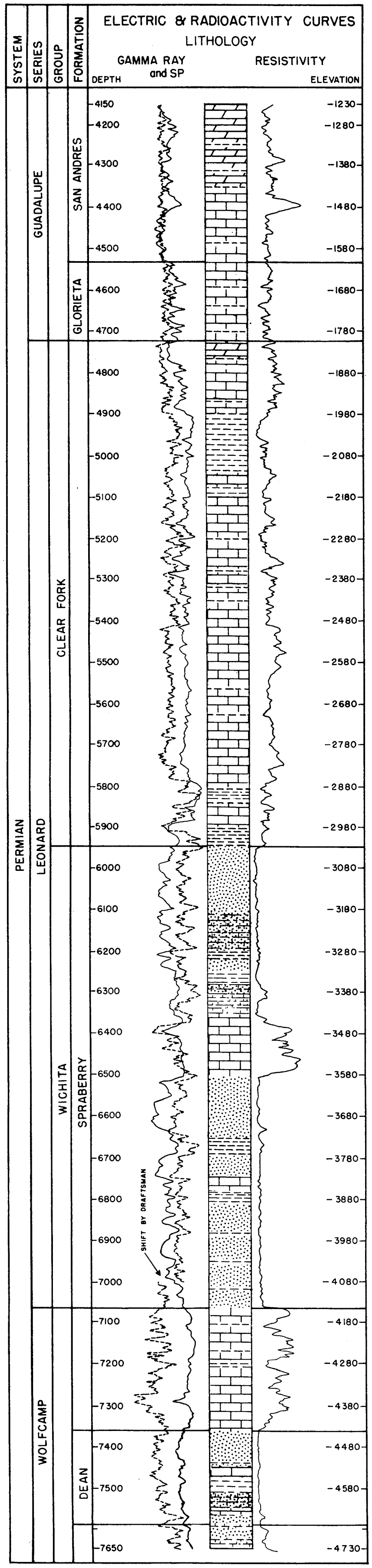
	A	B	C	D	E
Surface	2,924	2,920	2,920	2,915	2,911
Top of					
Yates formation	836	805	815	835	855
San Andres formation	-348	-348	-343	-326	-321
Spraberry formation	-3,023	-3,023	-3,022	-2,967	-2,995
Dean formation	-4,446	-4,439	-4,404	-4,405	-4,419
Strawn series	-5,748	-5,753	-5,700	-5,695	-5,735
Mississippian system	-6,096	-6,105		-6,070	-6,093
Ellenburger group	-6,416	-6,415		-6,384	-6,401
Total depth	-6,436	-6,440	-5,710	-6,452	-6,411

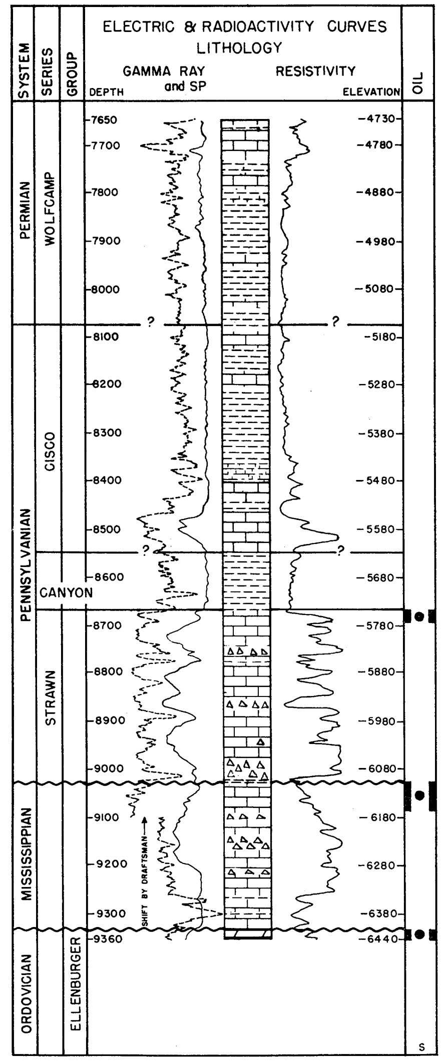
TYPICAL SECTION OF ROCKS PENETRATED



NOTE: This TYPICAL SECTION is based on the log of the dry hole offsetting to the west the Strawn discovery well. The position and extent of each reservoir is indicated although none is productive at this location.







PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
Field totals				
1950	1	1	23,437	23,437
1951	0	2	23,197	46,634
1952	1	2	9,792	156,426
Strawn				
1950	1	0	21,268	21,268
1951	0	1	18,688	39,956
1952	0	1	4,470	44,426
Mississippian				
1950	0	1	2,169	2,169
1951	0	1	4,509	6,678
1952	0	1	3,514	10,192
Ellenburger				
1952	1	0	1,808	1,808

Early in 1953, the one well which had produced from the Ellenburger reservoir was plugged back and was completed for production from the Mississippian reservoir.

OLSON FIELD

Crockett County, Texas

J. D. HOLME
Geologist, Sun Oil Company, Midland, Texas
May 27, 1954

LOCATION

The Olson field is in northwest Crockett County, approximately 10 miles southeast of Iraan in Pecos County and approximately 10 miles northeast of Sheffield in Pecos County. It is at the western dissected edge of the Edwards Plateau.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Core drilling and subsurface geology.

DISCOVERIES

Soma: March 17, 1947; Sun Oil Co. #7 J.M. Shannon Estate. Initial potential, after acidization, 114 Mcf of gas per day.

Queen: Gas: August 29, 1943; Plymouth Oil Co. #2-M J.M.Shannon Estate. Initial potential, 14 Mcf of gas per day.

Queen: Oil: May 17, 1950; H & F Oil Co. #1 J.M.Shannon Estate. Initial potential, after shot, pumping at rate of 160 barrels of oil per day.

San Andres and Field: June 22, 1940; Moore Exploration Co. #1 W.T.Nolke. Initial potential, after acidization, pumping, 130 barrels of oil per day.

ELEVATION OF SURFACE

At well locations: Highest, 2,719 ft.; lowest, 2,433 ft.

SURFACE FORMATIONS

All surface rocks within the area covered by the accompanying map are in the Fredericksburg and Washita groups of the Comanche series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 436 feet below the top of the Ellenburger group. This penetration was in Plymouth Oil Co. #1-A-O A.C.Hoover, located in Sec. 11, Block 66 as indicated on the accompanying map, at the total depth of 6,970 feet. Sulphur water at that depth prompted plugging back and completion in the reservoir in the San Andres formation.

NATURE OF TRAPS

Soma, Queen: Gas and Queen: Oil: Updip decrease of porosity on the east flank of an anticlinal fold.

San Andres: The accumulation is along the apex of an anticlinal fold, as indicated on the accompanying map.

LITHOLOGY OF RESERVOIR ROCKS

Soma: Sandstone; gray and brown, fine-grained.

Queen: Gas and Queen: Oil: Sandstone; red and gray, fine- to coarse-grained, with rounded, frosted quartz grains.

San Andres: Dolomite; white, crystalline.

CONTINUITY OF RESERVOIR ROCKS

Soma: Shows of gas in several wells indicate, but do not prove, that this reservoir rock is continuous throughout the northeastern part of the field.

Queen: Gas and Queen: Oil: The productive reservoir in any well can not be proved to be continuously open for migration of fluids beyond the patterned area in which the well is represented on the accompanying map.

San Andres: The reservoir rock in the San Andres formation appears to be continuous throughout the area of the accompanying map and considerably beyond its boundaries. However, the degree of porosity which occasions commercial production is probably not continuous far beyond the presently productive area.

WATER PRODUCTION

San Andres: Most of the San Andres wells are currently producing some water. At times of initial potential tests, at least 11 of the wells produced some water. As indicated above, the elevation at which water is yielded is quite irregular.

COMPLETION TREATMENT

Queen: Oil: Most of the Queen oil wells were given hydraulic fracture treatments.

San Andres: 12 wells were acidized only; 16 were shot only; 4 were acidized and shot.

PRODUCTIVE AREAS

	Acres
Soma	30
Queen: Gas	30
Queen: Oil	85
San Andres	900
Olson field	1,020

THICKNESSES OF RESERVOIR ROCKS

	Thickness, feet	
	Top to bottom	Net productive
Soma	40	15
Queen: Gas	30	12
Queen: Oil	20	20
San Andres	40	20

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

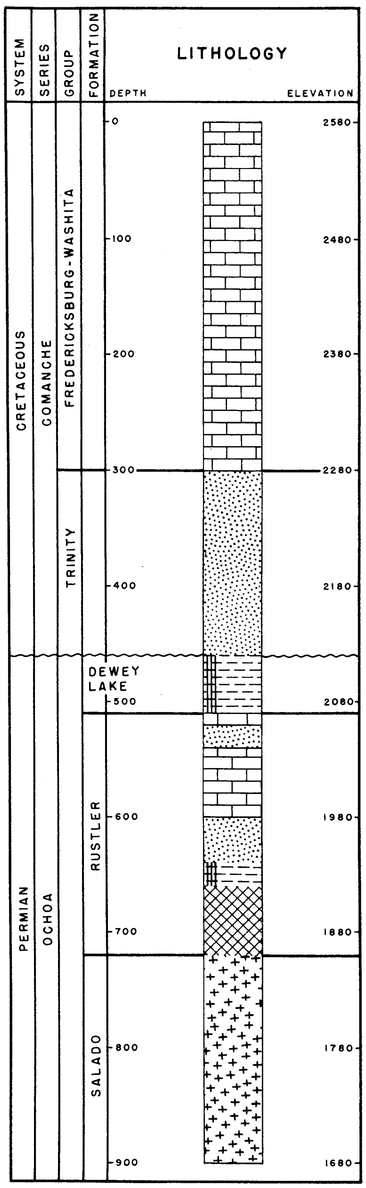
	Feet
Soma:	
Highest proven elevation of gas	1,275
Lowest proven elevation of gas	1,134
Known relief	141
Queen: Gas:	
Highest proven elevation of gas	692
Lowest proven elevation of gas	661
Known relief	31
Queen: Oil:	
Highest proven elevation of oil	679
Lowest proven elevation of oil	577
Known relief	102
San Andres:	
Highest proven elevation of oil	621
Lowest proven elevation of oil	425
Known relief	196

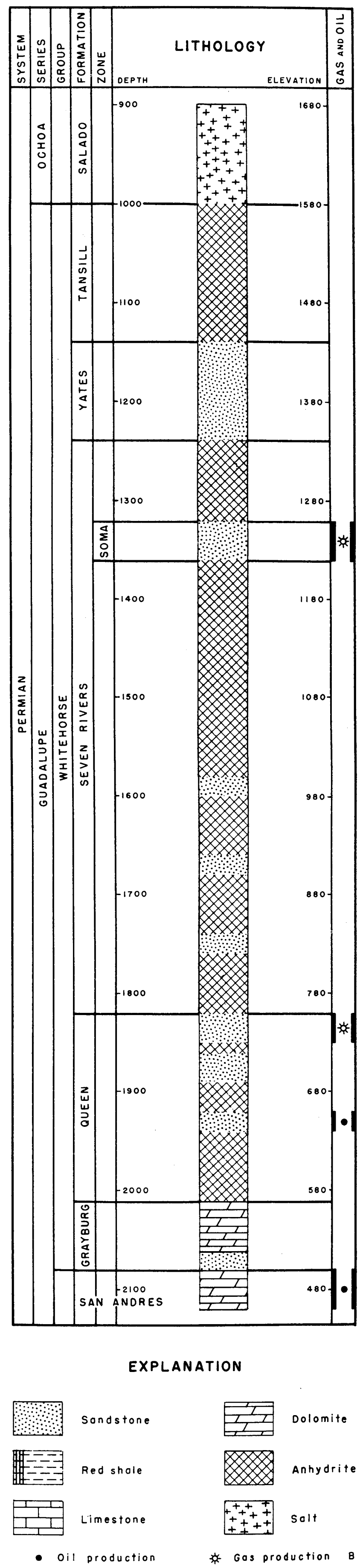
The oil-water contact in the San Andres reservoir is very erratic. Water has been found as high as 506 feet above sea level. In order to avoid water production, wells at locations where the reservoir is relatively low have been completed with as little penetration as necessary for a commercial rate of oil production.

CHARACTER OF OIL

	Gravity, A.P.I. @ 60° F.
Queen: Oil	30°
San Andres	25°

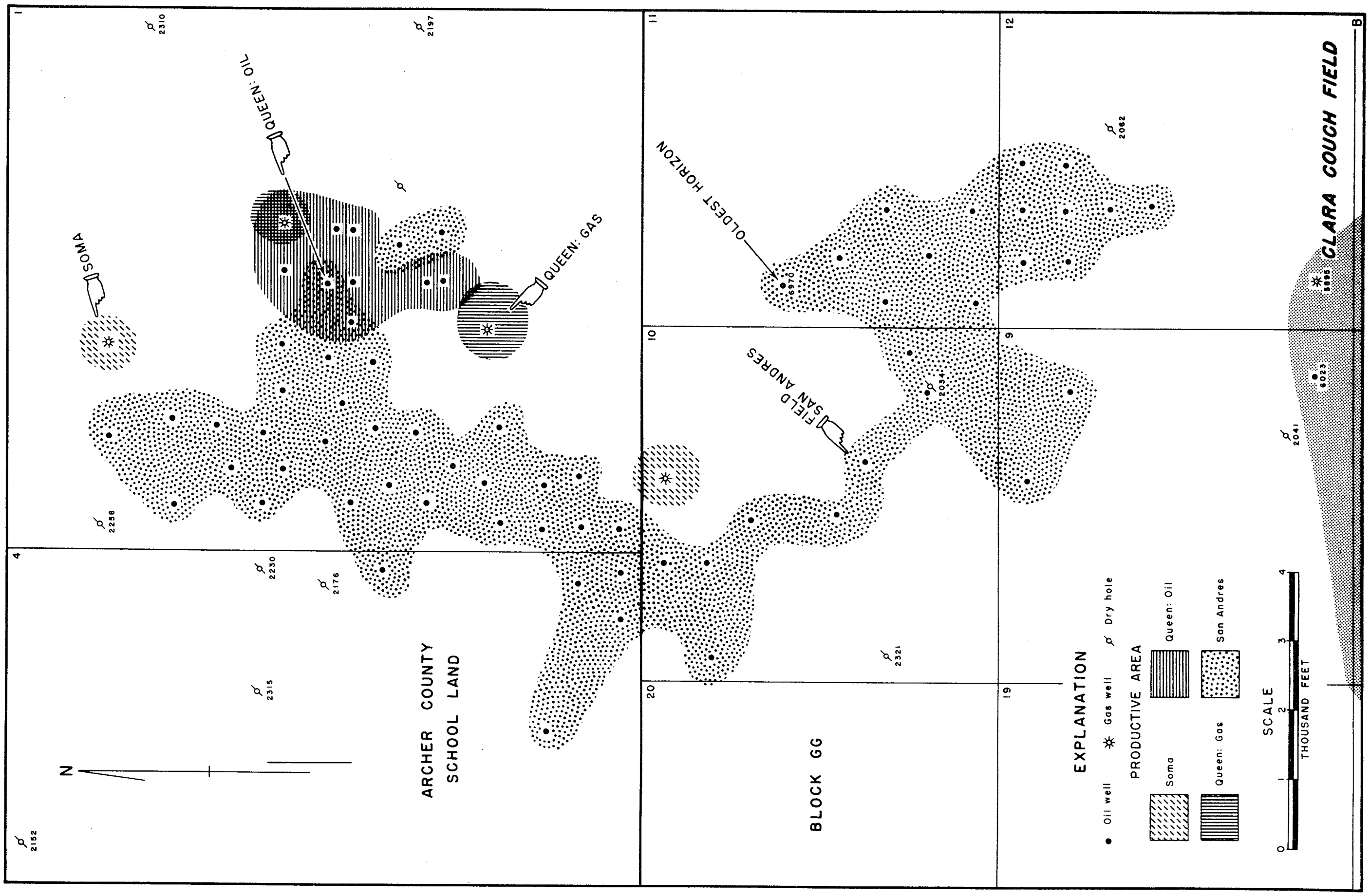
TYPICAL SECTION OF ROCKS PENETRATED

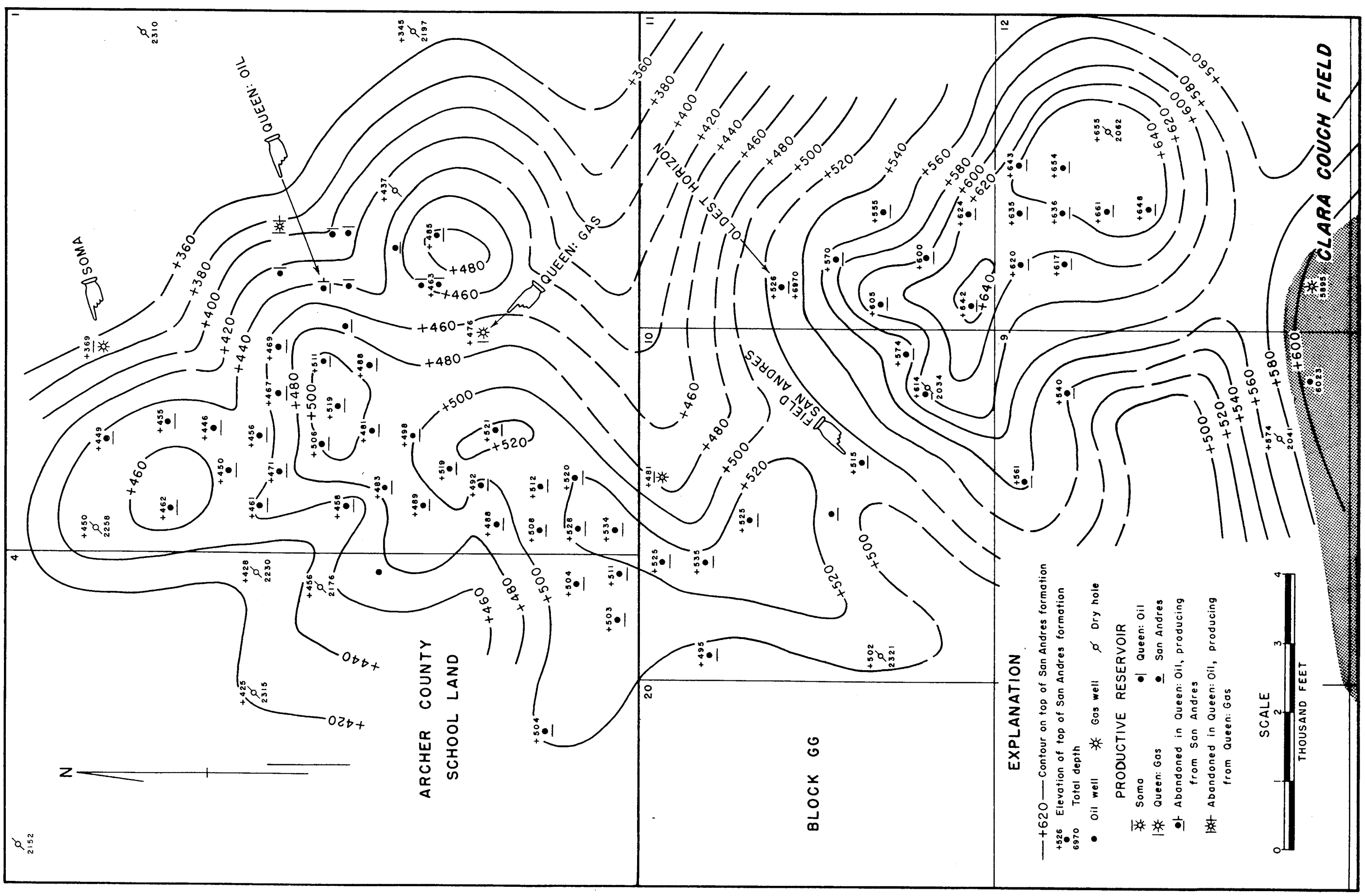




PRODUCTION HISTORY

Year	PRODUCTIVE WELLS at end of year: Oil Wells: Flow	Oil Wells: Pump	Gas Wells: Total	Gas Wells: Shut-in	OIL PRODUCTION (barrels): Yearly	Cumulative	GAS PRODUCTION (Mcf): Yearly	Cumulative
1941	0	1			4,634	4,634		
1942	0	3			5,843	10,477		
1943	0	5			15,326	25,803		
1944	1	14			45,645	71,448		
1945	0	20			59,592	131,041		
1946	0	29			70,095	201,135		
1947	0	32	2	1	161,445	362,580	37,758	48,364
1948	0	40	2	1	226,720	589,300	18,985	67,349
1949	0	49	2	1	229,835	819,135	10,138	77,487
1950	1	54	2	1	257,728	1,076,863	17,164	94,651
1951	0	59	2	1	375,661	1,452,524	27,740	122,391
1952	0	66	2	1	406,076	1,858,600	22,558	144,949
1953	0	68	2	1	388,123	2,246,723	30,985	175,934


SOMA
QUEEN: OIL
QUEEN: GAS
OLDEST HORIZON
FIELD SAN ANDRES
ARCHER COUNTY SCHOOL LAND
BLOCK GG
CLARA COUCH FIELD
EXPLANATION
Oil well
Gas well
Dry hole
PRODUCTIVE AREA
Soma
Queen: Oil
Queen: Gas
San Andres
SCALE
THOUSAND FEET


SOMA
QUEEN: OIL
QUEEN: GAS
OLDEST HORIZON
FIELD SAN ANDRES
ARCHER COUNTY SCHOOL LAND
BLOCK GG
CLARA COUCH FIELD
EXPLANATION
+620 Contour on top of San Andres formation
+526 Elevation of top of San Andres formation
6970 Total depth
Oil well
Gas well
Dry hole
PRODUCTIVE RESERVOIR
Soma
Queen: Oil
Queen: Gas
San Andres
Abandoned in Queen: Oil, producing from San Andres
Abandoned in Queen: Oil, producing from Queen: Gas
SCALE
THOUSAND FEET

OWNBY FIELD

Yoakum County, Texas

C. G. COOPER and B. J. FERRIS
Geologists, Shell Oil Co., Midland, Texas
January 1, 1953

LOCATION

The Ownby field is in the east central part of Yoakum County about 8 miles southeast of Plains, the county seat. It is at the extreme northeast end of a lobe on the continuously productive area which includes also the Wasson and Waples-Platter fields. Wasson, Waples-Platter and Ownby appear to constitute one continuously productive area and could logically be considered as one field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph and interpretation of subsurface data.

DISCOVERY

San Andres: April 22, 1941;
George P. Livermore, Inc. #1 E.Ownby

ELEVATION OF SURFACE

At well locations: Highest, 3,608 ft.; lowest, 3,556 ft.

TYPICAL SECTION OF ROCKS PENETRATED

For information relative to the stratigraphic section penetrated in this field, the reader is referred to the accompanying paper on the Waples-Platter field. The stratigraphic section is essentially the same in the two fields.

SURFACE FORMATION

Caliche and surface sand overlying Ogallala sand (Pliocene).

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the San Andres group 1,000 feet below its top.

NATURE OF TRAP

Anticlinal fold

MAP

Because of geographic and geologic relationships with the Waples-Platter field, the map data are presented on one map, which is included in the accompanying paper on the Waples-Platter field.

PRODUCTIVE AREA

San Andres and Field: 2,040 acres.

THICKNESS OF RESERVOIR ROCK

San Andres: From stratigraphic position of highest production to stratigraphic position of lowest production: Average, 65 feet.

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomitic limestone; gray, tan and brown, compact to saccharoidal, fine-grained cherty. The porosity and permeability are quite variable both vertically and horizontally. The extent of this portion of the San Andres group constituting the reservoir rock is determined by the stratigraphic range of rock sufficiently porous to yield oil into the wells. Since the porosity is so variable, a large portion of the reservoir rock is not productive.

CONTINUITY OF RESERVOIR ROCK

San Andres: The lithologic unit considered as reservoir rock is continuous throughout the area of the field; the porosity within the unit is quite variable. Generally at the apex of the structural fold, the stratigraphically higher portion of the reservoir rock is sufficiently porous to yield oil, whereas downdip that portion is non-porous and impermeable; at lower structural positions, the porosity is lower in the section.

CHARACTER OF OIL

San Andres:

Gravity, A.P.I. @ 60° F.	Average 29.9°
Sulphur, by weight:	2.26%
Color:	Dark green

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Andres:	Feet
Elevation of highest known gas	-1,617
Elevation of bottom of gas	-1,665±
Known relief	48±
Elevation of top of oil	-1,665±
Elevation of lowest known oil	-1,830
Known relief	165±

It appears that at the time of discovery of the Waples-Platter field in 1939, the oil-water contact at the south side of that field was at the elevation of -1,720 feet and that the contact sloped regularly northward to -1,830 feet at the north end of the Ownby field.

ACID TREATMENT

San Andres: All wells were treated with acid at time of completion. Treatments, in either one or two stages, ranged from 500 gallons to 15,000 gallons.

WATER PRODUCTION

Year	Barrels Yearly	Barrels Cumulative
1941	93	93
1942	1,369	1,462
1943	2,350	3,812
1944	12,467	16,279
1945	27,042	43,321
1946	22,469	65,790
1947	19,745	85,535
1948	27,845	113,380
1949	21,973	135,353
1950	16,886	152,239
1951	20,923	173,162
1952	39,835	212,997

At the end of 1952, 23 of the 52 wells were producing no water; water constituted 2% to 95% of the gross production of the other 29 wells.

An analysis of the water shows milligrams of constituents per liter of water as follows: calcium, 4,816; magnesium, 37; sodium, 77,548; bicarbonate, 87; carbonate, none; sulphate, 1,760; chloride, 126,844; total, 211,092.

PRODUCTION HISTORY

Year	Wells Producing at end of year: Flowing	Pumping	Oil Production (barrels): Yearly	Cumulative	Gas Production (Mcf): Yearly	Cumulative
1941	5	0	25,415	25,415	44,560	44,560
1942	5	0	45,338	70,753	55,039	99,599
1943	10	0	52,898	123,651	65,130	164,729
1944	17	7	168,719	292,370	159,560	324,289
1945	26	22	352,578	644,948	285,612	609,901
1946	26	22	413,343	1,058,291	339,130	949,031
1947	27	21	437,083	1,495,374	492,170	1,441,201
1948	24	24	449,245	1,944,619	629,622	2,070,823
1949	18	27	309,892	2,254,511	473,902	2,544,725
1950	18	32	295,649	2,550,160	402,276	2,947,001
1951	18	33	358,739	2,908,899	435,509	3,382,510
1952	15	37	308,606	3,217,505	386,375	3,768,885
1953*	12	40	284,450	3,501,955	502,135	4,271,020

*1953 data added by amendment.

PAGE FIELD

Schleicher County, Texas

SAMUEL P. ELLISON, Jr.
Professor of Geology, The University of Texas, Austin, Texas
September 22, 1955

LOCATION

The Page field is in south-central Schleicher County 7 miles east and 2 miles south of Eldorado, the county seat. It is near the southern margin of the Eastern platform.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Surface mapping of the Cretaceous rocks shows a northwestward-plunging irregularly shaped nose near the discovery well. Presumably, this surface structure, accompanied by ownership of a relatively large block of leaseholds, led to the drilling of the discovery well.

DISCOVERIES

Strawn: Gas: June 1934; John H. Cooper #1 Bert Page (now, Cooper Gas Co. #1-A-40 Bert Page). In November 1929, this well was commenced by Geo. T. Wilson et al, who ceased drilling in January 1931, at the depth of 5,053 feet. The well was acquired by John H. Cooper and deepening was commenced on May 15, 1934. Sweet gas with a condensate content of 0.7 gallon per Mcf was encountered in June 1934, at depth of 5,402 feet. Drilling was continued intermittently to the total depth of 6,257 feet. The well was plugged back to 5,550 feet and after being shot with 200 quarts of nitroglycerin and after acidization, it was completed as a gas-condensate well in January 1936. Initially, it produced at rate of 6,000 Mcf of gas per day through separator and against a back pressure. Railroad Commission tests in 1940 indicated an open flow capacity of 16,000 Mcf per day.

Strawn: Oil: June 18, 1939; Lone Star Gas Co. #1 Humble-Page (now, Cooper Gas Co. #1-C-30 Bert Page). After acidization, the well flowed 42° gravity oil through 12/64-inch choke at the rate of 158 barrels per day. It was rated as having a potential capacity of 259 barrels per day.

ELEVATION OF SURFACE

At well locations: Highest, 2,411 ft.; lowest, 2,265 ft.

SURFACE FORMATIONS

Lower Cretaceous (Fredericksburg and Washita) limestones and calcareous shales.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 572 feet below its top. This penetration was in Cooper Gas Co. #1-D-39 Bert Page at its total depth of 7,022 feet (-4,645).

NATURE OF TRAPS

Strawn: Porosity zones in the reef limestone mass are on a broad terrace and disappear updip to the north and east. Limestone grades into shale updip. The accompanying map showing the topography of the top of the Strawn reef indicates approximately 300 feet of relief.

PRODUCTIVE AREAS

Strawn:	Acres
Gas	400
Oil	1,480
Page field	1,600

THICKNESSES OF RESERVOIR ROCKS

Strawn:	Range, feet
Top of highest productive zone to bottom of lowest productive zone	210 to 470
Net productive	
Total for gas bearing zones	80 to 120
Total for oil bearing zones	10 to 60

LITHOLOGY OF RESERVOIR ROCKS

Strawn: Limestone; granular, paurograined, gray, calcitic, with porosity ranging up to 11.2% and permeability ranging up to 5.3 millidarcys. Individual porous and permeable zones are rarely more than a few feet thick and are separated by layers of dense, granular, light gray, non-permeable, calcitic limestone. On the basis of recorded core analyses, the maximum known oil saturation for any one porous zone is 46.7%.

CONTINUITY OF RESERVOIR ROCKS

Strawn: Two porosity zones containing gas and two porosity zones containing oil can be recognized throughout the field. A possible third oil zone below the two main producing zones may be recognized, but it is not continuous throughout the field. All porosity zones have greater irregularity in the southern part of the field.

PAGE FIELD, Schleicher County, Texas

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Strawn:	Feet
First gas zone:	
Elevation of top of gas	-2,861
Lowest known elevation of gas	-3,038
Known relief	177
No oil in this reservoir	
Second gas zone:	
Highest known elevation of gas	-3,021
Lowest known elevation of gas	-3,200
Known relief	179
No oil in this reservoir	
First oil zone:	
Elevation of top of gas	-3,168
Elevation of bottom of gas	-3,198
Relief	33
Elevation of top of oil	-3,198
Elevation of bottom of oil	-3,282
Relief	84
Second oil zone:	
No free gas cap	
Elevation of top of oil	-3,198
Elevation of bottom of oil	-3,311
Relief	113
Third oil zone:	
No free gas cap	
Elevation of top of oil	-3,350
Elevation of bottom of oil	-3,388
Relief	38

CHARACTER OF OIL

Gravity, A.P.I. @ 60° F.: 37° to 43°

CHARACTER OF GAS

No analysis of the gas is available. However, the gas is known to be sweet and known to be rich since condensate in large quantity is produced. The gravity of the condensate averages about 61° A.P.I. The stripped residue is sold to the city of Eldorado and to the Lone Star Gas Company for domestic utilization.

WATER PRODUCTION

Negligible.

ACID TREATMENT

Acid treatments range from 1,500 to 16,000 gallons per well; average about 4,000 gallons.

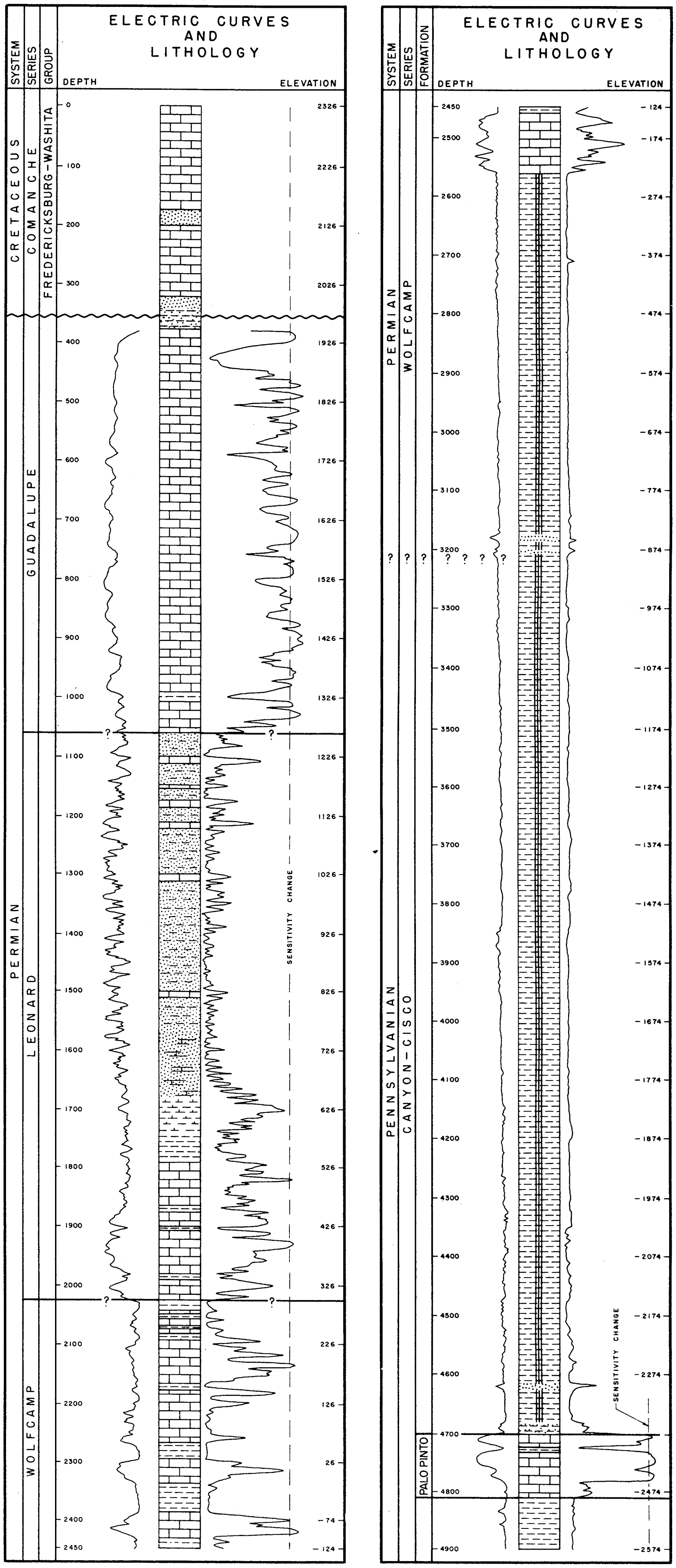
SELECTED REFERENCE

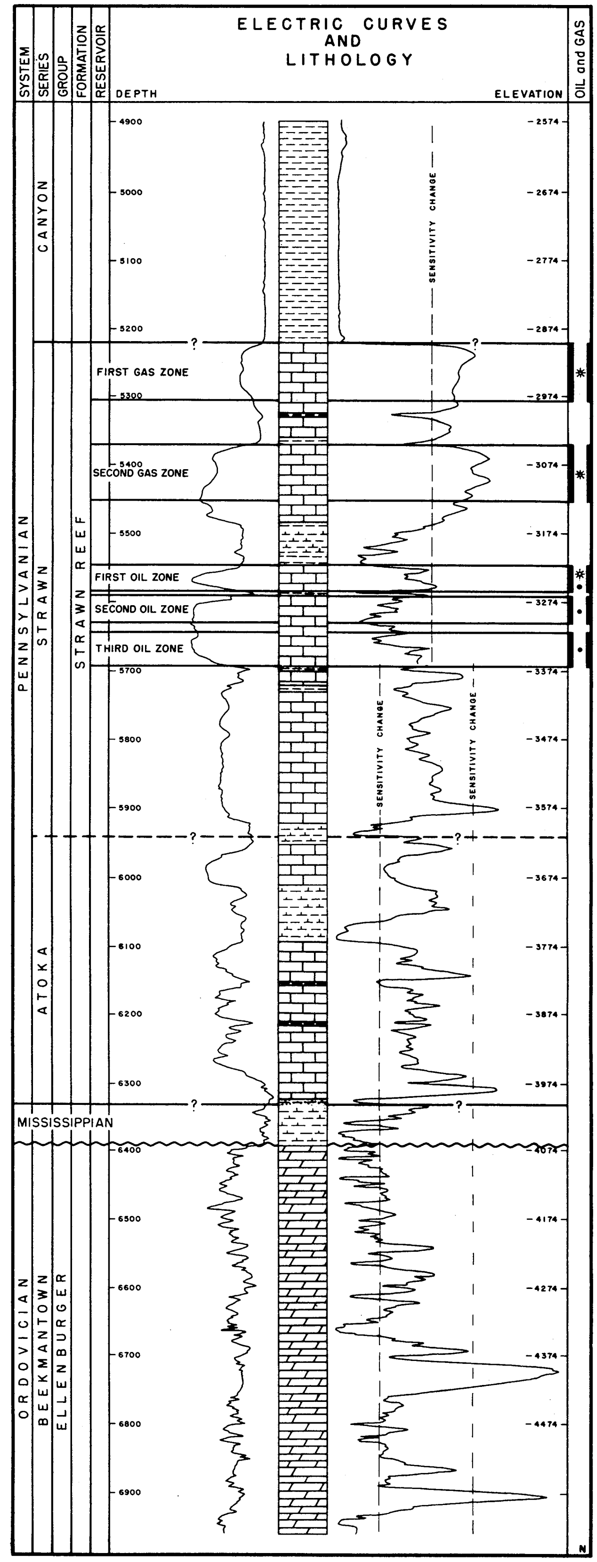
Simpson, Roscoe (1941) Page field, Schleicher County, Texas: Amer. Assoc. Petr. Geol., Bull., vol. 25, pp. 630-636.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)		CONDENSATE PRODUCTION (barrels)		GAS PRODUCTION (Mcf @ 14.65# & 60° F)	
	Oil		Gas &						
Year	Flow.	Artif.	Condensate	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
1934-38			1	None	None	Neg.	Neg.	Neg.	Neg.
1939	1		2	10,361	10,361	?	?	78,998	78,998
1940	1		3	12,520	22,881	?	?	58,784	137,782
1941	1		4	9,677	32,558	?	?	1,726,631	1,864,413
1942	1		5	7,859	40,417	?	4,634	2,556,747	4,421,160
1943	1		5	8,469	48,886	24,384	29,018	3,035,908	7,457,068
1944	1		5	8,263	57,149	18,879	47,897	2,625,511	10,082,579
1945	1		6	6,386	63,535	17,540	65,437	2,410,444	12,493,023
1946	5		7	56,875	120,410	13,325	78,762	2,277,125	14,770,148
1947	17	1	7	324,691	445,101	14,219	92,981	2,253,485	17,023,633
1948	32	0	5	589,078	1,034,179	6,111	99,092	1,024,655	18,048,288
1949	5	29	4	455,458	1,489,637	849	99,941	419,784	18,468,072
1950	5	29	4	311,885	1,801,522	796	100,737	157,462	18,625,534
1951	5	29	4	227,287	2,028,809	1,337	102,074	199,875	18,825,409
1952	3	33	7	210,600	2,239,409	1,321	103,395	363,960	19,189,369
1953	0	32	7	250,959	2,490,368	1,231	104,626	401,640	19,591,009
1954	0	33	9	268,589	2,758,957	1,577	106,203	511,501	20,102,510

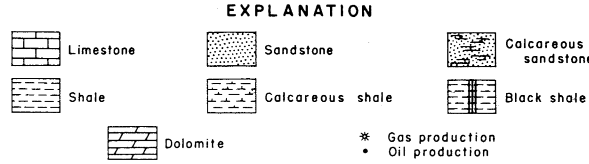
TYPICAL SECTION OF ROCKS PENETRATED

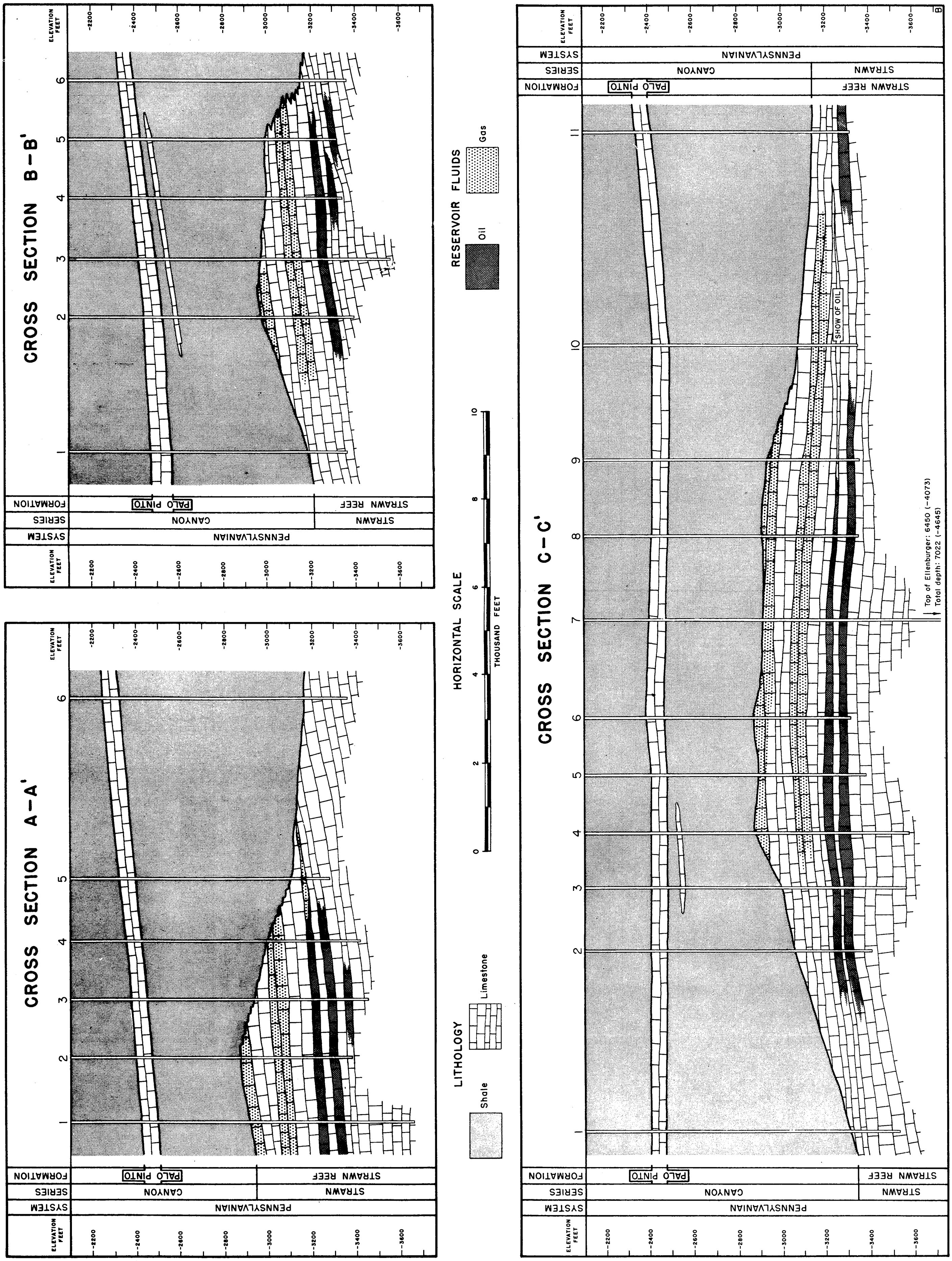


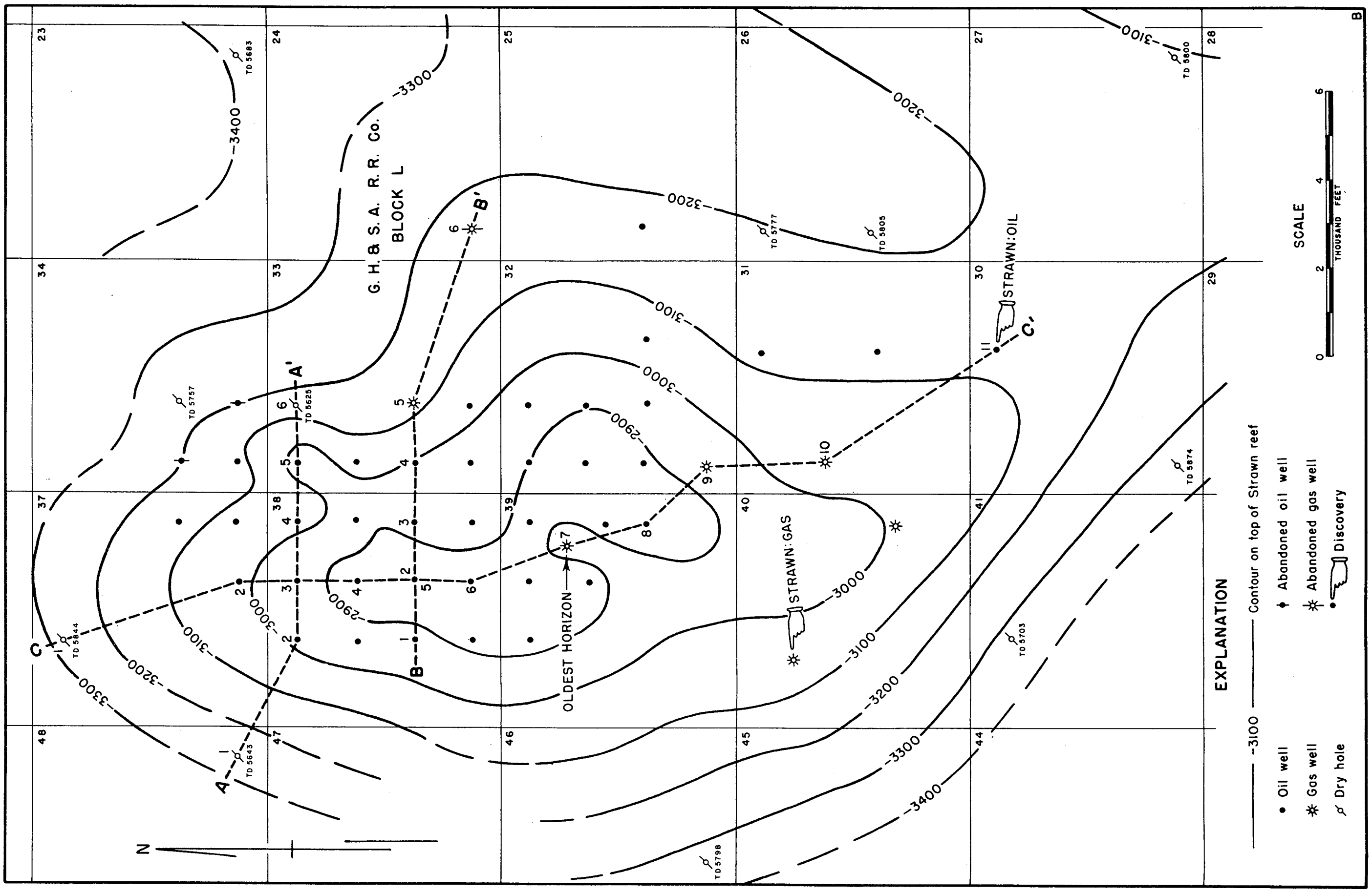


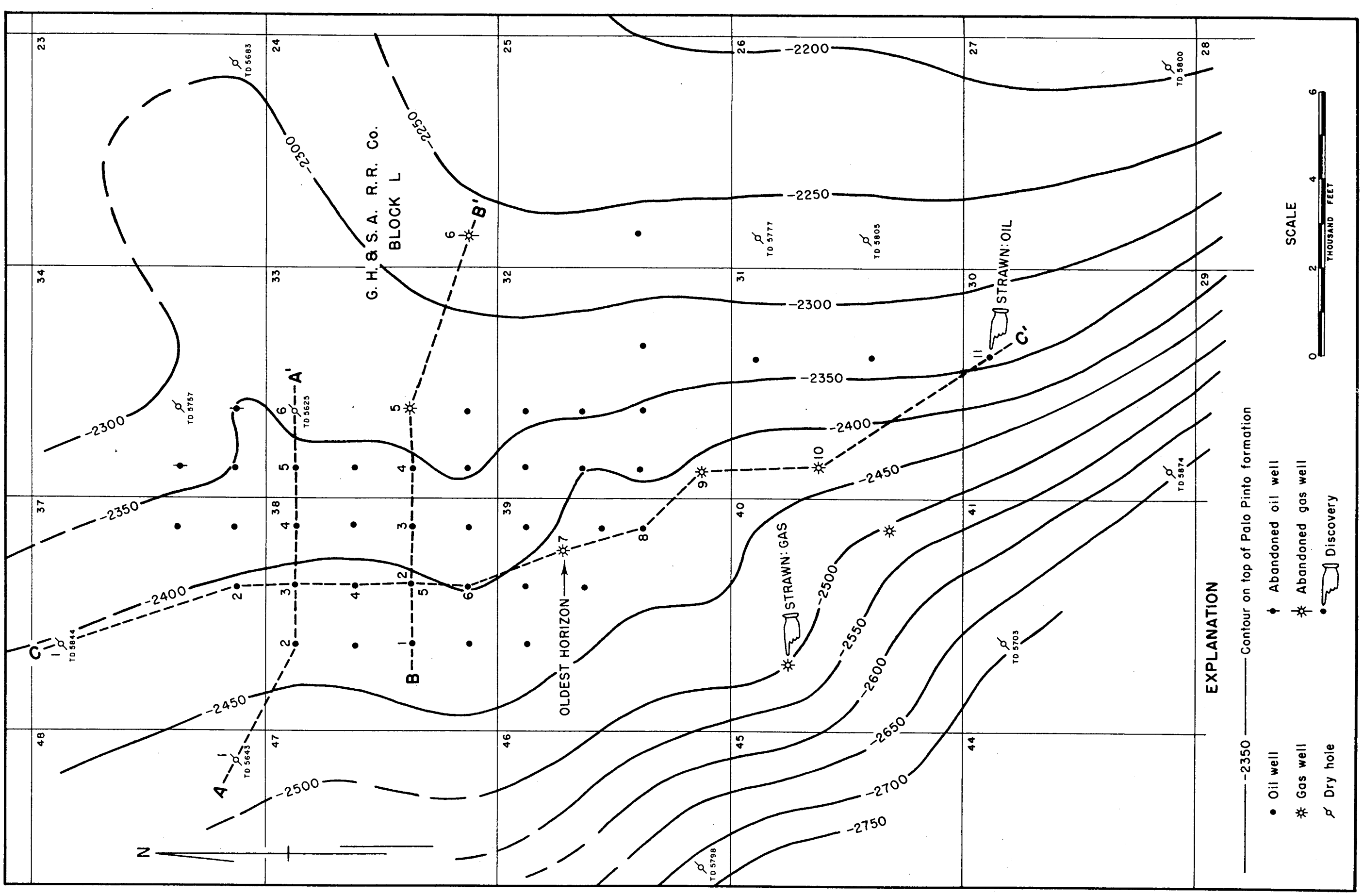
NOTE: This section is based on the log of Cooper Gas Co. #5-A-32 Bert Page to the depth of 5,690 feet and, below that depth, on the log of Cooper Gas Co. #1-D-39 Bert Page with depths and elevations adjusted.

EXPLANATION




CROSS SECTION B-B'
CROSS SECTION A-A'
CROSS SECTION C-C'
ELEVATION FEET
SYSTEM
SERIES
FORMATION
PENNSYLVANIAN
CANYON
STRAWN
PALO PINTO
STRAWN REEF
RESERVOIR FLUIDS
Oil
Gas
HORIZONTAL SCALE
THOUSAND FEET
LITHOLOGY
Shale
Limestone
SHOW OF OIL
Top of Ellenburger: 6450 (-4073)
Total depth: 7022 (-4645)


G. H. & S. A. R. R. Co.
BLOCK L
OLDEST HORIZON
STRAWN: GAS
STRAWN: OIL
-2900
-3000
-3100
-3200
-3300
-3400
EXPLANATION
-3100 Contour on top of Strawn reef
Oil well
Gas well
Dry hole
Abandoned oil well
Abandoned gas well
Discovery
SCALE
THOUSAND FEET


G. H. & S. A. R. R. Co.
BLOCK L
OLDEST HORIZON
STRAWN: GAS
STRAWN: OIL
-2200
-2250
-2300
-2350
-2400
-2450
-2500
-2550
-2600
-2650
-2700
-2750
EXPLANATION
-2350 Contour on top of Palo Pinto formation
Oil well
Gas well
Dry hole
Abandoned oil well
Abandoned gas well
Discovery
SCALE
THOUSAND FEET

PARKER FIELD

Andrews County, Texas

L. G. BYERLEY, Jr.
Geologist, Honolulu Oil Corporation, Midland, Texas
April 30, 1956

LOCATION

The Parker field is in central Andrews County about three miles south of the town of Andrews, county seat. It is in the midst of several fields on the eastern edge of the Central Basin platform. As indicated on an accompanying map, it overlaps slightly with the Andrews field. In the overlapped area, the wells which produce from San Andres are classified as in the Parker field and those which produce from Wolfcamp and/or Pennsylvanian are classified as in the Andrews field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The San Andres discovery well was drilled on the basis of evidence afforded by subsurface methods.

DISCOVERIES

San Andres: January 2, 1935;
Honolulu Oil Corp. and Llano Oil Co. #1 J. E. Parker (later, Honolulu Oil Corp. and Woodley Petroleum Co. #A-1 J. E. Parker).

Wolfcamp: September 19, 1953;
Fred Turner #1 J. E. Parker.

Pennsylvanian: July 14, 1954;
Fred Turner #2 J. E. Parker.

SURFACE FORMATION

Undifferentiated sands, gravels and caliche of the Tertiary system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 322 feet below its eroded top. This penetration was in Honolulu Oil Corp. #H-2 J. E. Parker, located in Sec. 20, Blk. A-43, where the total depth of 12,867 feet is indicated on an accompanying map. The accompanying TYPICAL SECTION is based on the log of this well.

ELEVATION OF SURFACE

At well locations: Highest, 3,219 ft.; lowest, 3,171 ft.

NATURE OF TRAPS

San Andres: It is believed that the high areas indicated by contours on an accompanying map are high because of local increases in thickness of the San Andres formation. These high areas are believed to be depositional features rather than structural features. Variation in permeability within these features appears to be the most important trap-forming factor.

Wolfcamp: The highs and lows caused by deposition over buried Pennsylvanian topography appear to have some effect on the accumulation of oil and gas, but the distribution of porosity and permeability is believed to be the most important trap-forming factor.

Pennsylvanian: The trap is probably due to a combination of folding and lensing of porous zones.

PRODUCTIVE AREAS

	Acres
San Andres	280
Wolfcamp	480
Pennsylvanian	480
Parker field	760

THICKNESSES OF RESERVOIR ROCKS

	Feet Min.	Feet Max.	Feet Avg.
San Andres:			
From top to bottom	35	141	79
Net productive	?	?	10-15
Wolfcamp:			
From top to bottom	93	105	100
Net productive	4	30	13
Pennsylvanian:			
From top to bottom	25	200	90
Net productive	8	29	23

LITHOLOGY OF RESERVOIR ROCKS

San Andres: White crystalline dolomite containing inclusions of anhydrite and with scattered zones of tan porous dolomite; greater granularity and more oolites in zones of higher porosity.

Wolfcamp: Light-gray to tan crystalline very fossiliferous limestone with porous lenses. Algal colonies have been noted in several cores. Dark-grey to black shale partings and stylolites are scattered throughout the section. Glauconite occurs near the base.

Pennsylvanian: Buff to tan crystalline fossiliferous limestone with porous lenses. Red and green shale partings and scattered oolitic zones occur in the upper portion.

CONTINUITY OF RESERVOIR ROCKS

San Andres: The San Andres reef facies, of which this reservoir rock is a portion, occurs all along the east edge of the Central Basin platform and the southeast edge of the North Basin platform. It also forms an arc through northern Andrews, Martin and Howard counties and along the west edge of the Eastern shelf. Along the eastern edge of the Parker field the San Andres dips rapidly basinward and an abrupt facies change occurs. This facies change marks the eastern extent of reef migration and is represented by an interfingering of the basin sandstones into the reef. The San Andres productive area in the Parker field is limited eastward in part by this facies change and in part by the dipping of the reservoir rock to below the elevation of the oil-water contact. In other directions, the productive area is limited by extent of porosity adequate for commercial production.

Wolfcamp: It appears that the reservoir rock is continuous throughout the area of the accompanying map and sufficiently beyond to include the whole of the Andrews field to the north, the Wemac field five miles to the east and the University Block 9 field two miles to the south. However, porosity adequate for commercial production is probably not continuous throughout the above indicated area.

Pennsylvanian: The reservoir rock is present and productive to the north in the Andrews field and to the south in the University Block 9 field. Westward it has been removed by erosional truncation which followed closely the end of Pennsylvanian time. The eastward continuity of the reservoir rock into the Midland basin has not yet been determined; it is known to extend downdip eastward to below the elevation of the oil-water contact in this field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Feet
San Andres:	
No free gas cap	
Elevation of top of oil	— 1,435
Elevation of lowest commercial oil production	— 1,540
Relief	105
Wolfcamp:	
No free gas cap	
Elevation of top of oil	— 5,406
Elevation of lowest commercial oil production	— 5,560
Relief	154
Pennsylvanian:	
No free gas cap	
Elevation of top of oil	— 5,834
Elevation of lowest commercial oil production	— 5,988
Relief	154

CHARACTER OF OIL

San Andres:	
Gravity, A. P. I. @ 60°F:	30°
Sulphur indications:	Sour
Wolfcamp:	
Gravity, A. P. I. @ 60°F:	37.3°
Base:	Intermediate
Viscosity at reservoir conditions of 129°F. and 3,555 psi:	0.92 centipoises
Pennsylvanian:	
Gravity, A. P. I. @ 60°F:	39.6°
Base:	Intermediate
Viscosity at reservoir conditions of 130°F. and 3,700 psi.:	0.694 centipoises

WATER PRODUCTION

San Andres: Some water is being produced. The quantity has not yet been sufficient to cause any serious operating problems.

Wolfcamp and Pennsylvanian: Each of these reservoirs yields a negligible amount of water.

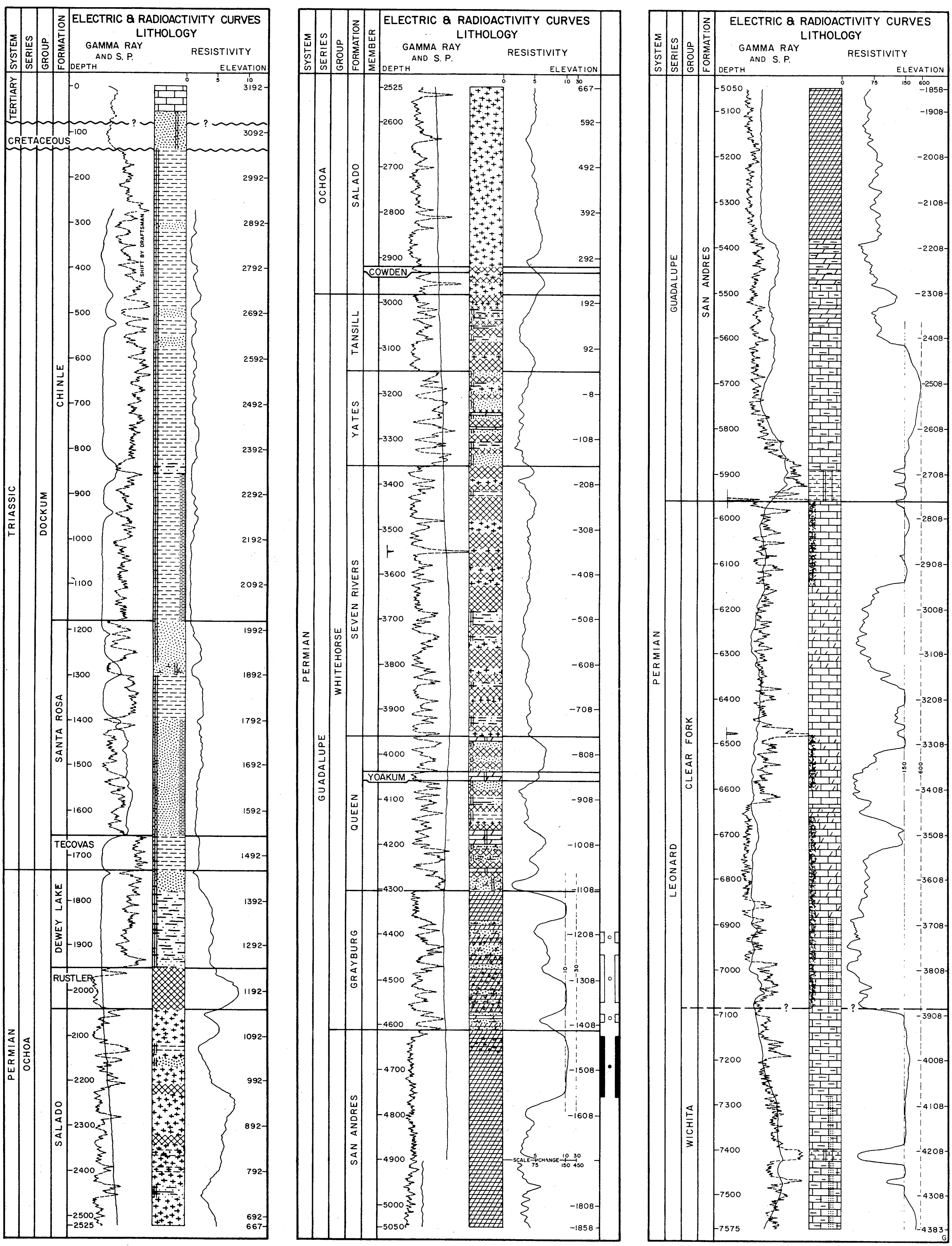
COMPLETION TREATMENT

San Andres: The first two wells were shot with 200 to 260 quarts of nitroglycerin. All subsequent wells have been treated with 3,000 to 7,000 gallons of acid, except that one well was treated with 2,000 gallons of acid and the reservoir rock was hydraulically fractured with 3,000 gallons of oil and sand.

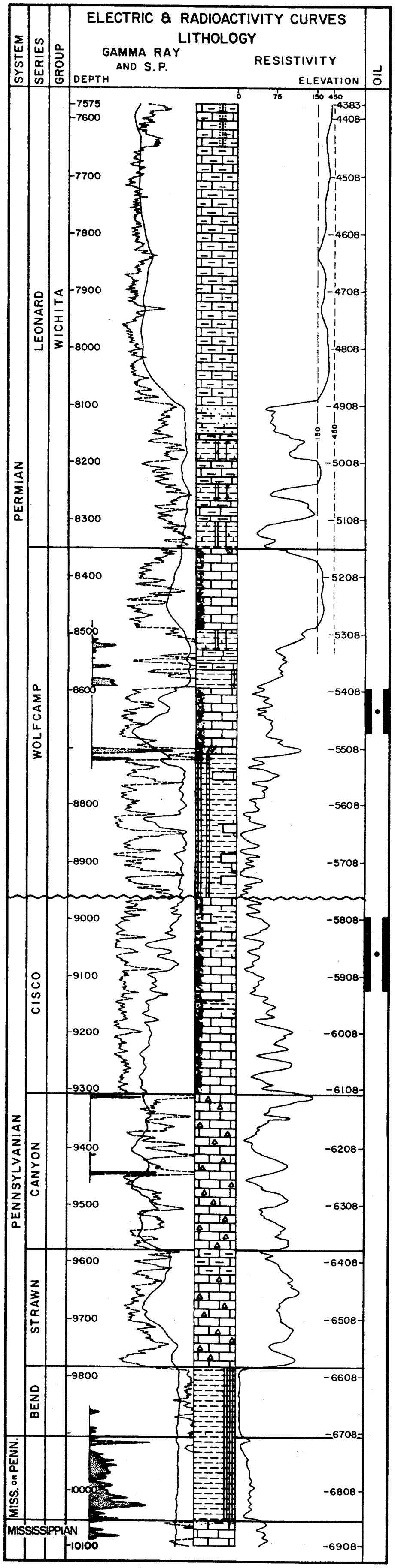
Wolfcamp: Each well except one, which was completed "natural", has been treated with 250 to 5,500 gallons of acid.

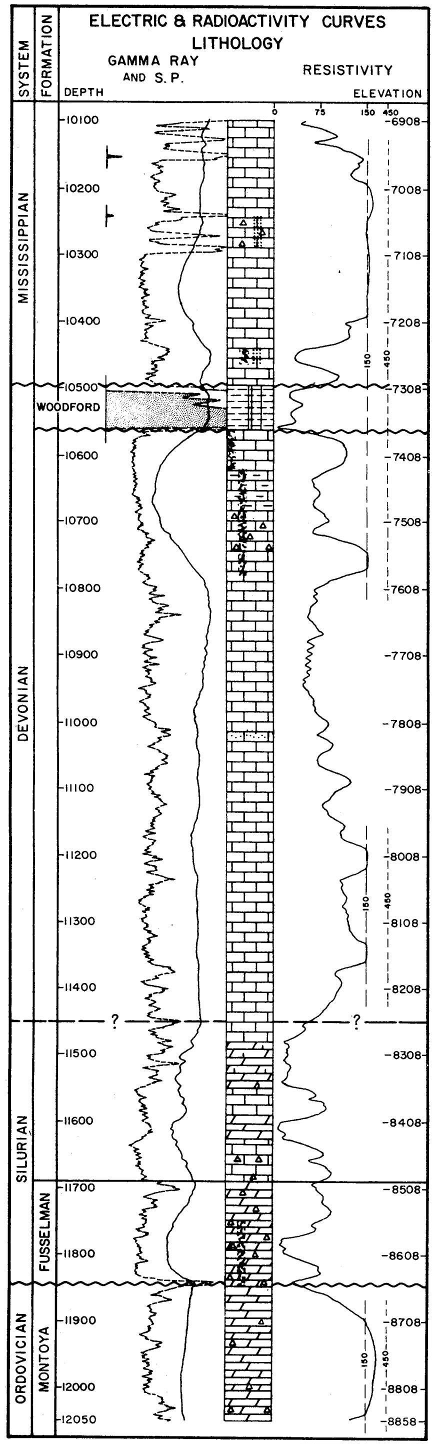
Pennsylvanian: Each well has been treated with 300 to 13,000 gallons of acid.

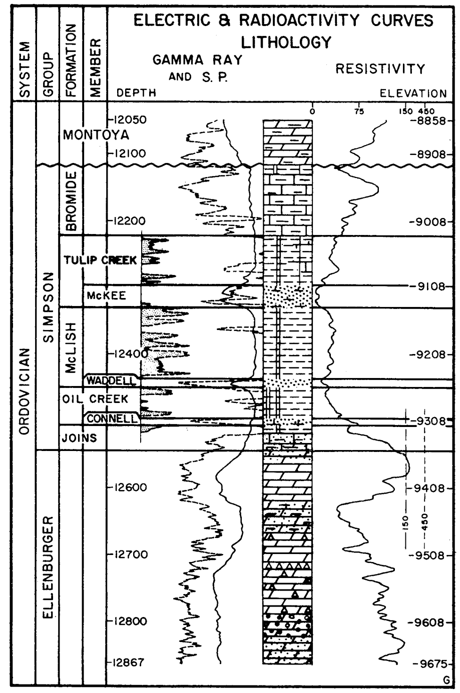
TYPICAL SECTION OF ROCKS PENETRATED



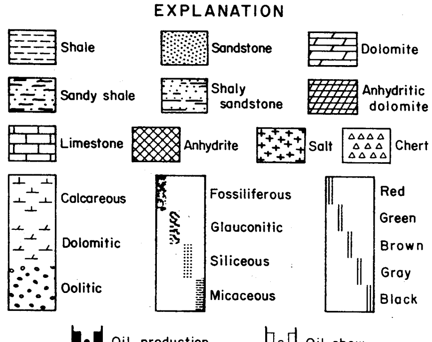
TYPICAL SECTION OF ROCKS PENETRATED







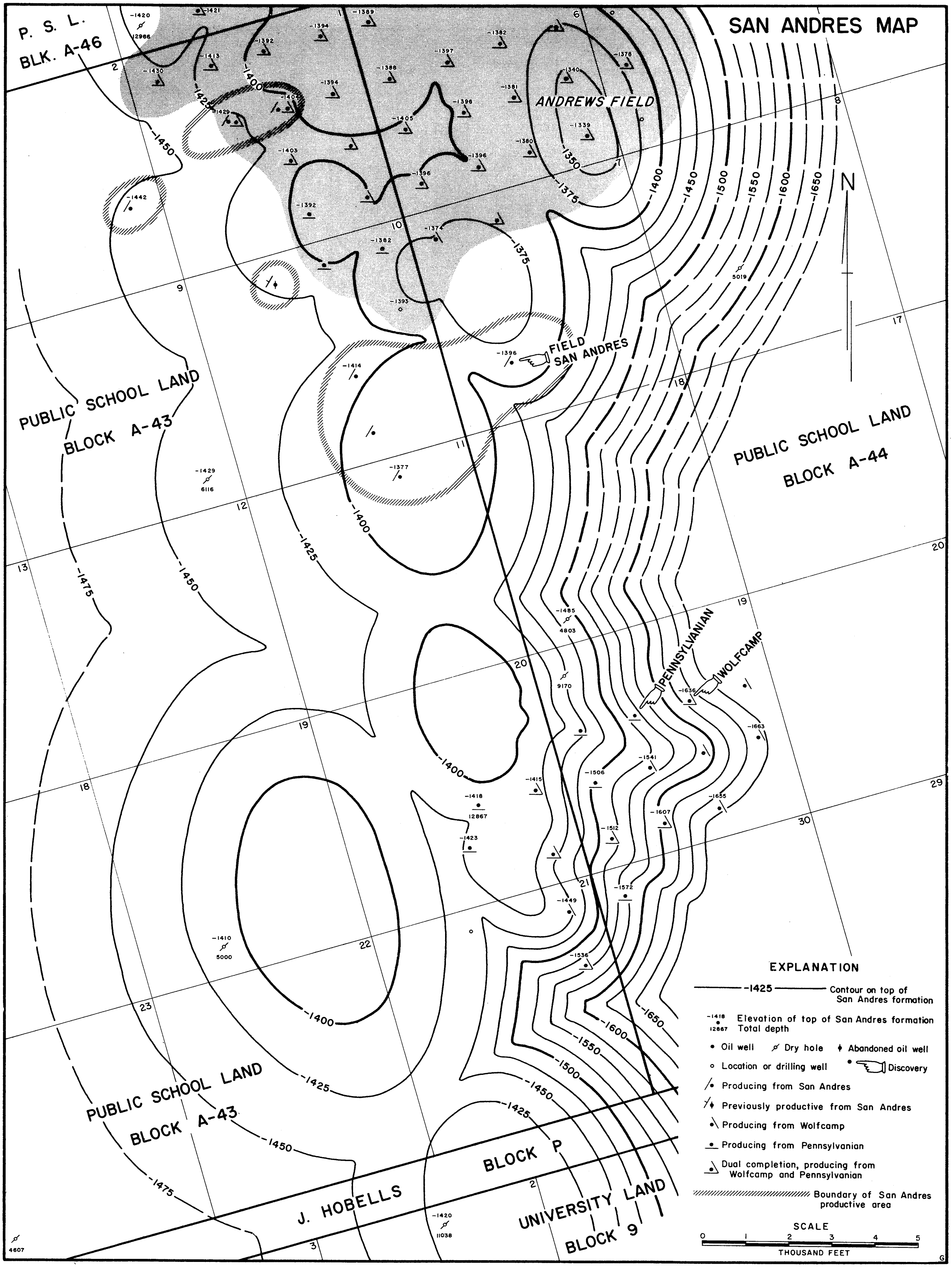
EXPLANATION

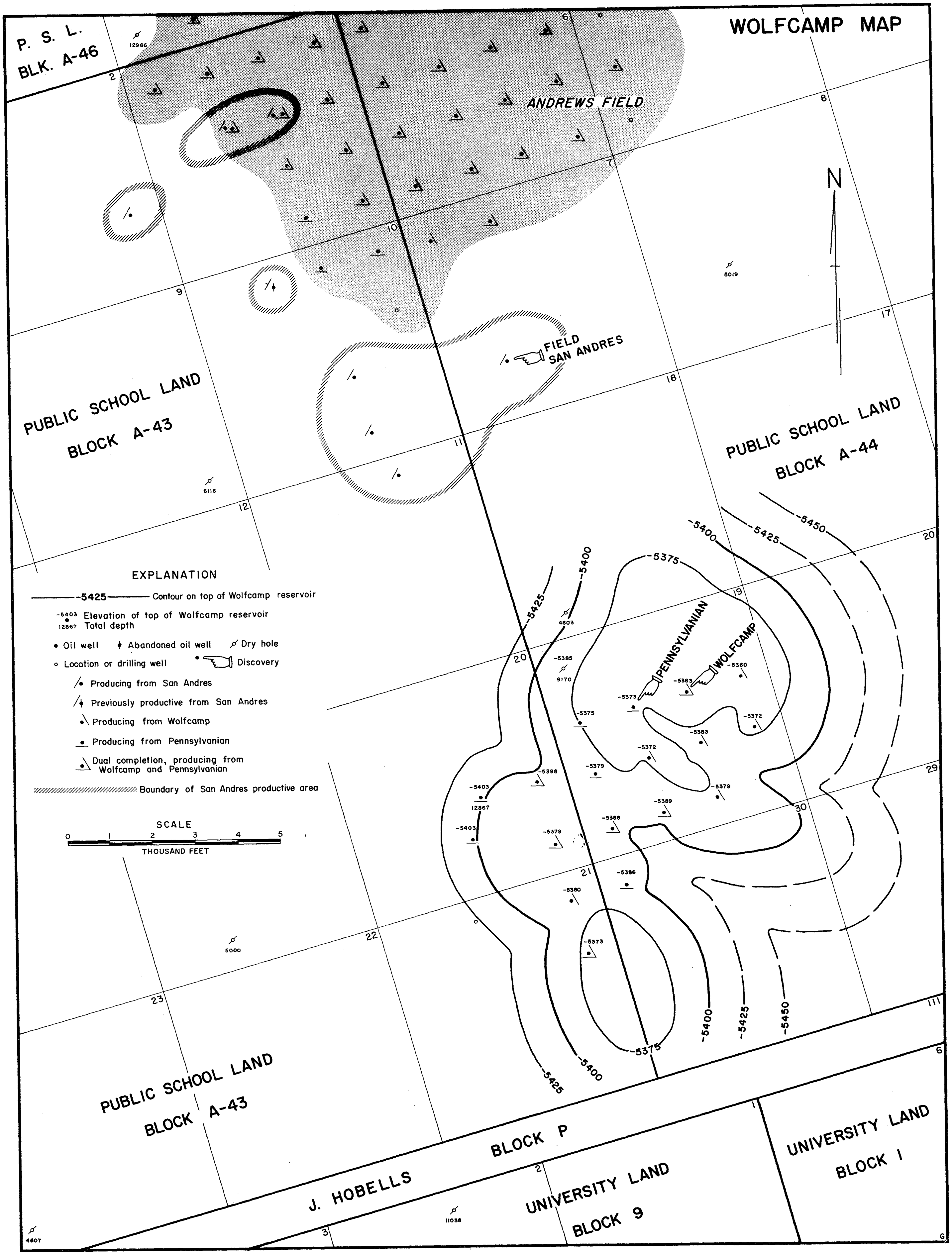


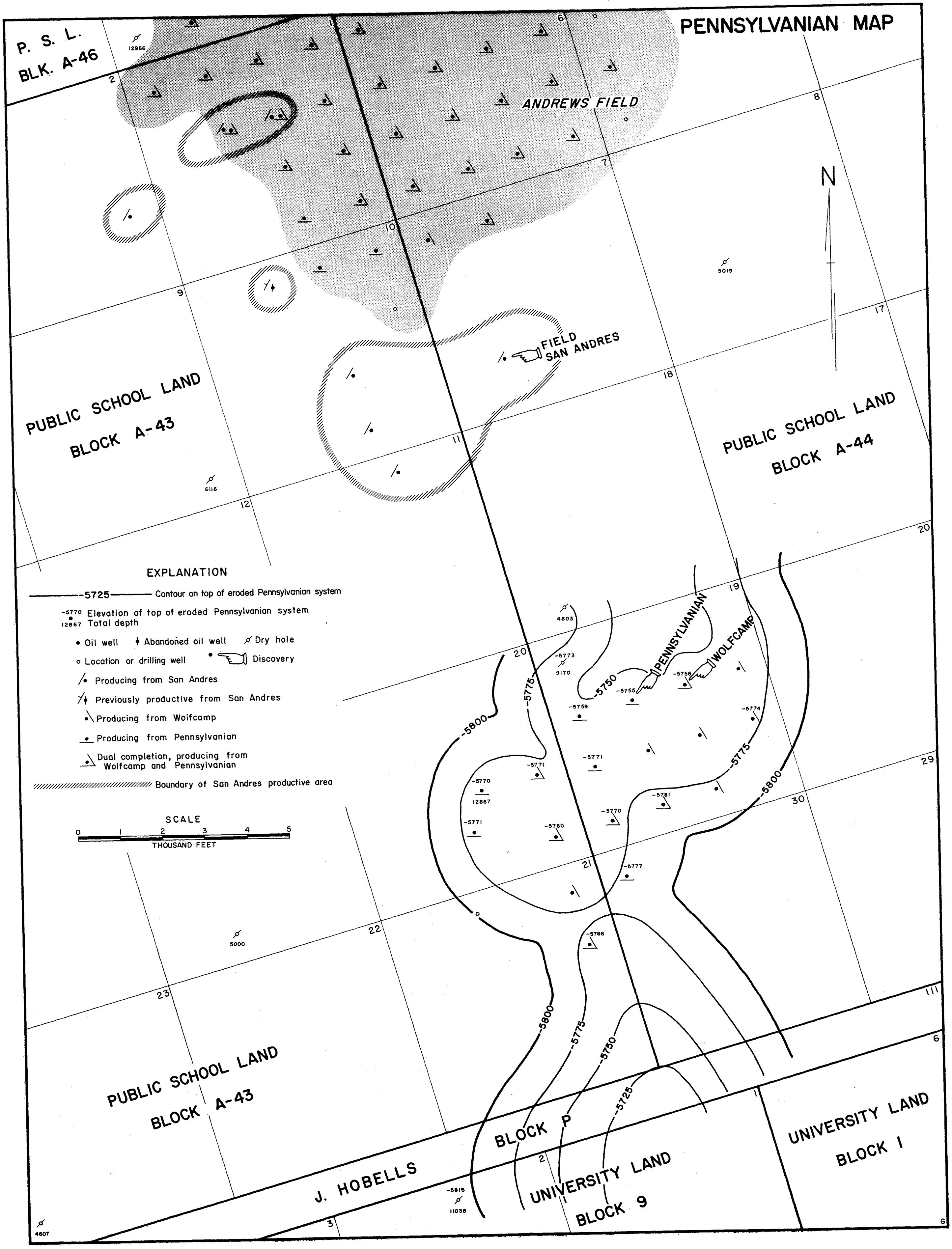
PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flow.	Artif.	Yearly	Cumulative
Field totals				
1935-1952	Same as San Andres			236,198
1953	2	6	41,265	277,463
1954	7	12	263,052	540,515
1955	12*	19*	457,306	997,821
San Andres:				
1935	0	2	11,647	11,647
1936	0	2	13,955	25,602
1937	0	2	12,473	38,075
1938	0	2	11,243	49,318
1939	0	2	9,656	58,974
1940	0	2	10,882	69,856
1941	0	2	10,541	80,397
1942	0	2	9,799	90,196
1943	0	2	9,738	99,934
1944	0	2	9,984	109,918
1945	0	2	9,301	119,219
1946	0	2	8,985	128,204
1947	0	2	9,680	137,884
1948	0	4	12,769	150,653
1949	0	5	27,074	177,727
1950	0	5	20,698	198,425
1951	0	5	20,122	218,547
1952	0	5	17,651	236,198
1953	0	6	21,275	257,473
1954	0	7	26,889	284,362
1955	0	7	27,487	311,849
Wolfcamp:				
1953	2	0	19,990	19,990
1954	2	4	161,276	181,266
1955	2	10	190,271	371,537
Pennsylvanian:				
1954	5	1	74,887	74,887
1955	10	2	239,548	314,435

* There are 25 producing wells, 7 of which produce from San Andres only, 6 from Wolfcamp only, 6 from Pennsylvanian only and 6 from both Wolfcamp and Pennsylvanian.


SAN ANDRES MAP
P. S. L.
BLK. A-46
ANDREWS FIELD
SAN ANDRES FIELD
PUBLIC SCHOOL LAND
BLOCK A-43
PUBLIC SCHOOL LAND
BLOCK A-44
PENNSYLVANIAN
WOLFCAMP
PUBLIC SCHOOL LAND
BLOCK A-43
BLOCK P
J. HOBELLS
UNIVERSITY LAND
BLOCK 9
N
EXPLANATION
-1425 Contour on top of San Andres formation
-1418 Elevation of top of San Andres formation
12867 Total depth
Oil well
Dry hole
Abandoned oil well
Location or drilling well
Discovery
Producing from San Andres
Previously productive from San Andres
Producing from Wolfcamp
Producing from Pennsylvanian
Dual completion, producing from Wolfcamp and Pennsylvanian
Boundary of San Andres productive area
SCALE
0 1 2 3 4 5
THOUSAND FEET


WOLFCAMP MAP
P. S. L.
BLK. A-46
ANDREWS FIELD
SAN ANDRES FIELD
PUBLIC SCHOOL LAND
BLOCK A-43
PUBLIC SCHOOL LAND
BLOCK A-44
PENNSYLVANIAN
WOLFCAMP
N
EXPLANATION
-5425 Contour on top of Wolfcamp reservoir
-5403 Elevation of top of Wolfcamp reservoir
12867 Total depth
Oil well
Abandoned oil well
Dry hole
Location or drilling well
Discovery
Producing from San Andres
Previously productive from San Andres
Producing from Wolfcamp
Producing from Pennsylvanian
Dual completion, producing from Wolfcamp and Pennsylvanian
Boundary of San Andres productive area
SCALE
THOUSAND FEET
PUBLIC SCHOOL LAND
BLOCK A-43
BLOCK P
J. HOBELLS
UNIVERSITY LAND
BLOCK 9
UNIVERSITY LAND
BLOCK I



PENNSYLVANIAN MAP
P. S. L. BLK. A-46
ANDREWS FIELD
N
FIELD SAN ANDRES
PUBLIC SCHOOL LAND BLOCK A-43
PUBLIC SCHOOL LAND BLOCK A-44
EXPLANATION
-5725 Contour on top of eroded Pennsylvanian system
-5770 Elevation of top of eroded Pennsylvanian system
12867 Total depth
Oil well
Abandoned oil well
Dry hole
Location or drilling well
Discovery
Producing from San Andres
Previously productive from San Andres
Producing from Wolfcamp
Producing from Pennsylvanian
Dual completion, producing from Wolfcamp and Pennsylvanian
Boundary of San Andres productive area
SCALE
0 1 2 3 4 5
THOUSAND FEET
PENNSYLVANIAN
WOLFCAMP
PUBLIC SCHOOL LAND BLOCK A-43
BLOCK P
J. HOBELLS
UNIVERSITY LAND BLOCK 9
UNIVERSITY LAND BLOCK I

PARKS FIELD

Midland County, Texas

JAMES RUSSELL COTTON
Geologist, Houston Oil Co. of Texas, Midland, Texas
January 1, 1954

LOCATION

The Parks field is in west central Midland County, about 10 miles southwest of the town of Midland.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Subsurface and seismic.

DISCOVERIES

Strawn: September 23, 1951;
Magnolia Petroleum Co. #1 A.B.Harrington
Bend: December 6, 1950;
Magnolia Petroleum Co. #1 H.F.Timmerman
Ellenburger and Field: June 30, 1950;
Magnolia Petroleum Co. #2 Roy Parks

ELEVATION OF SURFACE

Average, 2,835 feet.

SURFACE FORMATION

Trinity sandstone, overlain by a thin veneer of Pleistocene-Recent wind-blown sand.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 367 feet below the top of the Ellenburger group. This penetration was in Magnolia Petroleum Co. #1 H.S.Collins, which was drilled to the total depth of 13,302 feet at the location indicated on the accompanying map. The only other wells which have been drilled to the Ellenburger are the Ellenburger discovery well and the Bend discovery well.

CONTINUITY OF RESERVOIR ROCKS

Strawn, Bend and Ellenburger: The continuity of each of the reservoir rocks is interrupted by a normal fault which parallels the axis of the anticline. Except for this interruption, each of the reservoir rocks appears to be continuous throughout the area of the field and far beyond.

NATURE OF TRAPS

Strawn: The wells producing from this reservoir are at various positions on a faulted anticlinal fold. The primary trap-forming factor is probably the anticlinal fold; however, updip decrease of porosity appears to have been an important factor in occasioning accumulation.

Bend: The trap is at the apex of a faulted anticline, as indicated on the accompanying map. It appears likely that the trap is formed, in part, by termination of the reservoir rock against the fault.

Ellenburger: The three wells which have tested the Ellenburger are near the apex of an anticlinal fold. It appears that the trap which occasioned the accumulation of oil is due to anticlinal folding.

LITHOLOGY OF RESERVOIR ROCKS

Strawn: Limestone; tan to gray to brown, finely crystalline to densely crystalline, fossiliferous, slightly cherty in part and shaly near base.

Bend: Limestone, dark gray to gray-brown, finely crystalline to densely crystalline, slightly cherty and fossiliferous, with intermittent thin gray shale beds.

Ellenburger: Dolomite; tan to gray-white, finely crystalline to medium crystalline.

CHARACTER OF OIL

	Strawn	Bend	Ellenburger
Gravity, A.P.I. @ 60° F.	43°	44°	54°

WATER PRODUCTION

Strawn: Negligible
Bend: Negligible
Ellenburger: Large percentage of gross production

ACID TREATMENT

Strawn: The quantity of acid used in each well ranged from 250 gallons to 30,500 gallons.

Bend: Some wells were completed "natural". The quantity of acid used in the treated wells ranged up to 70,250 gallons.

Ellenburger: No one of the three wells completed in Ellenburger was treated with acid.

PRODUCTIVE AREAS

	Acres
Strawn	400
Bend	2,880
Ellenburger (depleted)	20
Parks field	3,280

THICKNESSES OF RESERVOIR ROCKS

	Feet		
	Min.	Max.	Avg.
Strawn	10	60	30
Bend	20	79	46
Ellenburger	28	28	28

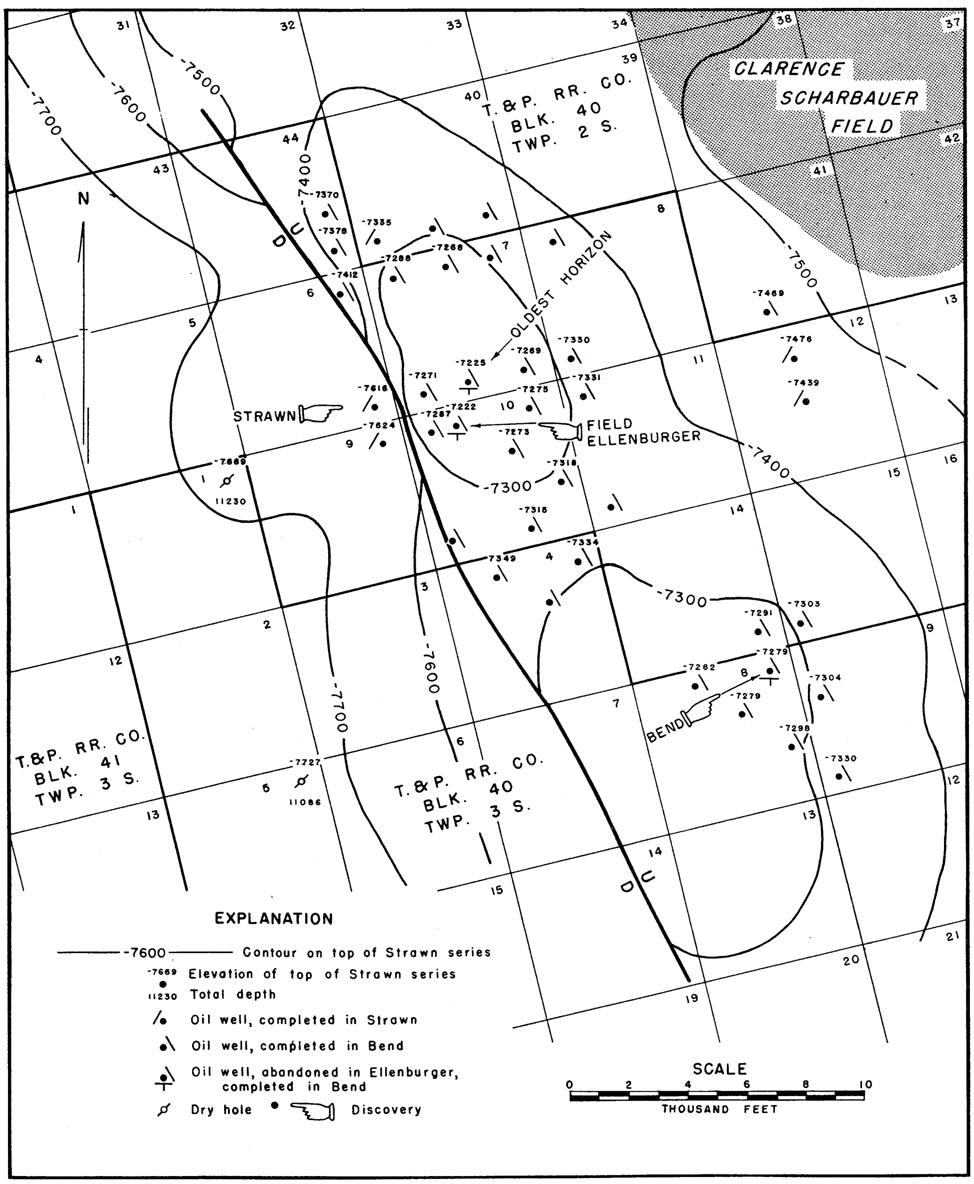
ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Strawn	Bend	Ellenburger
No free gas in any reservoir			
Elevation of top of oil, feet	-7,401	-7,555	-10,107
Elevation of bottom of oil, ft.	-7,742	-7,877	-10,135
Relief, feet	341	322	28

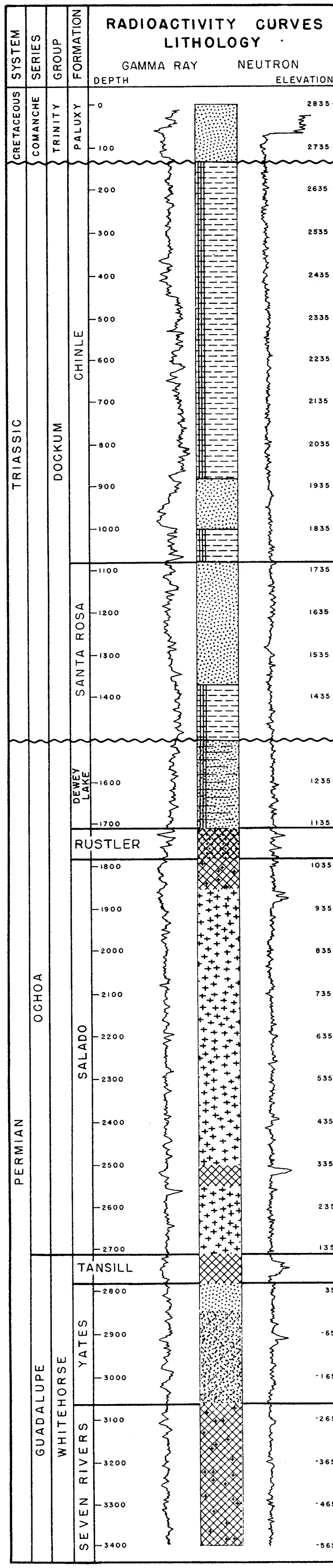
PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year — All flowing	OIL PRODUCTION (barrels) — Yearly	OIL PRODUCTION (barrels) — Cumulative
Field totals			
1950	2	62,840	62,840
1951	14	470,072	532,912
1952	29	789,002	1,321,914
1953	41	712,554	2,034,468
Strawn			
1951	3	49,616	49,616
1952	4	89,543	139,159
1953	5	74,278	213,437
Bend			
1950	1	5,516	5,516
1951	11	420,456	425,972
1952	25	699,459	1,125,431
1953	36	638,276	1,763,707
Ellenburger			
1950	1	57,324	57,324
1951	0	0	57,324

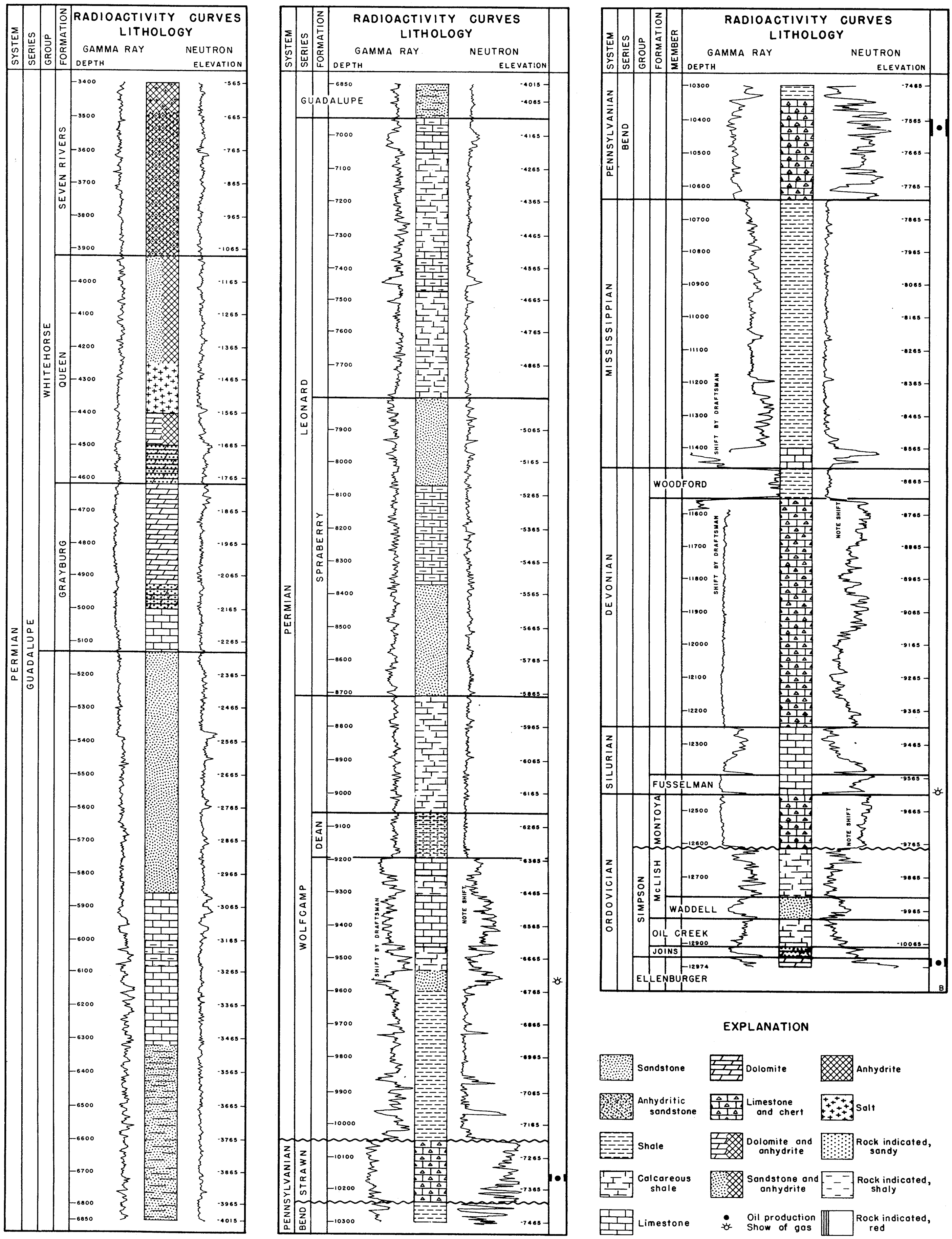
Only one well, the discovery well, has been completed for production from Ellenburger. It was abandoned in Ellenburger and plugged back to Bend in January 1951.



TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED



PECOS VALLEY FIELD

Pecos and Ward Counties, Texas

ROSS H. LEY
District Geologist, Sun Oil Company, Midland, Texas
February 11, 1956

LOCATION and FIELD NAMES

The Pecos Valley field occupies an area extending across the Pecos River mainly in northwestern Pecos County and partly in southeastern Ward County. The irregularly shaped area extends 11 miles in a north-south direction with the northern tip 7 miles southeast of the town of Grandfalls in Ward County. This field is on the Central Basin platform near its southwest edge.

The production from the Yates formation in this field has been treated in publications generally as from three distinct fields under the names of Orient field, Pecos Valley High Gravity field and Pecos Valley Low Gravity field. The area commonly designated as the Orient field is at the northwest tip of the Yates productive area. The Pecos Valley Low Gravity field includes two distinct areas, one in the central portion and the other at the south end of the Yates productive area. These three distinct areas are indicated on an accompanying map. The area of the Pecos Valley High Gravity field is the remainder of the Yates productive area as that area is indicated by the distribution of well symbols indicating production from the Yates formation. However, until the beginning of 1939, Pecos Valley High Gravity field and Pecos Valley Low Gravity field were treated as one field, the Pecos Valley field, and that field included also such well or wells as were in Sec. 46, Blk. 10, H. & G. N. R. R. Co. survey. At the beginning of 1939, all wells producing oil heavier than 32° gravity were classified as in the Pecos Valley Low Gravity field and all wells producing oil lighter than 32° gravity were classified as in the Pecos Valley High Gravity field.

Since the time of their first production in 1929, the Railroad Commission has treated as in either the Pecos Valley field or the Pecos Valley Low Gravity field, whichever name was currently effective, such producing wells (never more than three) as were in Sec. 46, Blk. 10, H. & G. N. R. R. Co. survey. In this paper, those wells are not considered as within the area of the Pecos Valley field; they are considered as in the Lehn-Apco field.

A group of 5 wells in Sec. 36, Blk. 3 and Sec. 21, Blk. 10, about the center of the Pecos Valley field, has been treated generally in petroleum publications and by the Railroad Commission as constituting the Jamison & Pollard field. The first of these wells was completed July 24, 1940; all had been abandoned before the end of 1953. They produced from a zone in the Whitehorse Dolomite.

At the time of its completion, the well listed under DISCOVERIES as the first Fusselman discovery well, was considered as the discovery well of a new field. The field was named North Heiner field and the well was operated under that name until its abandonment in 1952. It was the only well in the field. In this paper, that well is treated as in the Pecos Valley field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Random drilling where the operator owned fee title to a large area of land.

DISCOVERIES

Yates and Field: November 20, 1928; Pecos Valley Oil Company #1 Fee. Flowed "natural" from depth of 1,628 feet at daily rate of 105 barrels of 37° gravity oil.

Yates: Orient: April 2, 1948; R. R. Herrell #1 W. C. Jackson et al (now, C. N. Smith #1 Jackson-State). After shot, flowed through ½-inch choke at daily rate of 66 barrels of 37.5° gravity oil; gas-oil ratio, 680 : 1; T. D., 1,826 feet.

Whitehorse Dolomite: July 24, 1940; Ward-Pecos Petroleum Corp. #DE-6 Pecos Valley Oil Co. Flowed at daily rate of 193 barrels of oil and 1,900 barrels of water. Depth to top of reservoir, 2,037 ft.; T. D., 2,049 ft. At time of completion, this well was classified as in the Pecos Valley Low Gravity field; at the beginning of 1941 it was reclassified and treated as the first well in the Jamison & Pollard field. Ownership was transferred from Ward-Pecos Petroleum Corp. to Jamison & Pollard effective January 1, 1941; then to Pollard & Davis effective November 1, 1948.

Wolfcamp: July 10, 1951; Callery & Hurt, Inc. #D-1 Redmond "J". After acid treatment, flowed through 14/64-inch choke at daily rate of 500 Mcf of gas and 3 barrels of condensate; T. D., 8,414 feet.

Devonian: May 28, 1953; H. L. Hunt #1 H. J. Eaton. After treatment with 3,500 gallons of acid, flowed through 15/64-inch choke at daily rate of 3,527 Mcf of gas and 65.17 barrels of 61.6° gravity condensate; gas-oil ratio, 54,120 : 1; depth of reservoir, 5,368 - 5,404 feet.

Fusselman: August 19, 1948; Humble Oil & Refining Co. #1 A. D. Unsicker. Flowed through 2-inch tubing at daily rate of 67 barrels of 39.4° gravity oil and 14 barrels of water; gas-oil ratio, 210 : 1; drilled to total depth of 8,460 feet in Ellenburger and completed for production through perforations from 5,630 - 5,660 feet. This well was recognized as the discovery well of the North Heiner field and was the only well ever treated as in that field. It was abandoned in 1951.

Fusselman: May 17, 1953; Sinclair Oil & Gas Co. #1 Realty Trust. Flowed "natural" through ½-inch choke at daily rate of 452 barrels of 42.1° gravity oil; gas-oil ratio, 342 : 1. This well was drilled to total depth of 8,100 feet in 1950 and completed in Ellenburger; later plugged back to 5,760 feet; depth of Fusselman reservoir, 5,682 - 5,732 feet.

Montoya: February 14, 1951; Callery & Hurt, Inc. #A-1 H. J. Eaton. After mud-acid treatment, flowed through open 2-inch tubing at daily rate of 22,000 Mcf of gas and 153.6 barrels of 75.2° gravity condensate; gas-oil ratio, 42,300 : 1; T. D., 8,061 feet; depth of reservoir, 5,328 - 5,470 feet.

McKee: March 24, 1951; G. H. Vaughn #1 Iowa Realty Trust. Flowed "natural" through 3/8-inch choke at daily rate of 3,300 Mcf of gas. In Ellenburger at T. D., 8,323 feet.

Ellenburger: October 2, 1949; Fullerton Oil Co. #D-1 Kone Production Co. Flowed "natural" through 3/4-inch choke at daily rate of 505 barrels of 43.6° gravity oil; gas-oil ratio, 629 : 1; top of reservoir at 7,971 feet; T. D., 8,210 feet; plugged back to 8,157 feet.

YATES RESERVOIRS

Generally in prior publications, the Yates production of this field is treated as coming from three fields (Orient, Pecos Valley High Gravity and Pecos Valley Low Gravity), but there has been no subdivision on the basis of reservoirs. It is recognized that the Yates formation contains several distinct reservoirs within the area here treated as the area of the Pecos Valley field. However, it is not practical to delineate the several reservoirs and to present data for each separately. Therefore, the Yates reservoirs are treated as a group rather than to endeavor to present data for each reservoir separately.

Within the Yates productive area there are multitudes of variations in porosity and permeability, with the result that there are many small erratic accumulations of oil and gas. There are many independent reservoirs with their own independent gas-oil and oil-water contacts. Many of these reservoirs appear to contain no water below the accumulation of oil and/ or gas. In some parts of the field, particularly in the southern and southwestern portions, the degree of porosity is so low that only gas will flow from the reservoirs.

The degree of porosity appears to have a relationship with local structural conditions. There is a tendency for the Yates sandstone to be shaly and have low porosity in locally low areas. This probably indicates that the Yates was deposited on an irregular surface closely similar in form to that of the top of the Yates at present and as portrayed on an accompanying map.

As indicated on the accompanying TYPICAL SECTION, there are two general productive zones in the Yates formation. In general, the higher gravity oil is produced from the upper zone and the lower gravity oil is produced from the lower zone. At the stratigraphic position of the upper zone, which is sandstone within the area of the field, there is less sand eastward (updip); at the east edge of the area covered by the accompanying map, the rock at this stratigraphic position is principally anhydrite. Likewise, the lower zone contains less sand eastward, where there is a greater percentage of shale and anhydrite; at the east edge of the area, the rock at this stratigraphic position is all anhydrite. The eastward decrease of porosity and permeability is such as to constitute barriers to migration of fluids. In the eastern portion of the area, many wells drilled with cable tools encounter no fluids of any kind in the Yates section. Westward and southwestward from the producing area, the lower of the above mentioned two zones grades into tight limestone; the upper zone is of the same character as in the productive area.

Within and immediately adjoining the Pecos Valley field, the Yates formation has been penetrated at about 780 locations; at 561 locations where wells were completed in the Yates formation, at locations of 191 shallow dry holes and at 28 locations where penetration was carried into pre-Permian rocks. Of the 561 wells completed in the Yates formation, 130 have either been abandoned or converted to water injection wells.

ELEVATION OF SURFACE

Elevations at well locations: Highest, 2,547 feet, at the south end of the field; lowest, 2,401 feet, at the Pecos River.

SURFACE FORMATIONS

Rocks of the Quaternary system occupy most of the surface; rocks of the Fredericksburg and Trinity groups of the Cretaceous system and rocks of the Triassic system occupy minor areas.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 575 feet below its top. This penetration was in the Montoya discovery well at its total depth of 8,061 feet.

NATURE OF TRAPS

Yates: The predominating trap-forming factor is updip decrease of porosity and permeability in sloping reservoir rocks. However, it appears probable that there are several distinct reservoirs in the Yates formation and that some of the accumulations are due, at least in part, to other trap-forming factors, particularly, to convex folding and to updip termination due to lensing.

Whitehorse Dolomite: Convex folding.

Wolfcamp: The trap at the location of the single productive well appears to be due to anticlinal folding. For approximate structural conditions, see accompanying map showing contours on top of Yates formation.

Devonian: The trap was formed by updip termination of reservoir rock by truncation and with sealing by overlying relatively impervious rock.

Fusselman, Montoya and Ellenburger: Updip termination against a fault on an anticlinal nose.

McKee: Both updip termination due to lensing and updip decrease of porosity and permeability in a sloping reservoir rock.

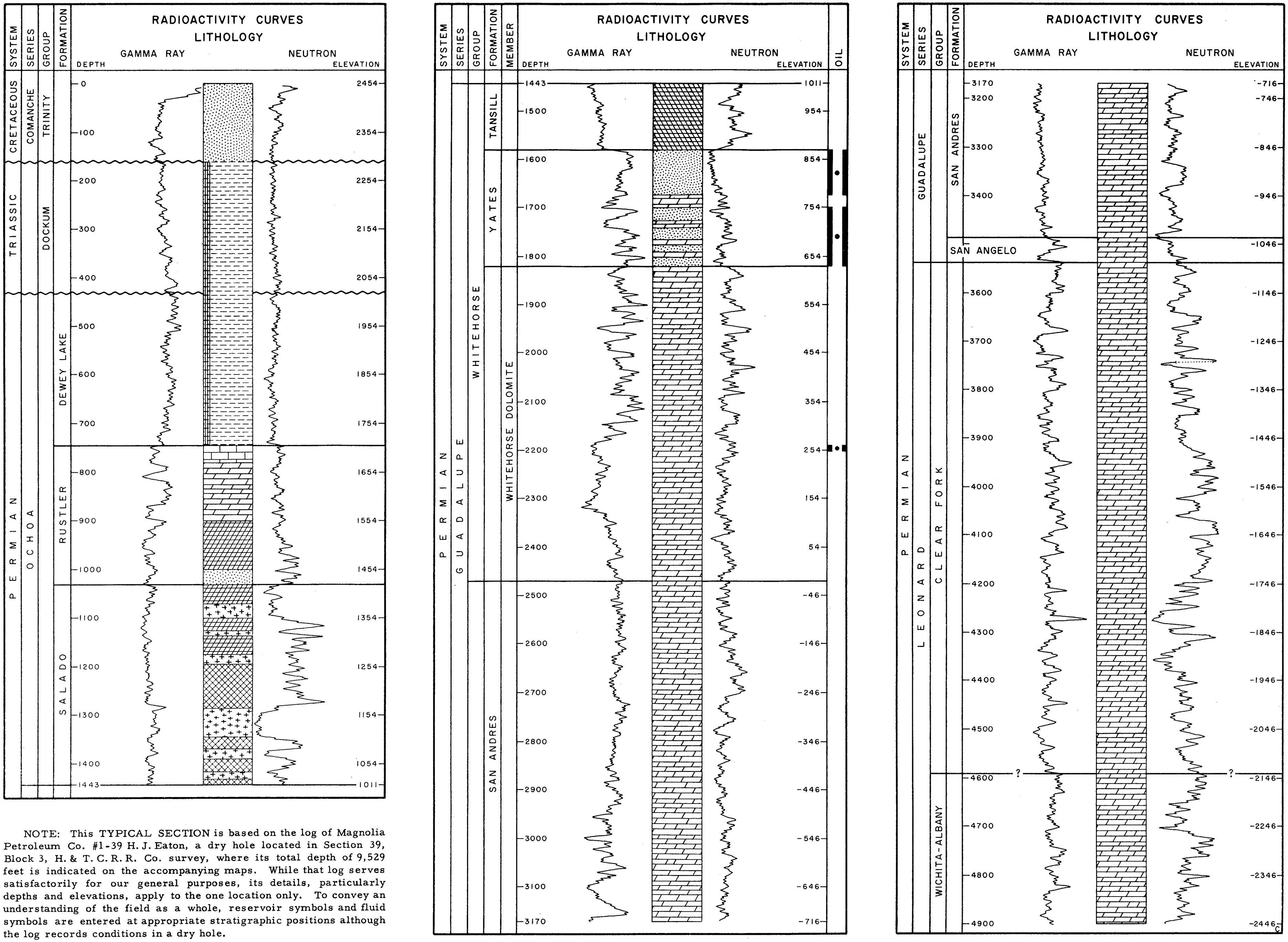
PRODUCTIVE AREAS

	Acres
Yates	10,440
Wolfcamp	320
Whitehorse Dolomite	120
Devonian	1,400
Fusselman	400
Montoya	320
McKee	640
Ellenburger (depleted)	160
Pecos Valley field	12,200

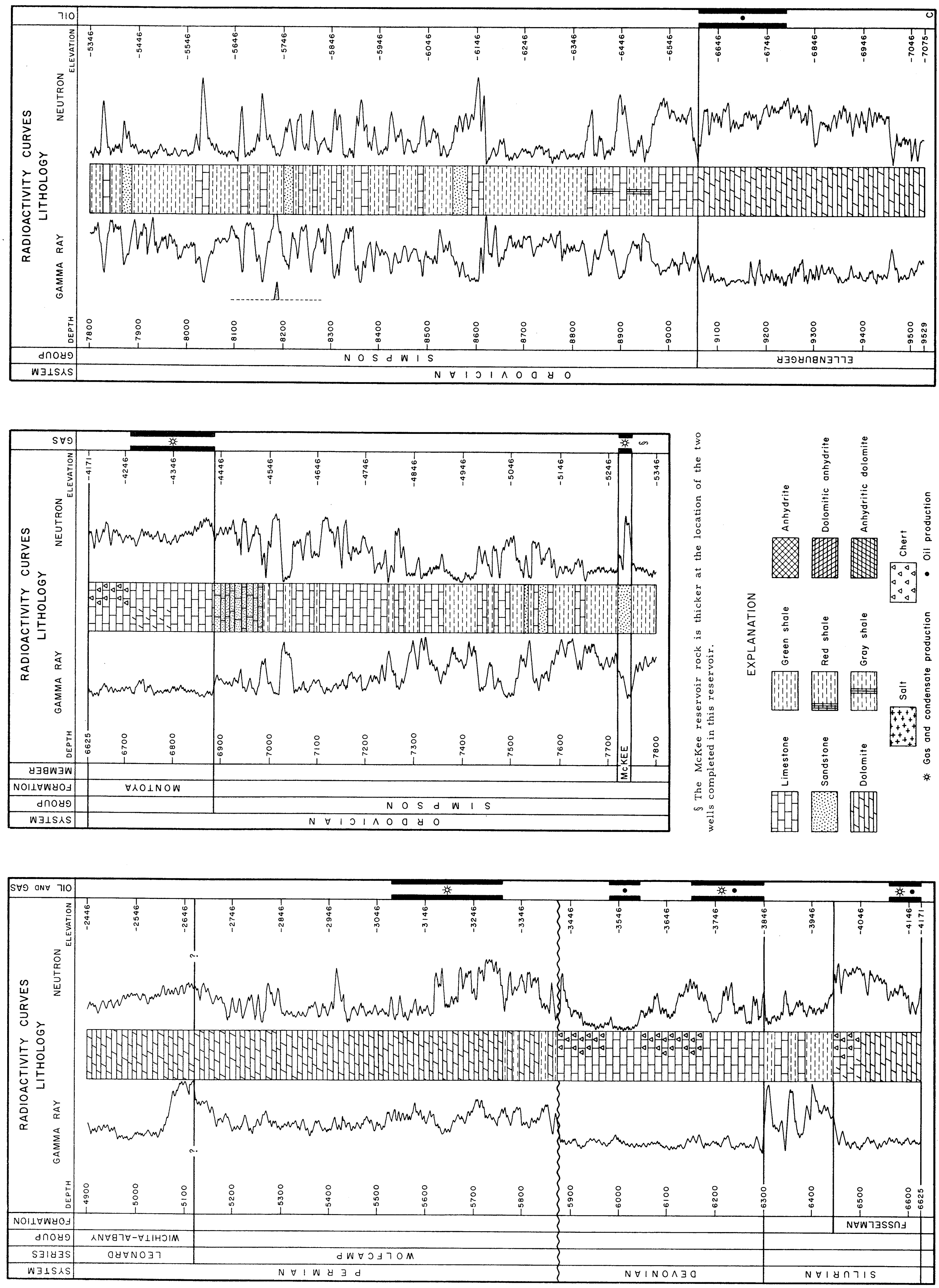
THICKNESSES OF RESERVOIR ROCKS

	Feet, average	
	Top to bottom	Net productive
Yates		
High Gravity area	100	13
Low Gravity areas	120	16
Orient area	62	13
Whitehorse Dolomite	6	2
Wolfcamp (one well)	235	175
Devonian (seven wells)		
Where only 1 zone is productive	70	20
Where 2 zones are productive	185	60
Fusselman (four wells completed; one abandoned)	75	32
Montoya (one well)	175	90
McKee (two wells)	55	37
Ellenburger (4 wells completed; all abandoned)	180	96

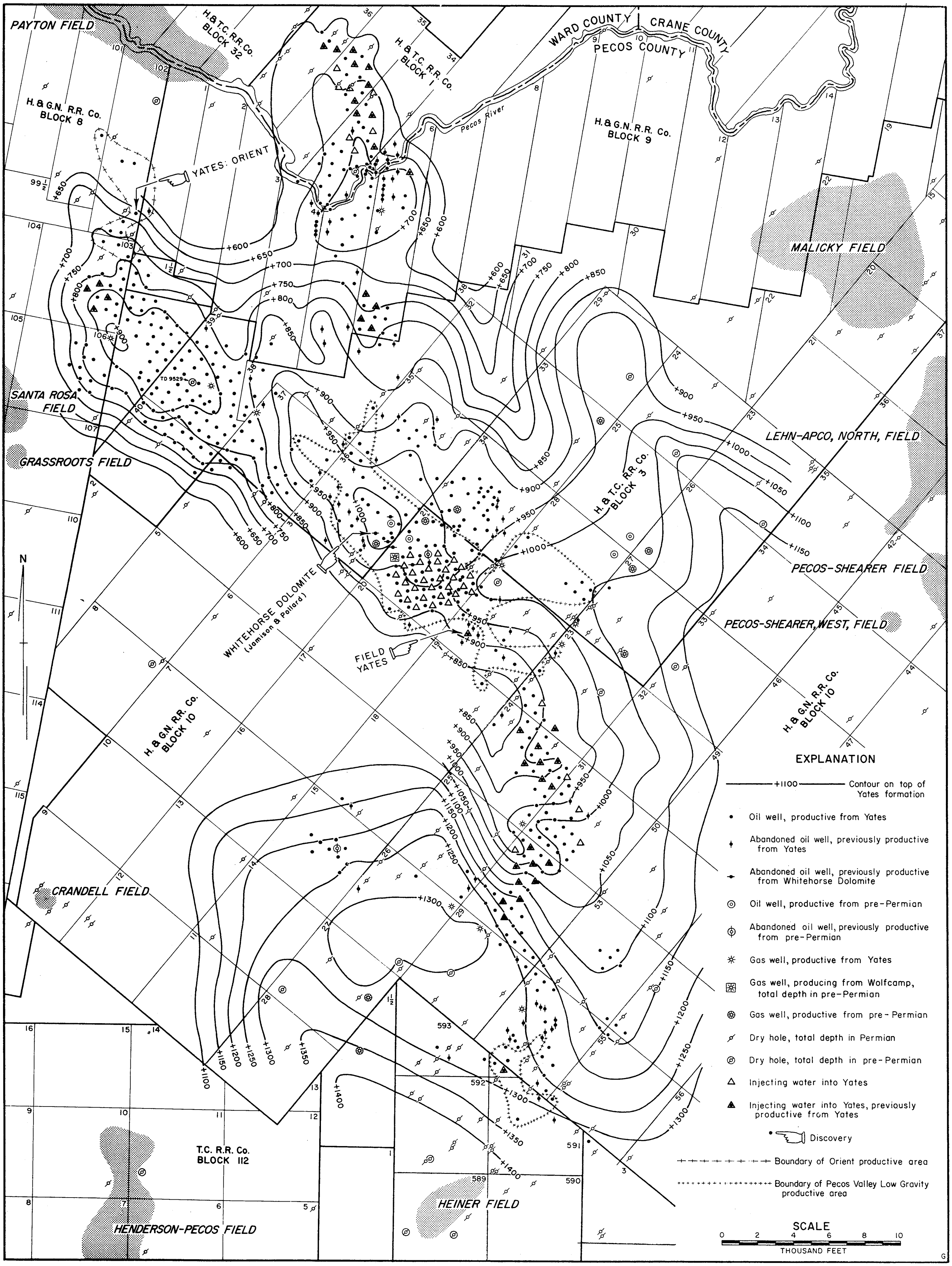
TYPICAL SECTION OF ROCKS PENETRATED

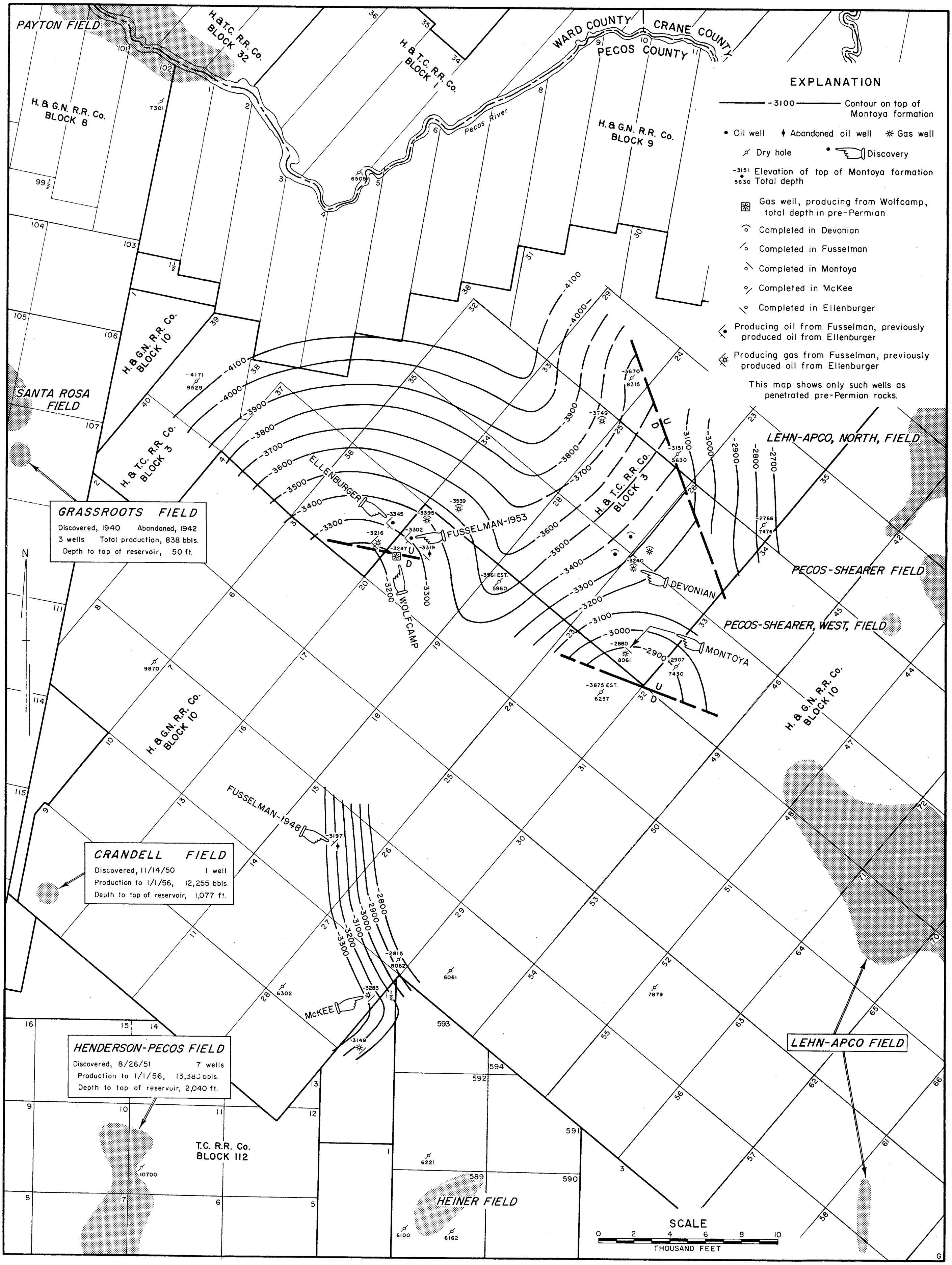


NOTE: This TYPICAL SECTION is based on the log of Magnolia Petroleum Co. #1-39 H. J. Eaton, a dry hole located in Section 39, Block 3, H. & T. C. R. R. Co. survey, where its total depth of 9,529 feet is indicated on the accompanying maps. While that log serves satisfactorily for our general purposes, its details, particularly depths and elevations, apply to the one location only. To convey an understanding of the field as a whole, reservoir symbols and fluid symbols are entered at appropriate stratigraphic positions although the log records conditions in a dry hole.



TYPICAL SECTION OF ROCKS PENETRATED


PAYTON FIELD
H.&T.C. R.R. Co. BLOCK 32
H.&T.C. R.R. Co. BLOCK 1
WARD COUNTY
CRANE COUNTY
PECOS COUNTY
H.&G.N. R.R. Co. BLOCK 8
YATES: ORIENT
Pecos River
H.&G.N. R.R. Co. BLOCK 9
MALICKY FIELD
SANTA ROSA FIELD
TD 9529
GRASSROOTS FIELD
LEHN-APCO, NORTH, FIELD
H.&T.C. R.R. Co. BLOCK 3
PECOS-SHEARER FIELD
PECOS-SHEARER, WEST, FIELD
WHITEHORSE DOLOMITE (Jamison & Pollard)
FIELD YATES
H.&G.N. R.R. Co. BLOCK 10
H.&G.N. R.R. Co. BLOCK 10
N
CRANDELL FIELD
T.C. R.R. Co. BLOCK 112
HEINER FIELD
HENDERSON-PECOS FIELD
EXPLANATION
+1100 Contour on top of Yates formation
Oil well, productive from Yates
Abandoned oil well, previously productive from Yates
Abandoned oil well, previously productive from Whitehorse Dolomite
Oil well, productive from pre-Permian
Abandoned oil well, previously productive from pre-Permian
Gas well, productive from Yates
Gas well, producing from Wolfcamp, total depth in pre-Permian
Gas well, productive from pre-Permian
Dry hole, total depth in Permian
Dry hole, total depth in pre-Permian
Injecting water into Yates
Injecting water into Yates, previously productive from Yates
Discovery
Boundary of Orient productive area
Boundary of Pecos Valley Low Gravity productive area
SCALE
0 2 4 6 8 10
THOUSAND FEET


PAYTON FIELD
H. & T.C. R.R. Co. BLOCK 32
H. & T.C. R.R. Co. BLOCK 1
WARD COUNTY
CRANE COUNTY
PECOS COUNTY
H. & G.N. R.R. Co. BLOCK 8
H. & G.N. R.R. Co. BLOCK 9
Pecos River
EXPLANATION
3100 Contour on top of Montoya formation
Oil well
Abandoned oil well
Gas well
Dry hole
Discovery
-3151 5630 Elevation of top of Montoya formation Total depth
Gas well, producing from Wolfcamp, total depth in pre-Permian
Completed in Devonian
Completed in Fusselman
Completed in Montoya
Completed in McKee
Completed in Ellenburger
Producing oil from Fusselman, previously produced oil from Ellenburger
Producing gas from Fusselman, previously produced oil from Ellenburger
This map shows only such wells as penetrated pre-Permian rocks.
H. & G.N. R.R. Co. BLOCK 10
SANTA ROSA FIELD
H. & T.C. R.R. Co. BLOCK 3
LEHN-APCO, NORTH, FIELD
ELLENBURGER
FUSSELMAN-1953
WOLFCAMP
DEVONIAN
PECOS-SHEARER FIELD
PECOS-SHEARER, WEST, FIELD
MONTOYA
GRASSROOTS FIELD
Discovered, 1940 Abandoned, 1942
3 wells Total production, 838 bbls.
Depth to top of reservoir, 50 ft.
N
H. & G.N. R.R. Co. BLOCK 10
FUSSELMAN-1948
CRANDELL FIELD
Discovered, 11/14/50 1 well
Production to 1/1/56, 12,255 bbls.
Depth to top of reservoir, 1,077 ft.
McKEE
HENDERSON-PECOS FIELD
Discovered, 8/26/51 7 wells
Production to 1/1/56, 13,383 bbls.
Depth to top of reservoir, 2,040 ft.
T.C. R.R. Co. BLOCK 112
LEHN-APCO FIELD
HEINER FIELD
SCALE
0 2 4 6 8 10
THOUSAND FEET

LITHOLOGY OF RESERVOIR ROCKS

Yates: Sandstone; gray to brown, fine- to medium-grained with thin interbedded shale streaks and numerous rounded frosted quartz grains. See the entry under the heading YATES RESERVOIRS.

Whitehorse Dolomite: Dolomite; brown to tan.

Wolfcamp: Dolomite; brown, gray, tan, finely porous.

Devonian: Limestone; white to brownish-white, finely crystalline with abundant milky-white or smoky chert.

Fusselman: Dolomite; tannish-gray to brown, finely crystalline to medium crystalline with tannish-white, fine to very fine, cherty limestone.

Montoya: Dolomite and limestone; tan with milky tannish-white smoky chert.

McKee: Sandstone; grayish-white to gray, fine to coarse. The composition, particularly the clay content, varies widely in short distances.

Ellenburger: Dolomite; brown to tan, finely crystalline to medium crystalline, with scattered embedded sand grains.

CONTINUITY OF RESERVOIR ROCKS

Yates: The Yates formation is continuous throughout the area of the accompanying map; the individual reservoirs are of only local extent. As reported under the heading YATES RESERVOIRS, there are many reservoirs in the Yates formation.

Whitehorse Dolomite: Available data do not provide a basis for correlating the reservoir rock beyond the immediate vicinity of the wells where it was productive. It is probably continuous throughout a large area, but only locally sufficiently porous to yield oil.

Wolfcamp: The reservoir rock is continuous throughout the area of the accompanying map.

Devonian, Fusselman and Montoya: Each of these reservoir rocks has been truncated by pre-Permian erosion. Furthermore, faulting has interrupted their continuity. The details of the continuity of these reservoir rocks are not yet determinable because, within and immediately adjoining the area of the Pecos Valley field, there have been only 28 penetrations into pre-Permian rocks.

McKee and Ellenburger: Each of these reservoir rocks appears to be continuous throughout the area of the accompanying map except for interruptions by faulting.

COMPLETION TREATMENT

Yates: In practically all wells, at time of completion, the Yates reservoirs have been treated either by shooting with nitroglycerin or, in recent years, by hydraulic fracturing. Hydraulic fracturing has been used in practically all of the recent completions.

Pre-Permian reservoirs: The pre-Permian reservoirs are commonly treated with acid at time of well completion.

SECONDARY RECOVERY

There are now 10 water-flood projects operating in the Pecos Valley field, all flushing Yates reservoirs. Three additional similar projects will be started in the immediate future. Results of water-flooding are reflected in the following PRODUCTION HISTORY by the increase in 1953 in Yates Low Gravity and by the increase in 1955 in Yates High Gravity.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Proven elevation, feet				Relief, feet
	GAS		OIL		
	Highest	Lowest	Highest	Lowest	
Yates	1,274	506	1,209	469	(*)
Whitehorse Dol.	No free gas		464	399	65
Wolfcamp	-2,685	-2,945	No known oil (**)		260
Devonian	-2,915	-3,121	-3,001	-3,129	214
Fusselman	-3,045	-3,224	-3,206	-3,332	287
Montoya	-2,880	-3,032	No known oil (**)		152
McKee	-4,123	-4,307	No known oil (**)		184
Ellenburger	No free gas		-5,521	-5,742	221

The above figures represent conditions as of respective discovery dates.

(*) The fluid columns of individual reservoirs in the Yates formation have not been determined. See entry under YATES RESERVOIRS.

(**) The liquid hydrocarbons (condensate) produced from Wolfcamp, Montoya and McKee are probably all in the form of gas in the reservoirs.

CHARACTER OF LIQUIDS

	OIL		CONDENSATE
	Gravity, A. P. I. @ 60°F.	Sulphur indication	Gravity, A. P. I. @ 60°F.
Yates			
High gravity	32-40	Sweet	
Low gravity	24-32	Sweet	
Orient	27-37	Sweet	
Whitehorse Dol.	24	1.14%	
Wolfcamp			50
Devonian	34-38	Sweet	62
Fusselman	42-53	Sweet	72
Montoya			68
McKee			64
Ellenburger	44	Sweet	

For analyses see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 33, 63 and 64.

		Lab. ref. No.	31162	38155
U. S. Bureau of Mines				
Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939)	Group 2	Item	73	72
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944)		Page	27	28

WATER PRODUCTION

The quantity of water has never been sufficient to constitute a serious handicap to producing operations.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)	
	OIL		GAS		
	Flow	Pump		Yearly	Cumulative
Yates, High Gravity					
1928-1938 *					666,xxx
1939	48	40	?	306,936	973,xxx
1940	46	56	?	277,091	1,250,xxx
1941	43	58	?	240,328	1,490,xxx
1942	42	58	?	190,432	1,680,xxx
1943	42	59	?	146,318	1,827,xxx
1944	35	64	?	129,003	1,956,xxx
1945	44	66	?	137,805	2,094,xxx
1946	50	63	?	180,929	2,275,xxx
1947	62	59	?	206,962	2,481,xxx
1948	73	71	?	307,923	2,789,xxx
1949	152	72	?	521,938	3,311,xxx
1950	92	150	?	581,066	3,892,xxx
1951	69	199	?	501,650	4,394,xxx
1952	65	201	?	489,652	4,884,xxx
1953	82	217	?	532,121	5,416,xxx
1954	79	222	?	509,249	5,925,xxx
1955	?	?	?	790,890	6,716,xxx
Yates, Low Gravity					
1928-1938 *					408,xxx
1939	52	18	?	171,521	580,xxx
1940	36	42	?	199,411	779,xxx
1941	27	50	?	184,374	963,xxx
1942	26	47	?	110,442	1,074,xxx
1943	26	45	?	93,963	1,168,xxx
1944	12	54	?	82,122	1,250,xxx
1945	12	48	?	72,208	1,322,xxx
1946	9	55	?	75,135	1,397,xxx
1947	9	54	?	69,961	1,467,xxx
1948	8	55	?	67,593	1,535,xxx
1949	5	54	?	62,945	1,598,xxx
1950	8	48	?	58,479	1,656,xxx
1951	9	51	?	60,789	1,717,xxx
1952	8	49	?	73,557	1,791,xxx
1953	9	53	?	110,873	1,901,xxx
1954	8	63	?	213,440	2,115,xxx
1955	?	?	?	343,626	2,458,xxx
Yates, Orient					
1948	3	6	0	15,438	15,438
1949	0	5	0	29,441	44,879
1950	0	5	0	7,000	51,879
1951	1	5	0	9,725	61,604
1952	3	6	0	22,596	84,200
1953	2	8	0	24,573	108,773
1954	2	8	0	14,178	122,951
1955	2	8	0	13,425	136,376

GAS PRODUCTION

A few wells (on the order of 10) in different parts of the field have been completed for production of gas from Yates reservoirs. Capacities range from a few hundred Mcf to 18,000 Mcf of gas per day. During the early development history of the field, on the structural high centering on the Pecos River, numerous wells encountered strong flows of gas at the top of the Yates formation but were deepened and completed as oil wells.

In the early 1930's, a 4-inch gas pipe line was built to supply gas to the town of Fort Stockton, located 22 miles southwest of the field. This line was connected to two wells, one in the west corner of Sec. 27, Blk. 3, and the other near the north corner of Sec. 23, Blk. 10, and transported about 50 Mcf of gas per day. The line was originally operated by Pecos Crude Oil Purchasing Corporation, which later sold the line to Big Bend Pipe Line Company, which, in turn, sold the line to the city of Fort Stockton which operated the line until 1940 when it was abandoned in favor of a gas supply from the Fort Stockton field. Plans to extend the line from Fort Stockton to Alpine and Marfa were never executed.

The original Yates gas well, O. J. Perren #1 H. J. Eaton, completed in August 1929, in the west corner of Sec. 27, Blk. 3, is still producing gas. Gas from this well, now designated as Callery & Hurt, Inc. #1 Pickle-Eaton, in addition to gas from the one Montoya well, Callery & Hurt, Inc. #A-1 H. J. Eaton, was used to gas-lift oil from Ellenburger wells two miles to the northwest. It is now being used to fuel irrigation pumps.

In late 1954, El Paso Natural Gas Company began taking casing head gas from the pre-Permian gas-condensate wells.

FOOTNOTE

* Prior to 1939, Yates High Gravity and Yates Low Gravity were treated by reporting agencies as a single unit. Because of confusion in the records, the quantities produced annually are not reported herein. The writer believes that the cumulative total to the end of 1938 amounted to 1,073,687 barrels. The allocation between High Gravity and Low Gravity is not readily definitely determinable; however, sufficiently accurate for our purposes is the ratio indicated by data on pages 362-364, A. I. M. E. Petroleum Development and Technology - 1943 (covering 1942). Those data indicate that 62% of the cumulative total was from the Yates High Gravity area and 38% was from the Yates Low Gravity area. On the basis of that ratio, the writer estimates that the production prior to 1939 amounted to 665,686 barrels from Yates High Gravity and 408,001 barrels from Yates Low Gravity.

PRODUCTION HISTORY (Continued)

	OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)		CONDENSATE PRODUCTION (barrels)	
	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
Whitehorse Dolomite						
1940	4,324	4,324				
1941	22,975	27,299				
1942	27,247	54,546				
1943	21,646	76,192				
1944	13,400	89,592				
1945	15,739	105,331				
1946	42,687	148,018				
1947	9,642	157,660				
1948	6,618	164,278				
1949	25,027	189,305				
1950	4,082	193,387				
1951	1,797	195,184				
1952	790	195,974				
1953	90	196,064				
1954	0	196,064				
1955	0	196,064				
Wolfcamp						
1953	0	0	3,300	3,300	116	116
1954	0	0	10,251	13,551	207	323
1955	0	0	65,018	78,569	1,158	1,481
Devonian						
1953	7,714	7,714	0	0	0	0
1954	47,399	55,113	8,676	8,676	329	329
1955	54,918	110,031	635,544	644,220	13,732	14,061
Fusselman (*)						
1949	2,270	2,270	0	0	0	0
1950	2,185	4,455	0	0	0	0
1951	1,191	5,646	0	0	0	0
1952	0	5,646	0	0	0	0
1953	22,095	27,741	0	0	0	0
1954	19,040	46,781	0	0	0	0
1955	12,092	58,873	40,692	40,692	274	274
Montoya						
1951	0	0	291,286	291,286	4,588	4,588
1952	0	0	246,888	538,174	3,890	8,478
1953	0	0	193,568	731,742	3,620	12,098
1954	0	0	0	731,742	0	12,098
1955	0	0	462,256	1,193,998	8,462	20,560
McKee						
1951	0	0	?	?	173	173
1952	0	0	0	?	0	173
1953	0	0	0	?	0	173
1954	0	0	0	?	0	173
1955	0	0	262,604	262,604+	3,041	3,214
Ellenburger						
1949	14,372	14,372	0	0	0	0
1950	70,250	84,622	0	0	0	0
1951	25,777	110,399	0	0	0	0
1952	14,997	125,396	0	0	0	0
1953	6,165	131,561	0	0	0	0
1954	3,351	134,912	0	0	0	0
1955	481	135,393	0	0	0	0

(*) Although the first Fusselman discovery well was completed in 1948, we find no record of production prior to the beginning of 1949. The one well flowed during the first half of 1949 and was operated by pumping until its abandonment in 1951. It was reported generally as in the North Heiner field and was the only well treated as in that field.

PEGASUS FIELD

Midland and Upton Counties, Texas

ROBERT R. HARBISON
Geologist, Stanolind Oil & Gas Co., Midland, Texas
January 1, 1955

LOCATION

The Pegasus field occupies an area which is partly in southwest Midland County and partly in northwest Upton County. It is about 20 miles south of the town of Midland, county seat of Midland County, and about 17 miles southeast of the town of Odessa, county seat of Ector County. It is in the southwestern part of the Midland basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph surveying and core drilling led to the discovery of the field.

DISCOVERIES

San Andres: January 20, 1954;
Sinclair Oil & Gas Co. #17 J.H.Tippett.
Spraberry: January 10, 1952;
Republic Nat. Gas Co. #2 Amer. Republics Corp.
Wolfcamp: November 21, 1952;
Wilshire Oil Co. #1-12 W.R.Timmons.
Bend: February 13, 1951;
C.W.Murchison #1 Joe Cannon.
Devonian: June 19, 1952;
Superior Oil Co. #4 J.D.Windham "16".
Ellenburger and Field: March 15, 1949;
Magnolia Petroleum Co. #1-A TXL.

ELEVATION OF SURFACE

At well locations: Highest, 2,891 feet; lowest, 2,840 feet.

SURFACE FORMATIONS

Fredericksburg limestone and overlying unconsolidated Quaternary deposits constitute the surface rocks within the area of the field.

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Sandstone; fine-grained, slightly calcareous, light gray in color when not stained; contains partings of dark brown argillaceous limestone and thin streaks of black shale.

Spraberry: Limestone; brown, fine-grained crystalline.

Wolfcamp: Limestone; tan to brown, fine-grained crystalline.

Bend: Three beds of limestone; tan to brown, chalky and fine-grained crystalline; separated by streaks of shale.

Devonian: Limestone; brown, fine-grained crystalline, cherty.

Ellenburger: Dolomite; light brown, fine- to medium-grained crystalline.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 800 feet below the top of the Ellenburger group. This penetration was in the discovery well for the field and for the Ellenburger reservoir, the log of which served as a basis for the accompanying TYPICAL SECTION.

NATURE OF TRAPS

San Andres: The six wells producing from the San Andres reservoir are located in the north part of the field near the axis of an anticlinal fold. Anticlinal folding is evidently the primary trap-forming factor. However, it appears that the reservoir rock is only locally sufficiently porous for free migration of fluids and that variation in degree of porosity and permeability may have contributed locally to the trapping of the oil.

Spraberry: Updip termination of reservoir due to lensing.

Wolfcamp: At the north end of the field, there are three wells producing from a reservoir in the Wolfcamp series. The accumulation in this reservoir appears to be due partly to convex folding, but probably more importantly to variation in character of reservoir rock. Updip decrease of porosity appears to be an important trap-forming factor. The Wolfcamp discovery well, located at the south end of the field and now abandoned, probably produced from a separate and distinct lens having favorable porosity.

Bend: Convex folding.

Devonian: Anticlinal folding and updip termination of reservoir due to lensing.

Ellenburger: Convex folding.

CONTINUITY OF RESERVOIR ROCKS

San Andres: The reservoir rock cannot be correlated beyond the immediate vicinity of the six productive wells. It is certain that the degree of porosity favorable for commercial production is not continuous within the area of the field except in the immediate vicinity of the six wells.

Spraberry: The reservoir rock appears to be merely a local lens terminating updip on the south flank of the anticlinal fold.

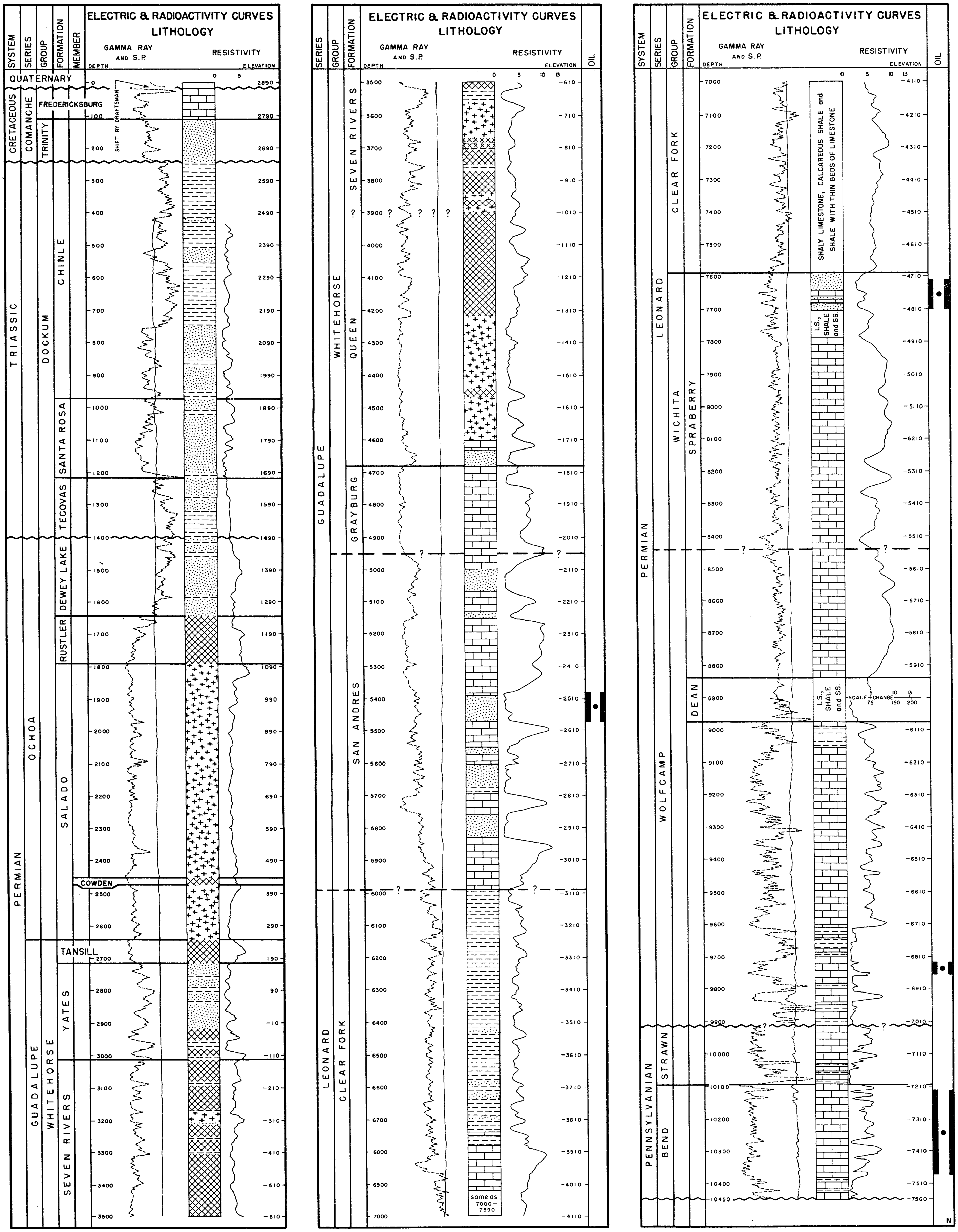
Wolfcamp: The bed of limestone is continuous throughout the area of the field, but the areas where porosity is adequate for commercial production are only local. It appears that productivity is determined by degree of porosity in a continuous limestone bed.

Bend: The reservoir rock in the Bend series is continuous throughout the area of the field.

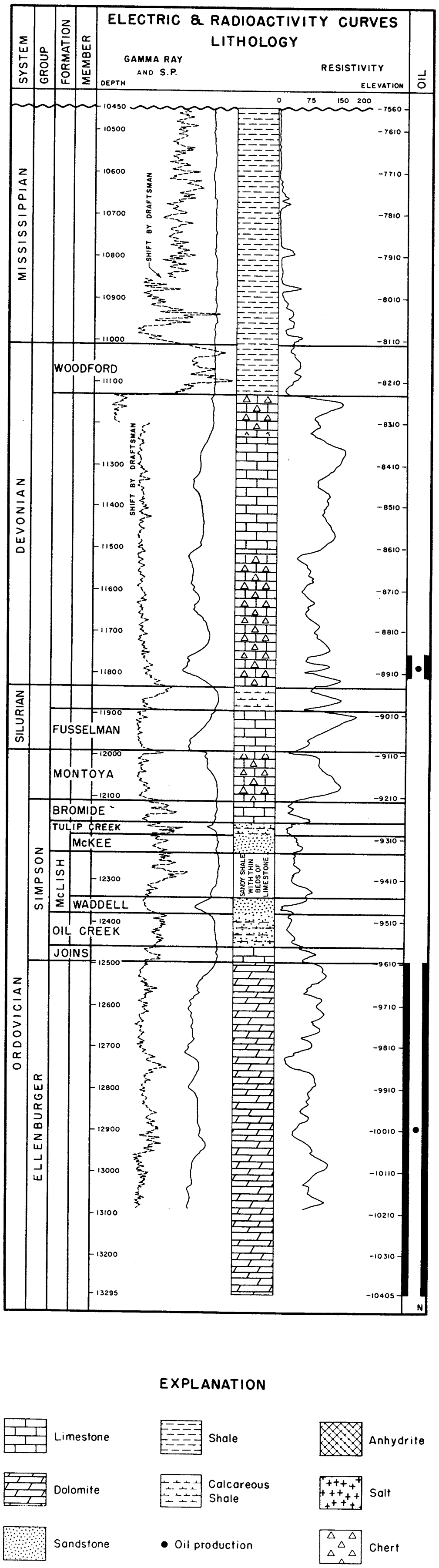
Devonian: Except where broken by faulting, the bed of limestone is continuous throughout the area of the field, but favorable porosity occurs only in a small area in the north end of the field.

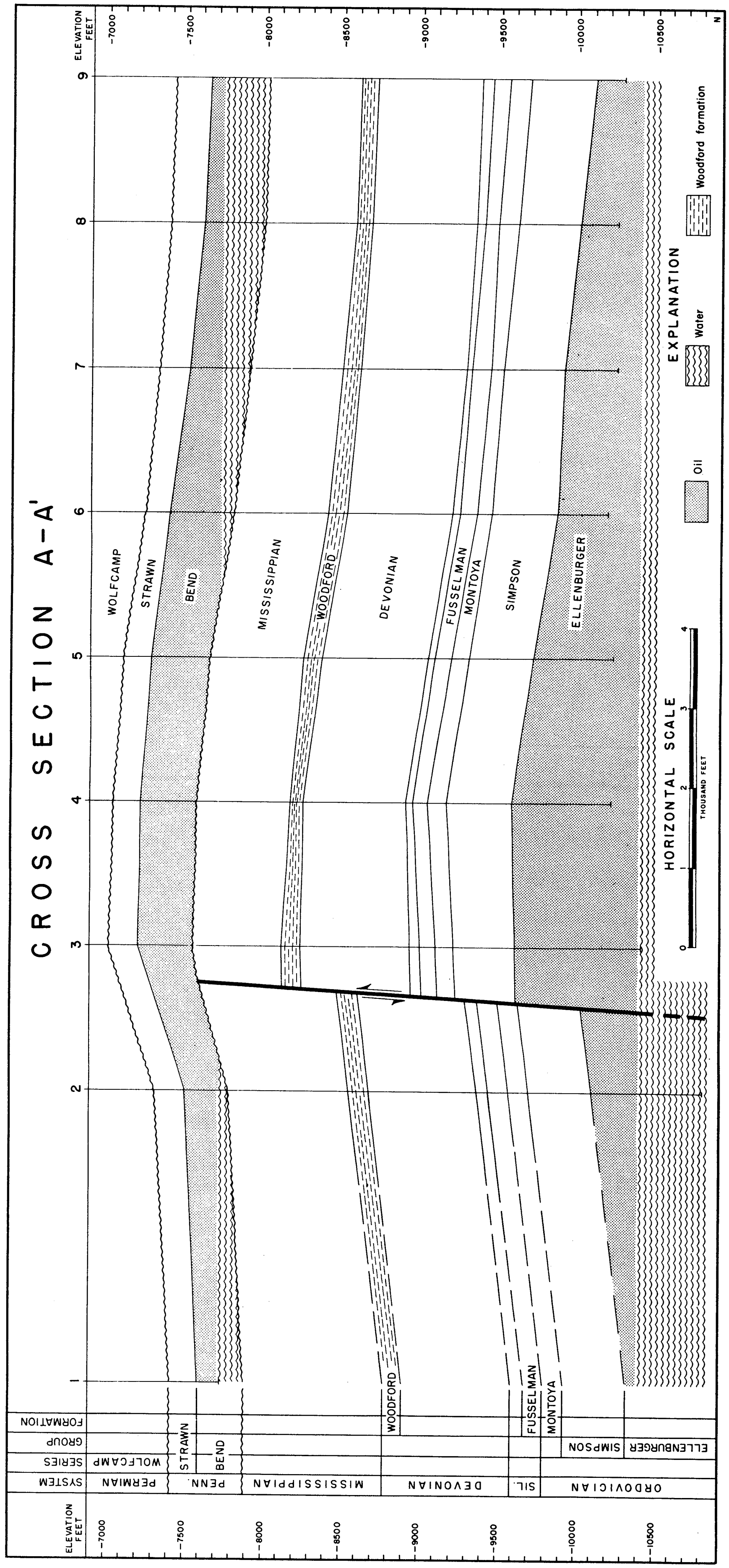
Ellenburger: Except where broken by faulting, the Ellenburger reservoir is continuous throughout the area of the field.

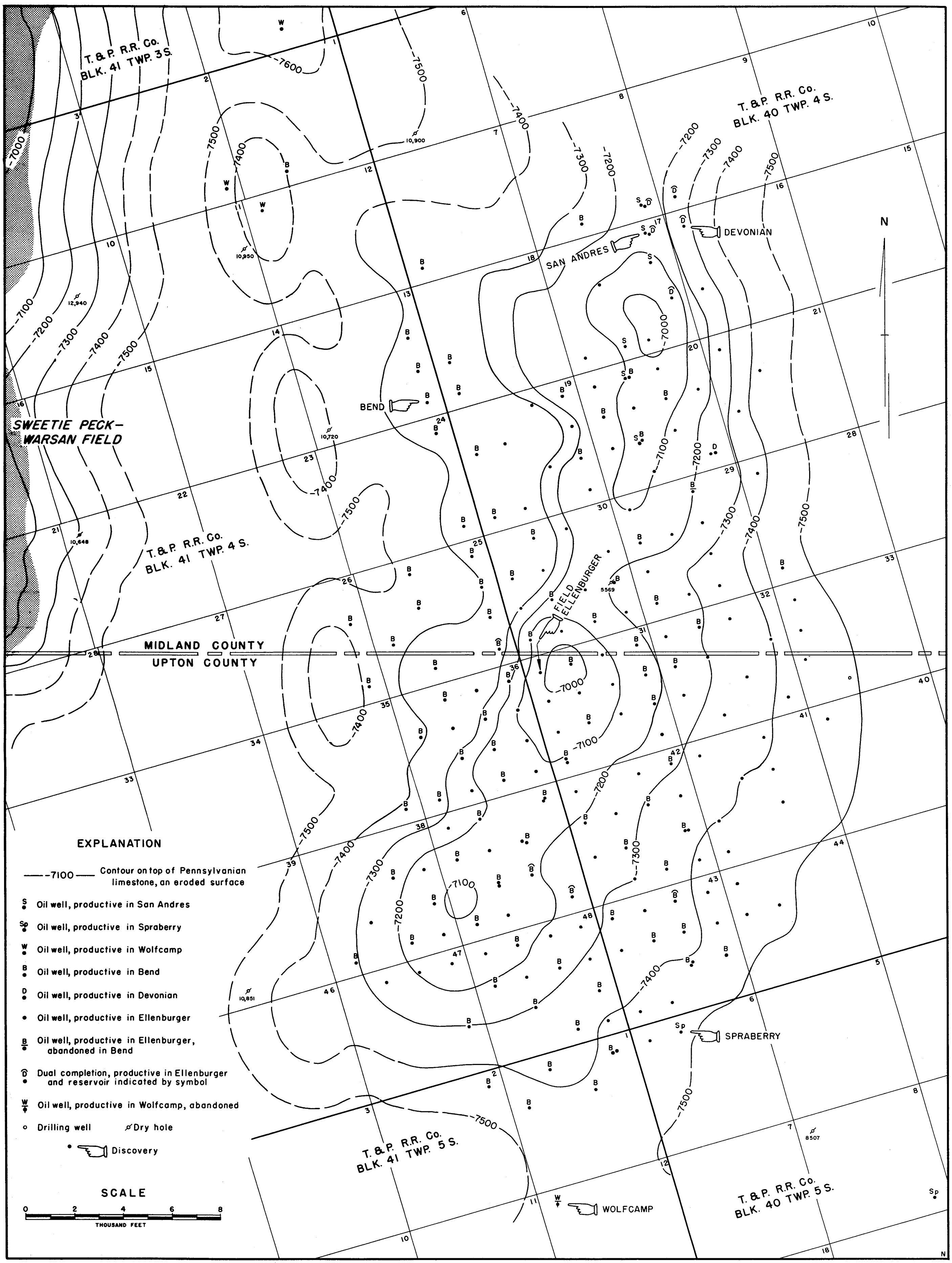
TYPICAL SECTION OF ROCKS PENETRATED

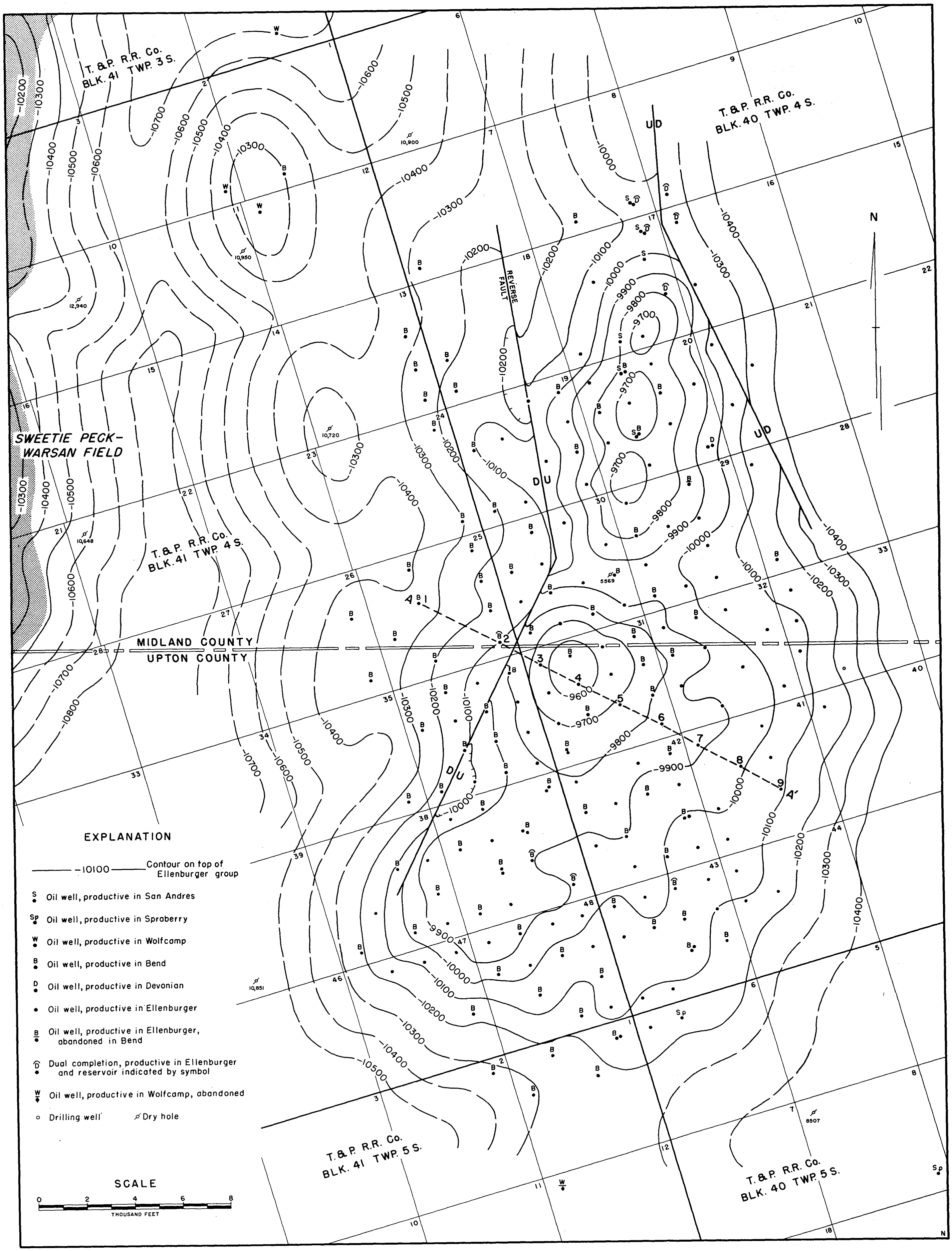


TYPICAL SECTION OF ROCKS PENETRATED






T. & P. R.R. Co. BLK. 41 TWP. 3 S.
T. & P. R.R. Co. BLK. 40 TWP. 4 S.
T. & P. R.R. Co. BLK. 41 TWP. 4 S.
T. & P. R.R. Co. BLK. 41 TWP. 5 S.
T. & P. R.R. Co. BLK. 40 TWP. 5 S.
SWEETIE PECK-WARSAN FIELD
MIDLAND COUNTY
UPTON COUNTY
DEVONIAN
SAN ANDRES
BEND
ELLENBURGER FIELD
SPRABERRY
WOLFCAMP
N
EXPLANATION
—7100— Contour on top of Pennsylvanian limestone, an eroded surface
S Oil well, productive in San Andres
Sp Oil well, productive in Spraberry
W Oil well, productive in Wolfcamp
B Oil well, productive in Bend
D Oil well, productive in Devonian
Oil well, productive in Ellenburger
B Oil well, productive in Ellenburger, abandoned in Bend
Dual completion, productive in Ellenburger and reservoir indicated by symbol
W Oil well, productive in Wolfcamp, abandoned
Drilling well
Dry hole
Discovery
SCALE
0 2 4 6 8
THOUSAND FEET


T. & P. R.R. Co. BLK. 41 TWP. 3 S.
T. & P. R.R. Co. BLK. 40 TWP. 4 S.
T. & P. R.R. Co. BLK. 41 TWP. 4 S.
T. & P. R.R. Co. BLK. 41 TWP. 5 S.
T. & P. R.R. Co. BLK. 40 TWP. 5 S.
SWEETIE PECK-WARSAN FIELD
MIDLAND COUNTY
UPTON COUNTY
REVERSE FAULT
N
EXPLANATION
Contour on top of Ellenburger group
Oil well, productive in San Andres
Oil well, productive in Spraberry
Oil well, productive in Wolfcamp
Oil well, productive in Bend
Oil well, productive in Devonian
Oil well, productive in Ellenburger
Oil well, productive in Ellenburger, abandoned in Bend
Dual completion, productive in Ellenburger and reservoir indicated by symbol
Oil well, productive in Wolfcamp, abandoned
Drilling well
Dry hole
SCALE
0 2 4 6 8
THOUSAND FEET

PRODUCTIVE AREAS

	Acres
San Andres	240
Spraberry	80
Wolfcamp	160
Bend	19,200
Devonian	240
Ellenburger	12,600
Pegasus field	19,200

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation of oil, feet		Relief,
	Top	Bottom	feet
San Andres	-2,719	?	?
Spraberry	-4,897	?	?
Wolfcamp	-5,415	?	?
Bend	-7,156	-7,723	567
Devonian	-8,935	-9,557	622
Ellenburger	-9,581	-10,410	829

THICKNESSES OF RESERVOIR ROCKS

	Feet, average	
	Top to bottom	Net productive
San Andres	70	?
Spraberry	200	45
Wolfcamp	40	10
Bend	290	60
Devonian	50	20
Ellenburger	450	250

CHARACTER OF OIL

	Gravity, A.P.I. @ 60° F.	Sulphur, %
San Andres	29	?
Spraberry	38	0.33
Wolfcamp	42	0.12
Bend	44	0.07
Devonian	48	0.08
Ellenburger	53	0.09

For analyses of Ellenburger oil see:
U. S. Bureau of Mines — Lab. ref. No. 50048
Analyses of Crude Oils from Some West Texas Fields. R.I. 4959 (1953) — Item 42

COMPLETION TREATMENT

San Andres: One San Andres well was completed "natural"; in one well, the reservoir rock was treated with 500 gallons of acid and then hydraulically fractured with 10,000 gallons of oil and sand; one well was treated with 350 gallons of acid; in two, the reservoir rock was fractured with 4,000 gallons of sand and oil; in one, with 12,000 gallons of sand and oil.

Spraberry: In the first of the two wells, the reservoir rock was treated with 2,500 gallons of acid and was hydraulically fractured with 2,250 gallons of sand and oil; in the second well, the reservoir rock was treated with 1,500 gallons of acid and was hydraulically fractured with 18,000 gallons of sand and oil.

Wolfcamp: The four Wolfcamp wells were treated with 3,500, 3,000, 2,000 and 1,500 gallons of acid respectively.

Bend: Quantities of acid were determined on the basis of information provided by swab tests. Many wells were completed "natural". The quantities of acid ranged from none to 25,000 gallons.

Devonian: The quantities of acid ranged from 500 to 39,000 gallons of acid.

Ellenburger: Many wells were completed "natural". The quantities of acid ranged from none to 62,000 gallons. Quantities used in wells at locations structurally low were greater than in wells at structurally high locations because the degree of porosity of the reservoir rock is lower at the lower structural positions.

PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Wells producing at end of year: Pumping	Oil production (barrels): Yearly	Oil production (barrels): Cumulative
Field totals				
1949	4	0	260,420	260,420
1950	30	0	1,292,744	1,553,164
1951	68	1	4,038,491	5,591,655
1952	122	5	4,384,926	9,976,581
1953	182	11	5,628,010	15,604,591
1954	218	11	5,747,578	21,352,169
San Andres				
1954	2	4	97,761	97,761
Spraberry				
1952	1	1	8,862	8,862
1953	0	2	17,513	26,375
1954	0	2	18,582	44,957
Wolfcamp				
1952	4	0	6,695	6,695
1953	3	0	8,292	14,987
1954	2	0	6,210	21,197
Bend				
1951	16	1	378,686	378,686
1952	32	3	883,858	1,262,544
1953	66	3	1,573,998	2,836,542
1954	95	3	1,751,176	4,587,718
Devonian				
1952	1	0	11,358	11,358
1953	6	0	113,483	124,841
1954	5	0	105,680	230,521
Ellenburger				
1949	4	0	260,420	260,420
1950	30	0	1,292,744	1,553,164
1951	52	0	3,659,805	5,212,969
1952	84	1	3,474,153	8,687,122
1953	107	6	3,914,724	12,601,846
1954	114	2	3,768,169	16,370,015

REPRESSURING OPERATIONS: Repressuring of the Bend and Ellenburger reservoirs is to be conducted under a unitization plan covering the whole of the productive areas of these reservoirs. Pressure in the Bend reservoir has declined from the initial of 4,567 psi. to about 3,000 psi.; in the Ellenburger reservoir, from 5,668 psi. to about 3,600 psi. Injection of gas into the Bend reservoir has already been initiated and injection of water into the Bend and into the Ellenburger will be started in the near future. Gas is being injected into the Bend at the unusually high pressure of 3,500 psi. and it is anticipated that the pressure may be increased to 4,500 psi. Injection of water into Ellenburger at the depth of about 13,000 feet will establish a depth record for such operations.

The gas which is being injected is residue gas supplied by the Pegasus Unit gasoline plant. About 5 million cubic feet of gas is being injected daily through a pilot well in the southwest part of the field.

PETERSBURG FIELD

Hale County, Texas

B. H. BONEY
Geologist, Cabot Carbon Company, Midland, Texas
May 19, 1953

LOCATION

The Petersburg field (one well) is in southeastern Hale County about 6 miles northwest of the town of Petersburg. Regionally, it is on the Matador arch between the main Permian basin of West Texas and the shallower Palo Duro basin of the Texas Panhandle.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph.

DISCOVERY

Cisco: February 5, 1947; Stanolind Oil & Gas Co. #1 E.L.Fisher. On potential test, flowed 1,008 barrels of oil in 18 hours.

ELEVATION OF SURFACE

Derrick floor: 3,316 feet.

SURFACE FORMATION

Ogallala formation of the Pliocene series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the single well in the field is about 434 feet below the top of the Cisco series. The oldest horizon penetrated in the vicinity of the field is in rocks of pre-Cambrian age. Stanolind Oil & Gas Co. #2 E.L.Fisher, the dry hole about two thousand feet northeast of the productive well, drilled 372 feet into pre-Cambrian rocks. The location of this dry hole is in Sec. 5 where the total depth of 8,394 feet is indicated on the accompanying maps. This is the only well in the vicinity which drilled below rocks of Pennsylvanian age.

NATURE OF TRAP

Cisco: Limestone reef

PRODUCTIVE AREA

Cisco and Field: Approximately 40 acres.

THICKNESS OF RESERVOIR ROCK

Cisco: In the one productive well, it is 111 feet from top of productive rock to bottom of productive rock. Because of poor core recovery, the portion of the total thickness which yielded oil is not determinable.

LITHOLOGY OF RESERVOIR ROCK

Cisco: Reef limestone; light gray, fine to medium crystalline with dense streaks, highly fossiliferous. Fossils are predominantly crinoid stems.

CONTINUITY OF RESERVOIR ROCK

Cisco: The reservoir rock has been found in only the one well. Evidently it is a small reef with distribution limited to the immediate vicinity of the well.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Cisco:	Feet
No free gas	
Elevation of top of oil	-3,566
Elevation of bottom of oil	-3,677
Relief	111

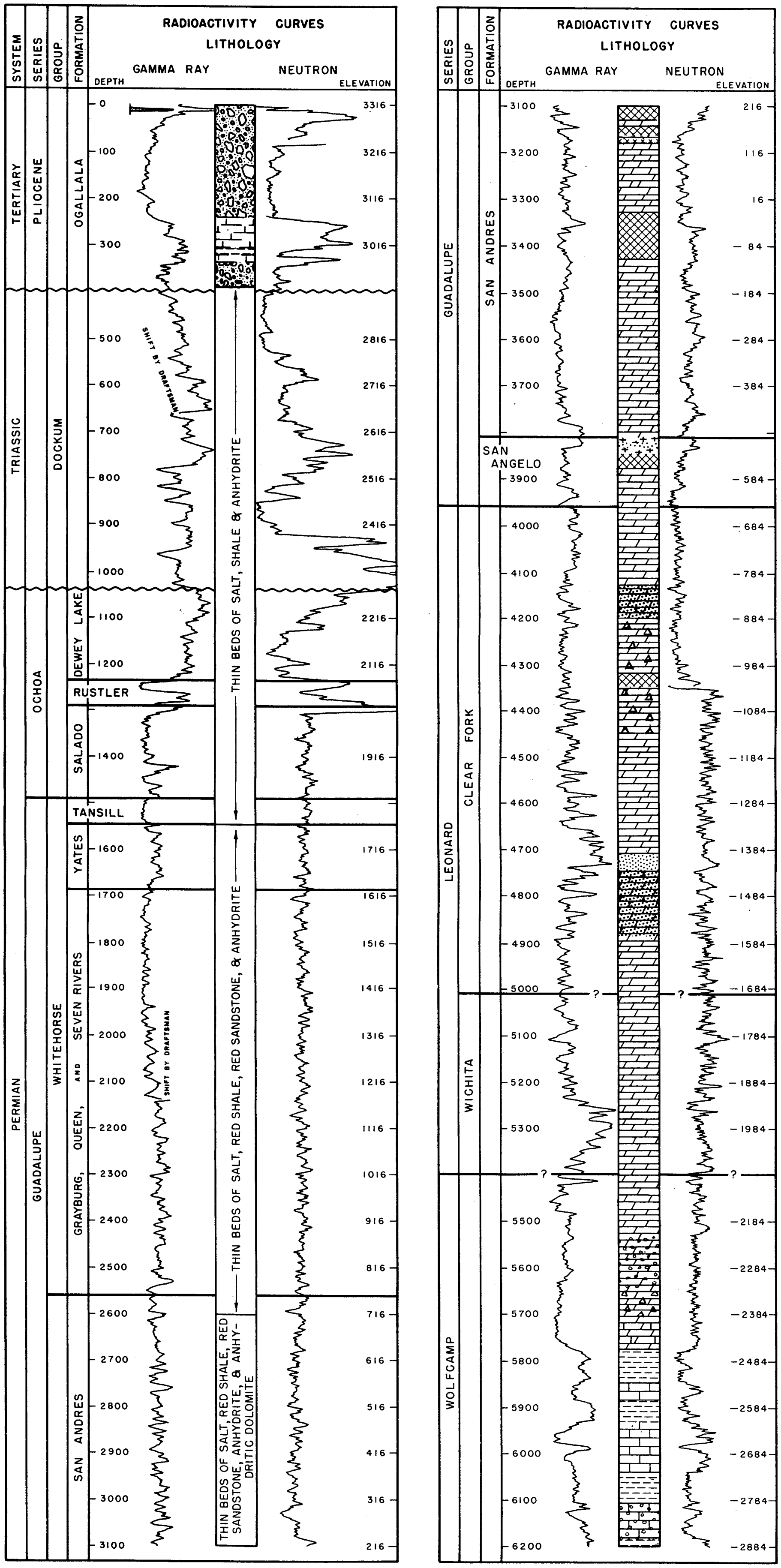
CHARACTER OF OIL

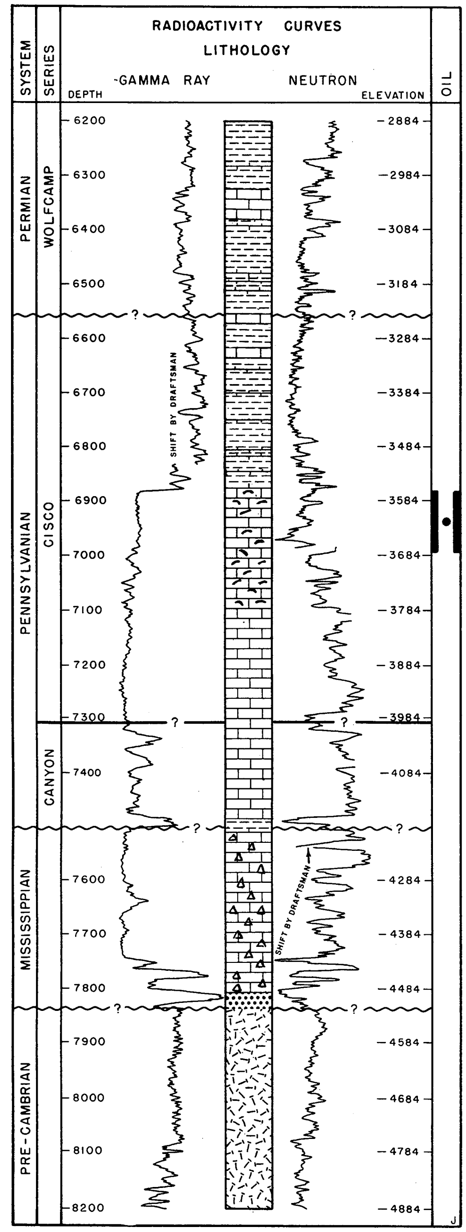
Cisco:	
Gravity, A.P.I. @ 60° F.	39°
Base,	Paraffin

WATER PRODUCTION

Cisco: The encroachment of salt water was very rapid. After producing oil only five months, the well started producing salt water and by the end of the first year, water constituted about 10% of the gross production. In May, 1948, the production was at the rate of 40 barrels of oil and 8 barrels of water per day. The well was then treated with 1,000 gallons of acid and production increased to the rate of 72 barrels of oil and 98 barrels of water per day. In early May, 1953, production was at the rate of 25 barrels of oil and 150 barrels of water per day.

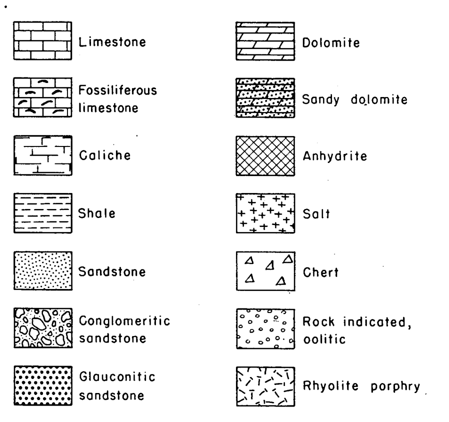
TYPICAL SECTION OF ROCKS PENETRATED





NOTE: This TYPICAL SECTION is based on a composite log of the productive well and the dry hole where the oldest horizon was penetrated. The depths and elevations below the productive zone have been adjusted.

EXPLANATION



ACID TREATMENT

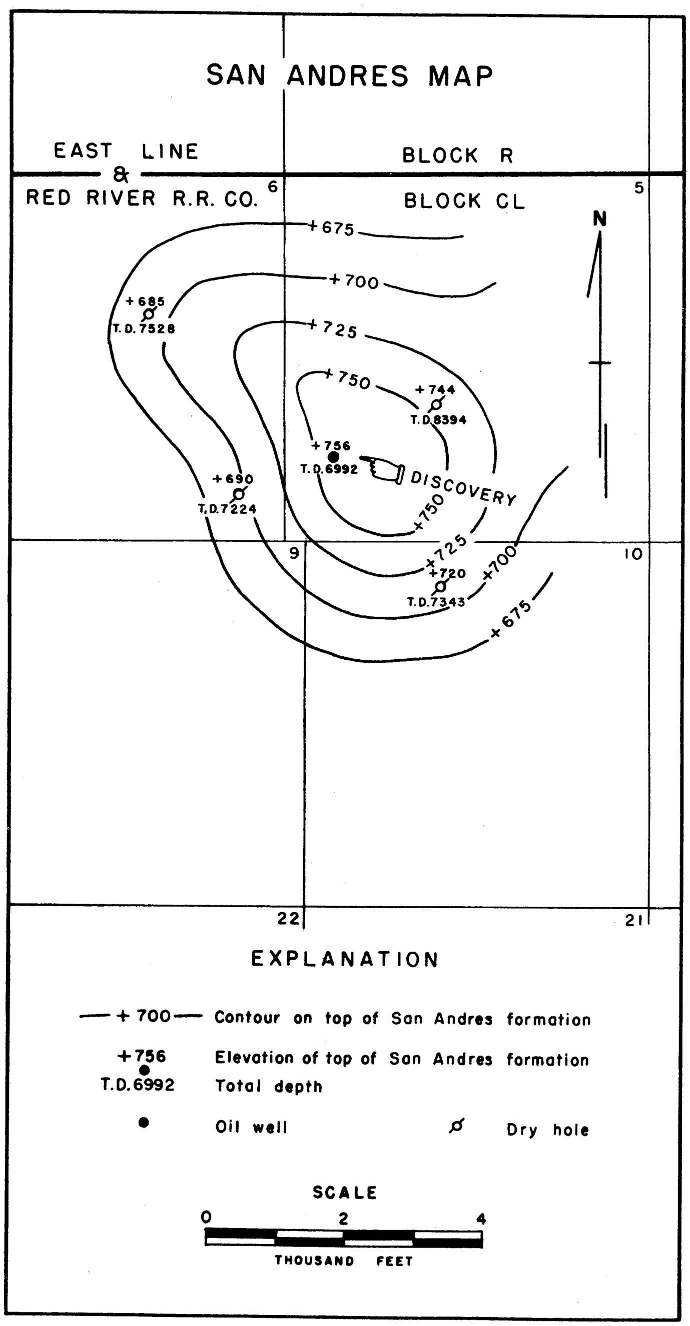
Cisco: At time of completion, the well was treated with 2,500 gallons of acid through open hole. In May, 1948, it was treated with 1,000 gallons of acid and daily production increased from 40 barrels of oil and 8 barrels of water to 72 barrels of oil and 98 barrels of water.

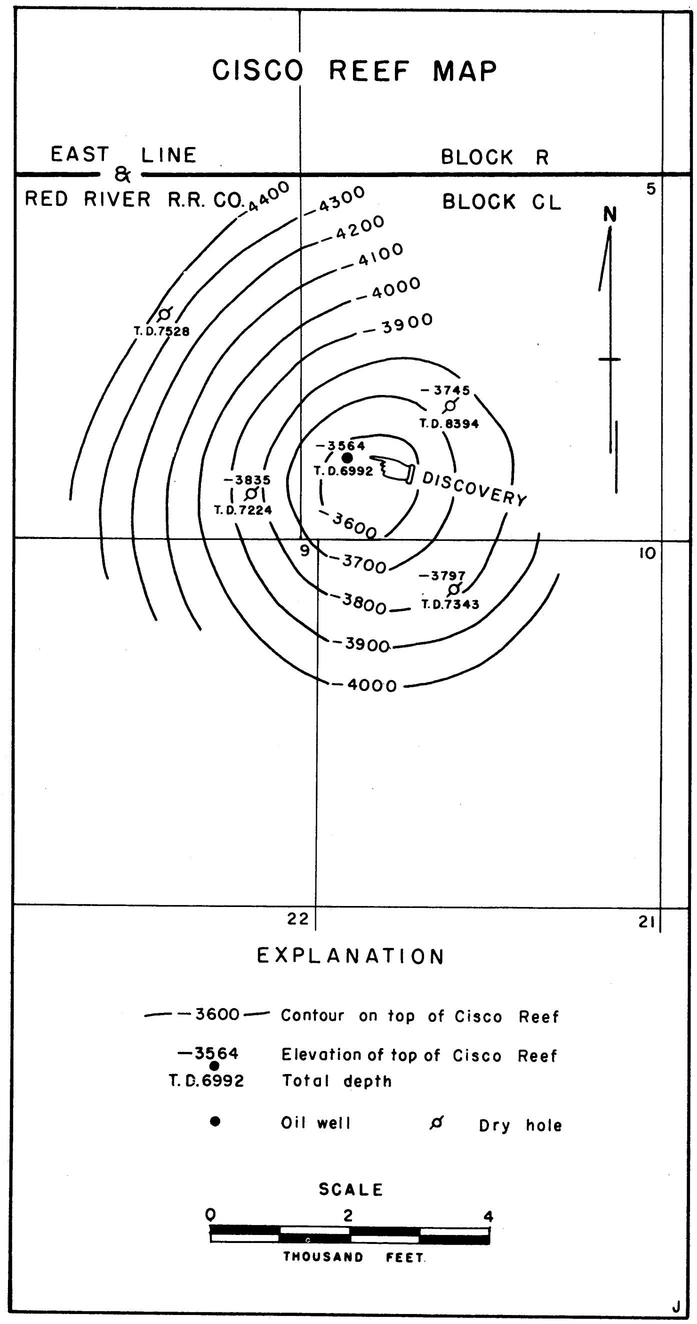
SELECTED REFERENCE

Mallory, R. W. (1948) Petersburg Oil Pool, Hale County, Texas: Amer. Assoc. Petr. Geol. Bull., vol. 32, pp. 780-789.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1947	1	0	39,919	39,919
1948	0	1	17,510	57,429
1949	0	1	11,875	69,304
1950	0	1	9,282	78,586
1951	0	1	7,607	86,193
1952	0	1	6,306	92,499





POLAR FIELD

Kent County, Texas

M. A. CUSTER, Jr.
Geologist, Humble Oil & Refining Co., Midland, Texas
January 25, 1955

LOCATION, OTHER NAMES and HISTORY

The Polar field is near the southwest corner of Kent County 1 mile northwest of the town of Polar. It is on the Eastern shelf.

Under the designation of Polar field, four wells were completed in 1946 and 1947 in the Ellenburger dolomite. These wells were all abandoned before the end of 1950. On February 28, 1954, King Oil Co. #1 C. E. Cargile, located near the southwest corner of Sec. 25, Blk. 5, was completed in a zone in the Strawn series of the Pennsylvanian system and the well was reported as being in the Polar (Pennsylvanian) field. After producing a total of 2,862 barrels, the well was deepened and completed on October 28, 1954 as Woodson Oil Co. #1 C. E. Cargile in the Ellenburger dolomite and was reported as being in the Polar (Ellenburger) field. It produced 64 barrels during October, 597 barrels during November and 43 barrels during December. (P. S.: It was plugged and abandoned on 4/23/55 after having produced an additional 58 barrels, which brought its Ellenburger production to 762 barrels.) The small quantity of oil recovered from the Pennsylvanian zone does not warrant considering that zone as a commercial reservoir.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Subsurface geology indicated the general area as favorable; reflection seismograph served to localize the exploratory test drilling.

DISCOVERY

Ellenburger May 1, 1946; Humble Oil & Refining Co. #1 Lida Vick. During initial potential test, flowed at daily rate of 207 barrels of 38.6° gravity oil and 3 barrels of water through perforations at 7,775 - 7,810 feet.

ELEVATION OF SURFACE

At well locations: Highest, 2,355 ft.; lowest, 2,305 ft.

SURFACE FORMATIONS

Gravel and caliche of Recent age and reddish-brown sands and shales of Triassic age.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Ellenburger group about 175 feet below its eroded top. This penetration was in Cosden Petroleum Corp. #1 W. G. Williams, a dry hole about 3 miles southwest of the field at the location where the total depth of 8,055 feet is indicated on the accompanying map.

NATURE OF TRAP

The oil accumulation was in porous Ellenburger dolomite near its eroded top on the crest of a small domal type structure.

PRODUCTIVE AREA

Ellenburger and Field: 400 acres

THICKNESS OF RESERVOIR ROCK

Ellenburger:	Feet, avg.
From top to bottom of productive zone	37
Net productive	15

LITHOLOGY OF RESERVOIR ROCK

Ellenburger: Dolomite; white, light tan and grey; medium- to coarse-grained crystalline; slightly cherty; contains a few large sand grains.

CONTINUITY OF RESERVOIR ROCKS

Ellenburger: The Ellenburger dolomite is continuous throughout the area of the field and throughout most of West Texas.

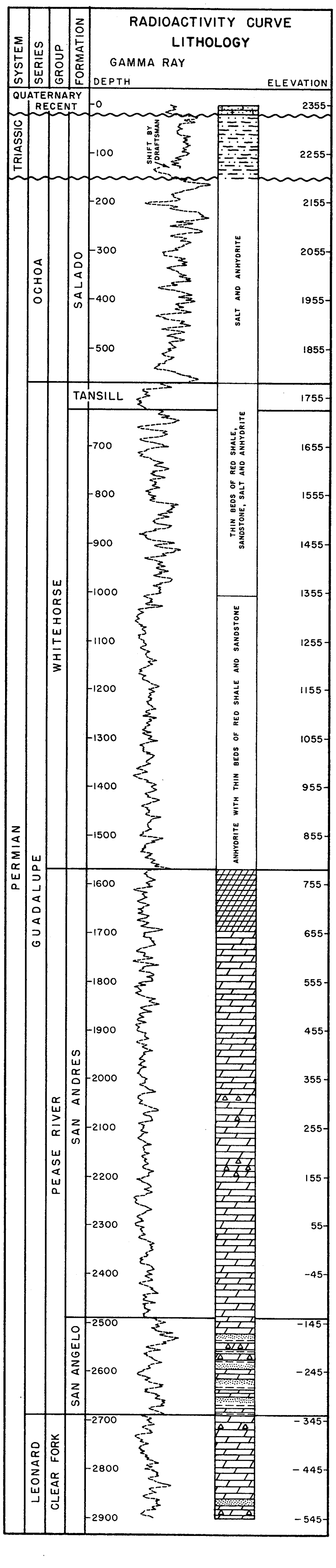
ELEVATION AND RELIEF OF PRODUCTIVE ZONE

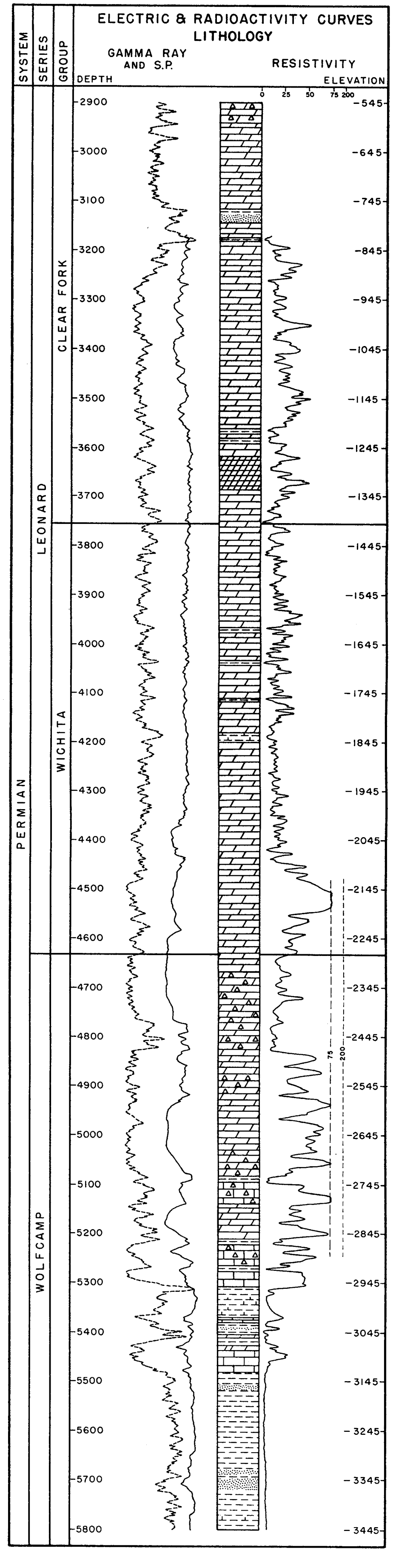
Ellenburger:	Feet
Elevation of top of oil	-5,457
Elevation of bottom of oil	-5,504
Relief	47

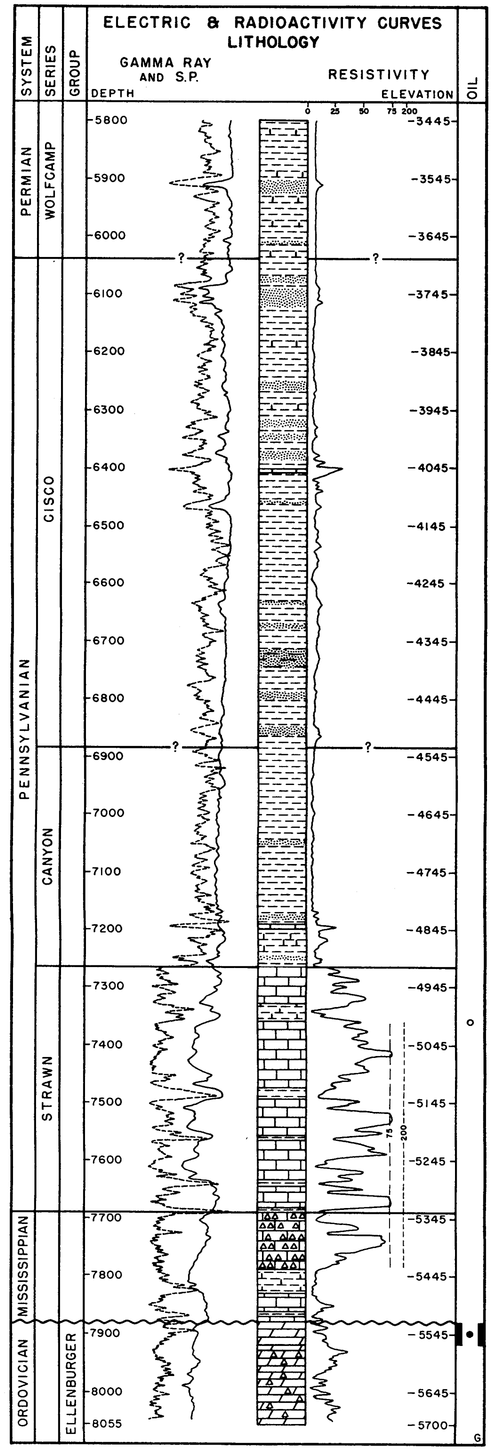
ACID TREATMENT

Ellenburger: Each well was treated with acid; the quantity of acid ranged from 500 to 13,000 gallons.

TYPICAL SECTION OF ROCKS PENETRATED

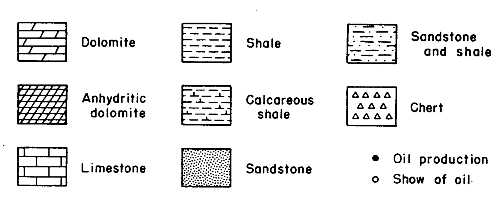






NOTE: The above TYPICAL SECTION is based on the log of Cosden Petroleum Corp. #1 W.G.Williams, the dry hole which penetrated the oldest horizon penetrated in the vicinity of the field. It was selected because of its depth and because it provides radioactivity and electrical curves. The reservoir symbol and the symbol for show of oil are entered to report conditions in other wells.

EXPLANATION



CHARACTER OF OIL

Ellenburger:

Gravity, A. P. I. @ 60°F.:	39.75°
Sulphur:	0.43%
Color:	Green

For analyses see:

U. S. Bureau of Mines — Lab. ref. No. 46106
Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953) — Item 44

WATER PRODUCTION

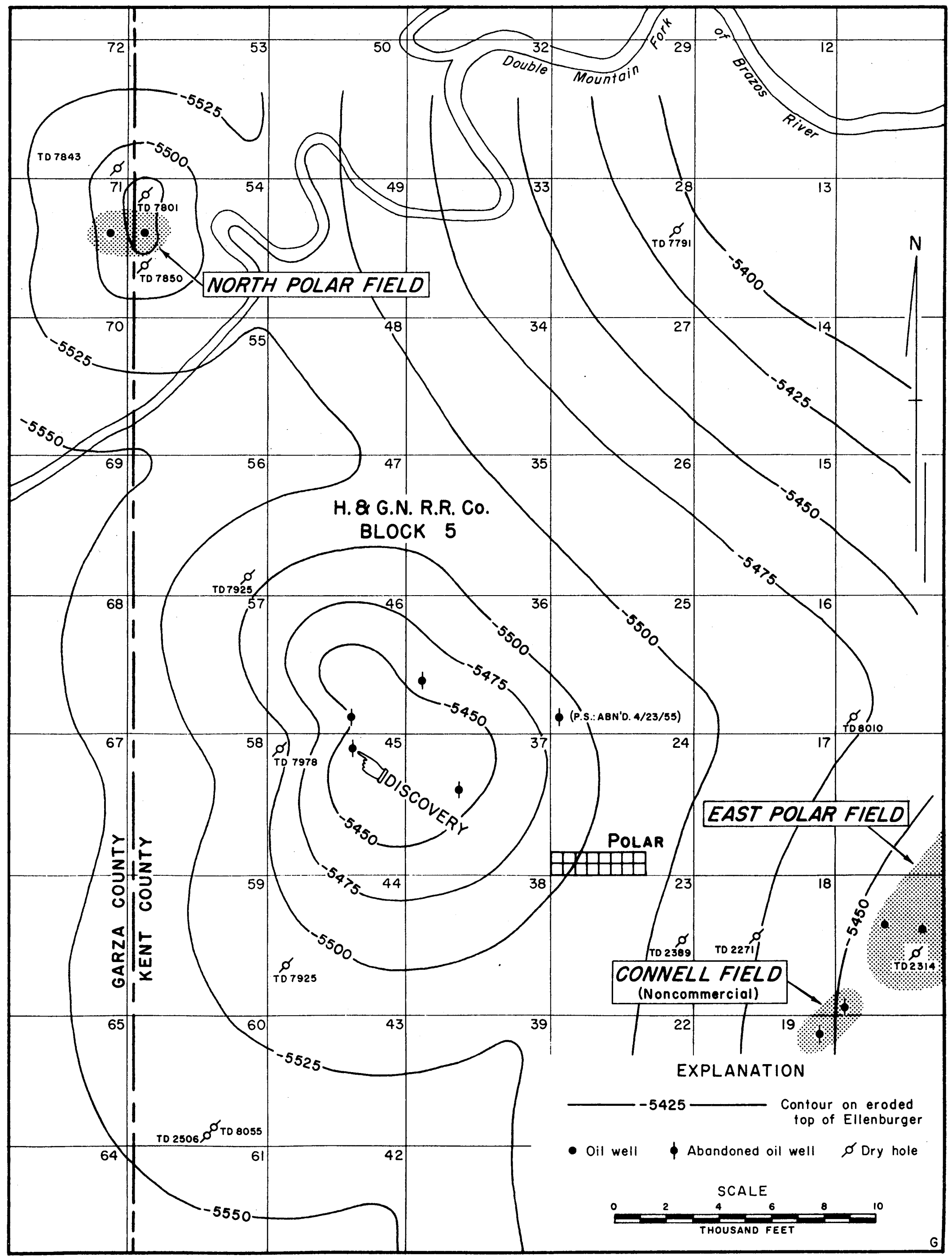
Ellenburger: The quantities of water produced by individual wells at time of completion varied through a wide range; however, before abandonment, water constituted a large portion of the gross production of every well. Data are not available for determining the quantities of water produced.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flow	Pump	OIL PRODUCTION (barrels): Yearly	Cumulative
1946	1	1	26,872	26,872
1947	1	2	36,630	63,502
1948	0	2	17,873	81,375
1949	0	2	9,693	91,068
1950	0	0	8,984	100,052
1951-53	0	0	0	100,052
1954	0	1	3,566	103,618
1955*	0	0	58	103,676

OIL PRODUCTION: All except 2,862 barrels of the above indicated oil was produced from Ellenburger dolomite. On February 28, 1954, King Oil Co. #1 C. E. Cargile, located near the southwest corner of Sec. 25, Blk. 5, was completed in a zone in the Strawn series and produced from this zone 982 barrels during March; 777 barrels during April; 543 barrels during May; 278 barrels during June; 126 barrels during July and 156 barrels during September; total, 2,862 barrels. This well was then deepened to Ellenburger and produced 64 barrels during October; 597 barrels during November and 43 barrels during December; total of 704 barrels from Ellenburger in 1954. (P. S.: It was plugged and abandoned on 4/23/55 after having produced an additional 58 barrels, which brought its Ellenburger production to 762 barrels.)

*1955 data added by amendment.



PRUITT FIELD

Ward County, Texas

EDWARD R. KENNEDY, Jr.
Geologist, Argo Oil Corporation, Midland, Texas
June 10, 1954

LOCATION

The Pruitt field (one well, now abandoned) is in northwest Ward County, $11\frac{1}{2}$ miles north of Barstow and 12 miles southeast of Mentone, the county seat of Loving County.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The writer has been unable to determine which methods of exploration led to the discovery of this field. It is likely that the discovery resulted from random drilling.

DISCOVERY

Bell Canyon: July 6, 1942;
Fred A. Hyer #1 T. B. Pruitt (commenced as J.E.Fitzpatrick Trust #1 T.B.Pruitt).

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated by the one productive well is in the Bell Canyon formation 11 feet below the base of the Lamar member. The oldest horizon penetrated in the vicinity of the field is in the Bell Canyon formation 168 feet below the base of the Lamar member. This penetration was in Anderson-Prichard Oil Corp. #1 J.D.Campbell, the dry hole located about 1,850 feet northwest of the productive well. The accompanying TYPICAL SECTION is based on the log of that dry hole.

NATURE OF TRAP

Bell Canyon: Data are not adequate for determining the factors which occasioned the trapping of oil. However, it appears likely that the trap is due to updip decrease of porosity and permeability on an eastward plunging structural nose.

PRODUCTIVE AREA

Bell Canyon: It is impossible to determine the extent of the area, probably less than 40 acres, which contributed to the production of the one well, now abandoned.

THICKNESS OF RESERVOIR ROCK

Bell Canyon: Approximately 10 feet.

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: Clean, gray, friable, porous, fine-grained sandstone.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The reservoir rock appears to be continuous throughout a large area, but probably varies considerably in thickness, porosity and permeability within relatively short distances.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet
Elevation of top of oil	-2,186
Elevation of bottom of oil	-2,196
Relief	10

The above figures are based on shooting-line measurements and are believed to be correct. Other reported measurements to top and bottom of oil are as much as 33 feet less.

CHARACTER OF OIL

Bell Canyon: Gravity, A.P.I. @ 60°F., 32°

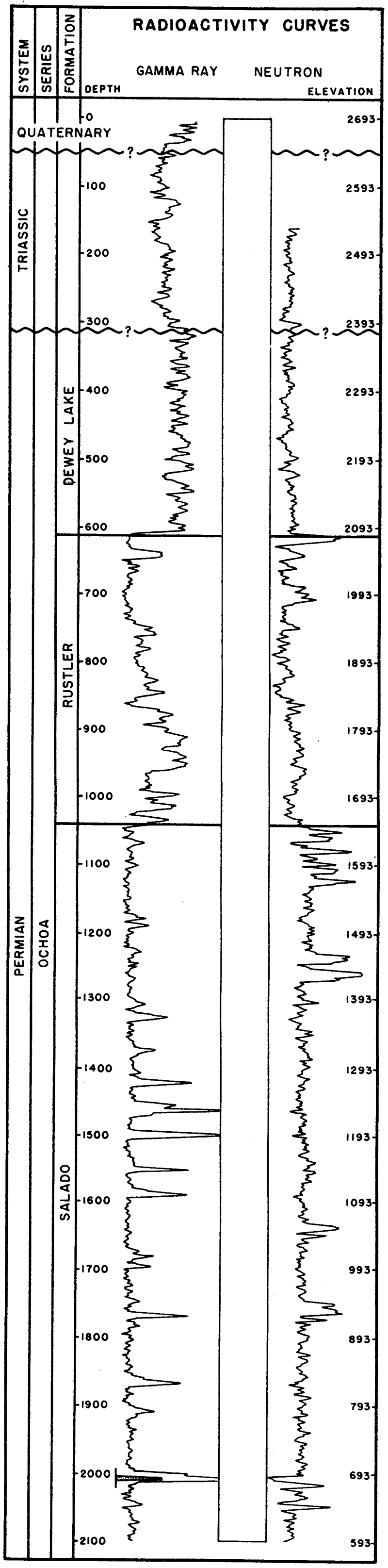
WATER PRODUCTION

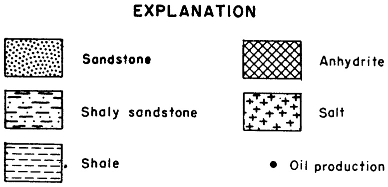
Bell Canyon: Water constituted 40% of the initial gross production, which was at the daily rate of 15 barrels of oil and 10 barrels of salt water.

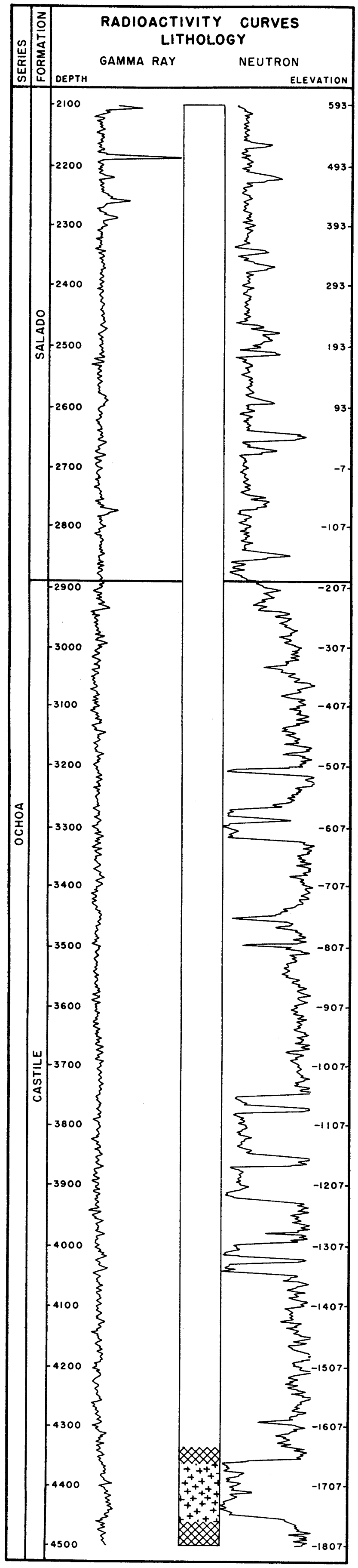
COMPLETION TREATMENT

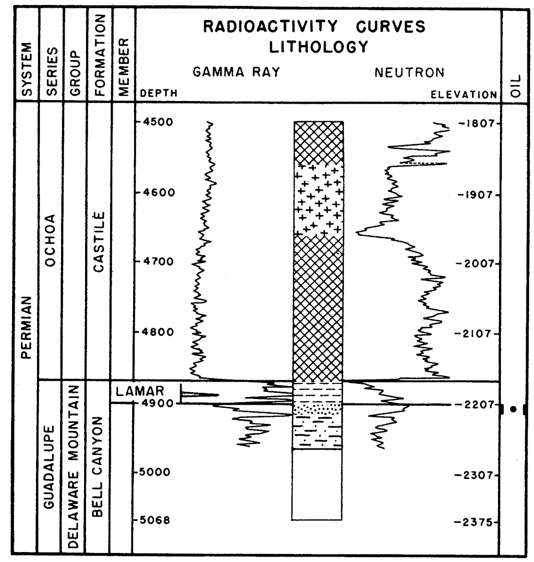
Bell Canyon: The reservoir rock was shot with 100 quarts of nitroglycerin.

TYPICAL SECTION OF ROCKS PENETRATED









ELEVATION OF SURFACE

The surface at the location of the one well is 2,694 feet above sea level.

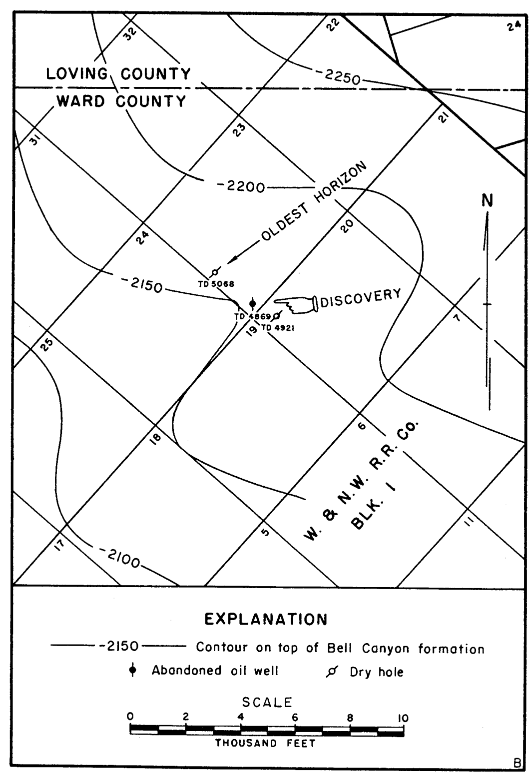
SURFACE FORMATION

Undifferentiated rocks of the Quaternary system.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year Flowing	OIL PRODUCTION (barrels) Yearly	Cumulative
1942	1	1,902	1,902
1943	1	1,428	3,330
1944	0	92	3,422

The last reported production was in April, 1944.



QUITO FIELD
Ward County, Texas

EDWARD R. KENNEDY, Jr.
Geologist, Argo Oil Corporation, Midland, Texas
January 1, 1956

LOCATION

The Quito field is in west-central Ward County, 11 miles west of Pyote, 6 miles northeast of Barstow and about $4\frac{1}{2}$ miles northwest of the railroad siding of Quito.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Subsurface geology.

DISCOVERY

Bell Canyon: April 4, 1953; Argo Oil Corp. #1 John Olson.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Cherry Canyon formation 149 feet below its top. This penetration was in Argo Oil Corp. #1 Radford Grocery at its total depth of 5,886 feet. This well is located in Sec. 194 where the total depth 5,886 is indicated on the accompanying map.

NATURE OF TRAP

Bell Canyon: A complex permeability trap on an east-trending structural nose.

PRODUCTIVE AREA

Bell Canyon: Development to date proves that the productive area includes at least 1,200 acres. Further development may prove that the productive area is considerably more extensive.

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: Sandstone; gray, fine-grained, friable, with porosity and permeability varying in a wide range and with shale interstratified as indicated on the accompanying graph under the heading TYPICAL DETAIL OF PRODUCTIVE SECTION. The reservoir rock contains five sandstone zones separated by shales and shaly sandstones. The individual sandstone zones are lenticular and vary considerably in thickness and permeability within the area of the field. The upper-most sandstone, the most important oil-bearing zone, varies from 6 feet of impermeable, shaly sandstone to 39 feet of favorably permeable, non-shaly sandstone.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The reservoir rock is continuous throughout the area of the accompanying map. While the general character of the reservoir rock as a stratigraphic unit is about the same throughout the area, the individual layers vary considerably locally with the result that there is interruption of conditions favorable for migration of reservoir fluids. Because of the lenticularity of the sandstone members and the variation in the degrees of porosity and permeability, from a practical operating standpoint, the individual lenses determine the extent of continuity.

NEAR-BY RECENT DISCOVERIES

Exploratory drilling in 1955 at two locations within the area covered by the accompanying map resulted in completions as oil wells. With further development, it may be proved that these discoveries should be treated as extensions of the Quito field, but, at least for present purposes, they are considered as in productive areas beyond the limit of the Quito field. Both are producing from reservoir rocks of about the same character and at about the same stratigraphic position as the Quito reservoir rocks, and the oil is of about the same gravity. One is named West Quito field, where there are now three wells, and the other is named Regan-Edwards field.

West Quito field: Chambers & Kennedy #1 D.J.Creedon was completed on 5/29/55 and was treated as the discovery well of a new field. Landa Oil Co. #1 G.H.Watt (TD 4850) was completed on 10/18/55 as a northwest offset and Honolulu Oil Corp. #1 J.E.Echols (TD 4902) was completed on 1/1/56 as a southwest offset. At the end of 1955, there were two oil wells in the field, one flowing and one pumping; they had produced a total of 5,252 barrels of oil.

Regan-Edwards field: Ken Regan & Associates #2 P.W. Edwards et al was completed on 8/19/55 and was treated as the discovery well of a new field. At the end of 1955, this well was pumping and had produced a total of approximately 1,400 barrels of oil.

THICKNESSES OF RESERVOIR ROCK

Bell Canyon:	Feet		
	Min.	Max.	Avg.
From top to bottom	142	194	170
Net productive	5	50	15

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet, approx.
No free gas cap	
Elevation of highest known oil	-2,182
Elevation of lowest known oil	-2,453
Known relief	271

The above figures represent approximately the general conditions at time of discovery. However, it appears that the oil-water contact was not at a uniform elevation in all sandstone lenses. Furthermore, in the uppermost sandstone, it appears that the oil-water contact slopes eastward; from -2,218 at the western edge of the field to -2,325 at the eastern edge of the field. The position of the oil-water contact has not been definitely determined in any of the other sandstone members.

WATER PRODUCTION

Bell Canyon: Every well produces some water. The ratio of water to gross fluid produced by individual wells ranges from 1% to 85%. Water accompanies oil in the production from every productive member of the reservoir rock.

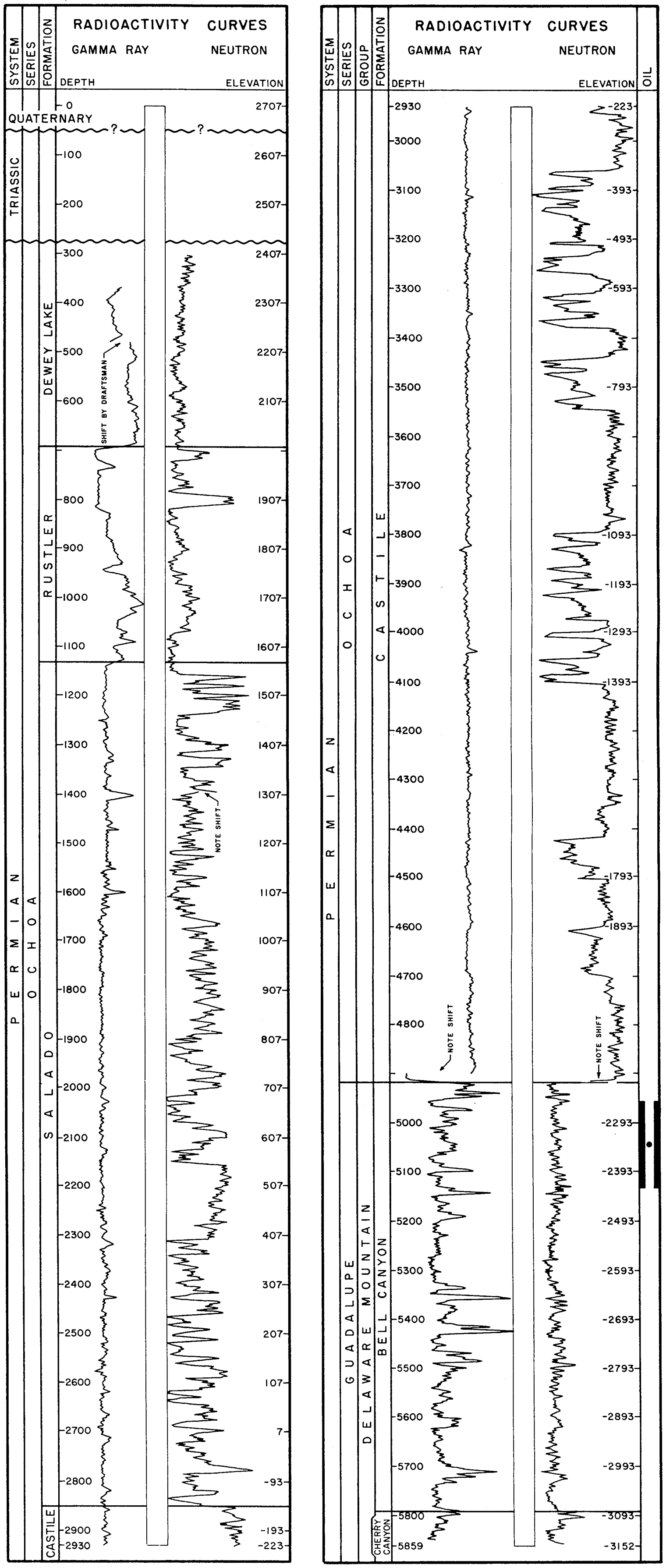
COMPLETION TREATMENT

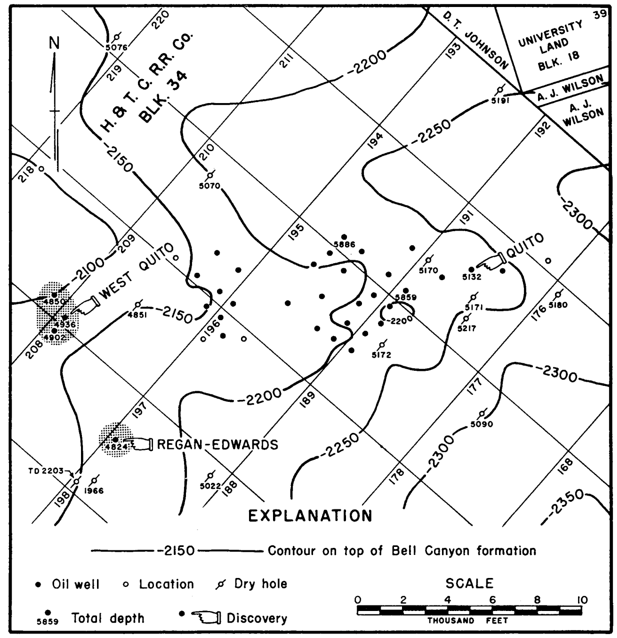
Bell Canyon: The reservoir rock in every well has been subjected to hydraulic fracturing by some one of the several processes now used.

TYPICAL SECTION OF ROCKS PENETRATED

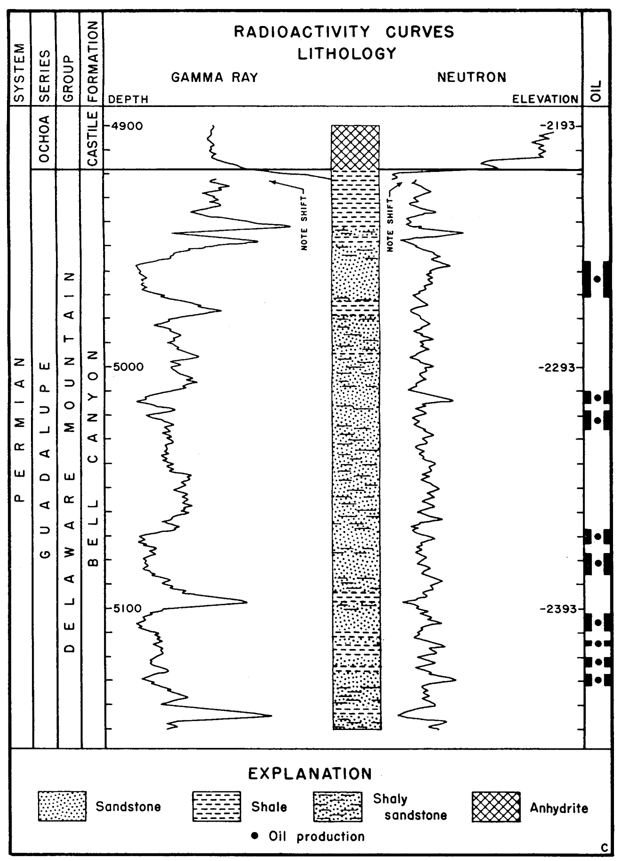
SURFACE FORMATION: Undifferentiated Quaternary.

ELEVATION OF SURFACE: At well locations: Highest, 2,704 feet; lowest, 2,588 feet.





TYPICAL DETAIL OF PRODUCTIVE SECTION



CHARACTER OF OIL

Bell Canyon: Gravity, A. P. I. @ 60°F., 38.2° to 39.1°.

PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Wells producing at end of year: Pumping	Oil production (barrels): Yearly	Oil production (barrels): Cumulative
1953	6	1	42,522	42,522
1954	10	10	180,217	222,739
1955	13	17	223,819	446,558

REINECKE FIELD

Borden County, Texas

R. LELAND REDLINE
Chief Geologist, Great Western Drilling Co., Midland, Texas
October 13, 1954

LOCATION

The Reinecke field is near the southeast corner of Borden County; 4 miles from the east boundary and 2 miles from the south boundary. It is in Block 25 of Houston & Texas Central R.R. Co. survey.

NEAR-BY NONCOMMERCIAL PROSPECTS

GARNER: The well which prompted the designation of the Garner field is near the southeast corner of the area covered by the accompanying map. Rowan Oil Co. #1 C.H. Garner was completed on April 3, 1951 in the Clear Fork group with an initial daily pumping capacity of 133 barrels of 27° gravity oil and no water through perforations between 4,242 feet and 4,272 feet after having been plugged back from the total depth of 7,520 feet. It was generally recognized as a discovery well and was so treated in several publications. It produced 3,566 barrels of oil during 1951 and 847 barrels during 1952. It was plugged and abandoned on October 26, 1952.

REINECKE (CLEAR FORK): D.D.Feldman Oil & Gas #1 A.O.Murphy, located near the north boundary of the area covered by the accompanying map, is the only well ever completed in the field designated by the Railroad Commission as the Reinecke (Clear Fork) field. This well was completed September 26, 1952 with an initial daily pumping capacity of 179 barrels of 38° gravity oil; gas-oil ratio, 288:1. It was drilled to a total depth of 6,995 feet and was plugged back to 4,919 feet. The top of the reservoir rock, which is in the Clear Fork group, is at the depth of 4,559 feet. The well produced 2,610 barrels of oil during 1952 and 1,055 barrels during 1953 and was plugged and abandoned January 21, 1954.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The general trend of previously discovered fields indicated chances sufficiently favorable to warrant drilling under the terms of an available drilling deal.

DISCOVERY

Cisco: February 2, 1950; George P. Livermore, Inc. #1 W. Reinecke (now, Great Western Drilling Co. #1 W. Reinecke).

ELEVATION OF SURFACE

At well locations: Highest, 2,370 feet; lowest, 2,300 feet.

SURFACE FORMATION

Recent alluvium and undifferentiated red beds of the Triassic system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Pennsylvanian system. The oldest horizon penetrated in the vicinity of the field is 65 feet below the top of the Ellenburger group. This penetration was in Chapman & McFarlin #2 A.L.Holley, located near the southwest corner of section 52, where the total depth of 8,112 feet is indicated on the accompanying map.

NATURE OF TRAP

Cisco: Convex upper limit of reef limestone which is covered by relatively impervious shale.

THICKNESS OF RESERVOIR ROCK

Cisco: The maximum gross thickness of the reservoir rock is on the order of 300 feet.

LITHOLOGY OF RESERVOIR ROCK

Cisco: Reef limestone. In several wells, commercial production has been found in a thin dolomitized zone of limestone above the main white fossiliferous limestone reef. In one well, Cosden Petroleum Corp. #2 I.B.Holbein, such a zone occurs several hundred feet above the main limestone reef, but it seems probable that this particular zone is productive merely because it is connected to the main reef by fractures and solution channels. The writer considers it possible that some of these dolomitized zones are of early Wolfcamp age.

CONTINUITY OF RESERVOIR ROCK

Cisco: The same general reef is continuous northeastward through Scurry County and southeastward on an arc which crosses the southeast corner of Borden County, turns northward in Howard County and swings northwestward across the southwest corner of Borden County and into Dawson County.

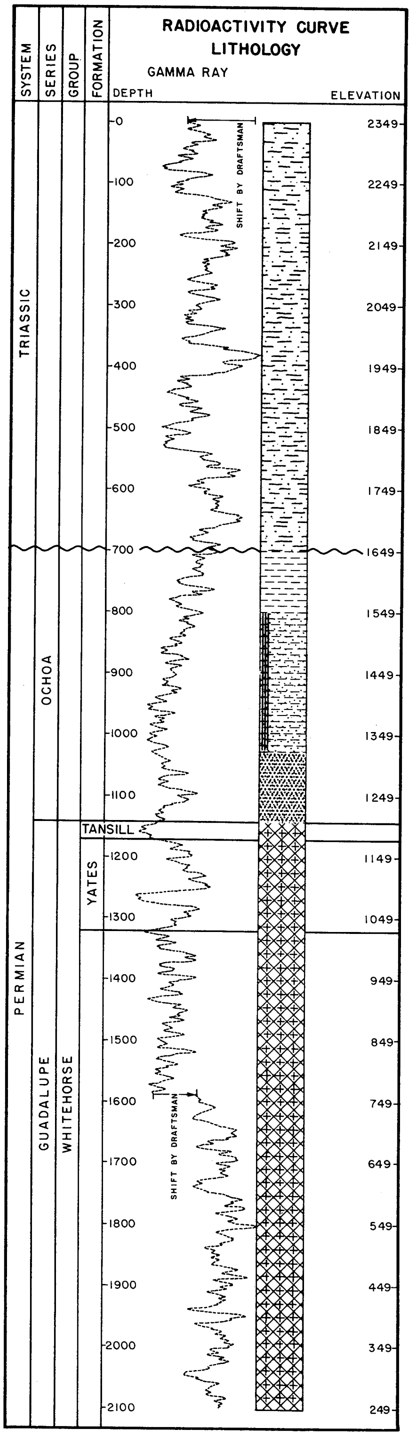
WATER PRODUCTION

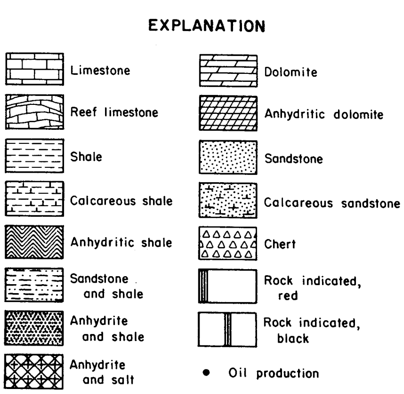
Cisco: Production of salt water has amounted to about one million barrels to date. At present, seven wells are producing bottom-hole water in varying percentages ranging from 4% to 98% of gross liquid produced. The absence of a gas cap, coupled with a uniform rise of bottom-hole pressure whenever the field is shut in for bottom-hole pressure surveys, suggests that water drive may contribute to reservoir energy. Production of liquids is now at a rate faster than migration of water into the productive area.

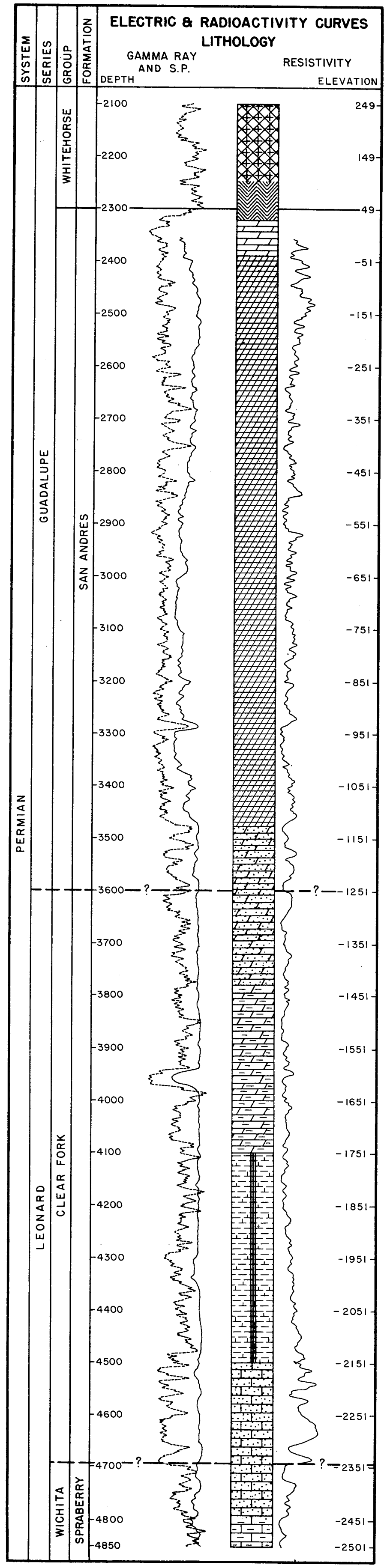
ACID TREATMENT

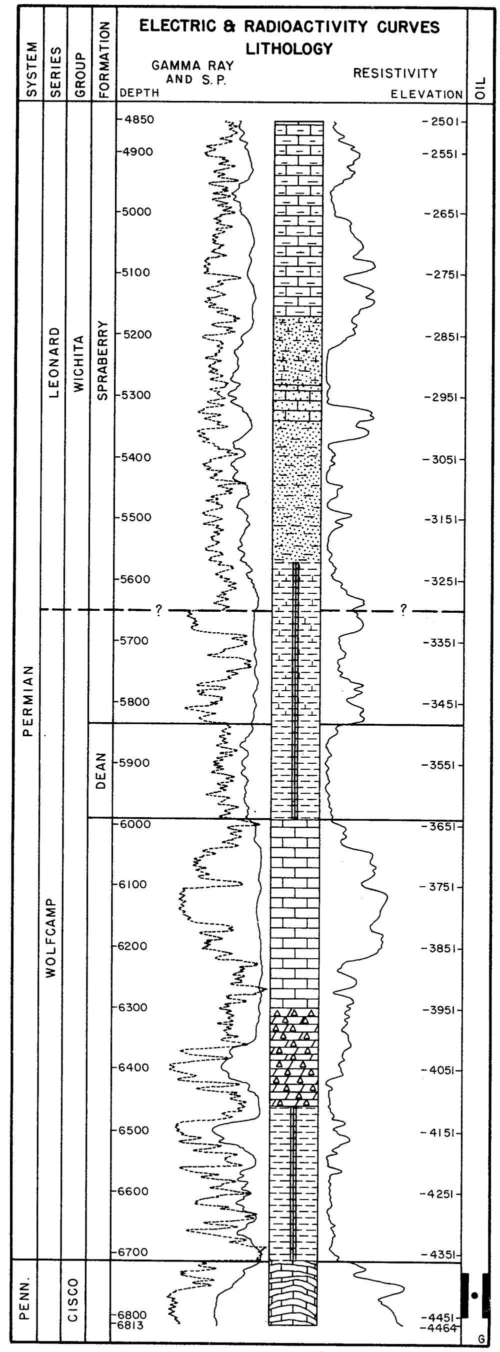
Cisco: There has been no uniform program for acid treatment of the reservoir. Several operators have used small wash-shots (1,000 gallons) to clean mud contamination from the reef limestone, although there has been little difficulty in flowing the wells naturally.

TYPICAL SECTION OF ROCKS PENETRATED









PRODUCTIVE AREA

Cisco and Field 2,700 acres.

RESERVOIR PRESSURE and OIL SAMPLE DATA

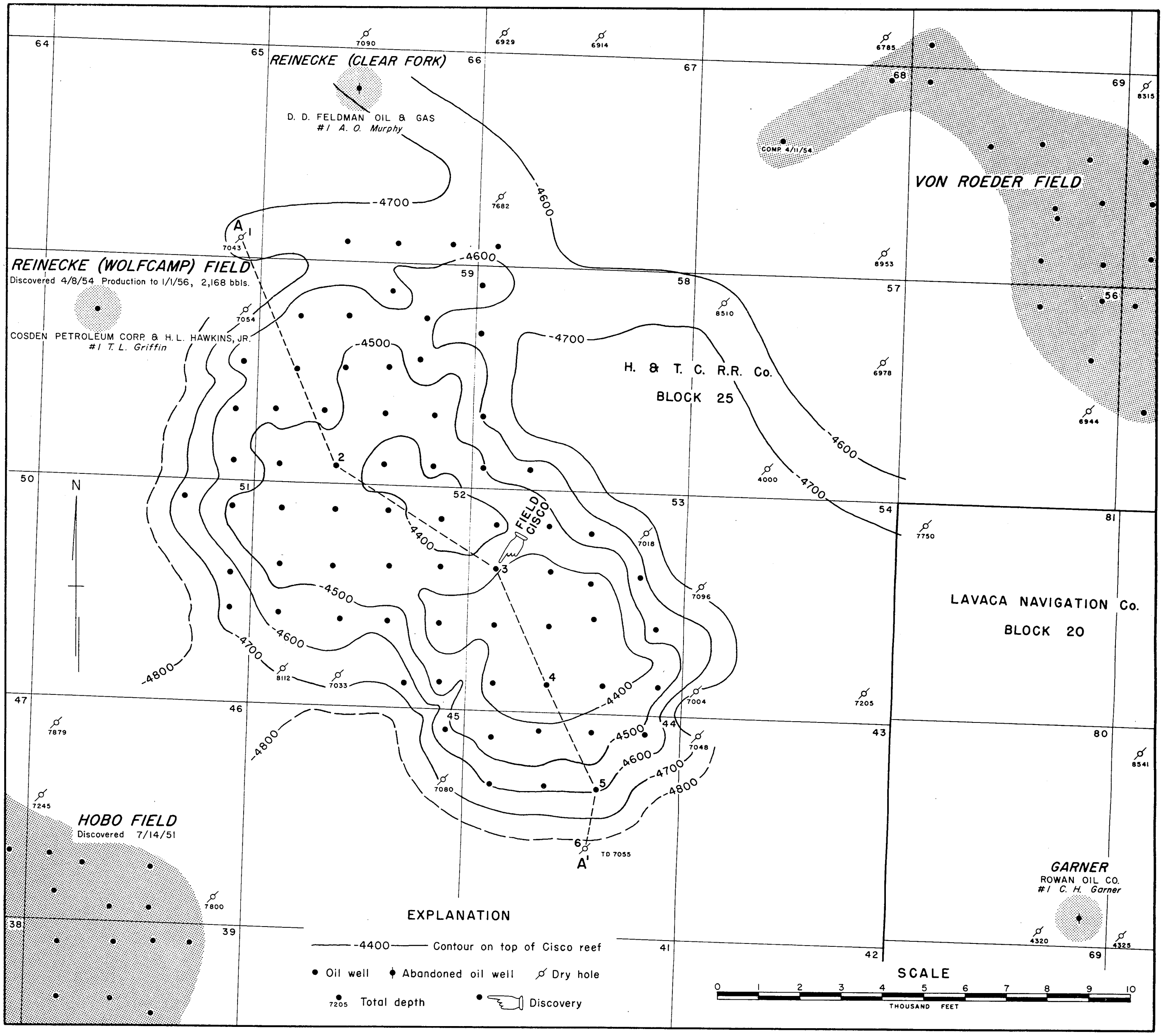
Cisco:

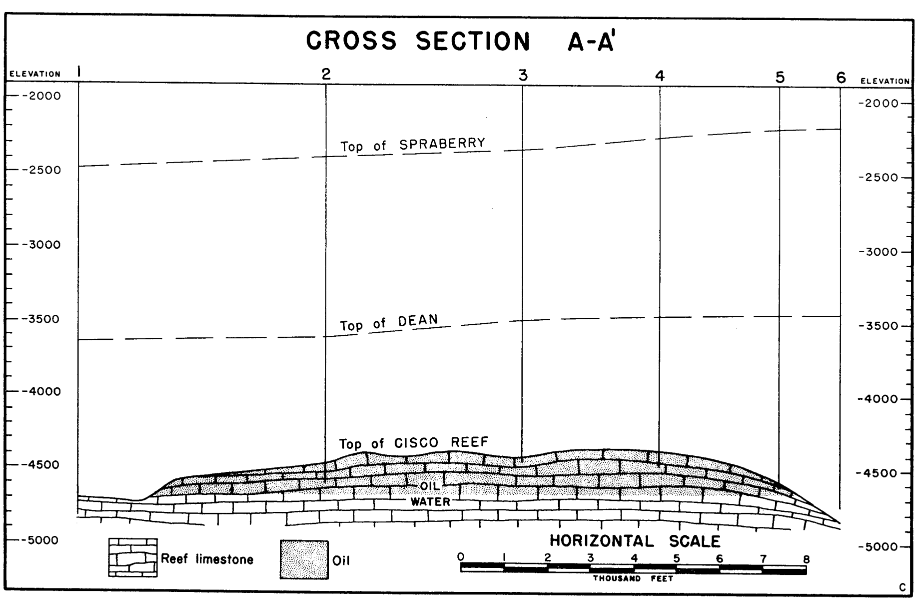
Reservoir pressure at -4,400 feet	
2/2/50 (initial)	3,164 psi.
9/2/53 (field average)	2,432 psi.
Gravity of oil, A.P.I. @ 60°F.	46.4°
Sulphur in oil	0.18%
Solution gas:oil ratio	1,000:1
Saturation pressure @ 139°F.	2,010 psi.
Volume factor (surface:reservoir)	1.795
Shrinkage factor (reservoir:surface)	0.557

For analyses see:

U. S. Bureau of Mines — Lab. ref. No. 51065, Item 59

Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953)





ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Cisco:	Feet
No free gas cap	
Elevation of top of oil	-4,356
Elevation of bottom of oil	-4,660
Relief	304

The above figures represent an estimate of conditions at the time of the discovery of the field. The oil-water contact is undoubtedly a little higher now; probably 10 to 15 feet higher.

PRODUCTION HISTORY

Cisco and Total field:

	No. of WELLS at end of year			OIL PRODUCTION (barrels)	
Year	Flow.	Pump.	Shut-in	Yearly	Cumulative
1950	47	0	0	1,223,234	1,223,234
1951	68	2	0	3,080,586	4,303,820
1952	67	2	0	2,919,210	7,223,030
1953	65	3	1	2,696,575	9,919,605
1954*	65	4	1	1,638,944	11,558,549
1955*	65	4	1	1,568,875	13,127,424

*Data for 1954 and 1955 added by amendment.

RUSSELL FIELD

Gaines County, Texas

MARSHALL W. BAILEY and CLYDE M. RASCOE
Geologists, The Atlantic Refining Company, Midland, Texas
March 31, 1953

INTRODUCTION

A very active drilling campaign is now being conducted in this field by several companies. Because of this activity, determinative data are being added often and current interpretations vary considerably. Therefore, it is not practical to include in this paper either structural contour maps or cross sections.

LOCATION and OTHER NAME

The Russell field is in northwest Gaines County about 18 miles northwest of Seminole, county seat, and about 5 miles east of the Texas - New Mexico state boundary line. It is near the northern end of the Central Basin platform.

The area where the Devonian is productive is known as the North Russell Devonian field. By southeastward development from the discovery well, that area now overlaps the area where shallower reservoirs have long been productive, which area has been known as the Russell field ever since the discovery of commercial production in 1943. Since the two areas now overlap, they are being treated as one field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Shallow reflection seismic work by Shell Oil Company in 1939.

VARIATIONS IN THICKNESSES

Quaternary, Triassic, Permian and Cisco: Normal off-structure thickening.

Canyon, Strawn, Bend and Mississippian: Over the crest of the anticlinal structure, beds which are probably of Canyon age appear to lie unconformably on beds of the Osage group. Rocks representing the hiatus (i.e., Meramac and possible Chester of Upper Mississippian age and Bend and Strawn of Pennsylvanian age) are believed to be present on the flanks in an onlapping relationship. Paleontological identifications of the lower Permian and Pennsylvanian beds are not available to the writers.

Devonian: The Woodford thins slightly over the crest of the anticline. The Devonian system has not been entirely penetrated.

DISCOVERIES

Upper Clear Fork: April 3, 1945;
Shell Oil Co. #2-A E.H. Jones
Lower Clear Fork: February 12, 1943;
Shell Oil Co. #1 D.N. Leaverton
Devonian: November 11, 1948;
Argo Oil Corp. #1-N E.H. Jones

ELEVATION OF SURFACE

At well locations: Highest, 3,615 feet; lowest, 3,527 feet.

SURFACE FORMATION

Undifferentiated sands and caliche of Quaternary system.

OLDEST HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is in the Devonian system about 467 feet below the Woodford formation. This penetration was in Magnolia & Atlantic #18 H. & J. Unit 1-D, located in Sec. 491, Block G, C.C.S.D. & R.G.N.G. R. R. survey.

PRODUCTIVE AREAS

	Acres
Upper Clear Fork	1,400
Lower Clear Fork	3,000
Devonian	1,520
Russell field	4,160

It is probable that further development will warrant increasing each of the above estimates.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Upper Clear Fork	Lower Clear Fork	Devonian
Elevation of top of oil, feet	-2,347	-3,705	-7,120
Elevation of bottom of oil, feet	-2,558 to -2,590	-4,433+	-7,600
Relief, feet	243	728+	480

The above figures represent conditions in each reservoir at time of discovery. There was not then, nor is there now, a gas cap in any one of the three reservoirs.

Upper Clear Fork: The maximum oil column at any one place is 230 feet; average is 136 feet. The elevation of the oil-water contact is erratic and varies by as much as 32 feet; generally it is higher where the top of the reservoir is higher. It is not yet known whether the oil-water contact is advancing upward regularly as oil is withdrawn or whether there is any appreciable water drive.

Lower Clear Fork: Except in wells producing from the Devonian, there has been no penetration of the entire Lower Clear Fork formation. The deepest penetration by a Lower Clear Fork producer was in a well where the total depth is at the elevation of -4,433 feet; water had not yet been reached at that depth; there is an oil column of 590 feet in this well. The average penetration is 419 feet. No definite water table or bottom of oil has been established.

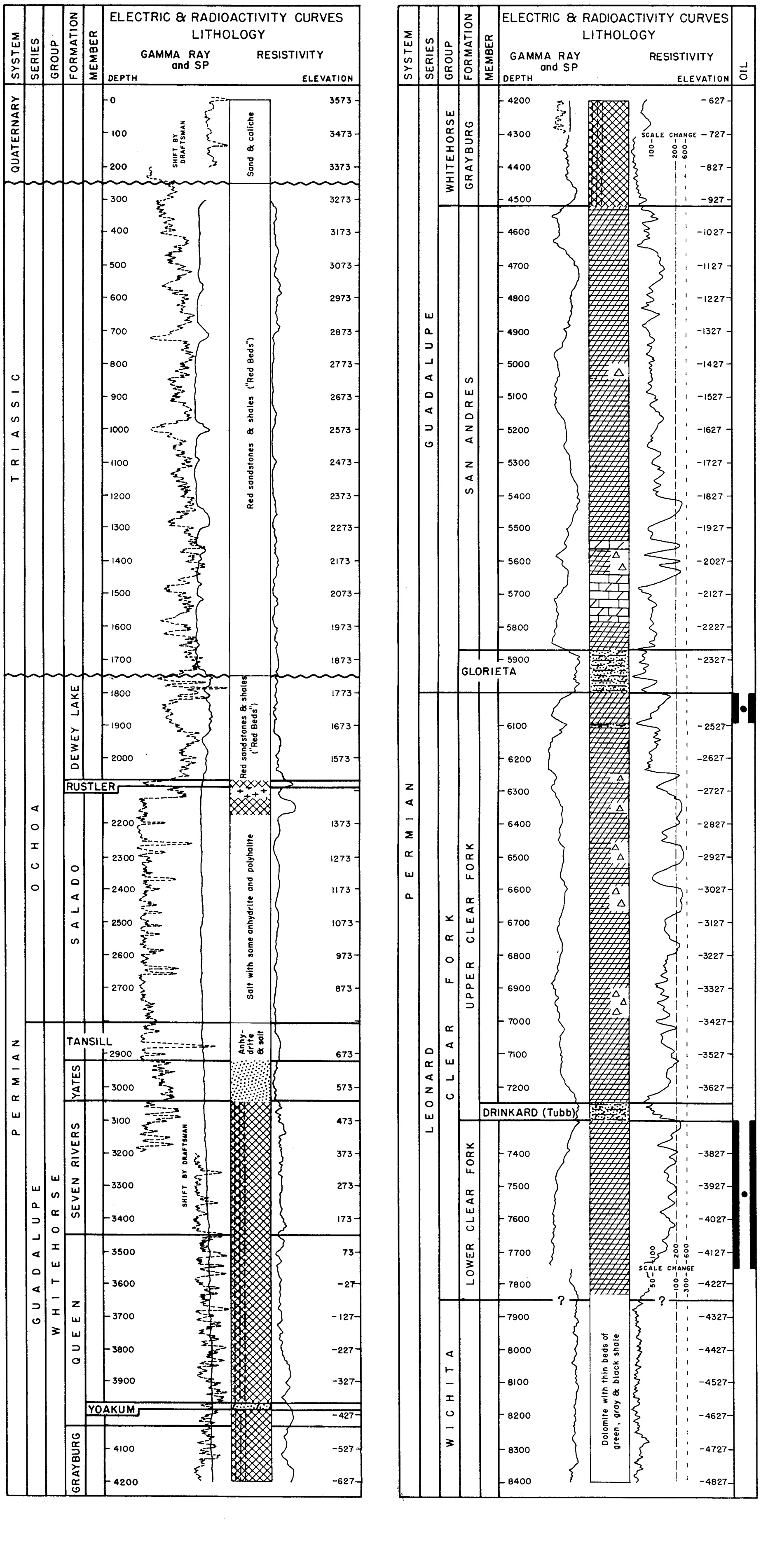
Devonian: The maximum oil column at any one place is 467 feet; average is 100 feet.

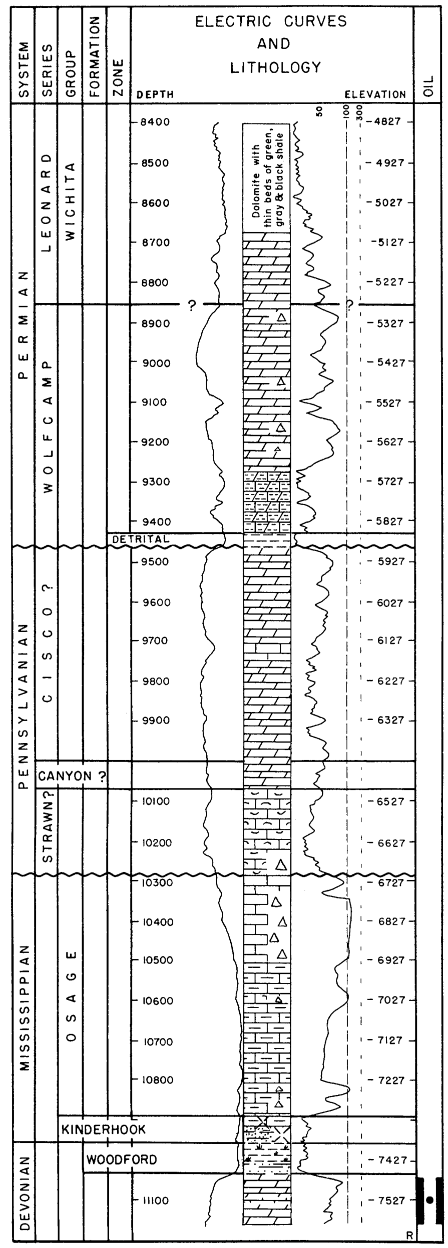
CHARACTER OF OIL

	Upper Clear Fork	Lower Clear Fork	Devonian
Gravity, A.P.I. @ 60° F.	34.5°	43.7°	37.2° - 41.6°
Sulphur	1.25%	1.13%	0.22%
Odor	Sour	Sour	
Appearance	Green	Brown-green	Brown-green
Pour point	-20°F	-15°F	-20°F
Boiling point	90°F		
Type	Naphthalenic Wax-bearing	Naphthalenic Wax-bearing	Intermediate

The analysis of the Upper Clear Fork oil was made by Shell Oil Co. November 25, 1952 of a sample from Shell Oil Co. #4-B E.H. Jones. The analysis of the Lower Clear Fork oil was made by Atlantic Refining Co. in 1940 of a sample from Shell Oil Co. #1 D.N. Leaverton.

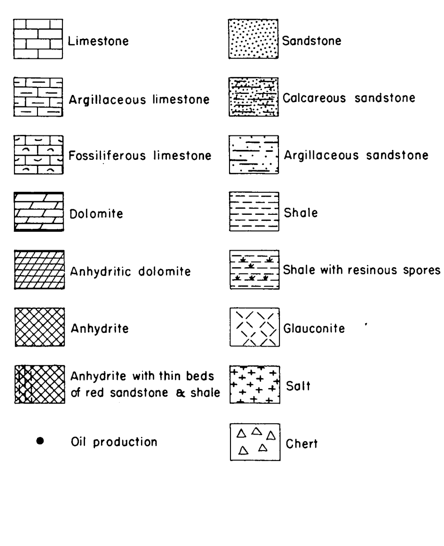
TYPICAL SECTION OF ROCKS PENETRATED

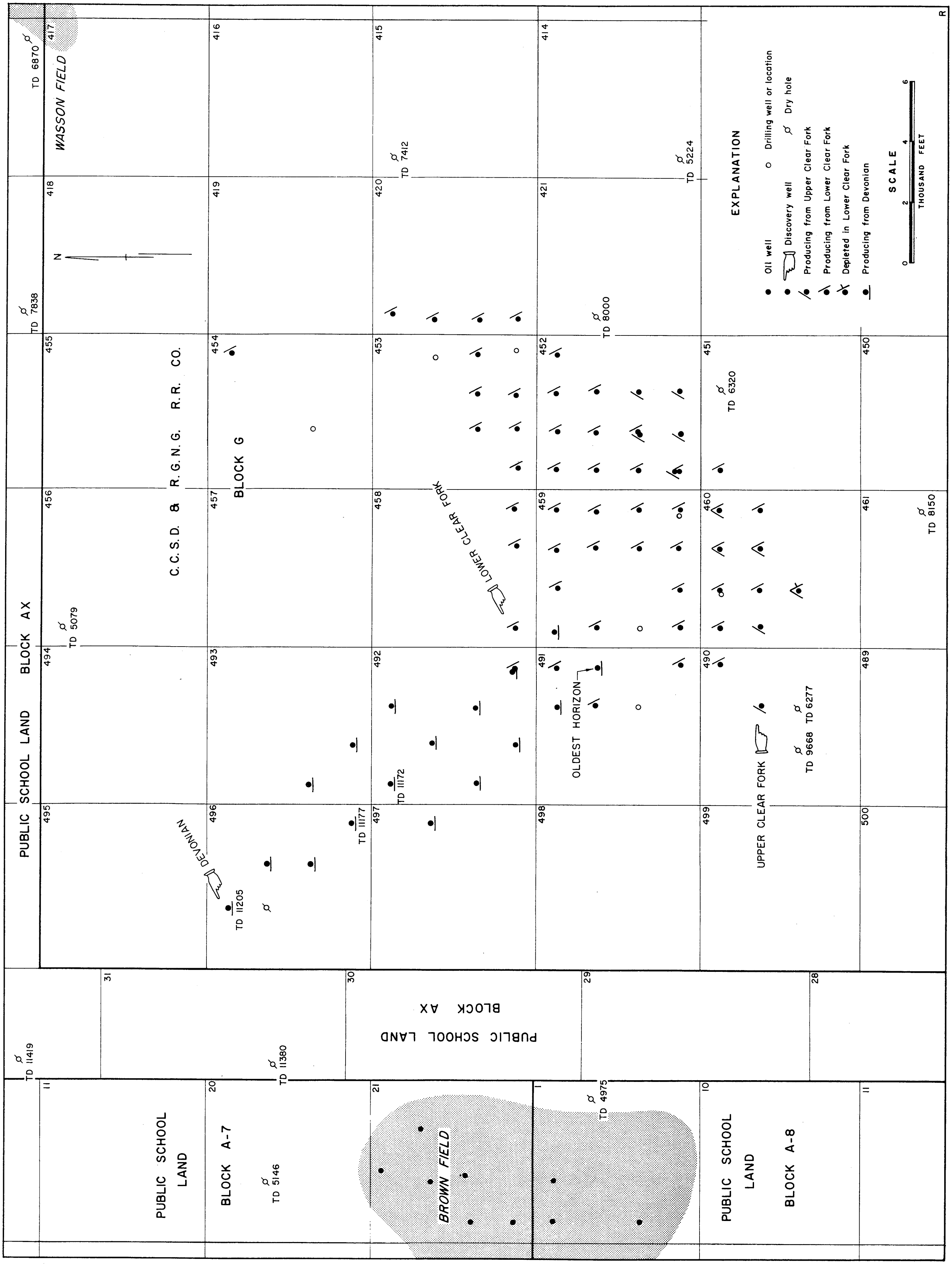




NOTE: This TYPICAL SECTION is based on a composite log compiled from the logs of three wells.

EXPLANATION





WASSON FIELD
PUBLIC SCHOOL LAND BLOCK AX
C.C.S.D. & R.G.N.G. R.R. CO.
BLOCK G
LOWER CLEAR FORK
DEVONIAN
OLDEST HORIZON
UPPER CLEAR FORK
PUBLIC SCHOOL LAND
BLOCK AX
PUBLIC SCHOOL LAND
BLOCK A-7
BROWN FIELD
PUBLIC SCHOOL LAND
BLOCK A-8
TD 6870
TD 7838
TD 7412
TD 5224
TD 8000
TD 6320
TD 8150
TD 5079
TD 6277
TD 9668
TD 11172
TD 11177
TD 11205
TD 11419
TD 11380
TD 5146
TD 4975
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R
EXPLANATION
Oil well
Drilling well or location
Discovery well
Dry hole
Producing from Upper Clear Fork
Producing from Lower Clear Fork
Depleted in Lower Clear Fork
Producing from Devonian
SCALE
0 2 4 6
THOUSAND FEET

NATURE OF TRAPS

Upper Clear Fork and Lower Clear Fork: The trap in each of these two reservoirs is due to a combination of anticlinal structure and updip decrease of porosity.

Devonian: Anticlinal structure.

THICKNESSES OF RESERVOIR ROCKS

	Feet		
Upper Clear Fork	Min.	Max.	Avg.
From top to bottom	34	230	150
Net productive	12	80	50
Lower Clear Fork			
From top to bottom	495	530	512
Net productive	165	177	171
Devonian			
From top to bottom	65	467	100
Net productive	50	150	75

WATER PRODUCTION

Upper Clear Fork: On or about January 1, 1953, 4 of the 8 producing wells were producing water in ratios varying from 25 to 90% of gross liquid.

Lower Clear Fork: Water constitutes less than 5% of gross liquid produced.

Devonian: On or about January 1, 1953, 6 of the 16 producing wells were producing water in ratios varying from 10 to 60% of gross liquid.

CONTINUITY OF RESERVOIR ROCKS

Upper Clear Fork and Lower Clear Fork: Each of these reservoir rocks can be correlated throughout the area covered by the accompanying map. However, the degree of porosity which occasions commercial production is very erratic, and, with few exceptions, is not continuous at any one stratigraphic position throughout more than a few hundred acres. Although there are productive reservoirs at corresponding stratigraphic positions in several fields on the Central Basin platform, it is not likely that conditions favorable for migration of reservoir fluids are continuous from either of these reservoirs to any reservoir in any other field. In the Lower Clear Fork on the east flank of the field, both the lateral and downward extent of the reservoir is determined by a facies change from a porous dolomite to a dense limestone.

Devonian: While this reservoir rock is continuous throughout the area of the accompanying map, the lithologic characteristics change considerably within that area. The relative amounts of dolomite and limestone vary from well to well. Although there is considerable variation in porosity and permeability, it appears probable that there is sufficient continuity of porosity and permeability to permit migration of reservoir fluids throughout the area covered by the accompanying map.

LITHOLOGY OF RESERVOIR ROCKS

Upper Clear Fork: Dolomite; anhydritic, buff to tan, finely crystalline, with fair intercrystalline and solution porosity.

Lower Clear Fork: Dolomite; slightly anhydritic, buff to tan with some zones of gray and brown mottling, fine to medium crystalline, with fair intercrystalline and solution porosity. Thin spicular chert zones occur locally.

Devonian: Interbedded limestone and dolomite containing small amounts of white chert; tan to white, fine to medium crystalline, with good vuggy and intercrystalline porosity, especially in the dolomite, which constitutes more than half of the reservoir rock.

ACID TREATMENT

Upper Clear Fork: Common practice is to wash reservoir with 500 gallons of mud acid and then treat with 1,500 to 5,000 gallons of regular acid. Ordinarily, 1,500 gallons is sufficient, but the quantity varies in accordance with the response of each individual well.

Lower Clear Fork: Common practice is to wash reservoir with 500 gallons of mud acid and then treat with 10,000 to 20,000 gallons of regular acid. Ordinarily, 10,000 to 12,000 gallons is sufficient, but the quantity varies with the thickness of reservoir rock treated and in accordance with the response of each individual well.

Devonian: Some wells are completed without acid treatment; others are treated with acid in quantities varying with the response of each individual well. Commonly, the treatment is with only 500 to 1,000 gallons of mud acid, but one well was treated with 12,000 gallons of regular acid. Ordinarily, the treatment is with 1,000 to 2,500 gallons of regular acid.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Upper Clear Fork				
1945	1	0	24,531	24,531
1946	1	1	25,514	50,045
1947	2	1	47,342	97,387
1948	2	2	52,181	149,568
1949	3	2	63,852	213,420
1950	3	2	83,102	296,522
1951	3	2	87,285	383,807
1952	2	4	80,608	464,415
Lower Clear Fork				
1943	1	1	39,425	39,425
1944	3	2	100,535	139,960
1945	2	8	225,290	365,250
1946	6	12	355,299	720,549
1947	9	20	438,772	1,159,321
1948	5	26	497,433	1,656,754
1949	3	32	394,048	2,050,802
1950	6	35	453,673	2,504,475
1951	4	41	595,175	3,099,650
1952	6	42	528,075	3,627,725
Devonian				
1948	0	1	4,386	4,386
1949	0	1	45,908	50,294
1950	2	1	64,304	114,598
1951	8	1	350,545	465,143
1952	13	3	798,388	1,263,531

GAS PRODUCTION: The only gas production has been incidental to oil production. The quantities produced have been minor and have been utilized in field operations. No analysis of the gas is available.

SAN BENITO FIELD
Coke County, Texas

J. R. KIENE
Geologist, Sinclair Oil & Gas Co., Midland, Texas
July 9, 1954

LOCATION

The San Benito field is in north central Coke County 11 miles northwest of the town of Robert Lee, county seat.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The location of the discovery well was based on studies of surface and subsurface geological data supplemented by magnetometer data.

MAP and STRATIGRAPHIC SECTION

Because of geographic and geologic relationships, Arledge field and San Benito field are shown on the same map; presented in the foregoing paper on the Arledge field.

The TYPICAL SECTION in the paper on the Arledge field applies also to this field. The stratigraphic position of the reservoir in the producing well in this field is the same as that of the reservoir in the Arledge field. The Ellenburger zone which produced for a short time is at the top of such Ellenburger as is present at this location. However, the top of the Ellenburger is an eroded surface and the exact position within the Ellenburger group is not known.

DISCOVERIES

Strawn: July 23, 1948; Alan Guiberson #1 J.Lassiter. During initial potential test, flowed through 17/64-inch choke at daily rate of 319 barrels of oil and 25 barrels of water.

Ellenburger: Oct. 4, 1948; Algord Oil Co. #2 J.Lassiter. During initial potential test, pumped at daily rate of 176 barrels of oil and 53 barrels of water.

ELEVATION OF SURFACE

	Ground	Derrick floor
Elev. at Strawn well, feet	2,111±	2,121
Elev. at Ellenburger well, ft.	2,133±	2,143

SURFACE FORMATIONS

Undifferentiated formations of the Fredericksburg and Trinity groups are exposed on the hills and undifferentiated Tertiary beds occur in the valleys.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is 148 feet below the eroded top of the Ellenburger group. This penetration was in C.W.Sharp #1 B.D.Gartman, the dry hole about 1,300 feet west of the field discovery well.

NATURE OF TRAPS

Strawn and Ellenburger: The trap in each of the two reservoirs appears to be due to convex folding. There is a structural closure which amounts to at least as much as 17 feet at the top of the Strawn reservoir rock.

LITHOLOGY OF RESERVOIR ROCKS

Strawn: Limestone; dark brown, finely crystalline to dense, both intercrystalline and vug type porosity.

Ellenburger: Dolomite; light gray, coarsely crystalline, intercrystalline type porosity.

PRODUCTIVE AREAS

Strawn	40 acres
Ellenburger (depleted)	40 acres

THICKNESSES OF RESERVOIR ROCKS

Net productive	Feet, approx.
Strawn	25
Ellenburger (depleted)	50

CONTINUITY OF RESERVOIR ROCKS

Strawn: The reservoir rock appears to be continuous throughout the area covered by the map presented in the foregoing paper on the Arledge field.

Ellenburger: The continuity of the particular zone which was productive at the location of the abandoned well is not determinable from available data.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Strawn	Ellenburger
Elevation of top of oil, feet.	-4,373	-4,675
Elevation of bottom of oil, ft.	-4,398	-4,725
Relief	25	50

The above figures represent estimates of elevations as of respective discovery dates.

CHARACTER OF OIL

	Strawn	Ellenburger
Gravity, A.P.I. @ 60° F.	47°	45°
Sulphur	0.2%	0.1%

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Strawn:				
1948	1	0	11,198	11,198
1949	1	0	15,270	22,468
1950	0	1	3,933	26,401
1951	0	1	2,684	29,085
1952	0	1	4,364	33,449
1953	0	1	1,247	34,696
Ellenburger:				
1948	0	1	2,200	2,200
1949	0	0	200	2,400

The only well which has produced from the Ellenburger, was completed on October 4, 1948 and was plugged and abandoned on January 27, 1949.

SCURRY FIELD

Scurry, Kent and Borden Counties, Texas

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March 1, 1954

LOCATION and INTRODUCTION

The Scurry field is mainly in Scurry County covering an area about 32 miles long and generally 4 to 8 miles wide extending from near the southwest corner of Scurry County northeastward just west of the town of Snyder and extending 4 miles into Kent County. It includes 4 wells in Borden County, 2,185 in Scurry County and 153 in Kent County.

Oil is produced from 38 distinct reservoirs at 13 stratigraphic positions The stratigraphic positions are shown ón the accompanying TYPICAL SECTION; the areal extent of each reservoir is shown on one or more of the maps on the accompanying fold-in plate. The stratigraphic positions and the number of reservoirs at each position are indicated in the following tabulation.

Stratigraphic position	Number of reservoirs	Located on map	Prod. areas Total acres
San Andres	2	II	920
San Angelo	2	IV	240
Clear Fork	1	IV	1,880
"Wolfcamp"	1	V	160
Cogdell	1	II	320
Fuller	3	II	800
"Cisco"	3	III	4,040
"Canyon"	6	I, II, III, IV, V	83,160
Strawn Zone A	1	I	40
Strawn Zone B	5	I	1,160
Strawn Zone C	9	I	760
Strawn Zone D	1	I	240
Ellenburger	3	I	120
Scurry field	38		86,200

In the following presentation, where the entry applies to both of the two San Andres reservoirs, the heading is "San Andres (A, B)"; to the one Cogdell reservoir, "Cogdell (A)"; to the three Fuller reservoirs, "Fuller (A, B, C)", etc.

The stratigraphic names in quotation marks are in common usage in the senses indicated on TYPICAL SECTION. Their usage here in quotation marks is not intended as an endorsement of such usages; it is merely the result of an effort to facilitate proper coordination of the information herein with corresponding and related information in other publications.

* Publication authorized by Director, U. S. Geological Survey. Stratigraphic nomenclature does not necessarily conform to that of U.S. Geological Survey.

FIELD NAMES

The Scurry field includes 23 fields as now designated by the Railroad Commission of Texas. Nine additional designations formerly used by the Commission are no longer used. The following tabulation lists those designations in the left column and, in the right column, indicates the corresponding stratigraphic positions and areas as designated in this paper.

Now used by Comm.	Designation herein:
Cogdell	"Canyon" (A)
Cogdell (4900')	Cogdell (A)
Cogdell (Fuller Sand)	Fuller (A, B)
Cogdell (San Andres)	San Andres (A, B)
Cogdell (Strawn)	Strawn Zone C (A)
Cogdell, West (Strawn)	Strawn Zone C (B, C)
Dermott	Ellenburger (A)
Diamond 'M' Canyon	"Canyon" (B)
Diamond 'M' Clearfork	Clear Fork (A)
Diamond 'M' San Andres	San Angelo (A, B)
Diamond 'M' Wolfcamp	"Wolfcamp" (A)
Early (Strawn)	Strawn Zone B (B, D)
Fuller	Fuller (C)
Fuller, Southeast (7100' Strawn)	"Canyon" (D)
Fuller (Strawn 'B')	Strawn Zone B (A)
Kelly-Snyder	"Canyon" (B)
Kelly-Snyder (Caddo)	Strawn Zone C (H, I)
Kelly-Snyder (Cisco Sd.)	"Cisco" (A, B, C)
North Snyder (Strawn Zone 'A')	Strawn Zone A (A)
North Snyder (Strawn Zone 'B')	Strawn Zone B (B, C, E)
North Snyder (Strawn Zone 'C')	Strawn Zone C (D, E, F, G) and Strawn Zone D (A)
Schattel	"Canyon" (F)
Vernon Cox (Canyon Rf.)	"Canyon" (C)

No longer used by Comm.	
Brown (Cisco Sand)	"Cisco" (A)
Collins	Strawn Zone B (B)
Eiland (Ellenburger)	Ellenburger (C)
Kelly	"Canyon" (B)
North Snyder	"Canyon" (B)
North Snyder Ellenburger	Ellenburger (B)
North Snyder Strawn	"Canyon" (E) Strawn Zones B (B, C, E), C (D, E, G) and D (A)
Parks (Cisco Sand)	"Cisco" (A)
Sharon Ridge Canyon	"Canyon" (B)

METHODS OF EXPLORATION LEADING TO DISCOVERY

The location of the field discovery well was based on a seismograph survey and a study of the subsurface geological data.

DISCOVERIES

San Andres (A, B): November 10, 1951;
Chapman & McFarlin Producing Co. #33-A D.M.Cogdell

San Angelo (A, B): December 14, 1950;
Robert W. McKissick #1 Hugh Birdwell

Clear Fork (A): October 15, 1949;
Hiawatha Oil & Gas Co. #7 L.M.Wilson

"Wolfcamp" (A): October 14, 1952;
Humble Oil & Refining Co. #4-B J.E.Sorrels

Cogdell (A): April 14, 1950;
Chapman & McFarlin Producing Co. #6 D.M.Cogdell.

Fuller (A, B, C): November 18, 1950;
Chapman & McFarlin Producing Co. #25 D.M.Cogdell

"Cisco" (A, B, C): April 21, 1951;
Standard Oil Co. of Texas #1-S G.E.Parks

"Canyon" (A-F) and Field: July 16, 1948;
Sun Oil Co. and Humble Oil & Refining Co. #1 Emil Schattel

Strawn Zone A (A): May 15, 1953;
Ralph A. Johnson and W.S.Johnson #1 V.H.Wade

Strawn Zone B (A-E): April 14, 1949;
Placid Oil Co. #1 W.W.Early

Strawn Zone C (A-I): November 5, 1948;
Magnolia Petroleum Co. #1 Winston Brothers

Strawn Zone D (A): April 21, 1951;
Cities Service Oil Co. #4 Poponoe "B"

Ellenburger (A, B, C): April 27, 1949;
Humble Oil & Refining Co. #1-B B.A.Moore

SURFACE FORMATIONS

The Ogallala formation of the Tertiary system, the Fredericksburg and Trinity groups of the Cretaceous system, the Dockum group of the Triassic system, and the Whitehorse group of the Permian system crop out within the area of the field.

LITHOLOGY OF RESERVOIR ROCKS

San Andres (A, B): Dolomite; light olive-gray, fine-grained, porous.

San Angelo (A, B): Sandstone; light-gray, very-fine- to fine-grained; contains some interbedded shale and siltstone.

Clear Fork (A): Dolomite; light olive-gray, scattered anhydrite aggregates, poor to good porosity.

"Wolfcamp" (A): Limestone; light- to medium-gray, fine-grained, poor to fair porosity.

Cogdell (A): Limestone; light-gray, fine-grained, vuggy.

Fuller (A, B, C): Sandstone; fine- to medium-grained, angular to subangular, fair to good porosity and permeability; contains interbedded thin shales and siltstones.

"Cisco" (A, B, C): Sandstone; fine- to medium-grained, subangular, loosely cemented, fair porosity; contains varying amounts of silty material and interbedded shales and siltstones.

"Canyon" (A-F): Limestone; clastic, fine- to boulder-sized fragments; contains a small amount of lithographic limestone and shale; porosity is extremely variable, averaging 10.5% for productive rock.

Strawn Zones A, B, C and D (all reservoirs): Limestone; clastic, fine- to medium-grained; porosity is extremely variable.

Ellenburger (A, B, C): Dolomite; white to light brownish-gray, fine-grained; contains a small percentage of white chert; fair to poor porosity.

RESERVOIR ENERGY

"Canyon" (A-F): The expansion of gas from solution is the primary type of reservoir energy in the "Canyon" reservoirs. No appreciable water drive or encroachment of water is evident. Reservoir pressure has steadily declined from the initial 3,122 psi. to as low as 1,675 psi. in some places. The importance of pressure maintenance was recognized early in the development of the field. As early as December 1950, experimental water injection was begun. Gas injection on an experimental basis was started in June 1951. At present, a large-scale pressure maintenance program under a unitization agreement is being initiated for a large part of the "Canyon" producing area. Both gas injection and water injection are to be used in this program.

Other reservoirs: Information is scanty concerning the reservoir energy in other reservoirs. Water drive appears to be the primary source of energy in most of the reservoirs other than "Canyon" (A-F).

ELEVATION OF SURFACE

At well locations (derrick floor): Highest, 2,622 feet; lowest, 2,124 feet.

NATURE OF TRAPS

San Andres (A, B): Accumulation in each of the two reservoirs appears to be due to decrease in porosity updip to the east.

San Angelo (A, B): The factors which occasioned accumulation are not known. Since the degree of porosity and permeability of the productive sandstone is known to be irregular and since this sandstone generally yields water where penetrated within the area of the field, it is believed that the traps are due to updip decrease of porosity and permeability although the degree of inclination of the reservoir rock is evidently very low.

Clear Fork (A), Cogdell (A) and Fuller (A, B, C): The accumulation in each of these reservoirs is due to a convex fold. The structure of each reservoir rock is probably due mainly to differential compaction of lower beds deposited on and in the vicinity of a reef.

"Wolfcamp" (A): The accumulation appears to be due mainly to updip decrease of porosity and permeability where the reservoir rock is warped into a gentle nose on a general westward dip.

"Cisco" (A, B, C): The primary trap-forming factor is a convex fold, but variation in degree of porosity and permeability is a contributing factor, and probably the dominating factor as to "Cisco" (B) and "Cisco" (C).

"Canyon" (A-F): The accumulation of oil in each of these reservoirs is due to a simple convex trap resulting from topography of highly porous reef limestone. The oil is trapped in buried topographic crests overlain and surrounded by relatively impervious shale.

Strawn Zones A, B, C and D (All reservoirs): The writer has not determined precisely the trap-forming factors for each of the 16 reservoirs in the Strawn series. However, it is evident that all accumulations are due to reef conditions. Generally, the accumulations appear to be in reservoirs with convex upper limits where the inclination of the reservoir rocks has resulted from deposition on a sloping surface and, to a lesser degree, from differential compaction of lower beds. Updip decrease in porosity and permeability within complex reef may be the controlling factor for some reservoirs.

Ellenburger (A, B, C): There is only a single well in each of the three reservoirs. Data are not available for determining the trap-forming factors.

OLDEST HORIZON PENETRATED

The oldest rock penetrated in the vicinity of the field is pre-Cambrian granite. The greatest penetration into the granite was in Humble Oil & Refining Company #14 LeRoy Spires, Jr., located in Sec. 719, Block 97, H. & T. C. survey, which reached a total depth of 8,292 feet (-5,856 feet) after having penetrated 36 feet of granite. One other hole in the immediate vicinity of the field and two holes within the field were drilled into the pre-Cambrian granite. A few holes in the southern part of the field were drilled deeper, but were in younger rocks at their total depths because of regional tilting and thickening southwestward.

THICKNESSES OF RESERVOIR ROCKS

	Feet		
	Min.	Max.	Avg.
San Andres (A, B):			
Thickness of producing zone	19	38	28
Net productive thickness	?	?	?
San Angelo (A, B):			
Thickness of producing zone	12	52	34
Net productive thickness	?	?	?
Clear Fork (A):			
Thickness of producing zone	45	190	110
Net productive thickness	10	60	20
"Wolfcamp" (A):			
Thickness of producing zone	20	34	26
Net productive thickness	?	?	?
Cogdell (A):			
Thickness of producing zone	23	46	39
Net productive thickness	5	19	12
Fuller (A, B, C):			
Thickness of producing zone	4	36	21
Net productive thickness	4	32	18
"Cisco" (A, B, C):			
Thickness of producing zone	9	110	38
Net productive thickness	9	45	20
"Canyon" (A-F):			
Thickness of producing zone	5	770	350
Net productive thickness	5	635	180
Strawn Zone A (A):			
Thickness of producing zone			28
Net productive thickness			28
Strawn Zone B (A-E):			
Thickness of producing zone	15	86	48
Net productive thickness	6	50	20
Strawn Zone C (A-I):			
Thickness of producing zone	10	42	23
Net productive thickness	5	13	10
Strawn Zone D (A):			
Thickness of producing zone	30	54	38
Net productive thickness	10	18	12
Ellenburger (A, B, C):			
Thickness of producing zone	20	50	25
Net productive thickness	?	?	?

CONTINUITY OF RESERVOIR ROCKS

San Andres (A, B): The bed of dolomite which is productive in the two small areas indicated on Map II is probably continuous throughout the area of the field. However, the degrees of porosity and permeability are quite variable.

San Angelo (A, B): The sandstone in the San Angelo formation appears to be continuous throughout the area of the field. Generally, the degree of permeability is too low for commercial production of oil.

Clear Fork (A): The dolomite in the Clear Fork group which is productive in an area of about 1,880 acres in the south part of the field is continuous throughout the area of the field. Generally it is not sufficiently porous and permeable to yield oil commercially.

"Wolfcamp" (A): The bedded limestone in the Wolfcamp series, part of which produces oil, is continuous throughout the area of the field. Generally, the degree of porosity and permeability are not favorable for production of oil.

Cogdell (A): Although the limestone which is productive in 8 wells near the north end of the field has not been separately identified in the south part of the field, it appears likely that it is continuous throughout the northern three-fourths of the field. Where it has been identified, the degree of porosity appears adequate for free migration of reservoir fluids.

Fuller (A, B, C): The Fuller member has been recognized in only the northern part of the field. It is productive in three small areas covered by accompanying Map II but has been recognized only slightly further south than the southern border of that map. It appears to be continuous in the northern part of the field and to have a sufficient degree of porosity and permeability for free migration of reservoir fluids.

"Cisco" (A, B, C): Although the three reservoirs indicated on Map III are at the same stratigraphic position, it is not known whether there is continuity of conditions favorable for migration of reservoir fluids between the three areas. Throughout the area of the entire field, there is sandstone at or near this stratigraphic position, but, because of lenticularity, together with lateral variations in content of shale and siltstone, it is very difficult to correlate the individual sandstone beds.

"Canyon" (A - F): The "Canyon" reef is continuous throughout the field. It produces oil in all wells where it is above the water level except for a few wells on the margin of the field where such reef limestone as is above the water level is very dense.

Strawn Zones A, B, C and D (all reservoirs): The 16 reservoirs are all related to reef conditions. The continuity of each reservoir rock is dependent upon its particular reef relationships.

Ellenburger (A, B, C): The productive rock in each of the three reservoirs is at the top of such portion of the Ellenburger dolomite as is present at the particular location. The top of the Ellenburger is a truncated surface throughout the area of the field. The exact position within the Ellenburger has not been determined for any one of the reservoirs and therefore the continuity of the reservoir rock cannot be determined. However, the Ellenburger dolomite has been demonstrated by many wells to be continuous throughout the area of the field.

CHARACTER OF OIL

	Gravity, A.P.I. @ 60° F.			Sulphur, %	
	Min.	Max.	Avg.	Less than	Color
San Andres (A, B)	36.2	39.0	38.0		
San Angelo (A, B)	33.2	39.0	35.9		
Clear Fork (A)	28.0	34.0	31.0	1.00	
"Wolfcamp" (A)	42.1	43.3	42.4		
Cogdell (A)	41.5	42.7	42.1	0.50	Dark greenish-black
Fuller (A, B, C)	40.0	45.6	42.1	0.25	Dark- to light-green
"Cisco" (A, B, C)	38.2	43.7	42.3		Dark-green
"Canyon" (A-F)	39.4	45.4	43.0	0.50	Green to greenish-black
Strawn Zone A (A)			37.2		
Strawn Zone B (A-E)	37.3	42.4	38.0	0.40	Green to greenish-brown
Strawn Zone C (A-I)	33.5	45.1	40.3	0.50	Green to greenish-brown
Strawn Zone D (A)	38.6	40.6	39.5		
Ellenburger (A, B, C)	36 0	46.5	41.2	0.30	Dark green to brownish-green

For analyses see:

U.S.Bureau of Mines

Analyses of Crude Oils from some West Texas fields, R.I. 4959 (March 1953). Items 49, 50, 51, 52, 53, 54, 56, 57, 58, 61, 62, 63, 64, 65 and 66.

* A New Method of Determining Variations in Physical Properties of Oil in a Reservoir, with application to the Scurry Reef Field, Scurry County, Texas, R.I. 5106 (February 1955).

* Added by amendment.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation of oil (feet) Top	Elevation of oil (feet) Bottom	Relief (feet)
San Andres (A)	664	615	49
San Andres (B)	563	550	13
San Angelo (A)	-97	-149	52
San Angelo (B)	-95	-135	40
Clear Fork (A)	-725	-950	225
"Wolfcamp" (A)	-3,007	-3,152	145
Cogdell (A)	-2,538	-2,604	66
Fuller (A)	-2,641	-2,670	29
Fuller (B)	-2,658	-2,670	12
Fuller (C)	-2,682	-2,755	73
"Cisco" (A)	-3,615	-3,900	285
"Cisco" (B)	-3,680	-3,790	110
"Cisco" (C)	-3,779	-3,861	82
"Canyon" (A)	-3,792	-4,560	768
"Canyon" (B)	-3,738	-4,540	802
"Canyon" (C)	-4,660	-4,674	14
"Canyon" (D)	-4,810	-4,820	10
"Canyon" (E)	-4,769	-4,793	24
"Canyon" (F)	-4,425	-4,501	76
Strawn Zone A (A)	-4,672	-4,700	28
Strawn Zone B (A)	-4,840	-4,855	15
Strawn Zone B (B)	-4,890	-4,935	45
Strawn Zone B (C)	-4,845	-4,955	110
Strawn Zone B (D)	-5,128	-5,153	25
Strawn Zone B (E)	-4,956	-5,011	55
Strawn Zone C (A)	-4,917	-4,982	65
Strawn Zone C (B)	-5,065	-5,088	23
Strawn Zone C (C)	-5,091	-5,111	20
Strawn Zone C (D)	-4,981	-5,019	38
Strawn Zone C (E)	-5,094	-5,122	28
Strawn Zone C (F)	-4,989	-5,000	11
Strawn Zone C (G)	-5,070	-5,090	20
Strawn Zone C (H)	-5,208	-5,240	32
Strawn Zone C (I)	-5,215	-5,257	42
Strawn Zone D (A)	-5,175	-5,301	126
Ellenburger (A)	-5,580	-5,630	50
Ellenburger (B)	-4,385	-5,405	20
Ellenburger (C)	-5,713	-5,733	20

CHARACTER OF GAS

No gas analyses are available. The only gas produced is gas which comes out of solution as the oil is produced. No free gas has been found in any of the reservoirs discovered to date.

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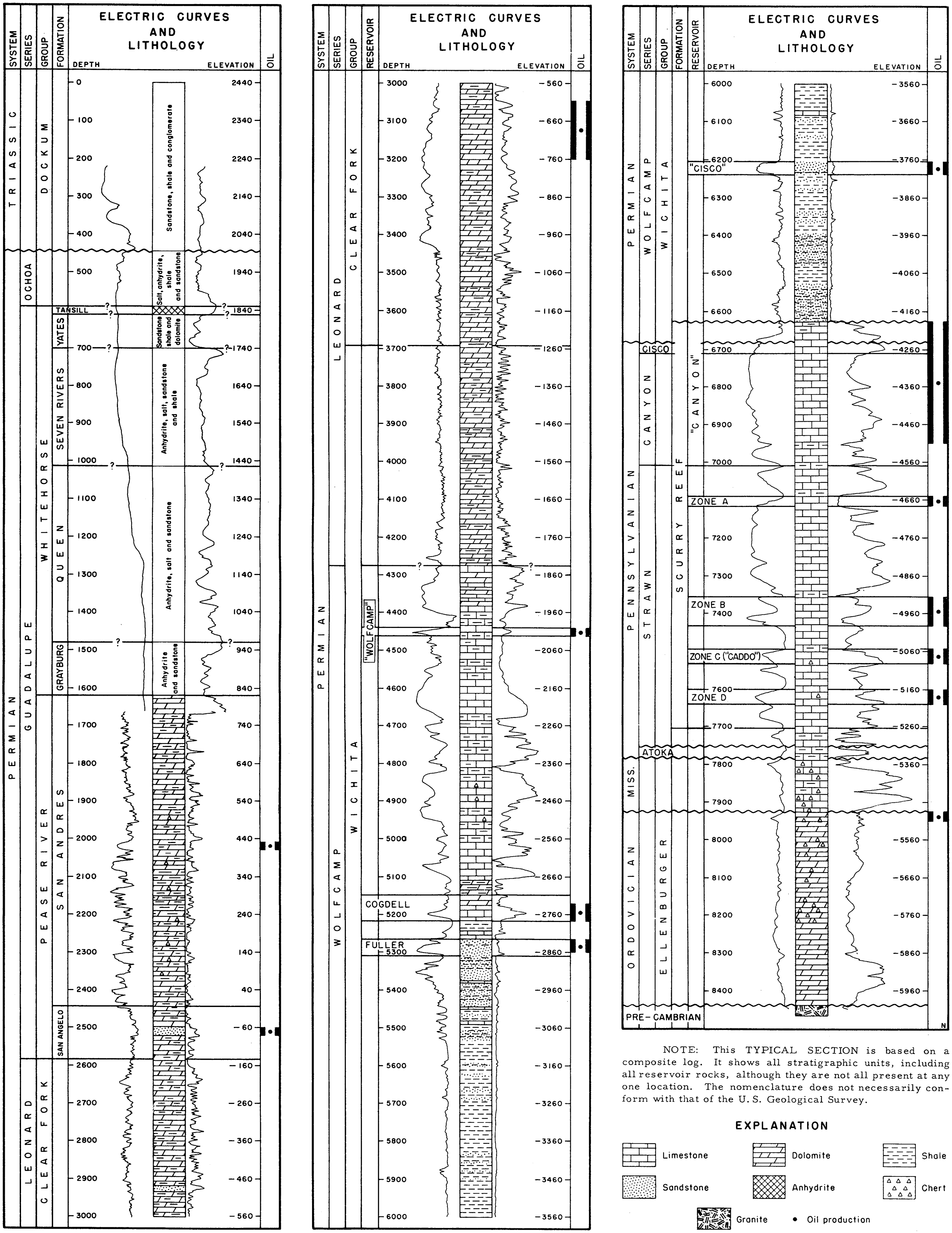
TYPICAL SECTION OF ROCKS PENETRATED



NOTE: This TYPICAL SECTION is based on a composite log. It shows all stratigraphic units, including all reservoir rocks, although they are not all present at any one location. The nomenclature does not necessarily conform with that of the U. S. Geological Survey.

EXPLANATION

Limestone, Dolomite, Shale, Sandstone, Anhydrite, Chert, Granite, • Oil production

(see SCURRY map)

WATER PRODUCTION and ACID TREATMENT

	WATER	ACID TREATMENT			
	% of wells showing water at time of initial completion	% of wells treated (approximate)	Minimum treatment (gallons)	Maximum treatment (gallons)	Average treatment (gallons)
San Andres (A, B)	8	100	1,500	8,000	5,000
San Angelo (A, B)	100	33	1,000	2,250	1,675
Clear Fork (A)	75	95	2,500	20,000	10,500
"Wolfcamp" (A)	0	25	1,000	1,000	1,000
Cogdell (A)	0	50	250	2,000	950
Fuller (A, B, C)	20	0	0	0	0
"Cisco" (A, B, C)	0	10	20	6,300	1,100
"Canyon" (A - F)	5	90	250	10,000	1,000
Strawn Zone A (A)	0	0	0	0	0
Strawn Zone B (A - E)	10	50	500	5,500	2,500
Strawn Zone C (A - I)	35	67	500	2,000	1,000
Strawn Zone D (A)	15	100	500	10,000	4,100
Ellenburger (A, B, C)	100	67	2,000	3,000	2,500

TREATMENT by the Hydrofrac method has been applied to about 15% of all "Cisco" wells. Quantities used in such treatments ranged from 1,500 gallons to 6,000 gallons and averaged about 2,300 gallons. Nitroglycerin was used in the San Angelo discovery well and in about 10% of the wells completed in the reservior in the Clear Fork group.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)	
	Total	Flow.	Pump.	Yearly	Cumulative
Field totals					
1948	4	3	1	24,530	24,530
1949	319	308	11	4,259,144	4,283,674
1950	1,653	1,544	109	38,197,586	42,481,260
1951	2,026	1,744	282	50,156,616	92,637,876
1952	2,230	1,612	618	49,508,703	142,146,579
1953	2,322	?	?	44,961,345	187,107,924
San Andres (A, B)					
1951	1	0	1	880	880
1952	13	0	13	31,033	31,913
1953	22	?	?	37,830	69,743
San Angelo (A, B)					
1950	1	0	1	1,052	1,052
1951	1	0	1	2,038	3,090
1952	1	0	1	1,449	4,539
1953	5	?	?	4,374	8,913
Clear Fork (A)					
1949	2	0	2	5,037	5,037
1950	9	0	9	51,890	56,927
1951	33	0	33	100,225	157,152
1952	38	2	36	98,430	255,582
1953	49	?	?	99,679	355,261
"Wolfcamp"(A)					
1952	1	0	1	9,305	9,305
1953	4	?	?	146,102	155,407
Cogdell (A)					
1950	2	0	2	48,000	48,000
1951	2	0	2	65,436	113,436
1952	5	0	5	65,308	178,744
1953	7	?	?	101,113	279,857
Fuller (A, B, C)					
1950	1	0	1	4,060	4,060
1951	16	15	1	159,714	163,774
1952	19	13	6	367,163	530,937
1953	21	?	?	360,470	891,407
"Cisco" (A, B, C)					
1951	30	25	5	242,464	242,464
1952	101	13	88	1,613,068	1,855,532
1953	101	?	?	1,286,591	3,142,123
"Canyon" (A - F)					
1948	4	3	1	24,530	24,530
1949	311	307	4	4,217,163	4,241,693
1950	1,616	1,527	89	37,536,840	41,778,533
1951	1,910	1,695	215	48,557,200	90,335,733
1952	2,010	1,580	430	46,503,825	136,839,558
1953	2,069	?	?	42,192,138	179,031,696
Strawn Zones A, B, C and D (all reservoirs)*					
1949	4	1	3	32,482	32,482
1950	22	17	5	551,203	583,685
1951	32	9	23	1,026,019	1,609,704
1952	41	4	37	817,342	2,427,046
1953	43	?	?	731,619	3,158,665
Ellenburger (A, B, C)					
1949	2	0	2	4,462	4,462
1950	2	0	2	4,541	9,003
1951	1	0	1	2,640	11,643
1952	1	0	1	1,780	13,423
1953	1	?	?	1,429	14,852

*A few of the wells are dually completed in Strawn Zones B and C; each such well is counted as a single well.

GAS PRODUCTION: The only gas production has been incidental to oil production. No estimates of the quantities produced are available.

SEMINOLE FIELD

Gaines County, Texas

E. R. DOUGLAS
Geologist, The Atlantic Refining Company, Midland, Texas
May 15, 1953

LOCATION

The Seminole field extends from a location a mile south of the town of Seminole, county seat of Gaines County, northwestward a distance of 9 miles. It is on the northeast edge of the Central Basin platform.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of subsurface geological data and of the results of seismic and torsion balance surveys led to the discovery of the field. Before the commencement of the drilling operations which led directly to the discovery, it was widely known among operators that geophysical methods indicated the presence of a large anticline. Harry Adams Corporation and W. T. Walsh #1 S. J. Averitt, in the northeast corner of section 228, block G, Waxahachie Tap Railroad Co. survey, was commenced October 7, 1935 and, before the end of the year, had encountered a large gas flow at depth of 4,885 feet. While contending with mechanical difficulties, the well gauged at the rate of 12,000 Mcf of gas per day after it had been drilled to its final total depth of 4,915 feet. It was abandoned early in 1936 after tools had been lost in the hole. It was at a location only 466 feet from where the field discovery well was later drilled.

DISCOVERIES

San Andres: January 8, 1937;
Amerada Petroleum Corp. #1-A S. J. Averitt
Clear Fork*:
Amerada Petroleum Corp. #9 T. S. Riley

ELEVATION OF SURFACE

At well locations: Highest, 3,432 feet; lowest, 3,277 feet.

SURFACE FORMATION

Undifferentiated sands and caliche of the Tertiary system.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Wolfcamp series 2,512 feet below its top. This penetration was in Amerada Petroleum Corp. #6 R. W. Robertson at its total depth of 9,312 feet.

PRODUCTIVE AREAS

	Acres
San Andres	13,411
Clear Fork	840
Seminole field	13,411

It is probable that future development will warrant increasing the above estimate for Clear Fork.

*The reservoir in the Clear Fork group has been designated by the Railroad Commission of Texas as the Seminole San Angelo field.

NATURE OF TRAPS

San Andres and Clear Fork: The trap in each of these two reservoirs is due to convex folding.

THICKNESSES OF RESERVOIR ROCKS

	Feet Max.	Min.	Avg.
San Andres §:			
From top to bottom			
Gas cap	142	0	60
Oil	262	40	200
Net productive			
Gas cap	60	0	40
Oil	150	20	87
Clear Fork:			
From top to bottom	356	100	236
Net productive	150	50	80

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomite; anhydritic, tan, granular to dense.

Clear Fork: Dolomite; anhydritic, tan, dense to finely crystalline.

CONTINUITY OF RESERVOIR ROCKS

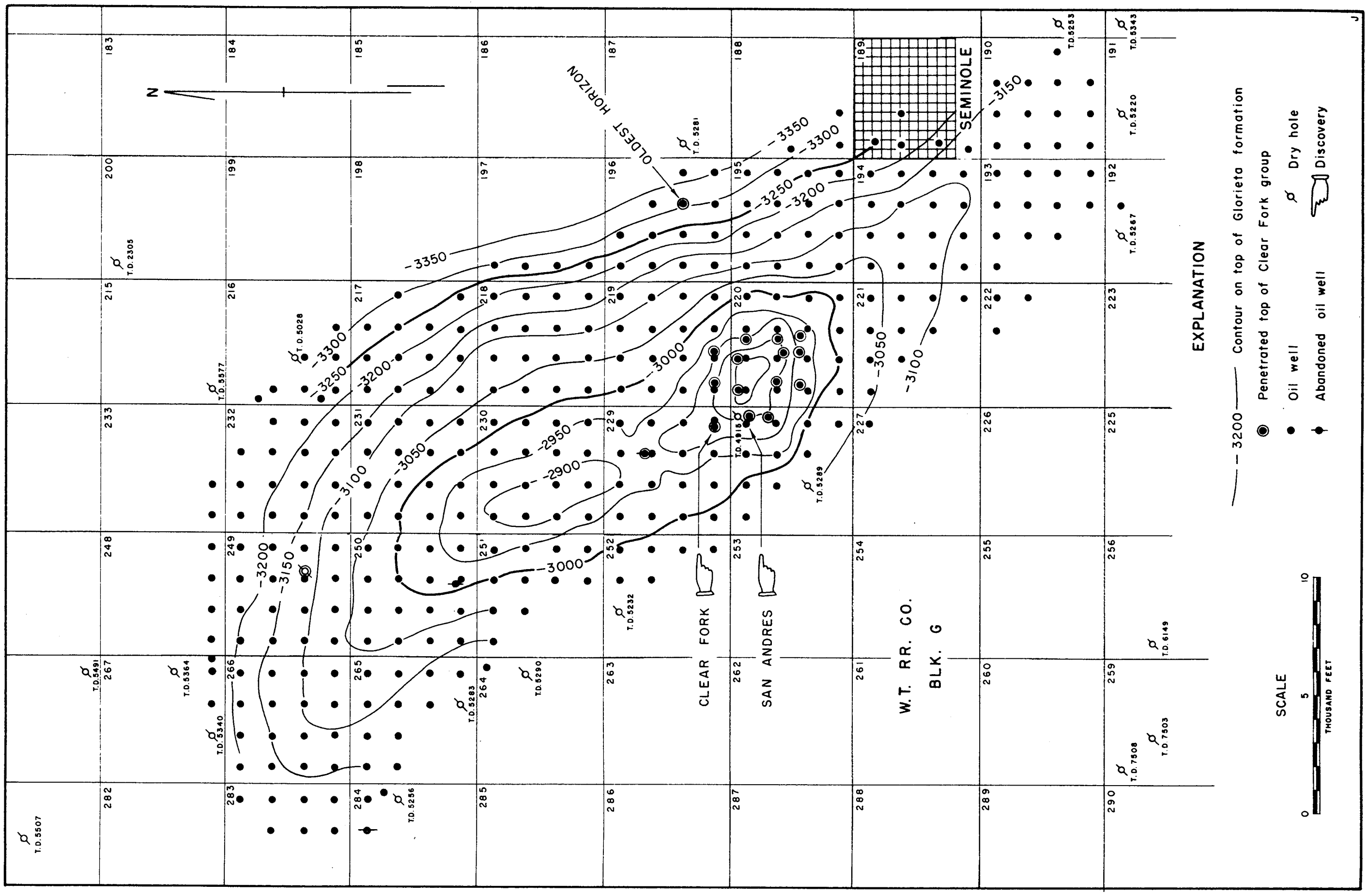
San Andres: The reservoir rock in the San Andres formation is continuous throughout the area of the field and probably far beyond the extent of the field. At about the same position in the San Andres formation there is dolomite of about the same characteristics throughout the area of the Central Basin platform and the Northern Shelf area of the Midland basin but whether the degrees of porosity and permeability are continuously sufficient for migration of reservoir fluids is not known. Secondary anhydrite commonly restricts porosity and permeability.

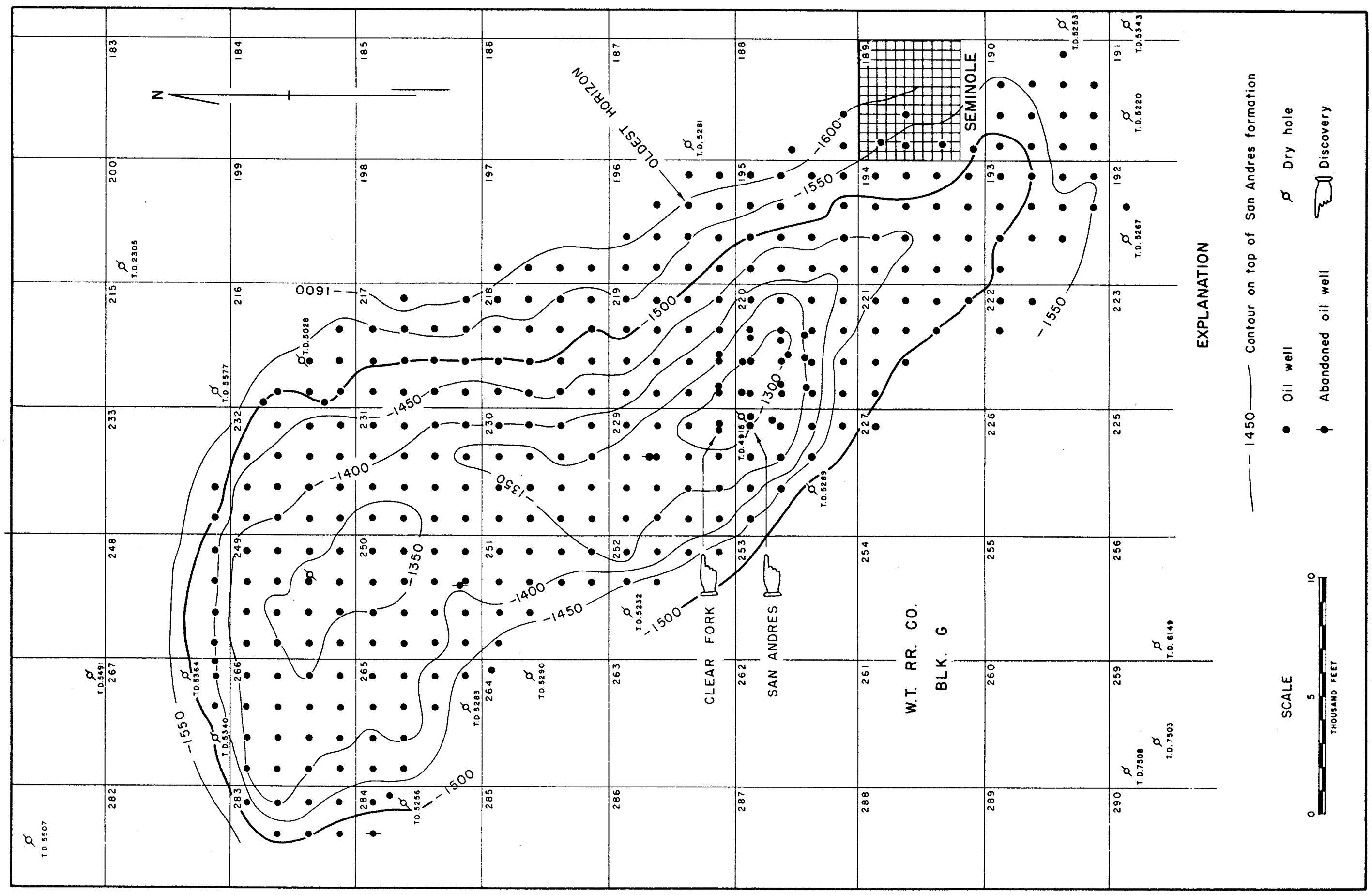
Clear Fork: The degree of porosity and permeability is so variable that continuity of reservoir is difficult to determine. Dolomite of about the same characteristics is widespread in the region but actual continuity of the reservoir beyond the presently productive wells cannot be determined.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

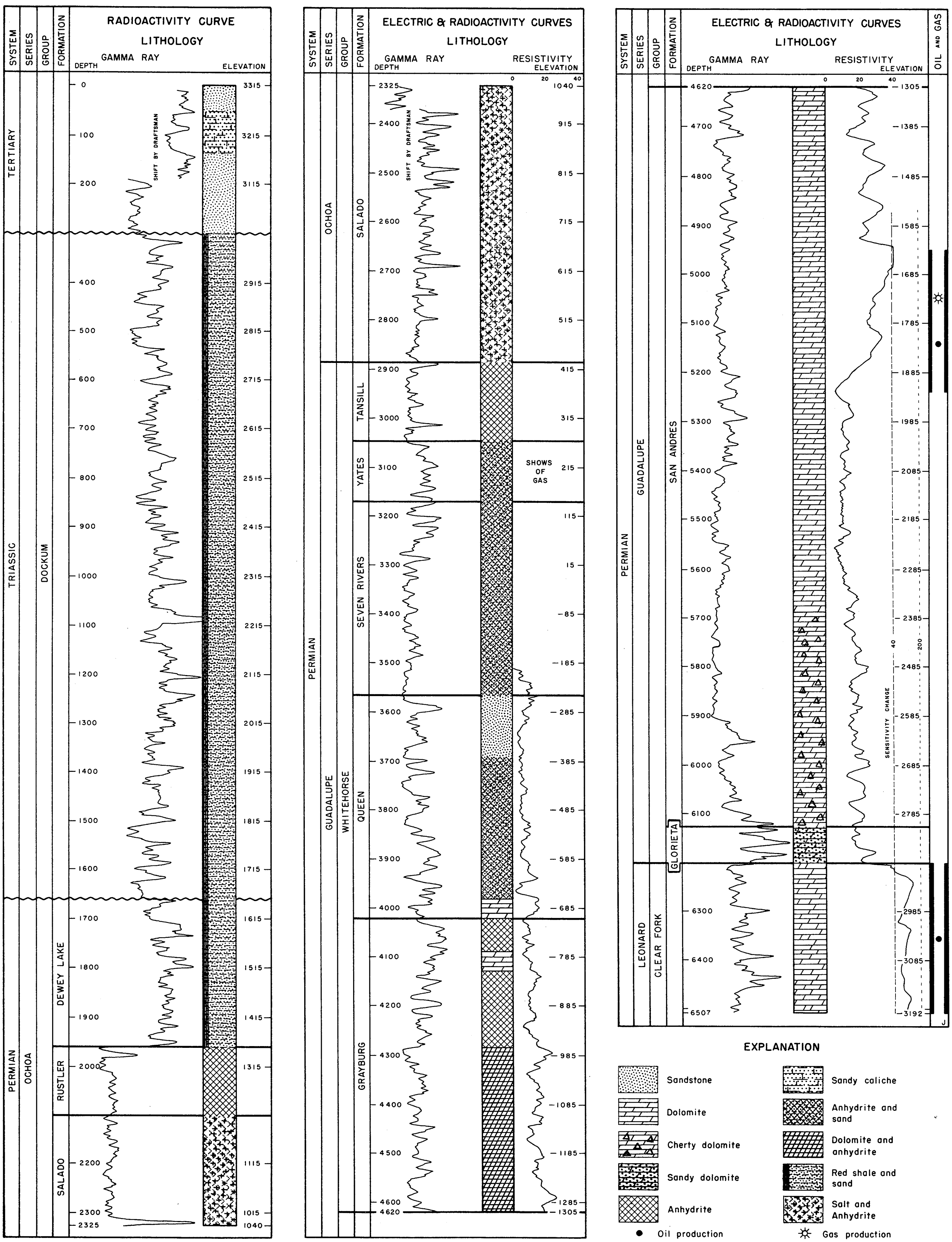
	Feet
San Andres:	
Elevation of top of gas	-1,557
Elevation of bottom of gas	-1,699
Relief	142
Elevation of top of oil	-1,699
Elevation of bottom of oil	-1,961
Relief	262
Clear Fork:	
No free gas cap	
Elevation of top of oil	-2,865
Elevation of bottom of oil	-3,221
Relief	356

§It appears that the author has confused relief of fluids with thickness of reservoir rock. See TYPICAL SECTION for approximate gross thickness. — Editor


EXPLANATION
—3200— Contour on top of Glorieta formation
Penetrated top of Clear Fork group
Oil well
Abandoned oil well
Dry hole
Discovery
SCALE
THOUSAND FEET
SEMINOLE
OLDEST HORIZON
CLEAR FORK
SAN ANDRES
W.T. RR. CO.
BLK. G


EXPLANATION
—1450— Contour on top of San Andres formation
Oil well
Abandoned oil well
Dry hole
Discovery
SCALE
THOUSAND FEET
SEMINOLE
OLDEST HORIZON
CLEAR FORK
SAN ANDRES
W.T. RR. CO.
BLK. G

TYPICAL SECTION OF ROCKS PENETRATED



ACID TREATMENT

San Andres: About 50% of the San Andres wells were acidized in the process of completion. The quantities used averaged about 4,000 gallons of acid per treatment. An additional 20% of the wells were shot with an average charge of 160 quarts of nitroglycerin.

Clear Fork: Generally the Clear Fork wells are acidized in the process of completion. The average quantity of acid is about 6,000 gallons per well.

CHARACTER OF OIL

	San Andres	Clear Fork
Gravity, A.P.I. @ 60° F.	33	28
Sulphur	1.76%	?
Color	Greenish black	Greenish black
Base	Paraffin	Paraffin

For analyses of San Andres oil see:

Railroad Commission of Texas

Analyses of Texas Crude Oils (1940), pp. 34 & 64

U. S. Bureau of Mines Lab. ref. No. 39249

Analyses of Crude Oils from Some Fields of Texas. R. I. 3699 (1943) Item 72

Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944) Page 29

Analyses of Crude Oils from 283 Important Oil Fields of the United States. R. I. 4289 (1948) Item 249

CHARACTER OF GAS

Following is an analysis of a sample of gas from the San Andres reservoir.

Component	Mol. %		
Carbon dioxide	5.88	Heating value: B.t.u. per cu.ft.	1,401
Methane	60.16		
Ethane	17.73		
Propane	10.11	Hydrogen sulphide: Grs. per 100 cu.ft.	1,000
Iso-butane	1.42		
N-butane	2.66		
Pentanes	2.04		
	100.00	Specific gravity	0.9027

WATER PRODUCTION

San Andres: At the northwest end of the field, 15 wells are making water with amounts varying from 2 to 65% of gross production of the individual wells. Edge wells along the east flank make small amounts of water ranging generally from 2 to 6% but with the exception that one producer makes 93% water. Three wells on the southeast plunge of the anticline produce 8 to 14% water and five wells on the west edge are making 8 to 24% water.

Clear Fork: At the southeast edge of the Clear Fork producing area, one well makes 30% water and another makes 45% water. Water encroachment and low rate of oil production recently forced abandonment of the Clear Fork well about ½ mile northwest of the Clear Fork discovery well.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year*			OIL PRODUCTION (barrels)				GAS PRODUCTION (Mcf)**	
	San Andres		Clear Fork	San Andres	Clear Fork	Total field		San Andres & Field Total	
Year	Flow.	Artif.	Pump.	Yearly	Yearly	Yearly	Cumulative	Yearly	Cumulative
1936	1	0		1,361		1,361	1,361	4,053	4,053
1937	4	0		27,771		27,771	29,132	82,702	86,755
1938	9	0		125,348		125,348	154,480	339,159	425,914
1939	19	3		177,418		177,418	331,898	236,725	662,639
1940	162	0		981,971		981,971	1,313,869	1,030,070	1,692,709
1941	281	3		2,612,959		2,612,959	3,926,868	1,940,988	3,633,697
1942	287	5		1,430,618		1,430,618	5,357,446	1,051,928	4,685,625
1943	293	12		2,840,039		2,840,039	8,197,485	2,188,369	6,873,994
1944	308	17		8,777,396		8,777,396	16,974,881	7,076,609	13,950,603
1945	308	21		8,240,861		8,240,861	25,215,742	7,343,048	21,293,651
1946	305	24		7,480,092		7,480,092	32,695,834	7,693,607	28,987,258
1947	295	34	1	7,284,200	1,741	7,285,941	39,981,775	8,441,679	37,428,937
1948	296	34	1	8,067,748	24,351	8,092,099	48,073,874	10,235,314	47,664,251
1949	294	38	2	5,282,742	29,997	5,312,739	53,386,613	7,029,171	54,693,422
1950	292	41	3	5,076,549	42,654	5,119,203	58,505,816	6,888,823	61,582,245
1951	291	42	11	5,967,734	128,905	6,096,639	64,602,455	8,817,874	70,400,119
1952	290	43	15	5,331,197	267,432	5,598,629	70,201,084	2,987,334§	73,387,453§

*Many of the San Andres wells produce both oil and gas.

**Estimates of gas withdrawals are based on total amount of oil withdrawn each month.. Such amount is multiplied by weighted gas-oil ratio for corresponding month.

§The entry for 1952 gas production is the estimate for the first three months only.

SHAFTER LAKE — DEEP ROCK FIELD

Andrews County, Texas

JAMES B. ZIMMERMAN
Geologist, University Lands, Midland, Texas
April 10, 1953

LOCATION and INTRODUCTION

The Shafter Lake – Deep Rock field is in central Andrews County 5 miles northwest of the town of Andrews, county seat. It is on the Central Basin platform.

The area treated in this paper includes proration units designated by the Railroad Commission of Texas as Deep Rock, Deep Rock Glorieta, Shafter Lake Clearfork, Shafter Lake Devonian, Shafter Lake East Pennsylvanian, Shafter Lake Ellenburger, Shafter Lake North San Andres, Shafter Lake Pennsylvanian, Shafter Lake Wolfcamp, Shafter Lake Yates Gas and Shafter Lake Yates Oil.

The following names have had some usage in prior publications in designating portions of the field: Fisher, Jones, Kuykendall, Ogden, Patillos, Tripp and Turner.

In the following presentation, the writer recognizes 10 distinct reservoirs at 8 stratigraphic positions. The stratigraphic positions are shown on the accompanying TYPICAL SECTION and the areal extents are shown on accompanying maps; identifying symbols (letters) are entered to facilitate correlation of data.

DISCOVERIES

Yates: December 14, 1938;
The Texas Company #H-1 University

Deep Rock San Andres and Field: Dec. 6, 1929;
Deep Rock Oil Co. #1 C. E. Ogden

North San Andres: September 21, 1952;
Tobe Foster #AO-1 Cities Service Oil Co. & Superior Oil Co. – University

Deep Rock Clear Fork: December 15, 1948;
Lario Oil & Gas Co. #B-1 Hayden Miles et al

Shafter Lake Clear Fork: June 30, 1948;
Phillips Petroleum Co. #T-1 University

Wolfcamp: February 21, 1948;
Frank & George Frankel #C-1 University

Pennsylvanian: January 29, 1950;
Sinclair Oil & Gas Co. #154-12 University

East Pennsylvanian: July 16, 1951;
Cities Service Oil Co. #B-1 M. H. Reed

Devonian: October 12, 1947;
Sinclair Oil & Gas Co. #173-1 Skelly-University

Ellenburger: December 4, 1948;
Sinclair Oil & Gas Co. #154-2-E University

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of subsurface geological data led to the drilling of the well which discovered the field. Subsequent to that discovery, there were extensive geophysical surveys in the region. The well which discovered East Pennsylvanian was drilled definitely as an exploratory well and was located on the basis of reflection seismograph data. Seismograph data probably influenced the choice of locations of others of the foregoing listed discovery wells.

ELEVATION OF SURFACE

At well locations: Highest, 3,291 ft.; lowest, 3,110 ft.

SURFACE FORMATION

Undifferentiated sands, gravels and caliche of the Tertiary system.

NATURE OF TRAPS

Yates: The accumulation of gas and oil in this reservoir is due primarily to convex folding. It appears likely that decrease in porosity and permeability has served as a secondary factor locally.

Deep Rock San Andres: Convex folding and both lateral and updip termination of reservoir due to decrease of porosity.

North San Andres: Updip and lateral termination of reservoir due to decrease of porosity.

Deep Rock Clear Fork and Shafter Lake Clear Fork: While anticlinal folding is probably the primary factor which occasioned accumulation in each of these reservoirs, it appears that, generally, the degree of porosity of the reservoir rock is not sufficient for commercial production and that variation in porosity and permeability are important trap-forming factors.

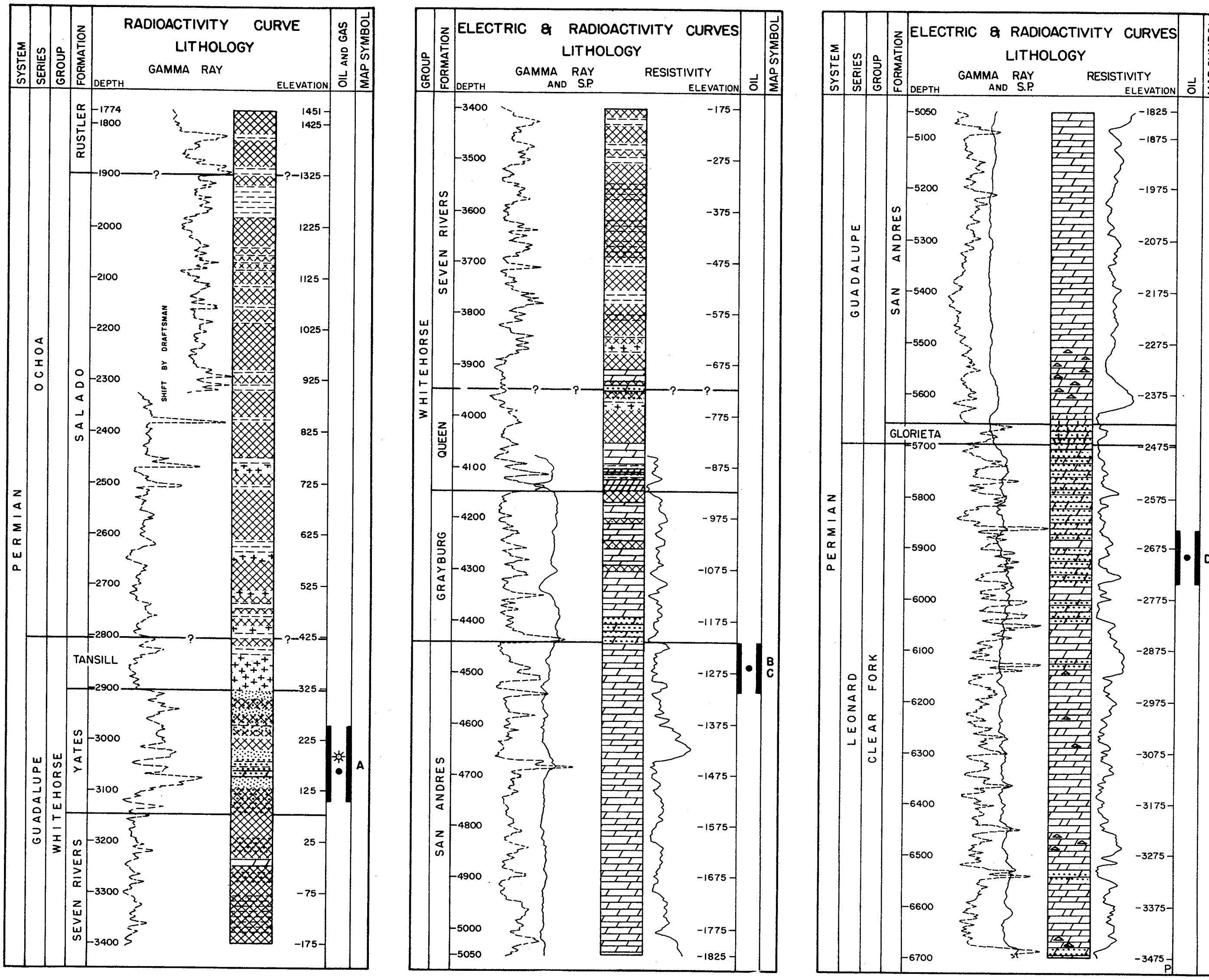
Wolfcamp: Convex folding.

Pennsylvanian: The one well completed in this reservoir, and which has been abandoned, is at the apex of an anticlinal fold. The trap is probably due to convex folding.

East Pennsylvanian: Data are not adequate for determining the trap-forming factors which occasioned the accumulation at the location of the one well completed in this reservoir.

Devonian and Ellenburger: Convex folding.

TYPICAL SECTION OF ROCKS PENETRATED



ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Elevation of oil, feet Top	Bottom	Relief, feet
Yates (Re gas, see note)*	170	67*	103+
Deep Rock San Andres Main field (south)	-998	-1,194	196
North and east	-1,220	-1,370	150
North San Andres	-1,290	-1,370	80
Deep Rock Clear Fork	-2,551	-2,651	100
Shafter Lake Clear Fork	-3,530	-3,680	150
Wolfcamp	-5,139	-5,343	204
Pennsylvanian	-5,253	-5,323	70
East Pennsylvanian	-6,014	-6,024	10
Devonian	-6,017	-6,727	710
Ellenburger	-8,234	-8,644	410

*Yates: Elevation of top of gas, 331 feet; elevation of bottom of gas, 170 feet; relief, 161 feet. The elevation of the oil-water contact has not yet been determined; it is lower than 100 feet and higher than 45 feet.

No free gas cap has been found in any reservoir other than the reservoir in the Yates formation.

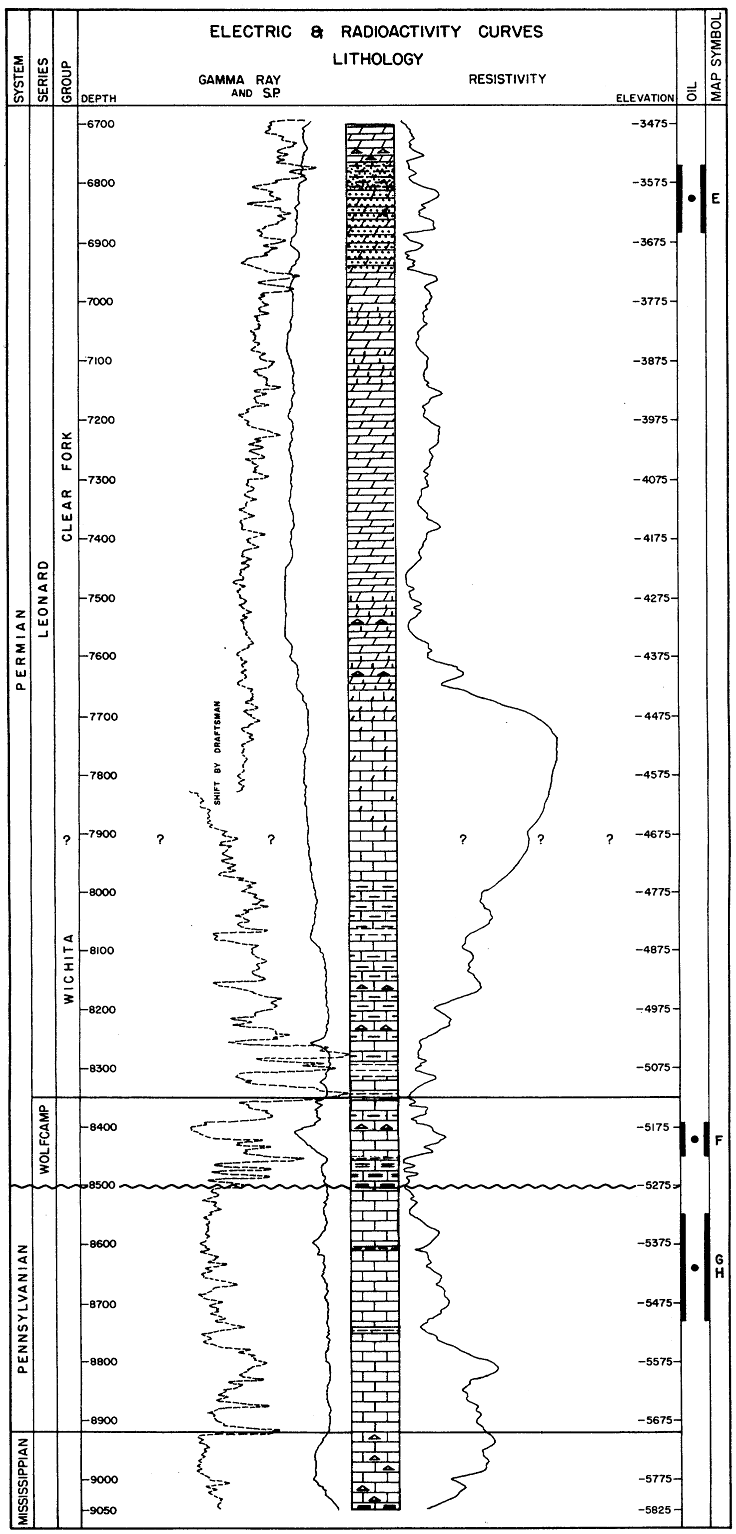
RESERVOIR TEMPERATURE and PRESSURE and OIL SAMPLE DATA

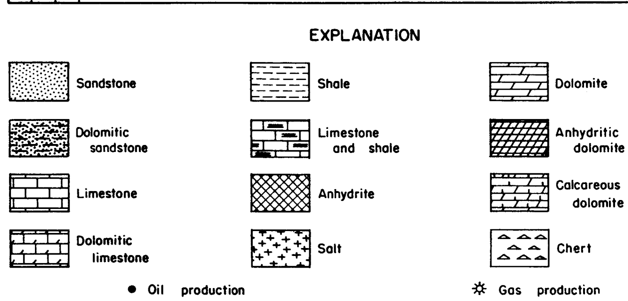
	Original bottom hole Temp. (°F)	Press. (psi)	Original gas-oil ratio (cf/bbl)	Bubble point (psi)	Volume factor (sur.: res.)	Character of oil Gravity A.P.I. @ 60°F.	Type
Yates	87	1,940	200:1 to 5,000:1	?	1.4 est.	42.0	Sweet
Deep Rock San Andres	93	1,600	50:1 to 1,400:1	?	?	30.0	Sour
North San Andres	93	1,600	190:1 to 230:1	?	?	31.2	Sour
Deep Rock Clear Fork	103	2,000	29:1	?	?	30.0	Sour
Shafter Lake Clear Fork	108	2,210	528:1	1,310	1.342	41.4	Sour
Wolfcamp	125	3,414	800:1	1,467	1.43	41.0	Sweet
Pennsylvanian	127	2,825	233:1	?	?	38.4	Sweet
East Pennsylvanian	129	4,625	982:1	?	?	39.0	Sweet
Devonian	135	4,200	289:1	1,210	1.25	38.1	Sweet
Ellenburger	152	4,664	244:1	800±	1.24	42.5	Sweet

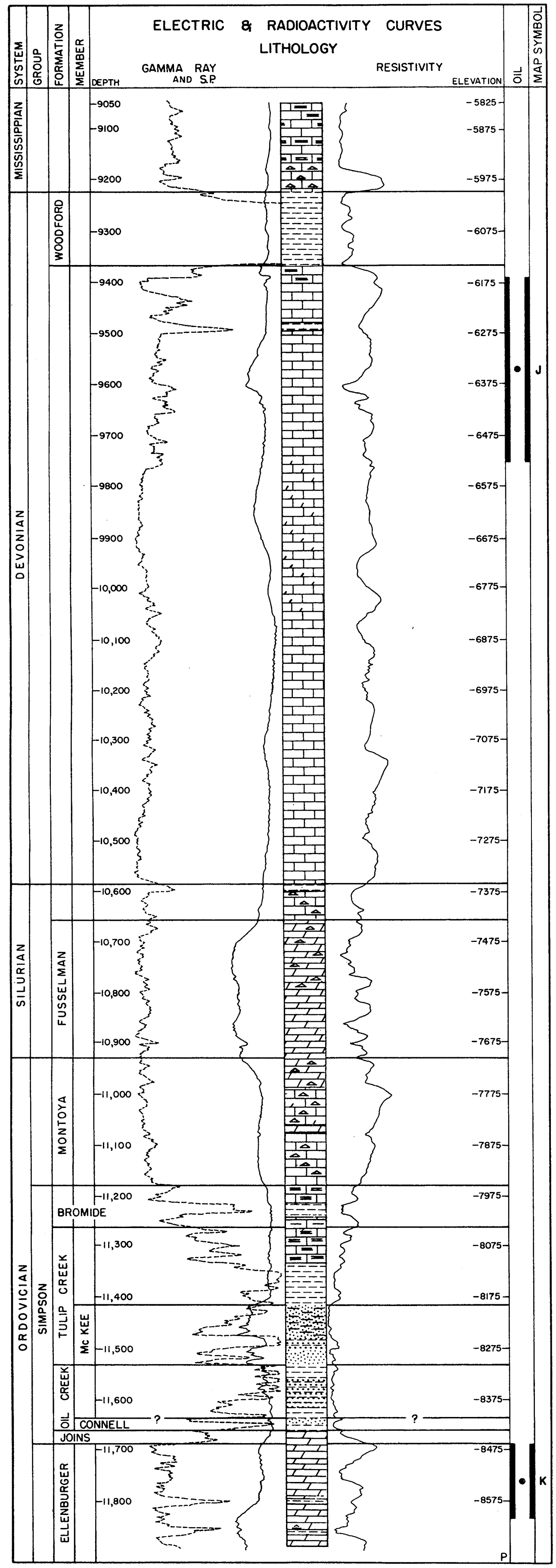
For analyses of Devonian and Ellenburger samples see:

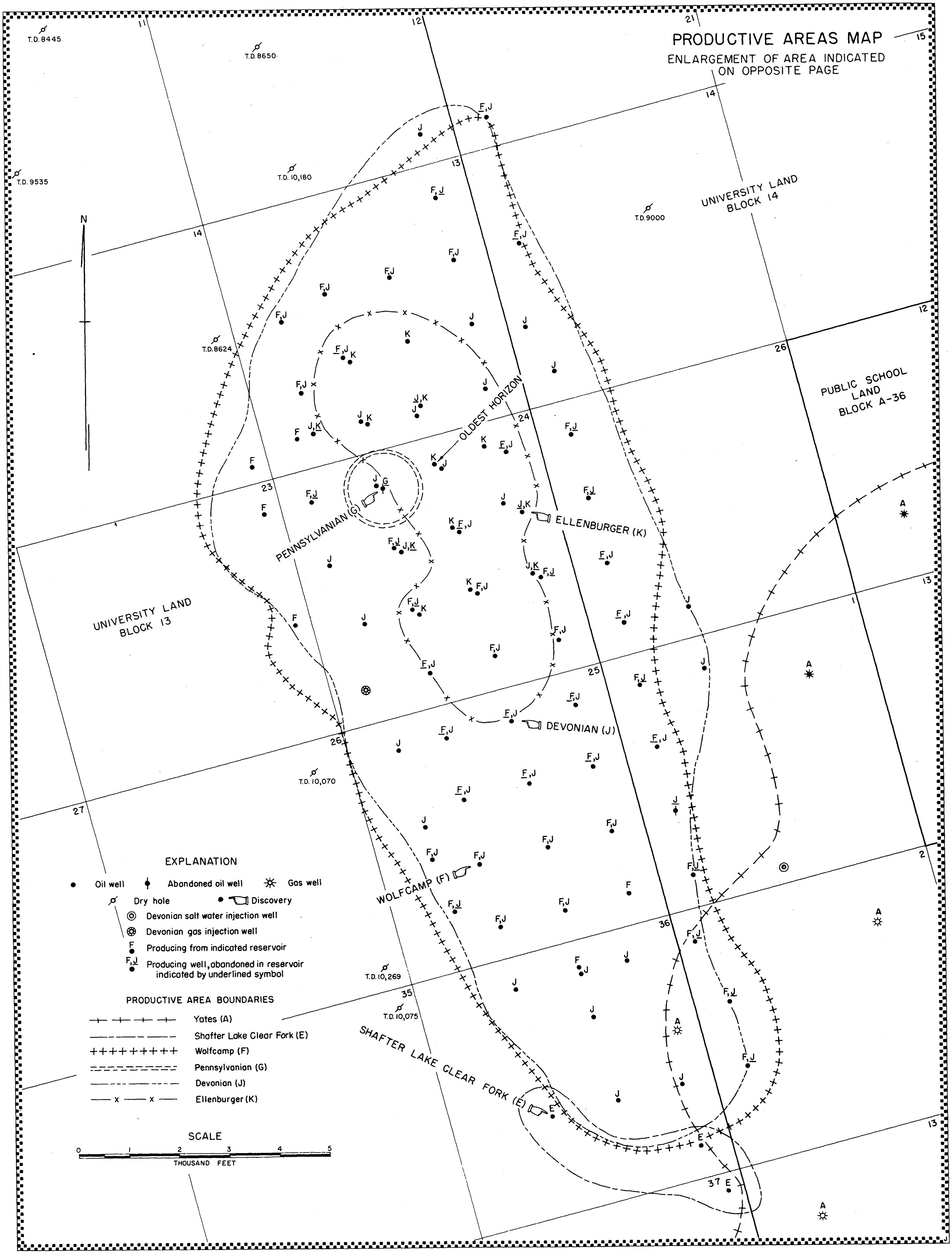
U. S. Bureau of Mines	Lab. ref. No.	51056	51055
Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953)	Item	46	47

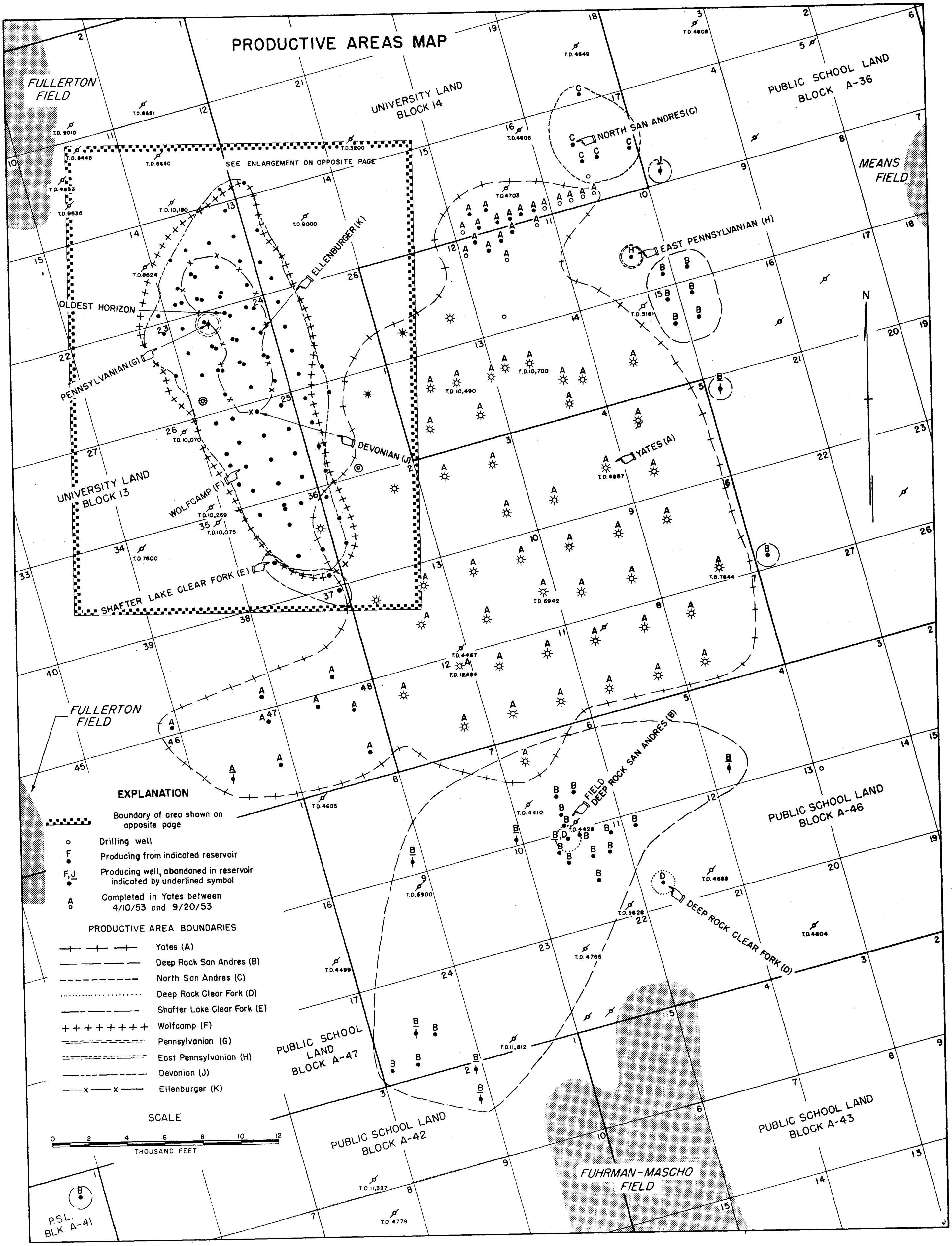
TYPICAL SECTION OF ROCKS PENETRATED








PRODUCTIVE AREAS MAP
ENLARGEMENT OF AREA INDICATED ON OPPOSITE PAGE
UNIVERSITY LAND BLOCK 14
UNIVERSITY LAND BLOCK 13
PUBLIC SCHOOL LAND BLOCK A-36
OLDEST HORIZON
PENNSYLVANIAN (G)
ELLENBURGER (K)
DEVONIAN (J)
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
T.D. 8445
T.D. 8650
T.D. 9535
T.D. 10,180
T.D. 9000
T.D. 8624
T.D. 10,070
T.D. 10,269
T.D. 10,075
EXPLANATION
Oil well
Abandoned oil well
Gas well
Dry hole
Discovery
Devonian salt water injection well
Devonian gas injection well
Producing from indicated reservoir
Producing well, abandoned in reservoir indicated by underlined symbol
PRODUCTIVE AREA BOUNDARIES
Yates (A)
Shafter Lake Clear Fork (E)
Wolfcamp (F)
Pennsylvanian (G)
Devonian (J)
Ellenburger (K)
SCALE
0 1 2 3 4 5
THOUSAND FEET


PRODUCTIVE AREAS MAP
FULLERTON FIELD
UNIVERSITY LAND BLOCK 14
PUBLIC SCHOOL LAND BLOCK A-36
MEANS FIELD
SEE ENLARGEMENT ON OPPOSITE PAGE
NORTH SAN ANDRES (C)
ELLENBURGER (K)
EAST PENNSYLVANIAN (H)
OLDEST HORIZON
PENNSYLVANIAN (G)
DEVONIAN (J)
YATES (A)
UNIVERSITY LAND BLOCK 13
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
FULLERTON FIELD
DEEP ROCK SAN ANDRES (B) FIELD
PUBLIC SCHOOL LAND BLOCK A-46
DEEP ROCK CLEAR FORK (D)
EXPLANATION
Boundary of area shown on opposite page
Drilling well
Producing from indicated reservoir
Producing well, abandoned in reservoir indicated by underlined symbol
Completed in Yates between 4/10/53 and 9/20/53
PRODUCTIVE AREA BOUNDARIES
Yates (A)
Deep Rock San Andres (B)
North San Andres (C)
Deep Rock Clear Fork (D)
Shafter Lake Clear Fork (E)
Wolfcamp (F)
Pennsylvanian (G)
East Pennsylvanian (H)
Devonian (J)
Ellenburger (K)
SCALE
0 2 4 6 8 10 12
THOUSAND FEET
PUBLIC SCHOOL LAND BLOCK A-47
PUBLIC SCHOOL LAND BLOCK A-42
PUBLIC SCHOOL LAND BLOCK A-43
FUHRMAN-MASCHO FIELD
P.S.L. BLK. A-41

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 335 feet below its top. This penetration was in Sinclair Oil & Gas Co. #154-8 University, Sec. 24, Block 13, University Lands survey, at its total depth of 11,805 feet. Although Sinclair #154-12 (1,100 feet westward) drilled deeper (T.D. 11,945 feet), it drilled only 51 feet into Ellenburger.

THICKNESSES OF RESERVOIR ROCKS

	Feet, approximate average	
	Top to Bottom	Net Productive
Yates	34	20
Deep Rock San Andres	100	65
North San Andres	45	30
Deep Rock Clear Fork	95	50
Shafter Lake Clear Fork	110	75
Wolfcamp	60	30
Pennsylvanian	70	50
East Pennsylvanian	10	10
Devonian	380	120
Ellenburger	146	65

LITHOLOGY OF RESERVOIR ROCKS

Yates: A hard, reddish gray to red, fine-grained sandstone with large frosted quartz grains alternating with some thin beds of anhydrite, shale and dolomite.

Deep Rock San Andres and North San Andres: A hard, tan to white, fine crystalline dolomite.

Deep Rock Clear Fork: A hard, dense, brownish gray, silty dolomite.

Shafter Lake Clear Fork: A hard, buff to tan, finely crystalline, silty to sandy dolomite with slight traces of chert.

Wolfcamp: A hard, black to light gray, medium crystalline, cherty limestone.

Pennsylvanian and East Pennsylvanian: A hard, white, medium crystalline, chalky, fossiliferous limestone with some thin shale streaks.

Devonian: A hard, light brown to white, medium crystalline, chalky limestone with some chert and traces of dolomite.

Ellenburger: A hard, tan, medium to coarsely crystalline, fossiliferous, fractured dolomite with white chert.

PRODUCTIVE AREAS

	Acres
Yates (gas, 7,840; oil, 880+)	12,600
Deep Rock San Andres	5,760
North San Andres	420
Deep Rock Clear Fork	80
Shafter Lake Clear Fork	140
Wolfcamp	2,930
Pennsylvanian	40
East Pennsylvanian	40
Devonian	2,840
Ellenburger	520
Shafter Lake — Deep Rock field	20,730

The Yates oil area has not been defined and therefore the above estimate includes only the area proven to date. Development now in progress will probably warrant increasing this estimate.

CONTINUITY OF RESERVOIR ROCKS

Yates: The reservoir rock is continuous throughout the area of the field; its porosity (normally, about 20%) and permeability are continuous but decrease toward the edge of the field and are negligible in the bordering dry holes. The reservoir has a solution gas drive.

San Andres: The reservoir rock is continuous throughout the area of the field; its porosity (normally 15% to 20% in productive areas) is erratic and appears to be too low for migration of fluids except in the southern and eastern edges of the field. A solution gas drive provides the reservoir energy.

Deep Rock Clear Fork and Shafter Lake Clear Fork: Each of these reservoir rocks is continuous throughout the area of the field. The porosity of each is very low. A solution gas drive provides the reservoir energy in each.

Wolfcamp: The reservoir rock is continuous throughout the area of the field; its porosity (normally, about 17.7%) and permeability (normally, about 48 md) are too low for migration of fluids except in the area of the large anticline in the western part of the field. A solution gas drive provides the reservoir energy.

Pennsylvanian: The reservoir rock is continuous throughout the area of the field; its porosity is very low.

Devonian: The reservoir rock is continuous throughout the area of the field; its effective porosity appears to be associated with a chalky facies. A solution gas drive provides the reservoir energy.

Ellenburger: The reservoir rock and its effective porosity and permeability (normally, about 213 md) are continuous throughout the area of the field and certainly for some miles beyond in all directions. Due to good secondary vuggy porosity and a high degree of fracturing, conditions are favorable for migration of fluids. There is a good water drive.

CHARACTER OF GAS

Following are analyses of two representative samples of gas taken from two wells producing from the Yates reservoir, the only reservoir which originally contained free gas.

Component	Mol.%	Mol.%
Oxygen	0.00	0.00
Carbon dioxide	0.10	0.00
Nitrogen	17.15	18.55
Methane	67.77	65.57
Ethane	8.87	9.11
Propane	3.84	4.49
Iso-butane	.47	.36
N-butane	1.07	1.01
Iso-pentane	.17	.26
N-pentane	.28	.21
Hexanes	.17	.23
Heptanes plus	.11	.21
	100.00	100.00

Calculated gross heating value @ 60° F. and 760 mm: 1,023 B.t.u. per cubic foot.

COMPLETION TREATMENT

Yates: The 48 gas wells were completed "natural". Of the 15 wells completed as oil wells, 4 were completed "natural", 4 with hydraulic fracturing, 4 with hydraulic fracturing and mud acid, 2 with acid and hydraulic fracturing and 1 with fracture-jel. Quantities used were as follows: hydraulic fracturing, 1,500 to 5,000 gallons, normal, 1,500 gallons; mud acid, 250 to 500 gallons; acid, 2,000 gallons; fracture-jel, 5,500 gallons.

Deep Rock San Andres: 15 wells were completed "natural"; 9 with acid treatment of 1,000 to 8,000 gallons, normal, 5,000 gallons; 4 were shot with 420 to 1,500 quarts of nitroglycerin, normal, 500 to 600 quarts; 2 were shot with nitroglycerin, 480 and 680 quarts respectively, and treated with acid, 2,000 and 8,000 gallons respectively.

North San Andres: 3 wells were completed "natural", 1 with 5,000 gallons of acid.

Deep Rock Glorieta: The two wells were each treated with 2,000 gallons of acid.

Shafter Lake Clear Fork: 1 well completed "natural", 2 with acid treatment, 1 with 9,000 gallons and the other with 9,500 gallons.

Wolfcamp: 2 wells completed "natural"; 47 with acid treatment of 500 to 5,000 gallons, normal, 1,500 to 2,000 gallons.

Pennsylvanian: The one well was treated with 16,000 gallons of acid.

East Pennsylvanian: The one well was treated with 250 gallons of acid.

Devonian: 16 wells completed "natural"; 47 with acid treatment of 1,000 to 15,000 gallons, normal, 1,000 to 2,000 gallons; 1 with 500 gallons of mud acid.

Ellenburger: 1 well completed "natural"; 9 with acid treatment of 500 to 10,000 gallons, normal, 1,000 to 3,000 gallons.

VARIATIONS IN THICKNESSES

The Simpson group and the Mississippian and Pennsylvanian systems are thicker on the flanks of the anticline than they are over the axis. The Simpson thickens about 150 feet and Mississippian and Pennsylvanian combined thicken about 350 feet. The thickness of the Devonian remains fairly uniform.

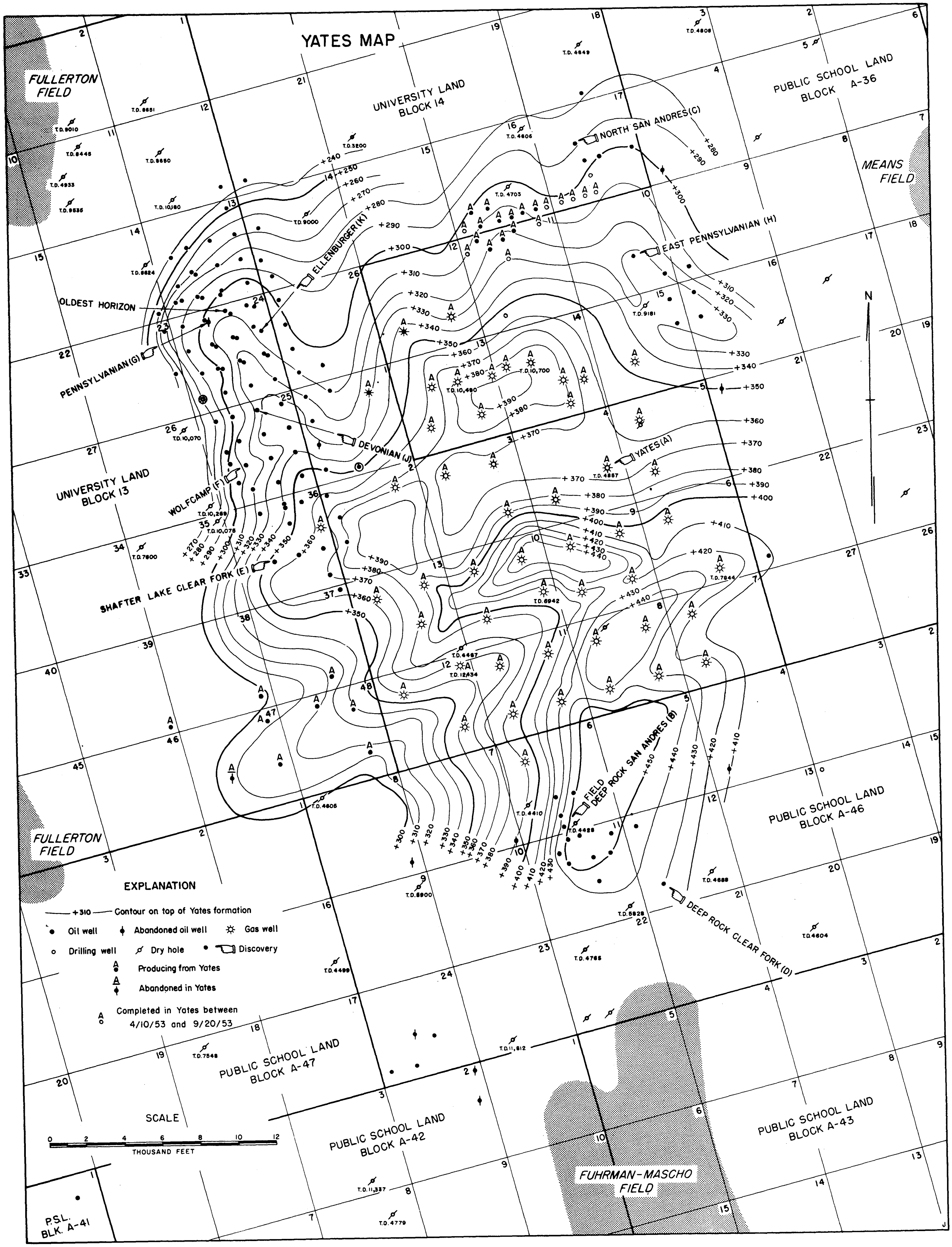
WATER PRODUCTION

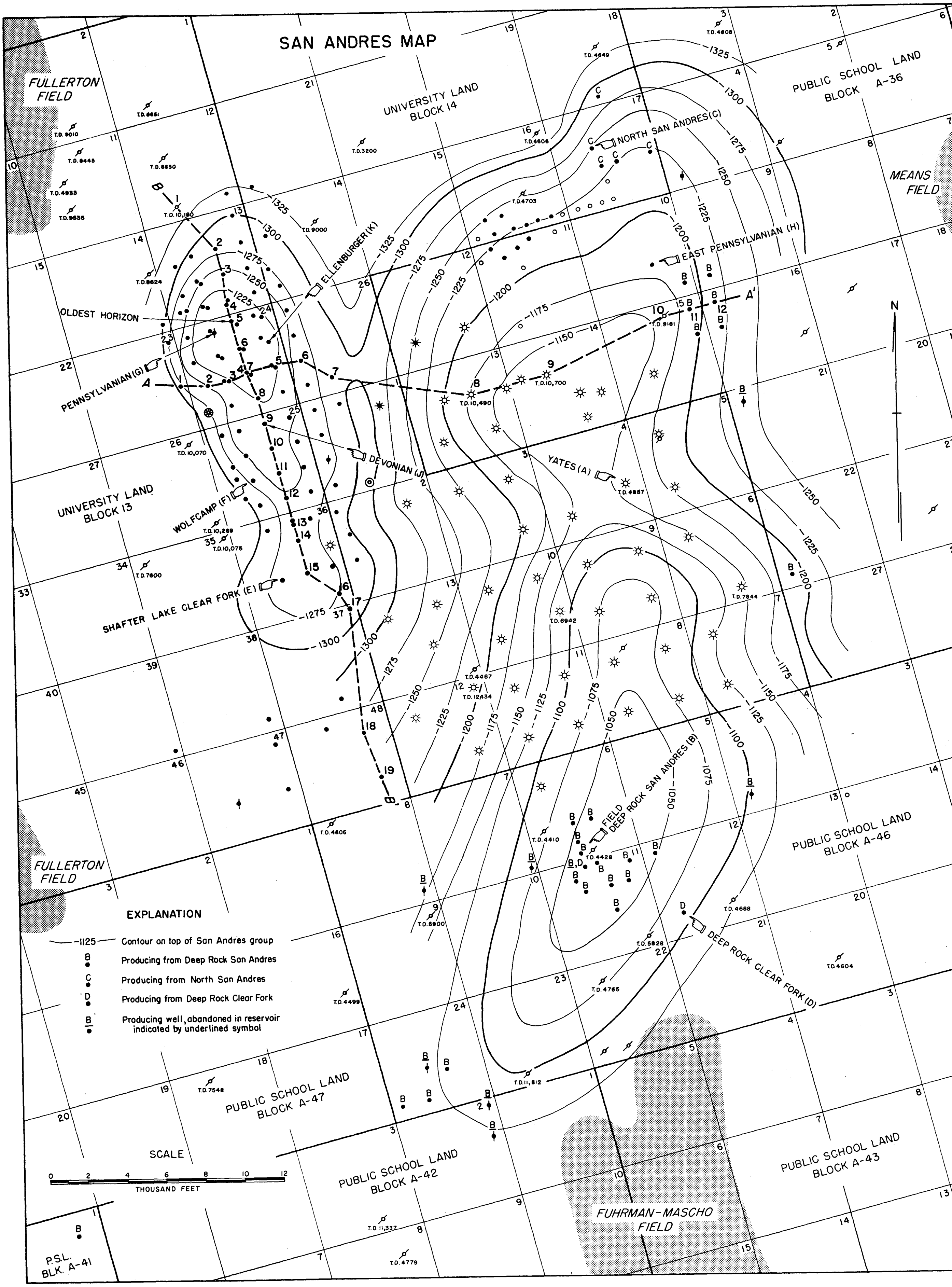
The quantity of water produced from each Yates, Deep Rock San Andres and North San Andres has been either none or negligible. The gross production of one of the two wells producing from Deep Rock Clear Fork is reported as currently about 60% water. The number of wells producing water at the end of each year and the quantities of water produced from the other reservoirs are indicated below.

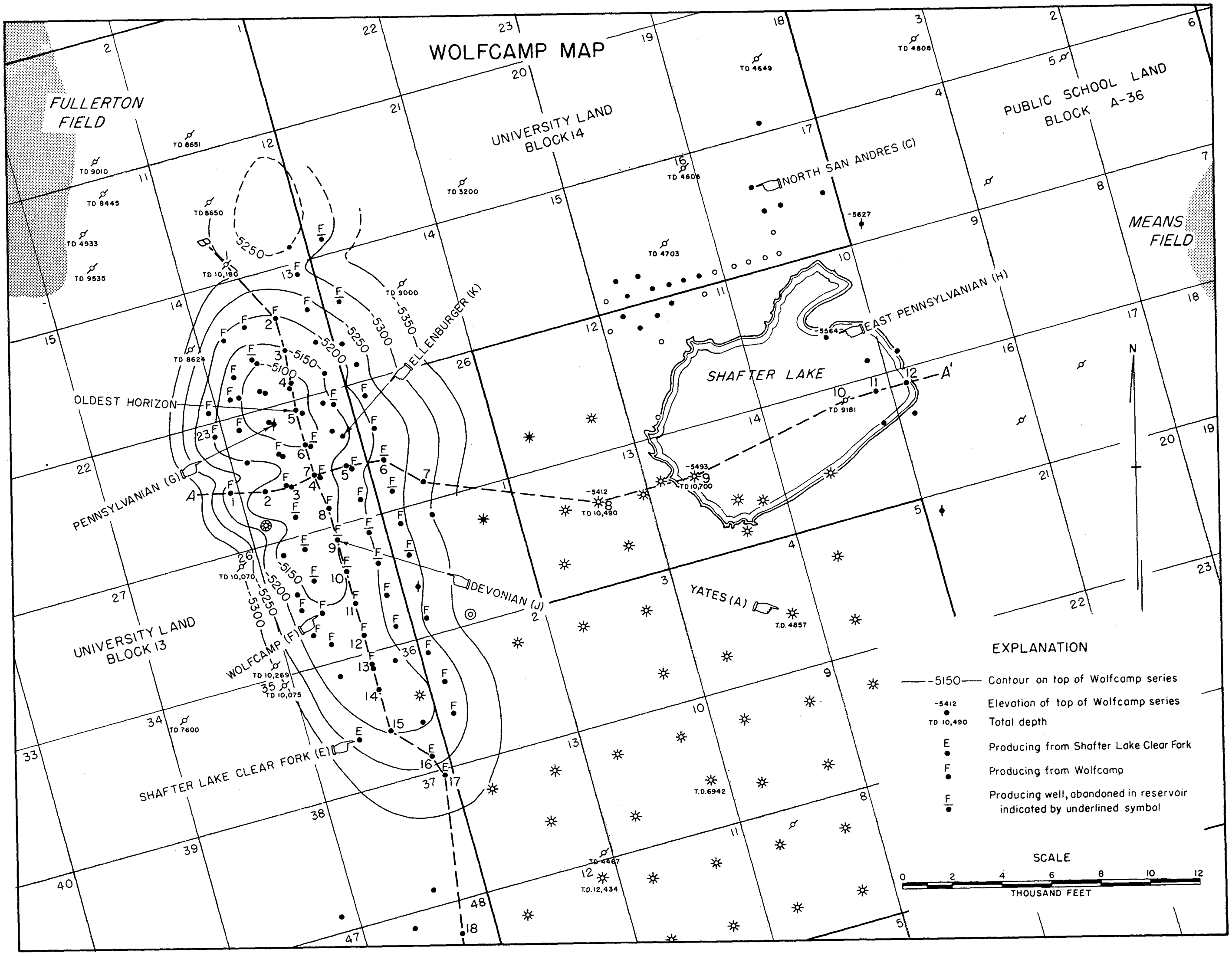
Year	No. of Wells	Water (bbls)	No. of Wells	Water (bbls)
Shafter Lake Clear Fork			Wolfcamp	
1948	1	620		
1949	2	6,590	5	24,655
1950	2	2,976	6	18,811
1951	2	1,583	4	17,706
1952	2	2,173	4	11,754
Total		13,942		72,926
Pennsylvanian			East Pennsylvanian	
1950	1	199		
1951	1	255	1	12,395
1952	1	368	1	9,080
Total		822		21,475
Devonian			Ellenburger	
1948	3	16,734		
1949	10	182,184	3	8,457
1950	10	394,201	4	154,486
1951	11	477,771	3	744,962
1952	10	573,497	3	1,098,605
Total		1,644,387		2,006,510

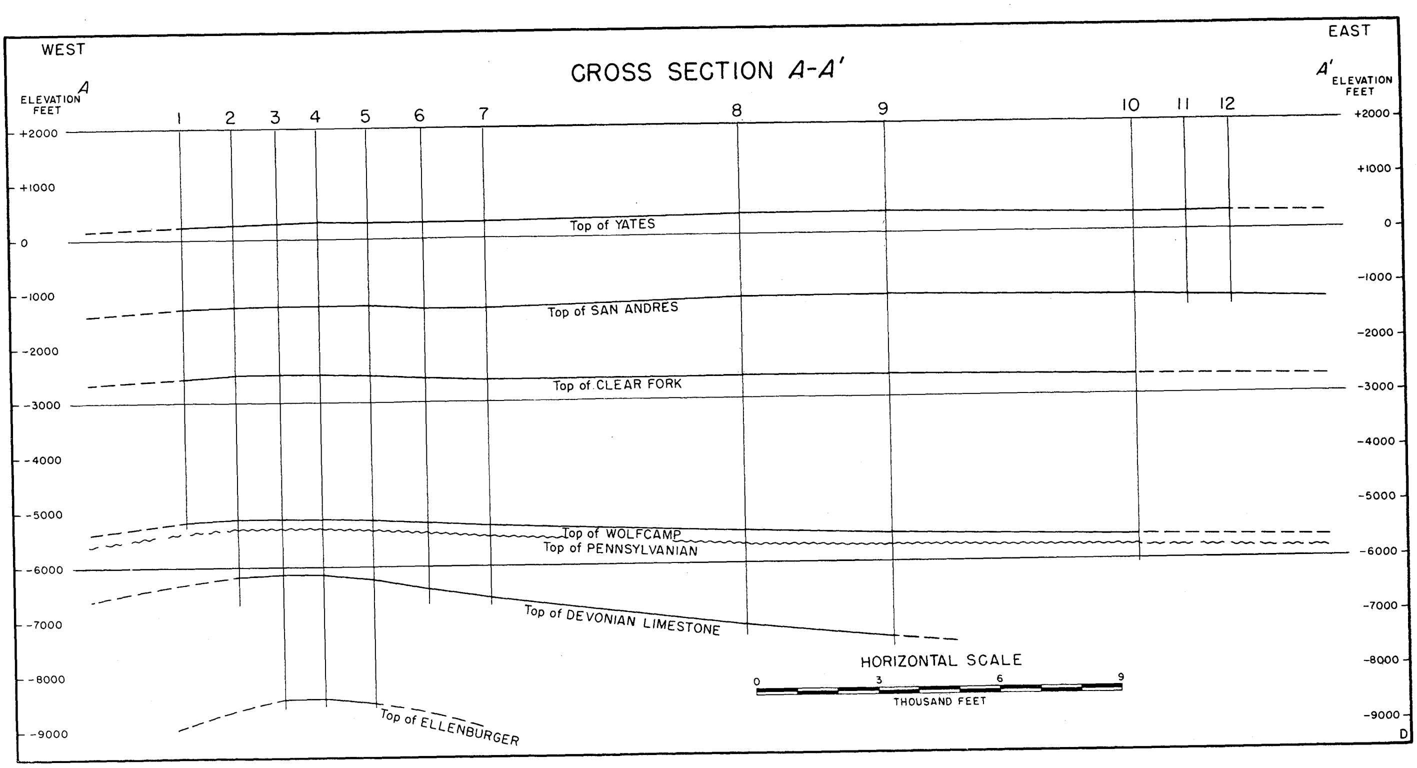
PRESSURE MAINTENANCE

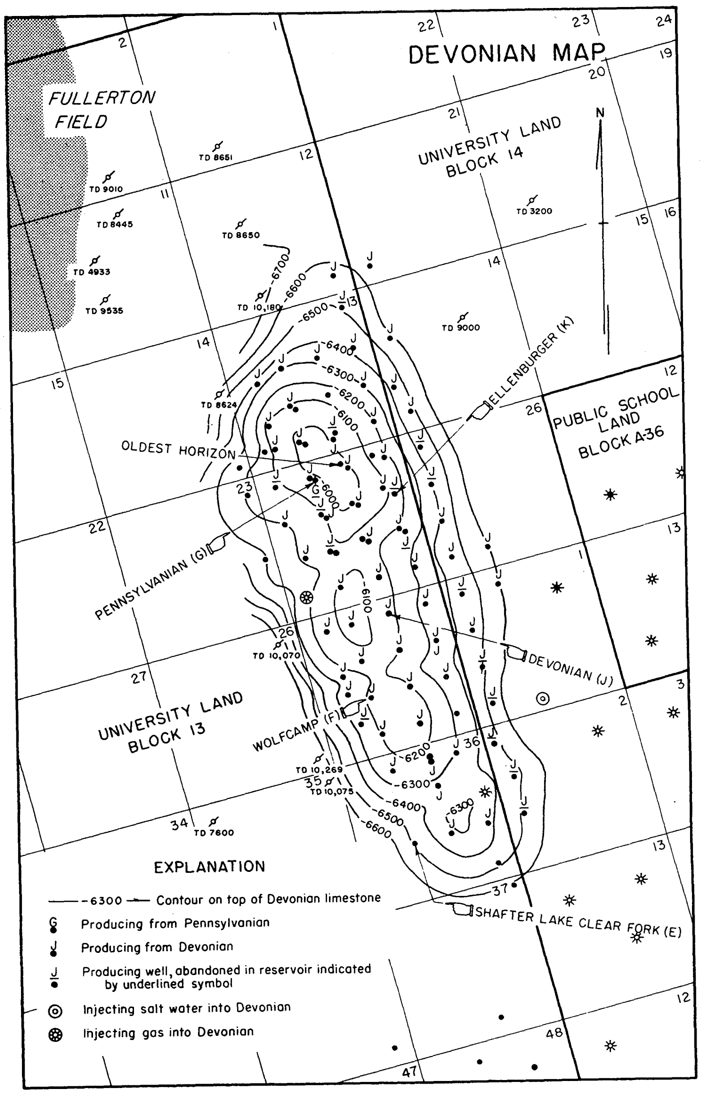
Decline of pressure in the Devonian reservoir is being checked by injection of water through one well and gas through another well. Both operations were started in 1951, during which year 258,010 barrels of water and 11,366 Mcf of gas were injected. During 1952, 1,770,425 barrels of water and 321,397 Mcf of gas were injected.

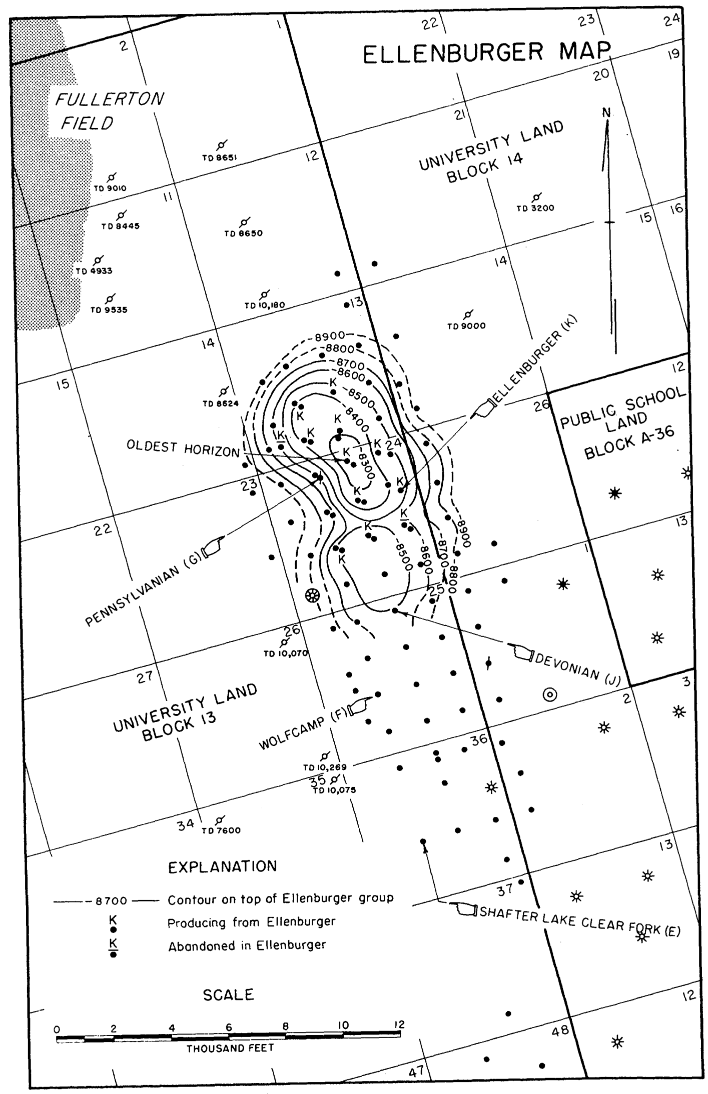

YATES MAP
FULLERTON FIELD
UNIVERSITY LAND BLOCK 14
PUBLIC SCHOOL LAND BLOCK A-36
MEANS FIELD
NORTH SAN ANDRES (C)
EAST PENNSYLVANIAN (H)
ELLENBURGER (K)
OLDEST HORIZON
PENNSYLVANIAN (G)
DEVONIAN (J)
YATES (A)
UNIVERSITY LAND BLOCK 13
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
DEEP ROCK SAN ANDRES (B)
FIELD
DEEP ROCK CLEAR FORK (D)
PUBLIC SCHOOL LAND BLOCK A-46
FULLERTON FIELD
EXPLANATION
+310 Contour on top of Yates formation
Oil well
Abandoned oil well
Gas well
Drilling well
Dry hole
Discovery
Producing from Yates
Abandoned in Yates
Completed in Yates between 4/10/53 and 9/20/53
PUBLIC SCHOOL LAND BLOCK A-47
SCALE
0 2 4 6 8 10 12
THOUSAND FEET
PUBLIC SCHOOL LAND BLOCK A-42
PUBLIC SCHOOL LAND BLOCK A-43
FUHRMAN-MASCHO FIELD
P.S.L. BLK. A-41
N

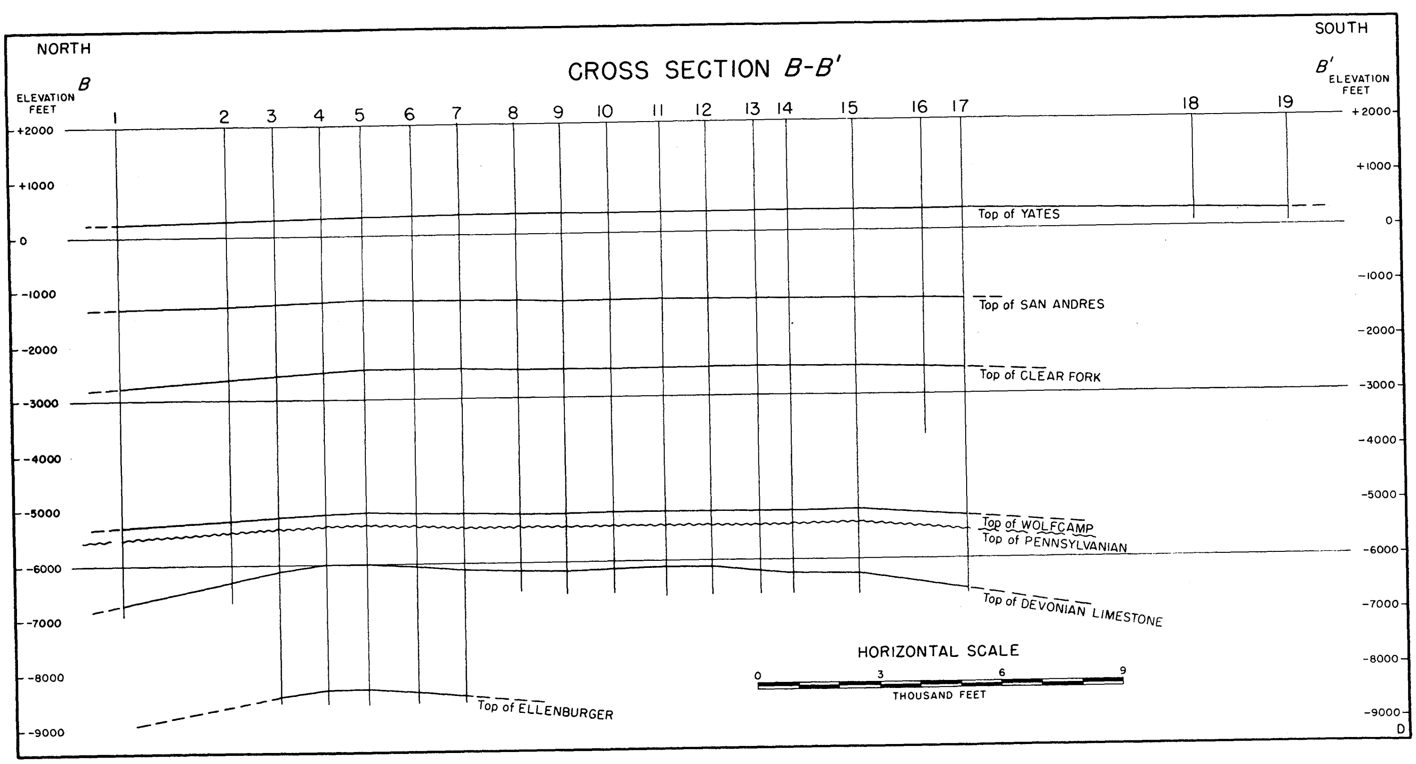

SAN ANDRES MAP
FULLERTON FIELD
UNIVERSITY LAND BLOCK 14
PUBLIC SCHOOL LAND BLOCK A-36
MEANS FIELD
NORTH SAN ANDRES (C)
EAST PENNSYLVANIAN (H)
ELLENBURGER (K)
OLDEST HORIZON
PENNSYLVANIAN (G)
DEVONIAN (J)
YATES (A)
UNIVERSITY LAND BLOCK 13
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
DEEP ROCK SAN ANDRES (B) FIELD
PUBLIC SCHOOL LAND BLOCK A-46
FULLERTON FIELD
DEEP ROCK CLEAR FORK (D)
EXPLANATION
—1125— Contour on top of San Andres group
B Producing from Deep Rock San Andres
C Producing from North San Andres
D Producing from Deep Rock Clear Fork
B Producing well, abandoned in reservoir indicated by underlined symbol
PUBLIC SCHOOL LAND BLOCK A-47
SCALE
0 2 4 6 8 10 12
THOUSAND FEET
PUBLIC SCHOOL LAND BLOCK A-42
PUBLIC SCHOOL LAND BLOCK A-43
FUHRMAN-MASCHO FIELD
P.S.L. BLK. A-41
N


WOLFCAMP MAP
FULLERTON FIELD
UNIVERSITY LAND BLOCK 14
PUBLIC SCHOOL LAND BLOCK A-36
MEANS FIELD
NORTH SAN ANDRES (C)
EAST PENNSYLVANIAN (H)
SHAFTER LAKE
ELLENBURGER (K)
OLDEST HORIZON
PENNSYLVANIAN (G)
DEVONIAN (J)
YATES (A)
UNIVERSITY LAND BLOCK 13
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
EXPLANATION
-5150 Contour on top of Wolfcamp series
-5412 Elevation of top of Wolfcamp series
TD 10,490 Total depth
E Producing from Shafter Lake Clear Fork
F Producing from Wolfcamp
F Producing well, abandoned in reservoir indicated by underlined symbol
SCALE
0 2 4 6 8 10 12
THOUSAND FEET


WEST
EAST
CROSS SECTION A-A'
A
A'
ELEVATION FEET
+2000
+1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
Top of YATES
Top of SAN ANDRES
Top of CLEAR FORK
Top of WOLFCAMP
Top of PENNSYLVANIAN
Top of DEVONIAN LIMESTONE
Top of ELLENBURGER
HORIZONTAL SCALE
0 3 6 9
THOUSAND FEET


DEVONIAN MAP
FULLERTON FIELD
UNIVERSITY LAND BLOCK 14
PUBLIC SCHOOL LAND BLOCK A-36
UNIVERSITY LAND BLOCK 13
OLDEST HORIZON
ELLENBURGER (K)
PENNSYLVANIAN (G)
DEVONIAN (J)
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
TD 8651
TD 9010
TD 8445
TD 4933
TD 9535
TD 8650
TD 10,180
TD 3200
TD 9000
TD 8624
TD 10,070
TD 10,269
TD 10,075
TD 7600
EXPLANATION
-6300 Contour on top of Devonian limestone
Producing from Pennsylvanian
Producing from Devonian
Producing well, abandoned in reservoir indicated by underlined symbol
Injecting salt water into Devonian
Injecting gas into Devonian


ELLENBURGER MAP
FULLERTON FIELD
UNIVERSITY LAND BLOCK 14
PUBLIC SCHOOL LAND BLOCK A-36
UNIVERSITY LAND BLOCK 13
OLDEST HORIZON
ELLENBURGER (K)
PENNSYLVANIAN (G)
DEVONIAN (J)
WOLFCAMP (F)
SHAFTER LAKE CLEAR FORK (E)
EXPLANATION
-8700 Contour on top of Ellenburger group
Producing from Ellenburger
Abandoned in Ellenburger
SCALE
0 2 4 6 8 10 12
THOUSAND FEET


CROSS SECTION B-B'
NORTH
SOUTH
ELEVATION FEET
Top of YATES
Top of SAN ANDRES
Top of CLEAR FORK
Top of WOLFCAMP
Top of PENNSYLVANIAN
Top of DEVONIAN LIMESTONE
Top of ELLENBURGER
HORIZONTAL SCALE
0 3 6 9
THOUSAND FEET

PRODUCTION HISTORY

Year	Wells Producing at end of year: Flow.	Pump.	Gas lift	Oil Production (barrels): Yearly	Cumulative	Gas Production (Mcf): Yearly	Cumulative
Field totals							
1929-1938					687,609		
1939	3	8	0	65,704	753,313	5,750	5,750
1940	3	8	0	49,236	802,549	14,185	19,935
1941	5	6	0	52,056	854,605	16,168	36,103
1942	3	8	0	29,319	883,924	15,755	51,858
1943	3	10	0	20,683	904,607	15,971	67,829
1944	3	11	0	32,034	936,641	28,546	96,375
1945	14	11	0	36,007	972,648	125,481	221,856
1946	19	11	0	41,181	1,013,829	855,595	1,077,451
1947	27	17	0	92,512	1,106,341	1,595,267	2,672,718
1948	94	21	0	1,880,972	2,987,313	3,316,318	5,989,036
1949	73	58	13	3,506,299	6,493,612	4,878,490	10,867,526
1950	65	78	8	2,929,545	9,423,157	4,512,259	15,379,785
1951	66	88	6	3,199,903	12,623,060	4,263,448	19,643,233
1952	75	108	4	2,929,263	15,552,323	4,483,009	24,126,242
1953*	?	?	?	3,108,256	18,660,579	5,880,346	30,006,588
Yates							
1939	1	0	0			5,750	5,750
1940	1	0	0			14,185	19,935
1941	1	0	0			16,168	36,103
1942	1	0	0			15,755	51,858
1943	1	0	0			15,971	67,829
1944	1	0	0			28,546	96,375
1945	12	0	0	465	465	125,481	221,856
1946	17	0	0	3,263	3,728	855,595	1,077,451
1947	22	0	0	5,475	9,203	1,589,054	2,666,505
1948	33	0	0	399	9,602	2,494,770	5,161,275
1949	38	0	0	1,974	11,576	3,478,295	8,639,570
1950	38	0	0	1,436	13,012	3,349,697	11,989,267
1951	42	0	0	1,264	14,276	3,041,079	15,030,346
1952	61	0	0	16,680	30,956	3,118,071	18,148,417
1953*	?	?	?	233,783	264,739	3,721,414	21,869,831
Deep Rock San Andres							
1929-1938					687,609§		
1939	2	8	0	65,704	753,313		
1940	2	8	0	49,236	802,549		
1941	4	6	0	52,056	854,605		
1942	2	8	0	29,319	883,924		
1943	2	10	0	20,683	904,607		
1944	2	11	0	32,034	936,641		
1945	2	11	0	35,542	972,183		
1946	2	11	0	37,918	1,010,101		
1947	4	17	0	69,603	1,079,704		
1948	4	16	0	95,979	1,175,683		
1949	4	15	0	78,266	1,253,949		
1950	4	17	0	77,204	1,331,153		
1951	4	17	0	85,362	1,416,515		
1952	3	21	0	105,572	1,522,087		
1953*	?	?	?	105,921	1,628,008		

* 1953 data added by amendment.

§ The only readily available record for years prior to 1939 reports totals for Deep Rock San Andres combined with Fuhrman and Fuhrman-Walker. The writer is unable to segregate the quantities.

Year	Wells Producing at end of year: Flow.	Pump.	Gas lift	Oil Production (barrels): Yearly	Cumulative	Gas Production (Mcf): Yearly	Cumulative
North San Andres							
1952	2	2	0	6,387	6,387	774	774
1953*	?	?	?	32,810	39,197	5,574	6,348
Deep Rock Clear Fork							
1948	0	1	0	891	891	0	0
1949	0	1	0	9,592	10,483	0	0
1950	1	1	0	14,283	24,766	0	0
1951	1	1	0	16,455	41,221	0	0
1952	0	2	0	18,758	59,979	0	0
1953*	?	?	?	15,564	75,543	0	0
Shafter Lake Clear Fork							
1948	0	1	0	3,694	3,694	Neg.	Neg.
1949	0	1	0	21,390	25,084	Neg.	Neg.
1950	0	2	0	17,195	42,279	1,125	1,125
1951	0	2	0	13,619	55,898	471	1,596
1952	0	2	0	27,079	82,977	5,441	7,037
1953*	?	?	?	47,960	130,937	13,963	21,000
Wolfcamp							
1948	29	1	0	432,814	432,814	319,772	319,772
1949	8	7	5	610,980	1,043,794	438,069	757,841
1950	4	13	3	468,769	1,512,563	335,778	1,093,619
1951	3	21	1	657,657	2,170,220	477,441	1,571,060
1952	3	26	0	737,313	2,907,533	520,015	2,091,075
1953*	?	?	?	884,042	3,791,575	1,120,651	3,211,726
Pennsylvanian:							
1950	0	0	1	9,958	9,958	2,415	2,415
1951	0	0	1	6,016	15,974	2,778	5,193
1952	0	1	0	5,104	21,078	437	5,630
1953*§	0	0	0	1,342	22,420	58	5,688
East Pennsylvanian							
1951	1	0	0	8,954	8,954	9,159	9,159
1952	1	0	0	6,893	15,847	7,673	16,832
1953*	?	?	?	2,439	18,286	3,000	19,832
Devonian							
1947	1	0	0	17,434	17,434	6,213	6,213
1948	37	1	0	1,336,754	1,354,188	498,832	505,045
1949	13	33	8	2,156,644	3,510,832	819,783	1,324,828
1950	10	42	4	1,574,968	5,085,800	635,739	1,960,567
1951	7	44	4	1,716,927	6,802,727	559,005	2,519,572
1952	3	46	4	1,495,859	8,298,586	707,039	3,226,611
1953*	?	?	?	1,360,851	9,659,437	907,302	4,133,913
Ellenburger							
1948	0	1	0	10,441	10,441	2,944	2,944
1949	10	0	0	627,453	637,894	142,343	145,287
1950	8	3	0	765,732	1,403,626	187,505	332,792
1951	8	3	0	693,649	2,097,275	173,515	506,307
1952	2	8	0	509,618	2,606,893	123,556	629,863
1953*	?	?	?	423,544	3,030,437	108,384	738,247

* 1953 data added by amendment.

§ The one Pennsylvanian well was plugged back to Wolfcamp on April 12, 1953.

SHANNON FIELD

Crockett County, Texas

J. D. HOLME
Geologist, Sun Oil Company, Midland, Texas
May 1, 1953

LOCATION and OTHER NAMES

The Shannon field is in northwest Crockett County about 14 miles east of the town of Iraan, Pecos County. It is at the western dissected edge of the Edwards Plateau.

Prior to 1947, the one well which had produced from the Grayburg reservoir was considered as in a separate field designated as the Live Oak field. In 1947, the Railroad Commission changed its designation to "Shannon (Grayburg)" and reporting organizations generally followed the change. The Railroad Commission reports the production from the San Andres reservoir as from the "Shannon (San Andres) field".

METHODS OF EXPLORATION LEADING TO DISCOVERY

Mapping of surface rocks indicated structural conditions favorable for accumulation of oil and gas. Core drilling to the Yates formation by Moore Exploration Company confirmed evidence afforded by surface exposures.

DISCOVERIES

Queen: September 1, 1944; Sohio Petroleum Co. #3-24 Margaret A. Shannon Estate. Drilled to total depth of 2,410 feet, from where sulphur water filled hole 600 feet in 8 hours. Plugged back to 1,983 feet and perforated casing with 80 holes from 1,960 to 1,970 feet. During potential test, production was at rate of 4,450 Mcf of gas per day. However, due to the lack of a market outlet, the well has been shut-in since its completion.

Grayburg and Field: July 13, 1940; Moore Brothers and Olson Oil Co. #1 A.C.Hoover. Pumped 53 barrels of oil per day after shot.

San Andres: May 21, 1943; John I. Moore & P. D. Moore #1-12 Margaret A. Shannon Estate. Pumped 45 barrels of oil and 10.5 barrels of salt water per day after shot and treatment with acid.

ELEVATION OF SURFACE

At well locations: Highest, 2,747 feet; lowest, 2,366 feet.

SURFACE FORMATION

All surface rocks within the area covered by the accompanying map are in the Edwards formation.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area covered by the accompanying map is in the Ellenburger group 650 feet below its top. This penetration was in John I. Moore #1-D A.C.Hoover, located in the northeast corner of Sec. 17, G.C. & S.F. R. R. Co. Block 1; total depth, 8,440 feet.

PRODUCTIVE AREAS

	Acres
Queen (gas)	60
Grayburg	120
San Andres	1,800
Shannon field	1,925

NATURE OF TRAPS

Queen, Grayburg and San Andres: It appears that updip decrease of porosity and permeability is the principal trap-forming factor in each of the reservoirs. The locations of the commercial accumulations of oil and gas are in the vicinity of structural conditions favorable for structural traps, but it appears that porosity and permeability are so irregular that they determine the location of each accumulation.

San Andres: As indicated on the accompanying map, there are several distinct areas where wells have been completed as commercial producers. Around and between these productive areas, many tests have yielded shows of oil and gas but not in sufficient quantity to warrant completion as producers. In view of the irregularity of porosity and permeability, it is not known whether there is one single accumulation or several isolated accumulations. In any case, it is evident that irregularity in degree of porosity and permeability has been a dominant factor in forming the trap, or traps, in which the oil has accumulated.

THICKNESSES OF RESERVOIR ROCKS

	Queen	Grayburg	San Andres
From top to bottom, feet, avg.	20	80	66

LITHOLOGY OF RESERVOIR ROCKS

Queen: Sandstone; red and gray, fine- to coarse-grained, with numerous rounded frosted quartz grains.

Grayburg: Dolomite; buff and brown, dense to finely crystalline, with very low porosity and permeability. This reservoir rock is partly in the Grayburg formation and partly in the San Andres formation. That portion in the Grayburg formation is only locally sufficiently porous to yield oil. It has been penetrated in all wells drilled in the area covered by the accompanying map and is productive in only three wells.

San Andres: Dolomite; white and tan, finely crystalline, generally with very low porosity and permeability. Throughout most of the area covered by the accompanying map, porosity and permeability are too low to yield oil and gas at rates sufficient for commercial production.

CONTINUITY OF RESERVOIR ROCKS

In no case can the productive reservoir in any well be proven to be continuously open for migration of fluids beyond the patterned area in which the well is represented on the accompanying map. However, it seems likely that the San Andres production is all from a single reservoir even though intercommunication has not been proven.

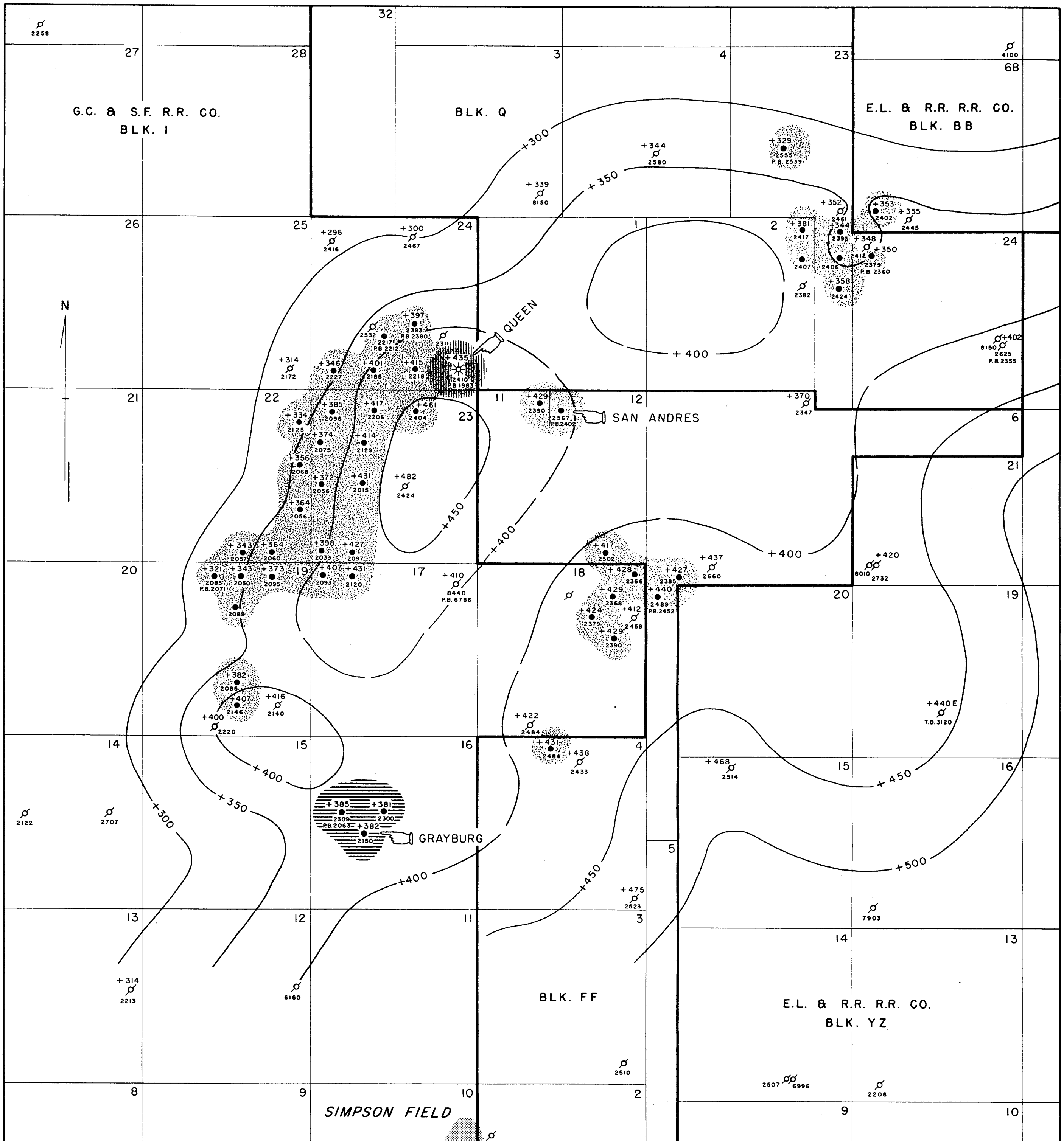
CHARACTER OF OIL

	Grayburg	San Andres
Gravity, A.P.I. @ 60° F., avg.	29°	25°

ACID TREATMENT

More than half of all oil wells in the field were acidized at the time of completion. Many were shot. Some were acidized and shot.

SHANNON FIELD, Crockett County, Texas



NOTE: All oil wells except the three in the Grayburg productive area are producing from the San Andres reservoir. The single gas well was completed for production from the Queen reservoir, but has been shut in since the time of its completion because of lack of market outlet.

SCALE

0 2 4 6 8 10

THOUSAND FEET

EXPLANATION

+400 Contour on top of San Andres formation

+329 Elevation of top of San Andres formation

2555 Total depth of well

P.B. 2539 Plugged-back depth of well

Gas well · Oil well · Dry hole · Discovery

PRODUCTIVE AREAS

Queen · Grayburg · San Andres

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Feet
Queen (one well)	
Elevation of top of gas	725
Elevation of bottom of gas	705
Relief	20
Grayburg	
Highest proven elevation of oil	461
Lowest proven elevation of oil	376
Proven relief of oil column	85
San Andres	
Highest proven elevation of oil	431
Lowest proven elevation of oil	261
Apparent relief	170

Water has been found below oil in San Andres rocks as high as 344 feet and at various elevations down to the lowest proven elevation of oil. There probably never was a definite oil-water contact throughout the field.

WATER PRODUCTION

Grayburg: No water has been produced.

San Andres: A few of the wells produced some water on initial potential test. These wells now produce a very large percentage of water. Other wells which were water-free at time of potential test now produce some water. However, some wells still produce no water. There is no definite relationship between water production and elevation.

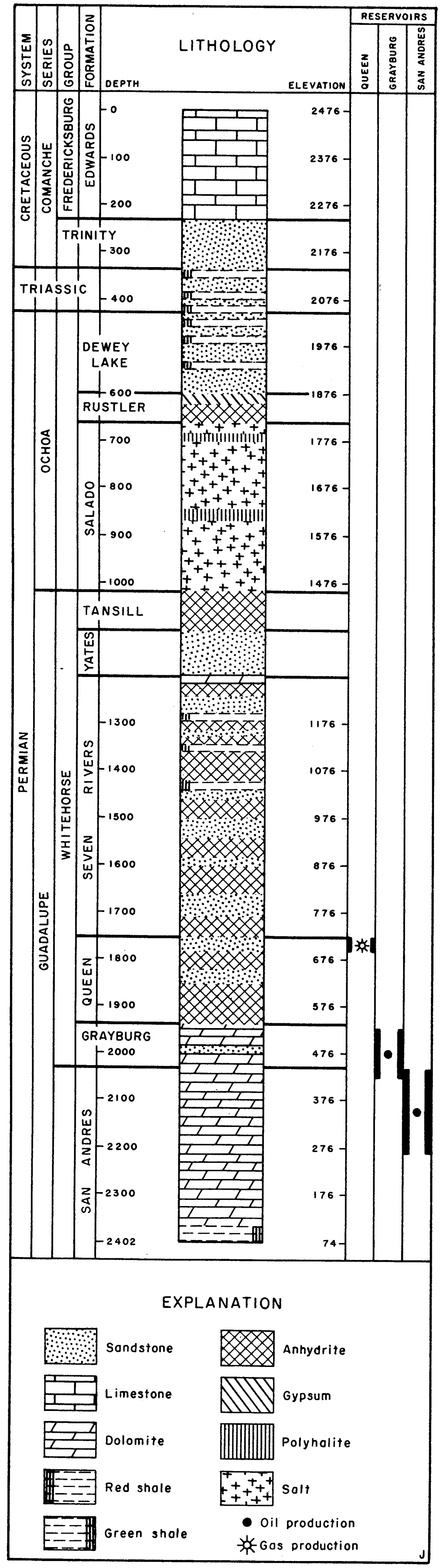
PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Grayburg				
1940	0	1	7xx	7xx
1941	0	1	1,612	2,4xx
1942	0	1	1,108	3,5xx
1943	0	1	558	4,0xx
1944	0	1	7xx	4,8xx
1945	0	1	955	5,7xx
1946	0	1	1,104	6,8xx
1947	0	3	1,727	8,6xx
1948	0	3	1,988	10,6xx
1949	0	3	1,201	11,8xx
1950	0	3	1,144	12,9xx
1951	0	3	994	13,9xx
1952	0	3	1,001	14,9xx
1953*	0	3	938	15,8xx
San Andres				
1943	0	1	223	223
1944	0	4	401	624
1945	4	4	600	1,224
1946	4	4	0	1,224
1947	0	29	213,327	214,551
1948	0	37	272,081	486,632
1949	0	34	198,547	685,179
1950	2	38	207,980	893,159
1951	0	41	202,451	1,095,610
1952	0	42	170,200	1,265,810
1953*	0	40	163,220	1,429,030

*1953 data added by amendment.

GAS PRODUCTION: The only gas production has been incidental to oil production. The quantities produced have been minor and have been utilized in field operations. The one gas well (Queen) has been shut-in since the time of its completion because of lack of a market outlet.

TYPICAL SECTION OF ROCKS PENETRATED



SIMPSON FIELD

Crockett County, Texas

D. E. DAUGHERTY, H. J. McCOOL and J. A. BODJO
Geologists, Sinclair Oil and Gas Company, Midland, Texas
May 7, 1954

LOCATION

The Simpson field is in west central Crockett County about 26 miles west and slightly north of the town of Ozona, county seat, and is about 2 miles south of the Shannon field and 4 miles east of the Olson field.

MAP

Because of geographic and geologic relationships, Hoover field and Simpson field are shown on the same map; presented in the foregoing paper on the Hoover field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

The discovery well was located on the basis of studies of surface and subsurface geological data.

DISCOVERIES

Seven Rivers: October 25, 1947; C.W. Brown #1-D A.C.Hoover. Pumped 77 barrels of oil in 24 hours.

Grayburg and Field: September 30, 1930; Magnolia Petroleum Co. #2 A.C.Hoover. At time of completion, the well produced by swabbing at rate of 22 barrels of oil per day. It produced a total 110 barrels of oil in ten days. It stood idle during several years and was sold to J.N.Simpson on October 1, 1937. Simpson revived production and then sold to Pitzer & West who drilled deeper in 1938 from the former total depth of 2,056 feet to the new total depth of 2,064 feet. Production, after shot, was at rate of 51 barrels per day by pumping. The well then produced 695 barrels of oil. It was plugged and abandoned in May 1938, after having inspired drilling operations in the vicinity which resulted eventually in establishing commercial production.

ELEVATION OF SURFACE

At well locations: Highest, 2,521 feet; lowest, 2,346 feet.

SURFACE FORMATIONS

Undifferentiated formations of the Fredericksburg and Washita groups of the Comanche series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Wolfcamp series 710 feet below the base of the Dean formation. This penetration was in Magnolia Petroleum Co. #1 A.C.Hoover, a dry hole about one mile northwest of the field. The accompanying TYPICAL SECTION is based on the log of that dry hole.

NATURE OF TRAPS

Seven Rivers: Updip lensing of reservoir on a structural nose.

Grayburg: Updip termination of reservoir due to lensing.

PRODUCTIVE AREAS

	Acres
Seven Rivers	100
Grayburg	600
Simpson field	700

THICKNESSES OF RESERVOIR ROCKS

	Feet, avg.
Seven Rivers:	
From top to bottom	29
Net productive	20
Grayburg:	
From top to bottom	98
Net productive	25

LITHOLOGY OF RESERVOIR ROCKS

Seven Rivers: Grayish-green, slightly glauconitic, very loosely cemented sandstone.

Grayburg: Tan to brown, finely-granular to crystalline dolomite with interbedded gray-green, medium-grained sandstone.

CONTINUITY OF RESERVOIR ROCKS

Seven Rivers and Grayburg: The stratigraphic equivalent of each of the two reservoir rocks is continuous throughout the area covered by the accompanying map. However, due to small local lenses and irregularity of porosity and permeability, it appears doubtful that conditions are favorable for migration of fluids in either reservoir rock for any considerable distance beyond the local productive areas.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Seven Rivers	Grayburg
Elevation of top of oil, feet	957	438
Elevation of bottom of oil, feet	928	340
Relief	29	98

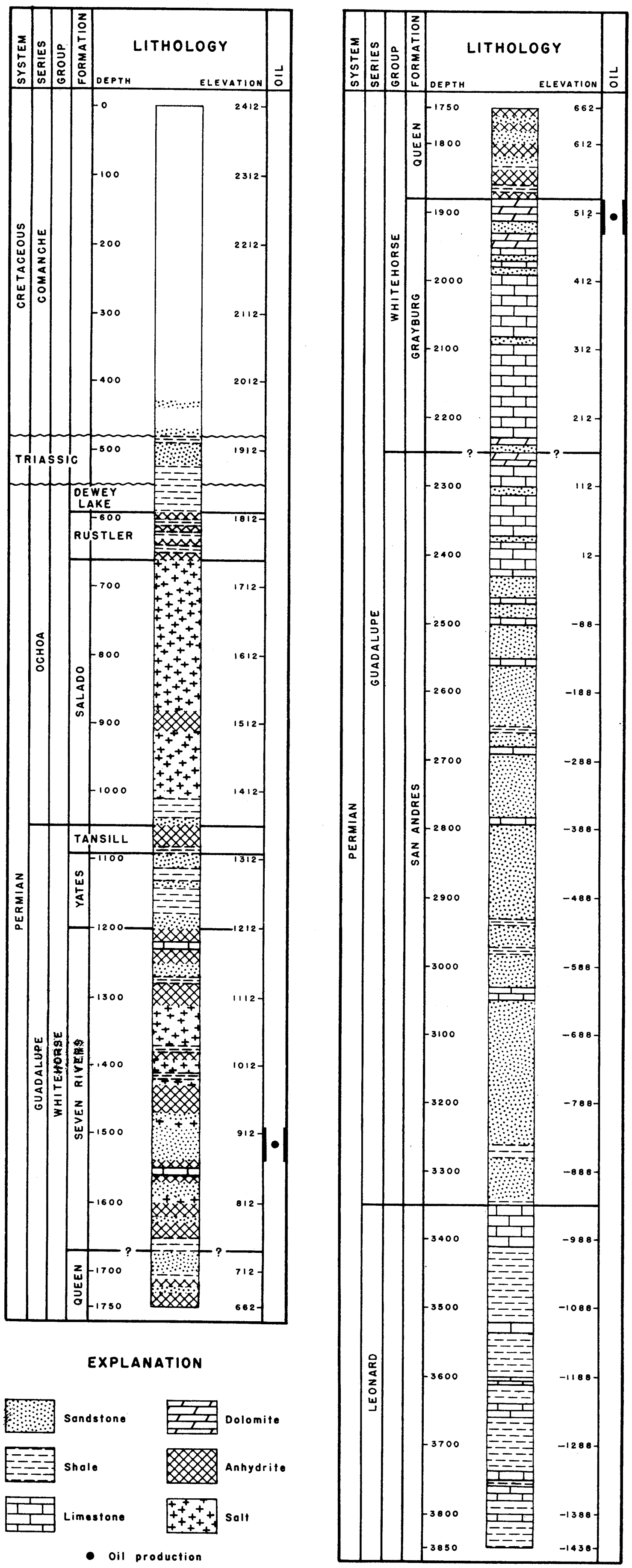
CHARACTER OF OIL

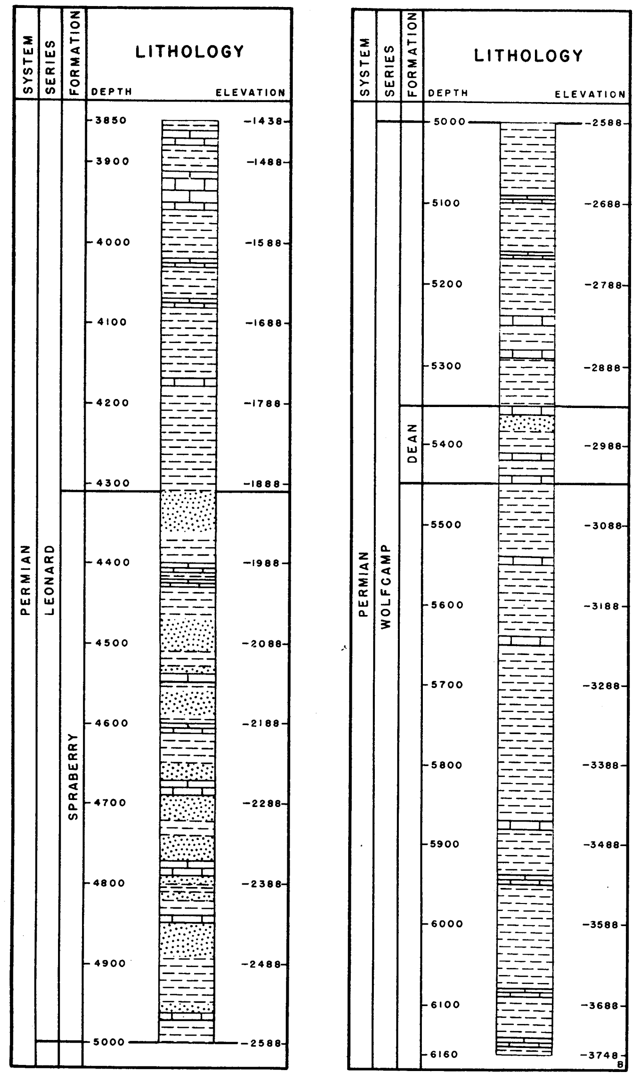
Seven Rivers and Grayburg: Gravity, A.P.I. @ 60° F.: Range, 24° - 33°; average, 27.7°

WATER PRODUCTION

Very little water has been produced from either of the two reservoirs.

TYPICAL SECTION OF ROCKS PENETRATED





PRODUCTION HISTORY

Total field

Year	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	Cumulative
1930-1938	1	?	1,935
1939	1	1,000	2,935
1940	0	0	2,935
1941	1	1,793	4,728
1942	1	938	5,666
1943	1	252	5,918
1944	0	0	5,918
1945	0	0	5,918
1946	0	0	5,918
1947	3	3,185	9,103
1948	5	9,723	18,826
1949	8	14,381	33,207
1950	5	10,722	43,929
1951	8	8,180	52,109
1952	7	7,920	60,029
1953	11	6,278	66,307

SMITH-SPRABERRY FIELD

Dawson County, Texas

W. D. GALLOWAY
Geologist, Standard Oil Co. of Texas, Midland, Texas
June 30, 1955

LOCATION

The Smith-Spraberry field is in north central Dawson County about 13 miles northwest of Lamesa and 4 miles southwest of O'Donnell.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Favorable structural conditions were first indicated by seismic exploration for the Standard Oil Company of Texas in 1950. The discovery well was drilled in late 1950 to test the Pennsylvanian. No oil was found in the Pennsylvanian and the well was plugged back and completed in the lower Spraberry.

DISCOVERY

Lower Spraberry: December 1, 1950;
Standard Oil Co. of Texas #1 M.V.A.Smith.

ELEVATION OF SURFACE

At well locations: Highest, 3, 085 ft.; lowest, 3, 062 ft.

SURFACE FORMATION

Undifferentiated Tertiary.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated within the vicinity of the field is 146 feet below the top of the Ellenburger dolomite. This penetration was at the total depth of 11, 376 feet in Standard Oil Co. of Texas #4 M. V. A. Smith #1.

NATURE OF TRAP

Lower Spraberry: Variation in degree of permeability appears to be the primary trap-forming factor. The convex form of the top of the reservoir rock probably contributes locally to forming the trap.

PRODUCTIVE AREA

Lower Spraberry and Field: Irregularity of porosity and permeability precludes a close estimate of the productive area. In the writer's opinion, development to date indicates that the productive area is at least 400 acres in extent.

WATER PRODUCTION

Lower Spraberry: Production of water has been nearly negligible.

THICKNESSES OF RESERVOIR ROCK

Lower Spraberry:	Feet		
	Min.	Max.	Avg.
From top to bottom	22	36	30
Net productive	0	17	11

LITHOLOGY OF RESERVOIR ROCK

Lower Spraberry: Sandstone; gray to brown, uniformly very fine-grained, shaly and calcareous and with partings of various thicknesses of silt, shale and calcareous material.

CONTINUITY OF RESERVOIR ROCK

Lower Spraberry: The reservoir is due to a local condition in the lower Spraberry member, which member is continuous throughout a large part of the Midland basin. The degree of porosity and permeability adequate for commercial production is a very local condition in the particular sandstone which is productive in this field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Lower Spraberry:	Feet
Elevation of top of productive zone	-4, 840
Elevation of bottom of productive zone	-4, 891
Relief of productive zone	51

Oil occupies interstitial space in the Lower Spraberry member both upward and downward from the elevations above stated, but the degree of permeability is too low for commercial production beyond the above indicated elevations. The elevation of the oil-water contact has not been determined, but it is known to be above -4,895 feet.

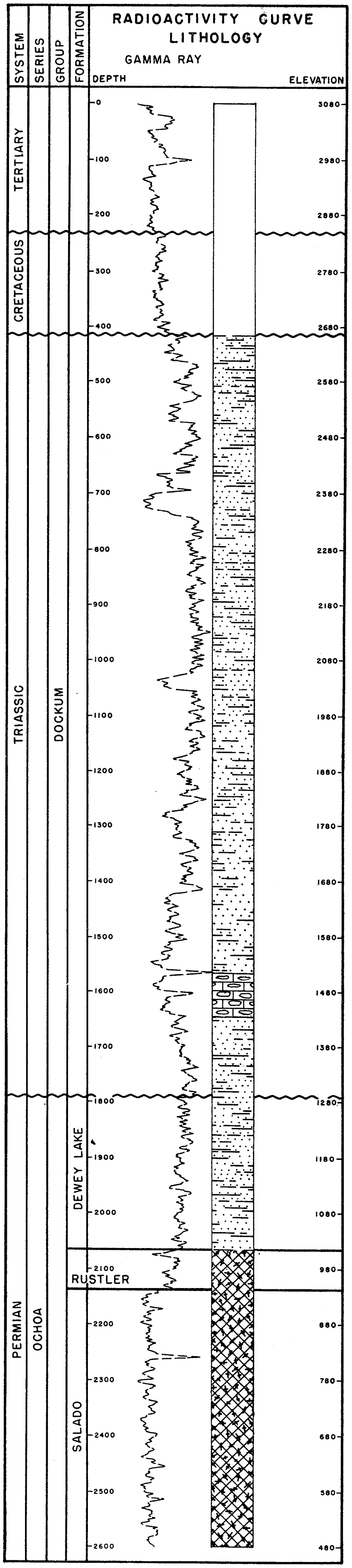
CHARACTER OF GAS

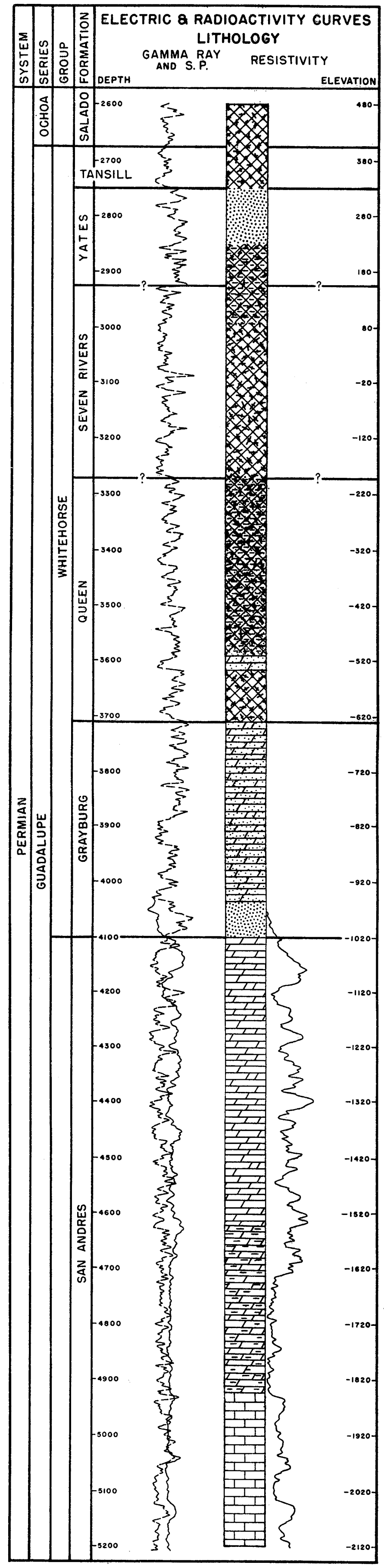
Lower Spraberry: No analysis is available. The only gas production is incidental to oil production and the quantity of gas is very small.

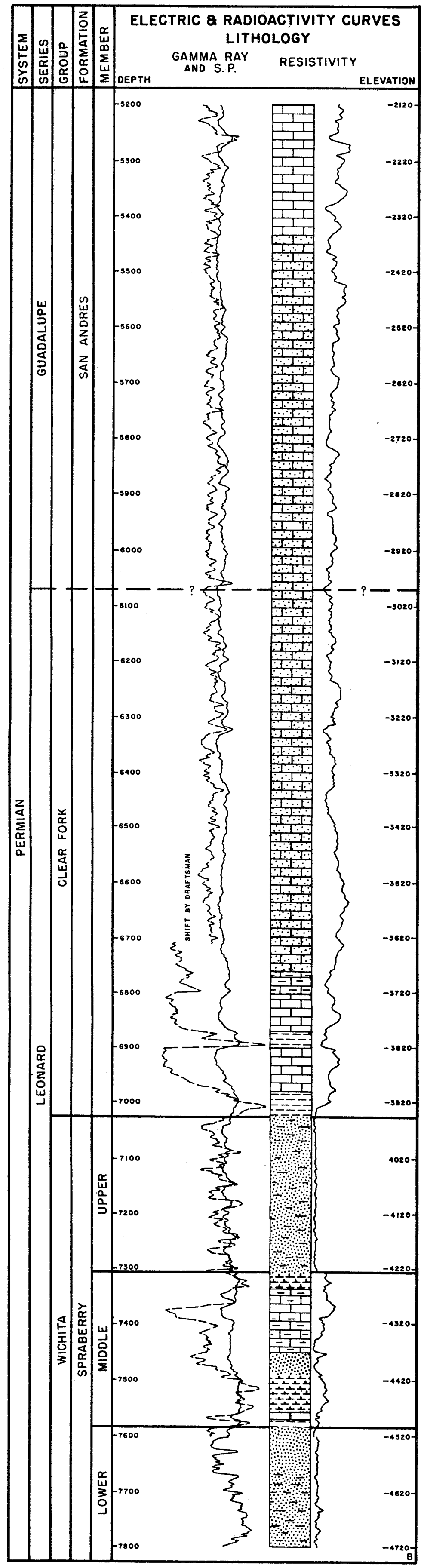
COMPLETION TREATMENT

Lower Spraberry: In one well, the reservoir rock was hydraulically fractured by injection of 3,000 gallons of fluid and 1,500 pounds of sand with a maximum treating pressure of 2,650 psi. The other wells were shot with 110 to 170 quarts of nitroglycerin.

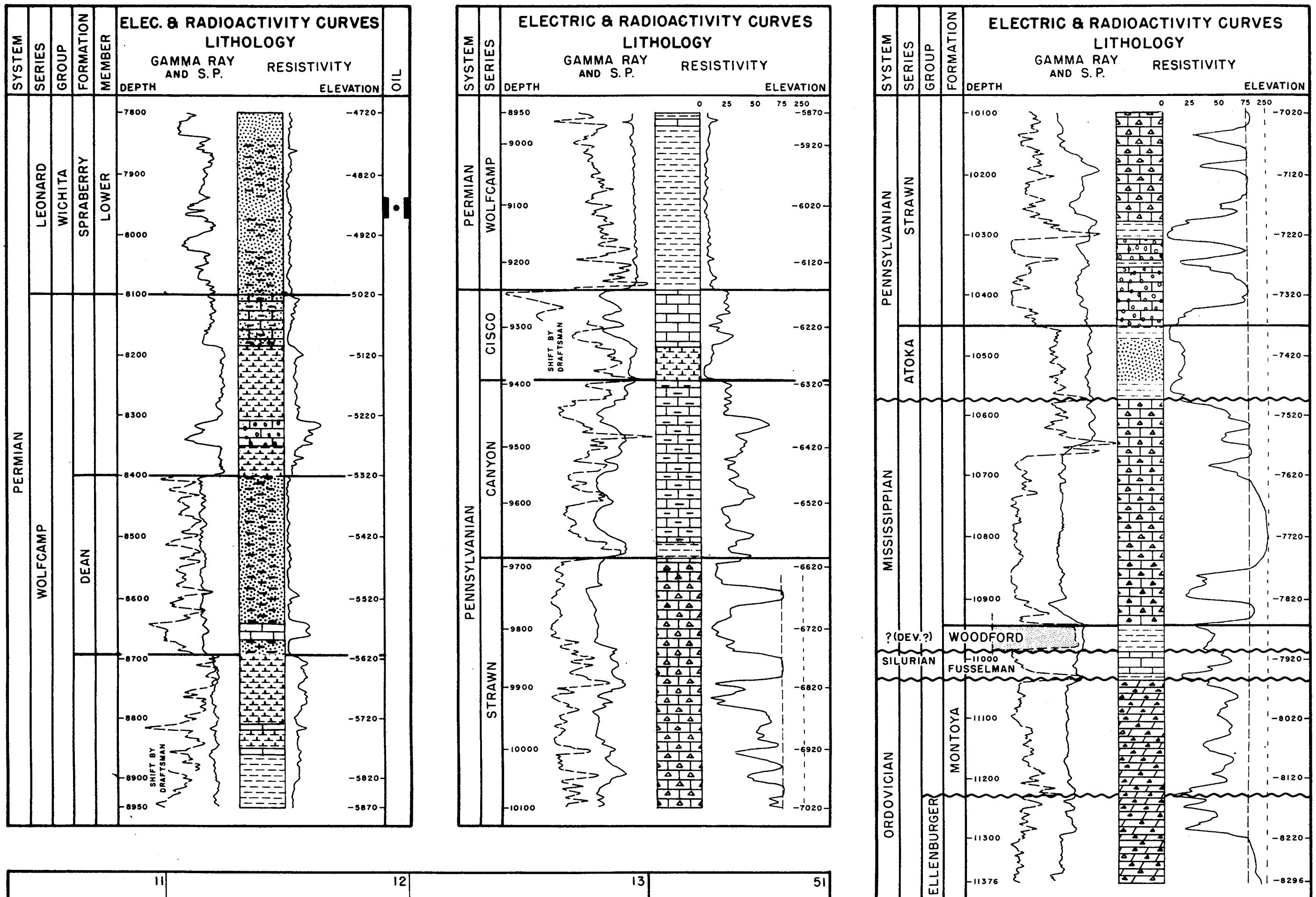
TYPICAL SECTION OF ROCKS PENETRATED





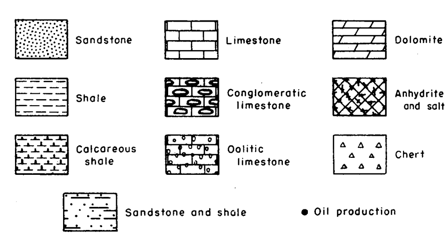


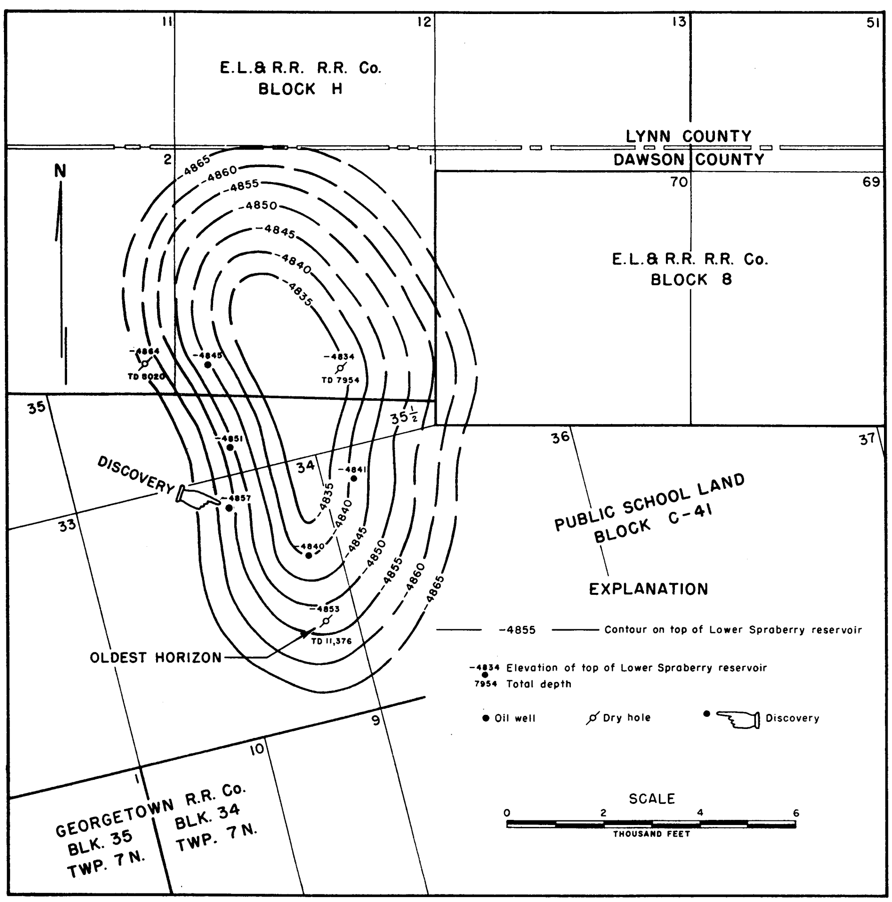
TYPICAL SECTION OF ROCKS PENETRATED



NOTE: The above TYPICAL SECTION is based on the log of the well which penetrated the oldest horizon except that between the depths of 7,600 feet and 8,400 feet it is based on the log of the discovery well.

EXPLANATION





CHARACTER OF OIL

Lower Spraberry:

Gravity, A.P.I. @ 60° F.: Range, 37.5° to 39.8°; avg., 38°
Sulphur: 0.149% Color: Green
Base: Mixed paraffin and asphalt
Viscosity, S. U.: @ 130° F., 36.8 sec.; @ 100° F., 40.6 sec.; @ 60° F., 51.4 sec.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year: Flowing	Pumping	OIL PRODUCTION (barresl): Yearly	Cumulative
1950	1	0	2,001	2,001
1951	0	2	35,297	37,298
1952	0	5	73,900	111,198
1953	0	5	60,802	172,000
1954	0	5	48,597	220,597

SOUTH BROWNFIELD FIELD

Terry County, Texas

MARSHALL L. MASON, JR.
Geologist, Union Oil Company of California, Midland, Texas
January 1, 1953

LOCATION

The South Brownfield field is in southeast central Terry County, about 4½ miles southeast of Brownfield, county seat. It is in Secs. 72 and 91, Block T, Dallas & Wichita Railroad Co. survey. It is the most northern of three fields in southern Terry County that produce from reefs of late Pennsylvanian or early Permian age; the others are Wellman and Adair.

METHOD OF EXPLORATION LEADING TO DISCOVERY

This field was discovered as a result of a reflection seismograph survey conducted in the latter part of 1949 and early 1950 for the Union Oil Company of California. On the basis of this survey, leases were acquired and the discovery well was commenced May 28, 1950, and drilled to a depth of 10,182 feet, where it was completed on August 14, 1950.

DISCOVERY

Pennsylvanian reef: August 14, 1950; Union Oil Company #1 Laura Cotton. Flowing potential, 1,812 barrels of oil per day.

ELEVATION OF SURFACE

At well locations: Highest, 3,271 ft.; lowest, 3,252 ft.

SURFACE FORMATION

Tertiary sand

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is 440 feet below the top of the Strawn series. This penetration was in Union Oil Co. #3 Cristova Stitt, the most western well in the field, where total depth of 11,000 feet is indicated on the accompanying map. The oldest horizon penetrated in the vicinity of the field is 188 feet below the top of the Ellenburger group. This penetration was in Union Oil Co. #2 Laura Cotton, the dry hole offset north of the discovery well.

NATURE OF TRAP

Pennsylvanian reef: The accumulation of oil and gas is due to a simple convex trap resulting from Pennsylvanian reef topography. The reef is approximately one mile long and one-half mile wide, with steep slopes on the north and south flanks. Overlying and surrounding shales confine the oil to the crest of the reef. Drilling to date has not indicated that the trap is influenced by any structural factors.

PRODUCTIVE AREA

Pennsylvanian reef: 320 acres.

There is a possibility that additional drilling might prove that a greater area is productive. However, it now appears that additional drilling is not warranted.

THICKNESSES OF RESERVOIR ROCK

Pennsylvanian reef:	Min.	Max.	Avg.
Net productive, feet	40	170	90

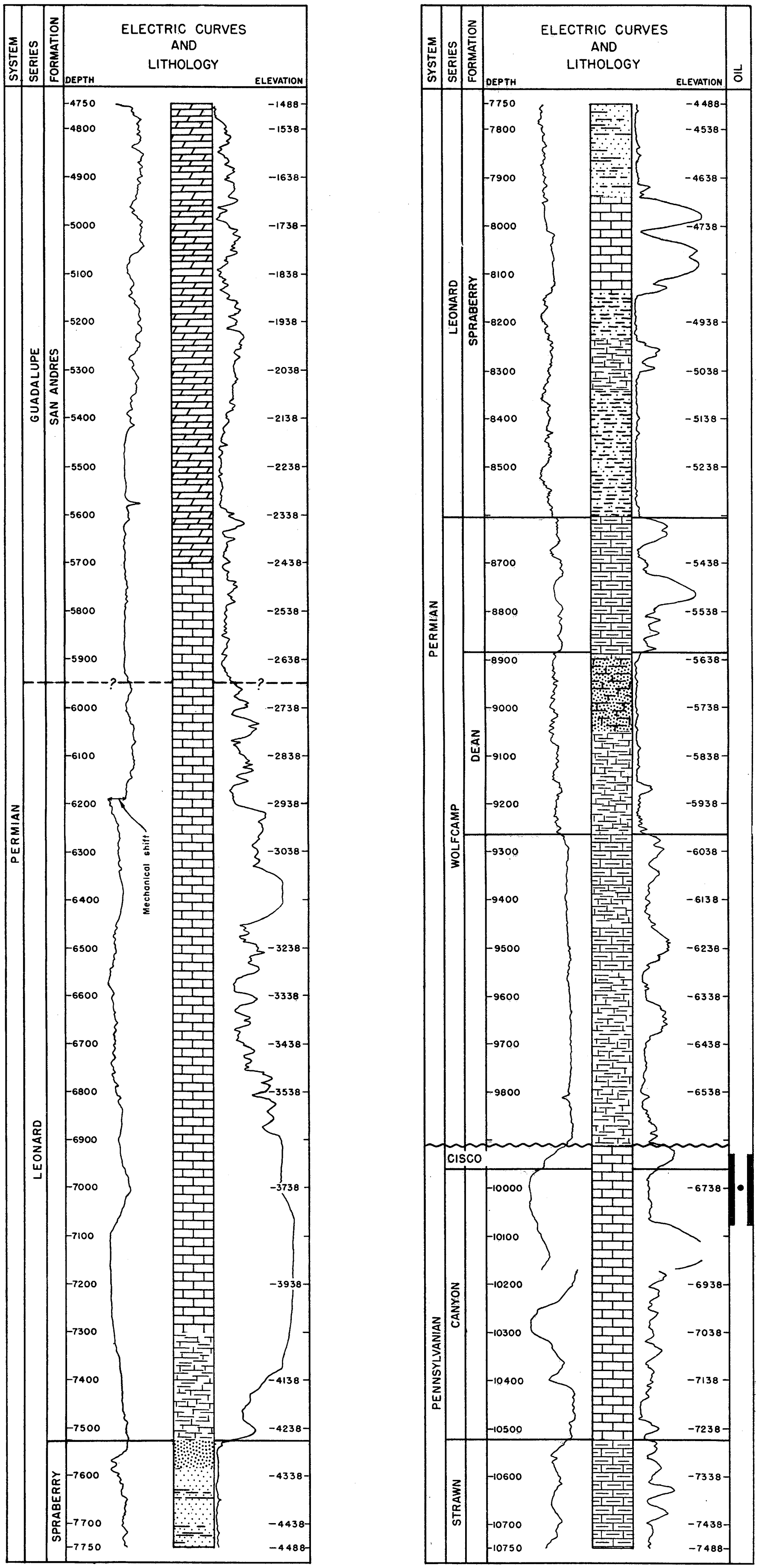
LITHOLOGY OF RESERVOIR ROCK

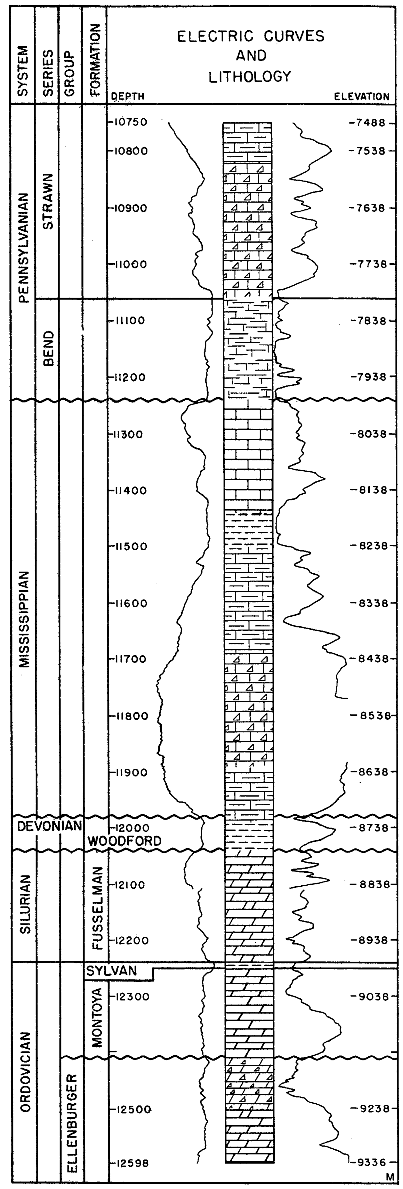
Pennsylvanian reef: White to light gray, fine to medium crystalline, highly fossiliferous, porous limestone containing secondary dolomite rhombs, calcite crystals and stylolites. The porosity is vuggy, cavernous and highly irregular. The degree of permeability is generally very high. The irregularity of porosity causes great variation in the productivity of the reservoir.

CONTINUITY OF RESERVOIR ROCK

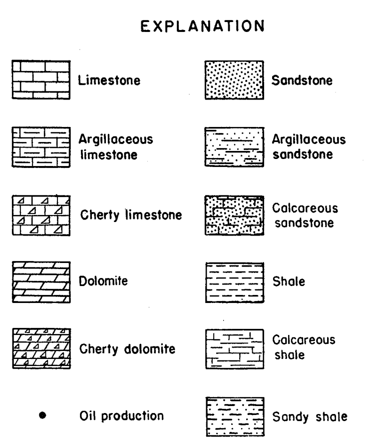
Pennsylvanian reef: The reservoir rock is a local reef of Cisco and Canyon age. Beyond the extent of the field but within the immediate region, generally there are no Pennsylvanian limestones above the Strawn series. Vertical and lateral gradation of limestone to shale restricts the reservoir to the reef mass. There are other isolated reservoirs of this type and age in the northern Midland basin and on the Eastern platform.

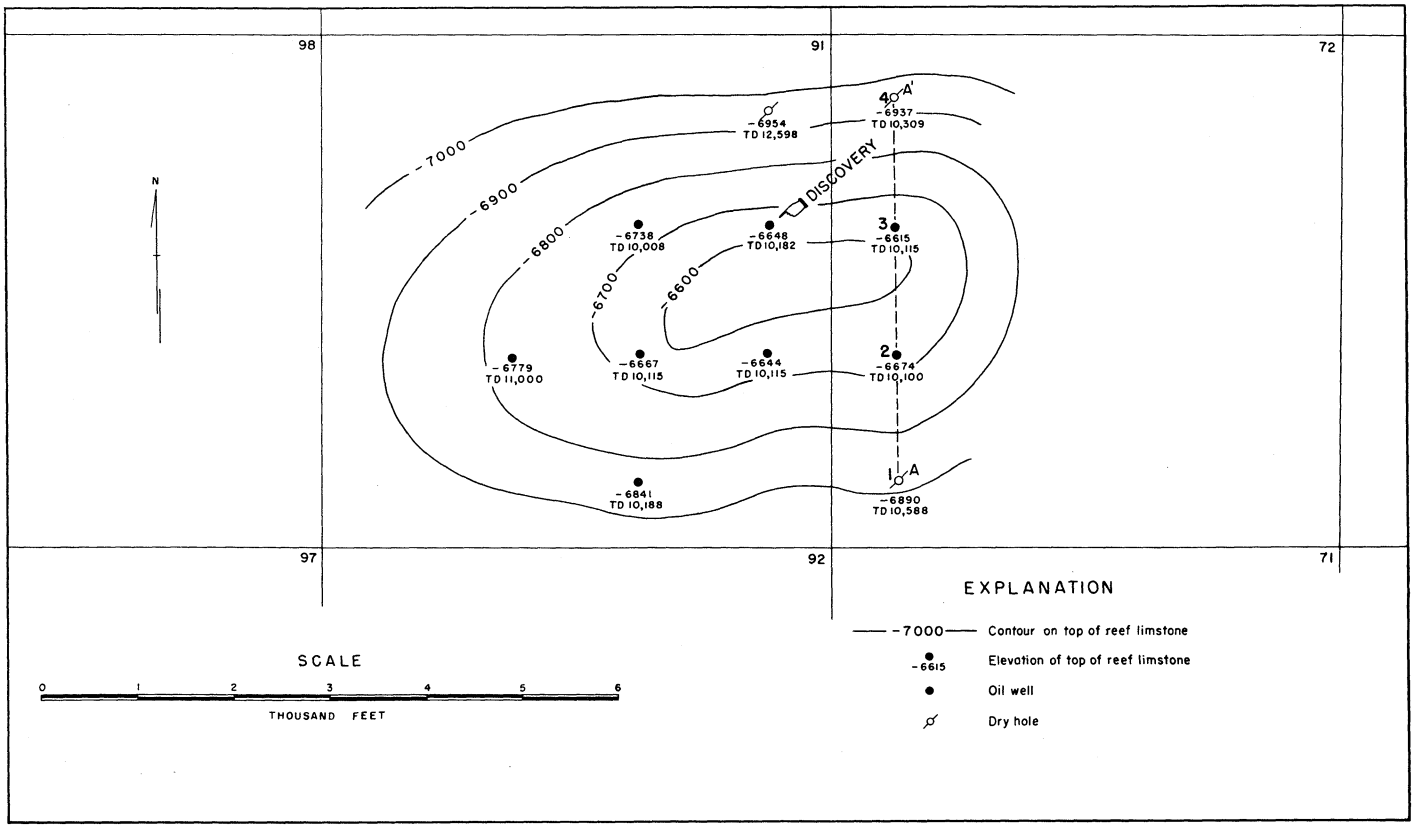
TYPICAL SECTION OF ROCKS PENETRATED





NOTE: This TYPICAL SECTION is based on a combination of the log of the discovery well and the log of the deepest test in the vicinity, the offset dry hole.




98
91
72
97
92
71
N
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-6700
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DISCOVERY
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A'
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2
3
4
-6954
TD 12,598
-6937
TD 10,309
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TD 10,008
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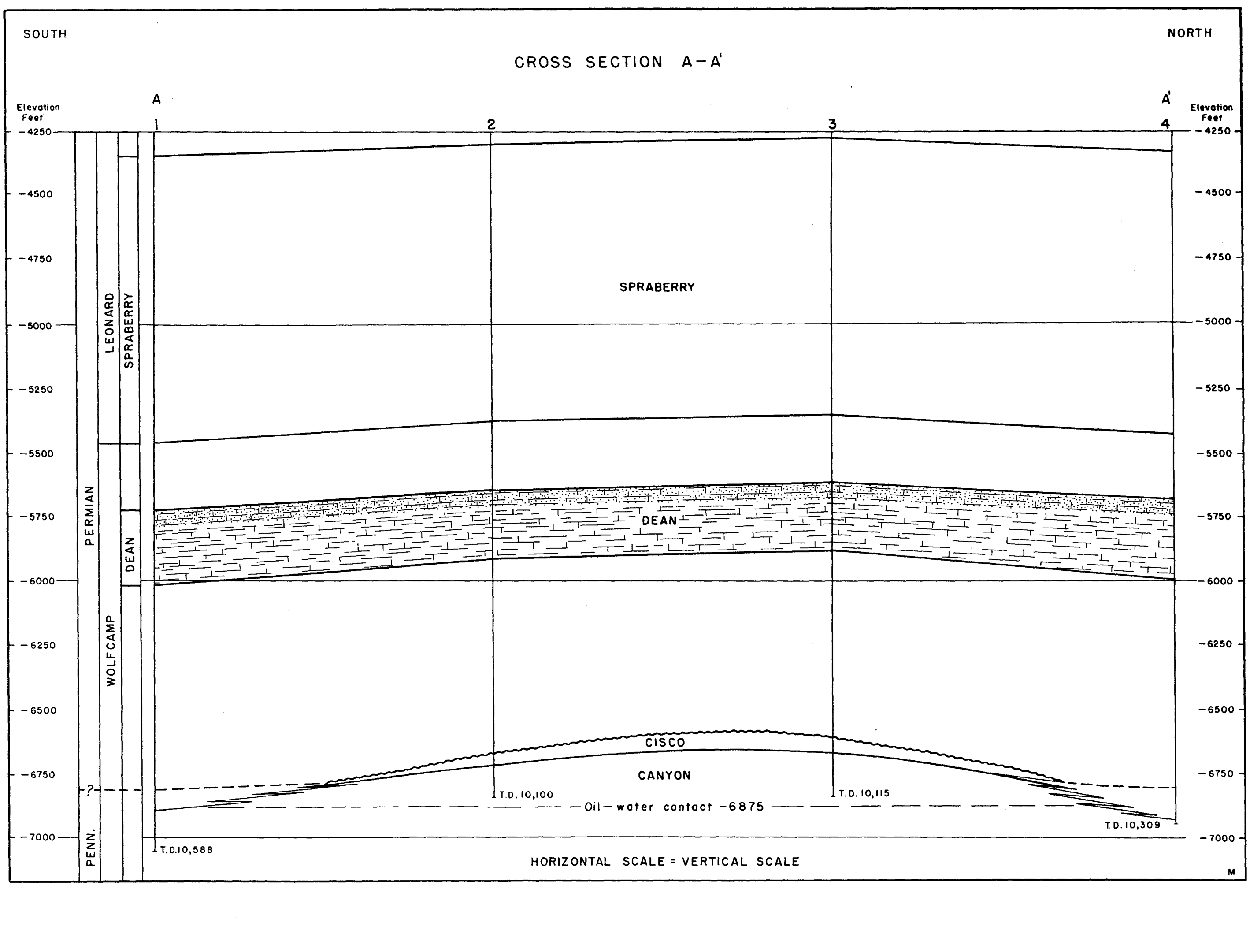
TD 10,182
-6615
TD 10,115
-6779
TD 11,000
-6667
TD 10,115
-6644
TD 10,115
-6674
TD 10,100
-6841
TD 10,188
-6890
TD 10,588
EXPLANATION
-7000 Contour on top of reef limstone
-6615 Elevation of top of reef limstone
Oil well
Dry hole
SCALE
0 1 2 3 4 5 6
THOUSAND FEET


SOUTH
NORTH
CROSS SECTION A-A'
Elevation Feet
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A'
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-7000
PERMIAN
PENN.
LEONARD
WOLFCAMP
SPRABERRY
DEAN
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SPRABERRY
DEAN
CISCO
CANYON
T.D. 10,100
T.D. 10,115
T.D. 10,588
T.D. 10,309
Oil-water contact -6875
HORIZONTAL SCALE = VERTICAL SCALE
M

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Pennsylvanian reef:	Feet
No free gas cap to date	
Elevation of top of oil	-6,639
Elevation of bottom of oil	-6,875
Maximum gross oil column	236

The above reported gross oil column should not be considered as actual oil column. The actual oil column varies from 40 feet to 170 feet due to the extremely variable porosity.

WATER PRODUCTION

Year	NUMBER OF WELLS PRODUCING WATER at end of year	WATER PRODUCTION (barrels) Yearly	Cumulative
1950	None	None	None
1951	7	1,985	1,985
1952	7	1,369	3,354

Since records for one well are not available, the above quantities were estimated on the basis of accurate records for six of the seven wells which produced water. One well in the eastern part of the field has produced no water to date.

RESERVOIR and OIL SAMPLE DATA

Original reservoir pressure	4,285 psi
Original reservoir temperature	154° F.
Gravity of oil, A.P.I. @ 60° F.	41.2°
Bubble point	1,675 psi
Solution gas-oil ratio	725 cf/bbl
Original volume factor, surface:reservoir	1.41

ACID TREATMENT

Four of the eight wells in the field were completed without acidization. Quantities used in the other wells ranged from 500 gallons to 12,000 gallons. Decision as to treatment of each well was based on nature of porosity of the reservoir rock at the particular location.

CHARACTER OF GAS

Component	Mol. %
Nitrogen	9.37
Oxygen	0.94
Methane	49.61
Ethane	12.50
Propane	18.30
Iso-butane	1.81
N-butane	5.00
Iso-pentane	1.11
N-pentane	0.45
Hexane	0.91
Heptanes plus	0.0

RESERVOIR ENERGY

Originally, the energizing force of the reservoir was water drive and oil expansion, but in the future it is expected that gas expansion plus water drive will be motivating agents. There was no original gas cap, but reservoir studies indicate that declining pressures will eventually cause the gas to come out of solution and form a gas cap in the crest of the reef.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year Flowing	Pumping	OIL PRODUCTION (barrels) Yearly	Cumulative	GAS PRODUCTION (Mcf)* Yearly	Cumulative
1950	3	0	51,988	51,988	33,532	33,532
1951	8	0	449,257	501,245	289,771	323,303
1952	0	8	310,878	812,123	200,516	523,819

*Gas production was estimated by taking the average gas-oil ratio and multiplying by the number of barrels of oil produced.

SOUTH KEYSTONE FIELD

Winkler County, Texas

W. C. OSBORNE
District Geologist, Union Oil & Gas Corp. of Louisiana, Midland, Texas
December 19, 1956

LOCATION

The South Keystone field is in east central Winkler County about 8 miles east of Kermit, county seat. It is about $3\frac{1}{2}$ miles southeast of the Keystone field and is on the same structural trend. The accompanying map overlaps slightly with the maps in the paper on the Keystone field presented earlier in this volume.

METHOD OF EXPLORATION LEADING TO DISCOVERY

As a result of reflection seismograph exploration, Gulf Oil Corporation discovered the anticlinal fold which later became productive. Gulf commenced the drilling of the discovery well on November 19, 1947.

DISCOVERY

"Tubb Zone": July 31, 1948; Gulf Oil Corp. #125-E (later, #125-T) Keystone Cattle Co. Completed in "Tubb Zone" from 6,400 feet to 6,600 feet with initial flowing potential of 162 barrels of oil per day through $\frac{1}{2}$-inch choke. The well was commenced as an Ellenburger test and was drilled 147 feet into Ellenburger at its total depth of 11,502 feet. Sulphur water was the only fluid found in Ellenburger. The well was plugged back to 6,600 feet for production from "Tubb Zone" and its designation was changed from #125-E to #125-T.

ELEVATION OF SURFACE

The elevation of the surface ranges from 2,946 feet to 2,977 feet above sea level.

TYPICAL SECTION OF ROCKS PENETRATED

The TYPICAL SECTION in the accompanying paper on the Keystone field serves to report the character of rocks penetrated in the South Keystone field. Although the rocks here are of essentially the same character as those in the Keystone field, where nine stratigraphic units are productive, only the reservoir designated as "Tubb Zone" is productive here; that zone is not productive in the Keystone field. The reservoir which is productive in the South Keystone field is generally called "Tubb Zone" although it is now known to be stratigraphically lower than the widely recognized unit properly designated by the same name. The top of the reservoir rock in this field is about 250 feet below the base of the widely recognized Tubb zone.

SURFACE FORMATION

Quaternary sand, with only a sparse growth of mesquite and grasses, covers the surface. The sand is so loose that travel off of roads is extremely difficult.

NATURE OF TRAP

"Tubb Zone": Anticlinal folding and variation in porosity and permeability.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 147 feet below its top. This penetration was in the discovery well at its total depth of 11,502 feet.

PRODUCTIVE AREA

"Tubb Zone" and Field: 560 acres.

THICKNESS OF RESERVOIR ROCK

"Tubb Zone":	Min.	Max.	Avg.
From top to bottom, feet	287	430	363

Available data do not afford an adequate basis for estimating net productive thickness.

LITHOLOGY OF RESERVOIR ROCK

"Tubb Zone": The reservoir rock is comprised of limestone and dolomite and a minor amount of silty sand. The ratio of limestone and dolomite to silty sand varies from well to well. Generally, limestone and dolomite constitute about 95% of the reservoir rock; everywhere, the amount of limestone and dolomite greatly exceeds the amount of silty sand. The limestone is tannish-brown, finely crystalline. The dolomite is also tannish-brown and finely crystalline; slightly harder than the limestone. The silty sand is gray. The dolomite members are more porous than the limestone members and yield most of the oil production. The silty sand does not contribute materially to the productive capacity. The better wells are those where the amount of dolomite exceeds the amount of limestone.

CONTINUITY OF RESERVOIR ROCK

"Tubb Zone": The reservoir rock is continuous throughout the area of the field. Its lithologic characteristics are so nearly the same as those of near-by rocks both higher and lower in the stratigraphic section that presently available data do not afford a basis for correlation beyond the immediate vicinity of the productive wells.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

"Tubb Zone":	Feet
Elevation of top of gas	-3,155
Elevation of bottom of gas	-3,495
Relief	340
Elevation of top of oil	-3,495
Elevation of bottom of oil	-3,585
Relief	90

The above data represent conditions at time of discovery of the field.

CHARACTER OF RESERVOIR WATER

"Tubb Zone": Average chloride content, 76,300 parts per million.

RESERVOIR TEMPERATURE and PRESSURE and OIL SAMPLE DATA

"Tubb Zone":

Original reservoir pressure, psi.	2,863
Original reservoir temperature, °F.	102
Gravity of oil, A.P.I. @ 60° F.	38.5
Sulphur in oil, %	0.48
Bubble point, psi.	2,844
Solution gas-oil ratio, cf/bbl.	1,050
Volume factor, surface:reservoir	1.525

CHARACTER OF GAS

"Tubb Zone": No analysis of the gas is available. The sulphur content is probably so high that the gas is not suitable for domestic utilization. Gas is produced only incidental to the production of oil and is flared.

WATER PRODUCTION

"Tubb Zone": Each well produces some water; no record is kept of the quantities. Data are not available for making even approximate estimates of the amounts of water which have been produced.

ACID TREATMENT

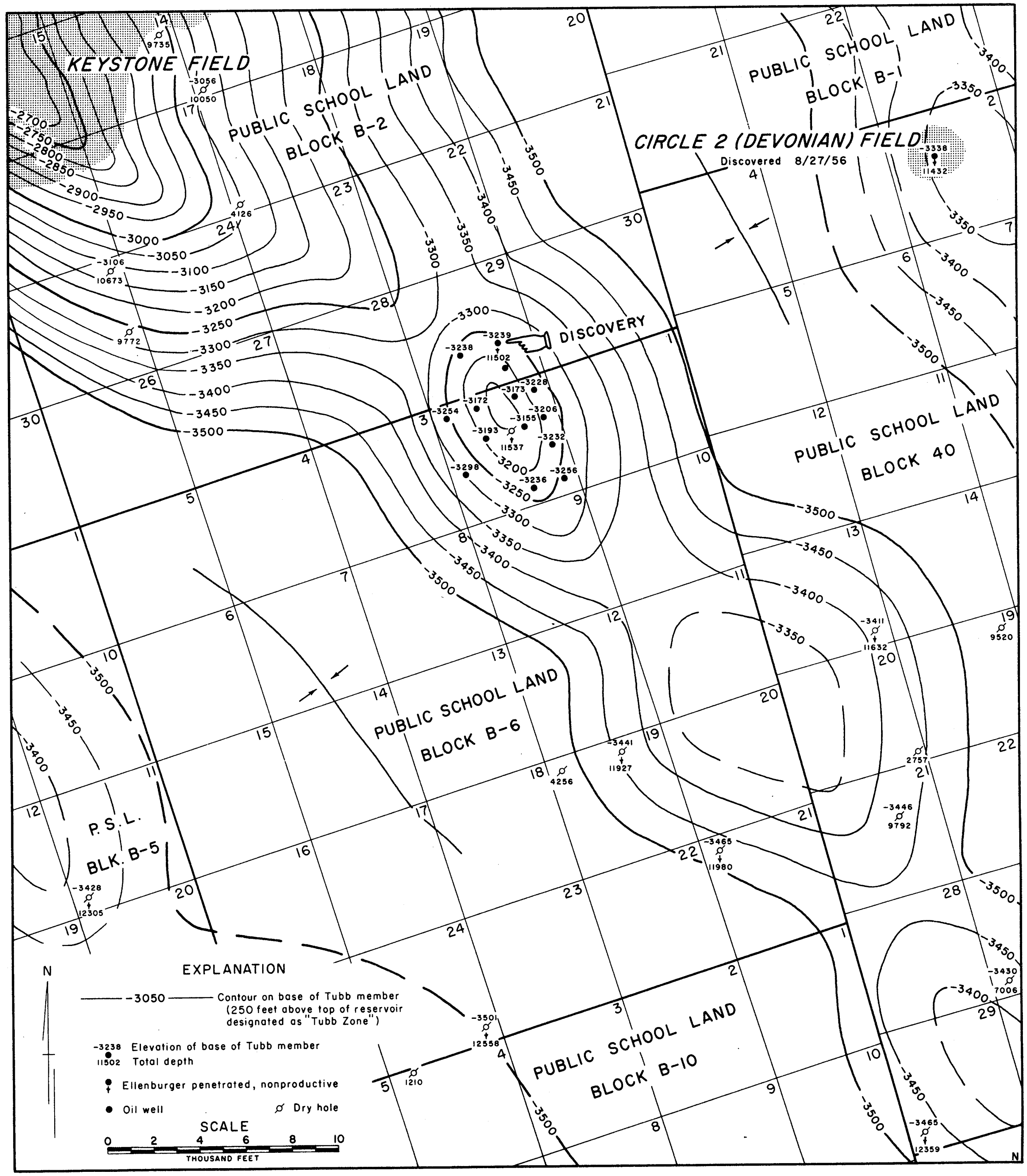
"Tubb Zone": All wells have been treated with acid. The quantity of acid has ranged from 500 gallons to 20,500 gallons. The normal treatment is with 2,500 to 5,500 gallons of acid.

RESERVOIR ENERGY

"Tubb Zone": The energy which expels the oil from the reservoir rock is due to gas expansion as pressure declines. Most of the currently effective energy is due to gas coming out of solution in the oil. There is an ineffectual gas cap whose pressure is too low to contribute materially to production of oil, particularly in view of the low permeability of the upper portion of the reservoir rock.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
1948	2	0	12,865	12,865
1949	5	3	124,879	137,744
1950	9	5	171,339	309,083
1951	9	5	154,969	464,052
1952	5	9	113,761	577,813
1953	5	9	104,900	682,713
1954	5	9	95,138	777,851
1955	5	9	84,930	862,781



SUSAN PEAK FIELD

Tom Green County, Texas

D. W. GRAHAM
District Geologist, Plymouth Oil Company, Midland, Texas
June 15, 1953

LOCATION and FIELD NAMES

The Susan Peak field is in southeastern Tom Green County about 20 miles southeast of San Angelo. It derives its name from the topographic feature known as Susan Peak, which is a low, rounded Cretaceous limestone peak located near the geographic center of the field.

The area which produces from the upper Strawn reservoir in the south half of sections 19 and 20 in the extreme south end of the field is treated as a separate field by the Railroad Commission of Texas and is designated as the South Susan Peak field.

During a few months early in the development of the area along Lipan Creek in the northeast part of the field, that area was treated as a separate field and was known as the Lipan field. The separation was soon abandoned and the Lipan area has ever since been treated as constituting a part of the Susan Peak field. As development has progressed, it has become doubtful that the productive area of any one of the three reservoirs in the Lipan area overlaps the productive area of any one of the three reservoirs in the Susan Peak area. It is now recognized that there are two distinct productive areas constituting the Susan Peak field: namely, the Susan Peak area and the Lipan area.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The lease block on which this field has been developed was originally taken on the basis of surface geological work, which showed a small northeast-southwest trending anticline centering near Susan Peak. Later, a reflection seismograph survey indicated an extension of this anticline northward beyond where surface exposures had provided data for mapping. The location for the discovery well was based largely on the results of the reflection seismograph survey.

DISCOVERIES

Susan Peak area:
- Canyon: May 31, 1949;
  - Plymouth Oil Co. #3-A J. D. Robertson
- Upper Strawn: September 3, 1949;
  - Plymouth Oil Co. #5-B J. W. Green
- Lower Strawn and Field: December 16, 1948;
  - Plymouth Oil Co. #1-A J. W. Green

Lipan area:
- Canyon: No commercial production
- Upper Strawn: May 1, 1949;
  - Wadley, Adams & Burns #1 J. W. Green
- Lower Strawn: September 18, 1949;
  - Wadley, Burns & Shanahan #3 J. W. Green
  - (Later, Mystic Oil Co. #3 J. W. Green)

ELEVATION OF SURFACE

Surface elevations within the area of the field range from 2,053 feet to 2,359 feet above sea level.

SURFACE FORMATION

Undifferentiated Cretaceous limestone

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in pre-Cambrian igneous complex 340 feet below where igneous material was first encountered, and 10 feet below the top of solid, unweathered, igneous rock. This penetration was in Plymouth Oil Co. #1-B J. W. Green, located in Sec. 193 and identified on an accompanying map by the label "OLDEST HORIZON". The accompanying TYPICAL SECTION is based on the log of this well.

NATURE OF TRAPS

Susan Peak area:
The trap in each of the three reservoir rocks is due to convex folding along the apex of an anticline.

Lipan area:
The trap in each of the three reservoir rocks is due primarily to updip decrease of porosity and permeability. There appear to be minor traps in small convex folds, but such traps constitute minor details within the major traps.

PRODUCTIVE AREAS

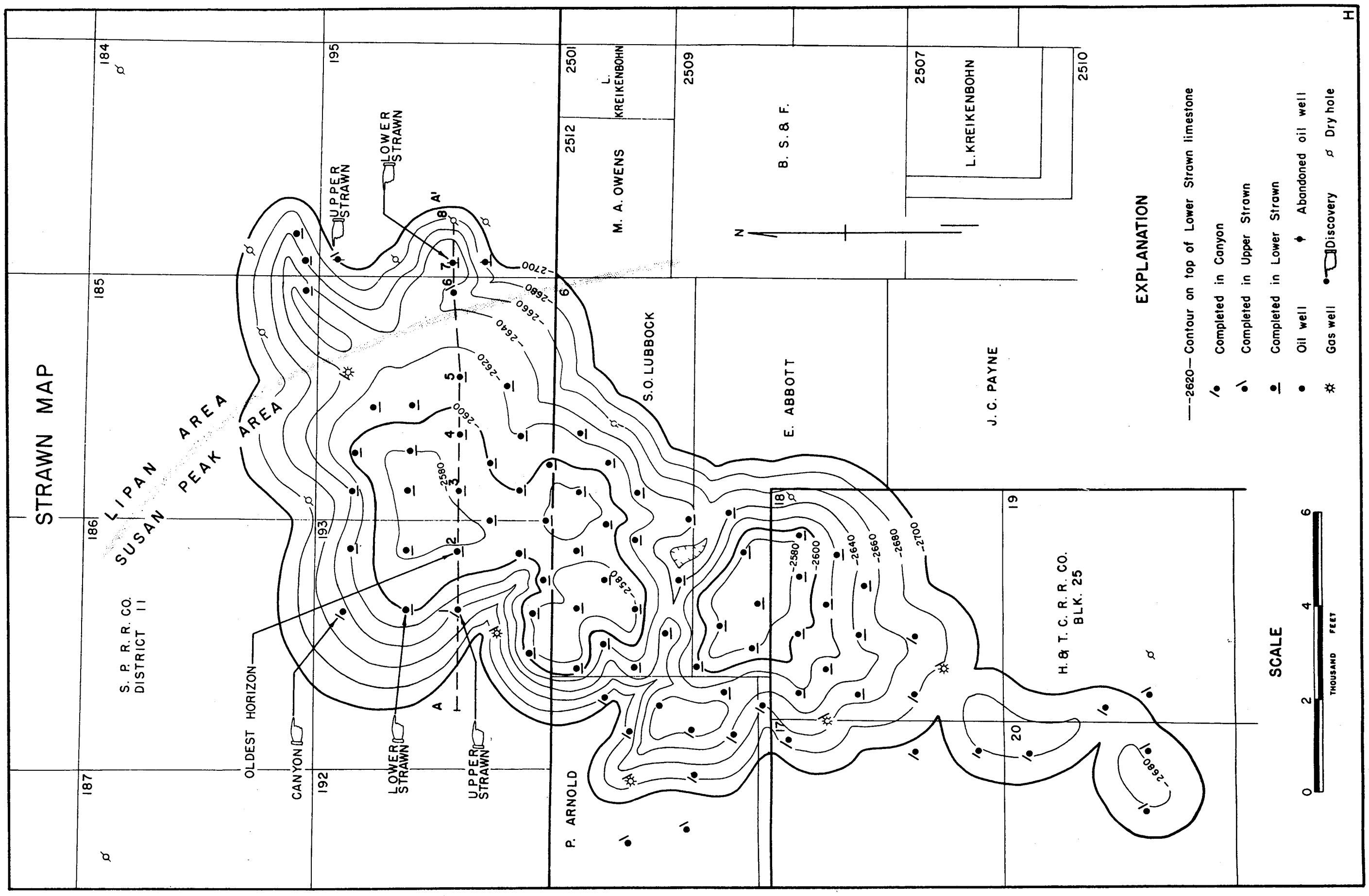
	Acres		
	Susan Peak	Lipan	Total
Canyon	720	None	720
Upper Strawn	200	80	280
Lower Strawn	1,880	160	2,040
Susan Peak field	2,700	200	2,900

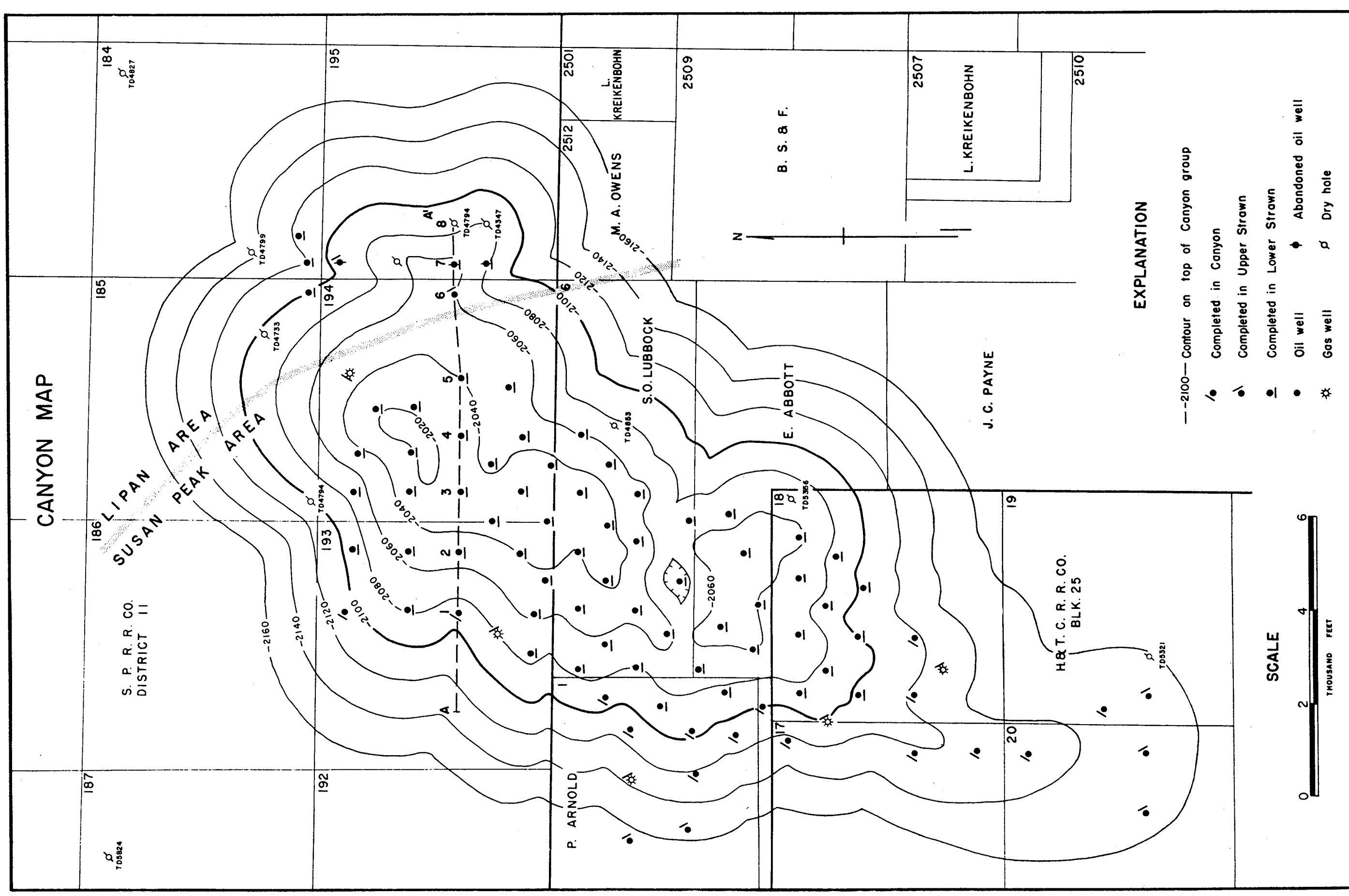
The productive areas of the Canyon and Upper Strawn reservoirs have not been fully defined in the Susan Peak area. The above figures represent best guesses on the basis of information now available; they may be as much as 10% more or as much as 30% less than the actual productive areas.

RESERVOIR TEMPERATURE AND PRESSURE

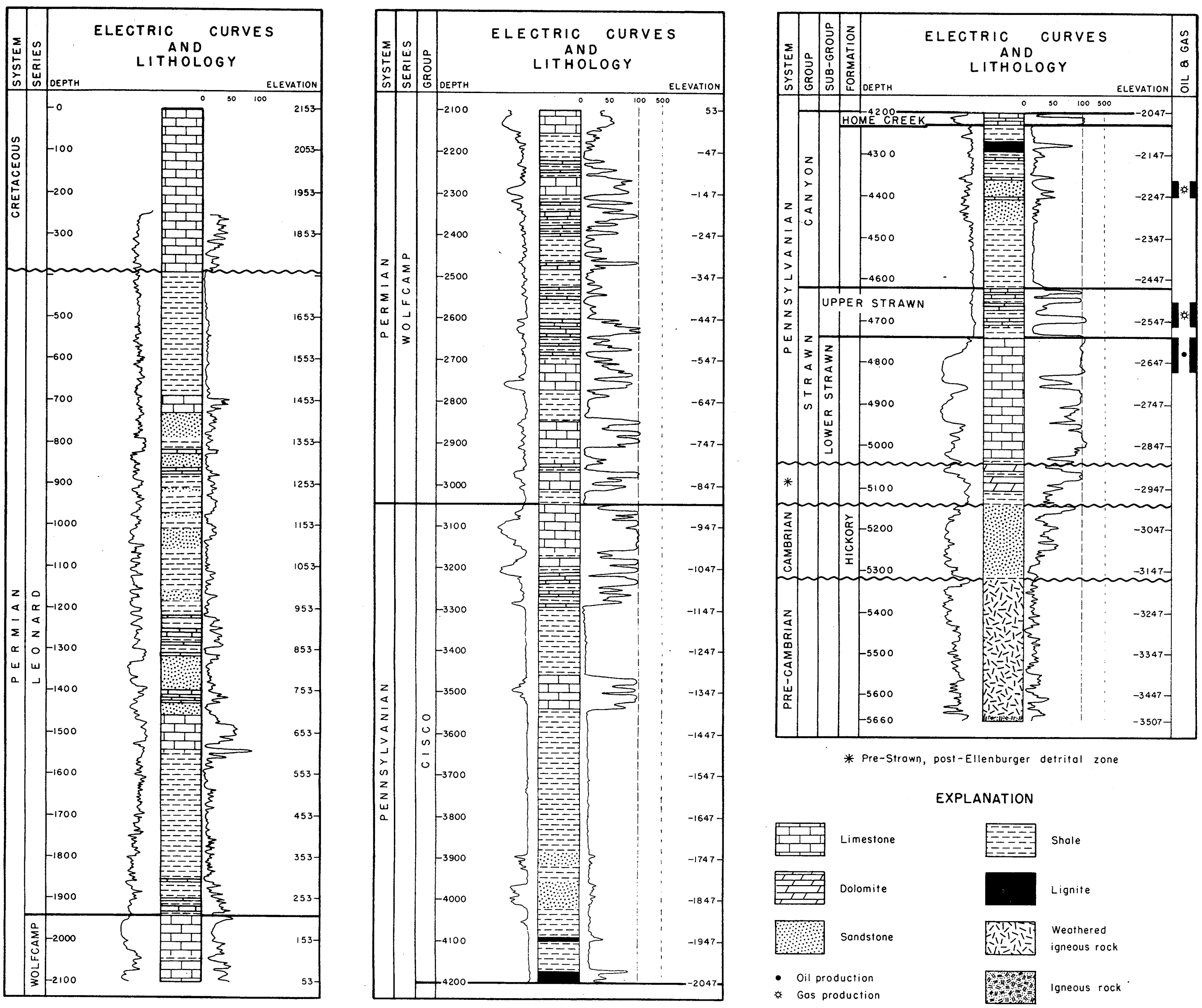
At time of discovery, the temperature in the lower Strawn reservoir in the Susan Peak area was 139° F. and the reservoir pressure was 1,921 psi. Corresponding data for other reservoirs are not available.

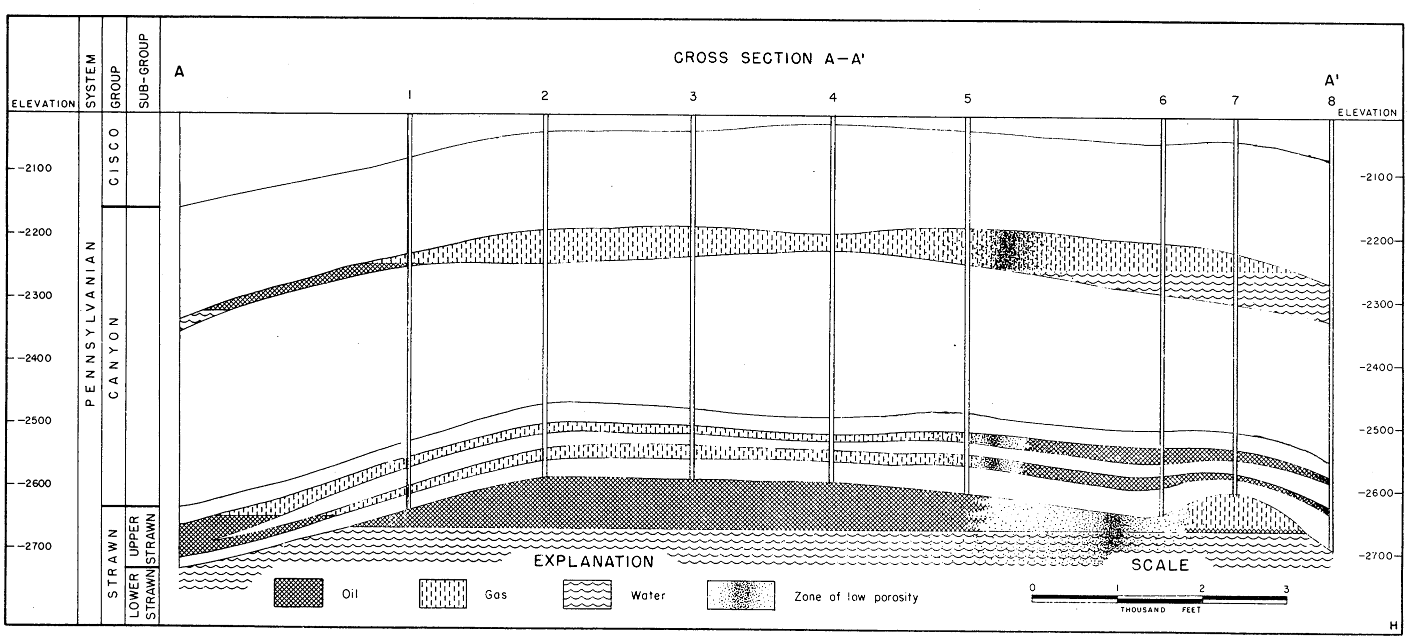
SUSAN PEAK FIELD, Tom Green County, Texas





TYPICAL SECTION OF ROCKS PENETRATED





THICKNESSES OF RESERVOIR ROCKS

From top to bottom:	Susan Peak area Feet Min.	Max.	Lipan area Feet Min.	Max.
Gross:				
Canyon	20	73	60	86
Upper Strawn	57	80	45	73
Lower Strawn	300	350	*	*
Exclusive of major shale partings:				
Canyon	20	56	52	76
Upper Strawn	30	70	26	55
Lower Strawn	300	350	*	*

*Complete thickness has not been penetrated.

LITHOLOGY OF RESERVOIR ROCKS

Canyon: The reservoir rock varies from a fairly clean white sand with only a little calcareous cement to a highly calcareous sandstone which might just as properly be classified as an arenaceous limestone.

Upper Strawn: The reservoir rock consists of two beds of limestone and an intervening bed of shale. The productive portion consists of the two beds of limestone, each of which is about 20 to 30 feet thick and is composed of dense, dark brown, calcareous, highly fractured limestone. Between the two beds of productive limestone is a bed of gray and green shale generally about 10 feet thick. The behavior of reservoir fluids proves that the two beds of limestone are parts of the same reservoir rock. The shale bed is probably not continuous throughout the area of the field; furthermore, it appears likely that the intercommunication is largely through fractures which extend across the intervening shale.

Lower Strawn: In the extreme northern and southern ends of the field, the Lower Strawn reservoir rock is a fairly uniform, massive, oolitic, coarsely granular, light brown to tan limestone. Throughout all the central portion of the field, the pay section in the Lower Strawn is divided into three distinct lithologic units. The upper unit is a relatively dense, highly fractured, dark brown, carbonaceous limestone, varying in thickness from practically zero to 45 feet. The middle unit is a highly fractured black shale bed about 6 feet thick. The lower unit is a massive, coarsely granular, highly porous, light tan limestone of the same general character as is exhibited by the entire section in the northern and southern ends of the field.

CONTINUITY OF RESERVOIR ROCKS

Each of the reservoir rocks in the Susan Peak area undoubtedly correlates with the reservoir rock in the corresponding stratigraphic unit in the Lipan area. Each appears to be continuous from one area to the other. However, between the two areas there is a narrow strip where porosity and permeability in each of the reservoir rocks are too low for free migration of reservoir fluids. The exact location of this belt of low porosity and permeability is not known for any one of the reservoir rocks. However, in each reservoir rock, it is evidently near the location of the boundary between the Susan Peak area and the Lipan area as that boundary is indicated on the accompanying maps.

Canyon: The sandstone bed which is productive is not known to extend beyond the immediate vicinity of the field.

Upper Strawn: The two limestone beds which are productive cannot be traced more than a few miles away from the Susan Peak field in any direction.

Lower Strawn: This limestone, with greatly varying thicknesses, is widely distributed across the Eastern shelf of the Midland basin. Westward toward the Midland basin, this limestone interfingers with, and finally is completely replaced by a basin type shale and silty sandstone facies.

CHARACTER OF GAS

Following is an analysis of separator gas from the Lower Strawn reservoir in the Susan Peak area. No other analysis of gas is available.

Component	Mol. %	G/Mcf
Methane	58.61	---
Ethane	15.08	---
Propane	16.05	4.403
Iso-butane	1.90	0.620
N-butane	5.11	1.607
Iso-pentane	0.68	0.248
N-pentane	0.80	0.289
Hexane	0.30	0.123
Heptane plus	0.17	0.082
Carbon dioxide	1.30	---

Specific gravity at 60° F.	.938
Heating value, B.t.u./cf	1,577
Gasoline content, G/Mcf	1.142

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Canyon Susan Peak	Canyon Lipan	Upper Strawn Susan Peak	Upper Strawn Lipan	Lower Strawn Susan Peak	Lower Strawn Lipan
Elevation of top of gas, feet	-2,182	-2,230	-2,509	No	No	-2,603
Elevation of bottom of gas, feet	-2,244	-2,244	-2,650	free	free	-2,660
Relief, feet	62	14	141	gas	gas	57
Elevation of top of oil, feet	-2,244	No	-2,650	-2,540	-2,556	-2,660
Elevation of bottom of oil, feet	-2,320	oil	-2,685+	-2,595+	-2,669	-2,669
Relief, feet	76	column	35+	55+	113	9
Elevation of top of water, feet	-2,320	-2,244	?	?	-2,669	-2,669

CHARACTER OF OIL

	Canyon	Upper Strawn	Lower Strawn
Gravity, A.P.I. @ 60° F.	37.4° - 39.6°	32° - 35°	39°
Sulphur	0.15	?	0.35

An analysis of a sample from one of the Lower Strawn reservoirs indicated the bubble point was at 1,667 psi; solution gas-oil ratio, 620 cubic feet per barrel; volume factor, surface: reservoir, 1.4116. Corresponding data relative to oil in the other reservoirs are not available.

For analyses see:				
U. S. Bureau of Mines	Laboratory reference No.	51080	51081	51082
Analyses of Crude Oils from Some West Texas Fields. R.I. 4959 (1953)	Item	81	80	79

PRODUCTION HISTORY

	Susan Peak area				Lipan area			
	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative	Flowing	Pumping	Yearly	Cumulative
Area totals								
1948	1	0	1,206	1,206	0	0	0	0
1949	31	3	269,834	271,040	2	2	21,255	21,255
1950	50	7	1,071,222	1,342,262	4	3	36,313	57,568
1951	55	10	1,634,724	2,976,986	3	1	40,058	97,626
1952	59*	10	1,354,399	4,331,385	3	1	35,049	132,675
Canyon								
1949	0	1	6,398	6,398	0	0	0	0
1950	7	3	121,633	128,031	0	0	0	0
1951	7	6	141,960	269,991	0	0	0	0
1952	7	6	90,600	360,591	0	0	0	0
Upper Strawn								
1949	0	1	2,412	2,412	1	2	3,140	3,140
1950	0	1	23,712	26,124	0	3	10,305	13,445
1951	2	1	41,145	67,269	0	1	11,380	24,825
1952	2	1	29,605	96,874	0	1	11,183	36,008
Lower Strawn								
1948	1	0	1,206	1,206	0	0	0	0
1949	31	1	261,024	262,230	1	0	18,115	18,115
1950	43	3	925,877	1,188,107	4	0	26,008	44,123
1951	46	3	1,451,619	2,639,726	3	0	28,678	72,801
1952	50*	3	1,234,194	3,873,920	3	0	23,866	96,667

*Seven flowing wells were completed in Lower Strawn in 1952; 3 wells which had been producing from Lower Strawn were converted to gas injection wells.

GAS PRODUCTION: No gas has ever been sold from this field. The wells completed in the Canyon and Upper Strawn reservoirs as gas wells are shut in for lack of a suitable market. All separator gas from the oil wells operated by Plymouth Oil Company is being injected into the Lower Strawn reservoir in the Susan Peak area by a cycling plant built by Plymouth Oil Company and placed in operation in April, 1952. This plant has capacity to compress and inject 3,000,000 cubic feet of gas per day.

SWEETIE PECK—WARSAN FIELD

Midland and Upton Counties, Texas

ROBERT R. HARBISON
Geologist, Stanolind Oil & Gas Co., Midland, Texas
January 1, 1955

LOCATION and FIELD NAMES

The Sweetie Peck - Warsan field is mainly in southwest Midland County, with only the three southernmost wells in Upton County. It is about 20 miles southwest of the town of Midland, county seat of Midland County, and about 15 miles southeast of the town of Odessa, county seat of Ector County. It is in the southwestern part of the Midland basin.

The hyphenated name of the field results from the history of its development. Early wells were all in the south part of the field, and that area was designated as the Sweetie Peck field. In 1953, production in a Pennsylvanian reservoir was discovered in a well in the southwest corner of Sec. 38, Bl. 41, T. 3 S. The area including that well, and now including 7 wells in sections 38, 39, 46 and 47, became known first as the Warren Pennsylvanian field and then later as the War-San field. The 7 wells are now treated by the Railroad Commission as, 4 in the War-San Pennsylvanian field and 3 in the War-San Ellenburger field. In this paper, the area containing these 7 wells is combined with the area of the Sweetie Peck field and the combined area is treated as one field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph surveying and core drilling led to the discovery of the field.

DISCOVERIES

Wolfcamp: June 10, 1950;
Norwood Drilling Co. #1-PW Josie Faye Peck.
Bend: June 10, 1950;
Norwood Drilling Co. #1-PW Josie Faye Peck.
Devonian: June 22, 1950;
General American Oil Co. #1-D Josie F. Peck.
Fusselman: November 22, 1950;
Benson & Montin, Inc. #1-E Josie Faye Peck.
Ellenburger and Field: March 4, 1950;
General American Oil Co. #1-E Josie F. Peck.

ELEVATION OF SURFACE

At well locations: Highest, 2,907 ft.; lowest, 2,888 ft.

SURFACE FORMATIONS

Fredericksburg limestone and overlying unconsolidated Quaternary deposits constitute the surface rocks within the area of the field.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 939 feet below the top of the Ellenburger group. This penetration was in Gulf Oil Corp. #1 Josie Faye Peck at its total depth of 14,219 feet. This well is on the east limb of the anticlinal fold and is about a mile from the south end of the field, as indicated on accompanying maps.

NATURE OF TRAPS

Wolfcamp: The trap appears to be due primarily to convex folding and secondarily to variation in degree of porosity.

Bend: Convex folding.

Devonian: Convex folding and variation in degree of porosity.

Fusselman: Convex folding and variation in degree of porosity.

Ellenburger: Convex folding.

PRODUCTIVE AREAS

	Acres
Wolfcamp	80
Bend	7,580
Devonian	120
Fusselman	120
Ellenburger	5,000
Sweetie Peck - Warsan field	7,580

THICKNESSES OF RESERVOIR ROCKS

	Feet, average	
	Top to bottom	Net productive
Wolfcamp	30	?
Bend	70	?
Devonian	70	40
Fusselman	?	30
Ellenburger	282	?

LITHOLOGY OF RESERVOIR ROCKS

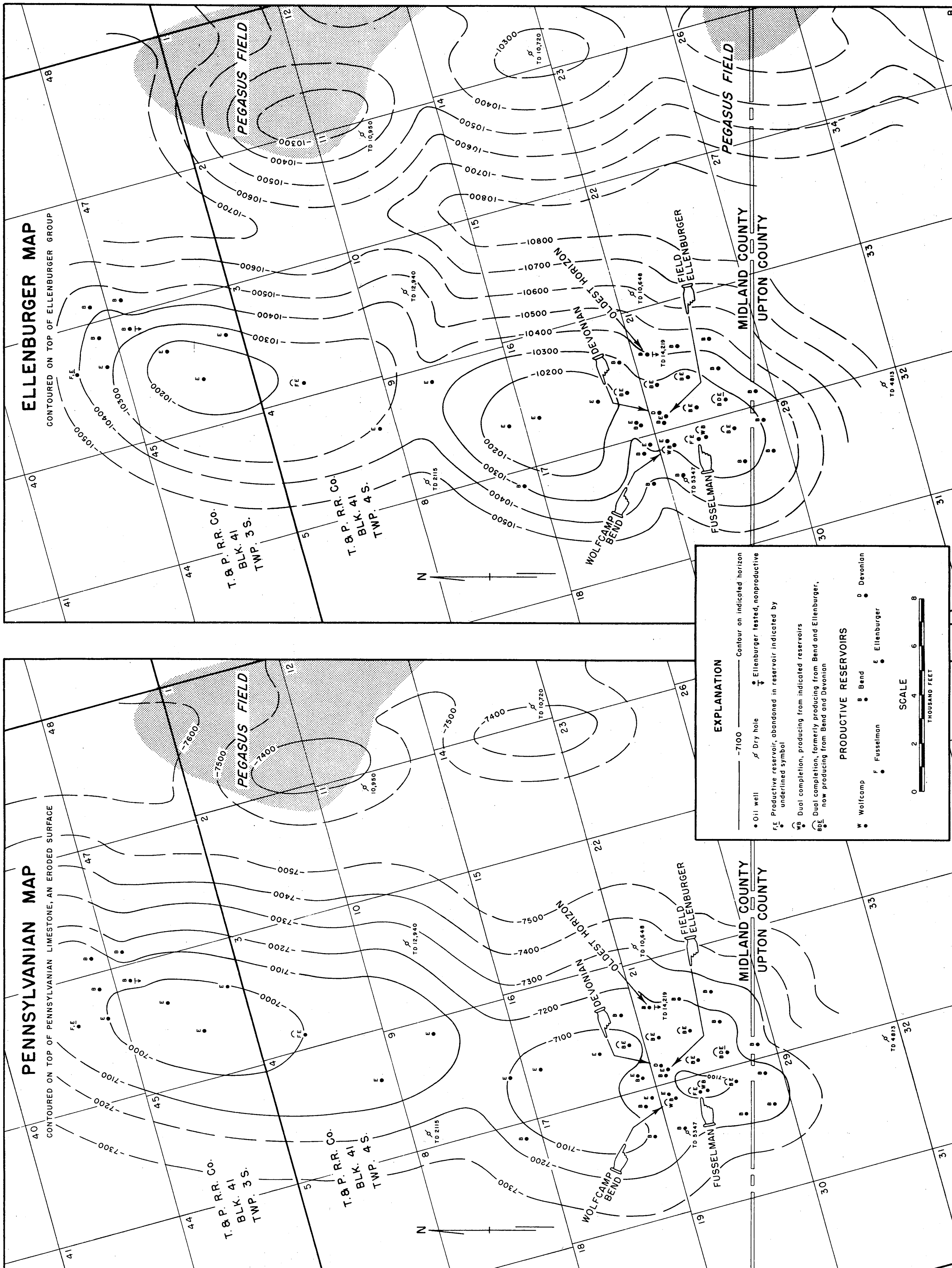
Wolfcamp: Limestone; tan to brown, fine-grained crystalline.

Bend: Limestone; tan to light brown, chalky, fine-grained crystalline.

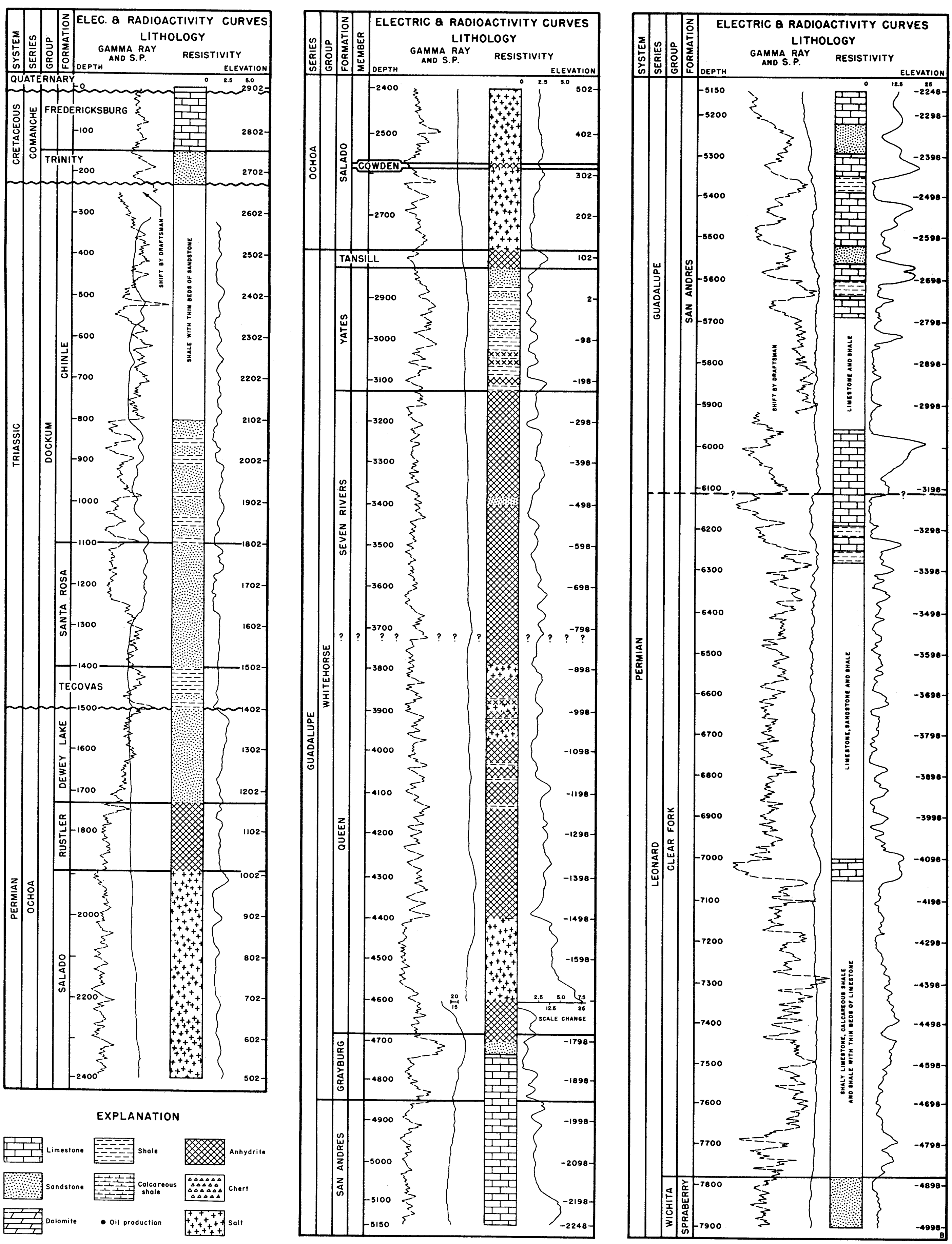
Devonian: Limestone; brown, fine-grained crystalline; contains blue-gray chert.

Fusselman: Limestone; white, fine- to medium-grained crystalline.

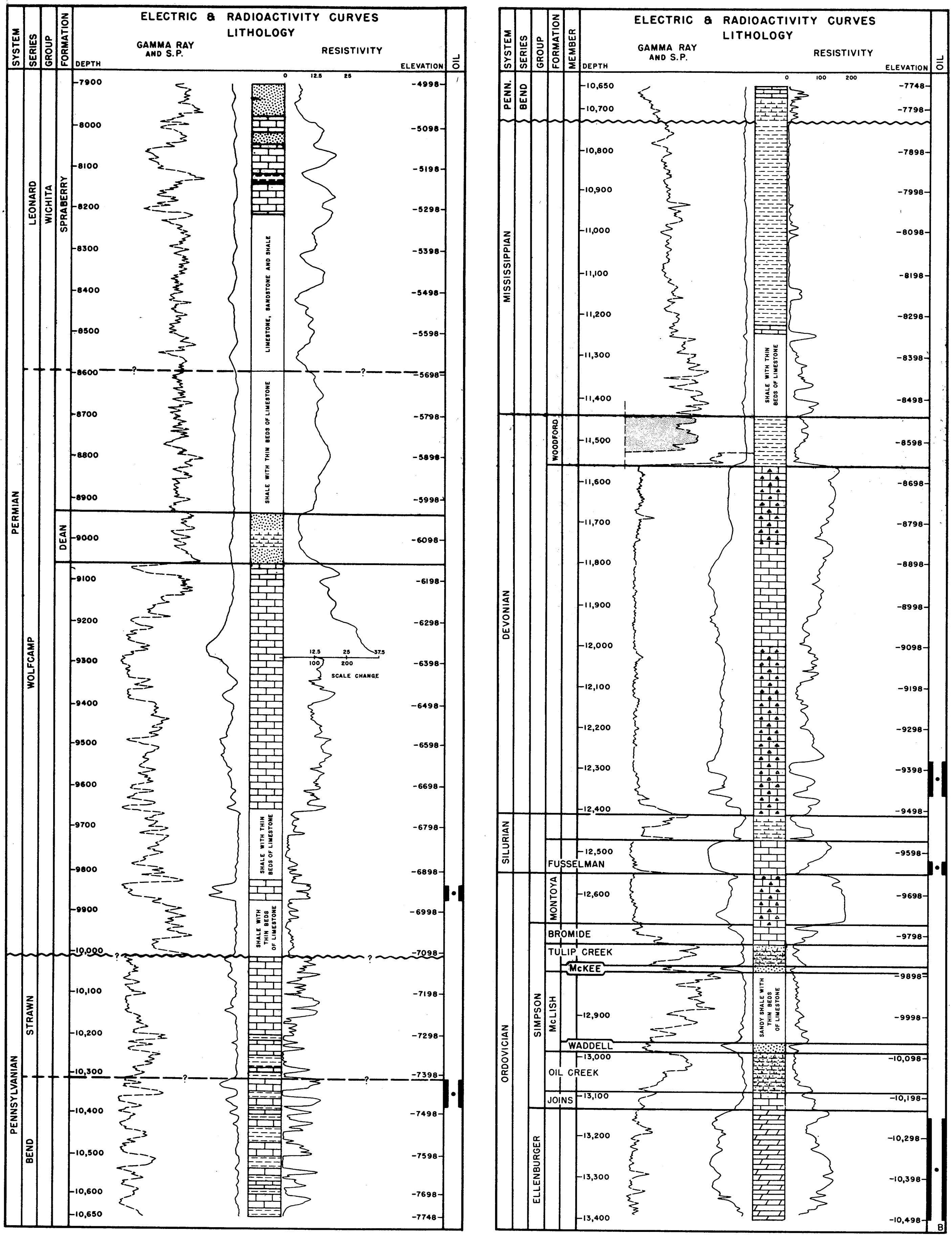
Ellenburger: Dolomite; light brown, fine- to medium-grained crystalline.


ELLENBURGER MAP
CONTOURED ON TOP OF ELLENBURGER GROUP
PENNSYLVANIAN MAP
CONTOURED ON TOP OF PENNSYLVANIAN LIMESTONE, AN ERODED SURFACE
PEGASUS FIELD
T. & P. R.R. Co.
BLK. 41
TWP. 3 S.
TWP. 4 S.
MIDLAND COUNTY
UPTON COUNTY
OLDEST HORIZON
DEVONIAN
ELLENBURGER FIELD
WOLFCAMP BEND
FUSSELMAN
EXPLANATION
Contour on indicated horizon
Oil well
Dry hole
Ellenburger tested, nonproductive
Productive reservoir, abandoned in reservoir indicated by underlined symbol
Dual completion, producing from indicated reservoirs
Dual completion, formerly producing from Bend and Ellenburger, now producing from Bend and Devonian
PRODUCTIVE RESERVOIRS
Wolfcamp
Fusselman
Bend
Ellenburger
Devonian
SCALE
THOUSAND FEET

TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED



CONTINUITY OF RESERVOIR ROCKS

Wolfcamp: The bed of limestone which is locally productive is continuous throughout the area of the field; however, the area where the degree of porosity is favorable for commercial production appears to be limited to the immediate vicinity of the two productive wells.

Bend: This reservoir rock is continuous throughout the area of the field.

Devonian: The bed of limestone which is productive at the locations of two wells is continuous throughout the area of the field; however, the area where the degree of porosity is favorable for commercial production appears to be limited to the immediate vicinity of the two wells.

Fusselman: The productive bed of limestone is continuous throughout the area of the field; however, its porosity is extremely irregular.

Ellenburger: This reservoir rock is continuous throughout the area of the field.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Known elevations of oil, feet		Known relief,
	Highest	Lowest	feet
Wolfcamp	-6,938	-6,990	52
Bend	-7,378	-7,650	272
Devonian	-9,382	-9,497	115
Fusselman	-9,582	-9,682	100
Ellenburger	-10,160	-10,442	282

The elevation of the oil-water contact is known in only the Ellenburger reservoir. It is not known how far the oil extends downward beyond the above reported elevations.

CHARACTER OF OIL

	Gravity, A.P.I. @ 60° F.	Sulphur, %
Wolfcamp	59	0.02
Bend	45	0.06
Devonian	48	0.05
Fusselman	51	0.04
Ellenburger	53	0.45

ACID TREATMENT

Wolfcamp: One well was treated with 500 gallons and the other with 10,000 gallons of acid.

Bend: Most of the Bend wells have been treated with acid; the quantities of acid have ranged from none to 4,000 gallons.

Devonian: The first Devonian well was washed with 500 gallons of acid and the second was treated with 2,000 gallons of acid.

Fusselman: Each of two of the three Fusselman wells was treated with 8,000 gallons of acid.

Ellenburger: Most of the Ellenburger wells have been treated with acid; the quantities of acid have ranged from none to 22,500 gallons.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
Field totals				
1950	19	0	510,819	510,819
1951	34	3	1,665,297	2,176,116
1952	34	6	937,869	3,113,985
1953	36	8	855,429	3,969,414
1954	36	8	978,126	4,947,540
Wolfcamp				
1950	1	0	10,308	10,308
1951	2	0	16,355	26,663
1952	2	0	5,071	31,734
1953	2	0	7,386	39,120
1954	1	0	5,004	44,124
Bend				
1950	9	0	191,004	191,004
1951	21	0	744,608	935,612
1952	23	0	237,224	1,172,836
1953	24	0	130,066	1,302,902
1954	19	0	218,404	1,521,306
Devonian				
1950	1	0	21,932	21,932
1951	1	0	19,679	41,611
1952	1	0	6,789	48,400
1953	1	0	5,228	53,628
1954	2	0	856	54,484
Fusselman				
1950	1	0	1,740	1,740
1951	1	0	21,683	23,423
1952	1	0	13,140	36,563
1953	1	1	22,000	58,563
1954	2	1	32,488	91,051
Ellenburger				
1950	6	0	285,835	285,835
1951	9	3	862,972	1,148,807
1952	7	6	675,645	1,824,452
1953	8	7	690,749	2,515,201
1954	12	7	721,374	3,236,575

In the above tabulation, the Warsan area is treated as an extension to the previously discovered Sweetie Peck field. The number of wells and the quantities of oil produced represent totals for the combined area. The appropriate of the above figures for 1953 and 1954 include the following numbers of wells and quantities of oil which apply to the Warsan area, which area includes such part of the field as is in Block 41, Twp. 3 S.

Warsan area totals				
1953	1	0	1,227	1,227
1954	8	0	301,838	303,065
Warsan Bend				
1953	1	0	1,227	1,227
1954	4	0	144,694	145,921
Warsan Fusselman				
1954	1	0	6,586	6,586
Warsan Ellenburger				
1954	3	0	150,558	150,558

TAYLOR - LINK FIELD

Pecos County, Texas

ROBERT H. TAYLOR
Geologist, Standard Oil Co. of Texas, Midland, Texas
April 15, 1955

LOCATION and FIELD NAMES

The Taylor-Link field is in eastern Pecos County about 30 miles east of Fort Stockton, county seat. It is one of a group of fields on the Central Basin platform near its southern end.

Soon after completion in the San Andres formation of Taylor-Link Oil Co. #1 University as the discovery well of the field, two gas wells were completed in the Grayburg formation about 4 miles southeastward. A few months previously (February 5, 1929), gas had been found in the San Andres formation at a location about a mile farther southeastward. Although there was only little interest in the occurrence of gas, the immediate vicinity of these gas wells became known as the Taylor-Link gas field and also as the Bakersfield field. It was designated by these names until about the mid-forties when it became known as the Cardinal gas field. This name is used currently in the reporting of gas production from the one remaining gas well in the vicinity.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of surface and subsurface geological data led to the discovery of the field.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 410 feet below its top. This penetration was in Stanolind Oil & Gas Co. #9-B University at its total depth of 8,690 feet. This test was located in the north-central part of the field as indicated on the accompanying map. It was commenced in November of 1949 and abandoned as a dry hole on May 1, 1950.

NATURE OF TRAPS

Yates and Grayburg: Anticlinal folding is the primary trap-forming factor in each of these reservoirs; variation in degree of porosity and permeability has contributed in a secondary manner to forming each of the traps.

San Andres: The accumulation of hydrocarbons is due to a trap formed by anticlinal folding. There are important variations in degrees of porosity and permeability, but apparently nowhere are they determinative in forming a trap.

DISCOVERIES

Yates: GAS: Discovery of gas in the Yates reservoir followed soon after discovery of oil in San Andres reservoir, but, commercially, the gas was more of a handicap than it was an asset. Production of oil from San Andres was the primary objective in the vicinity of the San Andres discovery well, and many wells were drilled through gas-bearing Yates for completion as oil wells in San Andres. Many of the San Andres wells within a mile to the southwestward of the San Andres discovery well could have been completed as Yates gas wells if such completion had been commercially feasible.

Yates: OIL: August 30, 1929; Shell Petroleum Corp. #1-C Bower-University (now, Sam Letwin #1-C Bower-University). Flowed initially at rate of 660 barrels of oil per hour from open hole at depth of 935 to 960 feet. This well ceased producing after it had produced only 16,941 barrels of oil and was then deepened to the San Andres reservoir where it was completed on December 9, 1929.

Grayburg: GAS: Two wells were completed in the Grayburg formation as gas wells at about the same time but they occasioned only minor interest because it was doubtful whether they had discovered commercial production. Tower & McKanna, Inc. #1 University was completed on September 8, 1929, and Continental Oil Co. #1 University was completed on September 10, 1929.

Grayburg: OIL: August 2, 1941; Milton Unger #1-A Shell-University (now, F.H.Walsh Investment Co. #1-A University). After being shot with 50 quarts of nitroglycerin, this well flowed at rate of 264 barrels of oil per day from depth between 1,445 and 1,470 feet; gas-oil ratio, 600:1.

San Andres: GAS: February 5, 1929; George H. Anderson and Tower & McKanna, Inc. #1 University. Drilled to depth of 1,998 feet and plugged back to produce gas from 1,960-1,963 feet; initial capacity, 7,000 Mcf per day; plugged and abandoned in 1948. Although this was the first well completed in what is now the area of the Taylor-Link field, it was of only minor importance in influencing activity in the area because of the fact that it was doubtful whether commercial production had been discovered.

San Andres and Field: OIL: June 15, 1929; Taylor-Link Oil Co. #1 University (later, Lee Petroleum Corp. #1 University; plugged and abandoned 9/19/41). Flowed at rate of 115 barrels of oil per day from depth of 1,613 to 1,625 feet; total depth, 1,635 feet; plugged back to 1,626 feet. Since this well was the first to discover unquestionably commercial production and since it inspired an aggressive development campaign, it is generally recognized as the field discovery well.

NEAR-BY NONCOMMERCIAL PROSPECT

In the south-central part of the area covered by the accompanying map, two wells were completed as oil wells and one was completed as a gas well in an area which was widely recognized as the McKenzie field although none of the wells produced sufficiently to return its cost.

Buell & Hagen #1-B University, located in Sec. 36, Blk. 18, where its total depth of 1,372 feet is indicated on the accompanying map, was completed on July 1, 1929, with initial daily capacity of 15 barrels of oil and 1,000 Mcf of gas from a reservoir in the Tansill formation at depth of 1,313 to 1,320 feet. The only definite record of production which we find indicates that the well produced 118 barrels of oil during December 1935 and 90 barrels of oil during each March and April of 1936. The well was acquired by Ajax Drilling Corporation in 1934 and was plugged and abandoned by that operator on May 11, 1936. An acid treatment report filed by Ajax indicates that the well was capable of producing about 5 barrels of oil per day prior to acid treatment and that after treatment with 1,000 gallons of acid on October 18, 1935, the well indicated a capacity of producing oil at rate of 250 barrels per day.

Southern Crude Oil Purchasing Co. #1 T. N. Mc Kenzie, located in Sec. 10, Blk. 604, where its total depth of 2,315 feet is indicated on the accompanying map, was completed as a gas well on March 20, 1930, with initial daily capacity of 1,300 Mcf of gas; no oil. The hole was plugged back with cement to 1,550 feet for production from reservoir at top of Yates formation; depth, 1,494 to 1,505 feet. We find no record of production from this well. It was plugged and abandoned on October 17, 1931.

Mac T. Anderson #1 T. N. McKenzie, located in Sec. 1, Blk. 604, where its total depth of 1,378 feet is indicated on the accompanying map, was completed on July 20, 1934, with initial daily capacity of 20 barrels of oil from a reservoir in the Tansill formation; depth, 1,338 to 1,353 feet. The well was shut in until October 10, 1935, at which time it was treated with 1,000 gallons of acid with the result that it appeared to be capable of producing at rate of 432 barrels of oil per day. Its oil production in 1935 amounted to 1,000 barrels during October and 400 barrels during December; in 1936, 300 barrels during January, 100 barrels during each February and March, 110 barrels during April, 100 barrels during June and 39 barrels during July; total, 2,149 barrels. Although it produced no additional oil, it was not plugged and abandoned until February 17, 1939.

CONTINUITY OF RESERVOIR ROCKS

Each of the reservoir rocks is continuous throughout the area of the field. However, porosity and permeability in the Yates and Grayburg reservoirs are only locally adequate for commercial production.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Yates	Grayburg	San Andres
Elev. of top of gas, ft.	1,700	?	975
Elev. of bottom of gas, ft.	1,610	?	945
Relief, feet	90	?	30
Elev. of top of oil, ft.	1,610	1,185	945
Elev. of bottom of oil, ft.	1,500	1,080	880
Relief, feet	110	105	65

The above figures represent estimated elevations as of respective discovery dates and apply to the field exclusive of that portion extending southeastward into Sections 3, 4, 10 and 11 of Block 17, commonly designated as the Cardinal gas field. A structural saddle, along with variations in degrees of porosity and permeability, has occasioned differences in elevations of fluid contacts in the two areas. It appears that the oil-water contact in the Grayburg reservoir was at the same elevation on either side of the saddle, but that the original gas-oil contact was lower in the southeast segment than in the main part of the field. Data relative to the Yates and San Andres reservoirs southwest of the saddle are too meager to afford a basis for estimating elevations of fluid contacts; no commercial oil has been found in either reservoir in this area; only showings of oil.

CHARACTER OF OIL

	Yates	Grayburg	San Andres
Gravity, A. P. I. @ 60°F.,	30°	32°	31°
Sulphur	?	?	1.32%

For analyses see:

Railroad Commission

Analyses of Texas Crude Oils (1940) pp. 34 and 64.

U. S. Bureau of Mines — Lab. ref. No. 31165

Tabulated Analyses of Texas Crude Oils. R. I. 3252 (1934) Grp. 2, Item	58
Tabulated Analyses of Texas Crude Oils. T. P. 607 (1939) Grp. 2, Item	81
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944) Page	34

ELEVATION OF SURFACE

At well locations: Highest, 2,752 ft.; lowest, 2,474 ft.

SURFACE FORMATIONS

Undifferentiated rocks of the Washita and Fredericksburg groups of the Comanche series.

THICKNESSES OF RESERVOIR ROCKS

Net productive	Feet Maximum	Feet Average
Yates	10	8
Grayburg	30	15
San Andres	80	40

LITHOLOGY OF RESERVOIR ROCKS

Yates: Thin beds of fine-grained sandstone interbedded with anhydrite. The sandstone is characterized by the presence of rounded frosted quartz grains. Porosity and permeability are quite variable and only locally adequate for commercial production. Extremely favorable porosity and permeability were manifested by a few wells with unusually high initial productive capacities; e.g., one well produced gas at the rate of 66,000 Mcf per day and one well produced oil at the rate of 2,000 barrels per day. The thickness of the reservoir rock is less over the apex of the anticline than on the flanks.

Grayburg: Interbedded sandstones and sandy dolomite. The sandstones are fine-grained. Porosity and permeability are quite variable; generally, too low for commercial production of oil except in a limited area mainly on the northeast flank of the anticline, as indicated by well symbols on the accompanying map.

San Andres: Dolomite; buff colored; generally, finely crystalline with favorable porosity. Although there are important variations in porosity, there is adequate continuity of porosity favorable for commercial production wherever the reservoir rock is higher than a few feet above the elevation of the oil-water contact (880 feet above sea level), with only minor exceptions.

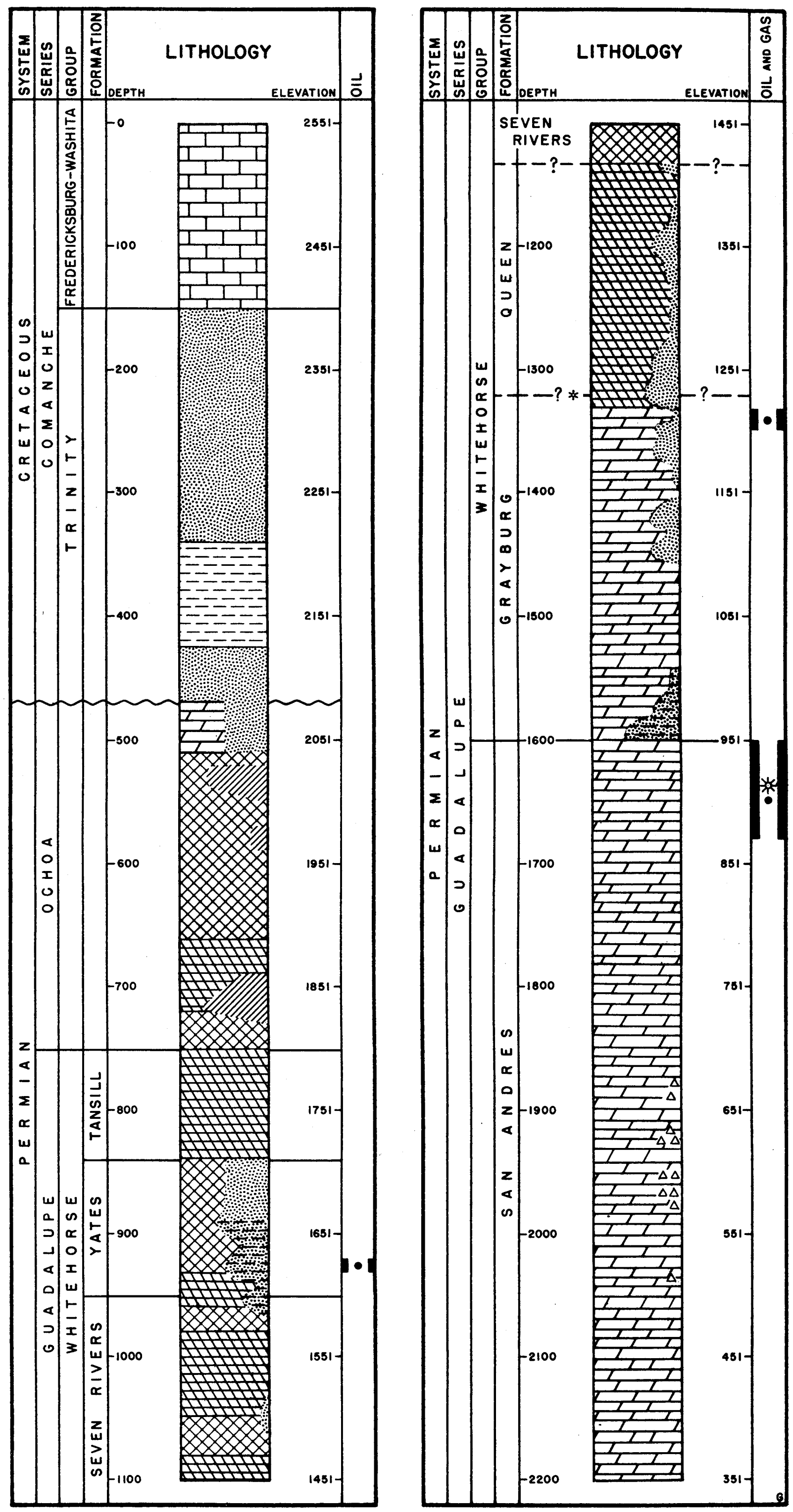
WATER PRODUCTION

Every well is producing some water. Definite data relative to quantities of water are not available.

ACID TREATMENT

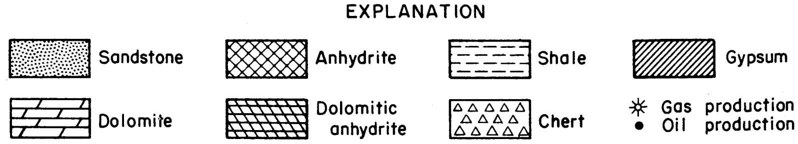
Most of the wells in the field have been treated with acid subsequent to completion. Acidization was initiated in the San Andres wells in 1933 and proved to be very profitable.

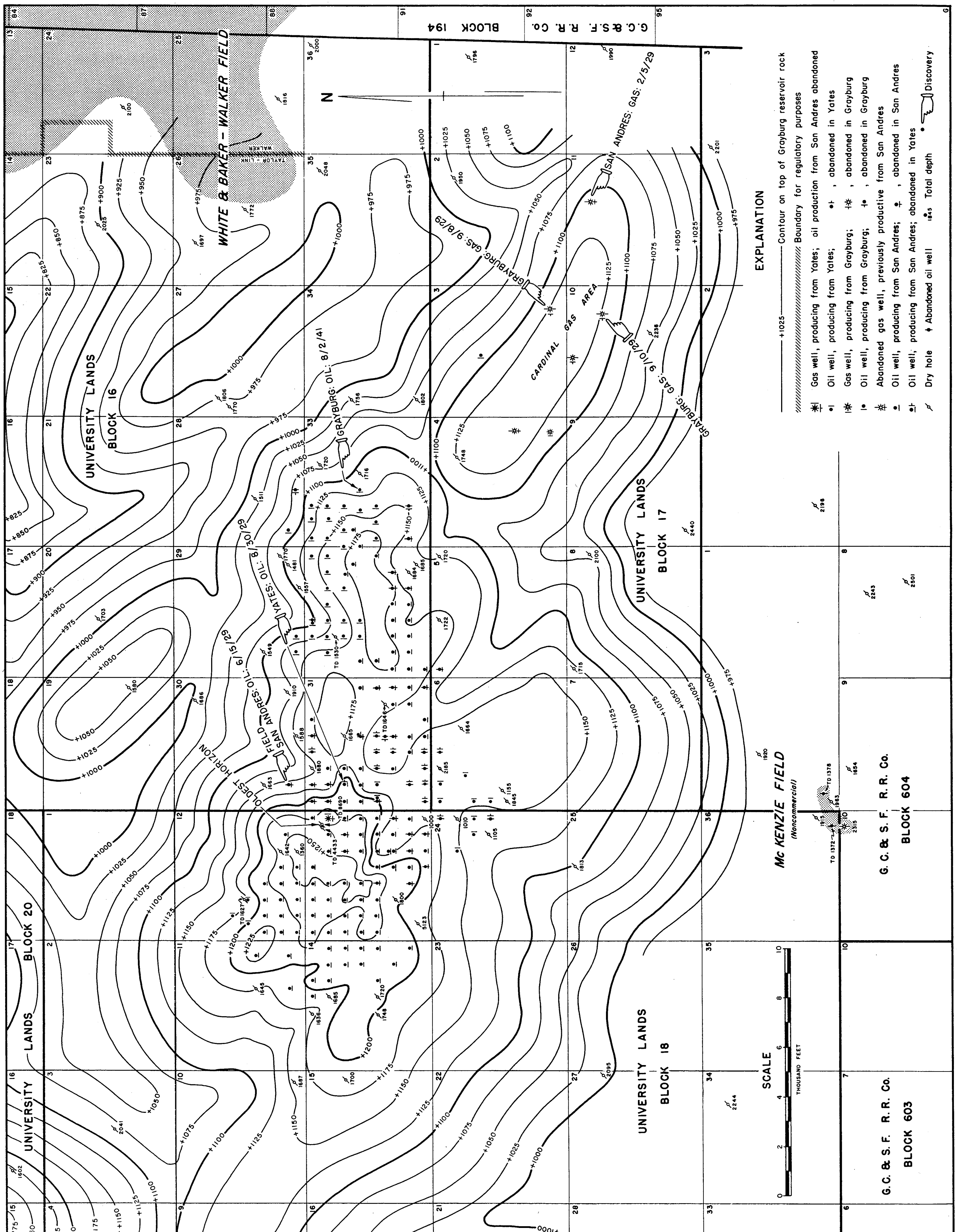
TYPICAL SECTION OF ROCKS PENETRATED



* The position of the Queen-Grayburg contact is questionable. It may be lower than above indicated. The reservoir rock herein indicated as in the Grayburg formation may be in the Queen formation. It is at about the same stratigraphic position as the principal reservoir in the White & Baker - Walker field.

EXPLANATION





WHITE & BAKER - WALKER FIELD
TAYLOR - LINK
WALKER
G. C. & S. F. R. R. Co.
BLOCK 194
UNIVERSITY LANDS
BLOCK 16
UNIVERSITY LANDS
BLOCK 17
UNIVERSITY LANDS
BLOCK 18
UNIVERSITY LANDS
BLOCK 20
G. C. & S. F. R. R. Co.
BLOCK 603
G. C. & S. F. R. R. Co.
BLOCK 604
Mc KENZIE FIELD
(Noncommercial)
CARDINAL GAS AREA
SAN ANDRES: GAS: 2/5/29
GRAYBURG: GAS: 9/8/29
GRAYBURG: GAS: 9/10/29
GRAYBURG: OIL: 8/2/41
YATES: OIL: 8/30/29
SAN ANDRES: OIL: 6/15/29
OLDEST HORIZON FIELD
N
SCALE
THOUSAND FEET
EXPLANATION
+1025 Contour on top of Grayburg reservoir rock
Boundary for regulatory purposes
Gas well, producing from Yates; oil production from San Andres abandoned
Oil well, producing from Yates; , abandoned in Yates
Gas well, producing from Grayburg; , abandoned in Grayburg
Oil well, producing from Grayburg; , abandoned in Grayburg
Abandoned gas well, previously productive from San Andres
Oil well, producing from San Andres; , abandoned in San Andres
Oil well, producing from San Andres; abandoned in Yates
Dry hole ♦ Abandoned oil well 1845 Total depth Discovery

PRODUCTION HISTORY

	WELLS PRODUCING at end of year				OIL PRODUCTION (barrels)	
	OIL					
	Flow.	Pump.	Total	GAS	Yearly	Cumulative
Field totals						
1929	?	?	30	?	558,102	558,102
1930	?	?	?	?	1,481,576	2,039,678
1931	?	?	56	?	505,056	2,544,734
1932	2	54	56	?	292,470	2,837,204
1933	2	45	47	?	214,904	3,052,108
1934	1	54	55	?	378,206	3,430,314
1935	0	55	55	?	432,540	3,862,854
1936	0	54	54	?	433,265	4,296,119
1937	1	62	63	?	414,201	4,710,320
1938	1	68	69	?	465,338	5,175,658
1939	2	82	84	0	539,058	5,714,716
1940	0	94	94	0	616,222	6,330,938
1941	6	102	108	0	700,117	7,031,055
1942	7	114	121	0	601,431	7,632,486
1943	18	108	126	0	569,561	8,202,047
1944	11	115	126	0	488,591	8,690,638
1945	12	122	134	0	429,063	9,119,701
1946	13	131	144	1	457,295	9,576,996
1947	3	141	144	2	374,647	9,951,643
1948	2	140	142	1	331,654	10,283,297
1949	2	141	143	2	280,773	10,564,070
1950	2	138	140	2	269,164	10,833,234
1951	6	138	144	2	244,520	11,077,754
1952	6	140	146	2	222,901	11,300,655
1953	7	136	143	2	211,179	11,511,834
1954	8	134	142	2	202,759	11,714,593
Yates						
1931	?	?	?	?*	?	347,369
1932	?	?	?	?*	36,319	383,688
1933	1	13	14	?*	33,833	417,521
1934	0	8	8	0*	18,270	435,791
1935	0	8	8	0*	15,000	450,791
1936	0	8	8	0*	15,000	465,791
1937	0	9	9	0*	27,500	493,291
1938	0	9	9	0*	21,000	514,291
1939	0	8	8	0*	19,590	533,881
1940	0	9	9	0*	22,760	556,641
San Andres						
1931	?	?	?	?*	?	2,173,700
1932	?	?	?	?*	274,348	2,448,048
1933	1	32	33	?*	186,145	2,634,193
1934	1	46	47	0*	361,644	2,995,837
1935	0	47	47	0*	420,273	3,416,110
1936	0	48	48	0*	433,265	3,849,375
1937	1	53	54	1*	387,335	4,236,710
1938	1	59	60	1*	444,338	4,681,048
1939	0	81	81	0*	519,468	5,200,516
1940	0	87	87	0*	604,323	5,804,839

*Exclusive of the wells in the Cardinal area.

Records of production by reservoirs are not available except for the period prior to 1941. The foregoing data relative to production from the Yates and San Andres reservoirs have been transcribed from annual issues of Petroleum Development and Technology published by American Institute of Mining and Metallurgical Engineers. They constitute the best available corresponding information pertaining to the only reservoirs which produced oil prior to 1941. Since the time of discovery of commercial oil in the Grayburg reservoir, the reporting agencies have not reported production of each reservoir separately.

The quantities of oil above reported under Field totals for the years prior to 1936 are in accordance with entries in annual issues of the Year Book published by National Oil Scouts Association. The quantities for 1936 et seq. are based on records of the Railroad Commission. The yearly totals for the Taylor-Link field as reported by the Commission for 1940 et seq. have been adjusted by deduction of quantities produced on two leases (Helmerich & Payne, Inc. University "F" and William Wolf University "A") which are here considered to be in the White & Baker-Walker field in its northwestern end although treated by the Commission as in the Taylor-Link field. Complete data relative to those properties are presented in the accompanying paper on the White & Baker-Walker field.

The above figures under Field totals representing number of wells producing at the end of each year have been compiled from three general sources. The entry for 1931 was transcribed from the corresponding Year Book, National Oil Scouts Association and all other entries for years prior to 1939 were transcribed from annual issues of Petroleum Development and Technology, American Institute of Mining and Metallurgical Engineers. The entries for 1939 et seq. have been transcribed from records of the Railroad Commission with appropriate adjustments applied to the figures for 1940 et seq. to correspond with the adjustments mentioned in the next preceding paragraph.

GAS PRODUCTION

Available records pertaining to gas production are incomplete; adequate for little more than showing that gas production has been of only minor importance. The first well completed in the field was a gas well. It was of doubtful commercial significance at the time of its completion. Although gas has probably been marketed in minor quantity in almost every year since discovery, records of quantities are available for only recent years. While it is probable that in the early years most of the marketed gas was used for drilling operations, it is certain that some gas was exported for domestic utilization. The following, which was written early in 1932, is quoted from page 457 of Geology of Natural Gas, American Association of Petroleum Geologists: "Until recently, a combination 5- and 6- inch line 17 miles long transported this gas northeast to the town of McCamey. This gas is high in hydrogen sulphide which necessitates the use of flues when it is burned for domestic purposes, and it is now being replaced by 'sweet' gas from the Big Lake field. As a reserve, it is not important."

The following data, which have been transcribed from Railroad Commission records, are believed to cover the total of gas marketed from gas wells during the indicated years:

	WELLS PRODUCING at end of year		GAS PRODUCTION (Mcf)	
Year	Main field area	Cardinal area	Main field area	Cardinal area
1946		1		5,660
1947		2		105,392
1948		1		127,749
1949	1	1	181	119,019
1950	1	1	4,040	19,658
1951	1	1	6,126	8,400
1952	1	1	7,147	13,527
1953	1	1	8,957	13,701
1954	1	1	4,409	17,056

TENNYSON FIELD

Coke County, Texas

RICHARD A. LISMAN
Geologist, Vincent & Welch, Inc., Midland, Texas
June 27, 1955

LOCATION

The Tennyson field (one well, now abandoned) is in the southeastern part of Coke County, 10 miles southeast of Robert Lee, county seat, and 4 miles northwest of the village of Tennyson. It is in Sec. 1, H.E. & W.T. R.R. survey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Seismograph surveys led to the drilling of the discovery well.

DISCOVERY

Ellenburger: May 23, 1948; Seaboard Oil Co. and Southern Minerals Corp. #1 M.G.Reed.

ELEVATION OF SURFACE

Derrick floor at the one productive well: 1,914 feet.

SURFACE FORMATION

San Angelo formation of the El Reno group of the Guadalupe series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the productive well is in the Ellenburger group 20 feet below its eroded top. The oldest horizon penetrated within the area covered by the accompanying map is in Cambrian sandstone 41 feet below its top. This penetration was in La Gloria Oil Corp. and Allen Dykes #1 M.G.Reed, located 2 3/4 miles southwest of the productive well and where the total depth of 6,779 feet is indicated on the accompanying map.

NATURE OF TRAP

The trap appears to be due to updip decrease of porosity on a small anticlinal nose.

PRODUCTIVE AREA

Ellenburger and Field: 40 acres.

THICKNESS OF RESERVOIR ROCK

Ellenburger: 12 feet.

LITHOLOGY OF RESERVOIR ROCK

Ellenburger: Dolomite; gray to tan, crystalline, with scattered vuggy porosity.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Ellenburger:	Feet
Elevation of top of oil	-4,268
Elevation of bottom of oil	-4,280
Relief	12

CHARACTER OF OIL

Ellenburger: Gravity, A. P. I. @ 60°F: 47°.

WATER PRODUCTION

Ellenburger: The liquid produced during the initial potential test was 59% water. Data concerning subsequent water production are not available.

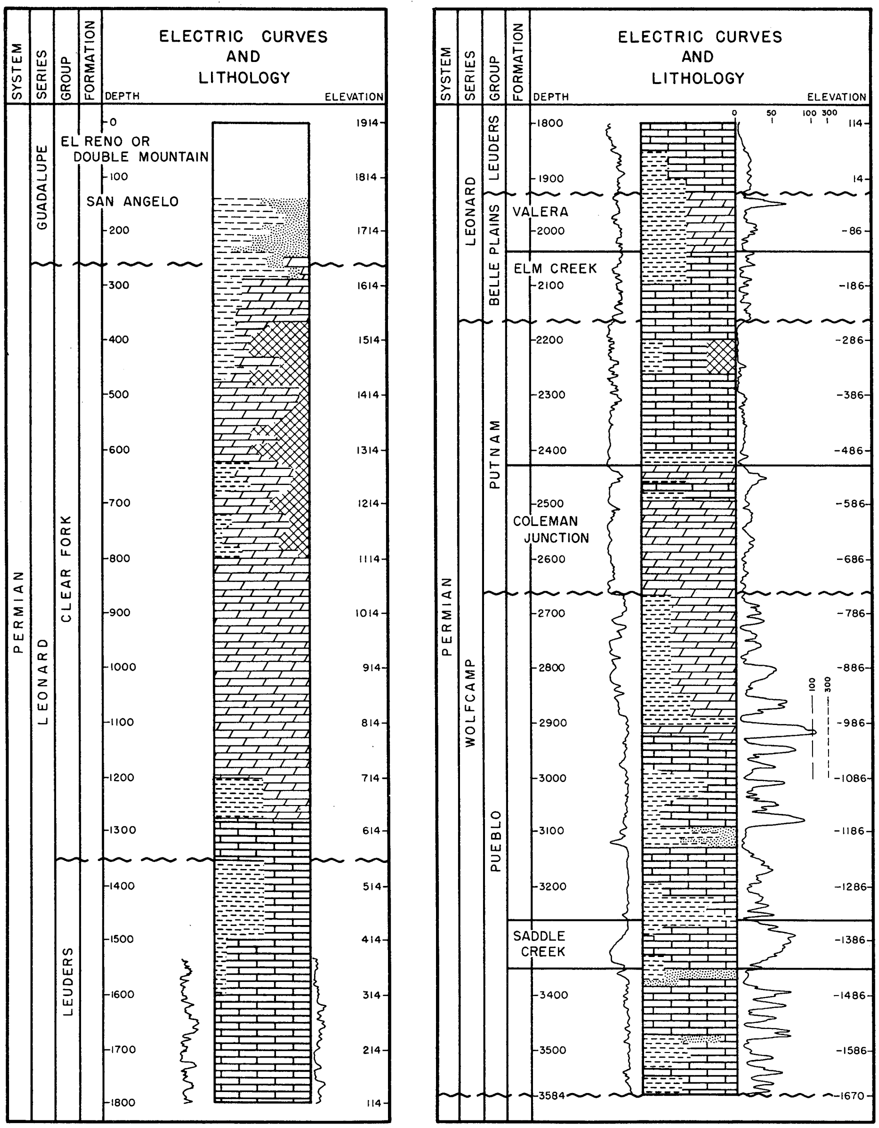
ACID TREATMENT

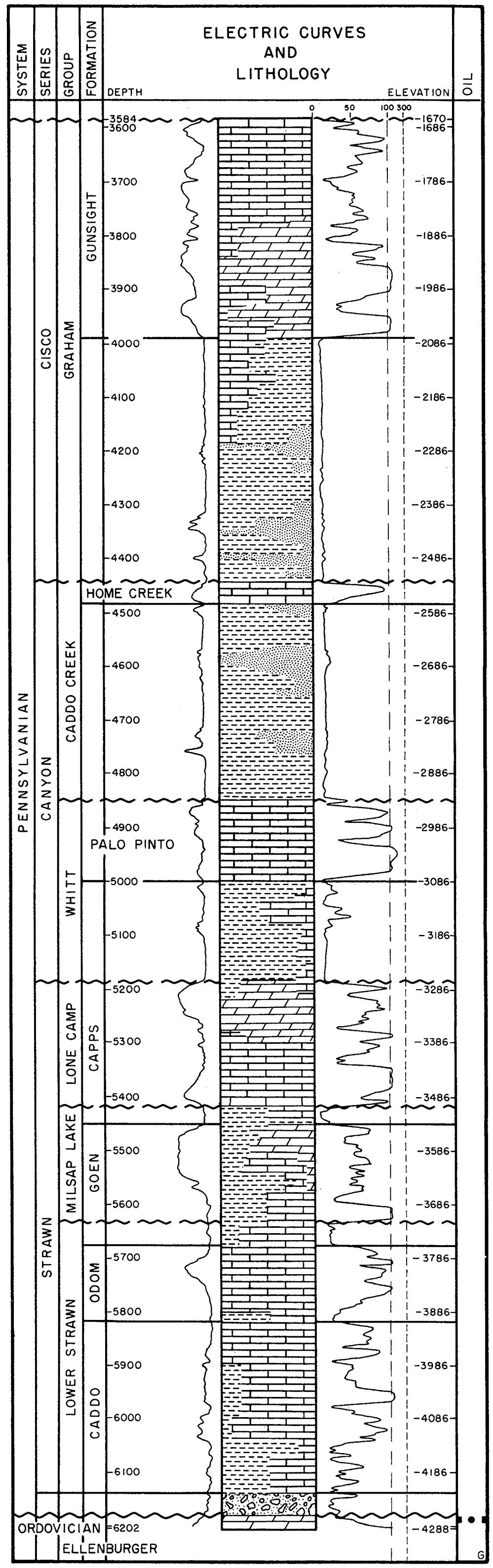
Ellenburger: The productive well was treated with 175 gallons of acid.

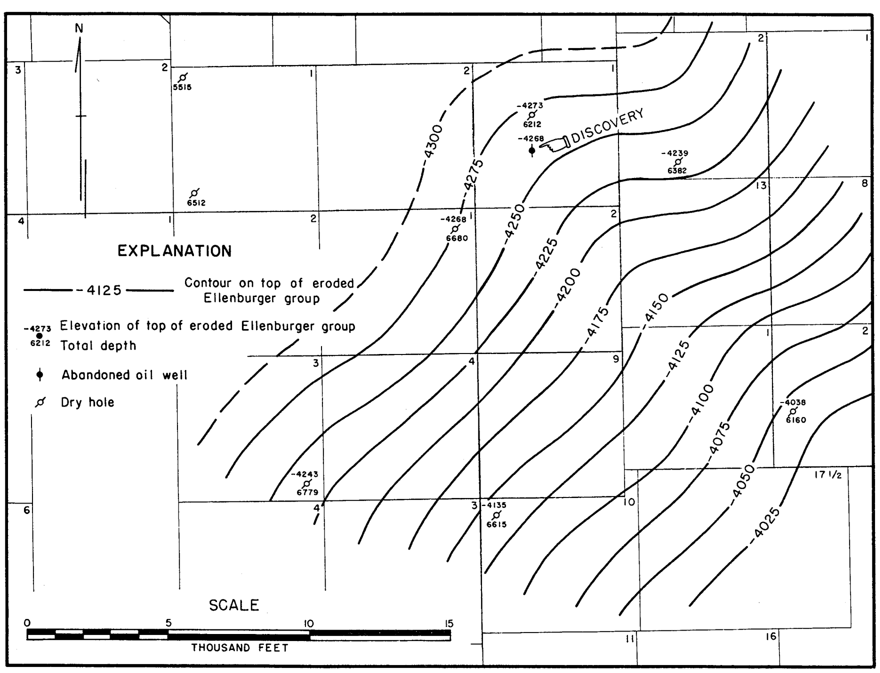
PRODUCTION HISTORY

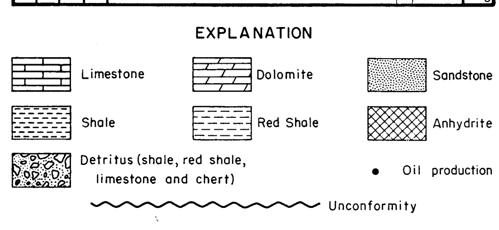
Ellenburger: The one well produced 20,797 barrels of oil during 1948 and 9,633 barrels during 1949. The well was abandoned in May 1949 after having produced a total of 30,430 barrels of oil.

SECTION OF ROCKS PENETRATED









TUCKER FIELD

Crane County, Texas

WILLIAM M. CAFFEY
Development Geologist, Standard Oil Co. of Texas, Midland, Texas
HERSHEL S. CARVER, Jr.
District Geologist, Standard Oil Co. of Texas, Amarillo, Texas

December 1, 1953

LOCATION

The Tucker field is in southwest Crane County 2 miles north of the Pecos River and 6 miles north of the town of Imperial in Pecos County. It is on the Central Basin platform and in the midst of many fields near the southern end of the platform.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Subsurface geology and geophysics, with more of the credit due to subsurface geology, prompted test-drilling. Geophysical exploration was difficult because of the unconformity at the base of the Permian.

On October 18, 1945, Magnolia Petroleum Co. #1-B H.H. Tucker was completed at total depth of 5,817 feet in the Waddell sand. Although a drill stem test had indicated a commercial well, the completed well flowed only 19 barrels of oil per day and, after producing a short time at a declining rate, was soon abandoned without having been a commercial producer.

DISCOVERIES

Clear Fork: May 26, 1950; Jergins Oil Co. #2 M.D. Self & State. Initial production, 52 barrels of oil and 21 barrels of water per day through perforations at 4,167 - 4,173 feet. This is the only well which has produced from this reservoir. It was abandoned in 1952.

McKee: January 15, 1952; George T. Abell #1 State-Brunson. Initial potential, 220 barrels of oil per day with gas-oil ratio of 550:1; top of reservoir at depth of 5,482 feet.

Waddell and Field: February 24, 1946; Standard Oil Co. of Texas #1 Nellie M. Tucker. Initial potential, 127 barrels of oil and 1,500 Mcf of gas per day through 1/4-inch choke; gas-oil ratio, 11,000:1

The writers wish to express their appreciation of the active assistance of Jack L. Lawton, Division Petroleum Engineer, Standard Oil Co. of Texas, and of other fellow engineers and to thank their employer for permission to publish this paper.

ELEVATION OF SURFACE

The surface elevation averages about 2,450 feet above sea level.

SURFACE FORMATION

Quaternary caliche and sand with total thickness of about 50 feet generally.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is 205 feet below the top of the Ellenburger. This penetration was in the Waddell discovery well at its total depth of 6,303 feet.

NATURE OF TRAPS

Clear Fork: The trap is due to updip and lateral decrease in degree of porosity.

McKee: The primary trap-forming factors are truncation of sloping reservoir rock and sealing by relatively impervious strata.

Waddell: The trap is due to updip decrease in porosity. Shale content of the Waddell sand gradually increases eastward with the result that this reservoir rock is not sufficiently porous updip from the -3,300-foot contour to permit migration of oil.

PRODUCTIVE AREAS

	Acres
Clear Fork (depleted)	10
McKee	80
Waddell	560
Tucker field	650

The estimate for McKee includes only the area considered as proven by development to date. It is probable that future development will warrant increasing this estimate. Furthermore, there is some possibility of future development warranting an increase of the estimate for Waddell.

THICKNESSES OF RESERVOIR ROCKS

Gross from top to bottom of productive rock	Feet Min.	Feet Max.
Clear Fork	3	25
McKee	30	60
Waddell	20	45

CONTINUITY OF RESERVOIR ROCKS

Clear Fork: This reservoir rock is identifiable as a stratigraphic unit throughout the area of the field. However, at only one location has it been found sufficiently thick and with sufficient degree of porosity to occasion commercial production. It probably correlates with the Tubb sandstone, which is productive in several nearby fields.

McKee: This reservoir rock is a blanket sandstone which was deposited as a continuous bed over a large area including several nearby fields. It has been eroded from the crest of the structural high on which this field is located.

Waddell: The Waddell sandstone was deposited as a blanket stratigraphic unit over a large portion of West Texas and Southeast New Mexico. It is characterized by local variation in degree of porosity and permeability and therefore is probably not continuous for free migration of fluids over large areas.

CHARACTER OF OIL

Clear Fork:	
Gravity, A.P.I. @ 60° F.	37°
McKee:	
Gravity, A.P.I. @ 60° F.	42°
Waddell:	
Gravity, A.P.I. @ 60° F.	38.3°
Sulphur,	0.414%
Color,	Dark green
Flash point,	Below 60° F.
Fire point,	Below 60° F.

Viscosity	Saybolt seconds
@ 60° F.	55.1
@ 100° F.	41.6
@ 130° F.	37.1
Pour point, ASTM D97	10° F.
Carbon residue, D189	2.25%
Salt content, lb./1,000 bbls.	1.53

Yield: Distillation at atmospheric pressure	
400 E. P. gasoline,	31.0%
525 E. P. kerosene,	16.0%
675 E. P. gas oil,	20.0%
Lube distillate	14.0%
Residue	18.5%

Source of sample:
Standard Oil Co. of Texas #1 H. A. Reynolds

LITHOLOGY OF RESERVOIR ROCKS

Clear Fork: Brown to gray, fine to medium, crystalline dolomite with some traces of asphalt.

McKee: Gray to brown, fine, quartz sand with a few large frosted grains. Much of the sand is cemented with lime or shale.

Waddell: The reservoir rock consists of two sand members with a parting of limy, green shale approximately 10 feet thick. The top sand is composed of fine, rounded sand grains cemented by shale updip and varies in thickness from 3 to 10 feet. The lower sand is similar, with the grains slightly smaller and more compacted, and, like the upper sand, is cemented by shale updip.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Clear Fork:	Feet
No free gas cap	
Elevation of top of oil	-1,704
Elevation of bottom of oil	-1,722
Relief	18

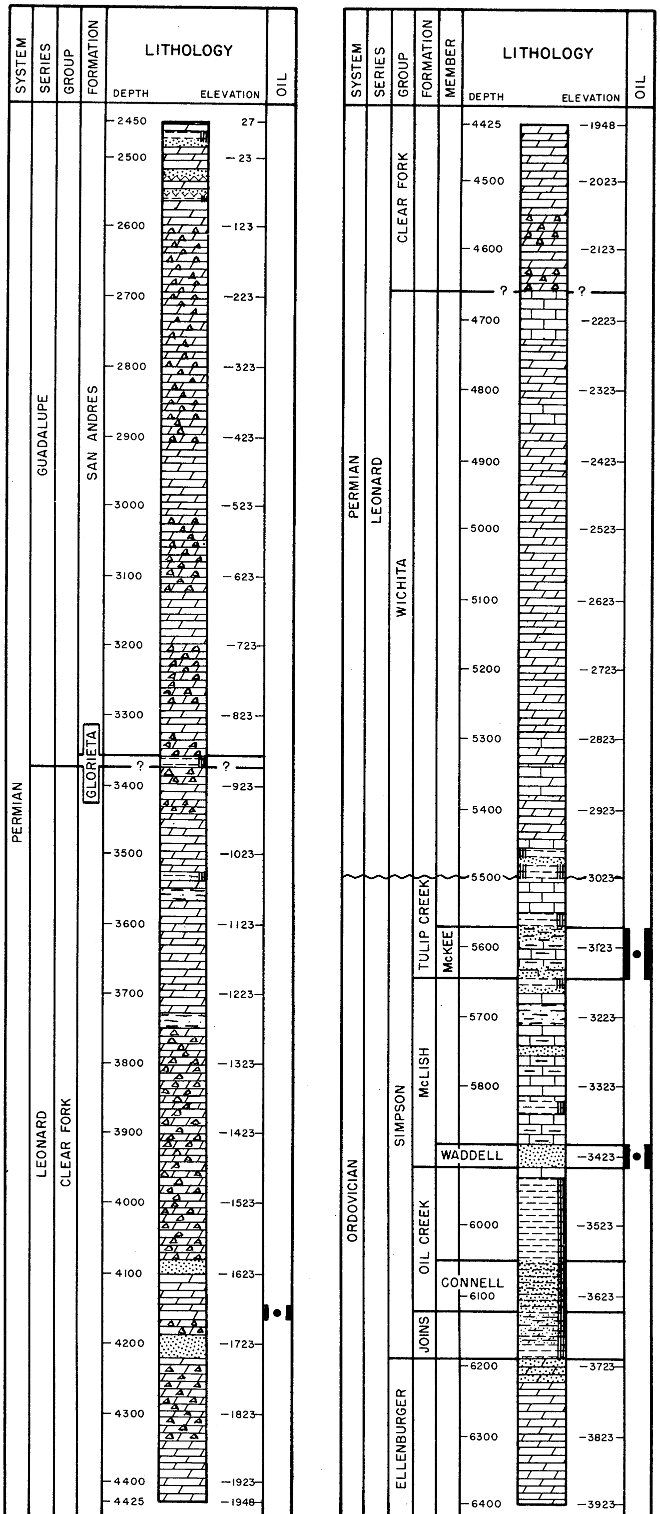
The above elevations are those in the one well where this reservoir was productive. In other wells, shows of oil have been found at higher and lower elevations. Data are not available for concluding whether there is a fairly definite oil-water contact level in this reservoir rock, which generally lacks sufficient porosity for commercial production.

McKee:	Feet
No free gas cap	
Highest known elevation of oil	-3,026
Lowest known elevation of oil	-3,079
Known relief	53

Waddell:	
Elevation of top of gas	-3,249
Elevation of bottom of gas	-3,327
Relief*	78
Elevation of top of oil	-3,327
Elevation of bottom of oil	-3,467
Relief	140

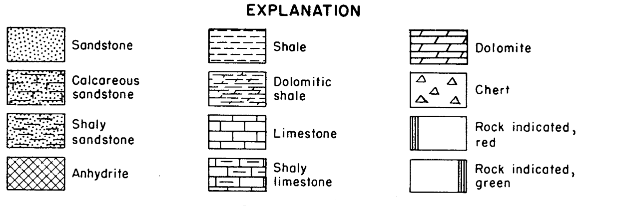
*The above indicated relief of 78 feet represents the original primary gas cap. This cap has been extended by expansion of gas with decrease of pressure and by gas coming out of solution as oil is produced. Because of the expansion of the gas cap, operators have squeezed off upper perforations in some of the oil wells. There is no gas well recognized as producing from this reservoir. Humble Oil & Refining Co. #1 N. M. Tucker, which may be completed in this reservoir, has been shut in for lack of market for gas most of the time since its completion on January 14, 1946. This well has been treated by the Railroad Commission as in the Abell field.

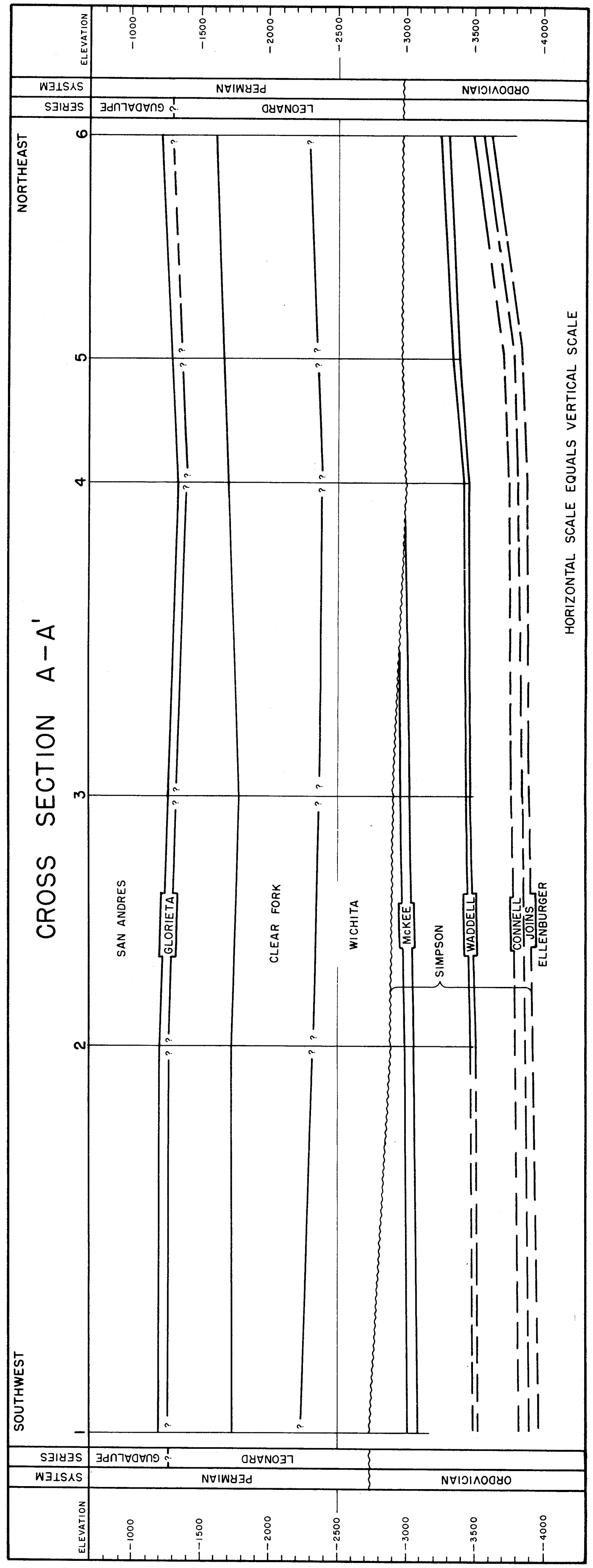
TYPICAL SECTION OF ROCKS PENETRATED

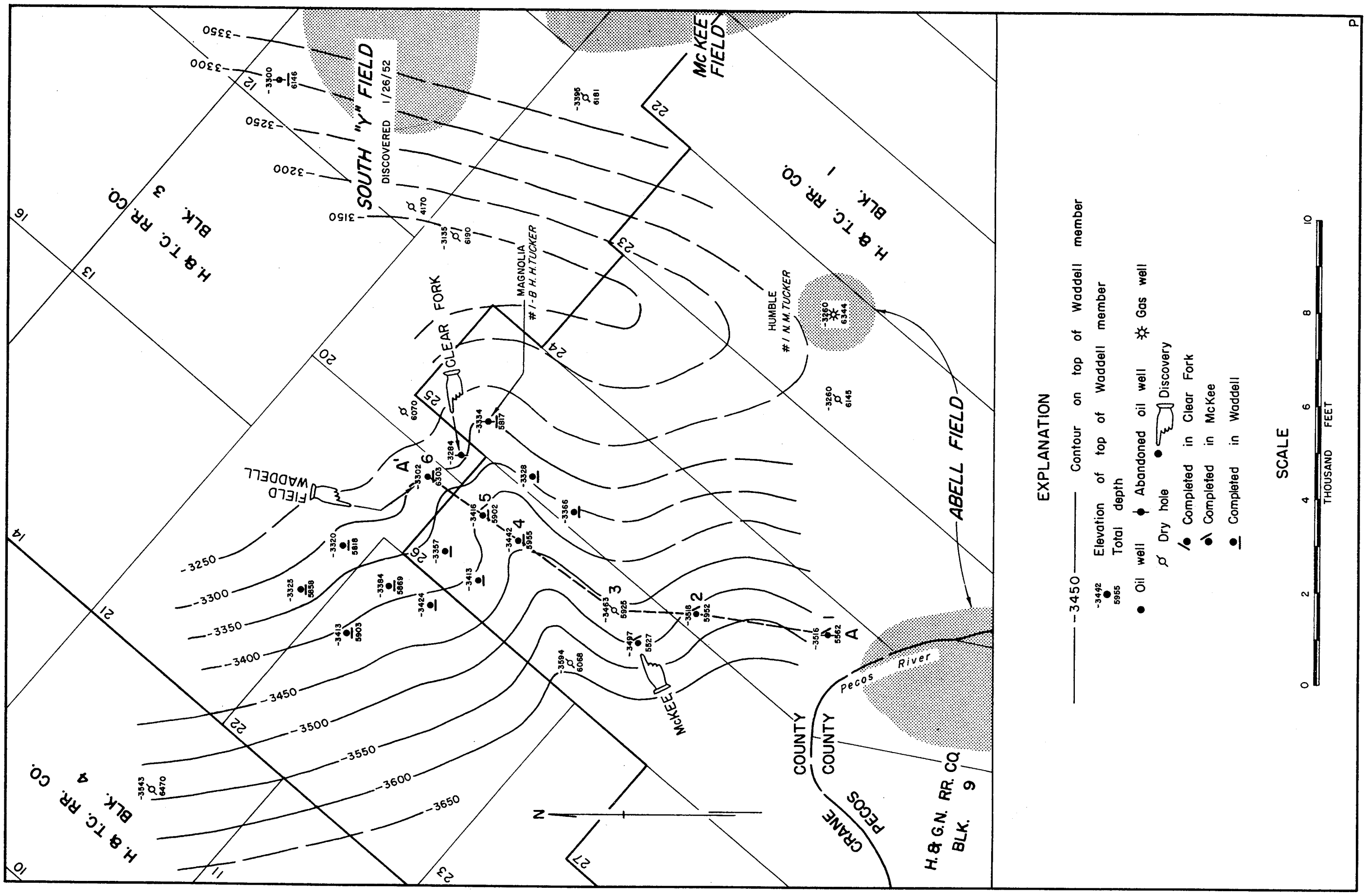


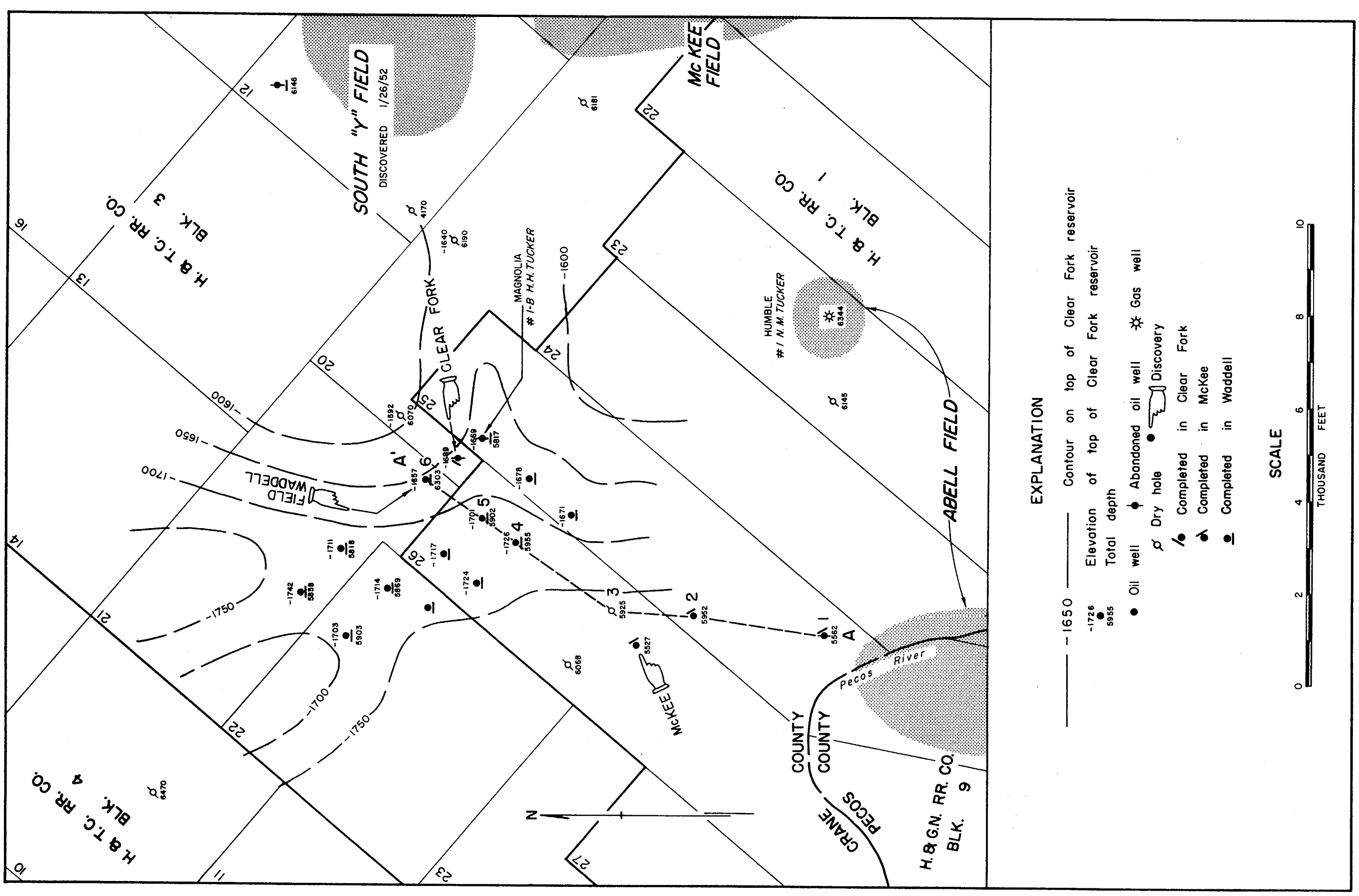
NOTE: This section is based on a composite log compiled from the logs of three wells.

EXPLANATION






EXPLANATION
Contour on top of Waddell member
Elevation of top of Waddell member
Total depth
Oil well
Abandoned oil well
Gas well
Dry hole
Discovery
Completed in Clear Fork
Completed in McKee
Completed in Waddell
SCALE
THOUSAND FEET
SOUTH "Y" FIELD
DISCOVERED 1/26/52
McKEE FIELD
ABELL FIELD
CLEAR FORK
WADDELL FIELD
McKEE
MAGNOLIA
1-B H.H. TUCKER
HUMBLE
1 N.M. TUCKER
H. & T.C. RR. CO.
BLK. 3
BLK. 1
BLK. 4
H.& G.N. RR. CO.
BLK. 9
CRANE COUNTY
PECOS COUNTY
Pecos River


EXPLANATION
Contour on top of Clear Fork reservoir
Elevation of top of Clear Fork reservoir
Total depth
Oil well
Abandoned oil well
Gas well
Dry hole
Discovery
Completed in Clear Fork
Completed in McKee
Completed in Waddell
SCALE
THOUSAND FEET
SOUTH "Y" FIELD
DISCOVERED 1/26/52
McKEE FIELD
ABELL FIELD
CLEAR FORK
WADDELL FIELD
McKEE
MAGNOLIA
1-B H.H. TUCKER
HUMBLE
1 N.M. TUCKER
H. & T.C. RR. CO.
BLK. 3
BLK. 1
BLK. 4
H.& G.N. RR. CO.
BLK. 9
CRANE COUNTY
PECOS COUNTY
Pecos River

CHARACTER OF GAS

Clear Fork: No analysis available
McKee: No analysis available
Waddell: Podbielniak analysis:

Component	Mol.%	G/Mcf
Carbon dioxide	Nil	
Methane	89.34	
Ethane	4.99	
Propane	3.12	0.856
Iso-butane	0.21	0.069
N-butane	1.13	0.355
Iso-pentane	0.16	0.058
N-pentane	0.47	0.170
Hexane	0.37	0.152
Heptane plus	0.21	0.097
Calculated yield:		
26# RVP gasoline		0.760
18# RVP gasoline		0.576

Source of sample:
Standard Oil Co. of Texas #1 H. A. Reynolds

RESERVOIR ENERGY

Clear Fork: Water drive.

McKee: Insufficient history for positive determination. Probably water drive.

Waddell: In the early stages of development, the reservoir energy appeared to be solely of the solution gas type. Subsequent development proved that there was a primary gas cap. During the several years of productive history, the gas-oil ratio has increased considerably in a few of the higher wells; from 11,000:1 to approximately 37,000:1 in the discovery well. The maximum recorded initial flowing reservoir pressure was 2,590 psi. and the calculated bubble point was 2,633 psi. The reservoir pressure is now around 2,100 to 2,300 psi. Apparently the primary gas cap has been effective in arresting the decline of reservoir pressure. There is no evidence of updip advance of the oil-water contact.

WATER PRODUCTION

Clear Fork: The water-oil ratio in the one productive well was initially 21:52. The rate of oil production declined and the rate of water production increased, with the result that operation became unprofitable and the well was abandoned.

McKee: Practically no water has been produced to date.

Waddell: No water has been produced to date.

ACID TREATMENT and HYDRAULIC FRACTURING

McKee: The southern of the two producing wells was acidized with 1,000 gallons and fractured with 2,000 gallons.

Waddell: The only well in which the Waddell reservoir was treated is the well in the north corner of Sec. 12, near the northeast corner of the area covered by the accompanying map. This well was acidized in two stages, first with 2,000 gallons and then with 1,500 gallons. At first, the treatment appeared to be successful, but the well was soon depleted and was abandoned.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Field totals				
1946	1	0	2,726	2,726
1947	1	0	28,900	31,626
1948	4	0	106,549	138,175
1949	7	0	223,809	361,984
1950	9	3	150,428	512,412
1951	8	2	97,742	610,154
1952	11	2	111,416	721,570
1953*	12	2	79,199	800,769
Clear Fork				
1950	1	1	5,765	5,765
1951	0	1	3,811	9,576
1952	0	0	0	9,576
McKee				
1952	2	0	15,722	15,722
1953*	2	0	7,164	22,886
Waddell				
1946	1	0	2,726	2,726
1947	1	0	28,900	31,626
1948	4	0	106,549	138,175
1949	7	0	223,809	361,984
1950	8	2	144,663	506,647
1951	8	1	93,931	600,578
1952	9	2	95,694	696,272
1953*	9	2	720,035	768,307

*1953 data added by amendment.

TUNSTILL FIELD

Loving and Reeves Counties, Texas

WILLIAM T. REID
Geologist, Continental Oil Co., Midland, Texas
August 17, 1953

LOCATION

The Tunstill field occupies an area about 5 miles long partly in Loving County and partly in Reeves County. The south end of the field is about 4 miles northeast of the town of Orla in Reeves County and the north end of the field is about 5 miles south of the New Mexico - Texas boundary line. It is one of several similar fields in the central portion of the Delaware basin.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Mapping of surface and subsurface geological data led to the discovery of the field.

DISCOVERIES

Bell Canyon: The first well completed as a productive well within the present area of the field was Pacific Mid-Continent Corp. #1 W. A. Tunstill, which was completed on October 12, 1938, as a gas well with potential capacity of 3,770 Mcf per day. After showings of gas from the depth of 3,291 to 3,302 feet, there was an oil showing at 3,302 feet; 17 barrels of oil was produced during a 7-hour test. The well was continued to the total depth of 3,305 feet and completed as a gas well. It created very little interest and evidently was not recognized at the time as having discovered a commercial field. It was deepened in 1939 to a total depth of 3,556 feet and was plugged and abandoned in 1941. On October 27, 1947, Louis Crouch and Texzona Production Co. #1 Tunstill Brothers was completed and was currently recognized as a discovery well. Early in August of 1947, it had unloaded its drilling mud at depth of 3,285 feet and again at 3,298 feet. It produced oil and drilling fluid at the rate of 15 to 20 barrels hourly. Drilling was halted at depth of 3,308 feet to install control-head and tanks. Without drilling deeper, the well was completed on October 27 as a flowing oil well with rated potential capacity of 71 barrels of oil per day.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the vicinity of the field is in the Cherry Canyon formation and is 1,397 feet below the top of the Delaware Mountain group. This penetration was in the dry hole near the west edge of the field and about ½ mile southwest of the Pecos River and near the southeast corner of section 4 where the total depth of 4,629 is indicated on the accompanying map.

NATURE OF TRAP

The oil accumulation is related to three factors, the predominant of which is a narrow terrace. Variation in degree of porosity and permeability is also an important trap-forming factor. Slight faulting is believed by the writer to contribute in a minor way to trapping of oil in certain parts of the field.

PRODUCTIVE AREA

Bell Canyon and Field: Development to date proves that an area of at least 4,240 acres is productive. Since drilling is still in progress, it seems likely that the productive area will be proven to be greater than it is now known to be.

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: Sandstone; calcareous, light to medium gray, fine-grained; interbedded with thin, black calcareous shale partings at various intervals.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: Throughout the Delaware basin there is a sandstone member at the stratigraphic position of this reservoir rock. The member appears to be continuous throughout this large area, but the degree of porosity and permeability varies considerably. However, it appears to be generally sufficiently porous to permit migration of reservoir fluids except locally where porosity and permeability are abnormally low.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet
Free gas in negligible quantity only	
Elevation of top of oil	-477
Elevation of bottom of oil	-692
Relief	215

RESERVOIR ENERGY

Bell Canyon: Production records indicate that the reservoir energy which expels the oil is due primarily to expansion of gas as it comes out of solution with decline of pressure. Although water is produced along with the oil, it does not appear that water is entering the general reservoir space at a sufficient rate to constitute a material water drive. The writer believes that the water which is being produced is water which is disseminated in the reservoir rock along with the oil.

ELEVATION OF SURFACE

At well locations: Highest, 3,062 feet
Lowest, 2,751 feet

SURFACE FORMATION

Undifferentiated Quaternary sands and gravels.

THICKNESS OF RESERVOIR ROCK

Bell Canyon:	Feet, average
From top to bottom	60
Net productive	10

CHARACTER OF OIL

Bell Canyon:

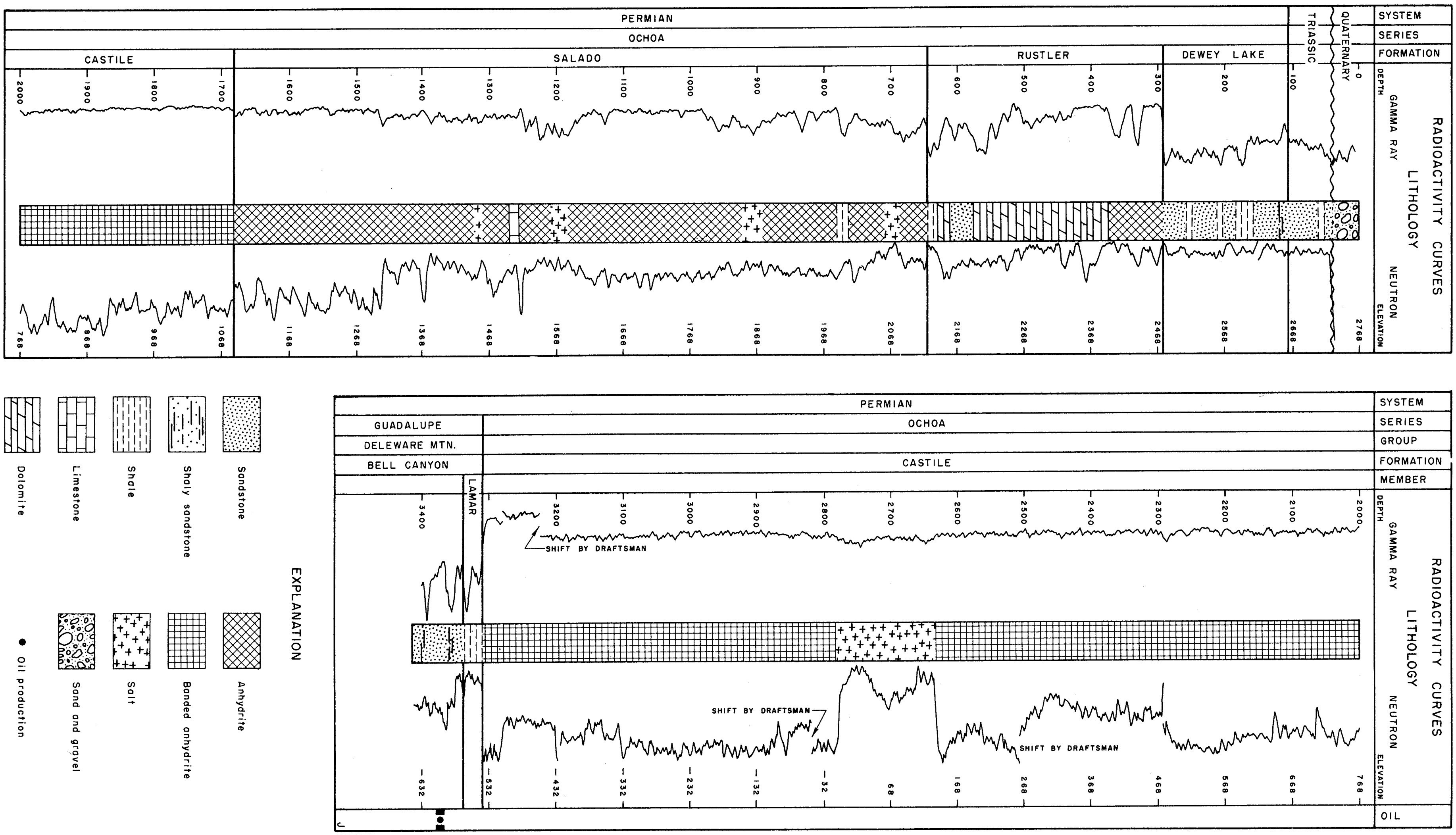
Gravity, A.P.I.,	36° - 43°;	avg. 40°
Sulphur		0.15%
Color		Green
Viscosity, Saybolt Universal @ 100° F.		35 sec.

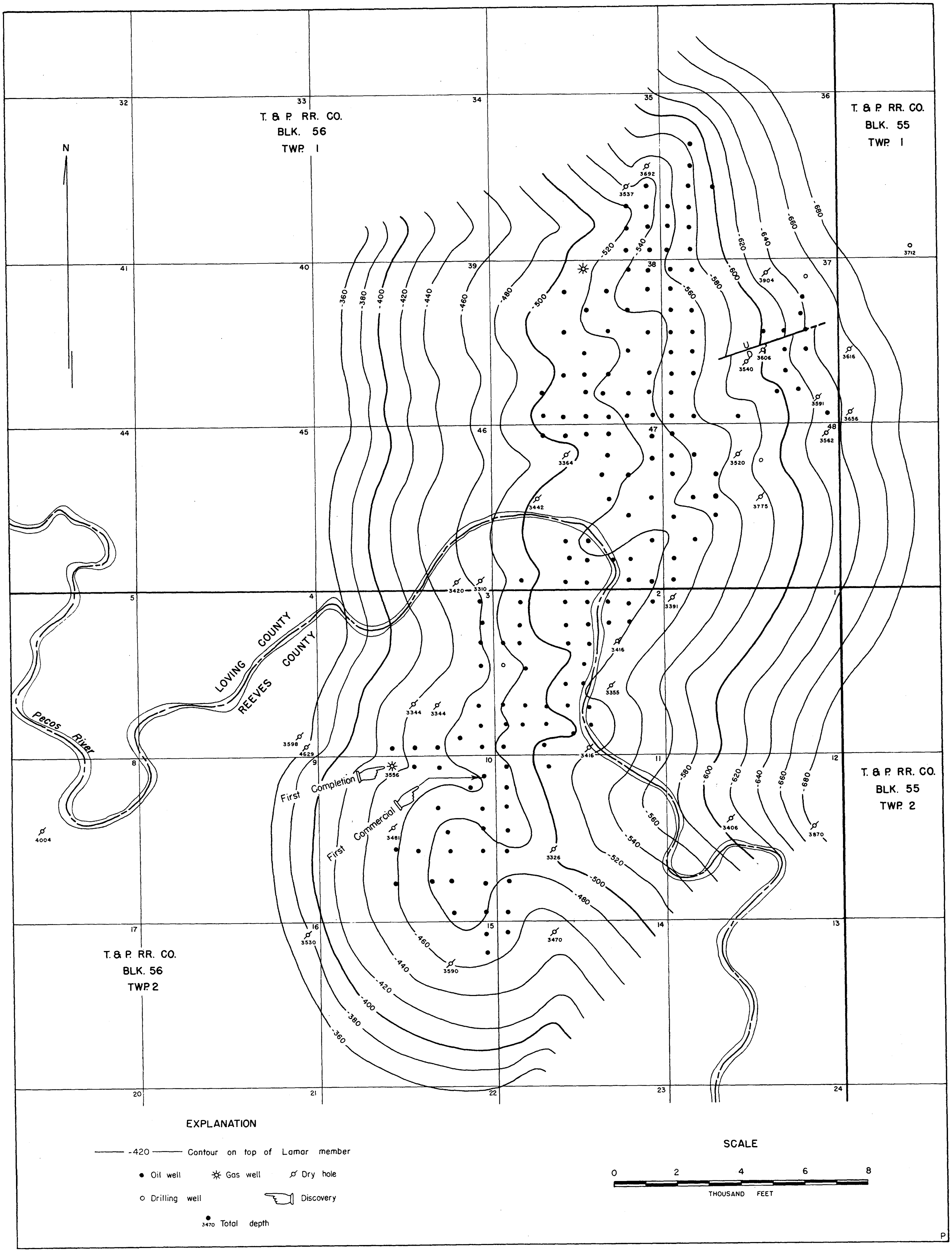
For analysis see:
U. S. Bureau of Mines Lab. ref. No. 51064
Analyses of Crude Oils From Some West Texas Fields.
R. I. 4959 (1953) Item 86

PRODUCTION HISTORY

Year	Wells producing at end of year: Oil, Flowing	Oil, Pumping	Gas	Oil production (barrels): Yearly	Cumulative	Gas production (Mcf): Yearly	Cumulative
1947	7	0	1	15,800	15,800	0	0
1948	41	4	1	478,680	494,480	28,079	28,079
1949	80	4	1	777,604	1,272,084	15,575	43,654
1950	88	14	1	952,641	2,224,725	18,775	62,429
1951	113	15	2	1,196,154	3,420,879	45,261	107,690
1952	141	25	2	1,528,000	4,948,879	20,988	128,678

TYPICAL SECTION OF ROCKS PENETRATED




T. & P. RR. CO.
BLK. 56
TWP. 1
T. & P. RR. CO.
BLK. 55
TWP. 1
T. & P. RR. CO.
BLK. 55
TWP. 2
T. & P. RR. CO.
BLK. 56
TWP. 2
N
LOVING COUNTY
REEVES COUNTY
Pecos River
First Completion
First Commercial
EXPLANATION
-420 Contour on top of Lamar member
Oil well
Gas well
Dry hole
Drilling well
Discovery
3470 Total depth
SCALE
0 2 4 6 8
THOUSAND FEET

T X L FIELD

Ector County, Texas

C. G. COOPER and B. J. FERRIS
Geologists, Shell Oil Company, Midland, Texas
June 30, 1954

LOCATION

The TXL field is in western Ector County about 20 miles west of Odessa, the county seat of Ector County. It is in the central portion of the Central Basin platform.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph.

DISCOVERIES

San Andres: April 17, 1952;
Phillips Petroleum Co. #TT-1 TXL.
Upper Clear Fork: July 8, 1946;
Phillips Petroleum Co. #E-1-A TXL.
Tubb: December 2, 1950;
Texas Gulf Producing Co. #1 Lola and Felix Woodard.
Wolfcamp: January 20, 1947;
American Republics Corp. #1 TXL.
Oil was first produced from this reservoir by Shell Oil Co. & Arkansas Fuel Oil Co. #E-1 E.R. Thomas Estate, which was completed in this reservoir on February 9, 1946, with initial potential of 16.2 barrels of oil per day; abandoned in this reservoir and completed in Devonian in July 1946 after having produced only 970 barrels of Wolfcamp oil; later, plugged back to Upper Clear Fork.
Devonian and Field: December 30, 1944;
Shell Oil Co. & Cities Service Oil Co. #1 TXL.
Fusselman South: December 20, 1946;
Superior Oil Co. #7 J.E.Parker.
Fusselman North: November 28, 1951;
Shell Oil Co. #A-2 J.D.Slator, Jr.
Waddell: May 23, 1953;
Phillips Petroleum Co. #D-5 TXL.
Ellenburger: May 15, 1945;
Shell Oil Co. #1-A A.E.Thomas.
Ellenburger Deep: February 7, 1946;
The Texas Co. #D-1 G.C.Fraser.

OLDEST ZONE PENETRATED

Pre-Cambrian.

NATURE OF TRAPS

San Andres: Not determined; possibly, variation in degree of porosity.

Upper Clear Fork and Tubb: Anticlinal fold.

Wolfcamp: Not determined. It appears that only locally is the reservoir rock sufficiently porous and permeable to permit migration of oil.

Devonian: Updip termination of reservoir due to erosional truncation.

Fusselman South and Fusselman North: Anticlinal fold with subsidiary faulting.

Waddell: Not determined; probably, anticlinal fold.

Ellenburger: Anticlinal fold generally; in south part of field, reservoir is terminated by faulting.

Ellenburger Deep: The trap is due primarily to an anticlinal fold on the downthrown side of a major fault.

PRODUCTIVE AREAS

	Acres
San Andres	80
Upper Clear Fork	6,240
Tubb	1,500
Wolfcamp	40
Devonian	5,500
Fusselman South	200
Fusselman North (gas, 360; oil, 1,200)	1,560
Waddell	40
Ellenburger	5,900
Ellenburger Deep	160
TXL field	16,440

THICKNESSES OF RESERVOIR ROCKS

Average gross from top to bottom	Feet
San Andres	200
Upper Clear Fork	525
Tubb	220
Wolfcamp	30
Devonian	160
Fusselman South	70
Fusselman North	70
Waddell	85
Ellenburger	205
Ellenburger Deep	150

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomitic limestone; tan to buff, fine- to medium-grained, porous.

Upper Clear Fork: Dolomitic limestone; light gray, brown and buff, compact to finely saccharoidal, cherty, slightly anhydritic.

Tubb: Dolomitic limestone; light brown, compact to finely saccharoidal, porous.

Wolfcamp: Dolomitic limestone; light tan to brown, compact, fine-grained.

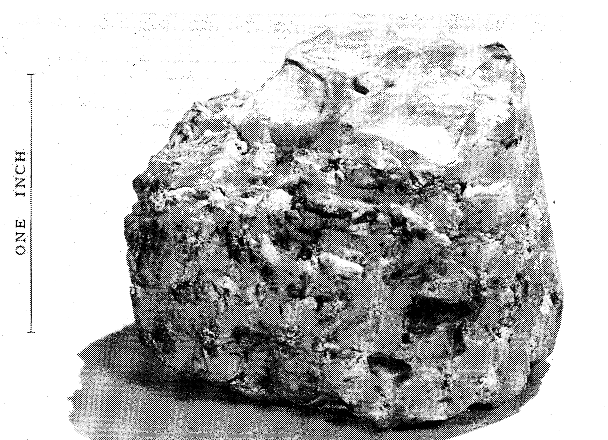
Devonian: The reservoir rock comprises an upper chert member and an underlying limestone member. The upper zone consists mainly of dense white to milky, porcellaneous chert in which porosity appears to have been developed by sub-aerial weathering along cracks and joints resulting in the formation of stream bed crevices filled with clastic material, as well as through metasomatic change of the dense chert into a porous form called tripolite. This zone is highly permeable. It constitutes the main Devonian reservoir. The underlying limestone member is quite cherty and in places has been converted almost entirely into tripolite, which, although highly porous, is nevertheless only poorly permeable. Because of this difference in lithology, wells at the updip edge of the accumulation exhibit markedly different reservoir characteristics from those lower on structure.

Fusselman South and Fusselman North: Glauconitic limestone; medium- to coarse-grained, compact, cherty.

Waddell: Sandstone; tan, medium-grained, angular, with green shale partings.

Ellenburger and Ellenburger Deep: Dolomite; brown to gray, medium- to coarse-grained, compact, rhombic, locally cherty.

CORE OF DEVONIAN RESERVOIR ROCK



From depth of 7,922 feet in
Shell Oil Co. & Arkansas Fuel Oil Co. #8-B E.R.Thomas et al
NE, SW, Sec. 20, Blk. 45, T. 1 S., T. & P.R.R. survey

CONTINUITY OF RESERVOIR ROCKS

As stratigraphic units, all reservoir rocks, with the exception of Devonian, show a fairly uniform development throughout the area of the field. Porosity and permeability, however, especially in the Permian reservoirs, exhibit variations which result in a wide range of productivities of wells. The Devonian reservoir is truncated to the extent that it is totally absent in a part of the field; its porosity decreases downdip.

CHARACTER OF OIL

	Gravity, A.P.I. @ 60°	Sulphur by wt.	Color
San Andres	37.2°	?	Dark green
Upper Clear Fork	36.3°	0.62%	Dark green
Tubb	37.2°	0.55%	Dark green
Devonian	40.7°	0.46%	Dark green
Fusselman South	38.5°	0.42%	Dark green
Fusselman North	37.3°	0.52%	Dark green
Waddell	44.4°	?	Dark green
Ellenburger	44.5°	0.15%	Dark green

For analyses see:

U.S.Bureau of Mines	Lab.ref.No.	46080	46081	46082
Analyses of Crude Oils from 283 Important Oil Fields of the U.S., R.I. 4289 (1948)	Item			264
Analyses of Crude Oils from Some West Texas Fields, R.I. 4959 (1953)	Item	87	88	

ACID TREATMENT

San Andres: Both wells were acidized at time of completion; one with 6,000 gallons and the other with 16,500 gallons of acid.

Upper Clear Fork: All wells are treated with acid before final completion. The gross thickness of the reservoir is so great that the acid is injected by stages into separate, selected portions of the total thickness. Treatments range from 2,000 gallons to 30,000 gallons in from one to six stages.

Tubb: Acid treatments ranging up to 13,000 gallons are given in from one to three stages.

Wolfcamp: The sole Wolfcamp producer was treated with 13,000 gallons of acid in four stages.

Devonian: The majority of the wells in the Devonian reservoir were completed by natural flow. In general, acid treatment was found necessary in wells located near the boundaries of the accumulation, either downdip where porosity grades to near zero or near the updip truncated edge where the presence of tripolite causes low permeability. Treatments ranged up to 27,500 gallons in four stages.

Fusselman South: Acid treatment commonly is limited to a mud acid wash or a one-stage injection of about 500 gallons.

Fusselman North: Most wells have been given a one-stage treatment with 500 gallons of acid.

Waddell: The sole producer was first treated with 500 gallons of acid and then given a 5,000-gallon hydraulic fracture treatment.

Ellenburger: Generally, wells completed in this reservoir flowed naturally. The few wells which required treatment were, with one or two exceptions, given either mud acid wash treatments or injections of from 1,000 to 2,000 gallons.

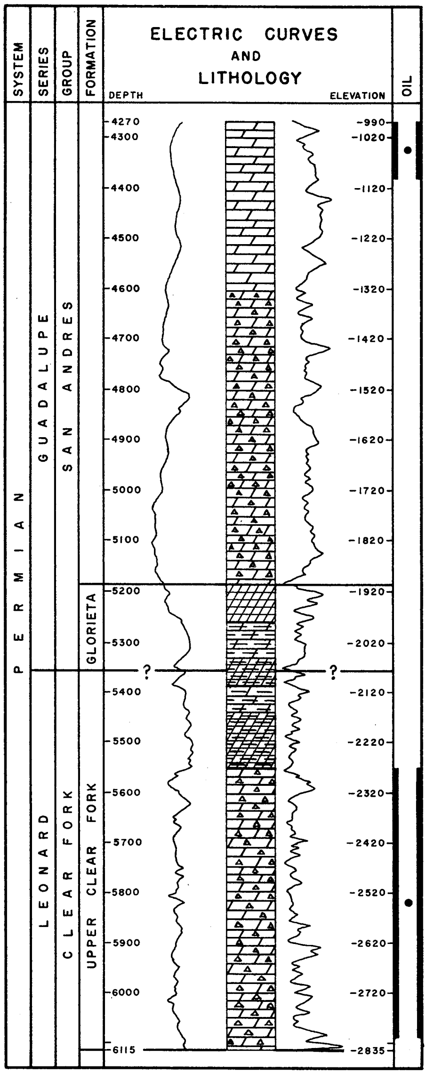
Ellenburger Deep: The wells in this reservoir all flowed naturally except one; that one was given a 1,000-gallon acid treatment.

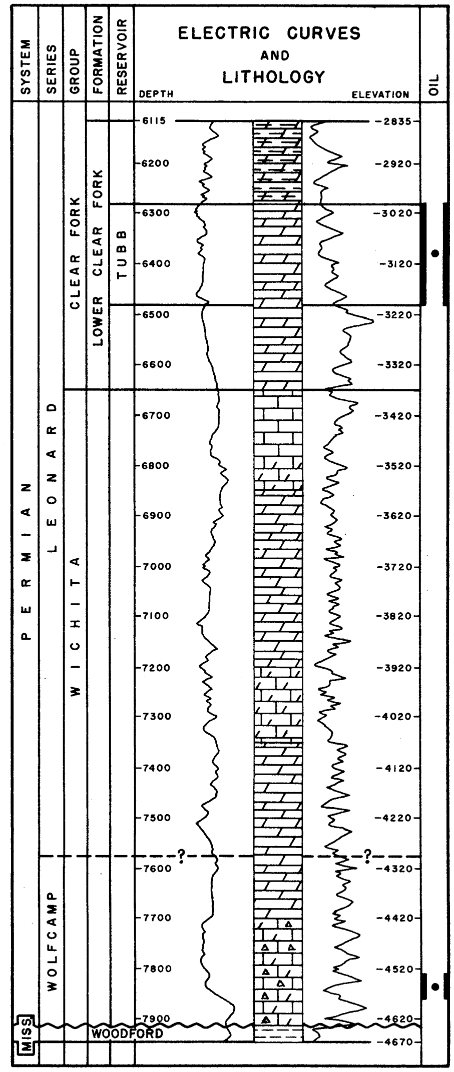
SELECTED REFERENCE

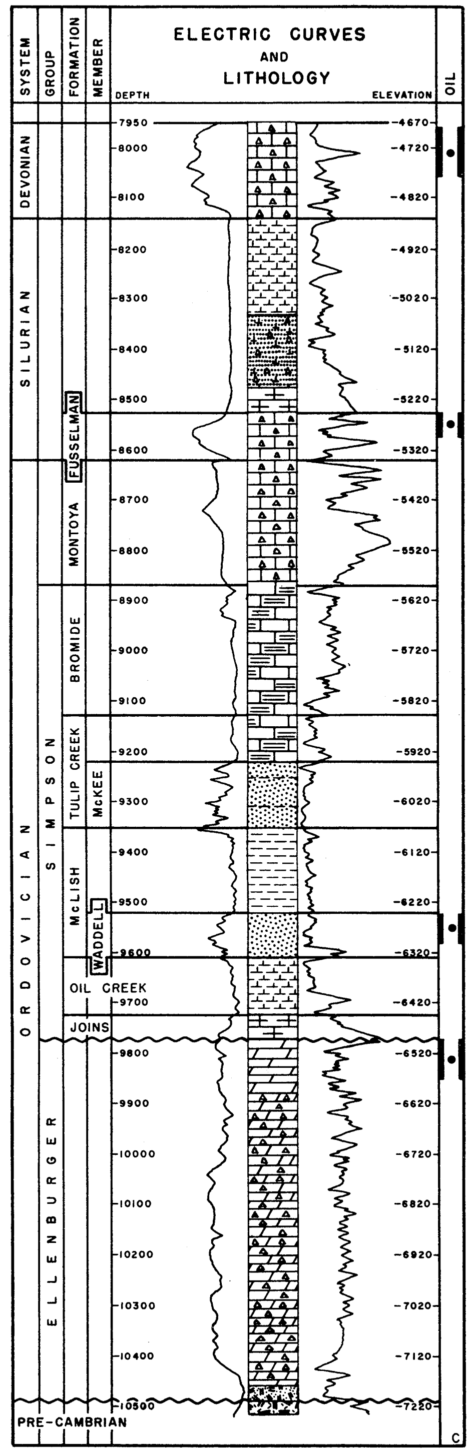
David, Max (1946) Devonian (?) producing zone, TXL pool, Ector County, Texas: Amer. Assoc. Petr. Geol., Bull., vol. 30, pp. 118-119.

TYPICAL SECTION OF ROCKS PENETRATED

SURFACE FORMATION: Lower Cretaceous limestone **ELEVATION OF SURFACE:** Highest, 3,361 feet; lowest, 3,058 feet







DEPTH, ELEVATION AND RELIEF OF PRODUCTIVE ZONES

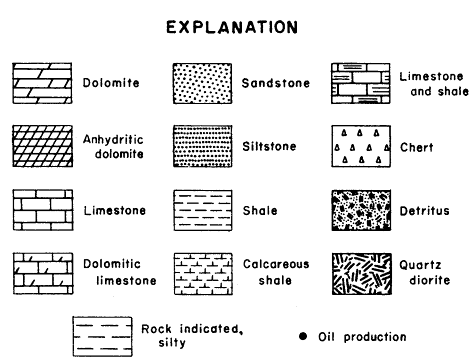
Free gas is present in only the north closure of the Fusselman North reservoir; there, the gas-oil contact was originally at -4,925 feet with maximum known gas column of 73 feet above that elevation.

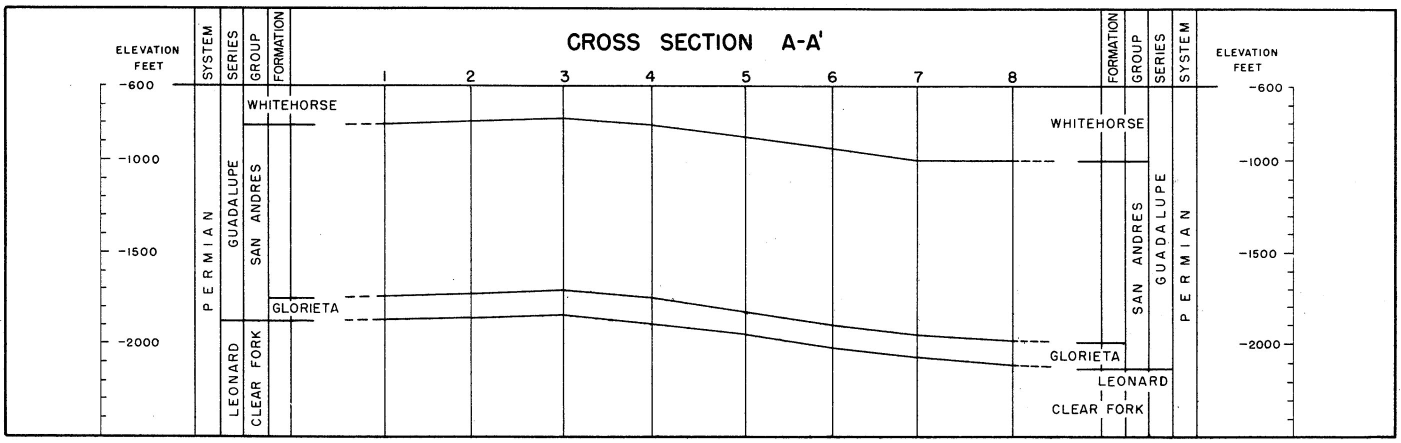
	Top of reservoir at wells				Elevation of oil (feet)		Oil Column (feet)
	Depth (ft. below D.F.)		Elevation (feet)				
	Minimum	Maximum	Highest	Lowest	Top	Bottom	
San Andres	4,260	4,290	-1,023	-1,058	Unknown	Unknown	Unknown
Upper Clear Fork	5,302	5,692	-2,047	-2,441	-2,047	-2,790	743
Tubb	6,001	6,280	-2,902	-3,171	-2,902	-3,175	273
Wolfcamp	7,795		-4,742		-4,742	Unknown	Unknown
Devonian*	7,690	8,090	-4,433	-4,733	-4,433	-4,850	417
Fusselman South	8,300	8,523	-5,050	-5,266	-5,050	-5,380	330
Fusselman North	8,164	8,493	-4,852	-5,153	-4,925	-5,185	260
Ellenburger	9,250		-5,940		-5,940	-6,600§	660
Ellenburger Deep	10,740		-7,475		-7,475	-7,675	200

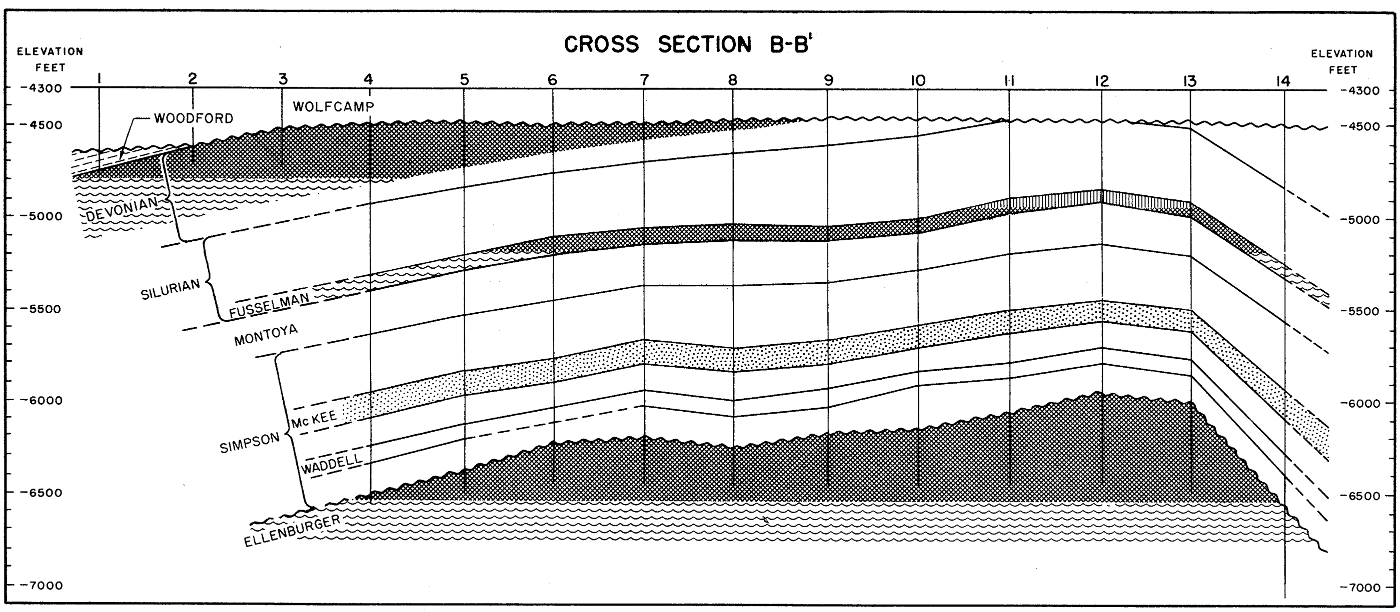
Figures reporting elevation of oil and oil column in the several reservoirs represent conditions at respective discovery dates.

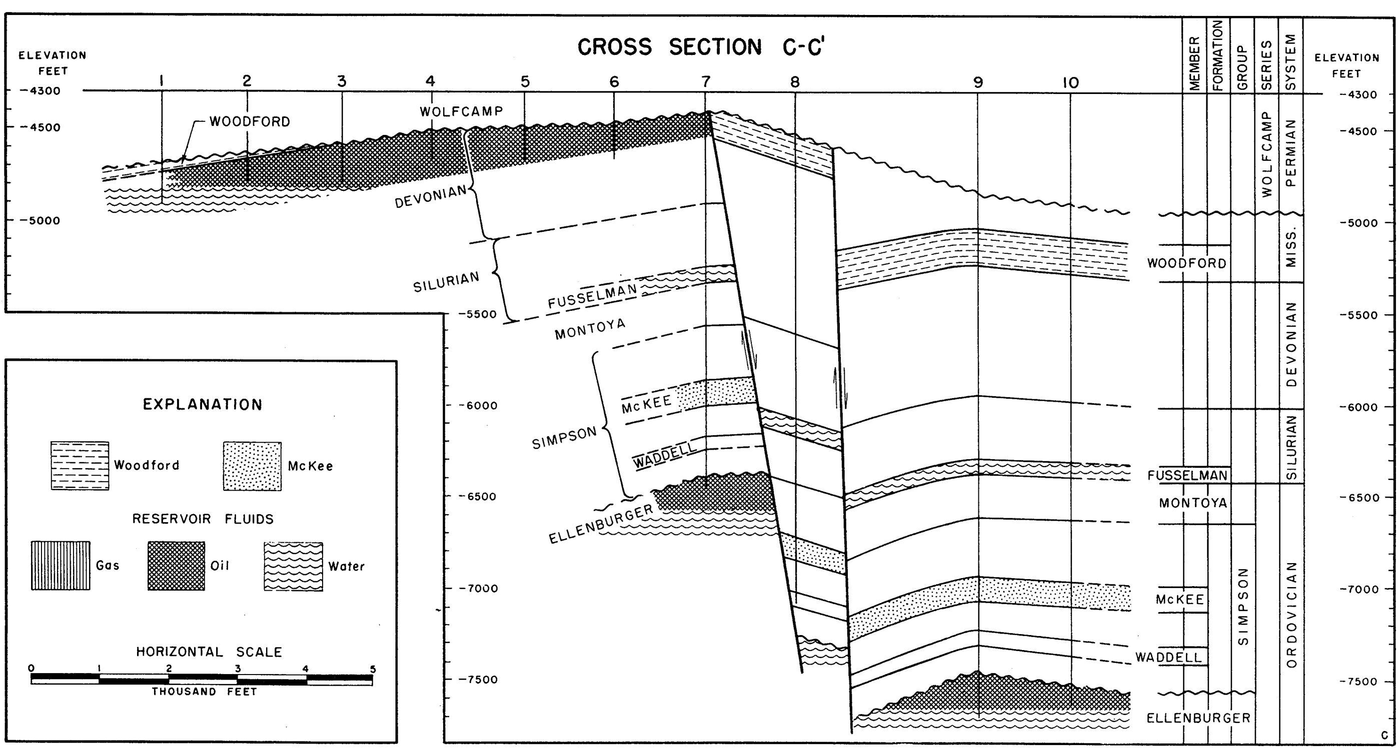
* The difference of 300 feet in the elevations of the top of the Devonian does not represent the proven structural relief since a portion of the Devonian has been eroded off at the higher location.

§ The elevation of the oil-water contact in the Ellenburger reservoir varied through a range of about 60 feet; from -6,540 feet to the extreme of -6,600 feet at the south extent of the Ellenburger productive area.




CROSS SECTION A-A'
ELEVATION FEET
-600
-1000
-1500
-2000
SYSTEM
SERIES
GROUP
FORMATION
1
2
3
4
5
6
7
8
PERMIAN
GUADALUPE
SAN ANDRES
WHITEHORSE
GLORIETA
LEONARD
CLEAR FORK


CROSS SECTION B-B'
ELEVATION FEET
-4300
-4500
-5000
-5500
-6000
-6500
-7000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
WOODFORD
WOLFCAMP
DEVONIAN
SILURIAN
FUSSELMAN
MONTOYA
SIMPSON
McKEE
WADDELL
ELLENBURGER


CROSS SECTION C-C'
ELEVATION FEET
-4300
-4500
-5000
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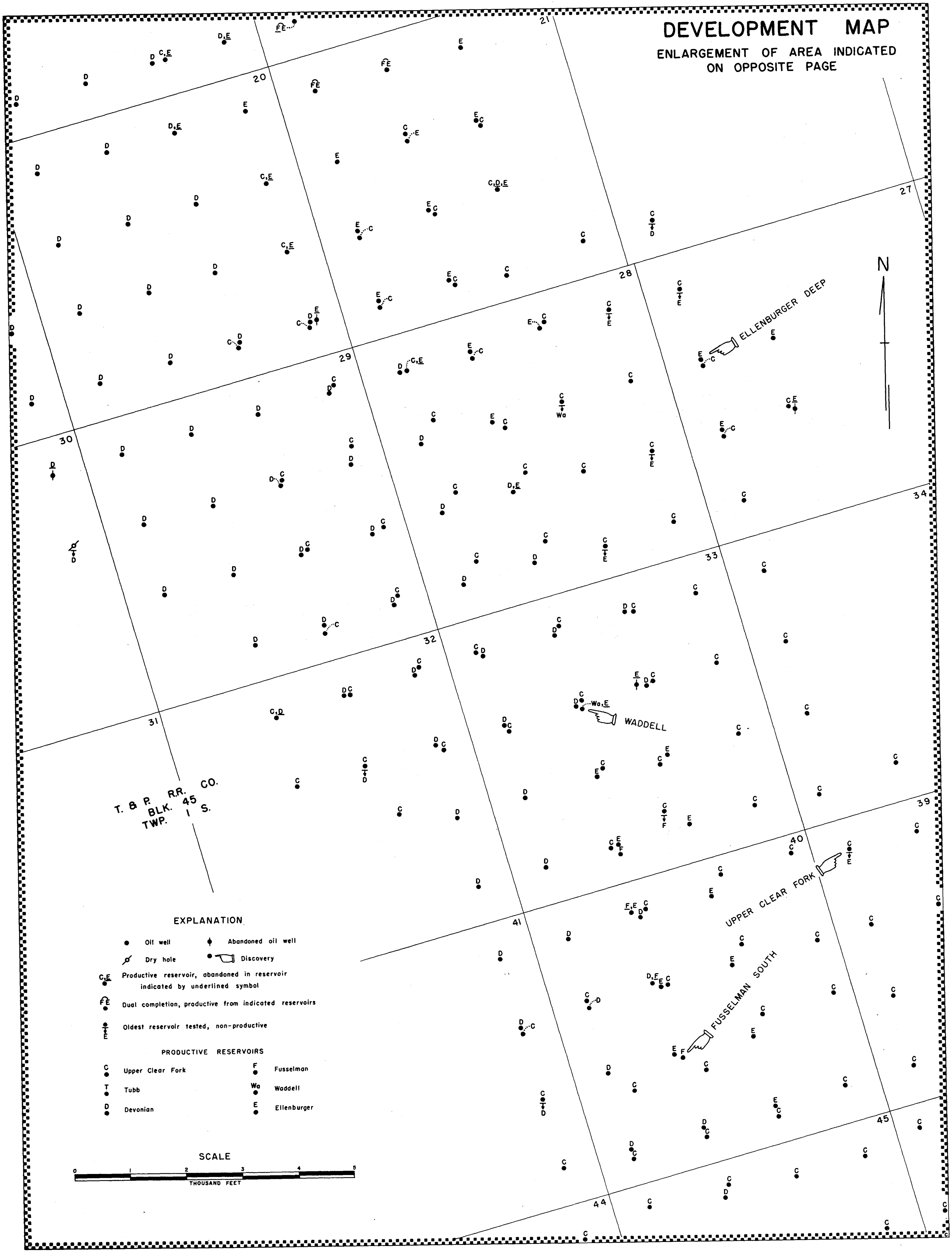
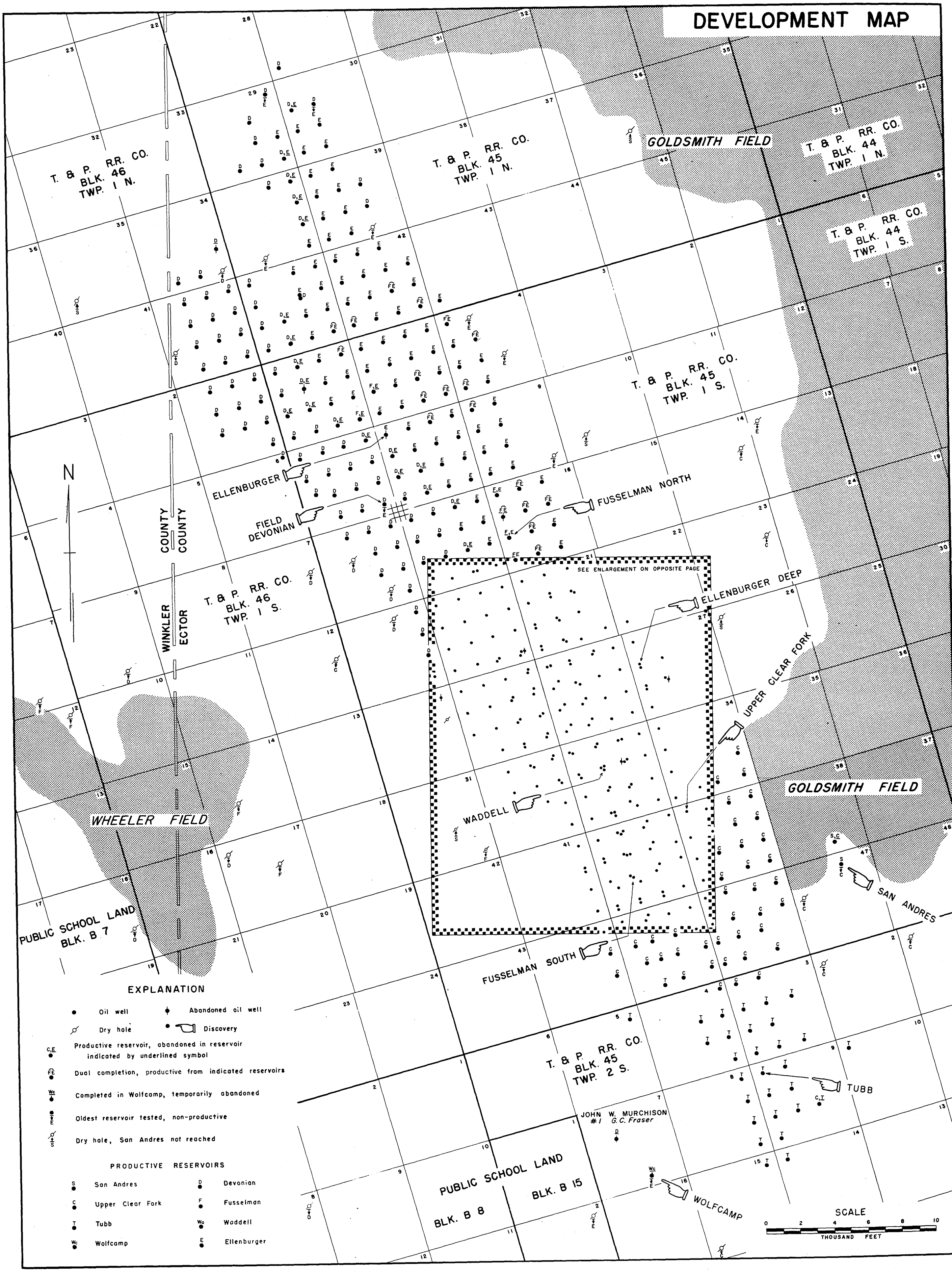
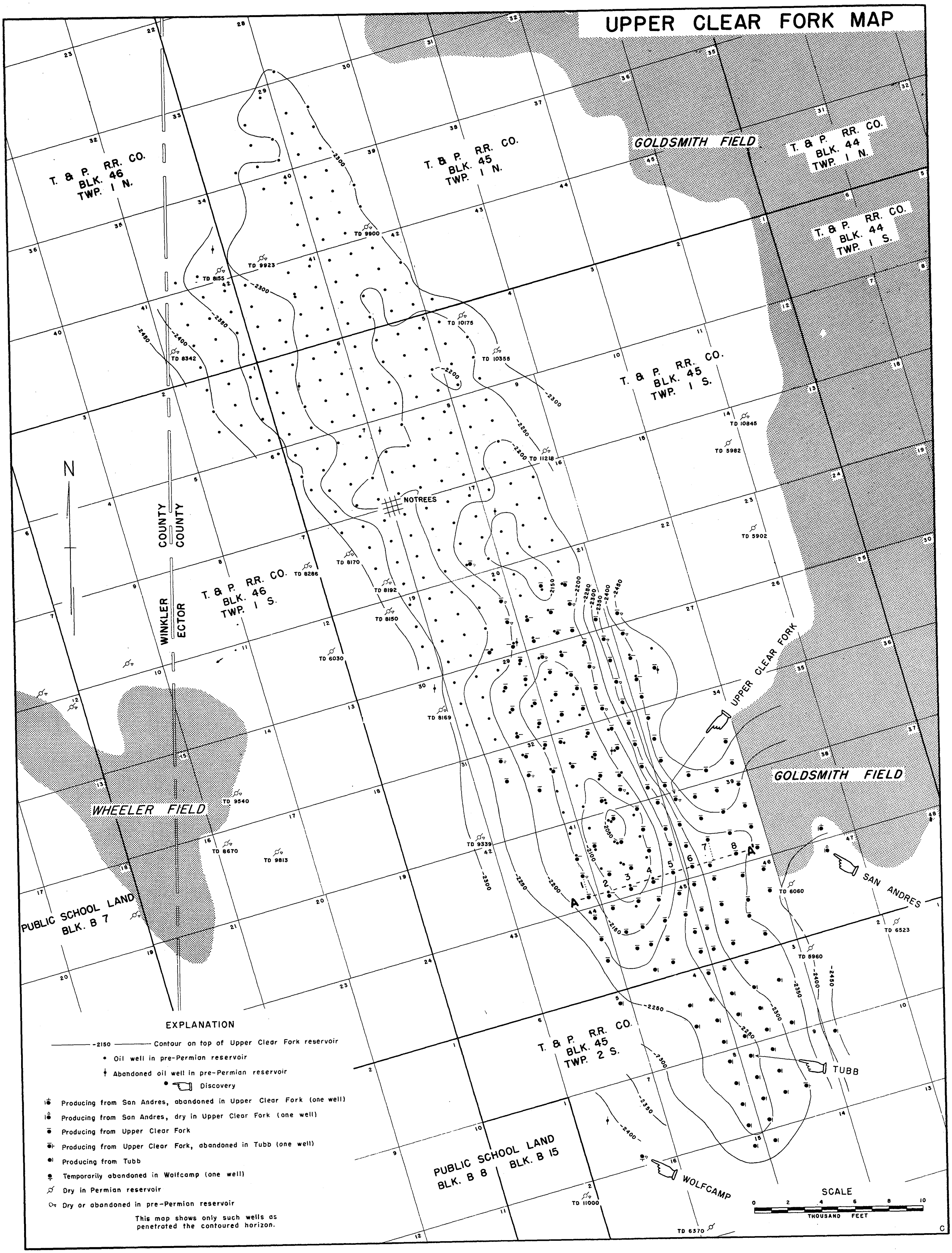
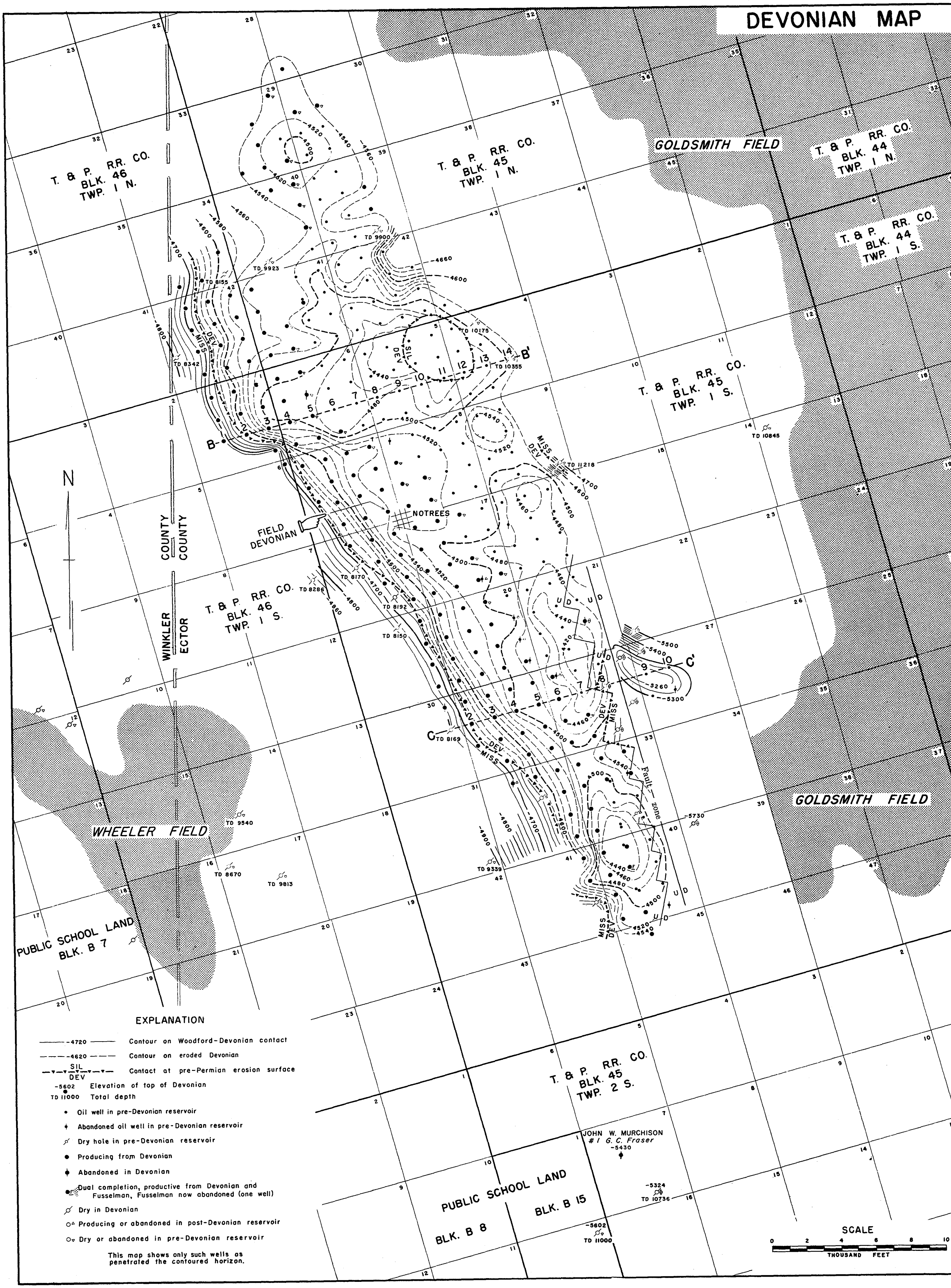
-6000
-6500
-7000
-7500
1
2
3
4
5
6
7
8
9
10
WOODFORD
WOLFCAMP
DEVONIAN
SILURIAN
FUSSELMAN
MONTOYA
SIMPSON
McKEE
WADDELL
ELLENBURGER
MEMBER
FORMATION
GROUP
SERIES
SYSTEM
PERMIAN
MISS.
DEVONIAN
SILURIAN
ORDOVICIAN
EXPLANATION
Woodford
McKee
RESERVOIR FLUIDS
Gas
Oil
Water
HORIZONTAL SCALE
0
1
2
3
4
5
THOUSAND FEET

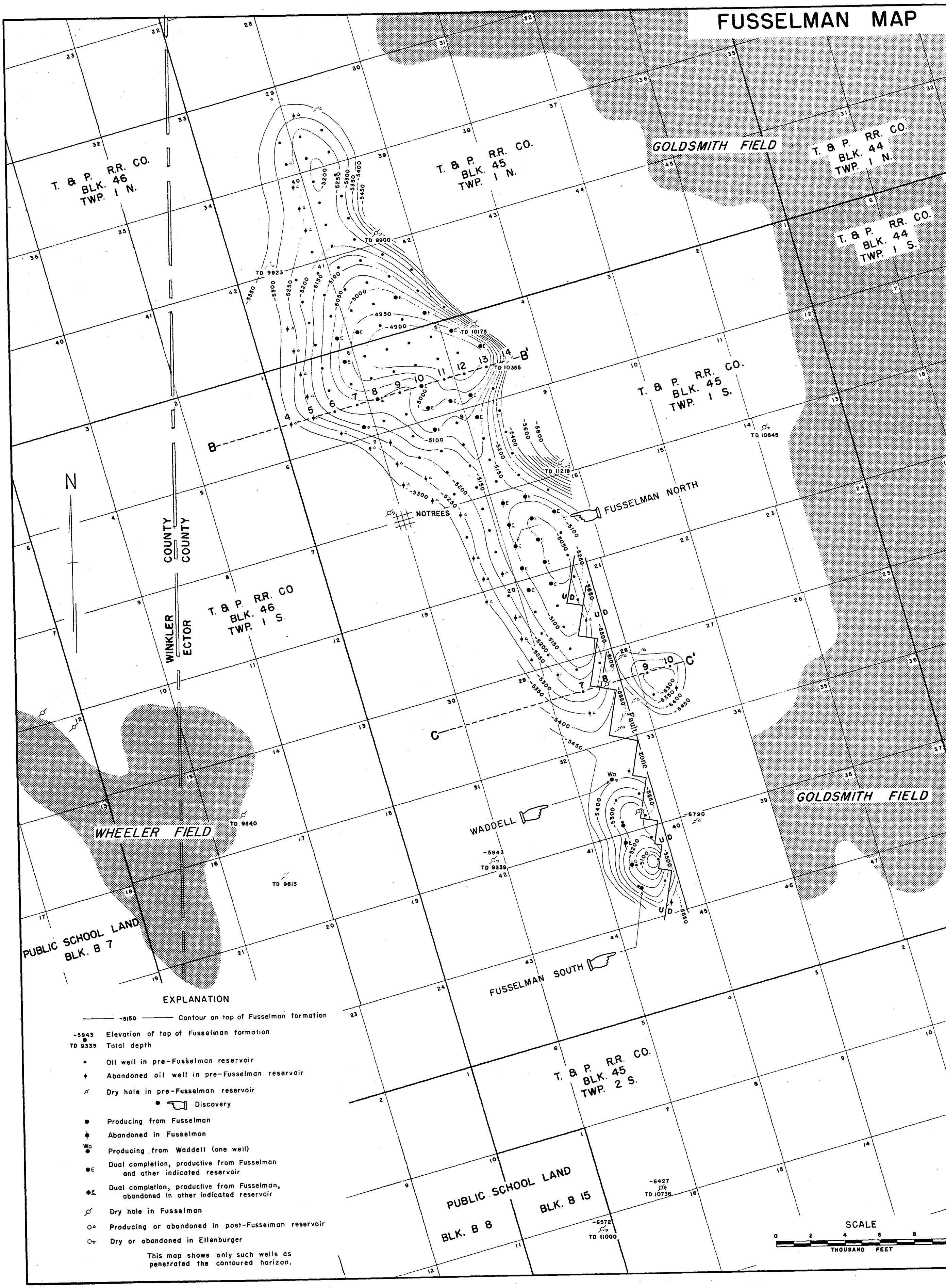


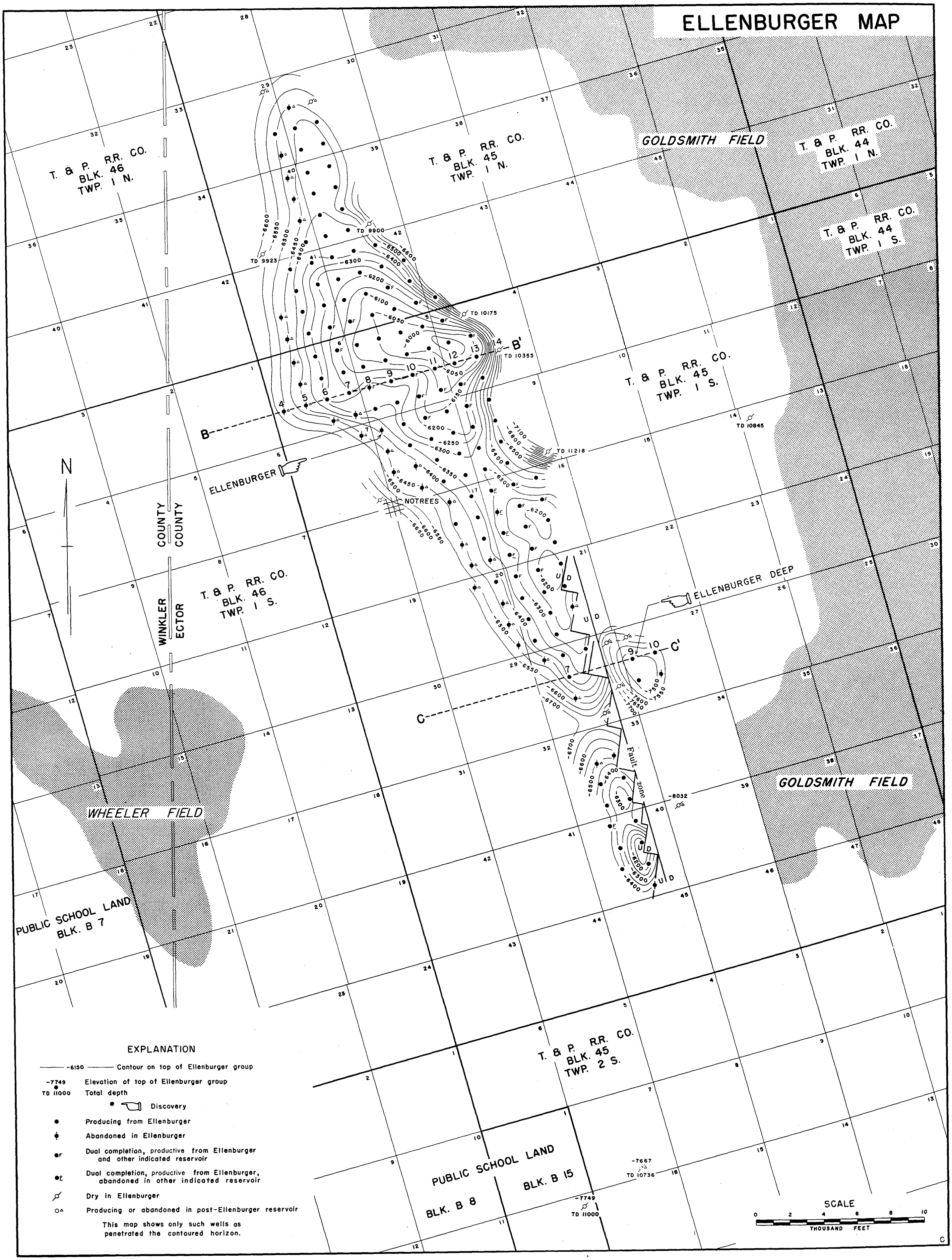
DEVELOPMENT MAP
ENLARGEMENT OF AREA INDICATED ON OPPOSITE PAGE
N
ELLENBURGER DEEP
WADDELL
UPPER CLEAR FORK
FUSSELMAN SOUTH
T. & P. RR. CO.
BLK. 45
TWP. 1 S.
20
21
27
28
29
30
31
32
33
34
39
40
41
44
45
EXPLANATION
Oil well
Abandoned oil well
Dry hole
Discovery
Productive reservoir, abandoned in reservoir indicated by underlined symbol
Dual completion, productive from indicated reservoirs
Oldest reservoir tested, non-productive
PRODUCTIVE RESERVOIRS
Upper Clear Fork
Fusselman
Tubb
Waddell
Devonian
Ellenburger
SCALE
0
1
2
3
4
5
THOUSAND FEET


DEVELOPMENT MAP
T. & P. RR. CO. BLK. 46 TWP. 1 N.
T. & P. RR. CO. BLK. 45 TWP. 1 N.
GOLDSMITH FIELD
T. & P. RR. CO. BLK. 44 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 1 S.
ELLENBURGER
FIELD DEVONIAN
FUSSELMAN NORTH
WINKLER COUNTY
ECTOR COUNTY
T. & P. RR. CO. BLK. 46 TWP. 1 S.
SEE ENLARGEMENT ON OPPOSITE PAGE
ELLENBURGER DEEP
UPPER CLEAR FORK
WADDELL
WHEELER FIELD
GOLDSMITH FIELD
SAN ANDRES
PUBLIC SCHOOL LAND BLK. B 7
FUSSELMAN SOUTH
T. & P. RR. CO. BLK. 45 TWP. 2 S.
TUBB
JOHN W. MURCHISON #1 G.C. Fraser
PUBLIC SCHOOL LAND
BLK. B 8
BLK. B 15
WOLFCAMP
SCALE
0 2 4 6 8 10
THOUSAND FEET
EXPLANATION
Oil well
Abandoned oil well
Dry hole
Discovery
Productive reservoir, abandoned in reservoir indicated by underlined symbol
Dual completion, productive from indicated reservoirs
Completed in Wolfcamp, temporarily abandoned
Oldest reservoir tested, non-productive
Dry hole, San Andres not reached
PRODUCTIVE RESERVOIRS
S San Andres
C Upper Clear Fork
T Tubb
Wc Wolfcamp
D Devonian
F Fusselman
Wa Waddell
E Ellenburger


UPPER CLEAR FORK MAP
GOLDSMITH FIELD
T. & P. RR. CO. BLK. 46 TWP. 1 N.
T. & P. RR. CO. BLK. 45 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 1 S.
T. & P. RR. CO. BLK. 46 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 2 S.
NOTREES
WINKLER COUNTY
ECTOR COUNTY
WHEELER FIELD
GOLDSMITH FIELD
PUBLIC SCHOOL LAND BLK. B 7
PUBLIC SCHOOL LAND BLK. B 8 BLK. B 15
UPPER CLEAR FORK
SAN ANDRES
TUBB
WOLFCAMP
A
A'
EXPLANATION
-2150 Contour on top of Upper Clear Fork reservoir
Oil well in pre-Permian reservoir
Abandoned oil well in pre-Permian reservoir
Discovery
Producing from San Andres, abandoned in Upper Clear Fork (one well)
Producing from San Andres, dry in Upper Clear Fork (one well)
Producing from Upper Clear Fork
Producing from Upper Clear Fork, abandoned in Tubb (one well)
Producing from Tubb
Temporarily abandoned in Wolfcamp (one well)
Dry in Permian reservoir
Dry or abandoned in pre-Permian reservoir
This map shows only such wells as penetrated the contoured horizon.
SCALE
0 2 4 6 8 10
THOUSAND FEET
C


DEVONIAN MAP
GOLDSMITH FIELD
T. & P. RR. CO. BLK. 46 TWP. 1 N.
T. & P. RR. CO. BLK. 45 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 1 S.
T. & P. RR. CO. BLK. 46 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 2 S.
WINKLER COUNTY
ECTOR COUNTY
DEVONIAN FIELD
NOTREES
WHEELER FIELD
PUBLIC SCHOOL LAND BLK. B 7
PUBLIC SCHOOL LAND BLK. B 8 BLK. B 15
JOHN W. MURCHISON #1 G. C. Fraser -5430
Fault zone
EXPLANATION
-4720 Contour on Woodford-Devonian contact
-4620 Contour on eroded Devonian
SIL/DEV Contact at pre-Permian erosion surface
-5602 Elevation of top of Devonian
TD 11000 Total depth
Oil well in pre-Devonian reservoir
Abandoned oil well in pre-Devonian reservoir
Dry hole in pre-Devonian reservoir
Producing from Devonian
Abandoned in Devonian
Dual completion, productive from Devonian and Fusselman, Fusselman now abandoned (one well)
Dry in Devonian
Producing or abandoned in post-Devonian reservoir
Dry or abandoned in pre-Devonian reservoir
This map shows only such wells as penetrated the contoured horizon.
SCALE
0 2 4 6 8 10
THOUSAND FEET


FUSSELMAN MAP
GOLDSMITH FIELD
T. & P. RR. CO. BLK. 44 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 1 N.
T. & P. RR. CO. BLK. 46 TWP. 1 N.
T. & P. RR. CO. BLK. 45 TWP. 1 S.
T. & P. RR. CO BLK. 46 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 2 S.
WINKLER COUNTY
ECTOR COUNTY
N
NOTREES
FUSSELMAN NORTH
WADDELL
FUSSELMAN SOUTH
Fault zone
WHEELER FIELD
GOLDSMITH FIELD
PUBLIC SCHOOL LAND BLK. B 7
PUBLIC SCHOOL LAND
BLK. B 8
BLK. B 15
B
B'
C
C'
TD 9900
TD 9923
TD 10175
TD 10355
TD 11218
TD 10845
TD 9540
TD 9813
-5943 TD 9339
-6790
-6427 TD 10736
-6572 TD 11000
EXPLANATION
-5150 Contour on top of Fusselman formation
-5943 Elevation of top of Fusselman formation
TD 9339 Total depth
Oil well in pre-Fusselman reservoir
Abandoned oil well in pre-Fusselman reservoir
Dry hole in pre-Fusselman reservoir
Discovery
Producing from Fusselman
Abandoned in Fusselman
Wa Producing from Waddell (one well)
Dual completion, productive from Fusselman and other indicated reservoir
Dual completion, productive from Fusselman, abandoned in other indicated reservoir
Dry hole in Fusselman
Producing or abandoned in post-Fusselman reservoir
Dry or abandoned in Ellenburger
This map shows only such wells as penetrated the contoured horizon.
SCALE
0 2 4 6 8 10
THOUSAND FEET


ELLENBURGER MAP
T. & P. RR. CO. BLK. 46 TWP. 1 N.
T. & P. RR. CO. BLK. 45 TWP. 1 N.
GOLDSMITH FIELD
T. & P. RR. CO. BLK. 44 TWP. 1 N.
T. & P. RR. CO. BLK. 44 TWP. 1 S.
T. & P. RR. CO. BLK. 45 TWP. 1 S.
T. & P. RR. CO. BLK. 46 TWP. 1 S.
WINKLER COUNTY
ECTOR COUNTY
N
ELLENBURGER
NOTREES
ELLENBURGER DEEP
Fault zone
B
B'
C
C'
WHEELER FIELD
GOLDSMITH FIELD
PUBLIC SCHOOL LAND BLK. B 7
T. & P. RR. CO. BLK. 45 TWP. 2 S.
PUBLIC SCHOOL LAND
BLK. B 8
BLK. B 15
TD 9900
TD 9923
TD 10175
TD 10355
TD 10845
TD 11218
-8032
-7667 TD 10736
-7749 TD 11000
EXPLANATION
-6150 Contour on top of Ellenburger group
-7749 TD 11000 Elevation of top of Ellenburger group Total depth
Discovery
Producing from Ellenburger
Abandoned in Ellenburger
Dual completion, productive from Ellenburger and other indicated reservoir
Dual completion, productive from Ellenburger, abandoned in other indicated reservoir
Dry in Ellenburger
Producing or abandoned in post-Ellenburger reservoir
This map shows only such wells as penetrated the contoured horizon.
SCALE
0 2 4 6 8 10
THOUSAND FEET

WATER PRODUCTION

Year	Upper Clear Fork (a)	Upper Clear Fork (b)	Tubb (a)	Tubb (b)	Devonian (a)	Devonian (b)	Fusselman South (a)	Fusselman South (b)	Ellenburger (a)	Ellenburger (b)	Ellenburger Deep (a)	Ellenburger Deep (b)
1945					1	265						
1946	4	363			3	6,115			1	90,278		
1947	13	7,034			10	39,080			4	143,515		
1948	18	26,089			19	107,190	1	7,058	28	1,783,170	2	5,895
1949	39	64,170			24	133,082	1	14,542	42	4,187,904	2	10,378
1950	40	54,022			40	91,498	2	6,378	38	2,704,935	4	97,251
1951	82	59,275	24	22,579	34	74,984	2	14,546	47	2,421,019	4	213,834
1952	106	76,611	26	33,320	43	96,515	2	9,873	46	1,656,070	4	153,613
1953	105	92,760	25	17,878	39	103,266	2	20,983	44	2,056,717	3	127,419

(a) Number of wells producing water. (b) Number of barrels of water produced.

San Andres: One of the two wells completed in the San Andres reservoir produced 1,825 barrels of water during 1953.

Upper Clear Fork: Most wells have produced small and varying amounts of water from date of completion. The water does not come from any particular level or zone; it appears to be very closely associated with the oil throughout the producing layers.

Wolfcamp: Only two wells have been completed in the Wolfcamp reservoir. During 1946, the first of these wells produced 970 barrels of oil and 4,000 barrels of water and was abandoned. The other well has produced water as follows: during 1947, 4,198 barrels; during 1948, 4,414 barrels; during 1949, 4,696 barrels. Since 1949, neither oil nor water has been produced.

Fusselman North: During 1952, 4 wells produced 102,466 barrels of water and during 1953, 15 wells produced 189,775 barrels of water.

Waddell: No water has been produced by the one well completed in the Waddell reservoir.

WATER ANALYSES

Milligrams per liter

Constituent	Upper Clear Fork	Devonian	Fusselman South	Fusselman North (a)	Fusselman North (b)*	Ellenburger	Ellenburger Deep
Calcium	13,147	10,136	8,450	8,081	2,908	1,713	209
Magnesium	609	2,260	313	1,373	539	577	343
Sodium	70,856	52,787	41,775	38,013	21,075	13,807	9,875
Bicarbonate	134	329	122	61	396	1,070	646
Carbonate	0	0	0	0	0	0	0
Sulphate	951	1,216	1,363	1,777	2,453	93	2,002
Chloride	133,527	104,664	79,200	75,566	37,020	25,312	14,742
Totals	219,224	171,292	131,223	124,871	64,391	42,572	27,817

* Fusselman North type (b) water was produced in the extreme north part of the field.

PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Wells producing at end of year: Artif. lift.	Oil production (barrels): Yearly	Oil production (barrels): Cumulative	Gas production (Mcf): Yearly	Gas production (Mcf): Cumulative
Field totals						
1944	1	0	400	400	349	349
1945	53	0	773,868	774,268	829,529	829,878
1946	163	4	5,145,384	5,919,652	5,153,691	5,983,569
1947	256	13	16,925,854	22,845,506	15,887,737	21,871,306
1948	273	45	24,026,931	46,872,437	24,975,244	46,846,550
1949	295	69	16,350,198	63,222,635	19,520,339	66,366,889
1950	281	107	13,539,190	76,761,825	22,756,997	89,123,886
1951	275	152	15,601,293	92,363,118	28,099,366	117,223,252
1952	276	181	13,099,477	105,462,595	29,937,472	147,160,724
1953	231	229	11,291,718	116,754,313	29,862,333	177,023,057
San Andres						
1952	1	1	3,616	3,616	1,172	1,172
1953	1	1	3,425	7,041	1,114	2,286

PRODUCTION HISTORY (Continued)

Year	Wells producing at end of year: Flowing	Wells producing at end of year: Artif. lift.	Oil production (barrels): Yearly	Oil production (barrels): Cumulative	Gas production (Mcf): Yearly	Gas production (Mcf): Cumulative
Upper Clear Fork						
1946	6	0	17,580	17,580	22,242	22,242
1947	12	4	135,764	153,344	133,445	155,687
1948	13	18	305,479	458,823	447,880	603,567
1949	39	27	686,116	1,144,939	914,462	1,518,029
1950	52	47	1,069,647	2,214,586	2,354,559	3,872,588
1951	49	57	1,207,152	3,421,738	2,958,399	6,830,987
1952	52	76	1,078,831	4,500,569	3,439,015	10,270,002
1953	42	94	994,616	5,495,185	3,918,619	14,188,621
Tubb						
1950	2	0	2,504	2,504	1,052	1,052
1951	6	18	257,665	260,169	266,291	267,343
1952	7	20	296,258	556,427	416,111	683,454
1953	5	21	236,587	793,014	613,984	1,297,438
Wolfcamp						
1946	0	1	970	970	0	0
1947	0	1	3,895	4,865	0	0
1948	0	1	2,224	7,089	0	0
1949	0	1	1,743	8,832	340	340
1950-1953	0	0	0	8,832	0	340
Devonian						
1944	1	0	400	400	349	349
1945	42	0	621,036	621,436	644,197	644,546
1946	82	3	2,688,204	3,309,640	2,537,384	3,181,930
1947	101	8	5,521,465	8,831,105	4,681,807	7,863,737
1948	108	20	7,940,282	16,771,387	8,328,716	16,192,453
1949	114	24	5,378,371	22,149,758	7,671,992	23,864,445
1950	104	33	4,274,684	26,424,442	11,482,469	35,346,914
1951	98	45	4,385,751	30,810,193	15,344,047	50,690,961
1952	82	63	2,903,357	33,713,550	16,163,191	66,854,152
1953	71	74	2,304,842	36,018,392	15,453,264	82,307,416
Fusselman South						
1946	1	0	2,044	2,044	1,962	1,962
1947	1	0	60,492	62,536	38,353	40,315
1948	3	1	112,623	175,159	98,594	138,909
1949	1	2	127,467	302,626	135,813	274,722
1950	0	3	60,625	363,251	105,426	380,148
1951	0	3	46,648	409,899	99,763	479,911
1952	1	2	16,847	426,746	175,753	655,664
1953	0	2	24,179	450,925	170,441	826,105
Fusselman North						
1951	4	0	10,245	10,245	6,923	6,923
1952	19	0	673,207	683,452	941,447	948,370
1953	15	7	591,583	1,275,035	1,623,452	2,571,922
Waddell						
1953	1	0	3,739	3,739	10,314	10,314
Ellenburger						
1945	11	0	152,832	152,832	185,332	185,332
1946	73	0	2,367,810	2,520,642	2,555,525	2,740,857
1947	139	0	11,025,148	13,545,790	10,934,550	13,675,407
1948	145	5	15,422,473	28,968,263	15,983,155	29,658,562
1949	139	13	10,041,961	39,010,224	10,734,966	40,393,528
1950	124	21	8,077,733	47,017,957	8,737,709	49,131,237
1951	117	26	9,598,298	56,616,255	9,385,953	58,517,190
1952	110	19	8,071,428	64,687,683	8,761,860	67,279,050
1953	96	27	7,086,991	71,774,674	8,038,354	75,317,404
Ellenburger Deep						
1946	1	0	68,776	68,776	36,578	36,578
1947	3	0	179,090	247,866	99,582	136,160
1948	4	0	243,850	491,716	116,899	253,059
1949	2	2	114,540	606,256	62,766	315,825
1950	1	3	123,997	730,253	75,782	391,607
1951	1	3	95,534	825,787	37,990	429,597
1952	4	0	55,933	881,720	38,923	468,520
1953	0	3	45,756	927,476	32,791	501,311

VERHALEN FIELD

Reeves County, Texas

EDWARD R. KENNEDY, Jr.
Geologist, Argo Oil Corporation, Midland, Texas
June 10, 1954

LOCATION

The Verhalen field (one well, now abandoned) is in southeastern Reeves County, 23 miles south of Pecos and 13 miles northeast of Balmorhea.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Gravity and magnetic surveying.

DISCOVERY

Wolfcamp: July 23, 1947;
Argo Oil Corporation #1 Dora Roberts.

ELEVATION OF SURFACE

The surface at the location of the one well is 2,870 feet above sea level. The depths indicated on the accompanying SECTION OF ROCKS PENETRATED were measured from derrick floor at the elevation of 2,880 feet.

SURFACE FORMATION

Undifferentiated rocks of the Comanche series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the one well in the field is about 500 feet below the top of the Canyon series, as indicated by the accompanying graphic section.

NATURE OF TRAP

Wolfcamp: Data for determining nature of trap are not available.

PRODUCTIVE AREA

Wolfcamp: Approximately 40 acres.

THICKNESS OF RESERVOIR ROCK

Wolfcamp: Thin beds of possible reservoir rock are scattered throughout 818 feet of section. The aggregate thickness of beds having appreciable shows of oil is approximately 90 feet. Completion of the productive well was effected from the entire 818-foot section, but drill-stem tests indicated that most of the oil came from a 30-foot section between the depths of 10,699 and 10,729 feet.

LITHOLOGY OF RESERVOIR ROCK

Wolfcamp: The reservoir rock consists of (a) scattered thin layers of hard brownish-gray sandy limestone, (b) hard brownish-gray sandy limestone breccia, and (c) gray fine-grained sandstone interbedded with gray to black silty shale and dark-brown silty argillaceous limestone. Vertical fractures are scattered throughout this section and it is possible that they constitute a considerable portion of the reservoir. There appears to be no bed with a high degree of porosity.

CONTINUITY OF RESERVOIR ROCK

Wolfcamp: Data are not available for determining the continuity of the several thin beds which were productive in the one well. Good shows of oil and gas have been found at approximately the same stratigraphic positions at other wells in the Delaware basin, but whether the beds are continuous between such wells is not determinable.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Wolfcamp:	Feet
Elevation of top of oil	-7,058
Elevation of bottom of oil	-7,876
Relief	818

Scattered shows of oil were found throughout the above indicated section and the well was completed for production from the entire section.

CHARACTER OF OIL

Wolfcamp: Gravity, A.P.I. @ 60° F., 43.3°

WATER PRODUCTION

Wolfcamp: Water constituted about 10% of the initial gross production, which was at the daily rate of 71 barrels of oil and 10 barrels of water.

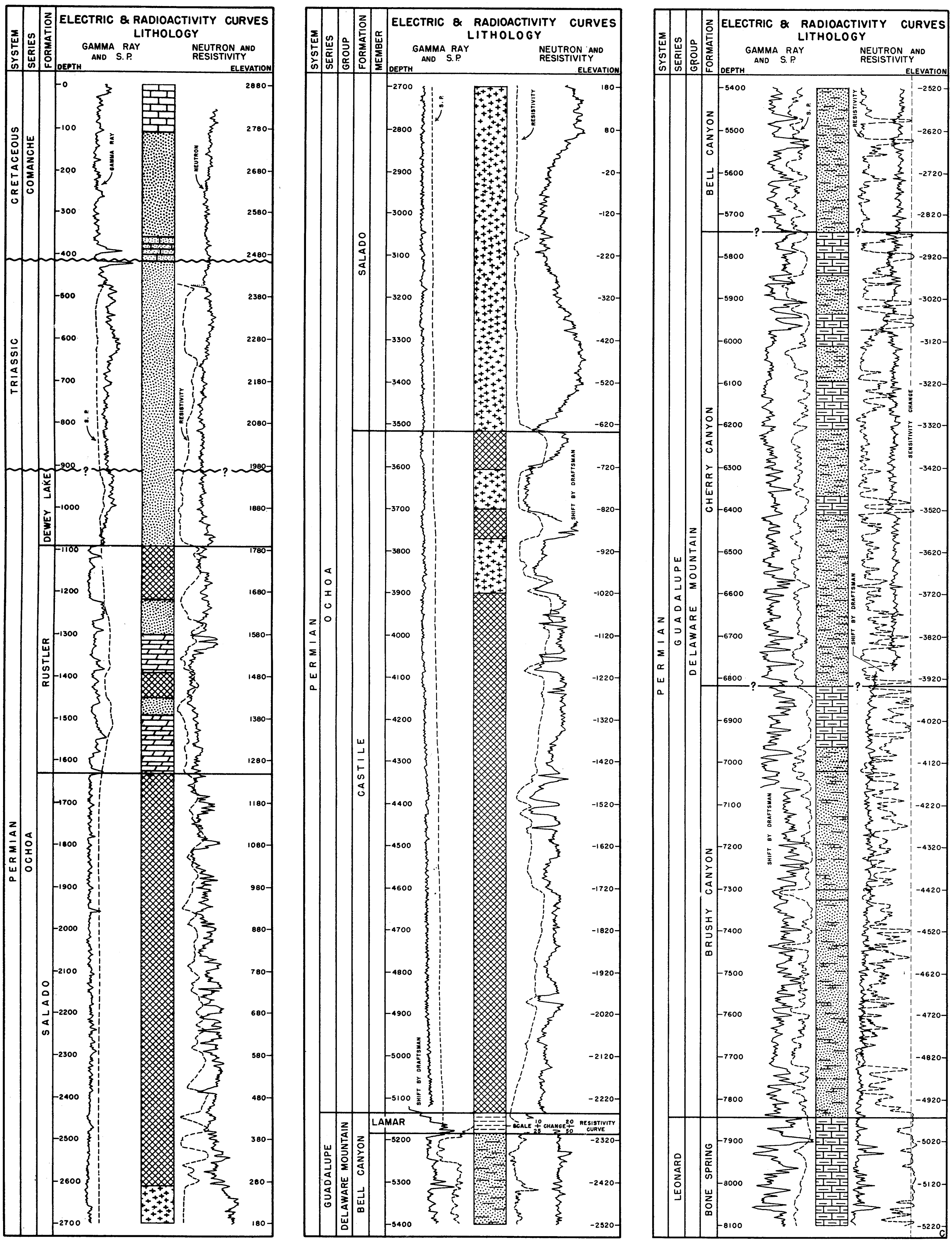
ACID TREATMENT

Wolfcamp: The reservoir rock was treated with 7,000 gallons of acid.

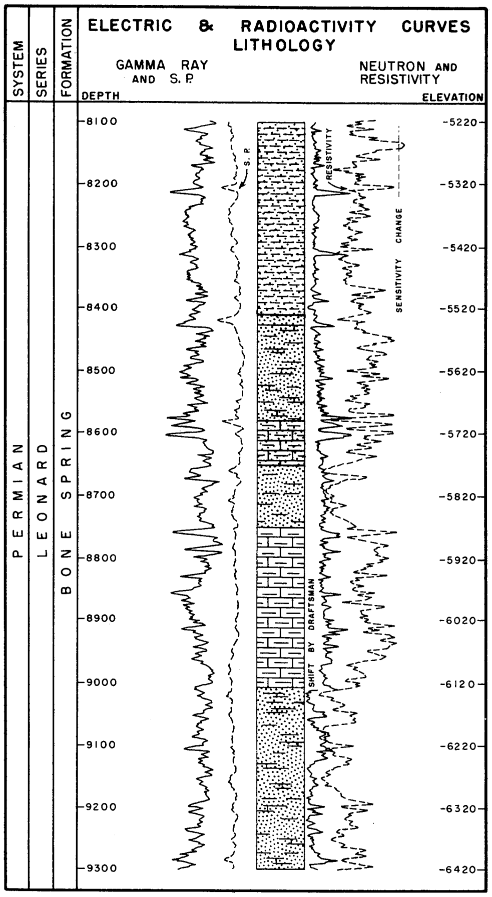
PRODUCTION HISTORY

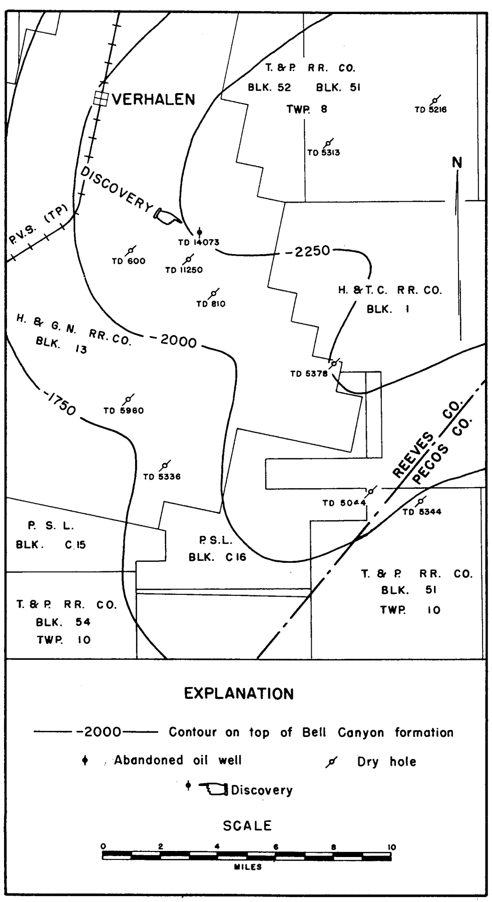
Wolfcamp: The one well flowed 2,722 barrels of oil during 1947 and 1,462 barrels during 1948; total, 4,184 barrels. The last reported production was in October 1948.

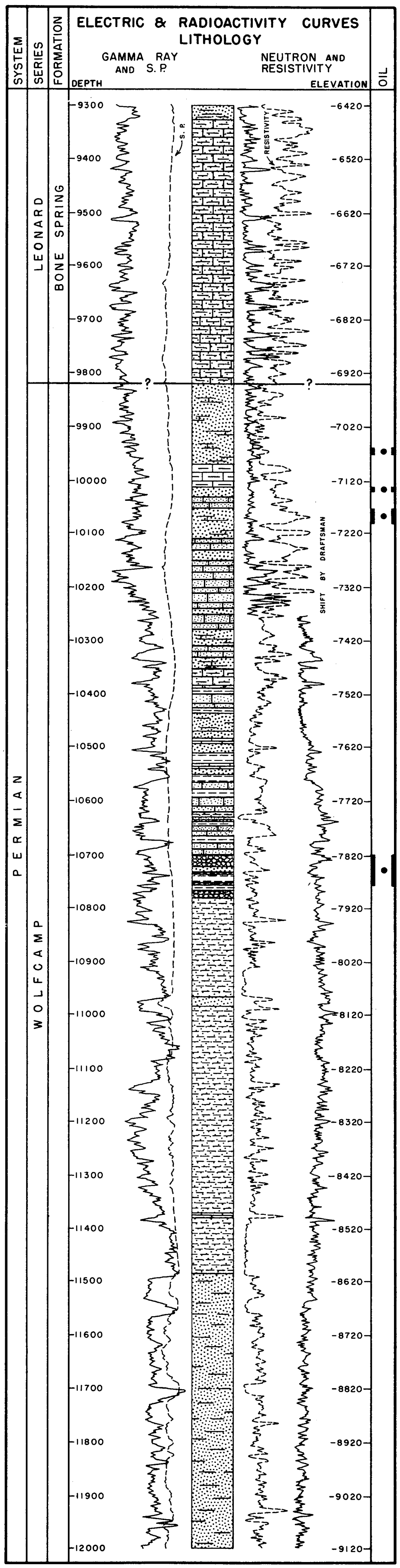
TYPICAL SECTION OF ROCKS PENETRATED

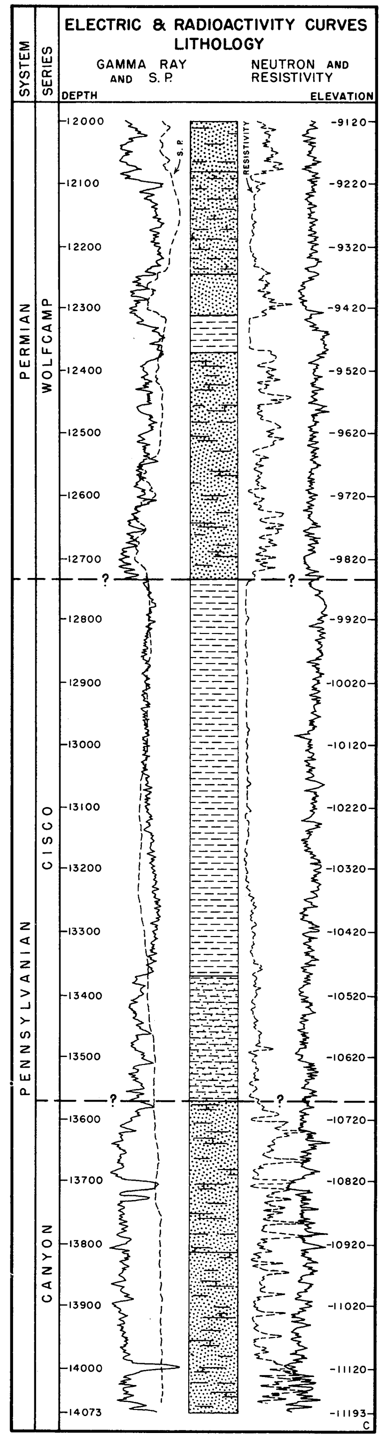


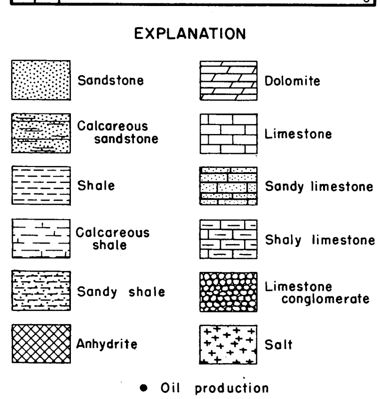
TYPICAL SECTION OF ROCKS PENETRATED











VON ROEDER FIELD

Borden County, Texas

WILLIAM B. ELLIS
Geologist, Carlton Beal & Associates, Midland, Texas
May 26, 1953

LOCATION and FIELD NAMES

The Von Roeder field is in extreme southeast Borden County about 19 miles southwest of Snyder, county seat of Scurry County. It is in the southeast arc of the major Pennsylvanian reef trend in the northern portion of the Midland basin.

There are two separate productive areas in the area herein treated as the Von Roeder field. The Railroad Commission of Texas designates the entire area as the Von Roeder field. Some operators differentiate by designating the northern productive area as the Von Roeder field and the southern productive area as the South Von Roeder field.

With the exception of one well in the southern area producing from a local reservoir in the Clear Fork group, all production is from reef limestone, mainly of Cisco and Canyon age. Although the Cisco-Canyon reservoir in the northern area is at the same general stratigraphic position as the Cisco-Canyon reservoir in the southern area, the two reservoirs are separate and distinct. There are five dry holes between them and there is a 25-foot difference in elevation of water table, and, furthermore, there is an appreciable difference in reservoir pressure. In the absence of recognized names for the three reservoirs, the following paragraph headings, taken into consideration with the accompanying TYPICAL SECTION, should serve to facilitate an accurate understanding of the significant data pertaining to the field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Location of the discovery well was based on a reflection seismic survey in an area where subsurface data indicated a major reef trend.

DISCOVERIES

Clear Fork: February 7, 1952;
Magnolia Petroleum Co. #6 W.E.Murphy. This is the only well completed in this reservoir.

Cisco-Canyon North and Field: December 16, 1949;
Amerada Petroleum Corp. #1 N.C.Von Roeder

Cisco-Canyon South: July 17, 1950;
P.R.Rutherford and Heep Oil Corp. #1 J.G.Davis

ELEVATION OF SURFACE

At well locations: Highest, 2,360 ft.; lowest, 2,220 ft.

SURFACE FORMATIONS

Recent alluvium and undifferentiated rocks of the Dockum group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is 25 feet below the top of the Ellenburger group. This penetration was in the dry hole in the northwest corner of Sec. 70, the total depth of which is 1,565 feet below the top of the Cisco series at this location.

NATURE OF TRAPS

Clear Fork: The accumulation is due to updip decrease of porosity and permeability in a sloping reservoir rock. The inclination of the reservoir rock is probably due to slight initial slope at time of deposition on the flank of a reef and to differential compaction of sediments below this reservoir rock.

Cisco-Canyon: Each of the two main accumulations in the Von Roeder field is due to a convex upper limit of reef limestone which is covered by relatively impervious black shale and claystone. The form of each trap has been determined by reef growth. There appears to be no warping due to tectonic movements of rocks below the reef limestone.

PRODUCTIVE AREAS

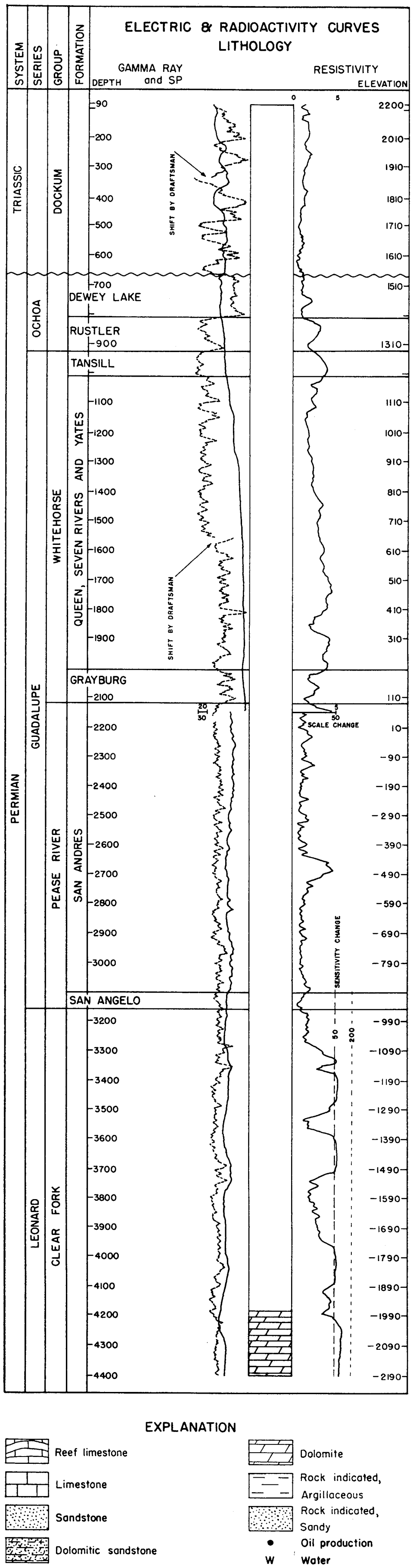
	Acres
Clear Fork	160*
Cisco-Canyon North	1,160
Cisco-Canyon South	960
Von Roeder field	2,120

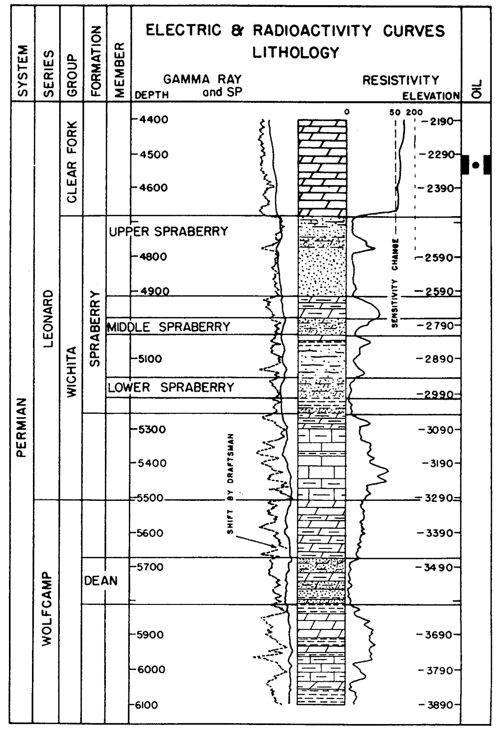
* It is probable that future development will warrant increasing the estimate for Clear Fork.

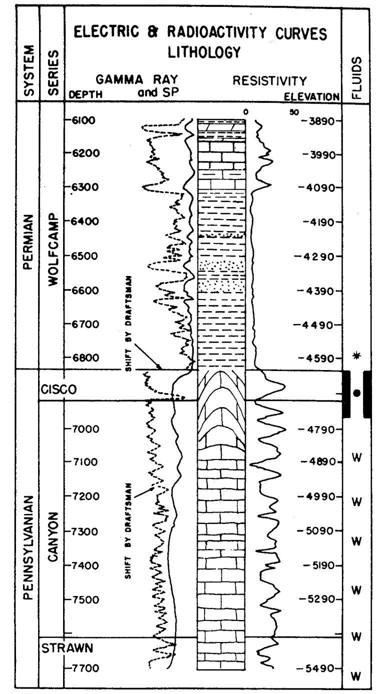
THICKNESSES OF RESERVOIR ROCKS

	Feet	
Clear Fork:	Max.	Min.
From top to bottom	50	50
Net productive	35	35
Cisco-Canyon North:		
From top to bottom	85	11
Net productive	39	5
Cisco-Canyon South:		
From top to bottom	157	10
Net productive	81	4

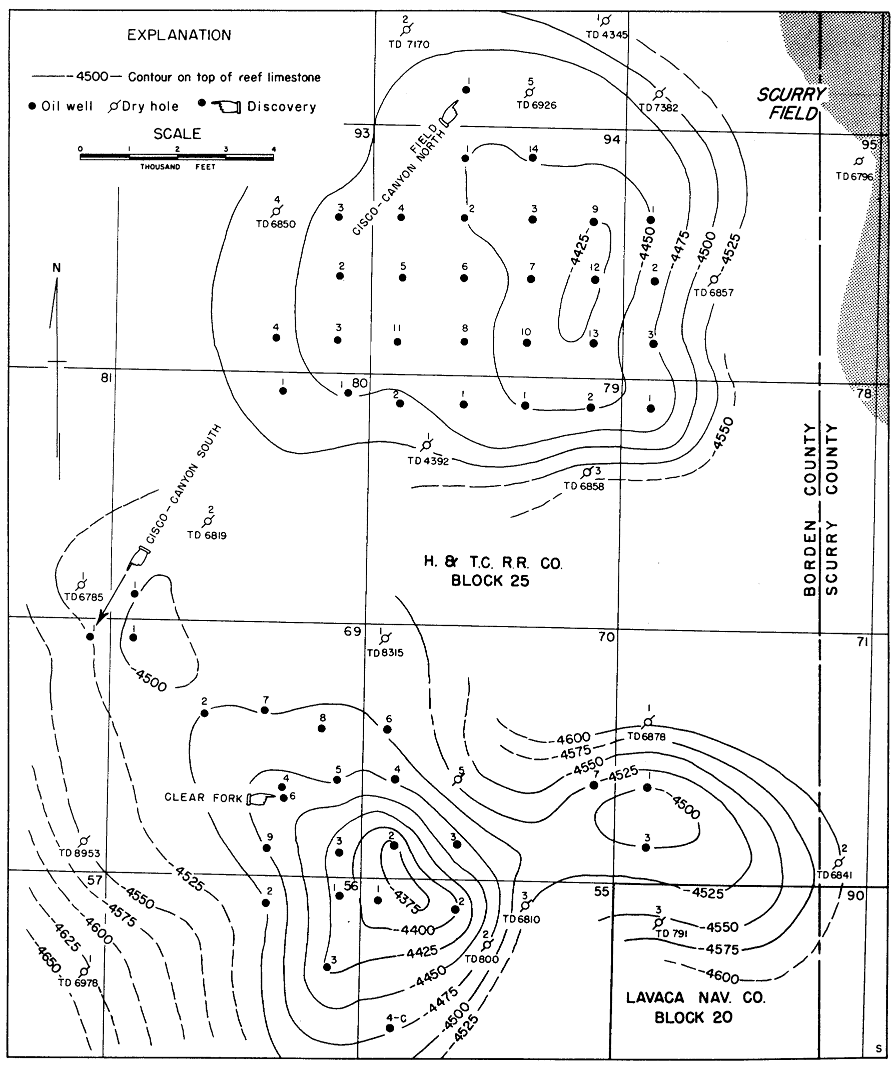
TYPICAL SECTION OF ROCKS PENETRATED







* In a few wells on the reef highs, the top few feet of productive limestone is probably Wolfcamp in age.



LITHOLOGY OF RESERVOIR ROCKS

Clear Fork: Dolomite; dark brown to buff, finely crystalline; minor streaks are siliceous, medium crystalline and contain anhydrite inclusions.

Cisco-Canyon: Reef limestone; buff to gray, fine to medium crystalline with dominantly secondary vuggy porosity and containing minor lenses of black bituminous shale and claystone.

CONTINUITY OF RESERVOIR ROCKS

Clear Fork: The stratigraphic equivalent of the rock which produces in the Clear Fork discovery well has been penetrated at the location of every well and dry hole (except for two dry holes less than 1,000 feet deep) within the area covered by the accompanying map. There have been shows of oil at this stratigraphic position, particularly in wells in the vicinity of the discovery well, but in no other well has there been a showing sufficiently promising to warrant completion for production under the conditions then existing. The stratigraphic unit is continuous throughout the area of the field, but porosity and permeability adequate for commercial production have been found in the vicinity of the discovery well only.

Cisco-Canyon: The two productive areas are on two distinct knobs on the same general reef. Water occupies the reef limestone interstices below -4,500 feet in the northern area and below -4,525 feet in the southern area, thus making two distinct productive areas. The same general reef is continuous northeastward through Scurry County and southeast on an arc which crosses the southeast corner of Borden County, turns northward in Howard County and swings northwest across the southwest corner of Borden County and into Dawson County. Within the area of the accompanying map, at only 7 locations where the Cisco-Canyon reef limestone has been penetrated above the respective water table have porosity and permeability been found too low for commercial production.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Clear Fork	Cisco-Canyon North	Cisco-Canyon South
No free gas cap			
Elevation of top of oil, ft.	-2,020	4,420	-4,370
Elevation of bottom of oil, ft.	-2,070	4,500	-4,525
Relief, feet	50	80	155

CHARACTER OF GAS

Clear Fork:
No commercial gas; quantity insufficient for gas-oil ratio test.

Cisco-Canyon:

Specific gravity,	.98
Gasoline,	1.26 gallons per Mcf
Heating value,	1,555 B.t.u./cf

CHARACTER OF OIL

Clear Fork:	
Gravity, A.P.I. @ 60° F.	24.3°
Cisco-Canyon:	
Gravity, A.P.I. @ 60° F.	41.7°
Sulphur	0.26%
Color	Dark green
Viscosity, Saybolt Universal @ 100° F.	45 sec.

For analyses see:
U. S. Bureau of Mines Lab. ref. No. 50035
Analyses of Crude Oils From Some West Texas Fields.
R. I. 4959 (1953) Item 69

WATER PRODUCTION

Clear Fork: Negligible.

Cisco-Canyon: With exceptions due to minor water encroachment in edge wells, water production is negligible.

ACID TREATMENT

Clear Fork: The only well was treated with 2,000 gallons of acid.

Cisco-Canyon: Many wells have been completed without acid treatment; others have been treated with acid in quantities varying from 500 to 7,500 gallons.

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year Flowing	Pumping	OIL PRODUCTION (barrels) Yearly	Cumulative
Field totals				
1949	1	0	1,182	1,182
1950	14	1	185,948	187,130
1951	36	2	1,238,858	1,425,988
1952	43	7	1,284,728	2,710,716
Clear Fork				
1952	0	1	25,613	25,613
Cisco-Canyon North				
1949	1	0	1,182	1,182
1950	11	1	151,524	152,706
1951	27	2	975,340	1,128,046
1952	25	4	808,446	1,936,492
Cisco-Canyon South				
1950	3	0	34,424	34,424
1951	9	0	263,518	297,942
1952	18	2	450,669	748,611

GAS PRODUCTION: The only gas production has been incidental to oil production. The quantities produced have been minor.

WAPLES - PLATTER FIELD

Yoakum County, Texas

C. G. COOPER and B. J. FERRIS
Geologists, Shell Oil Co., Midland, Texas
January 1, 1953

LOCATION

The Waples-Platter field is near the center of the southeast quarter of Yoakum County about 8 miles southeast of Plains, the county seat. It is between the Wasson and Ownby fields on the North Basin platform of the Northwestern Shelf area. Wasson, Waples-Platter and Ownby appear to constitute one continuously productive area and could logically be considered as one field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Reflection seismograph and interpretation of subsurface data.

DISCOVERY

San Andres: June 3, 1939;
Shell Oil Co. #1 Waples-Platter

ELEVATION OF SURFACE

At well locations: Highest, 3,585 ft.; lowest, 3,525 ft.

SURFACE FORMATION

Caliche and surface sand overlying Ogallala sand.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the San Andres group 640 feet below its top.

NATURE OF TRAP

Anticlinal fold

PRODUCTIVE AREA

San Andres and Field: 880 acres.

THICKNESS OF RESERVOIR ROCK

San Andres: From stratigraphic position of highest production to stratigraphic position of lowest production: Average, 65 feet.

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomitic limestone; gray, tan and brown, compact to saccharoidal, fine-grained, cherty. The porosity and permeability are quite variable both vertically and horizontally. The extent of the portion of the San Andres formation constituting the reservoir rock is determined by the stratigraphic range of rock sufficiently porous to yield oil into the wells. Since the porosity is so variable, a large portion of the reservoir rock is not productive.

CONTINUITY OF RESERVOIR ROCK

San Andres: The lithologic unit considered as reservoir rock is continuous throughout the area of the field; the porosity within the unit is quite variable. Generally at the apex of the structural fold, the stratigraphically higher portion of the reservoir rock is sufficiently porous to yield oil, whereas downdip that portion is non-porous and impermeable; at lower structural positions, the porosity is lower in the section.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

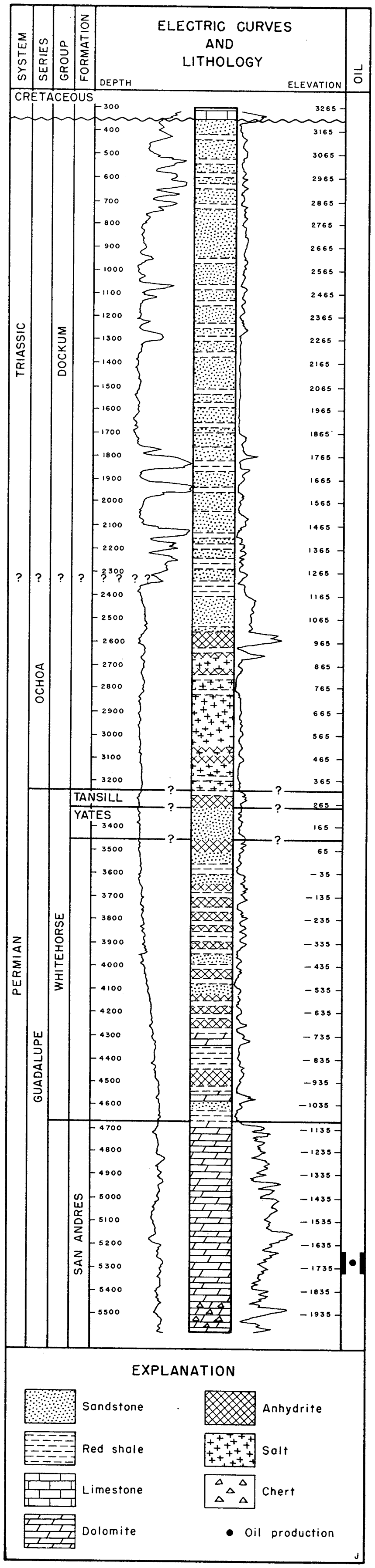
San Andres:	Feet
No free gas	
Elevation of highest known oil	-1,670 (?)
Elevation of bottom of oil	-1,720 to 1,760 (?)
Known relief	90

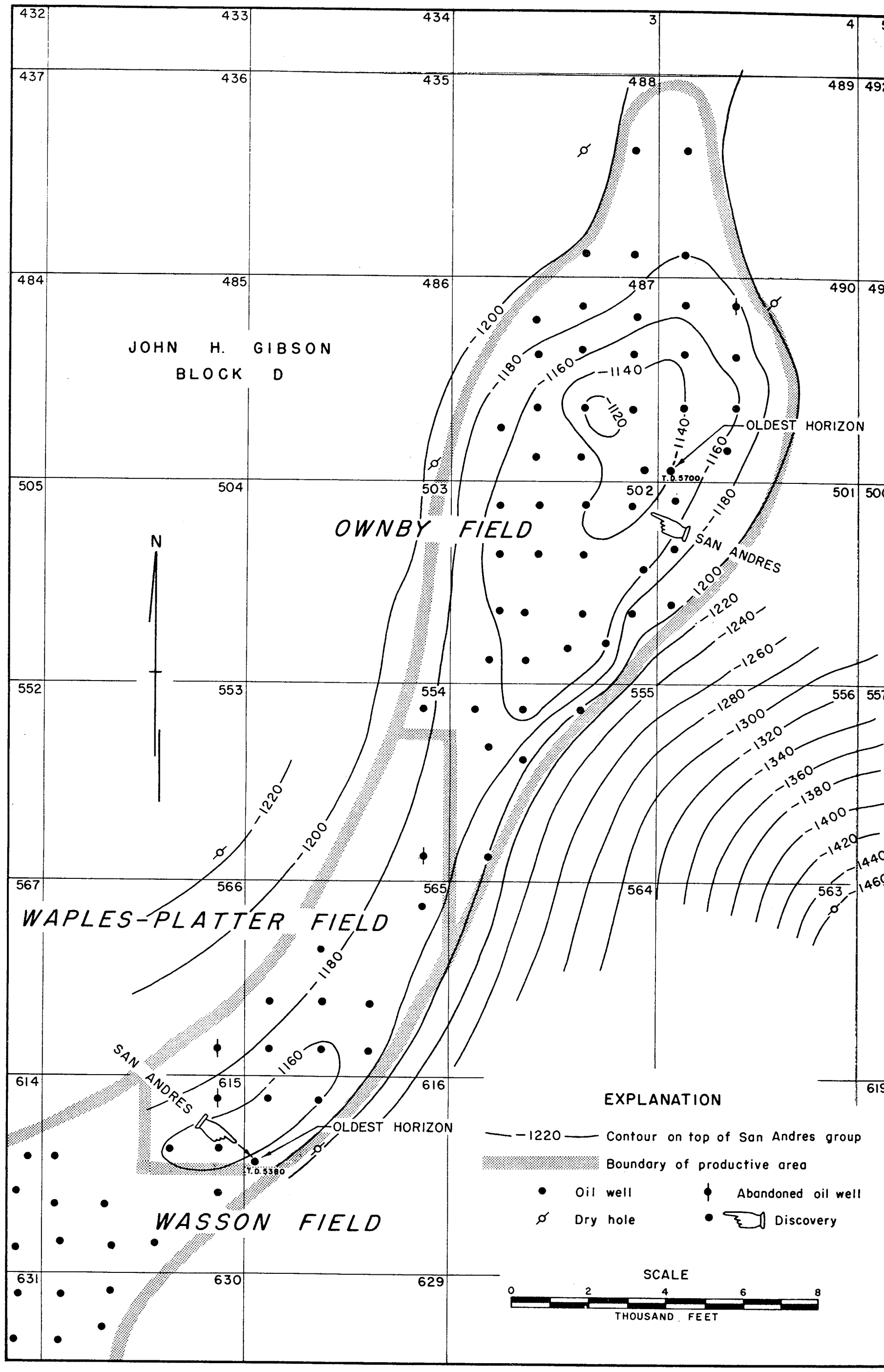
It appears that at the time of discovery of this field, the oil-water contact at the south end was at the elevation of -1,720 feet and that the contact sloped regularly northward to -1,830 feet at the north end of the Ownby field.

CHARACTER OF OIL

San Andres:	
Gravity, A.P.I. @ 60° F.	Average 29.9°
Sulphur, by weight:	2.26%
Color:	Dark green

TYPICAL SECTION OF ROCKS PENETRATED





WATER PRODUCTION

San Andres: Most of the wells have produced water either at completion or soon thereafter. At the end of 1952, only 2 of the 13 wells were producing no water; water constituted 2% to 64% of the gross production of the other 11 wells.

An analysis of the water shows milligrams of constituents per liter of water as follows: calcium, 3,900; magnesium, 2,190; sodium, 45,150; bicarbonate, 573; carbonate, none; sulphate, 3,240; chloride, 80,180; total, 135,233.

ACID TREATMENT

San Andres: All wells were treated with acid at time of completion. Treatments, in either one or two stages, ranged from 500 gallons to 15,000 gallons.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1939	0	1	9,244	9,244
1940	1	1	14,396	23,640
1941	1	1	17,804	41,444
1942	3	1	22,318	63,762
1943	3	3	32,992	96,754
1944	2	12	54,210	150,964
1945	1	14	77,607	228,571
1946	0	15	73,856	302,427
1947	0	14	65,590	368,017
1948	0	14	64,007	432,024
1949	0	14	50,024	482,048
1950	0	14	48,244	530,292
1951	0	14	55,144	585,436
1952	0	13	51,070	636,506
1953*	0	13	48,790	685,296

*1953 data added by amendment.

WASSON FIELD

Yoakum and Gaines Counties, Texas

W. T. SCHNEIDER
Manager of Exploration, Mid-Continent Division,
Honolulu Oil Corporation, Midland, Texas
January 1, 1955

LOCATION

The Wasson field occupies a triangular area mainly in southwestern Yoakum County with the southward corner extending into northwest Gaines County. The most western wells are about 4 miles from the Texas-New Mexico state boundary. From the standpoint of regional structure, the field is on the North Basin platform near its southern edge.

HISTORY and FIELD NAMES

For economic reasons (primarily, lack of pipeline outlet), completion of the field discovery well was not followed immediately by further drilling activity. Development proceeded slowly, as indicated by numbers of wells reported in the following PRODUCTION HISTORY. Wells within the present area of the field but at considerable distances from the field discovery well were considered as discovering new fields. Drilling activity centered around each of several outlying wells. Each productive area was designated by a separate field name; the first was the Bennett field; the second, the Wasson field and the third, the Denver field. As development proceeded, and additional areas were designated as fields, and as it became evident that the productive areas merge, the several field names lost their status as field names but were continued in use as sector names. For regulation purposes, on December 1, 1939, the Railroad Commission consolidated its rules and regulations applying to all sectors and designated the consolidated unit as the Wasson field. The names of Bennett, Denver, Roberts, Baumgart and Kendrick had temporary usage as field names and are used now to designate respective portions of the Wasson field. The name Wasson was applied to the second sector discovered and later was applied to the field as a whole. To avoid confusion, the sector originally designated as the Wasson field became identified as the South sector. As indicated on an accompanying map, the names Clawater and Dowden are also used to designate sectors of the field. The boundaries between the sectors are indefinite.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Studies of geological data afforded by previous drilling in the region and of data afforded by gravity and magnetic surveys led to the drilling of the field discovery well. Subsequent discovery wells and extension wells were located on the basis of subsurface data afforded by drilling and by data afforded by gravity, magnetic and seismic surveys.

DISCOVERIES

San Andres and Field: April 15, 1936;
Honolulu Oil Corp. & C.J.Davidson #1-678 L.P. Bennett (now Honolulu Oil Corp. & Cascade Petroleum Co. #1-678 L.P.Bennett).

Clear Fork 66: December 24, 1940;
A.G.Carter #5-D A.L.Wasson (now, Shell Oil Co. #5-D A.L.Wasson).

Clear Fork 72: December 20, 1941;
A.G.Carter #4-D A.L.Wasson (now, Shell Oil Co. #4-D A.L.Wasson).

Clear Fork Bennett: September 3, 1954;
Texas Pacific Coal & Oil Co. #55 Ruth Bennett 2-E Account.

ELEVATION OF SURFACE

As indicated by contours on an accompanying map, the surface slopes generally southeastward from an elevation of about 3,700 feet above sea-level on the west to about 3,520 feet on the east side of the field.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated is at the base of detrital sediments overlying granite. Within the productive area, the oldest stratigraphic horizon known to have been penetrated is in the Simpson group about 280 feet below its top. This penetration was in the well designated as Well (A) in the following tabulation under VARIATIONS IN THICKNESSES. This well was drilled 5 feet into granite. Only two other wells have been drilled into pre-Permian rocks. Data afforded by the three wells are presented in the above cited tabulation.

PRODUCTIVE AREAS

	Acres
San Andres	59,925
Clear Fork 66	1,000
Clear Fork 72	480
Clear Fork Bennett	80
Wasson field	59,950

THICKNESSES OF RESERVOIR ROCKS

	Feet		
From top to bottom, gross:	Min.	Max.	Avg.
San Andres	5	450	186
Clear Fork 66	98	621	362
Clear Fork 72	242	367	323
Clear Fork Bennett	80	137	108

SURFACE FORMATIONS

Recent caliche and wind-blown sands. Where there is a soil mantle, it is thin.

NATURE OF TRAPS

General: The trapping of fluids in each of the Permian reservoirs is occasioned by a balance of closely related regional, local, and temporal conditions that resulted in (1) a convex form of the upper extent of the reservoir rock, (2) local and regional variations in lithology and consequent porosity and permeability trapping, (3) volumetric ratio of fluids and permeable space, (4) geologic history. No single agency (such as structural attitude or lithological variations) can be isolated as the sole controlling factor. The geologic conditions cited are the result of (1) differential and regional subsidence of and around a pre-Permian uplift during the Permian period, (2) concurrent reef construction by chemical and organic processes around a subsiding pre-Permian high which not only kept abreast of the subsidence but slightly exceeded it on the eastern side of the field, where the maximum subsidence took place. Hence the present convex profile of the porous rocks of the Clear Fork and the San Andres reservoirs is the result of a negative process of downwarping and a concurrent constructive process of reef building. Progressive variations in the lithology of the reef facies from east to west account for variations in (1) well performance, (2) fluid contact elevations, and (3) reservoir thicknesses. The gross productive intervals of the Clear Fork reservoirs are much greater than that of the San Andres reservoir; however, the lower orders of permeability and porosity have made the Clear Fork reservoirs, thus far, less productive than the San Andres reservoir.

San Andres: The reservoir rock is thicker and has a higher degree of permeability in the eastern portion of the field where the maximum subsidence and the maximum reef development took place. The gas cap conforms to the highest structural position. Bottom waters do not conform to a sea-level datum, but are lower in the center and northern portions of the field. Along the eastern edge of the field the waters appear to occur along a stratigraphic position.

Clear Fork 66 and Clear Fork 72: The accumulation in each of these reservoirs appears to be controlled by a structural nose that may be due to reefing and differential movement; however, also permeability and porosity are trap-forming factors in the reef-like mass of dolomite.

Clear Fork Bennett: Insufficient data exist to determine the structural attitude of the reservoir rock. Rapid changes of permeability and porosity suggest a trap controlled by decrease of porosity and permeability to the west.

VARIATIONS IN THICKNESSES

Isopach maps between Permian markers show thinning in the areas where an accompanying map indicates the top of the San Andres as structurally high. With the exception of the post-Triassic beds, each stratigraphic unit above mid-San Andres shows some increment of thinning. The structural relief of the respective markers decreases from the lowest marker to the highest marker until, at the surface, the altitude of the beds shows only negligible deviation from the altitude due to regional tilt. However, the progressive westward migration of the structural axis, combined with the relatively strong eastward tilting, has, to a minor degree, masked the gradual upward thinning over the old structural axis.

Although only three wells have been drilled into pre-Permian rocks, it is evident that there are great variations in intervals between Permian and pre-Permian markers, due in part at least to truncation and off-lap of pre-Permian rocks. Variations in thicknesses are reflected in the following tabulation of data pertaining to the three wells which were drilled into pre-Permian rocks. In the following tabulation those wells are identified as Well (A), Well (B) and Well (C).

Well (A) was drilled as Denver Producing & Refining Co. #5-A C. A. Elliott and is now designated as Fikes & Murcheson #5-A C. A. Elliott. It is located in Sec. 832, Blk. D, John H. Gibson survey, where OLDEST HORIZON is entered on an accompanying map.

Well (B) is the Clear Fork 72 discovery well.

Well (C) is Honolulu Oil Corp. #9 E. Hovencamp, which is the Clear Fork 72 well in Sec. 890, Blk. D, John H. Gibson survey.

	(A)	(B)	(C)
Surface elevation, ft.	3,618	3,564	3,572
Total depth, feet	11,195	11,108	11,592
Elev. of total depth, ft.	-7,577	-7,544	-8,020
Elevation of top, feet:			
San Andres	-772	-766	-908
Glorieta	-2,162	-2,066	-2,258
Clear Fork	-2,632	-2,746	-2,948
Drinkard (Tubb)	-3,277	-3,396	-3,688
Abo	-3,827	-3,846	-4,278
Wolfcamp	-4,892	-5,206	-5,678
Pennsylvanian	-5,782	?	-7,378
Mississippian	-5,882	-6,536	-7,968
Woodford	-5,982	-6,936	
Devonian	-6,052	-6,986	
Fusselman	-6,892		
Montoya	-7,182		
Simpson	-7,292		
Granite	-7,572		

Interval, top to top, feet:	(A)	(B)	(C)
San Andres-Clear Fork	1,860	1,980	2,040
Clear Fork-Wolfcamp	2,260	2,460	2,730
Wolfcamp-Mississippian	990	1,330	2,290

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomite; granular, with high degree of porosity. In general, the percentage of granularly porous dolomite diminishes westward to the gain of finely crystalline dolomite with a low degree of porosity. In the eastern part of the field, the reservoir rock contains thin lentils of dense dolomite which occur in the manner of foreset beds, thus disclosing the incremental nature of the individual low stage reef units that combined to constitute the whole reef mass. These lentils disappear westward as they blend into tight finely crystalline dolomite. The reservoir rock is differentiated from overlying San Andres dolomite by the degree of porosity. However, it differs also in that it is of granular texture and contains minor amounts of chert and paper-thin partings of black shale. The porosity of the reservoir rock is of three types with pores averaging about 0.5 mm. in diameter and with diameters greater than 1 mm. very rare and with only very few larger than 2 mm.: (a) cavity-type with small irregularly shaped voids, (b) cast-type with pores showing fossil-cast outline and resulting from the removal of organic remains, and (c) intergranular-type in which the interstices are among the dolomite granules of varying degrees of crystallization. The coarser pores of cavity and cast types are not consistently filled with oil. The intergranular type constitutes a large part of the pore space and, though finer than the other two, appears to yield the most oil — apparently because of greater permeability. The top of the reservoir rock (i.e., the top of that portion of the San Andres dolomite which is sufficiently porous to yield oil and gas) is generally about 350 to 500 feet below the top of the San Andres formation.

Clear Fork 66 and Clear Fork 72: Dolomite; fine-grained with low porosity and low permeability. Porosity and permeability in both reservoirs vary abruptly.

Clear Fork Bennett: Dolomite; very similar to that of the other Clear Fork reservoirs.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

San Andres	Feet
Elevation of top of gas	-1,000
Elevation of bottom of gas	-1,316 to -1,340
Relief	340
Elevation of top of oil	-1,316 to -1,550
Elevation of bottom of oil	-1,428 to -1,740
Relief	424

The oil-water contact is highest at the south end of the field and lowest at the northeast corner.

Clear Fork 66	
No free gas	
Elevation of top of oil	-2,700 to -3,043(?)
Elevation of bottom of oil	-3,117 to -3,326(?)
Relief	626

Clear Fork 72	
No free gas	
Elevation of top of oil	-3,441 to -3,936
Elevation of bottom of oil	-3,796 to -4,178
Relief	737

Clear Fork Bennett	
No known gas cap	
Elevation of top of oil	-4,179
Elevation of bottom of oil	-4,316
Relief	137

The above data represent conditions as of respective discovery dates. Removal of fluids has occasioned some minor adjustments of fluid elevations, particularly the elevation of the gas-oil contact in the San Andres reservoir. The oil-water contacts in all reservoirs are now within a few feet of their positions at discovery dates.

CHARACTER OF GAS

Following is an analysis of a sample of typical casinghead gas from the San Andres reservoir:

Component	Mol. %	Calculated	
Hydrogen sulphide	0.26	Specific gravity	0.8998
Carbon dioxide	6.50		
Nitrogen	1.01	Gasoline	Gals. / Mcf
Methane	58.22		
Ethane	16.81	Iso-butane	0.4104
Propane	11.94	N-butane	0.9051
Iso-butane	1.26	Iso-pentane &	
N-butane	2.86	heavier	0.4124
Iso-pentane & heavier	1.13	35% butanes &	
	99.99	65% pentanes	0.6344

SELECTED REFERENCES

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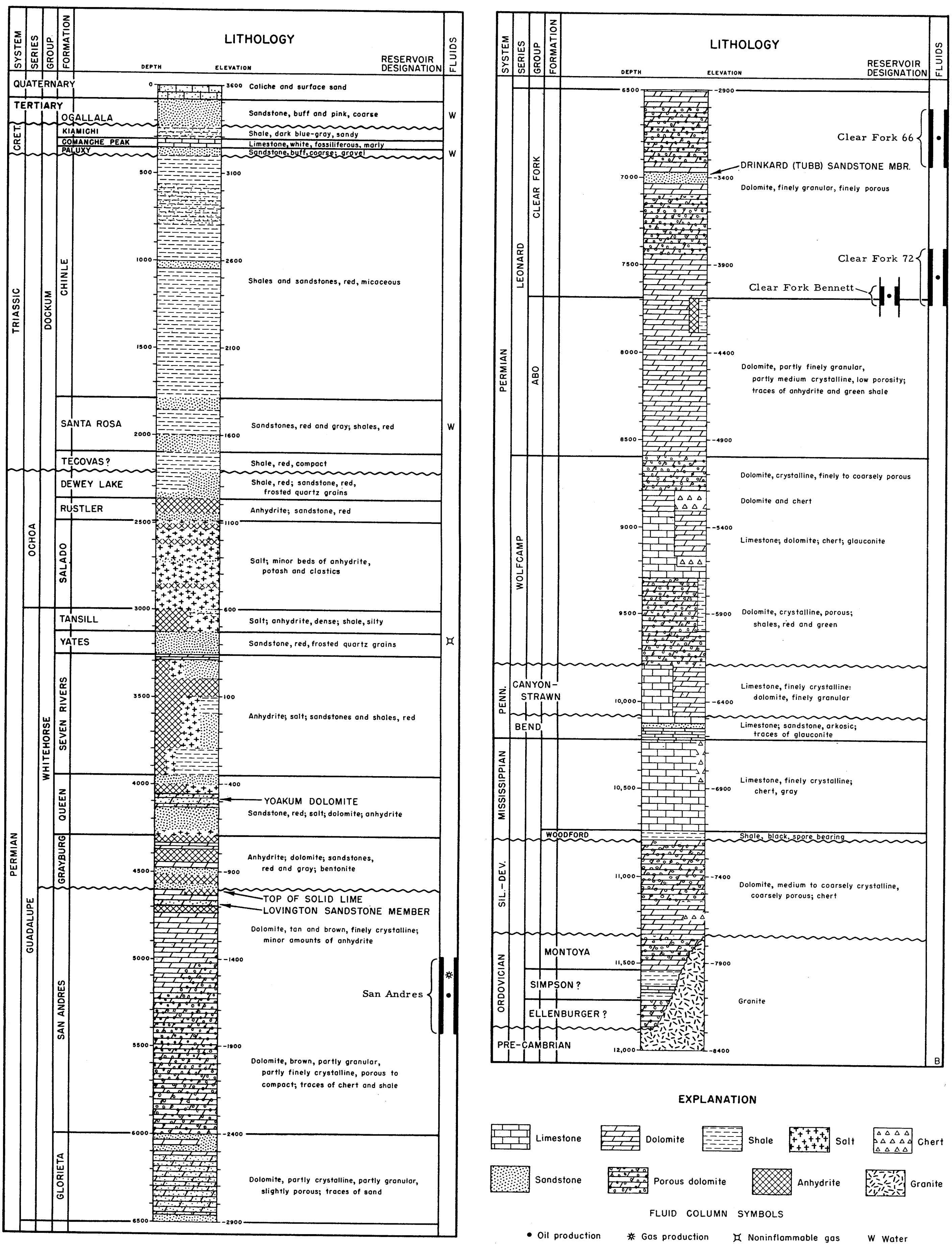
Cattell, R. A. (1953) Sulfur compounds identified in Wasson, Texas, crude oil: U. S. Bureau of Mines, I. C. 7659, p. 35.

GENERALIZED COMPOSITE SECTION OF ROCKS PENETRATED



NONINFLAMMABLE GAS

Throughout an area indicated on an accompanying map, the Yates formation yields noninflammable gas at pressures up to 2,800 psi. During development operations, this gas was a serious hazard and added considerably to the cost of wells; it forced setting of additional casing, caused casing to collapse in many wells and caused complete loss of several holes. While the Yates gas in the indicated area is under high pressure and is noninflammable, small quantities of normal, but lean, inflammable gas occur in the Yates formation in the central and west parts of the field. Gas showings, at least, have been found in the Yates formation throughout the area of the field. While some samples from the high-pressure area show as much as 97% nitrogen, the following composition is more generally representative: methane, 6.5%; ethane, 0.3%; propane, 0.2%; butane, 0.3%; pentane, 0.1%; nitrogen and inert gases, 92.5%; spectroscope analysis indicates no helium.

In a small portion of the above mentioned area where the Yates formation yields high-pressure noninflammable gas, a member of the Queen formation also yields noninflammable gas at about the same high pressure. Since this gas occurs only locally and was found in only a relatively few wells, it is not indicated on the accompanying typical section.

Since the above mentioned gas occurrences are not commercial, they are not given further treatment in this paper.

ACID TREATMENT

Multi-stage acid treatments have been used on nearly all wells; generally, three-stage, but occasionally, two-stage. The common practice has been the use of pressure treatment with 1,000, 2,000 and 5,000 gallons preceded by a wash treatment with about 700 gallons to clean the bore-hole wall. While the total quantity of acid has been normally about 8,700 gallons, more has been used in several wells, with the maximum known totaling 22,000 gallons. Generally, treatment requires 6 to 14 days.

WATER PRODUCTION

San Andres: On January 1, 1952, the gross production of each of 177 wells was more than 2% water. During test periods, the ratio of water to oil in the total production from the reservoir was 1 : 520 in 1938, 1 : 43 in 1944 and 1 : 53 late in 1951.

Clear Fork 66: During test periods, the ratio of water to oil in the total production from the reservoir has ranged from 1 : 321 to 1 : 20. During a test late in 1951, the ratio was 1 : 31.

Clear Fork 72: Water production has been negligible to date.

Clear Fork Bennett: Water production has been negligible to date.

CHARACTER OF OIL

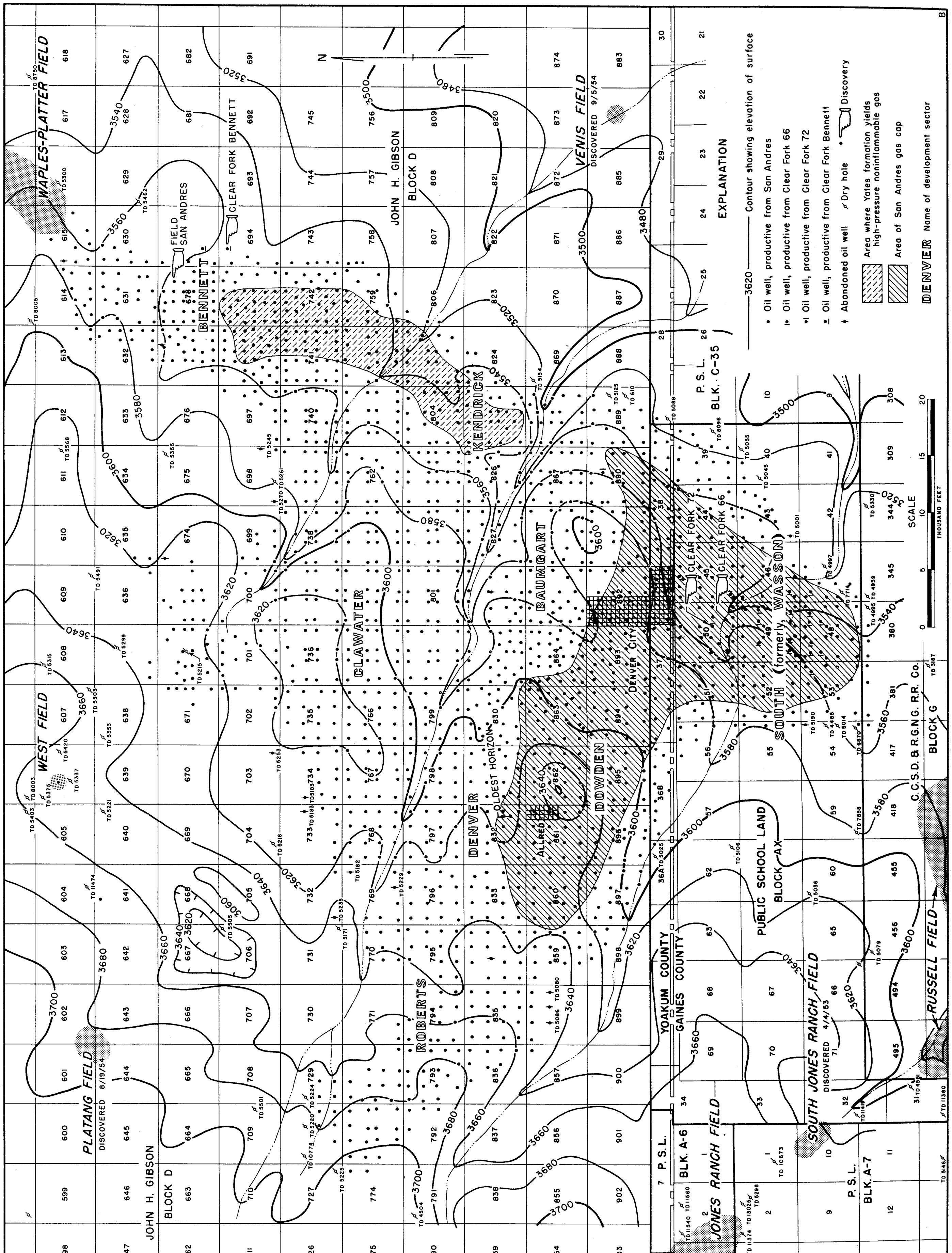
	San Andres	Clear Fork 66	Clear Fork 72	Clear Fork Bennett
Gravity, A.P.I. @ 60°F.	34.6°	32.8°	35.2°	30.7°
Sulphur	1.63%	1.41%	0.99%	Sour
Viscosity, S.U. @ 100°F., sec.	41	41	38	?

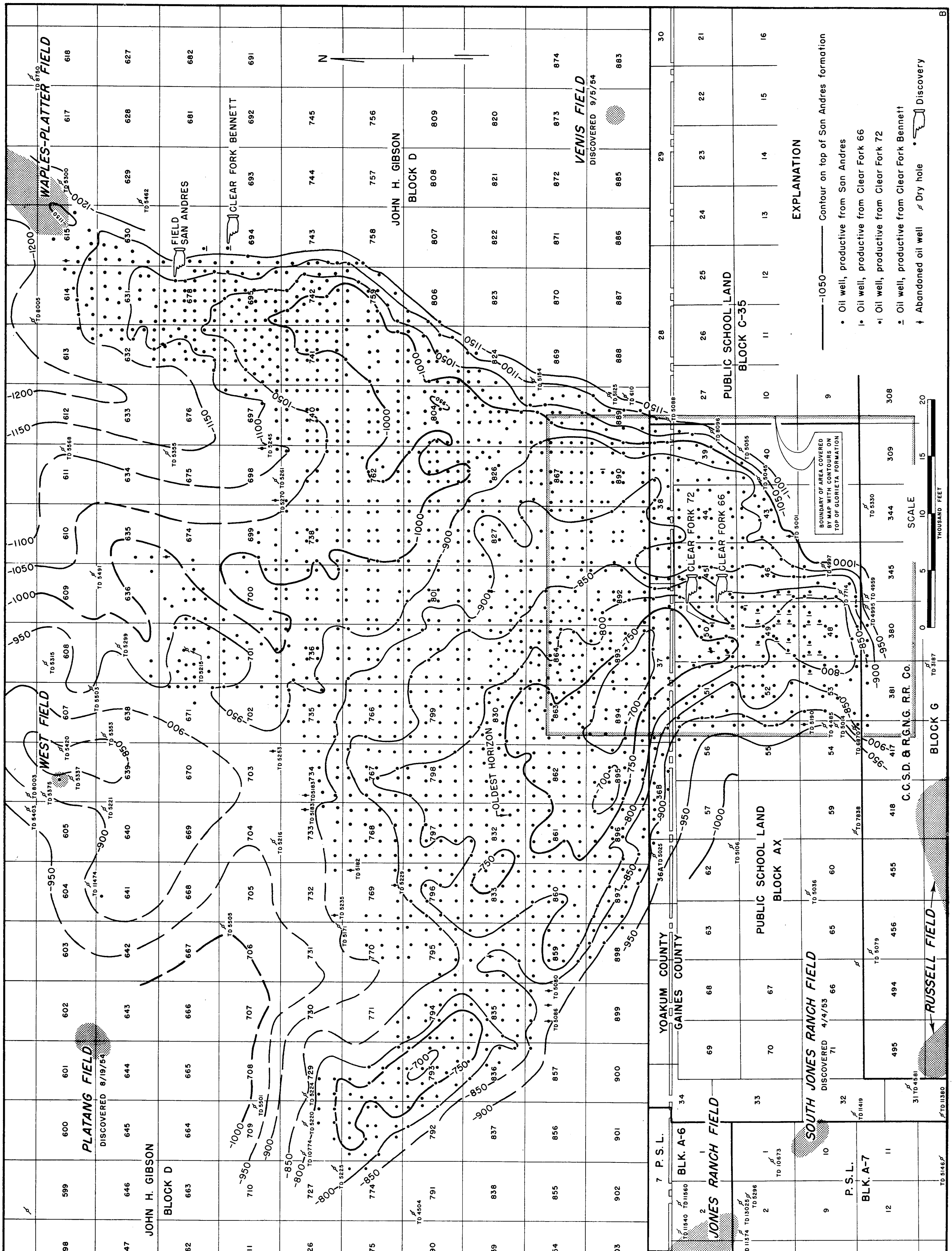
For analyses see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 34 and 64

U. S. Bureau of Mines	Reference designation
Tabulated Analyses of Texas Crude Oils. R.I. 3252 (1934)	A
Tabulated Analyses of Texas Crude Oils. T.P. 607 (1939)	B
Analyses of Crude Oils from Some West Texas Fields. R.I. 3744 (1944)	C
Analyses of Crude Oils from 283 Important Oil Fields of the U.S. R.I. 4289 (1948)	D
Analyses of Crude Oils from Some West Texas Fields. R.I. 4949 (1953)	E

Reference designation	Lab. ref. No.	31162	38146	38147	43143	43144	43145	48093	50070
A	Group 2, Item	2							
B	Group 2, Item		43	2					
C	Page				39	40	41		
D	Item			268					
E	Item							93	94

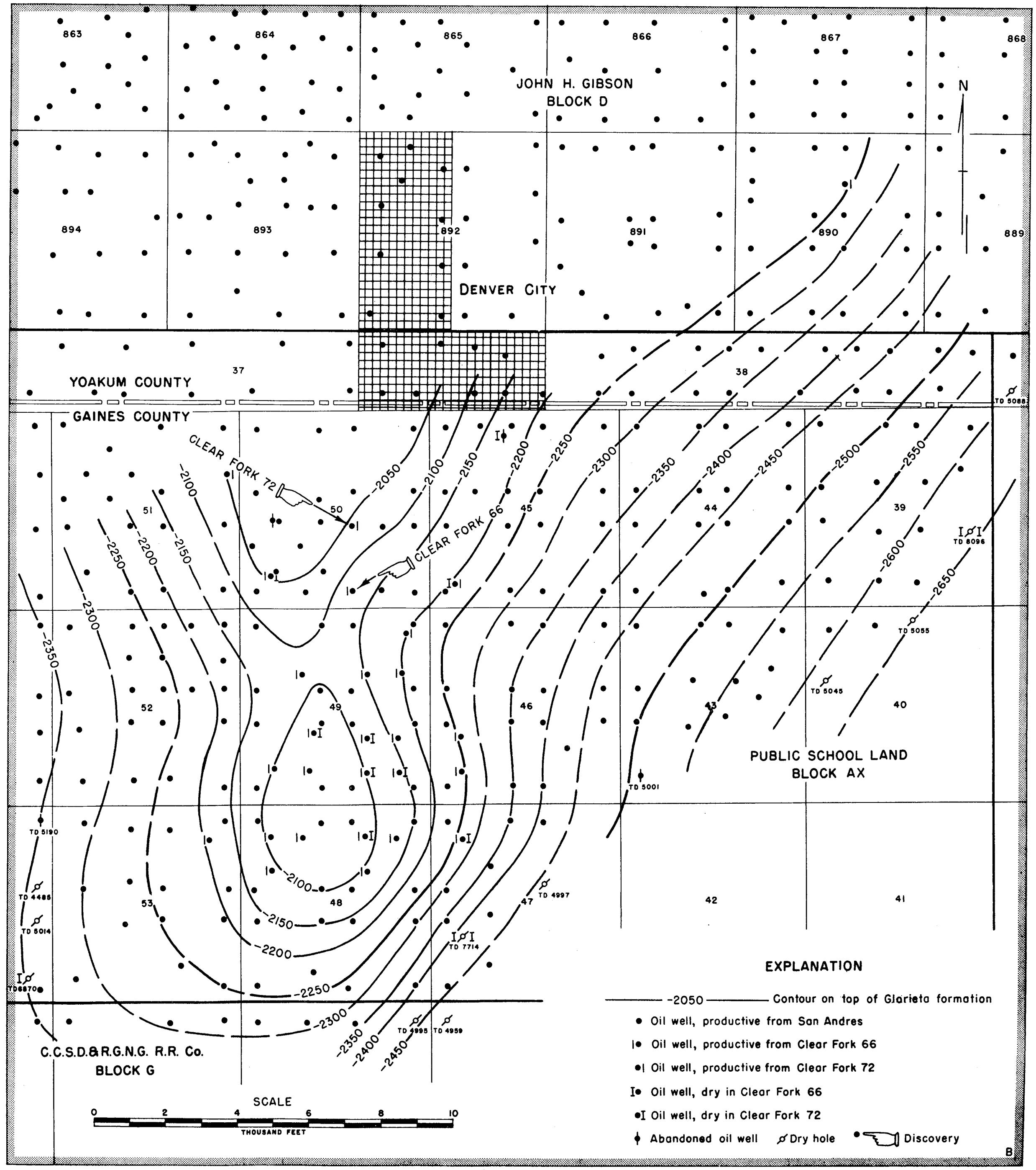

WAPLES-PLATTER FIELD
WEST FIELD
PLATANG FIELD
DISCOVERED 8/19/54
VENIS FIELD
DISCOVERED 9/5/54
SOUTH JONES RANCH FIELD
DISCOVERED 4/4/53
JONES RANCH FIELD
RUSSELL FIELD
JOHN H. GIBSON
BLOCK D
BENNETT
KENDRICK
CLAWATER
BAUMGART
DENVER
OLDEST HORIZON
DOWDEN
ALLRED
ROBERTS
SOUTH (formerly WASSON)
DENVER CITY
FIELD SAN ANDRES
CLEAR FORK BENNETT
CLEAR FORK 72
CLEAR FORK 66
YOAKUM COUNTY
GAINES COUNTY
PUBLIC SCHOOL LAND
BLOCK AX
P. S. L.
BLK. C-35
BLK. A-6
BLK. A-7
C. C. S. D. & R. G. N. G. R.R. Co.
BLOCK G
EXPLANATION
3620 Contour showing elevation of surface
Oil well, productive from San Andres
Oil well, productive from Clear Fork 66
Oil well, productive from Clear Fork 72
Oil well, productive from Clear Fork Bennett
Abandoned oil well
Dry hole
Discovery
Area where Yates formation yields high-pressure nonflammable gas
Area of San Andres gas cap
DENVER Name of development sector
SCALE
THOUSAND FEET
0 5 10 15 20


WAPLES-PLATTER FIELD
FIELD SAN ANDRES
CLEAR FORK BENNETT
JOHN H. GIBSON
BLOCK D
VENIS FIELD
DISCOVERED 9/5/54
PUBLIC SCHOOL LAND
BLOCK C-35
EXPLANATION
-1050 Contour on top of San Andres formation
Oil well, productive from San Andres
Oil well, productive from Clear Fork 66
Oil well, productive from Clear Fork 72
Oil well, productive from Clear Fork Bennett
Abandoned oil well
Dry hole
Discovery
BOUNDARY OF AREA COVERED BY MAP WITH CONTOURS ON TOP OF GLORIETA FORMATION
SCALE
THOUSAND FEET
CLEAR FORK 72
CLEAR FORK 66
WEST FIELD
OLDEST HORIZON
YOAKUM COUNTY
GAINES COUNTY
PUBLIC SCHOOL LAND
BLOCK AX
C.C.S.D. & R.G.N.G. R.R. Co.
BLOCK G
SOUTH JONES RANCH FIELD
DISCOVERED 4/4/53
RUSSELL FIELD
PLATANG FIELD
DISCOVERED 8/19/54
7 P. S. L.
BLK. A-6
JONES RANCH FIELD
P. S. L.
BLK. A-7

PRODUCTION HISTORY

Year	Wells producing at end of year: Flowing	Wells producing at end of year: Art. lift	Oil production (barrels): Yearly	Oil production (barrels): Cumulative
San Andres				
1936	1	0	9,506	9,506
1937	26	0	314,024	323,530
1938	201	0	2,801,645	3,125,175
1939	707	22	5,934,151	9,059,326
1940	1,021	23	10,976,744	20,036,070
1941	1,253	58	13,013,979	33,050,049
1942	1,311	68	9,511,962	42,562,011
1943	1,337	113	12,386,516	54,948,527
1944	1,366	143	23,725,909	78,674,436
1945	1,347	192	22,659,524	101,333,960
1946	1,346	198	20,706,513	122,040,473
1947	1,380	193	25,407,883	147,448,356
1948	1,377	211	28,165,780	175,614,136
1949	1,368	232	18,765,190	194,379,326
1950	1,387	247	18,051,249	212,430,575
1951	1,370	275	21,633,959	234,064,534
1952	1,376	302	19,438,608	253,503,142
1953	1,392	306	18,421,128	271,924,270
1954	1,380	319	15,415,569	287,339,839
Clear Fork 66				
1940	1	0	1,849	1,849
1941	1	0	19,173	21,022
1942	1	0	14,747	35,769
1943	1	0	19,013	54,782
1944	3	0	63,263	118,045
1945	11	0	245,461	363,506
1946	14	0	423,823	787,329
1947	14	6	512,459	1,299,788
1948	5	18	643,533	1,943,321
1949	1	21	447,359	2,390,680
1950	1	21	430,961	2,821,641
1951	1	21	502,507	3,324,148
1952	2	21	443,425	3,767,573
1953	1	22	421,714	4,189,287
1954	1	23	362,845	4,552,132
Clear Fork 72				
1941	1	0	1,077	1,077
1942	1	0	33,819	34,896
1943	1	0	14,932	49,828
1944	6	0	62,611	112,439
1945	10	0	180,232	292,671
1946	10	2	183,048	475,719
1947	5	2	129,927	605,646
1948	4	2	72,604	678,250
1949	0	5	37,290	715,540
1950	0	5	36,474	752,014
1951	0	5	34,988	787,002
1952	0	4	31,973	818,975
1953	0	4	29,473	848,448
1954	0	4	25,116	873,564
Clear Fork Bennett				
1954	0	2	11,954	11,954

GAS PRODUCTION: Although in the San Andres reservoir there was a gas cap which extended over an area of about 12,800 acres and which contained a large volume of free gas, there were only very few wells ever operated as gas wells. From time to time, there have been one, two or three wells operated temporarily as gas wells. The total quantity of gas produced by such wells has been relatively small. However, a very large quantity of gas has been produced incidental to the production of oil from the San Andres reservoir and minor amounts from the Clear Fork 66 and Clear Fork 72 reservoirs. The writer estimates that the total quantity of gas produced to January 1, 1941, amounted to 35,500,000 Mcf and to January 1, 1955, to 449,288,727 Mcf. Practically all of this gas has been treated in one or the other of two gasoline plants (combined capacity, 142,000 Mcf per day) located within the field. The liquid products have been exported mainly through two 6-inch pipelines, only one of which is now operating.



WATER VALLEY — CLARK FIELD

Tom Green and Sterling Counties, Texas

THOMAS H. COLE
Consulting Geologist, Midland, Texas
May 19, 1953

LOCATION

The Water Valley-Clark field is about nine miles west of the town of Water Valley and is partly in Tom Green County and partly in Sterling County. In prior publications, this field has been treated generally as two fields, the Water Valley field in Tom Green County and the Clark field in Sterling County.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Mapping of subsurface geological data.

DISCOVERIES

San Andres: November 1, 1948; Placid Oil Co. #1 L.T. Clark. This well was drilled to total depth of 7,738 feet (154 feet into Ellenburger) and was plugged back to produce from a zone in the San Andres formation, the top of which zone is at depth of 1,035 feet. The initial daily potential was at the rate of 43 barrels of oil per day.

San Angelo: February 3, 1950; Walker & Neill #1 George Weddell (now, Curtis Oil Co. #1 George Weddell).

SURFACE FORMATION

Undifferentiated Cretaceous limestone.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 781 feet below its top. This penetration was in The Ohio Oil Co. #1 L.T. Clark, which is located near the apex of the structural high near the north end of the field, as indicated on the accompanying map. The discovery well is the only other well which was drilled to the Ellenburger within the area of the accompanying map.

ELEVATION OF SURFACE

The elevation of surface ranges from 2,200 feet to 2,400 feet above sea level.

STRATIGRAPHIC POSITIONS OF RESERVOIR ROCKS

This field is characterized by a series of thin zones which yield oil into the drill-holes. These zones are at various stratigraphic positions and most of them are evidently of only local extent. It appears probable that there are many separate and distinct reservoirs without intercommunication except through drill-holes. While the productive zones are mainly in the middle portion of the San Andres formation, their stratigraphic positions range from the top of the San Andres downward into the uppermost part of the Clear Fork group. At the north end of the field, there are a few wells producing from near the top of the San Andres; southward, the correlative section is nonproductive. Near the south end of the field, several wells produce from thin zones in the San Andres and thin zones in the San Angelo, and two wells produce also from the uppermost part of the Clear Fork, where the production is not sufficient that it alone would be commercial.

NATURE OF TRAPS

Since an anticline is the dominating structural feature in the area of the field, it appears likely that convex folding constitutes the primary trap-forming factor, at least, as to several of the reservoirs. Updip and lateral lensing and decrease of porosity and permeability appear to have trapped the oil in several of the thin, local reservoirs.

THICKNESSES OF RESERVOIR ROCKS

The thicknesses of the several distinct reservoir rocks range from zero to about 20 feet. Except in the north part of the field (that part in Sterling County and known as the Clark field), the thickness of each productive zone is on the order of 5 feet or less. In Sterling County, four distinct reservoirs in the San Andres dolomite have been recognized and have thicknesses as follows: "980-foot", 15 feet; "1,010-foot (Clark zone)", 20 feet; "1,050-foot", 20 feet; and "1,080-foot", 15 feet. The number of zones and the total net thickness producing in individual wells is extremely variable.

The author thanks Mr. Clyde M. Pederson and Mr. Alan Roberts of Cities Service Oil Company, Mr. J. Spencer Collins of Tennessee Production Company and Mr. E. Russell Lloyd, Consultant, for their assistance in the preparation of this paper.

LITHOLOGY OF RESERVOIR ROCKS

San Andres: Dolomite and sandstone. Most of the production is from dolomite at locations where the degree of porosity is above normal. Local lenses of sandstone, generally less than 5 feet thick, yield oil at locations where the degree of porosity is favorable. Such locations are limited to that portion of the field in Tom Green County.

San Angelo: Sandstone. In the south part of the field, 23 wells are producing some oil from sandstone in the San Angelo formation.

Clear Fork: Dolomite. Two wells are producing a minor quantity of oil from dolomite at the top of the Clear Fork group.

CONTINUITY OF RESERVOIR ROCKS

The stratigraphic zone (San Andres - Clear Fork) in which the several reservoirs occur is continuous throughout the area of the accompanying map and is of about the same general character throughout that area. The individual reservoirs, however, are generally of only local extent. While it is evident that there is no long-distance continuity of zones where the degree of porosity and permeability are adequate for commercial production, it is not determinable whether there is continuity of porosity and permeability adequate for long-distance migration of fluids in geologic time.

CHARACTER OF OIL

Gravity, A.P.I. @ 60° F.:	28° - 34°
Sulphur:	1% - 1.5%
Base:	Asphalt
Color:	Dark brown, dark green and black
Gas content:	Undersaturated

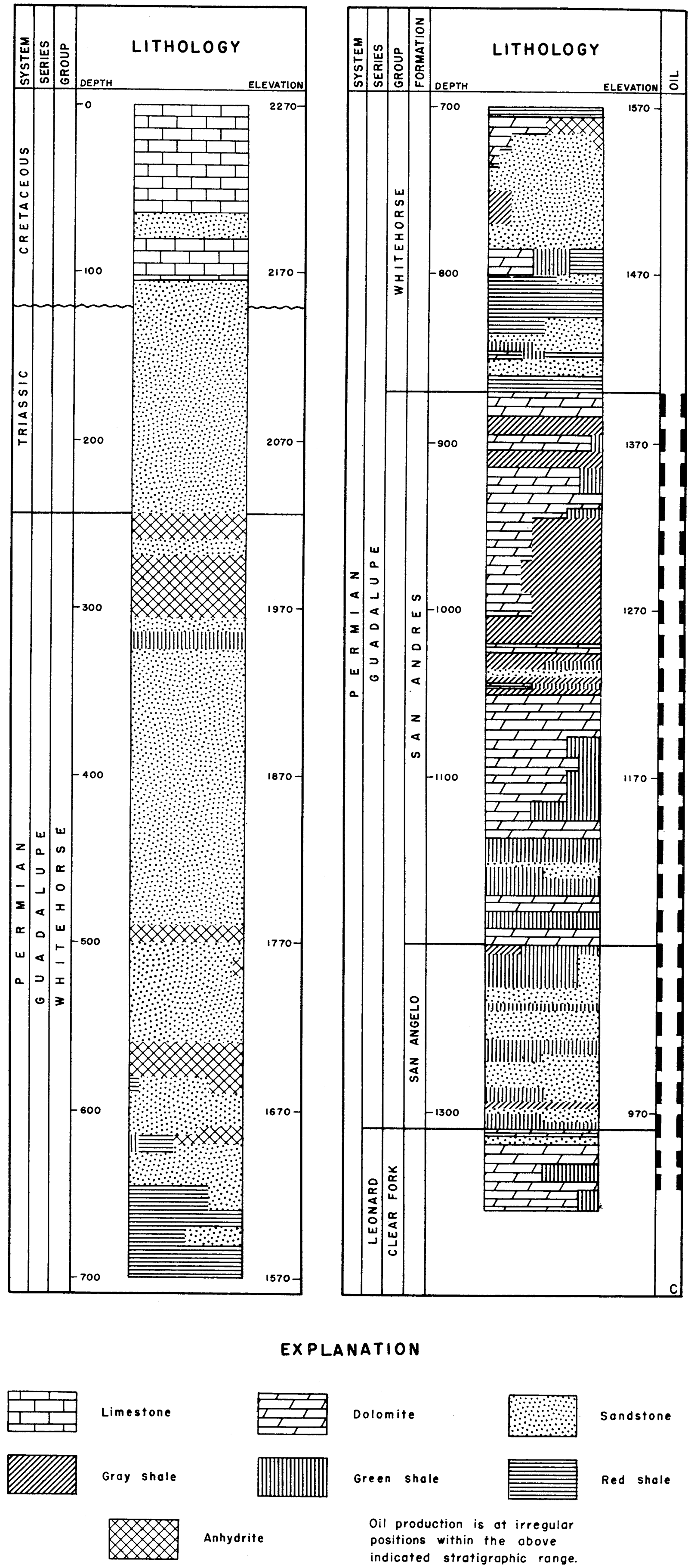
WATER PRODUCTION

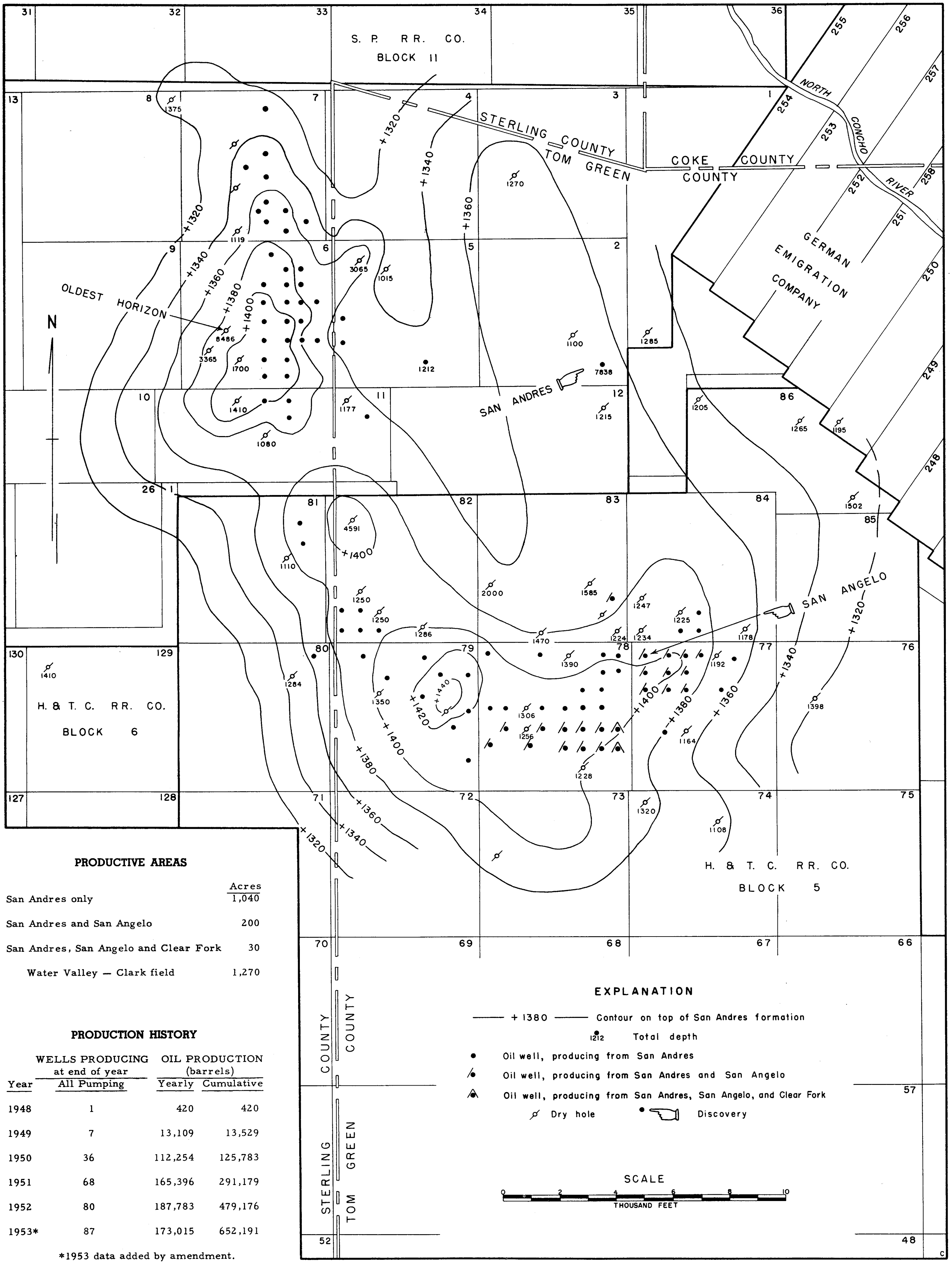
Most wells produce some water and at an essentially constant percentage of gross production. Generally, the percentage of water is directly related to structural position, with water constituting as much as 50% of the gross production of some of the low wells.

COMPLETION TREATMENT

The reservoirs in nearly all wells were treated at time of completion either by acidization, by shooting with nitroglycerin or by hydraulic fracturing. The dolomite reservoirs have been acidized generally with 500 to 1,000 gallons of acid, but, in a few wells, the quantity was as high as 7,000 gallons. As to the sandstone reservoirs, the general practice during the early history of the field was to shoot with 20 to 60 quarts of nitroglycerin. During recent completions, some operators have successfully used hydraulic fracture treatments; quantity of fluid has ranged from 25 to 100 gallons.

TYPICAL SECTION OF ROCKS PENETRATED





PRODUCTIVE AREAS

	Acres
San Andres only	1,040
San Andres and San Angelo	200
San Andres, San Angelo and Clear Fork	30
Water Valley — Clark field	1,270

PRODUCTION HISTORY

Year	WELLS PRODUCING at end of year All Pumping	OIL PRODUCTION (barrels) Yearly	Cumulative
1948	1	420	420
1949	7	13,109	13,529
1950	36	112,254	125,783
1951	68	165,396	291,179
1952	80	187,783	479,176
1953*	87	173,015	652,191

*1953 data added by amendment.

WEBB RAY FIELD

Upton County, Texas

E. S. HUGHES
Geologist, Gulf Oil Corporation, Fort Worth, Texas
January 1, 1955

LOCATION

The Webb Ray field is in southwest Upton County $2\frac{1}{2}$ miles southeast of the McCamey field and $5\frac{1}{2}$ miles east-southeast of the town of McCamey.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Mapping of subsurface geological data.

DISCOVERY

Grayburg: November 19, 1935; W.C.Ray #1 Cordova Union Oil Corp. The initial daily pumping capacity was at the rate of 334 barrels of fluid, 10% of which was water, from a total depth of 2,125 feet.

MAP, LITHOLOGY and STRATIGRAPHIC SECTION

Because of geographic and geologic relationships with the McCamey field, this field is shown on the map in the foregoing paper on that field.

The TYPICAL SECTION and the description of the lithology of the Grayburg reservoir rock in the paper on the McCamey field apply also to this field. The stratigraphic position of the reservoir in this field is the same as that of the Grayburg reservoir in the McCamey field.

ELEVATION OF SURFACE

At well locations: Highest, 2,622 ft.; lowest, 2,570 ft.

SURFACE FORMATION

Undifferentiated rocks of the Comanche series.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated in the Webb Ray field is in the Grayburg formation 216 feet below its top. This penetration was at the total depth of 2,176 feet in Cordova Union Oil Corp. #1 Cordova Union Oil Corp., located in the extreme southwest part of the field where the total depth of 2,176 feet is indicated on the accompanying map.

NATURE OF TRAP

Grayburg: The trap is due primarily to a small anticlinal fold with approximately 50 to 60 feet of closure.

PRODUCTIVE AREA

Grayburg and Field: Approximately 150 acres.

THICKNESS OF RESERVOIR ROCK

Grayburg: The gross thickness of the zone containing productive rock is on the order of 10 to 30 feet. Data are not available for estimating the portion of that zone which yields oil.

CHARACTER OF OIL

Grayburg: Gravity, A.P.I. @ 60° F., 26.5°

WATER PRODUCTION

Grayburg: At time of initial completion, sulphur water constituted a large portion, generally 10% to 75%, of the gross production of most of the wells. Detailed records of water production are not available.

COMPLETION TREATMENT

Grayburg: Most of the wells were treated with acid at time of completion; quantities used ranged from 1,000 gallons to 2,000 gallons. One well was shot with nitroglycerin.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year	OIL PRODUCTION (barrels)	
Year	Pumping	Yearly	Cumulative
1935	1	1,331	1,331
1936	2	12,809	14,140
1937	3	8,407	22,547
1938	4	8,277	30,824
1939	4	10,014	40,838
1940	4	8,785	49,623
1941	2	5,894	55,517
1942	2	3,972	59,489
1943	2	2,791	62,280
1944	1	1,490	63,770
1945	1	1,727	65,497
1946	1	2,633	68,130
1947	1	2,810	70,940
1948	1	2,816	73,756
1949	1	2,343	76,099
1950	1	2,422	78,521
1951	1	2,056	80,577
1952	1	1,695	82,272
1953	1	1,856	84,128
1954	1	1,419	85,547

WENDLAND FIELD

Coke County, Texas

C. R. WINKLER, Jr.
Geologist, American Republics Corporation, Midland, Texas
December 1, 1953

LOCATION

The Wendland field (one well) is in the J. A. Gutierrez survey in southeastern Coke County about 7 miles southeast of the town of Robert Lee, county seat.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Surface geological mapping and magnetic surveying.

DISCOVERY

Ellenburger: May 21, 1948;
Shamrock Oil & Gas Corp. #1 H.G. Wendland

ELEVATION OF SURFACE

At well location: 1,870 ft. (Derrick floor, 1,880 ft.)

SURFACE FORMATION

San Angelo formation of Double Mountain group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

25 feet below top of Ellenburger group.

NATURE OF TRAP

Ellenburger: The well is on a north-south trending Ellenburger terrace. The oil accumulation is isolated in a small local anticlinal fold on the larger structure. The factors controlling accumulation are those of a simple convex trap on an anticlinal fold.

PRODUCTIVE AREA

Ellenburger and Field: 40 acres.

THICKNESS OF RESERVOIR ROCK

Ellenburger: 20 feet, gross.

LITHOLOGY OF RESERVOIR ROCK

Ellenburger: Dolomite; varies from finely crystalline gray to medium crystalline tan; highly fractured. Small amounts of chert occur locally. Production is from fractures and a little inter-crystalline type porosity.

CONTINUITY OF RESERVOIR ROCK

Ellenburger: While the Ellenburger dolomite in which the reservoir occurs is continuous over a very large area, the porous condition which occasions commercial production at this location is a local condition, not present at the offset well and probably not continuously present throughout more than 40 acres surrounding the producing well.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Ellenburger:	Feet
No free gas cap	
Elevation of top of oil	-4,350
Elevation of oil-water contact	-4,370
Oil column	20

CHARACTER OF OIL

Ellenburger:	
Gravity, A.P.I. @ 60° F.	49°
Sulphur	0.1%

CHARACTER OF GAS

Ellenburger: The only gas produced is the small quantity which comes out of solution as the oil is produced. No analysis is available.

WATER PRODUCTION

Ellenburger: A small amount of water is produced with the oil. During potential test, water production was at the rate of $2\frac{1}{2}$ barrels per day.

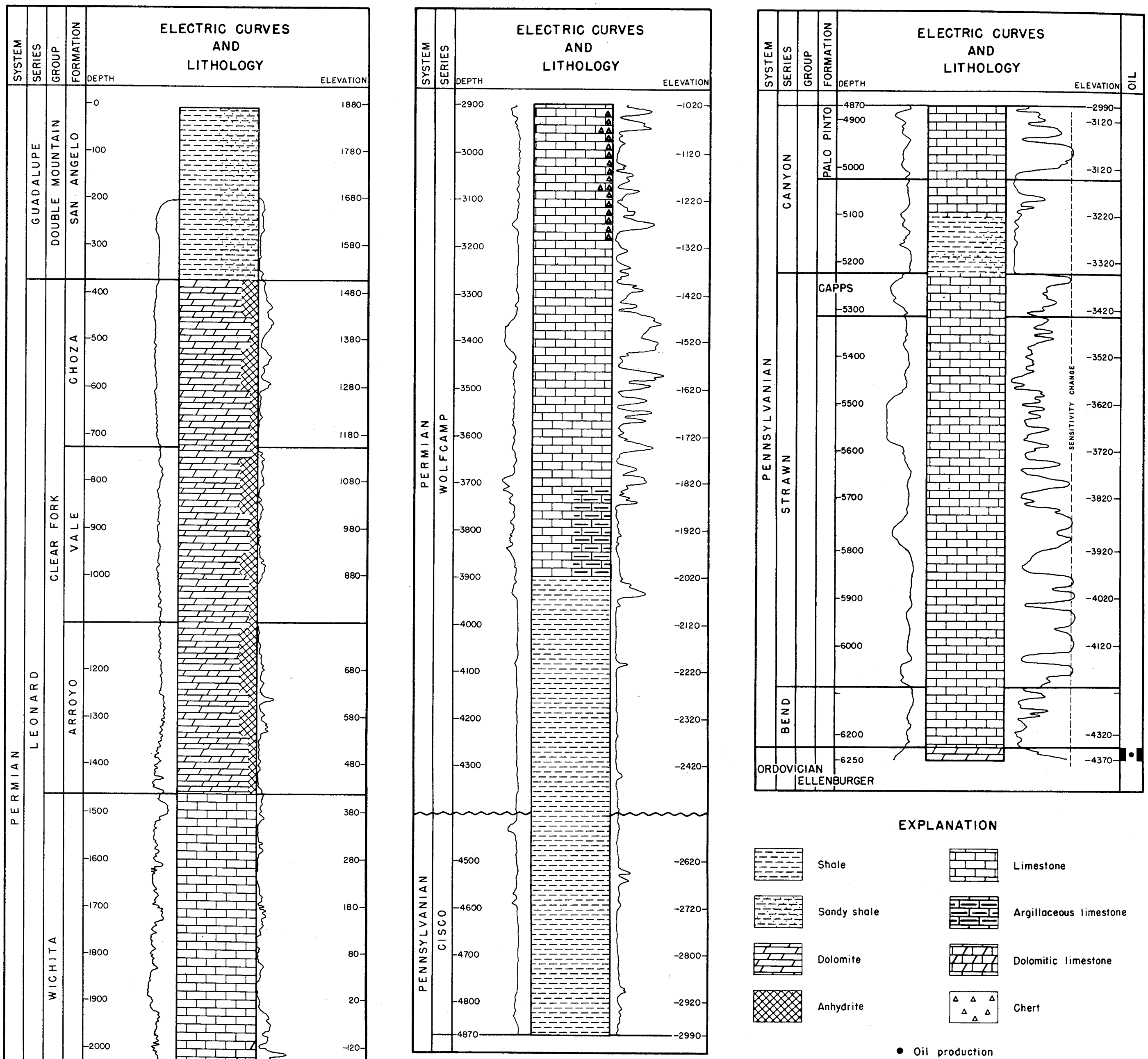
ACID TREATMENT

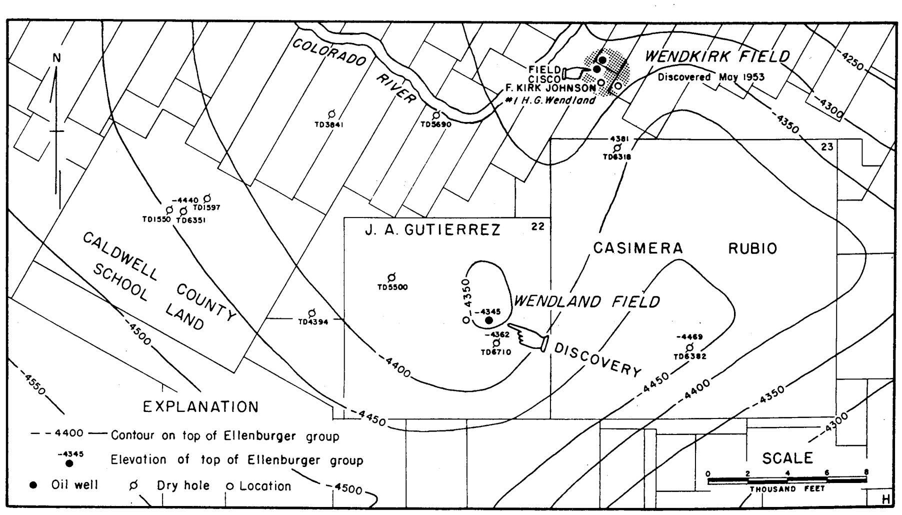
Ellenburger: The well was washed with 250 gallons of mud acid and then treated with 1,000 gallons of regular acid.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year	OIL PRODUCTION (barrels)	
Year	Pumping	Yearly	Cumulative
1948	1	2,627	2,627
1949	1	2,738	5,365
1950	1	1,978	7,343
1951	1	1,795	9,138
1952	1	1,407	10,545

SECTION OF ROCKS PENETRATED





WEST ANTON FIELD

Hockley County, Texas

C. S. PRESTON and M. V. SMITH
Geologists, Sunray Oil Corp., Midland, Texas
December 31, 1952

LOCATION

The West Anton field is 6 miles west of the town of Anton and 15 miles northeast of the town of Levelland, the county seat of Hockley County. It is one of several fields on the North Basin platform.

METHODS OF EXPLORATION LEADING TO DISCOVERY

In March, 1944, Humble Oil & Refining Co. conducted a broad reconnaissance survey in the region which includes the present area of the field. On the basis of a detailed seismic survey begun in March, 1949, Humble Oil & Refining Co. made the location for the test which became the discovery well.

DISCOVERY

Leonard: October 31, 1950;
Humble Oil & Refining Co., #1 J. J. Hobgood

ELEVATION OF SURFACE

At well locations: Highest, 3,470 ft.; lowest, 3,461 ft.

SURFACE FORMATION

Undifferentiated Tertiary sands.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest rocks penetrated within the area of the field were penetrated in the discovery well, the log of which afforded the basis for the accompanying TYPICAL SECTION OF ROCKS PENETRATED. The oldest sedimentary rock is about 1,250 feet below the top of the Wolfcamp series and is at the base of such portion of the Wolfcamp series as is present. The Wolfcamp unconformably overlies pre-Cambrian rhyolite, which was penetrated 1,129 feet. It appears probable that the pre-Cambrian rhyolite constituted a topographic high at the beginning of Wolfcamp time and that sediments of early Wolfcamp age were not deposited here.

Since the writers do not have positive proof that the rocks immediately overlying the pre-Cambrian rhyolite are actually of Wolfcamp age, it appears appropriate to recognize that other geologists have expressed the opinion that such rocks are of Ellenburger age. Top of Ellenburger has been reported at depth of 8,885 feet and top of Mississippi limestone at depth of 8,780 feet in the above mentioned well.

NATURE OF TRAP

Leonard: Convex folding is definitely the primary trap-forming factor. Fracturing of the reservoir rock appears to have been a secondary factor in occasioning the accumulation of oil at its present location.

PRODUCTIVE AREA

Leonard and Field: About 320 acres proven by development to date.

THICKNESSES OF RESERVOIR ROCK

	Feet		
Leonard:	Min.	Max.	Avg.
From top to bottom, gross	3	50	24

LITHOLOGY OF RESERVOIR ROCK

Leonard: Fractured, fine to medium crystalline, tan to brown dolomite with thin shale and limestone partings and with traces of sand. The fracturing is very erratic. The yielding of reservoir fluids is evidently determined by the fracturing. Some wells produce water along with oil from elevations far above those from which other wells produce only oil.

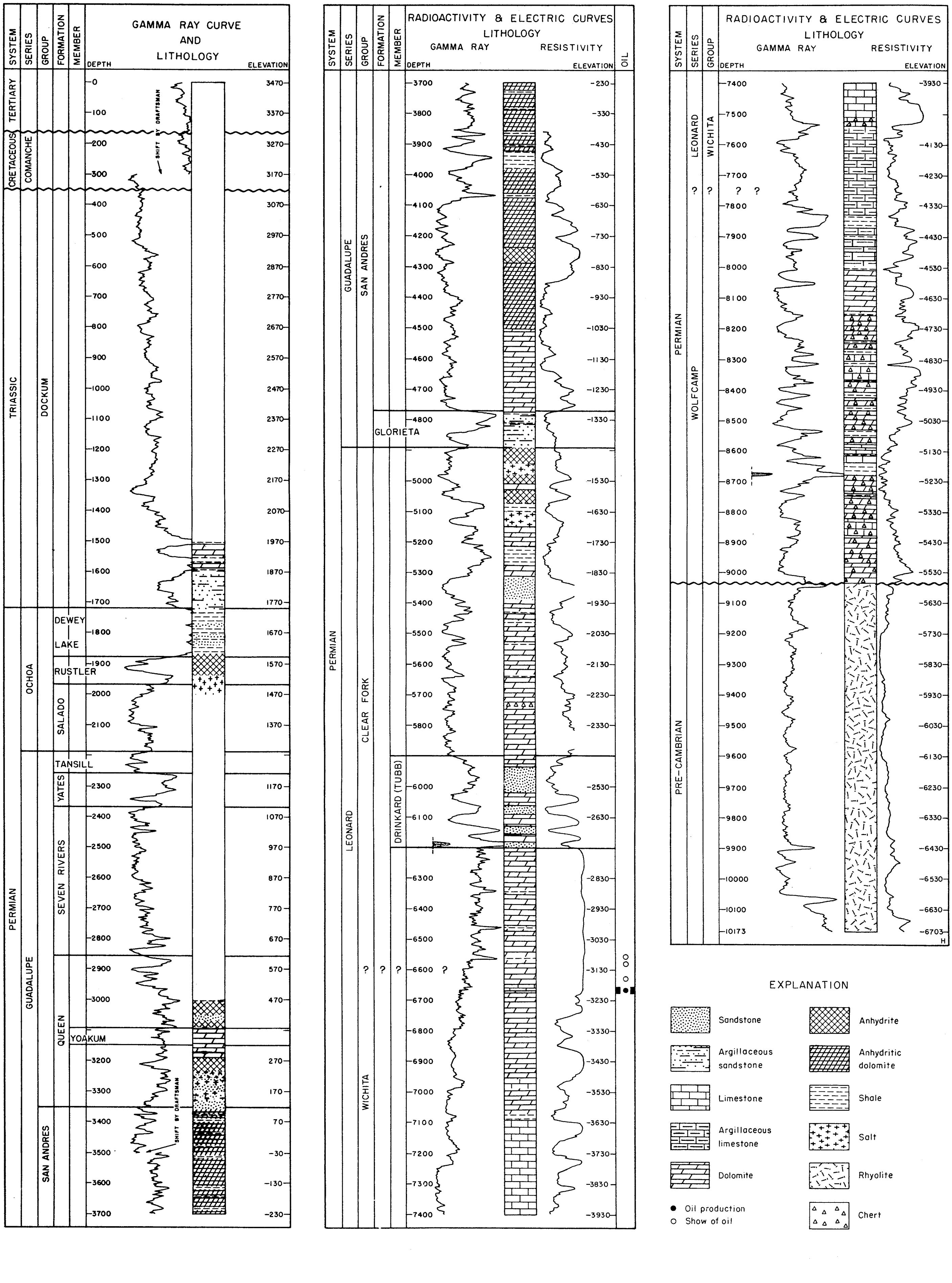
CONTINUITY OF RESERVOIR ROCK

Leonard: The reservoir rock which is productive in this field cannot yet be definitely correlated beyond the present extent of the field. The Leonard series, of which this reservoir rock is a member, contains productive reservoirs in many fields in the Permian basin, but data are not available for determining whether the reservoir rock in this field is exactly correlative with reservoir rocks at about the same stratigraphic position in other fields.

CHARACTER OF OIL

Leonard:	Range	Wtd. avg.
Gravity, A.P.I. @ 60° F.	24.2° - 25.9°	25.2°

TYPICAL SECTION OF ROCKS PENETRATED



ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Leonard:	Feet Highest	Feet Lowest
Elevation of top of oil in wells	-3,027	-3,195
Lowest elevation of oil in any water-free well since discovery		-3,121
Elevation from which water is produced	-3,100	-3,195

The free migration of oil in fractures has resulted in confusion relative to the elevation of the bottom of the oil in the reservoir at any given time. The available data do not afford a basis for conclusions more definite than can be deduced from the above figures.

WATER PRODUCTION

Leonard: Practically all wells are producing some water. Water constitutes as much as 90% of the gross fluid produced by some wells. The chloride content of the water is 53,000 parts per million.

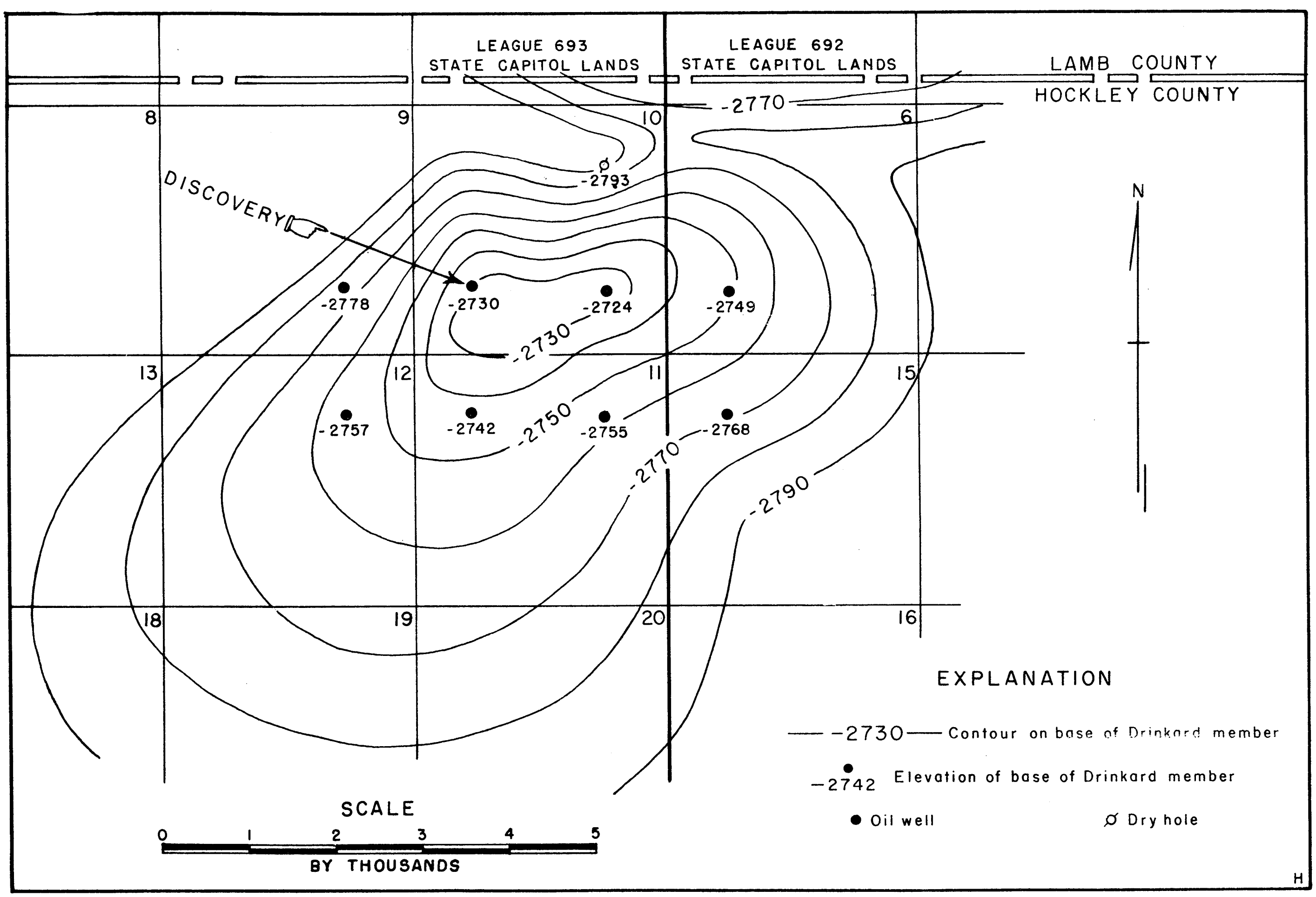
ACID TREATMENT

Leonard: All but one of the wells have been treated with acid. The quantity used in treating each well has ranged from 4,500 gallons to 6,500 gallons.

PRODUCTION HISTORY

Leonard and Field total:

Year	WELLS PRODUCING at end of year: Flowing	WELLS PRODUCING at end of year: Pumping	OIL PRODUCTION (barrels): Yearly	OIL PRODUCTION (barrels): Cumulative
1950	0	1	8,354	8,354
1951	0	8	116,418	124,772
1952	0	8	128,852	253,624



WEST SEMINOLE FIELD

Gaines County, Texas

CLYDE M. PEDERSON
Geologist, Cities Service Oil Co., Midland, Texas
October 24, 1952

LOCATION and DEFINITION

The West Seminole field is in west central Gaines County, with the eastern boundary of present development approximately 8 miles west of the town of Seminole. Regionally, the field is near the northeast edge of the Central Basin platform. The area of the field is defined to the north and to the south and, appears to be about defined to the east, but additional development will be necessary to define the northwest extent.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Mapping of data afforded by shallow wells indicated a structural high. This mapping was followed and confirmed by extensive seismograph exploration. The discovery well, located on the basis of seismograph work, was originally planned as a 7,500-foot test of the Clear Fork group, but was stopped at the total depth of 5,352 feet for completion after finding the productive zone in the San Andres formation. The second well, the deepest in the field to date, was drilled beyond the productive zone in the San Andres formation for the purpose of testing the Clear Fork group and was drilled 1,230 feet into that group with negative results.

DISCOVERY

San Andres: June 29, 1948; Cities Service Oil Co. and Atlantic Refining Co. #1 J. H. Proctor. Drilled to total depth of 5,352 feet and plugged back to 5,198 feet. During initial potential test, the well flowed from open hole from 5,031 to 5,198 feet at the rate of 411 barrels of oil per day through 30/64-inch choke.

ELEVATION OF SURFACE

At well locations: Highest, 3,476 ft.; lowest, 3,400 ft.

SURFACE FORMATION

The only rocks exposed at the surface are sands, gravels and clays of the Ogallala formation.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Clear Fork group 1,230 feet below its top. This penetration was in Cities Service Oil Co. and Atlantic Refining Co. #2 J. H. Proctor, which is the next well east of the discovery well and is located where the datum elevation is indicated as -1,334 feet on the accompanying map. The accompanying TYPICAL SECTION is based on the log of that well. It was drilled to the total depth of 7,660 feet.

NATURE OF TRAP

San Andres: Simple convex trap on a northwest-southeast trending anticline.

PRODUCTIVE AREA

San Andres and Field: Development to date proves approximately 3000 acres as productive. Since the northwest extent of the field has not yet been defined, the data are not yet available for a reliable estimate of the total productive area.

THICKNESSES OF RESERVOIR ROCK

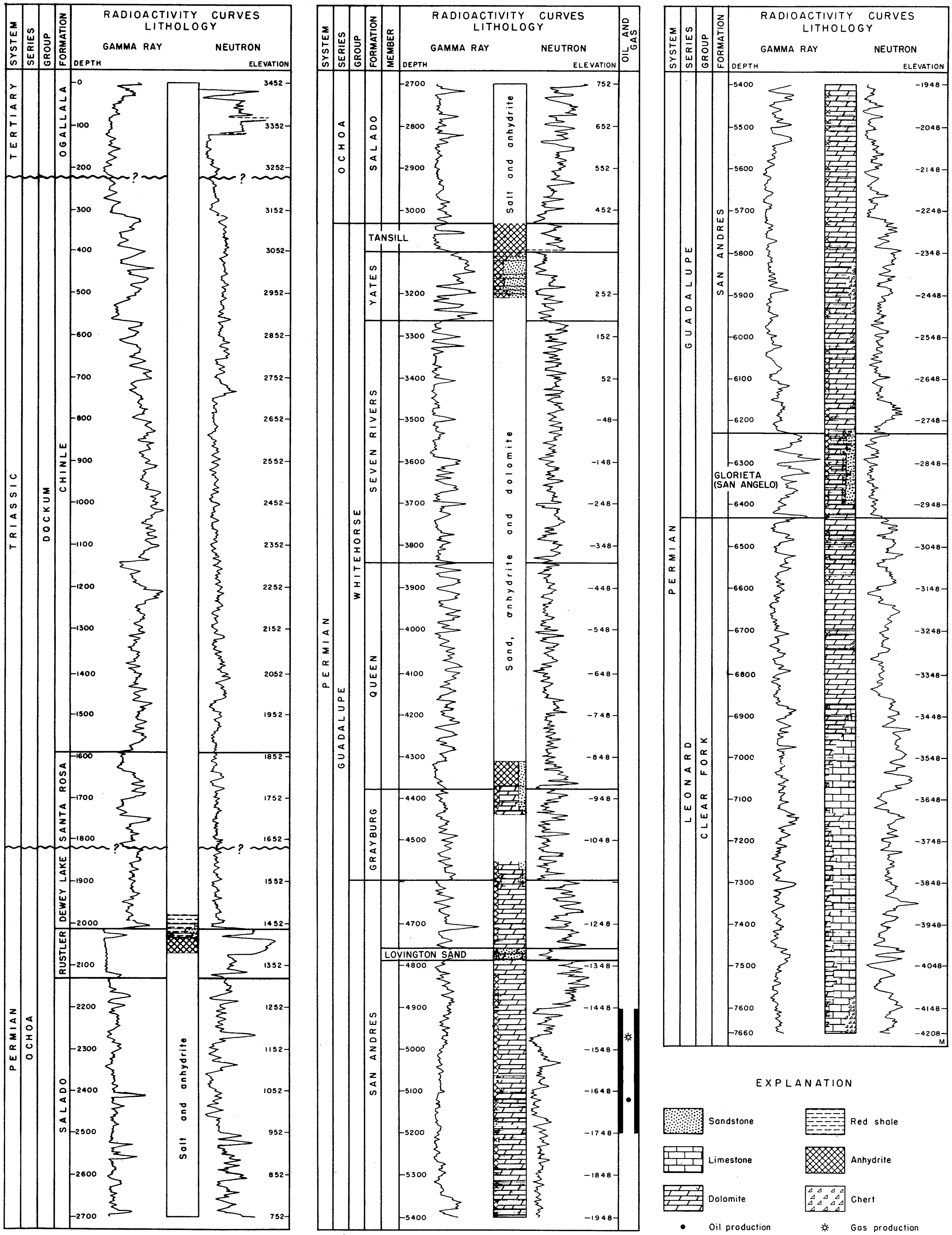
	Feet		
San Andres:	Min.	Max.	Avg.
From top to bottom	60	300	180

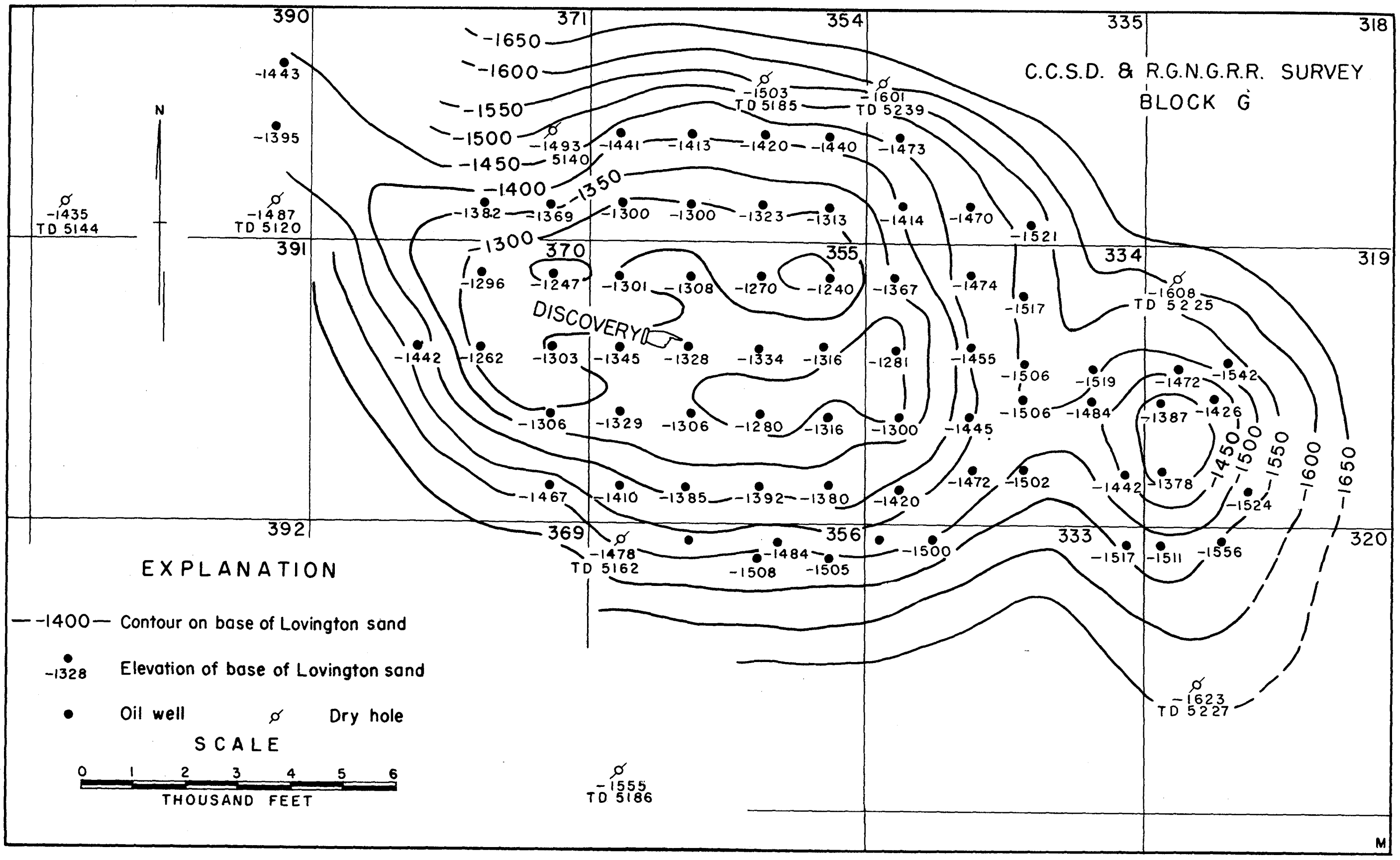
Net productive: 25% to 50% of gross from top to bottom

LITHOLOGY OF RESERVOIR ROCK

San Andres: Dolomite; medium crystalline, light brown and contains anhydrite inclusions. Throughout the field, except along the southwest flank, in that portion which is productive (25% to 50%) there is good, intercrystalline, solution type porosity which continues, but in less degree, out beyond the periphery of the field. The degree of porosity, as is characteristic of dolomite, is erratic and along the southwest flank approaches the lower limit for commercial production.

TYPICAL SECTION OF ROCKS PENETRATED





CONTINUITY OF RESERVOIR ROCK

San Andres: This reservoir rock is present throughout most of the Permian basin exclusive of that portion designated as Delaware basin. It is a prolific producing zone in numerous fields on the Central Basin platform and in scattered fields in the Midland basin and on the Eastern platform.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

San Andres:	Feet
Elevation of top of gas	-1,450
Elevation of bottom of gas	-1,585
Relief	135
Elevation of top of oil	-1,585
Elevation of bottom of oil	-1,650 to -1,760*
Relief	65 to 175

*The elevation of the oil-water contact was -1,760 feet, or lower, on the east end of the field; -1,750 on the highest part of the structure; -1,700 on the north, south and southwest flanks; -1,650 on the west and northwest extremities of present development.

The above figures represent conditions at the time of discovery of the field.

CHARACTER OF OIL

San Andres:	
Gravity, A.P.I. @ 60° F.,	30.5° to 36.5°
Sulphur,	1.18%
Color,	Dark green
Odor,	Sour

WATER PRODUCTION

San Andres: Only the lowermost edge wells have produced water in appreciable quantity.

ACID TREATMENT

San Andres: Several of the wells which would not produce their allowables without treatment were acidized with from 500 to 8,000 gallons of 15% acid. In practically all cases, the injection of acid resulted in substantially increased rates of production.

PRODUCTION HISTORY

San Andres and Field total:

Year	Wells Producing at end of year: Flowing	Pumping	Oil Production (barrels): Yearly	Cumulative
1948	4	1	20,685	20,685
1949	32	2	296,550	317,235
1950	41	5	736,738	1,053,973
1951	50	6	1,032,148	2,086,121
1952*	61	5	1,107,946	3,194,067

*1952 data added by amendment.

WHEAT FIELD

Loving County, Texas

F. H. REITER*
Geologist, Natural Gas Pipeline Co. of America, Amarillo, Texas
July 7, 1952

LOCATION

The Wheat field is located in southwest Loving County in Blocks 1 and 2 of the W. & N.W. R.R. Co. survey and Block 33 of the H. & T.C. R.R. Co. survey. It is near the geographic center of the Delaware basin, but on the west limb about one thousand feet higher than the synclinal axis.

METHODS OF EXPLORATION LEADING TO DISCOVERY

The first exploration was by random drilling and that was followed by interpretation of subsurface data. After the first well had been located by merely random drilling, Wallace Lee was consulted as to the locations for the second and third wells.

DISCOVERY

Bell Canyon: It was not until after completion of the third well that discovery of commercial production was proved. Although the first well, Toyah Bell Oil Co. #1 L. B. Russell (later, Ramsey Oil Co. #1 L. B. Russell), which was spudded in June 1920, flowed several heads of oil, it was never completed as a producing well. Because of bad casing and improper drilling, it was abandoned in 1925. The second well, Pecos Valley Petroleum Co. #1 J. J. Wheat (now Sinclair Prairie Oil Co. #1 A. S. Chapman or Wheat "B") was commenced in 1924 and, from a sand at depth of 4,212 to 4,259 feet, it produced 150 barrels of 40° gravity oil in four flows on September 1, 1925. On October 12, 1925, it was shot, but bridged 380 feet off bottom. At the close of that year, it had not yet been completed, but it appears that it was completed in 1926 as a 10-barrel well. The third well, Lockhart & Co. #1 R. L. Allen (now Sinclair Prairie Oil Co. #1 R. L. Allen), drilled in 1926, was also a small well until it was successfully shot in November 1927. The second well was then re-shot. The second and third wells having each shown capacity of about 100 barrels of oil per day, commercial production was considered proved and interest in the area was revived.

PRODUCTIVE AREA

Bell Canyon and Field: Approximately 4,600 acres. Further development is likely to increase this estimate.

*Formerly with Standard Oil Co. of Texas, Midland, Texas. The writer thanks John Emery Adams and Hugh N. Frenzel for their criticisms and the Standard Oil Co. of Texas for the use of its files.

ELEVATION OF SURFACE

At well locations: Highest, 2,790 ft.; lowest, 2,669 ft.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest stratigraphic horizon penetrated in the vicinity of the field is in the Bell Canyon formation of the Delaware Mountain group 930 feet below its top. This penetration was at the total depth of 5,083 feet at a location near the west edge of the field. The location may be identified on the accompanying map by the total depth figure.

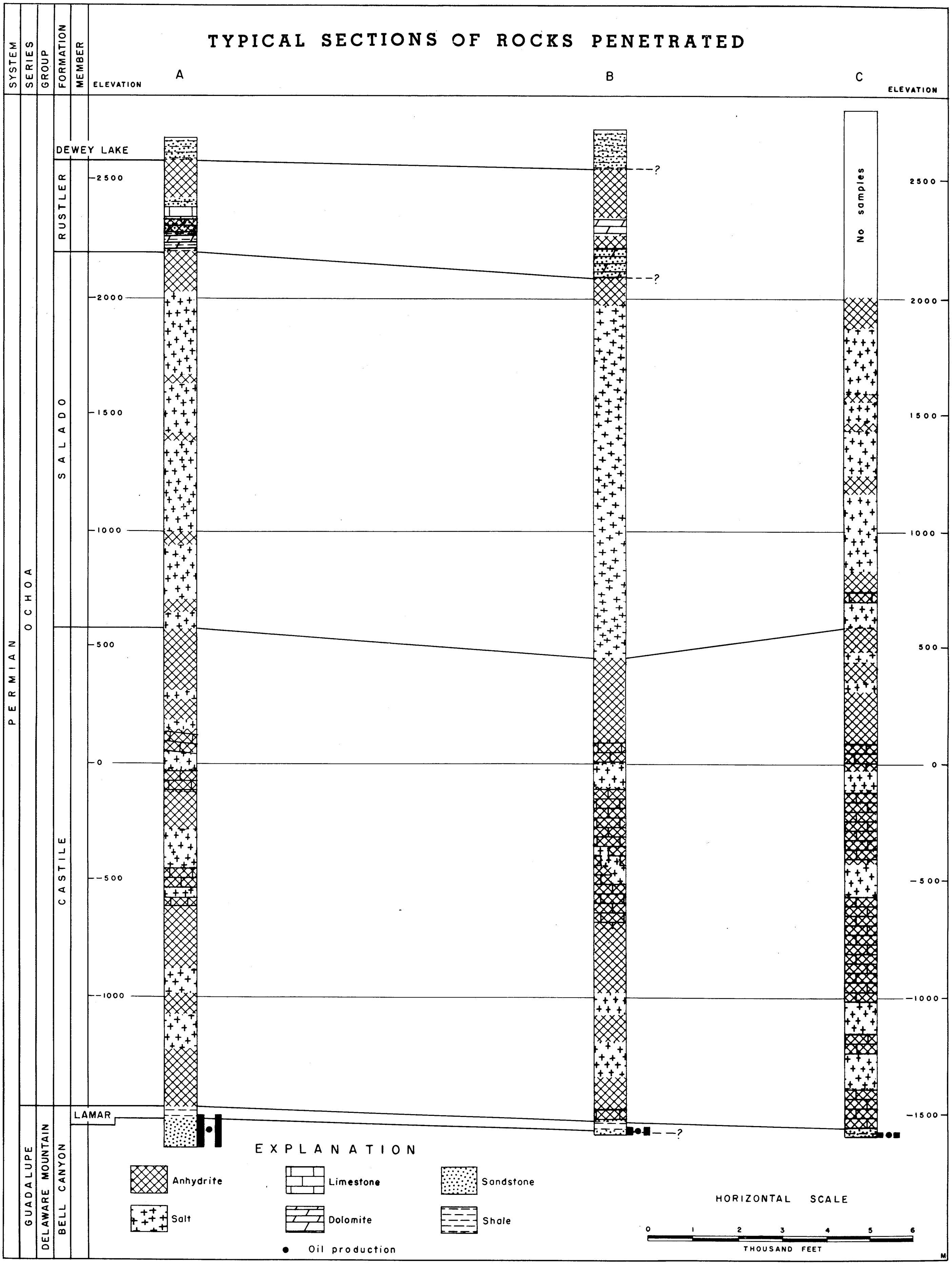
SURFACE FORMATIONS

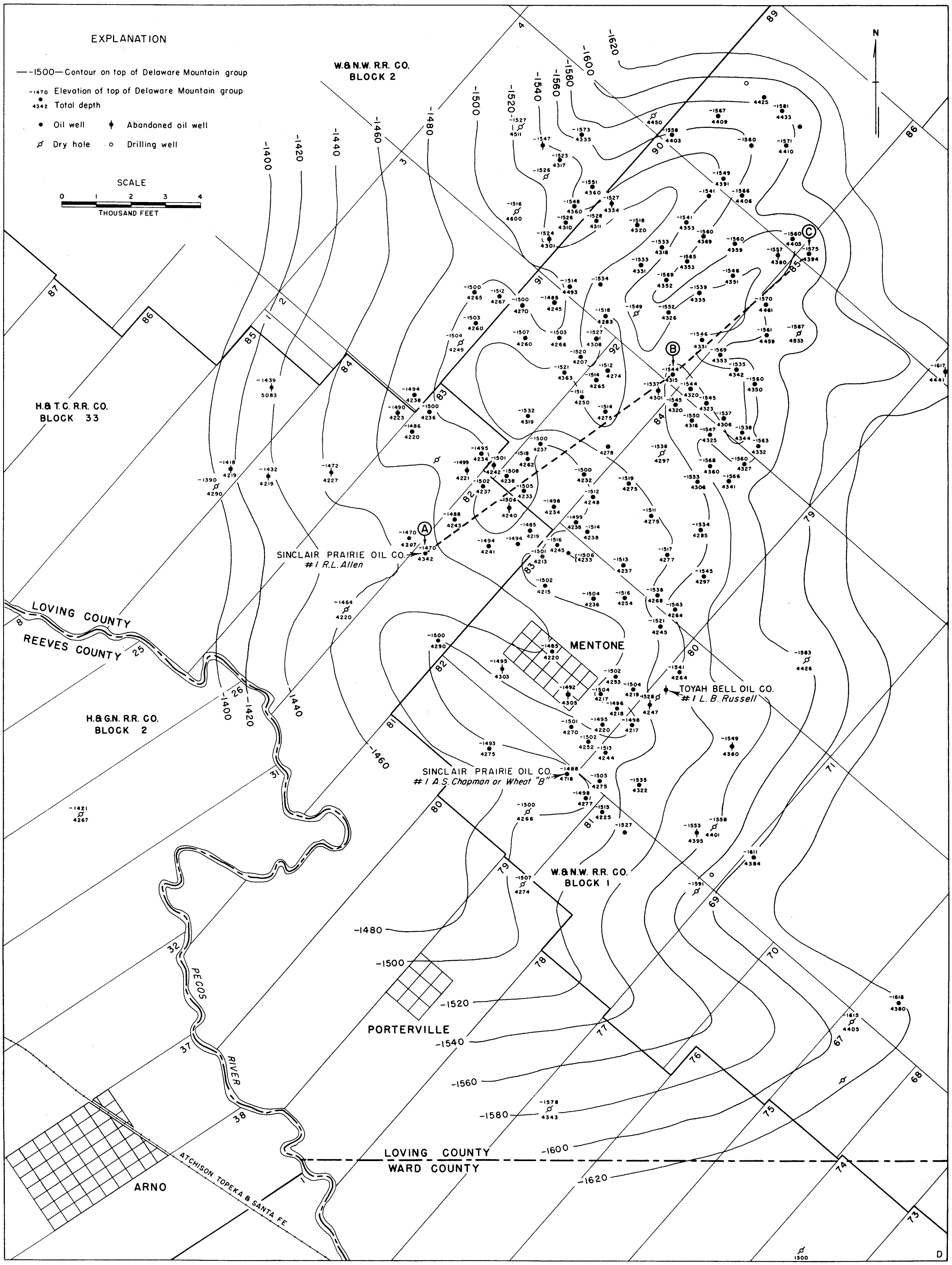
Recent caliche, alluvium and wind-blown sand.

NATURE OF TRAP and STRUCTURE

General structure: The Wheat field is on the west limb of the Delaware basin. The eastward dip at this location is less than normal and is interrupted by minor irregularities, as shown on the accompanying map. The general structural condition is essentially that of a terrace sloping gently eastward with much steeper east dip both east and west of the field.

Trap in Bell Canyon reservoir: Available facts are inadequate for positive determination of the factors which occasioned the accumulation of oil and gas. However, the facts appear to warrant the conclusion that the accumulation is due either to an open terrace or to updip decrease of permeability. The writer is inclined to favor the former interpretation. Geological evidence indicates that the structural noses at the top of the Delaware Mountain group were low closed convex folds prior to the Tertiary tilting of the entire Delaware basin. The fact that the oil is still at the location of the original convex folds can be explained by either of two theories. One is that the oil is actually moving updip, but the rate of movement is so slow and the time since tilting so short that the oil has not escaped yet. The second theory is that the oil is still trapped at the location of the original convex fold because the differential pressure between the oil reservoir and the water outside the reservoir is so slight that the water cohesion in the low permeability sand medium develops greater pressure in this capillary system than the differential pressure between the oil and water due to gravity differences and prevents updip migration.


SYSTEM
SERIES
GROUP
FORMATION
MEMBER
ELEVATION
TYPICAL SECTIONS OF ROCKS PENETRATED
A
B
C
ELEVATION
PERMIAN
OCHOA
GUADALUPE
DELAWARE MOUNTAIN
BELL CANYON
DEWEY LAKE
RUSTLER
SALADO
CASTILE
LAMAR
2500
2000
1500
1000
500
0
-500
-1000
-1500
No samples
EXPLANATION
Anhydrite
Salt
Limestone
Dolomite
Sandstone
Shale
Oil production
HORIZONTAL SCALE
0 1 2 3 4 5 6
THOUSAND FEET


EXPLANATION
—-1500— Contour on top of Delaware Mountain group
-1470 Elevation of top of Delaware Mountain group
4342 Total depth
Oil well
Abandoned oil well
Dry hole
Drilling well
SCALE
0 1 2 3 4
THOUSAND FEET
W.& N.W. R.R. CO. BLOCK 2
H.& T.C. R.R. CO. BLOCK 33
H.& G.N. R.R. CO. BLOCK 2
W.& N.W. R.R. CO. BLOCK 1
SINCLAIR PRAIRIE OIL CO. #1 R.L. Allen
SINCLAIR PRAIRIE OIL CO. #1 A.S. Chapman or Wheat "B"
TOYAH BELL OIL CO. #1 L. B. Russell
MENTONE
PORTERVILLE
ARNO
LOVING COUNTY
REEVES COUNTY
WARD COUNTY
PECOS RIVER
ATCHISON TOPEKA & SANTA FE
N

THICKNESS OF RESERVOIR ROCK

Bell Canyon: The reservoir is primarily in the upper 8 to 15 feet of a sandstone which has a total thickness of approximately 30 feet. This sandstone is overlain by about 30 feet of calcareous Lamar shale at the top of the Delaware Mountain group. In some wells, the lower 2 to 4 feet of this shale produces oil from vertical fractures which allow migration of the oil upward from the sandstone.

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: The productive sandstone is dark gray, fine, soft and slightly calcareous, grading downward into a hard, light gray, tight sandstone. The shale above is hard, black, sandy and also slightly calcareous. The shale is intensely fractured and many of the fractures contain secondary calcite.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The reservoir rock appears to be continuous throughout a very large area. There is a sandstone at the same stratigraphic position throughout a large portion of the Delaware basin. The productive reservoir in the Mason field appears to be at the same stratigraphic position.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet
Highest known elevation of oil	-1,410
Lowest known elevation of oil	-1,640
Known relief	230

CHARACTER OF OIL

Bell Canyon:
- Gravity: A.P.I. @ 60° F., 38°
- Sulphur: 0.14%
- Base: Intermediate and paraffinic-intermediate.

For analyses see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 34 and 65.
U. S. Bureau of Mines. Lab. ref. No. 26180 32207
Tabulated Analyses of Texas Crude Oils.
R. I. 3252 (1934) Grp. 2, Item 65 66
Tabulated Analyses of Texas Crude Oils.
T. P. 607 (1939) Grp. 2, Item 92 91
Analyses of Crude Oils from Some West Texas Fields R. I. 3744 (1944) page 43

CHARACTER OF GAS

Bell Canyon: Only a small amount of gas was found. It appeared to be in solution in the oil. The greatest volume of gas produced by any one well was at a rate slightly in excess of 250 Mcf per day. The gas is sweet and contains small quantities of gasoline.

WATER PRODUCTION

Bell Canyon: Only a small amount of water was ever produced with the oil. Generally the water production has been at about the ratio of one barrel of water to one hundred barrels of oil.

COMPLETION TREATMENT

Bell Canyon: In process of completion, the wells have been shot generally with 75 to 300 quarts of nitroglycerin; average, 100 quarts.

RESERVOIR ENERGY

Bell Canyon: The trend of gas-oil ratios indicates a dissolved gas drive with the possibility that gravity drainage becomes effective during the later producing life. Although a small quantity of water has always been produced with the oil, there appears to be no effective water drive. There has never been a gas cap drive; there was no free gas at the time of discovery nor has gas coming out of solution accumulated in sufficient quantity to form a gas cap.

SELECTED REFERENCES

Adams, J. E. (1936) Oil pool of open reservoir type: Amer. Assoc. Petr. Geol., Bull., vol. 20, pp. 780-795.

Wilson, W. B. (1936) Discussion of above paper; ibid., pp. 795-796.

PRODUCTION HISTORY

Bell Canyon and Field total:

Year	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
1926				2,168
1927			11,288	13,456
1928			68,488	81,944
1929			249,329	331,273
1930			668,215	999,488
1931			1,254,555	2,254,043
1932	57	5	1,125,965	3,380,008
1933	64	5	926,746	4,306,754
1934	69	4	802,144	5,108,898
1935	71	4	695,727	5,804,625
1936	74	4	604,496	6,409,121
1937	73	5	525,913	6,935,034
1938	53	14	457,636	7,392,670
1939	56	27	403,009	7,795,679
1940	54	31	394,676	8,199,355
1941	39	49	397,463	8,587,818
1942	37	49	339,251	8,927,069
1943	34	53	296,388	9,223,457
1944	32	54	276,554	9,500,011
1945	28	51	254,969	9,754,980
1946	23	54	248,510	10,003,490
1947	16	60	262,378	10,265,868
1948	14	61	257,203	10,523,071
1949	15	61	247,275	10,770,346
1950	16	65	260,061	11,030,407
1951	20	80	318,895	11,349,302
1952*	19	92	440,834	11,790,136

*1952 data added by amendment.

There had been a total of 128 productive wells completed prior to July 1, 1952.

WHEELER FIELD

Ector and Winkler Counties, Texas

R. E. LeBLOND
Consulting Geologist, Midland, Texas
May 10, 1956

LOCATION

The Wheeler field is on the common line of Ector and Winkler counties about 30 miles west of Odessa, county seat of Ector County, and 20 miles east of Kermit, county seat of Winkler County. It is near the geographic center of the Central Basin platform, which is the dominant structural feature of the Permian basin.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Credit for discovery of the field is due to reflection seismograph work. Both Shell Oil Co. and Stanolind Oil & Gas Co. conducted seismic surveys in the area in 1940 and 1941. The bulk of the acreage was under lease to Shell and that company commenced drilling on July 22, 1942. When the well had reached a depth of 9,437 feet, Stanolind acquired a one-half interest in the well and block of leases and assumed operation of the well. The well was then drilled to 10,697 feet, where, on July 9, 1943, it was completed as the discovery well; it flowed at the rate of 1,370 barrels of oil per day from the Ellenburger dolomite.

DISCOVERIES

Devonian: April 2, 1945;
Sun Oil Company #1 R. A. Wheeler

Fusselman: December 5, 1945;
Stanolind Oil & Gas Co. and Shell Oil Co. #1 Waddell Bros. & Co.

Ellenburger and Field: July 9, 1943;
Stanolind Oil & Gas Co. and Shell Oil Co. #1 W. D. Blue.

ELEVATION OF SURFACE

At well locations: Highest, 3,165 ft.; lowest, 3,051 ft.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 262 feet below its top. This penetration was in Phillips Petroleum Co. #G-1 T. & P. Lands Trust, located in the south corner of Sec. 11, Blk. 46, where the total depth of 10,677 feet is indicated on an accompanying map.

SURFACE FORMATIONS

Quaternary sand; mainly recent wind-blown sand.

NATURE OF TRAPS and STRUCTURE

The Wheeler structure is a bifurcated anticlinal fold. Its principal axis trends northwest-southeast in conformity with the general grain of the country. The oil in each of the three reservoirs is trapped along the crest of the fold. Although the anticline has two separate, nearly parallel, minor closures, the separate closures are not determinative except that the eastern one has occasioned accumulation of gas to form a local gas cap; oil extends downdip beyond the elevation of the minor closures.

Some geologists believe that the Wheeler structure is faulted; there is certainly some evidence in favor of faulting. Steep dip along the northeast flank of the west segment of the anticline is suggestive of normal faulting with downthrow to the east, and a similar situation exists on the east flank of the east segment. None of the wells, however, has intersected a fault, and apparently any faults which may be present have not disturbed the continuity of any of the three reservoirs. Until further drilling proves the presence of one or more faults, it is believed that the unfaulted version here presented is a more reasonable interpretation of the available data.

PRODUCTIVE AREAS

	Acres
Devonian	2,760
Fusselman	Not defined
Ellenburger	2,700
Wheeler field	2,800±

Development has defined fairly definitely the extent of the productive areas of the Devonian and Ellenburger reservoirs; the above figures represent reasonably close estimates as to these reservoirs. The Fusselman reservoir, however, is still in a preliminary stage of development with only 5 producing wells. Drill-stem tests and production tests in several wells drilled deeper throughout the field indicate that the porosity and permeability of the Fusselman reservoir rock are irregular. While it is a potentially good producer at several locations, it will not be productive throughout the area of the field.

LITHOLOGY OF RESERVOIR ROCKS

Devonian: This reservoir rock, which constitutes the upper 150 to 200 feet of the Devonian system, consists principally of chert with minor amounts of siliceous limestone. It contains chert in amounts ranging from 60% to 100% and includes a thin medium-grained glauconitic sandstone occurring about 140 feet below the top of the Devonian. This sandstone, which is 10 to 15 feet thick, produces oil in some wells; locally it is very hard and tightly cemented. The oil production is largely from the main chert body. The chert itself has a characteristic blue-white color and is intensely fractured. The limestone varies in texture from granular to coarsely crystalline and, in color, from tan to white. There are generally two zones of favorable porosity; however, at the locations of some wells, the two zones apparently merge and cannot be distinguished on electrical logs. The reservoir rock is intricately fractured, with vugs and cavities developed along fractures and bedding planes and especially at intersections of fractures and bedding planes. Very probably the two favorably porous zones represent exceptional development of cavernous or vuggy porosity. It appears likely that the entire reservoir is connected by means of vertical fracturing. The lower 250 feet of less cherty Devonian limestone contains too little oil to make it commercially productive; therefore it is not properly considered as a part of the reservoir rock.

Fusselman: This reservoir rock is a coarsely crystalline limestone, generally white, but with a pinkish cast at some places. Minor amounts of milky white chert occur throughout. The productive section seems to be confined largely to the upper 60 to 70 feet of the Fusselman formation. While generally the reservoir rock appears to be uniformly porous throughout, at the locations of a few wells, the upper 20 to 30 feet has higher than normal porosity. This zone with higher porosity is separated from the main body of reservoir rock by a thin, less porous zone. Probably fracturing and its attendant secondary vuggy or cavernous porosity accounts for little of the effective porosity of this reservoir rock. Intercrystalline porosity of the coarsely crystalline limestone constitutes most of the porosity. Permeability is quite irregular; at the locations of many wells, it is of a low order. Tests of the lower part of the Fusselman formation generally indicate the presence of little or no oil.

Ellenburger: This reservoir rock varies from very-fine-grained gray to rather coarsely crystalline, white-to-tan dolomite. It contains bands of darker colored dolomite at many places. Very minor amounts of chert occur, and there are occasional very thin partings of gray shale. Like that in the Devonian, the Ellenburger reservoir rock is highly fractured throughout and contains numerous vugs and cavities along fractures and bedding planes and especially at intersections of fractures and bedding planes. The reservoir cannot be subdivided into zones on the basis of porosity. It is probably interconnected from top to bottom by vertical fractures. In small local areas, the upper 20 to 50 feet of Ellenburger is tight, probably because of cementation of the fractures. Productive rock occurs throughout the tested portion of the Ellenburger group. The thickness of productive rock at any location is determined by the structural position; i. e., by the elevation of the top with respect to the elevation of the oil-water contact.

Basis for descriptions: There has been only very little coring of any of the reservoir rocks. The above descriptions are based largely on cuttings.

RESERVOIR ENERGY

Devonian: Expulsion by gas expansion was evident from the time of discovery, and it was evident that reservoir energy was due in part at least to gas coming out of solution. During the course of development of the field, it was found that a small gas cap existed on the crest of the dome in the eastern part of the field. After about three years of operations, there was a rather sharp increase in the amount of water production, particularly in the flank wells in the southern part of the field. At present, most of the wells produce some water. It is now evident that water drive also contributes to reservoir energy.

Fusselman: With only five wells having been completed for production from this reservoir, very little is known about the reservoir energy. It is presumed that expulsion is due primarily to gas coming out of solution; however, it is quite possible that there is a gas cap although none has yet been detected. The existence of a gas cap is in harmony with certain evidence, particularly, fairly high gas-oil ratios in the production of two wells and the showing of gas and condensate during a drill-stem test of another well. Some water is being produced, but there is no conclusive evidence of an effective water drive.

Ellenburger: This reservoir has an effective water drive. Water encroachment has been fairly uniform throughout the field. However, in spite of the fairly uniform encroachment, the elevation of the oil-water contact is now quite irregular, due mainly to irregularity of porosity and permeability and particularly to vertical fractures. As is characteristic of water-drive reservoirs, the bottom-hole pressure has declined only slightly from what it was at the time of discovery; i. e., 4,580 psi. There is no free gas cap in this reservoir.

THICKNESSES OF RESERVOIR ROCKS

Top to bottom:

	Feet		
	Min.	Max.	Avg.
Devonian	30	290	205
Fusselman	60	90	70
Ellenburger	342	342.	342

Net Productive:

The character of each reservoir rock is such that estimates of net productive thicknesses are of little accuracy or value.

CONTINUITY OF RESERVOIR ROCKS

Devonian: The reservoir rock is continuous throughout the area of the field and probably throughout a much larger surrounding area. It is part of the widely distributed Devonian system, which is recognizable over much of the Central Basin platform and outcropping in the mountainous areas many miles to the west and south. The producing zone in the Wheeler field is at the same stratigraphic position as one in the nearby TXL field and at essentially the same stratigraphic position as productive Devonian in several other fields.

Fusselman: The reservoir rock in the Fusselman formation appears to be continuous throughout the area of the field. However, porosity and permeability are quite variable--too low for commercial production at some places and probably too low in small local areas to permit migration of reservoir fluids even in geologic time.

Ellenburger: The reservoir rock in the Ellenburger group is continuous throughout the area of the field and probably throughout a much larger surrounding area. The Ellenburger group is widely distributed and is generally productive where structural conditions afford traps. It appears that a zone at the top of the Ellenburger is continuously favorable for migration of reservoir fluids throughout an enormous area in West Texas.

CHARACTER OF GAS

No analysis of gas from any of the reservoirs is available to the writer. Although a substantial amount of gas is produced with the oil from each reservoir, no important gas reserve is known to exist. Until September 1948, all of the gas production was flared, there being no gas processing plant available to handle the gas being produced. During September 1948, the Shell Oil Company's TXL gasoline plant was put into operation, and part of the gas is now being processed at this plant.

CHARACTER OF RESERVOIR WATERS

Devonian: Average chloride content, 39,235 parts per million (based on three samples).

Fusselman: No information available.

Ellenburger: Average chloride content, 94,700 parts per million (based on five samples).

COMPLETION TREATMENT

Devonian: Some Devonian wells were completed "natural"; others were acidized. The treatment depended on the behavior of each individual well. In some wells, only a 500-gallon mud acid wash was necessary, but treatments of as much as 15,000 gallons have been used. Ordinarily 2,000 to 5,000 gallons is the maximum amount of acid required.

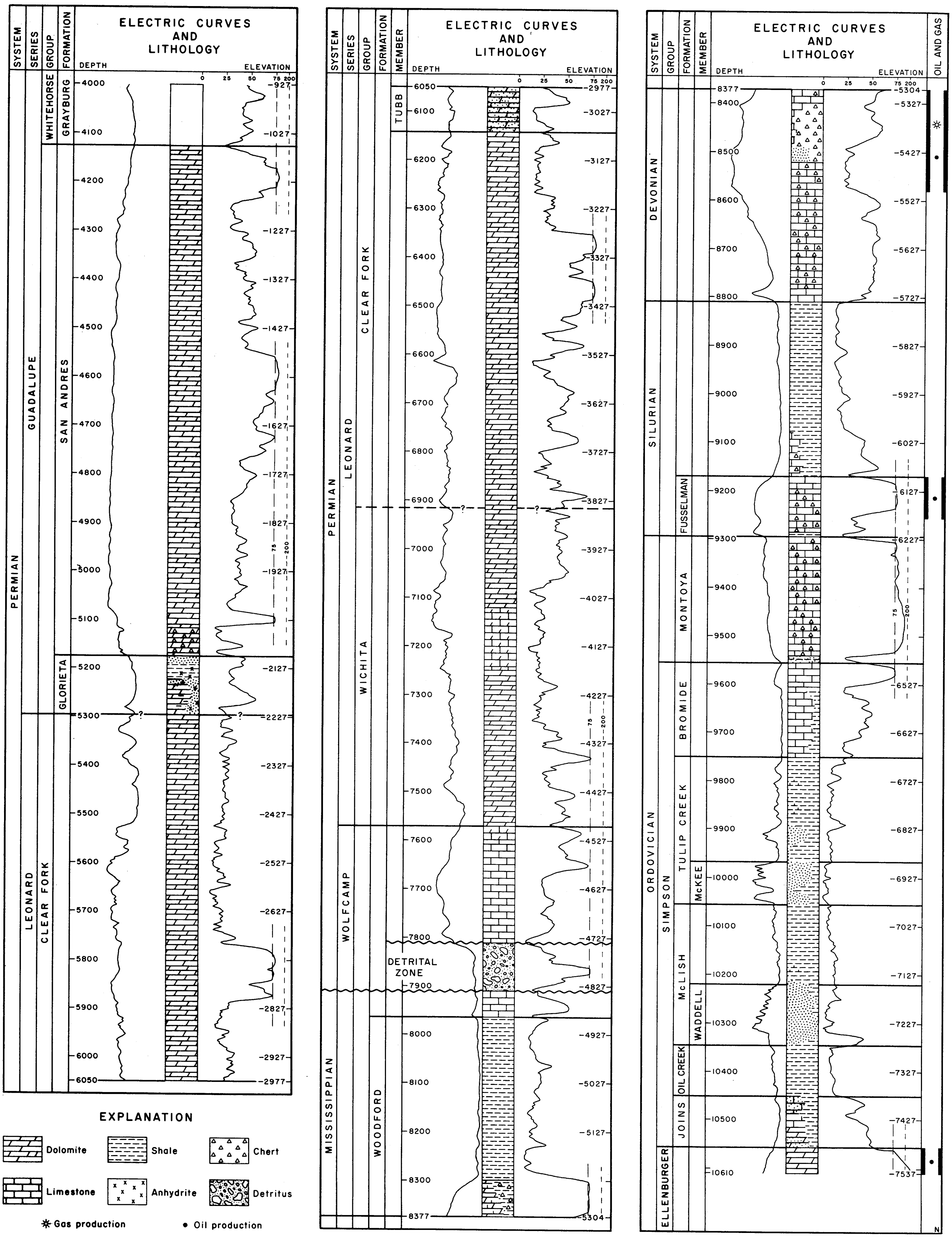
Fusselman: One well was very heavily acidized; about 20,000 gallons of acid was injected before production was obtained. One was completed "natural" and another was treated with 1,000 gallons of acid.

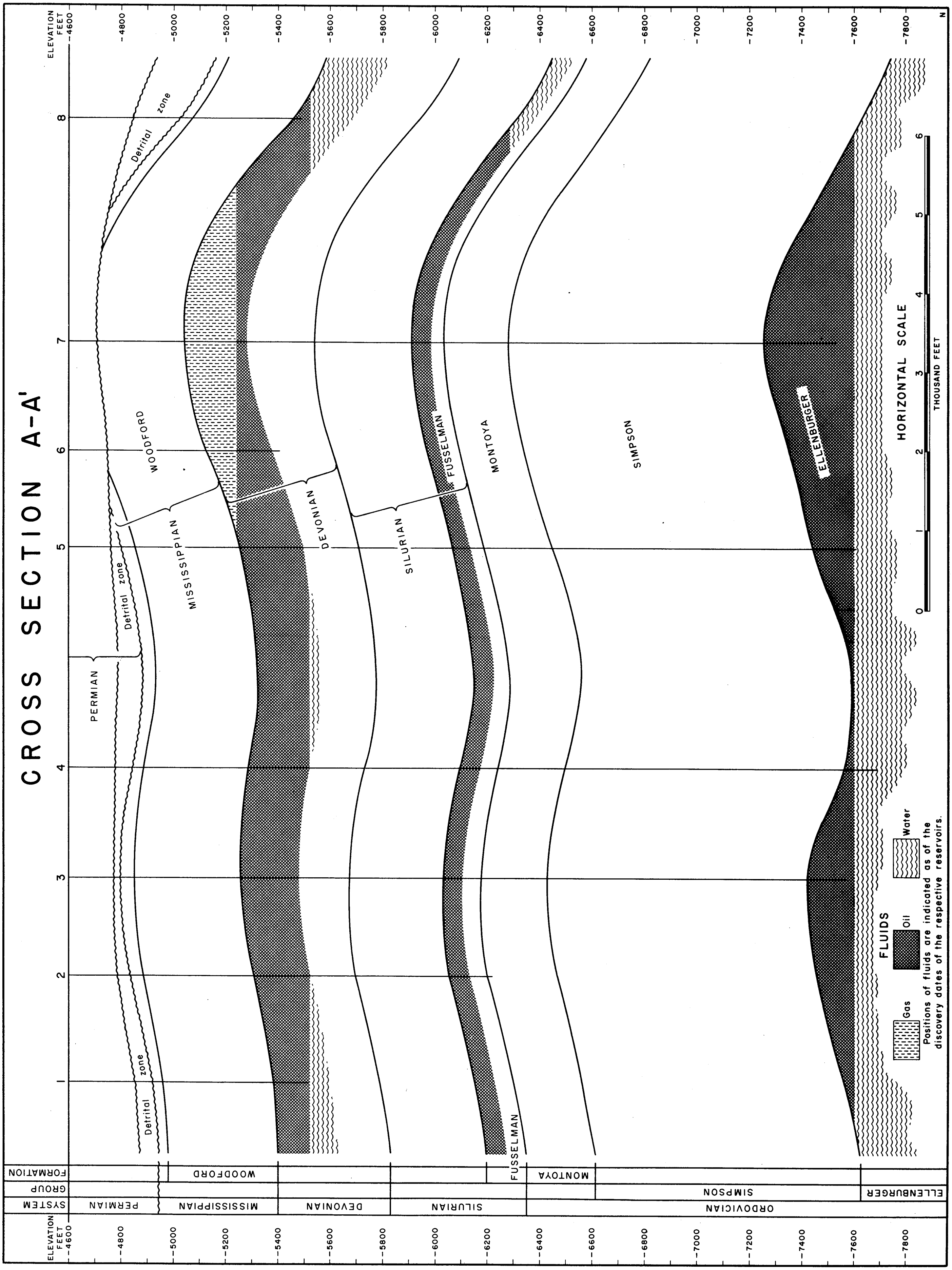
Ellenburger: Practically all Ellenburger completions have been "natural". However, in a few wells a 500-gallon mud acid wash was used to clean the reservoir before starting production. In a few instances, treatments of 1,000 to 3,000 gallons have been used where the Ellenburger was unusually tight.

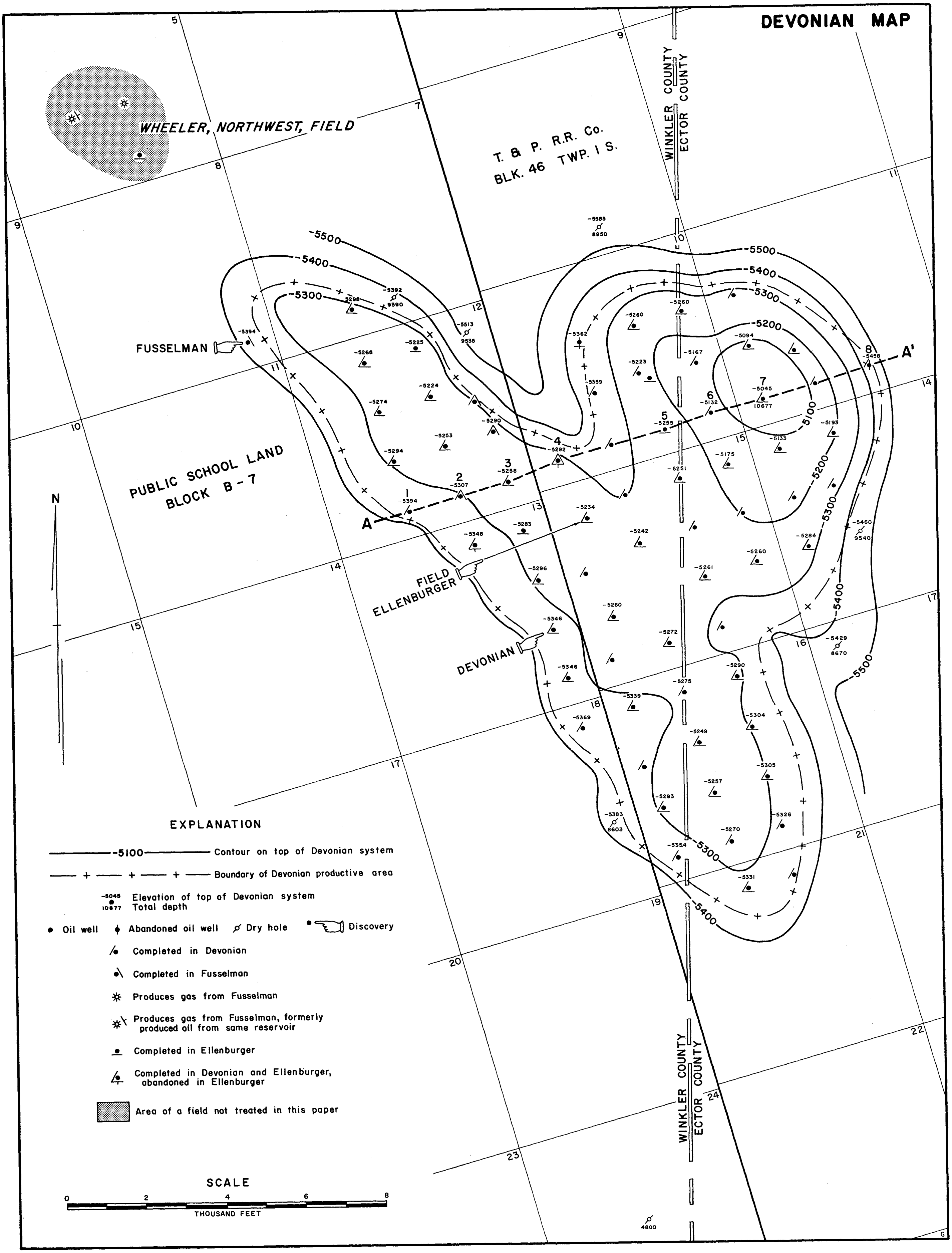
FOOTNOTE TO PRODUCTION HISTORY

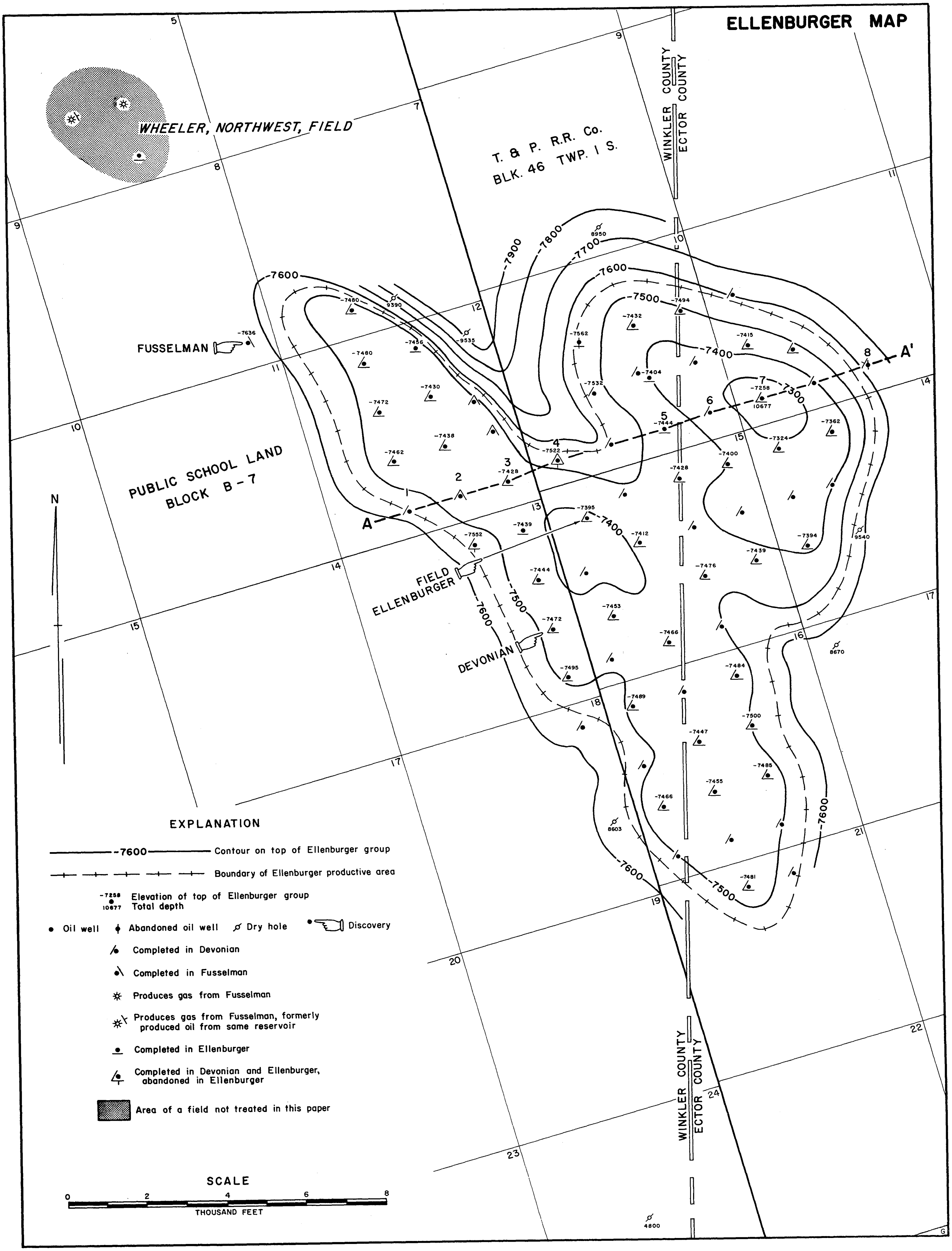
With reference to certain entries in the tabulation headed PRODUCTION HISTORY on a following page, the total number of wells producing in the field at the end of each year after 1944 was less than the sum of the figures representing the number of wells producing from the respective reservoirs; some wells produce from two reservoirs. Because of the many duel completions, available data are so confused that it is not practical to determine the net number of wells producing at the end of each year. The usual practice with dually completed wells is to discontinue operations in a reservoir whenever flowing stops; then, at a later date when the other reservoir ceases flowing, pumping is initiated to produce from either one or the other of the reservoirs. Procedures of experimenting and switching from one reservoir to the other make it impractical to determine status at the end of each year.

TYPICAL SECTION OF ROCKS PENETRATED




CROSS SECTION A-A'
ELEVATION FEET
-4600
-4800
-5000
-5200
-5400
-5600
-5800
-6000
-6200
-6400
-6600
-6800
-7000
-7200
-7400
-7600
-7800
N
SYSTEM
GROUP
FORMATION
PERMIAN
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
WOODFORD
FUSSELMAN
MONTOYA
SIMPSON
ELLENBURGER
Detrital zone
Detrital zone
Detrital zone
PERMIAN
WOODFORD
MISSISSIPPIAN
DEVONIAN
SILURIAN
FUSSELMAN
MONTOYA
SIMPSON
ELLENBURGER
FUSSELMAN
1
2
3
4
5
6
7
8
FLUIDS
Gas
Oil
Water
Positions of fluids are indicated as of the discovery dates of the respective reservoirs.
HORIZONTAL SCALE
THOUSAND FEET
0
1
2
3
4
5
6


DEVONIAN MAP
WHEELER, NORTHWEST, FIELD
T. & P. R.R. Co.
BLK. 46 TWP. 1 S.
WINKLER COUNTY
ECTOR COUNTY
PUBLIC SCHOOL LAND
BLOCK B-7
FUSSELMAN
FIELD
ELLENBURGER
DEVONIAN
A
A'
N
EXPLANATION
-5100 Contour on top of Devonian system
Boundary of Devonian productive area
-5045 10677 Elevation of top of Devonian system Total depth
Oil well
Abandoned oil well
Dry hole
Discovery
Completed in Devonian
Completed in Fusselman
Produces gas from Fusselman
Produces gas from Fusselman, formerly produced oil from same reservoir
Completed in Ellenburger
Completed in Devonian and Ellenburger, abandoned in Ellenburger
Area of a field not treated in this paper
SCALE
0 2 4 6 8
THOUSAND FEET


ELLENBURGER MAP
WHEELER, NORTHWEST, FIELD
T. & P. R.R. Co.
BLK. 46 TWP. 1 S.
WINKLER COUNTY
ECTOR COUNTY
PUBLIC SCHOOL LAND
BLOCK B-7
FUSSELMAN
FIELD ELLENBURGER
DEVONIAN
A
A'
N
EXPLANATION
-7600 Contour on top of Ellenburger group
Boundary of Ellenburger productive area
-7258 10677 Elevation of top of Ellenburger group Total depth
Oil well
Abandoned oil well
Dry hole
Discovery
Completed in Devonian
Completed in Fusselman
Produces gas from Fusselman
Produces gas from Fusselman, formerly produced oil from same reservoir
Completed in Ellenburger
Completed in Devonian and Ellenburger, abandoned in Ellenburger
Area of a field not treated in this paper
SCALE
0 2 4 6 8
THOUSAND FEET

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Devonian	Fusselman	Ellenburger
Sub-sea elevation of top of gas, feet	-5,092	Presence of free gas cap not established	No free gas cap
Sub-sea elevation of bottom of gas, feet	-5,240		
Gas column, feet	148		
Sub-sea elevation of top of oil, feet	-5,240	-6,057§	-7,258
Sub-sea elevation of bottom of oil, feet	-5,525 to -5,450*	-6,286§	-7,600**
Oil column, feet	210 to 285	229§	342**

All reservoirs: The above figures represent conditions as of respective discovery dates.

* Devonian: The sub-sea elevation of the oil-water contact ranged from -5,525 feet in north and central part of field to -5,450 in extreme south part of field.

§ Fusselman: The oil column or gas-oil column may be as much as 100 feet greater than estimated from data now available. The exact extent and nature of the hydrocarbon column will not be known until after completion of additional wells.

** Ellenburger: Water encroachment has materially changed the elevation of the oil-water contact. Due mainly to irregularity of porosity and permeability, and particularly to vertical fractures, the elevation of the oil-water contact is now so irregular that it is difficult to present a reasonably accurate understanding of the present condition. However, roughly, the oil-water contact is now generally about 50 feet higher than it was at time of discovery of the field.

RESERVOIR TEMPERATURE and PRESSURE and OIL SAMPLE DATA

	Devonian	Fusselman	Ellenburger
Original reservoir pressure, psi.	3,636	-	4,580
Original reservoir temperature, °F.	122	-	146
Gravity of oil, A. P. I. @ 60°F.	38	31	45
Sulphur in oil, %	0.86	-	0.2
Bubble point, psi.	3,600	-	2,830
Solution gas-oil ratio, cf/bbl.	1,937	-	1,360
Volume factor, surface:reservoir	1.505	-	1.75

Devonian and Ellenburger data were determined from bottom hole samples. Corresponding data are not available for the Fusselman reservoir.

WATER PRODUCTION

	Devonian			Fusselman			Ellenburger		
	No. of wells producing water	Water production (barrels)	%	No. of wells producing water	Water production (barrels)	%	No. of wells producing water	Water production (barrels)	%
1943	--	---	---	--	---	---	0	0	0.0
1944	--	---	---	--	---	---	0	0	0.0
1945	0	0	0.0	1	200	18.3	2	29,601	4.1
1946	0	0	0.0	1	1,805	14.5	6	29,062	3.2
1947	2	4,070	0.4	1	2,410	17.2	17	83,997	5.5
1948	7	13,310	0.7	2	3,073	4.5	23	228,351	10.1
1949	39	65,104	4.5	2	13,188	18.3	26	247,308	13.5
1950	46	89,458	7.5	3	5,823	12.6	33	580,997	28.2
1951	51	110,265	11.3	4	25,300	43.4	38	1,025,411	38.1
1952	50	118,283	20.6	2	34,228	53.4	35	875,515	40.3
1953	41	170,207	31.6	2	31,556	49.5	34	1,752,970	61.2
1954	?	145,134	33.2	?	4,711	13.1	?	1,533,529	66.4
1955	?	?	?	?	?	?	?	?	?

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)	
	Flowing	Pumping	Yearly	Cumulative	Yearly	Cumulative
Field totals						
1943	1	0	40,587	40,587	0	0
1944	8	0	305,193	345,780	425,439	425,439
1945	*	*	760,442	1,106,222	1,426,149	1,851,588
1946	*	*	1,297,504	2,403,726	1,747,121	3,598,709
1947	*	*	2,373,106	4,776,832	3,332,237	6,930,946
1948	*	*	4,057,058	8,833,890	5,523,742	12,454,688
1949	*	*	3,026,658	11,860,548	4,600,697	17,055,385
1950	*	*	2,624,178	14,484,726	5,743,145	22,798,530
1951	*	*	2,566,884	17,051,610	6,053,976	28,852,506
1952	*	*	1,781,637	18,833,247	5,123,455	33,975,961
1953	*	*	1,513,624	20,346,871	4,632,531	38,608,492
1954	*	*	1,099,145	21,446,016	4,103,142	42,711,634
1955	*	*	949,572	22,395,588	?	?
Devonian						
1945	3	0	68,908	68,908	76,687	76,687
1946	12	0	398,549	467,417	491,291	567,978
1947	32	1	924,865	1,392,282	1,319,013	1,886,991
1948	44	2	1,931,969	3,324,251	2,743,968	4,630,959
1949	45	7	1,377,106	4,701,357	2,397,164	7,028,123
1950	44	7	1,101,573	5,802,930	3,314,973	10,343,096
1951	43	7	866,307	6,669,237	3,621,100	13,964,196
1952	36	10	455,177	7,124,414	2,987,980	16,952,176
1953	26	16	367,892	7,492,306	2,696,622	19,648,798
1954	22	18	292,511	7,784,817	2,477,573	22,126,371
1955	24	16	277,017	8,061,834	?	?
Fusselman						
1945	0	1	893	893	1,883	1,883
1946	0	1	10,650	11,543	2,109	3,992
1947	1	1	11,572	23,115	503	4,495
1948	3	1	65,549	88,664	129,206	133,701
1949	3	1	58,869	147,533	85,744	219,445
1950	1	2	40,467	188,000	121,198	340,643
1951	1	2	33,026	221,026	92,488	433,131
1952	1	2	29,855	250,881	86,825	519,956
1953	2	1	32,176	283,057	108,919	628,875
1954	2	1	31,371	314,428	107,752	736,627
1955	3	2	67,260	381,688	?	?
Ellenburger						
1943	1	0	40,587	40,587	0	0
1944	8	0	305,193	345,780	425,439	425,439
1945	13	0	690,641	1,036,421	1,347,579	1,773,018
1946	21	0	888,345	1,924,766	1,253,721	3,026,739
1947	35	0	1,436,669	3,361,435	2,012,721	5,039,460
1948	37	1	2,059,540	5,420,975	2,650,568	7,690,028
1949	35	2	1,590,683	7,011,658	2,117,789	9,807,817
1950	35	2	1,482,138	8,493,796	2,306,974	12,114,791
1951	38	0	1,667,551	10,161,347	2,340,388	14,551,179
1952	26	9	1,296,605	11,457,952	2,048,650	16,503,829
1953	21	13	1,113,556	12,571,508	1,826,990	18,330,819
1954	15	17	775,263	13,346,771	1,517,817	19,848,636
1955	13	17	605,295	13,952,066	?	?

* See FOOTNOTE to PRODUCTION HISTORY entered on a preceding page.

WHITE & BAKER — WALKER FIELD

Pecos County, Texas

JAMES P. MURPHY
Geologist, Sinclair Oil & Gas Co., Midland, Texas
May 7, 1954

LOCATION and FIELD NAMES

The White & Baker — Walker field is in eastern Pecos County about 40 miles east of Fort Stockton, and is between the Taylor-Link field and the Yates field. It is on the Central Basin platform near the southern end of that platform.

The area treated herein as the White & Baker-Walker field includes areas treated by the Railroad Commission as the White & Baker field, as the Walker field and as a part of the Taylor-Link field. The dividing lines between the Commission areas are indicated on the accompanying map.

The accompanying map covers an area extending beyond the area of the White & Baker-Walker field and includes, near the southwestern corner, a portion of the Taylor-Link field and, near the eastern margin, the one well which constituted the noncommercial Lowery & Wilson (San Andres) field, which is treated briefly in the following paragraph. The Taylor-Link field is treated in another paper in this volume.

NEAR-BY NONCOMMERCIAL PROSPECT

The location of the well which prompted the designation of the Lowery & Wilson (San Andres) field is near the eastern margin of the area covered by the accompanying map. Helmerich & Payne, Inc. #1-F Lowery & Wilson was completed on July 25, 1951, in the San Andres formation with an initial daily flowing potential of 59 barrels of 33.8° gravity oil. The productive reservoir was reported at the depth of 2,000-2,012 feet; the top of the San Andres formation, 1,990 feet; total depth, 2,019 feet. The well produced 1,194 barrels of oil during 1951 and 101 barrels of oil in 1952; a total of 1,295 barrels before abandonment in 1952.

ELEVATION OF SURFACE

At well locations: Highest, 3,112 ft.; lowest, 2,640 ft.

SURFACE FORMATIONS

Undifferentiated limestones of the Washita and Fredericksburg groups.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Interpretation of surface and subsurface geological data led to the discovery of this field.

DISCOVERIES

Queen:

January 12, 1935; Gulf Production Co. #3 White & Baker. This well had produced 91 barrels of oil in December before its completion on January 12. Its capacity when completed was at rate of 52 barrels of oil per day. Before July 26, 1935, the daily rate of production had declined to 5 barrels of oil with water constituting 1% of gross liquid. The well was then shot with 180 quarts of nitroglycerin between the depths of 1,813 and 1,890 feet and production increased temporarily to 66 barrels of oil and 13 barrels of water per day. Operation soon became unprofitable and the well was plugged and abandoned on September 19, 1936.

March 30, 1938; Cardinal Oil Co. #1-36 White & Baker (later designated as Helmerich & Payne, Inc. #B-6 White & Baker). Initially bailed at rate of 5 barrels of oil per day. After shot with nitroglycerin from depth of 1,618 to 1,639 feet, the rate of production increased to 30 barrels of oil per day with considerable sulphur water which apparently came from near total depth of 1,802 feet and was later plugged off.

March 28, 1940; R.L.Walker #1 White & Baker (now Childress Royalty Co. #A-1 White & Baker). Initial capacity was at rate of 20 barrels of oil per day after shot with nitroglycerin.

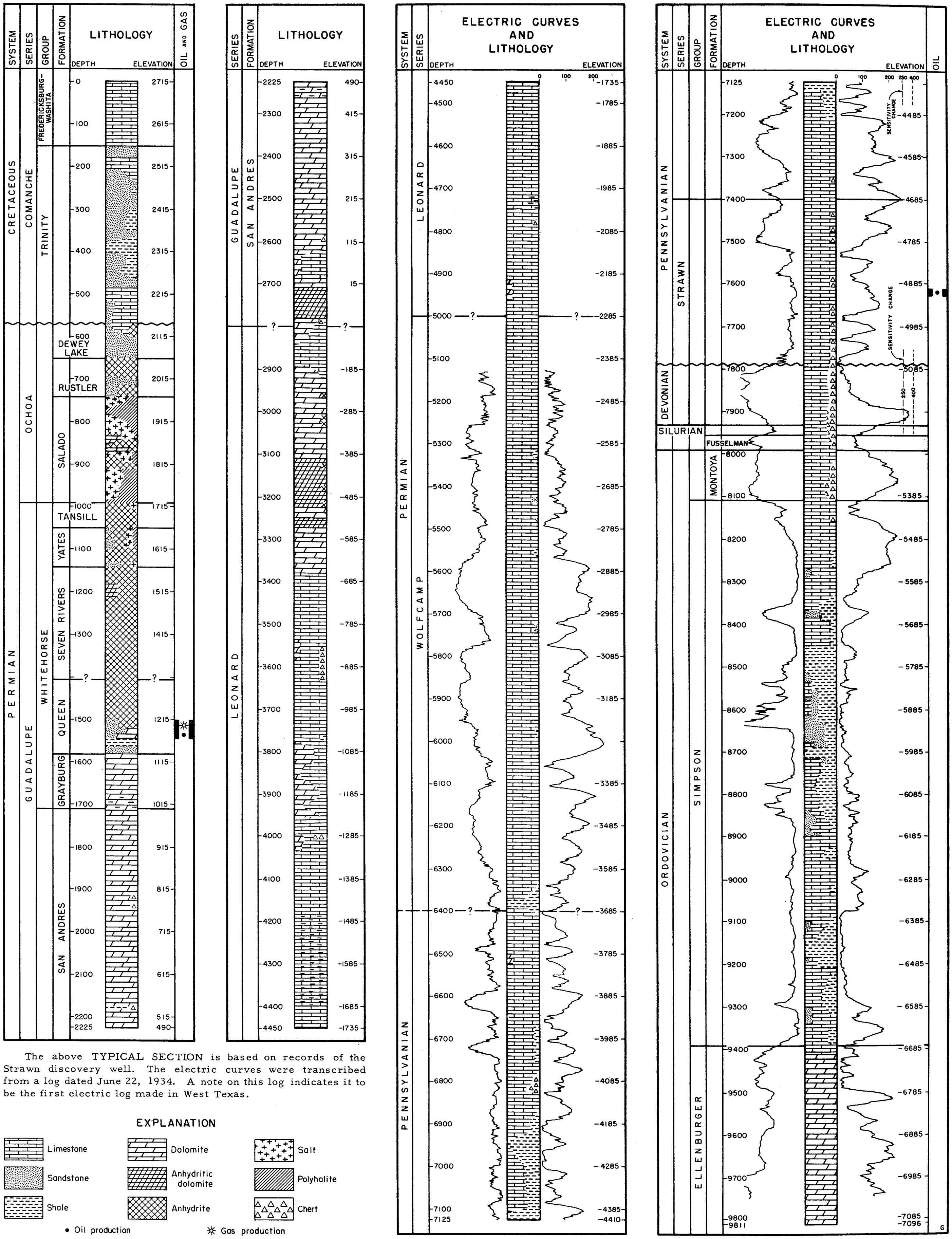
San Andres:

August 8, 1943; Cardinal Oil Co. #4-C White & Baker (later designated as Helmerich & Payne, Inc. #4-C White & Baker). This well produced gas from the Queen reservoir and oil from the San Andres reservoir. It is the only well completed in the San Andres reservoir; it was abandoned in San Andres in 1946.

Strawn:

December 22, 1945; Helmerich & Payne, Inc. #8-C White & Baker. This discovery was the result of a work-over of Humble Oil & Refining Co. #1 White & Baker, which was abandoned July 1934 as a dry hole after having been drilled to the total depth of 9,811 feet. This is the only well completed in the Strawn reservoir; it was abandoned in 1952. The accompanying TYPICAL SECTION is based on the log of this well.

TYPICAL SECTION OF ROCKS PENETRATED



The above TYPICAL SECTION is based on records of the Strawn discovery well. The electric curves were transcribed from a log dated June 22, 1934. A note on this log indicates it to be the first electric log made in West Texas.

EXPLANATION

Limestone, Dolomite, Salt, Sandstone, Anhydritic dolomite, Polyhalite, Shale, Anhydrite, Chert

• Oil production ☀ Gas production

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 548 feet below its top. This penetration was in Helmerich & Payne, Inc. #9-C White & Baker, the gas well located near the northwest corner of Sec. 44 where the total depth of 10,044 feet is indicated on the accompanying map.

NATURE OF TRAPS

Queen: Anticlinal folding appears to be the primary trap-forming factor with variation in degree of porosity and permeability contributing as a secondary factor.

San Andres and Strawn: Only one well has been productive in each of these reservoirs and both of these wells were located near the apex of a convex fold. While it appears that, as to each reservoir, convex folding is the primary factor, it is probable that variation in degree of porosity and permeability has functioned as a secondary factor.

PRODUCTIVE AREAS

	Acres
Queen	5,200
San Andres	40
Strawn	40
Field	5,200

THICKNESSES OF RESERVOIR ROCKS

Net productive:	Feet
Queen	5 to 35
San Andres	15±
Strawn	48±

LITHOLOGY OF RESERVOIR ROCKS

Queen: Interbedded sandstones and shales. The sandstones are white to gray, fine-grained, with degrees of porosity and permeability quite variable and too low for commercial production in some parts of the general area of the field.

San Andres: Gray to tan, medium- to fine-grained dolomite and limestone.

Strawn: White to gray-white and brown, finely-crystalline to dense, limestone.

CONTINUITY OF RESERVOIR ROCKS

Queen: The reservoir rock is continuous throughout the area of the field. However, locally in certain places, porosity and permeability are too low for commercial production.

San Andres and Strawn: Available data do not afford a basis for determination of continuity of either of these reservoir rocks.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Queen:	Feet
Highest known elevation of gas	1,540
Elev. of bottom of gas (gas-oil contact)	1,630
Known relief of gas column	90
Elevation of top of oil (gas-oil contact)	1,630
Elev. of bottom of oil (oil-water contact)	1,687
Relief of oil column	57

The above figures represent estimated elevations as of discovery date. Data are meager and unsatisfactory.

San Andres and Strawn: Data are not available.

CHARACTER OF OIL

	Queen	San Andres	Strawn
Gravity, A.P.I. @ 60° F.	32°	32.2°	37.9°
Sulphur	1.4%	?	?

For analyses see:
- Railroad Commission of Texas
  - Analyses of Texas Crude Oils. (1940), pp. 34 and 65.
- U. S. Bureau of Mines — Lab. ref. No. 38080
  - Tabulated Analyses of Texas Crude Oils. T.P. 607 (1939) Grp. 2, Item 93

CHARACTER OF GAS

Queen:	
Specific gravity	0.642
Sulphur indication	Sour

WATER PRODUCTION

Queen: Data relative to current water production are not readily available. It was a characteristic of the wells in this field that they produced very little water initially.

COMPLETION TREATMENT

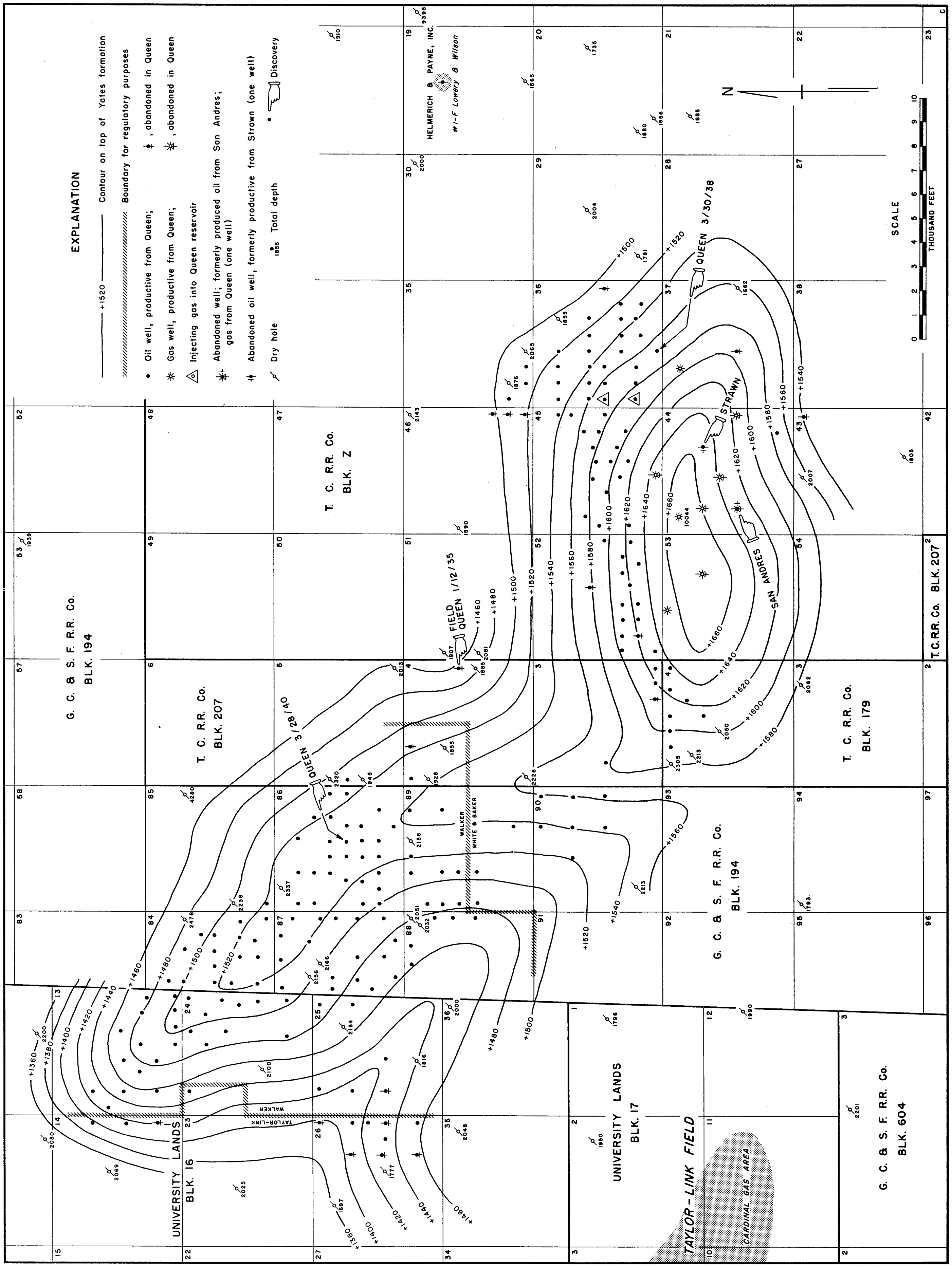
Queen: Generally, each well was shot with 20 to 100 quarts of nitroglycerin at time of completion.

SECONDARY RECOVERY

Queen: A gas repressuring project was begun in August 1947 by Helmerich & Payne, Inc. As indicated on the accompanying map, gas is now being injected into the reservoir through two wells.

SELECTED REFERENCE

Carsey, J. Ben (1935) Unconformities in the Humble White & Baker deep test, Pecos County, Texas: Bureau Econ. Geology, Univ. Texas, Bull. 3501, pp. 127-129.


EXPLANATION
+1520 Contour on top of Yates formation
Boundary for regulatory purposes
Oil well, productive from Queen; , abandoned in Queen
Gas well, productive from Queen; , abandoned in Queen
Injecting gas into Queen reservoir
Abandoned well; formerly produced oil from San Andres; gas from Queen (one well)
Abandoned oil well, formerly productive from Strawn (one well)
Dry hole
1855 Total depth
Discovery
HELMERICH & PAYNE, INC.
#1-F Lowery & Wilson
N
SCALE
THOUSAND FEET
QUEEN 3/30/38
STRAWN
SAN ANDRES
FIELD QUEEN 1/12/35
QUEEN 3/28/40
WALKER
WHITE & BAKER
TAYLOR-LINK
T. C. R.R. Co.
BLK. Z
G. C. & S. F. R.R. Co.
BLK. 194
T. C. R.R. Co.
BLK. 207
T.C.R.R. Co. BLK. 207
T. C. R.R. Co.
BLK. 179
UNIVERSITY LANDS
BLK. 16
UNIVERSITY LANDS
BLK. 17
TAYLOR-LINK FIELD
CARDINAL GAS AREA
G. C. & S. F. R.R. Co.
BLK. 604

PRODUCTION HISTORY

Field totals: Because of the fact that so nearly all of the production has come from one reservoir (Queen) and because of space requirements, it is left for the reader to add the figures for Queen, San Andres and Strawn to determine field totals.

Queen: The data for the Queen reservoir are reported below under four headings; viz: Queen total, wherein the figures represent totals for the three subdivisions; Queen (a), wherein the figures apply to that part of the field designated as the White & Baker field; Queen (b), wherein the figures apply to that part of the field designated as the Walker field; and, Queen (c), wherein the figures apply to the properties at the northwest end of the field which are treated by the Railroad Commission as in the Taylor-Link field.

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)		GAS PRODUCTION (Mcf)	
	Oil						
	Flowing	Pumping	Gas	Yearly	Cumulative	Yearly	Cumulative
Queen total:							
1934	0	0	0	91	91		
1935	0	1	0	1,831	1,922		
1936	0	1	0	1,123	3,045		
1937	0	0	0	0	3,045		
1938	2	0	0	4,771	7,816		
1939	7	0	0	34,437	42,253	3,344	3,344
1940	18	1	1	73,304	115,557	21,858	25,202
1941	50	8	2	223,465	339,022	42,019	67,221
1942	74	11	2	338,146	677,168	101,454	168,675
1943	93	14	2	475,766	1,152,934	158,332	327,007
1944	95	22	6	550,970	1,703,904	1,488,397	1,815,404
1945	110	32	7	604,121	2,308,025	1,520,851	3,336,255
1946	122	35	5	635,412	2,943,437	871,310	4,207,565
1947	120	48	1	604,059	3,547,496	207,315	4,414,880
1948	111	64	1	570,416	4,117,912	262,654	4,677,534
1949	94	82	1	473,521	4,591,433	166,492	4,844,026
1950	68	115	1	465,047	5,056,480	220,154	5,064,180
1951	71	119	1	410,621	5,467,101	193,473	5,257,653
1952	60	136	1	329,067	5,796,168	187,223	5,444,876
1953	50	132	1	287,143	6,083,311	173,828	5,618,704
1954	42	137	1	241,225	6,324,536	104,850	5,723,554
Queen (a):							
1934	0	0	0	91	91		
1935	0	1	0	1,831	1,922		
1936	0	1	0	1,123	3,045		
1937	0	0	0	0	3,045		
1938	2	0	0	4,771	7,816		
1939	7	0	0	34,437	42,253	3,344	3,344
1940	12	0	1	59,470	101,723	21,858	25,202
1941	18	0	2	70,504	172,227	42,019	67,221
1942	20	0	2	84,785	257,012	101,454	168,675
1943	29	1	2	117,945	374,957	158,332	327,007
1944	32	1	6	132,650	507,607	1,488,397	1,815,404
1945	48	3	7	186,929	694,536	1,520,851	3,336,255
1946	64	1	5	260,446	954,982	871,310	4,207,565
1947	65	9	1	266,483	1,221,465	207,315	4,414,880
1948	58	21	1	277,601	1,499,066	262,654	4,677,534
1949	57	21	1	243,846	1,742,912	166,492	4,844,026
1950	46	33	1	214,637	1,957,549	220,154	5,064,180
1951	42	39	1	180,521	2,138,070	193,473	5,257,653
1952	33	57	1	145,438	2,283,508	187,223	5,444,876
1953	33	41	1	147,676	2,431,184	173,828	5,618,704
1954	27	48	1	132,490	2,563,674	104,850	5,723,554

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
	Flowing	Pumping	Yearly	Cumulative
Queen (b):				
1940	5	1	11,987	11,987
1941	32	7	151,986	163,973
1942	52	11	244,643	408,616
1943	57	13	343,981	752,597
1944	57	17	399,511	1,152,108
1945	58	23	404,095	1,556,203
1946	54	28	362,781	1,918,984
1947	49	35	326,590	2,245,574
1948	47	39	283,447	2,529,021
1949	31	57	221,152	2,750,173
1950	20	75	241,105	2,991,278
1951	26	75	221,513	3,212,791
1952	25	73	177,019	3,389,810
1953	17	84	134,064	3,523,874
1954	15	82	104,555	3,628,429
Queen (c):				
1940	1	0	1,847	1,847
1941	0	1	975	2,822
1942	2	0	8,718	11,540
1943	7	0	13,840	25,380
1944	6	4	18,809	44,189
1945	4	6	13,097	57,286
1946	4	6	12,185	69,471
1947	6	4	10,986	80,457
1948	6	4	9,368	89,825
1949	6	4	8,523	98,348
1950	3	7	9,305	107,653
1951	3	5	8,587	116,240
1952	2	6	6,610	122,850
1953	0	7	5,403	128,253
1954	0	7	4,180	132,433
San Andres:				
1943	1	0	1,767	1,767
1944	1	0	8,526	10,293
1945	1	0	3,903	14,196
1946	0	0	2,838	17,034
Strawn:				
1945	1	0	519	519
1946	1	0	15,465	15,984
1947	1	0	5,885	21,869
1948	1	0	3,492	25,361
1949	1	0	3,322	28,683
1950	1	0	3,137	31,820
1951	1	0	2,289	34,109
1952	0	0	581	34,690

WIL-JOHN FIELD
Ward County, Texas

EDWARD R. KENNEDY, Jr.
Geologist, Argo Oil Corporation, Midland, Texas
July 1, 1955

LOCATION and FIELD NAMES

The Wil-John field is in south-central Ward County, 9 miles northeast of Barstow, $5\frac{1}{2}$ miles southwest of Pyote and about 3 miles northeast of the railroad siding of Quito.

Prior to the drilling of the well now recognized as the discovery well, three wells had been completed (two as oil wells and one as a gas well) in the area herein treated as the area of the Wil-John field. Although none of these wells was a commercial well, they occasioned the application from time to time of the names Wilson field, Hayes field and Quito field. These three names have now been superseded by the name Wil-John field. The name Quito field is now used to designate a field discovered April 4, 1953, about 6 miles to the northwest and treated in another paper in this volume.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Subsurface geology.

ELEVATION OF SURFACE

At well locations: Highest, 2,740 ft.; lowest, 2,670 ft.

SURFACE FORMATION

Undifferentiated Quaternary.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Bell Canyon formation 547 feet below its top. This penetration was in Argo Oil Corp. #1 Pat Wilson, the discovery well. The accompanying TYPICAL SECTION is based on the log of this well.

PRODUCTIVE AREA

Bell Canyon: It is estimated that the two wells which are now producing are draining oil from an area of 80 acres. The surrounding area where oil and gas have been yielded in less than commercial quantities is much greater.

DISCOVERY

Bell Canyon: January 13, 1954; Argo Oil Corporation #1 Pat Wilson et al. Initial potential, $27\frac{1}{2}$ barrels of oil per day through perforations at depth of 5,051-5,061 feet; gas-oil ratio, 2,974 : 1.

Three wells had been completed (two as oil wells and one as a gas well) at earlier dates, but since none of them was a commercial well, it seems appropriate to recognize the above indicated well as the discovery well of the field.

C.H. Mahres et al #1 Pat Wilson was completed September 14, 1937, after having been plugged back to 5,092 feet from the total depth of 5,094 feet. After a shot with 100 quarts of nitroglycerin, it produced oil at the rate of 132 barrels per day through tubing and was temporarily considered as the discovery well of a new field, called the Wilson field. In March 1938, the well was deepened to 5,120 feet. It was plugged and abandoned October 22, 1938, after pumping water at the rate of 10 barrels per day. It produced 1,917 barrels of oil during 1937; available records do not indicate that any oil was marketed subsequently.

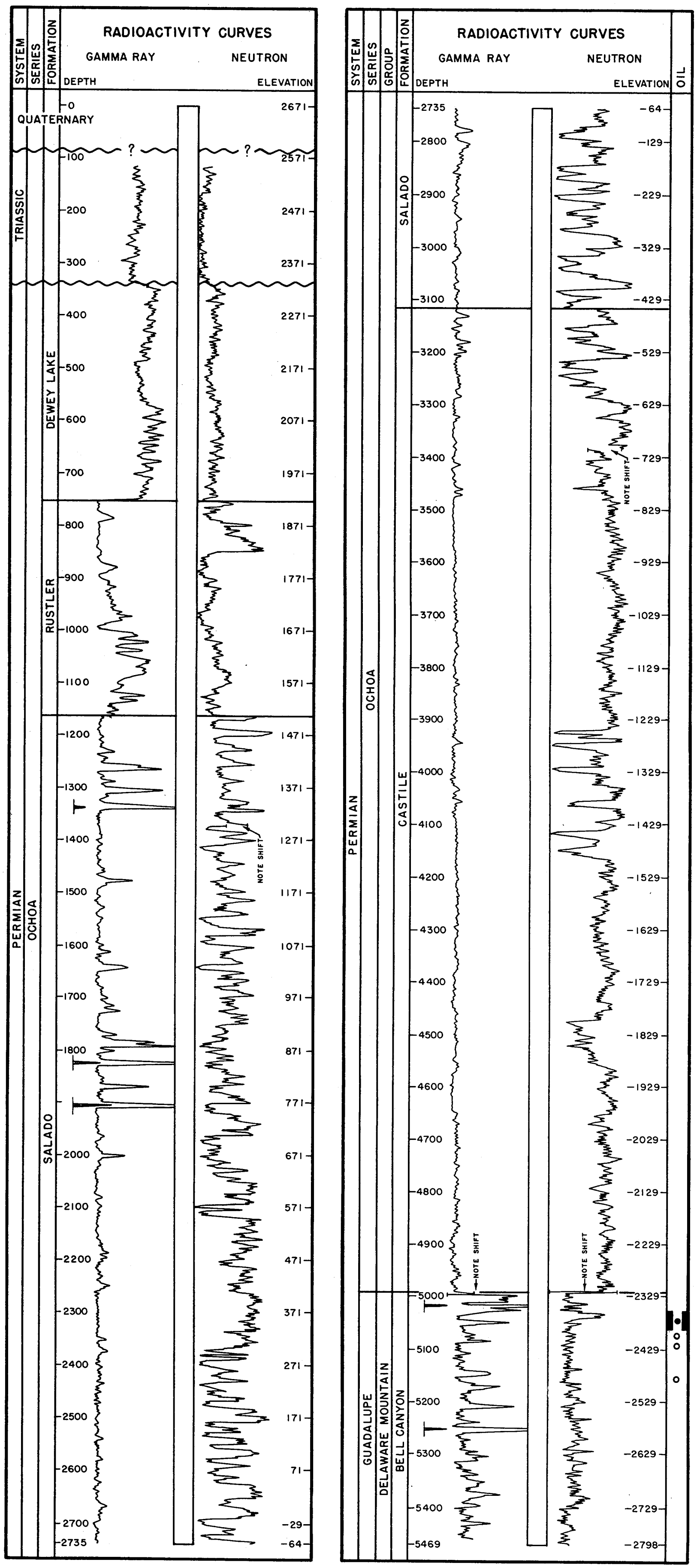
Kenneth Slack et al #1 Bird S. Hayes was completed July 20, 1940, as a gas well with capacity of 21,000 Mcf per day; pressure, 1,900 psi. This well was recognized as the discovery well of a field known both as the Hayes gas field and as the Quito field. It appears that gas marketed during 1941-1944 as from the Quito field was produced by this well; the quantities reported by the Railroad Commission were 181,141 Mcf during 1941; 202,421 Mcf during 1942; 256,545 Mcf during 1943 and 129,169 Mcf during 1944. Available records do not indicate any other production, either earlier or later. This well probably did not return its cost.

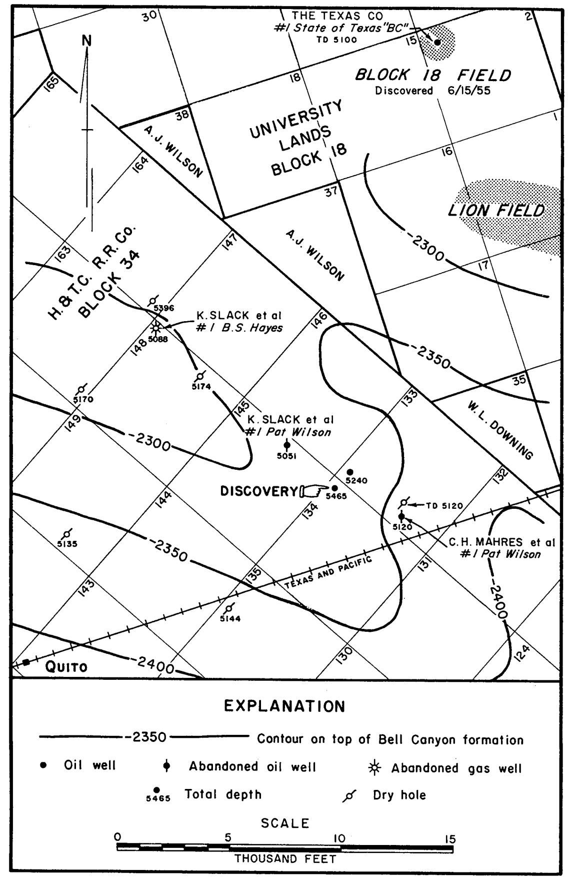
At the time of its completion on October 22, 1941, Kenneth Slack et al #1 Pat Wilson indicated a daily potential of 24 barrels of 42° gravity oil and 150 Mcf of gas and was temporarily recognized as a discovery well, but before the end of the year it was abandoned as noncommercial. Available records do not indicate that any oil was marketed from this well.

NATURE OF TRAP

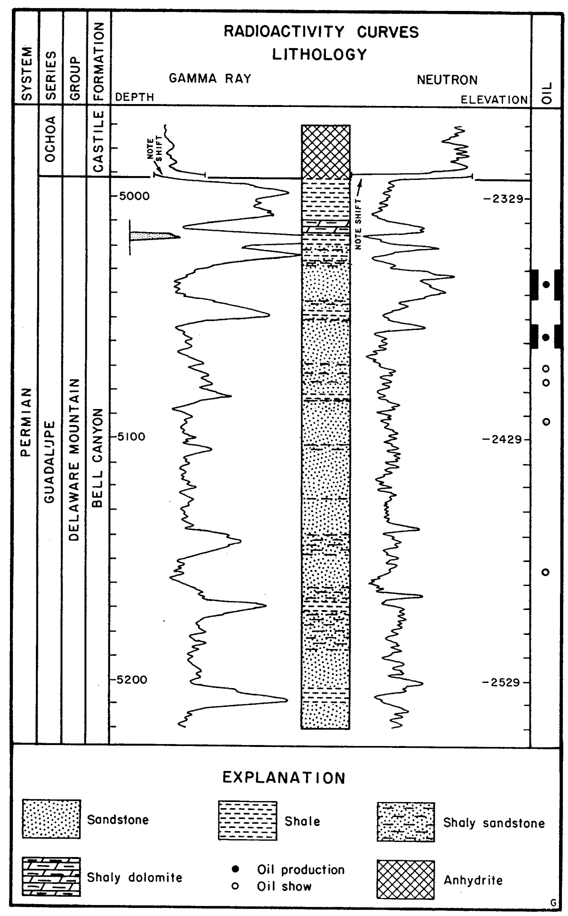
Bell Canyon: Complex permeability on the plunging axis of an anticline.

TYPICAL SECTION OF ROCKS PENETRATED





TYPICAL DETAIL OF PRODUCTIVE SECTION



THICKNESSES OF RESERVOIR ROCK

Bell Canyon:	Feet
From top to bottom	34
Net productive	24

The above figures apply to the two wells which are now producing. There are two productive sandstones with about 10 feet of non-productive shale between them. In the discovery well, the lower sandstone, about 10 feet thick, is producing; the upper sandstone has not been perforated for production. In the other well, the upper sandstone, about 14 feet thick, is producing; the lower sandstone has not been perforated for production.

LITHOLOGY OF RESERVOIR ROCK

Bell Canyon: Sandstone; gray, fine-grained, friable, with porosity and permeability varying in a wide range and with shale interstratified as indicated on the accompanying graph under the heading TYPICAL DETAIL OF PRODUCTIVE SECTION.

CONTINUITY OF RESERVOIR ROCK

Bell Canyon: The reservoir rock is continuous throughout the area of the accompanying map. While the general character is about the same throughout that area, the individual layers are generally of only local extent. Individual members cannot be correlated with certainty from well to well. Because of the lenticularity of the sandstone members and the variation in degrees of porosity and permeability, it is unlikely that there is sufficient freedom of migration of reservoir fluids to justify considering all of the productive lenses as part of one and the same reservoir. However, in geologic time, the reservoir fluids may have adjusted essentially in accordance with the interpretation that they were confined within a single container.

WATER PRODUCTION

Bell Canyon: Water constitutes a high percentage of the gross production of each of the two wells now producing. During initial potential test, water constituted, respectively, 85% and 50% of the gross production of the discovery well and of the other well.

COMPLETION TREATMENT

Bell Canyon: The reservoir rock in each of the two producing wells was subjected to hydraulic fracturing. The reservoir rock in each of the two abandoned oil wells was shot with 100 quarts of nitroglycerin. The abandoned gas well was completed without shooting or hydraulic fracturing.

ELEVATION AND RELIEF OF PRODUCTIVE ZONE

Bell Canyon:	Feet, approx.
Elevation of highest known gas	-2,303
Elevation of gas-oil contact	-2,358
Known relief	55
Elevation of gas-oil contact	-2,358
Elevation of oil-water contact	-2,390
Known relief	32

The above figures represent approximate conditions at time of first completion in the area. They do not have the normal significance of corresponding figures for other fields because it is doubtful whether there was ever continuous potential commercial production throughout the indicated interval. Dry holes and noncommercial wells demonstrate that porosity and permeability are too low for commercial production throughout a large portion of the area where trapping conditions appear favorable. Interfingering of sandstones which contain water, but no hydrocarbons, complicate the problem of estimating the elevation of the oil-water contact. No definite water table has yet been established. Oil was as low as -2,425 feet in C.H.Mahres et al #1 Pat Wilson.

CHARACTER OF OIL

Bell Canyon: Gravity, A. P. I. @ 60°F., 38.4°.

PRODUCTION HISTORY

Bell Canyon:

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
1937	0	0	1,919	1,919
1953	1	0	1,120	3,039
1954	2	0	11,944	14,983
1955 to 7/1	2	0	4,462	19,445

GAS PRODUCTION: The only reported gas production is that by Kenneth Slack et al #1 Bird S. Hayes mentioned above under DISCOVERY.

WILSHIRE FIELD

Upton County, Texas

ROBERT R. HARBISON
Geologist, Stanolind Oil & Gas Co., Midland, Texas
February 12, 1953

LOCATION AND DEFINITION

The Wilshire field is in west central Upton County $7\frac{1}{2}$ miles east of the Crane-Upton county line, and 6 miles east of the eastern extent of the McElroy field. It is in the southwestern part of the Midland basin and immediately east of the Central Basin platform.

The field is composed of the Wilshire, the Wilshire Pennsylvanian and the Wilshire Ellenburger pools. To date, the only well in the Wilshire pool is the Spraberry discovery well. The Wilshire Pennsylvanian pool includes only one presently productive well, the most northern well in the field; the discovery well was dually completed and was allowed to produce from the Pennsylvanian (Strawn) during only two months. The Wilshire Ellenburger pool includes 40 of the presently productive 42 wells in the field.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Several reflection seismograph surveys of the region had been made several years prior to the discovery of the field. It appears likely, therefore, that reflection seismograph surveying was at least among the exploration methods which led to the drilling of the discovery well.

DISCOVERIES

Spraberry: December 9, 1948;
Wilshire Oil Co. #23-148 McElroy Ranch

Strawn: April 24, 1951;
Sinclair Oil & Gas Co. #1 McElroy Ranch

This well was dually completed to produce from Strawn and Ellenburger. Beginning in May, 1951, it was allowed to produce from the two reservoirs, but after about two months, in accordance with an order of the Railroad Commission, production from Strawn was stopped and the well has not produced from Strawn since then. Sinclair Oil & Gas Co. #6 McElroy Ranch, 3 miles northward in Sec. 132, is the only other well which has produced from the Strawn reservoir. It was completed February 20, 1952.

Ellenburger: April 24, 1951;
Sinclair Oil & Gas Co. #1 McElroy Ranch

ELEVATION OF SURFACE

At well locations: Highest, 2,854 ft.; lowest, 2,749 ft.

SURFACE FORMATIONS

Undifferentiated rocks of the Fredericksburg group are at the surface throughout the area of the field.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the area of the field is in the Ellenburger group.

NATURE OF TRAPS

Spraberry: Unknown; probably either updip lensing or updip decrease of porosity.
Strawn: Convex fold.
Ellenburger: Convex fold.

PRODUCTIVE AREAS

	Acres
Spraberry	40
Strawn	80
Ellenburger	1640
Wilshire field	1720

It appears probable that future development will warrant increasing the above estimates.

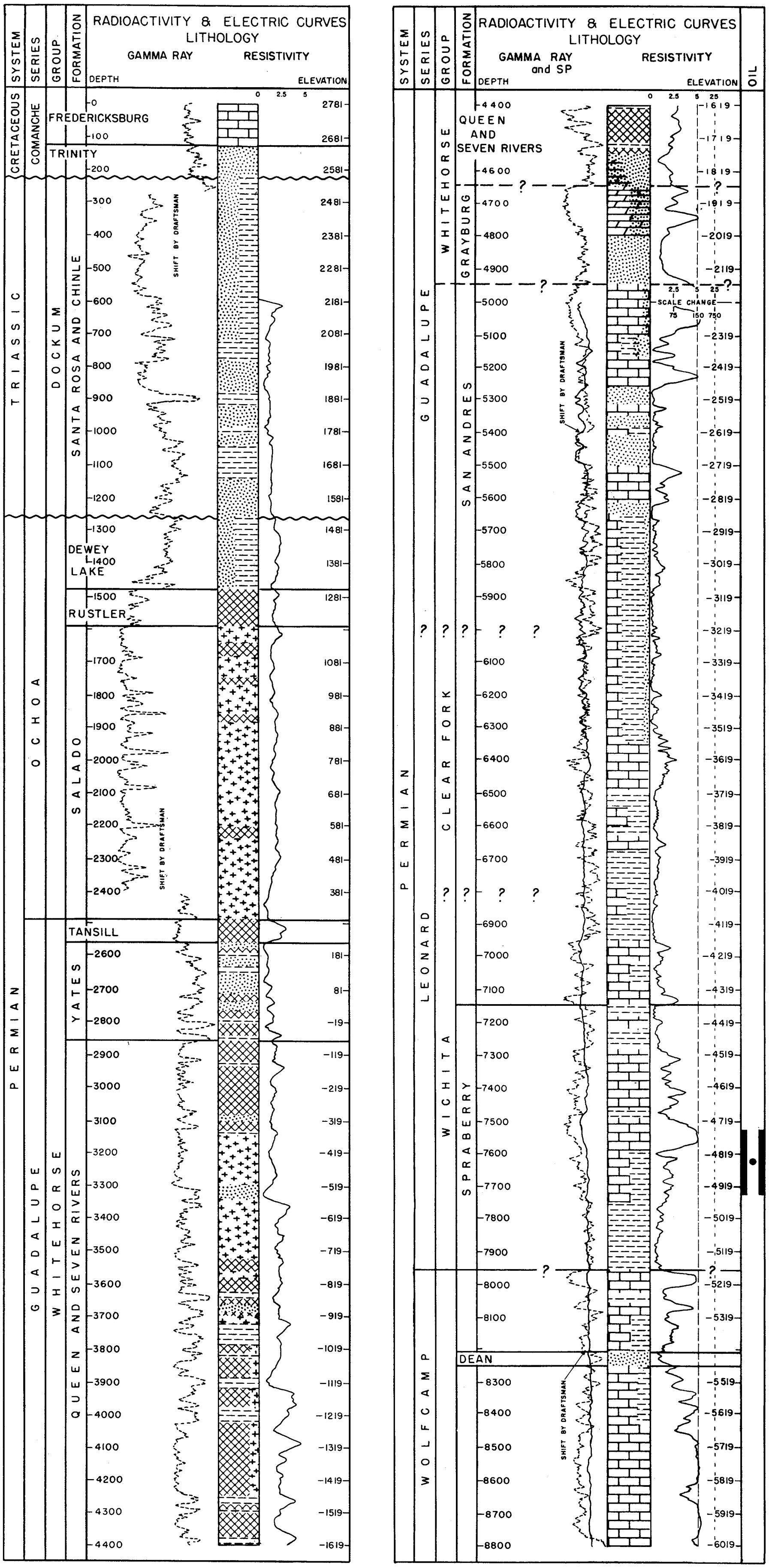
THICKNESSES OF RESERVOIR ROCKS

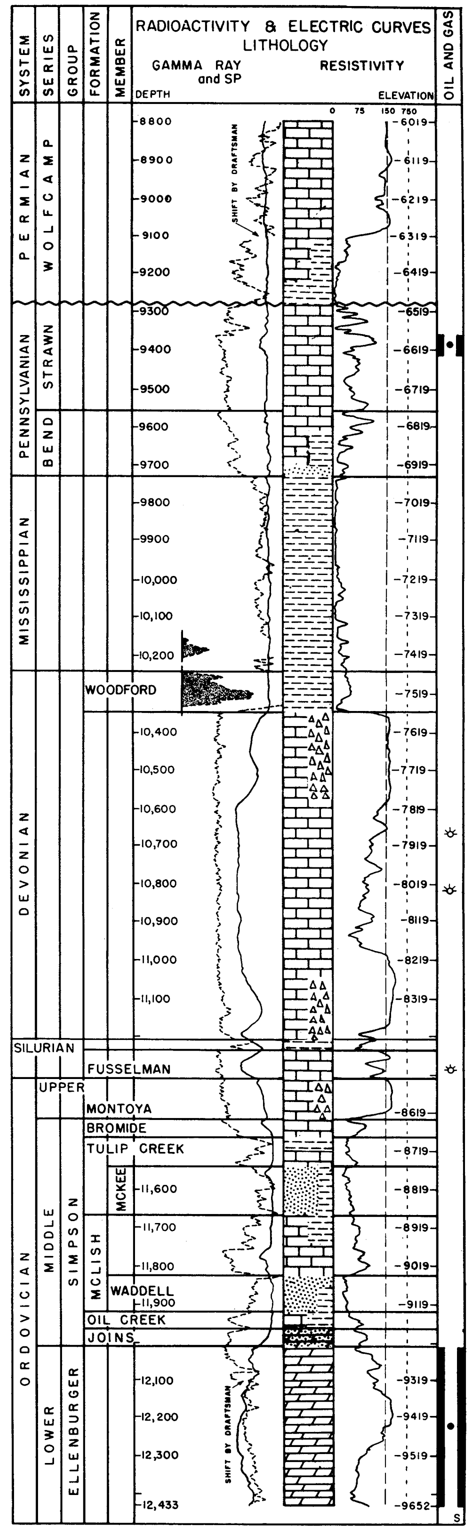
Spraberry: The gross thickness from top to bottom in the only productive well is 205 feet.

Strawn: The gross thickness from top to bottom in the one presently productive well is 65 feet. In the discovery well the gross thickness is about 40 feet and the net productive portions total about 25 feet.

Ellenburger: Average, 400 feet; maximum, 615 feet.

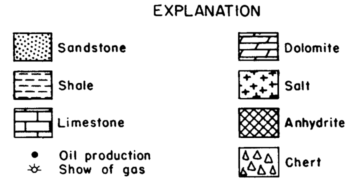
TYPICAL SECTION OF ROCKS PENETRATED

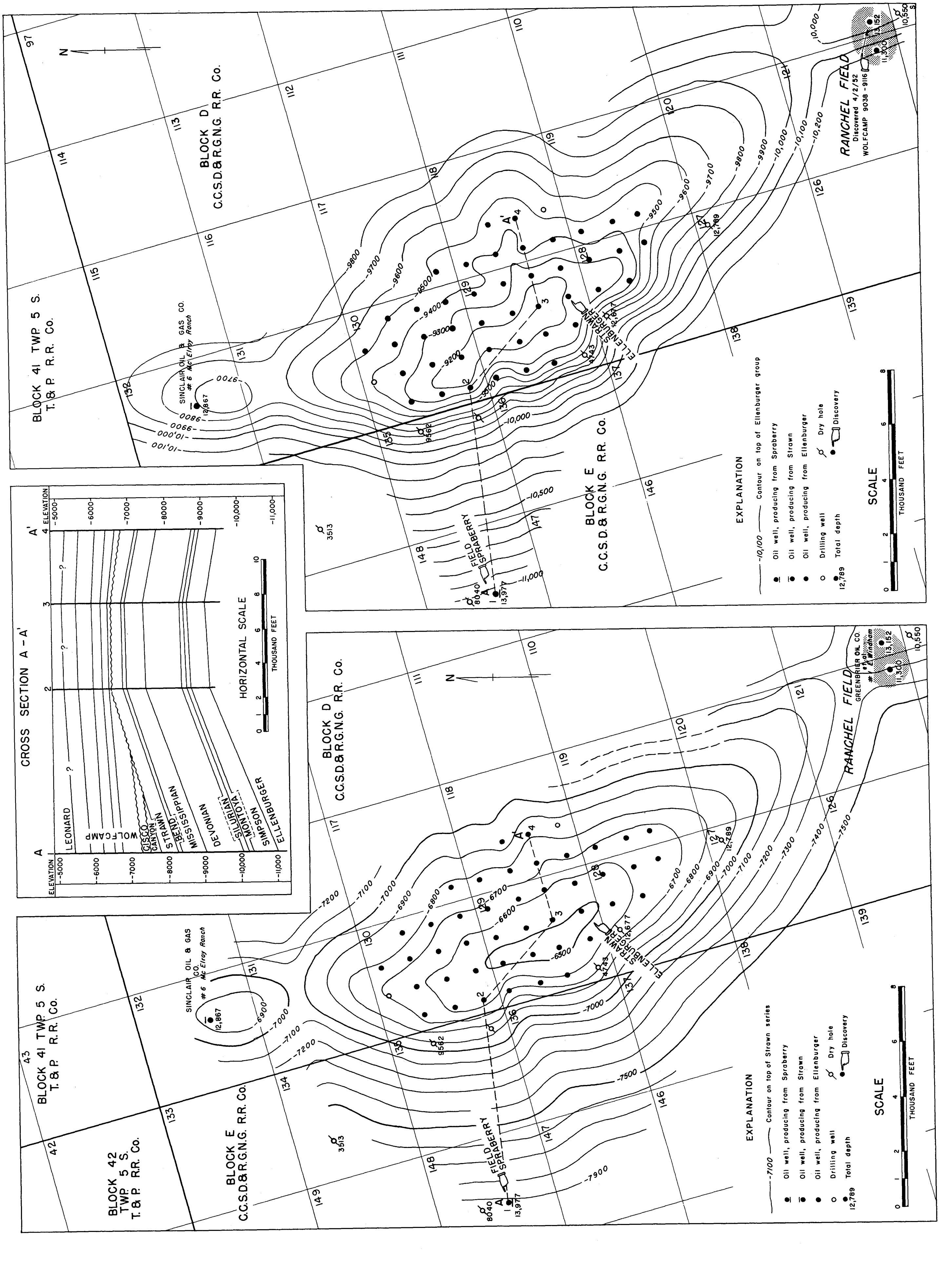




NOTE: This TYPICAL SECTION is based on the log of the Strawn and Ellenburger discovery well. The position of the Spraberry reservoir is indicated although commercial production was not found in the Spraberry at this location.

EXPLANATION




BLOCK D
C.C.S.D.& R.G.N.G. R.R. Co.
BLOCK 41 TWP. 5 S.
T. & P. R.R. Co.
BLOCK E
C.C.S.D.& R.G.N.G. R.R. Co.
BLOCK 42
TWP. 5 S.
T. & P. R.R. Co.
SINCLAIR OIL & GAS CO.
#6 Mc Elroy Ranch
RANCHEL FIELD
Discovered 4/2/52
WOLFCAMP 9038-9116
GREENBRIER OIL CO.
#1 Alf E. Windham
SPRABERRY FIELD
ELLENBURGER
STRAWN
CROSS SECTION A - A'
ELEVATION
LEONARD
WOLFCAMP
CISCO
CANYON
STRAWN
BEND
MISSISSIPPIAN
DEVONIAN
SILURIAN
MONTOYA
SIMPSON
ELLENBURGER
HORIZONTAL SCALE
THOUSAND FEET
EXPLANATION
-10,100 Contour on top of Ellenburger group
-7100 Contour on top of Strawn series
Oil well, producing from Spraberry
Oil well, producing from Strawn
Oil well, producing from Ellenburger
Drilling well
Dry hole
12,789 Total depth
Discovery
SCALE
THOUSAND FEET

LITHOLOGY OF RESERVOIR ROCKS

Spraberry: Limestone; brown, medium crystalline, oolitic.

Strawn: Limestone; brown, medium crystalline, fossiliferous, with some milky, mottled, translucent chert.

Ellenburger: Dolomite; brown, dark brown, gray and gray-white; very fine to coarsely crystalline with some chert. Figures representing degree of porosity are not available. An examination of several micrologs indicates about 120 feet of net productive dolomite, but estimating net pay in Ellenburger on the basis of micrologs is most difficult. It is suspected that the reservoir rock is fractured and that an exact determination of net pay cannot be derived from data afforded by our present methods of logging.

CONTINUITY OF RESERVOIR ROCKS

Spraberry: The reservoir rock is a member of a section which contains several such members. The particular member which is productive at the location of the only Spraberry well cannot be positively correlated although there are similar rocks at about the same stratigraphic position in other wells. The particular lens of favorable porosity is certainly not continuous beyond the immediate vicinity of the one well.

Strawn: The reservoir rock is continuous throughout the area of the field but the degree of porosity and permeability of that rock are quite variable.

Ellenburger: This reservoir rock is continuous throughout the area of the field and far beyond. There are minor variations in porosity and permeability. The degree of fracturing is a local feature.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Spraberry	Strawn	Ellenburger
Elev., top of oil, feet	-5,001	-6,509	-9,135
Elev., bottom of oil, feet	Unknown	Unknown	-9,750±
Relief, feet	Unknown	Unknown	616±

CHARACTER OF OIL

	Spraberry	Strawn	Ellenburger
Gravity, A.P.I. @ 60° F.	36.8	49.9	53.3

SELECTED REFERENCE

Berry, O. H., Jr. (1952) Wilshire Ellenburger field, Upton County, Texas: Amer. Inst. Min. & Met. Eng., Statistics of Oil and Gas Development and Production Covering 1951, pp. 442-444.

ACID TREATMENT

Spraberry: The reservoir rock in the one Spraberry well was treated with 10,000 gallons of acid prior to completion.

Strawn: The Strawn reservoir rock in the Strawn discovery well was treated with 2,000 gallons of acid prior to completion. The reservoir rock in the presently productive Strawn well was treated with 15,000 gallons of acid.

Ellenburger: Most of the Ellenburger wells have been completed without acid treatment. There have been no acid treatments subsequent to completion.

PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Field totals				
1948	0	1	2,954	2,954
1949	0	1	11,696	14,650
1950	0	1	6,929	21,579
1951	11	1	462,216	483,795
1952	41	1	3,887,071	4,370,866
Spraberry				
1948	0	1	2,954	2,954
1949	0	1	11,696	14,650
1950	0	1	6,929	21,579
1951	0	1	4,352	25,931
1952	0	1	2,780	28,711
Strawn				
1951	1	0	2,359	2,359
1952	1	0	9,653	12,012

The 1951 production was from the discovery well and the 1952 production was from Sinclair Oil & Gas Co. #6 McElroy Ranch.

Ellenburger				
1951	11	0	455,505	455,505
1952	40	0	3,874,638	4,330,143

WORLD FIELD

Crockett County, Texas

MARIA SPENCER and WARREN MUERY
Geologists, The Superior Oil Co., Midland, Texas
March 24, 1954

LOCATION and OTHER NAMES

The World field is in north central Crockett County, 3½ miles south of the Crockett-Reagan county boundary and 10 miles northwest of the Todd field.

This field has been designated in some publications as the World-Powell field. During its early history it was commonly designated in current publications as the Powell field.

METHOD OF EXPLORATION LEADING TO DISCOVERY

Surface mapping on beds of lower Cretaceous age indicated a favorable structural feature, which led to the drilling of the discovery well.

DISCOVERIES

Grayburg: May 30, 1925; World Oil Co. #1 L.P.Powell. Initial production, 50 barrels of oil per day. Total depth, 2,646 feet.

Strawn: September 22, 1951; Continental Oil Co. #1-E L.P.Powell. Completed as a flowing oil well with a potential of 288 barrels of oil per day. Total depth, 8,288 feet; plugged back to 8,141 feet. This is the only well completed in this reservoir. It was plugged and abandoned on January 13, 1953, due to decline in reservoir pressure.

ELEVATION OF SURFACE

At well locations: Highest, 2,800±ft.; lowest, 2,600±ft.

SURFACE FORMATION

The rocks exposed at the surface are mainly limestones of the Washita group.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated is in the Ellenburger group 520 feet below its top. This penetration was in Continental Oil Co. #2-E L.P.Powell, the well about 1,250 feet north of the Strawn discovery well and where the total depth of 8,738 feet is indicated on the accompanying map. Four wells within the area of the accompanying map were drilled into the Ellenburger group.

PRODUCTIVE AREAS

Grayburg	4,500 acres
Strawn (depleted)	40 acres
World field	4,500 acres

NATURE OF TRAPS

Grayburg: While anticlinal folding is the dominating trap-forming factor, the trap is due partly to lensing of porous zones in the reservoir rock on the east side of the field.

Strawn: Since the accumulation at the only productive well is at the apex of an anticlinal fold, it appears that anticlinal folding is the dominating trap-forming factor; however, the possibility that the accumulation is due merely to convexity of the upper limit of reef limestone cannot be eliminated.

THICKNESSES OF RESERVOIR ROCKS

Grayburg: The sum of thicknesses of zones of productive rock ranges from 2 feet up to 65 feet. However, penetration of reservoir rock in the productive wells averages only about 10 feet due to precaution to avoid unnecessary production of water.

Strawn: From top to bottom of productive rock in the single productive well is about 50 feet.

LITHOLOGY OF RESERVOIR ROCKS

Grayburg: Tan, saccharoidal, oolitic dolomite. The oolites are ellipsoidal and range in size from .1 mm to 1.5 mm, averaging approximately .5 mm. The porosity is probably a result of the oolitic character of the dolomite. Individual zones of good porosity are discontinuous.

Strawn: Coarsely crystalline, fossiliferous limestone.

CONTINUITY OF RESERVOIR ROCKS

Grayburg: The reservoir rock is continuous throughout the area covered by the accompanying map, but individual zones having favorable porosity are discontinuous; all zones grade into dense anhydritic dolomite on the east side of the field.

Strawn: Probably continuous throughout the area of the accompanying map.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

	Grayburg	Strawn
No free gas cap in either reservoir		
Elevation of top of oil, feet	145	-5,331
Elevation of bottom of oil, feet	82	-5,381
Relief, feet	63	50

CHARACTER OF OIL

	Grayburg	Strawn
Gravity, A.P.I. @ 60° F.	27° to 32°	40°
Sulphur	0.7%	

Grayburg: Generally, the quantity of gas in solution in the oil has not been quite enough to cause the wells to flow. However, a few wells have flowed their production temporarily.

For analyses of Grayburg oil see:

Railroad Commission of Texas

Analyses of Texas Crude Oils (1940) pp. 32 and 61

U.S.Bureau of Mines Lab.ref.No.		27867	31164
Analyses of Crude Oils from the West Texas District. R.I. 2849 (1927)	Page	16	
Tabulated Analyses of Texas Crude Oils. R.I. 3252 (1934) Group 2	Item	67	68
Tabulated Analyses of Texas Crude Oils. T.P. 607 (1939) Group 2	Item	94	95
Analyses of Crude Oils from Some West Texas Fields. R.I. 3744 (1944)	Page		44

WATER PRODUCTION

Grayburg: The percentage of water in gross production is extremely high and has been high continuously from the time of discovery. Because of the high water:oil ratio, there is a field rule forbidding the operation of a well whenever the water:oil ratio exceeds 20:1. At the present time, there is no apparent separation between the oil and water in the reservoir. There appears to be no definite oil-water contact, or, if there is, then its elevation is very irregular.

Strawn: No record of water production.

COMPLETION TREATMENT

Grayburg: The early wells were completed "natural". Some of the later wells were shot. Practically every well completed during the last fifteen years has been treated with 500 to 2,000 gallons of acid.

Strawn: The single productive well was treated with 3,000 gallons of acid at time of completion.

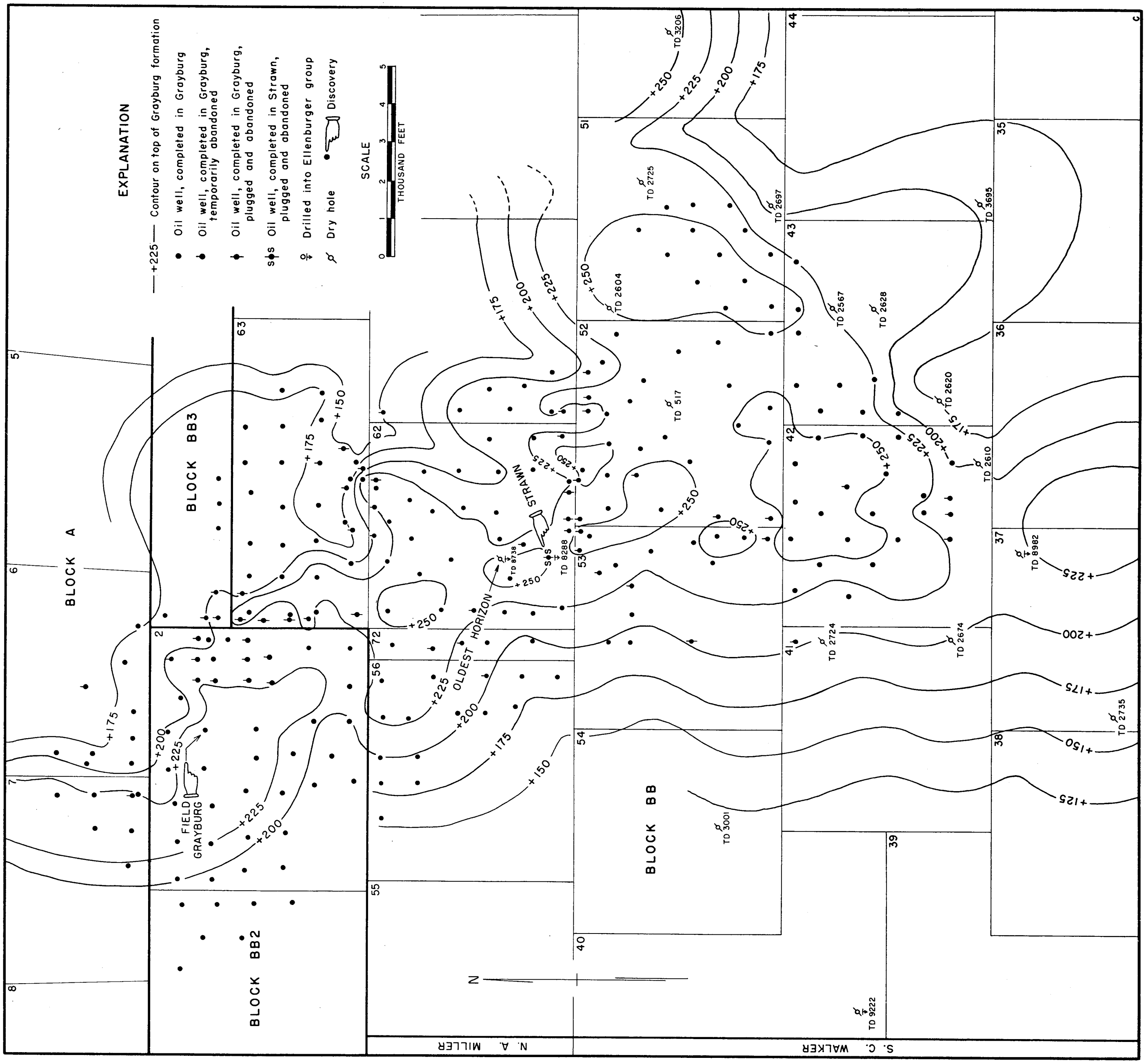
SELECTED REFERENCE

Stratigraphic Problems Committee (1953) North-South Cross Section through Permian Basin of West Texas: West Texas Geological Society Midland, Texas

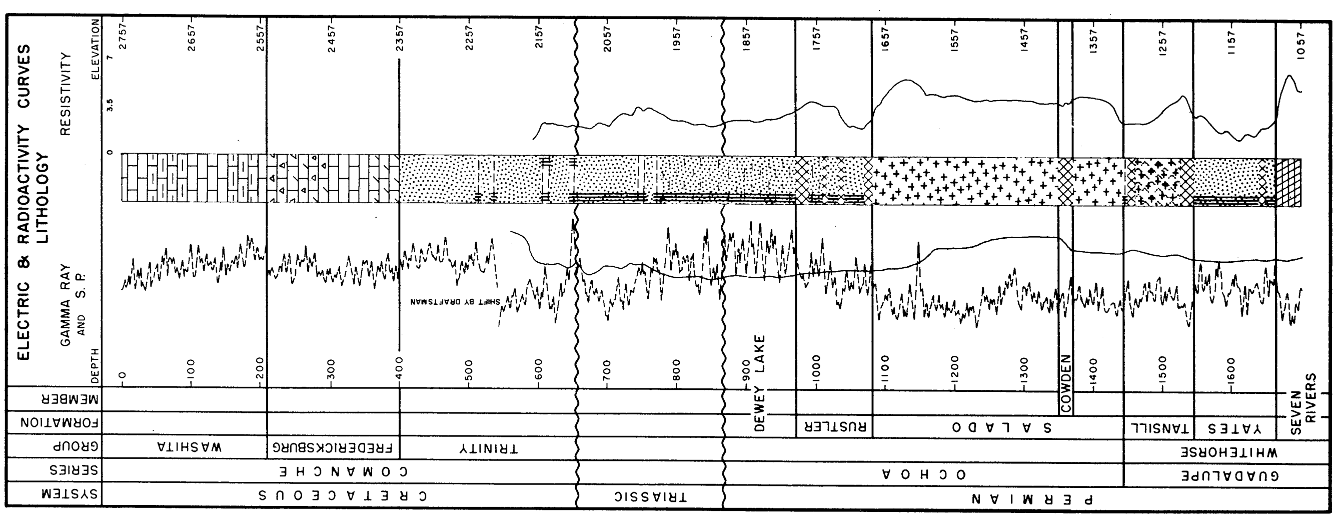
PRODUCTION HISTORY

	WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Flowing	Pumping	Yearly	Cumulative
Grayburg:				
1925			3,320	3,320
1926			278,688	282,008
1927			549,483	831,491
1928			852,758	1,684,249
1929			684,790	2,369,039
1930			677,364	3,046,403
1931			511,513	3,557,916
1932	0	36	419,840	3,977,756
1933	0	35	322,687	4,300,443
1934	0	41	259,860	4,560,303
1935	0	37	312,854	4,873,157
1936	0	39	390,025	5,263,182
1937	0	40	424,119	5,687,301
1938	0	42	302,979	5,990,280
1939	0	46	347,057	6,337,337
1940	0	50	411,932	6,749,269
1941	0	65	510,754	7,260,023
1942	0	78	608,608	7,868,631
1943	0	89	688,518	8,557,149
1944	0	90	717,284	9,274,433
1945	0	93	710,001	9,984,434
1946	0	101	717,014	10,701,448
1947	0	117	862,770	11,564,218
1948	0	120	949,869	12,514,087
1949	0	136	1,111,324	13,625,411
1950	0	156	1,426,278	15,051,689
1951	0	178	1,414,572	16,466,261
1952	0	182	1,506,896	17,973,157
1953	0	195	1,498,277	19,471,434
Strawn:				
1951	1	0	4,573	4,573
1952	1	0	4,340	8,913
1953	Abandoned		0	8,913

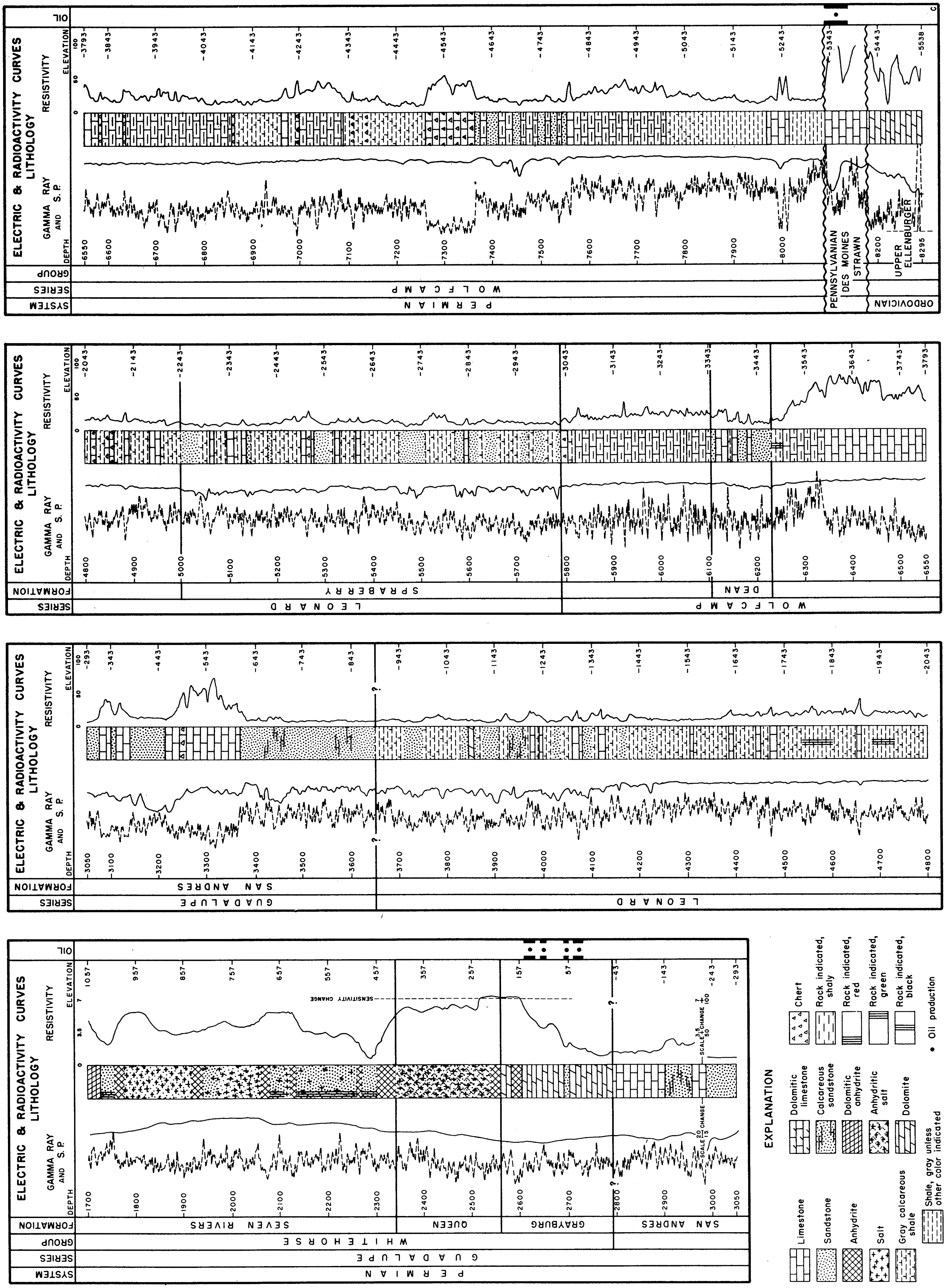
The figures representing yearly production for each year prior to 1934 have been transcribed from page 448 of TEXAS OIL AND GAS SINCF 1543 by C.A.Warner (Gulf Publishing Co.) and the figures for the years 1934-1937 are from the same source adjusted by deductions representing quantities produced in the Todd field, also in Crockett County, as reported in annual issues of PETROLEUM DFVELOPMENT AND TECHNOLOGY (A.I.M.E.). The figure for 1938 is that reported for the World field for that year in the corresponding volume of the A.I.M.E. series. The figures for 1939 and subsequent years have been transcribed from Annual Reports of the Railroad Commission.



TYPICAL SECTION OF ROCKS PENETRATED



TYPICAL SECTION OF ROCKS PENETRATED



YATES FIELD

Pecos and Crockett Counties, Texas

DAVID DONOGHUE and W. L. GUPTON, Jr.
Consulting Geologists, Fort Worth, Texas
January 10, 1956

LOCATION

The Yates field is for the most part in Pecos County with the eastern tip extending across the Pecos River into Crockett County. It is on the southern end of the Central Basin platform. Physiographically, it is in the dissected northwestern portion of the Edwards plateau.

INTRODUCTION

The Yates field is notable for the extremely large potential capacities of its wells, for the large return on capital invested, for low production costs and for the orderly and conservative manner in which it was developed and has been operated.

Mid-Kansas Oil & Gas Co. and Transcontinental Oil Co. #30 I. G. Yates "A", although it was completed at the depth of only 1,070 feet, had an initial capacity among the greatest, if not the greatest, of any well ever completed anywhere. Relative to this well, in their paper cited under SELECTED REFERENCES, Hennen and Metcalf say: "Official proration test of this well on September 23, 1929, gave it 8,528.4 barrels of oil an hour, or a daily potential of 204,681 barrels — the largest actually gauged production ever found for any well." At the time of completion on September 12, 1929, the well produced 4,365 barrels in 34 minutes, or at the rate of 185,000 barrels per day. Relative to the second most prolific well in the field, in their paper cited below, Carpenter and Hill say: "The California Co. Reid well #3, completed January 1, 1935, had an initial production of 7,005 barrels per hour or at the rate of 168,120 barrels per day. The initial production of this well, the second largest in the field, is particularly noteworthy because when it was completed the field was 8 years old and had produced about 200,000,000 barrels of oil." These two wells are in the east-central part of the field near the discovery well and are identified on the accompanying maps by entry of "A" and "B" respectively.

Although the capacities of the wells were generally extremely high, and many of them were enormous, production was held to a conservative rate. Throughout its history, the field has been conservatively developed and operated. Organized curtailment of production in Texas had its beginning in the Yates field October 1, 1927. The operators had ratified a voluntary plan of proration in September, 1927 and continued to operate voluntarily under modifications of that plan until enforcement was assumed by the Railroad Commission on July 1, 1928. (The Hendrick field, under an order effective May 5, 1928, was the first field prorated by authority of the Commission).

Production from the Yates field is reported in four catagories: viz., (a) Toborg, (b) Yates Sand, (c) Yates Lime and (d) seepage oil or salvage oil.

Toborg: The production in this catagory is commonly reported as from a separate and distinct field, with the name spelled variously as "Toborg", "Toburg", "Toberg", "Tobarg" and "Torburg". The correct spelling appears to be that of the name of the owner of the land on which the discovery well was drilled; that spelling appears to be "Toborg". In this paper, the Toborg production is treated as coming from a single distinct reservoir in the Yates field. However, it is recognized that there may be several distinct reservoirs and that the oil in some of them probably migrated, due to leaky casing, from the Yates Lime reservoir subsequent to the discovery of the field. Such oil is, of course, more closely related to the oil in the fourth of the above listed catagories than it is to such oil as was in the Toborg reservoir rock before development of the field. It appears likely that only a small percentage of the ultimate Toborg production was in the Toborg reservoir rocks when the Yates field was discovered. Prior to 1946, Toborg production was limited to a small area at the northwest edge of the Yates field. In the latter part of 1946, a drilling campaign was started, and now the Toborg productive area extends along the entire northeastern flank of the field. The total depths of the wells are mostly between 100 and 600 feet, with only a few slightly deeper and with many even shallower.

Yates Sand: The Yates sandstone was recognized early as a distinct stratigraphic unit and was used as a stratigraphic marker, first under the name of "Smith Sand", which name was preoccupied as the name for a stratigraphic unit, then under the name of "Yates Sand". Since the time when the formation was named in this field, it has been widely correlated throughout West Texas. Early in the development of the Yates field, substantial showings of oil were observed when this formation was penetrated, but production was deferred pending development of the more prolific Yates Lime. Since the time when producing operations were initiated in 1933, the production has been reported variously as from "Yates, Smith Sand", "Yates (Smith sand)", "Yates-Smith Sand", "Yates, sand", "Yates (sand)" and "Yates Sand".

Yates Lime: The reservoir herein designated by this name is by far the most important reservoir in the field. Only a relatively small quantity of oil has been produced from the other reservoirs. As indicated on the accompanying GENERALIZED COMPOSITE SECTION, the reservoir rock consists of rocks of Queen, Grayburg and San Andres formations. An understanding of this reservoir requires thinking of it as composed of two parts: viz., that part above the unconformity and that part below the unconformity. That part above the unconformity is at the base of the Queen formation. That part of the Queen formation (the River Bed Sand) which constitutes a part of the reservoir rock is not present everywhere in the field. There is no River Bed Sand throughout a considerable area at the structural apex, but, outward, except in the west-central part of the field, there is a varying amount of this member, with the maximum thickness around the periphery of the field — up to 120 feet at the northeast edge of the field. That part of the reservoir below the unconformity includes the main productive zone. The main productive zone, which is at the top of the Grayburg formation, has been called the "Brown Lime" and is a zone at the top of the "Big Lime" and has been correlated with the "Big Lake Lime", which is productive in the Big Lake field in Reagan County. The downward extent of the productive rock is not known, primarily because of a field rule that prohibited drilling more than 225 feet into the "Big Lime". In their paper cited below, Hennen and Metcalf say: "This excessive porosity seems to have been produced to a depth of several hundred feet into the limestone. No great decrease has been noticed to a depth of 225 feet in the many wells that have been drilled to that depth. There is every indication that it will continue to the general water-table of

INTRODUCTION (Continued)

the field, which, in the central part of the pool, will permit a penetration of more than 375 feet of probable pay zone."

Seepage oil: Early in October of 1928, surface seepage of oil was observed along the Pecos River. Recovery was begun on October 12, 1928. Oil was recovered by skimming the water of Pecos River, by trenching, by digging pits and by drilling shallow wells. Recovery by these methods had amounted to 400,000 barrels up to July 1, 1929; thereafter the rate of recovery increased rapidly and then declined, as indicated by the figures presented in the following PRODUCTION HISTORY, under Yates Lime: Seepage. Analyses of the oil corroborated the supposition that the occurrence was due to escape from the Yates Lime reservoir through imperfect casing installations. A careful investigation resulted in remedial work; particularly cementing, at several wells; one well was plugged and abandoned. A gradual reduction in the amount of seepage oil indicated that the remedial work at the wells had been effective in curtailing the leakage. The seepage oil that is definitely recognized as such is now reported as production from Yates Lime reservoir. However, it is highly probable that a material portion of the Toborg production has escaped from the Yates Lime reservoir through leaky casing. The recovery of seepage oil has been from recent sands and gravels along the Pecos River and from rocks at various stratigraphic positions within the range of the Toborg reservoir as indicated on the accompanying GENERALIZED COMPOSITE SECTION. Since seepage oil is not regarded as occurring naturally in a separate and distinct reservoir, corresponding treatment is omitted under several of the following headings.

METHODS OF EXPLORATION LEADING TO DISCOVERY

Surface geological mapping in 1923 by members of its staff led Transcontinental Oil Company to acquire leasehold rights on several favorable blocks in this general region, including a solid block of 9,690 acres now largely within the area of this field. The surface geological conditions led Mid-Kansas Oil & Gas Company to enter into a deal with Transcontinental whereby it drilled a test well on each of three of the several blocks in consideration of a half-interest in the leasehold rights on all of them. Then the two operators drilled, on a fifty-fifty basis, the exploratory test which became the discovery well of the Yates field.

SURFACE FORMATIONS

Rocks of Cretaceous age predominate, with merely a small area occupied by Triassic rocks and with a possibility that, within that small area, there is a very limited Permian outcrop. The rugged topography occasions surface outcrop of much more section than common in the oil fields of West Texas. The oldest surface rocks are of Triassic age, or possibly late Permian, and above those are the younger stratigraphic units as indicated on the accompanying GENERALIZED COMPOSITE SECTION; however, the section within the field extends further upward and includes a total thickness of about 620 feet of undifferentiated Fredericksburg — Washita limestone.

DISCOVERIES

Toborg: No single Toborg well has all the attributes considered normal for discovery wells. The first completion as a commercially productive well followed after the presence of oil in the Basement Sand had been demonstrated in several wells drilled deeper to the prolific Yates Lime reservoir. Showings of oil, some apparently commercial, in the Basement Sand were observed in wells in Sections 39 and 40, Block 194, G. C. & S. F. survey. The observance of the showing was followed in due course by completion of wells in the Basement Sand in the southern end of Section 539, Arnold & Barrett survey and in Sections 39 and 40, Block 194, G. C. & S. F. survey. The first completion appears to have been in September of 1928, and this was followed rapidly by many others. By the end of 1930 there were 40 of these shallow (350 to 600 feet) wells clustered at the northwest end of the Yates field.

Yates Sand: Good showings of oil, apparently commercial, were observed in the Yates Sand during the process of drilling to the prolific Yates Lime reservoir. These showings were particularly promising in wells in the vicinity of the common corner of Sections 23, 24, 27 and 28, Block 194, G. C. & S. F. survey. It appears that the first completion for production from this reservoir was in October of 1933 in the northeastern part of Section 24. The production was not very profitable and development progressed slowly, as indicated by entries in PRODUCTION HISTORY presented on a following page.

Yates Lime and Field: October 26, 1926; Mid-Kansas Oil & Gas Co. and Transcontinental Oil Co. #1 Ira G. Yates "A" (now, Ohio Oil Co. #1 Yates "A"). In their paper cited below under SELECTED REFERENCES, Hennen and Metcalf say: "It blew in unexpectedly in the top of the Big Lake lime at the shallow depth of 997 feet on October 28, 1926, with a large volume of gas and about 100 barrels of oil daily. Efforts were made immediately to mud off the oil and gas 'pay' until the well could be properly cased. It required several days to do this and it was accomplished only after a large quantity of mud had been blown out of the hole several times. The well was then deepened to 1,032 feet and completed on December 13, 1926, making 135 barrels per hour. Later (August 18, 1928) it was completed to its present depth of 1,150 feet and its proration test at that time was 2,950 barrels of oil per hour. Its proration test in the latter part of June, 1929, still gives it 2,999.31 barrels per hour, or 71,984 barrels daily. * * * The completion of this remarkable well on such a large dome in the surface (Cretaceous) beds created great excitement in the oil fraternity, and development followed rapidly. By July 1, 1928, 207 wells had been completed in the pool with a daily potential production of 2,575,047 barrels of oil, based on one-hour open-flow tests, and by July 1, 1929, a total of 306 producing wells had been completed with a daily potential production of 4,590,686 barrels, or a daily potential production per well of 12,439 barrels and 14,620 barrels for the respective dates. No such results have ever been duplicated in so many wells in any pool, regardless of depth to pay zones."

ELEVATION OF SURFACE

The elevation of the surface ranges from about 2,150 feet in the bed of the Pecos River up to about 3,000 feet at the high points on the mesas in the western portion of the field. A large part of the relief is in the almost vertical cliffs of the mesas.

OLDEST STRATIGRAPHIC HORIZON PENETRATED

The oldest horizon penetrated within the field is in the San Andres formation 292 feet below the top of the Grayburg formation. During nearly the whole of the period of development there was a field rule prohibiting drilling more than 225 feet below the top of the "Big Lime" (i. e., top of Grayburg). Penetration in many wells is at or near that limit; in only a very few wells is that limit exceeded.

The oldest horizon penetrated in the vicinity of the field is in the Ellenburger group 374 feet below its top. This penetration is in Standard Oil Co. of Texas #1 Douglas Oil Co. et al, a dry hole located near the southeast corner of Sec. 9, Block 194, where the total depth of 9,114 feet is indicated on the accompanying maps.

VARIATIONS IN THICKNESSES

In their paper cited under SELECTED REFERENCES, Hennen and Metcalf summarize certain important observations as follows: "The Permian sediments encountered in the field represent a somewhat abbreviated section of those normally found in the Permian basin. Because of the structural relief existing during the deposition of the upper Permian, these strata become much thinner toward the axis of the fold, and the upper part of the sediments is almost entirely missing in part of the field." The degree of thinning over the axis decreases upward in the section.

LITHOLOGY OF RESERVOIR ROCKS

Toborg: In the original productive area in Secs. 39 and 40, Blk. 194, G. C. & S. F. survey and Sec. 539, Arnold & Barrett survey, the Toborg reservoir rock is dolomite containing various amounts of coarse, well cemented sand and some free sulphur and with zones with porosity of the cavity or vug type. In the southeastern extension, production appears to come from several different zones, mainly zones in the Trinity sandstone where there is a high degree of porosity and permeability.

Yates Sand: This reservoir rock is a shaly, calcareous sandstone containing thin layers of gypsum, dolomite and anhydrite. The productive portion consists of lenses of soft, saccharoidal sandstone totaling about 8 to 10 feet in thickness.

Yates Lime: The Yates Lime reservoir occupies rocks in two distinct catagories: viz., those above the unconformity and those below the unconformity. Those above the unconformity are mainly basal sandstones in a series where anhydrite is dominant. There is a minor amount of re-deposited dolomite and dolomitic limestone at the base of this series, and this re-worked material is locally productive. However, most of the production from above the unconformity is from sandstone lenses in the basal portion of the anhydrite series. The main productive rock of this reservoir, and of the Yates field, is the "Brown Lime", which is immediately below the unconformity and at the top of the Grayburg formation. This limestone is dolomitic, has vuggy to cavernous porosity and a very high degree of permeability. The degree of porosity is much greater on the steeply dipping eastern flank than elsewhere. While it has been observed that porosity and permeability decrease only slightly with deeper penetration in so far as the limited penetrations provide data, it appears probable that, in general, there is a decrease beyond the extent of the penetrations.

NATURE OF TRAPS

Toborg: Either updip decrease of porosity or updip lensing on a structural nose appears to be the principal trap-forming factor accounting for the accumulation in the area where Toborg production was initiated. As the productive area spread, it appears likely that Toborg production came to include some seepage oil which had not yet been trapped since its escape from the Yates Lime reservoir.

Yates Sand: The accumulation in the Yates Sand appears to be due to updip and lateral variation in degree of porosity of the reservoir rock on a westward plunging structural nose.

Yates Lime: Anticlinal folding is the primary trap-forming factor. Truncation of the reservoir rocks and sealing by overlying relatively impervious younger rocks is also important in forming the trap. Although some productive lenses of the River Bed Sand member may be separated downdipward from underlying Grayburg limestone, it appears that there is updip intercommunication and that there is merely one trap in which the enormous quantity of Yates Lime oil has accumulated.

PRODUCTIVE AREAS

	Acres
Toborg	4,520
Yates Sand	660
Yates Lime	20,700
Yates field	22,430

THICKNESSES OF RESERVOIR ROCKS

Toborg: In the area where Toborg production was initiated, there is a single productive sandstone, generally 5 to 15 feet thick. However, that sandstone has not been correlated except in a very limited area. It is probable that there are many separate and distinct sandstones now contributing to the Toborg production and that those sandstones are distributed through a considerable stratigraphic range, as indicated on the accompanying GENERALIZED COMPOSITE SECTION. Available data do not warrant a guess as to total thickness.

Yates Sand: In the area where the Yates Sand is productive, the thickness from top to bottom is about 60 to 80 feet. The sum of the thicknesses of the portions which yield oil into the bore holes is about 8 to 10 feet.

Yates Lime: Data are not available for reporting appropriately on the thickness of the rock which yields the major production of the field. As indicated in the entry under this heading in the foregoing INTRODUCTION, a considerable portion of the contributing reservoir rock is below the extent of penetrations attained during development operations. The reservoir occupies rocks both above and below an unconformity, with considerable thickness between productive members at structurally low locations around the periphery of the field. The total net thickness of productive rock above the unconformity varies throughout the field from zero to 120 feet. That portion of the reservoir rock below the unconformity is certainly as much as 225 feet and probably does not exceed 400 feet in thickness.

CONTINUITY OF RESERVOIR ROCKS

Toborg: Except in the central part of the field where they have been removed by erosion, the Trinity and Triassic zones which contain the locally productive lenses are continuous throughout the area of the field and far beyond the extent of the field. However, the individual productive lenses are only local.

Yates Sand: The stratigraphic equivalent of the reservoir rock is recognizable throughout a large portion of the field. However, in only a small area in the western part of the field is the degree of porosity and permeability adequate for commercial production.

Yates Lime: That portion of the reservoir rock which is in the Queen formation consists of a series of members deposited around a sinking island. Even the higher members were not deposited over the apex of the anticline. The character of each productive member is different at different distances from the apex. That portion of the reservoir rock below the unconformity is continuous throughout the field and far beyond except that the uppermost portion of the Grayburg formation was truncated locally at the apex before post-erosional deposition was continuous over the entire area.

ELEVATION AND RELIEF OF PRODUCTIVE ZONES

Toborg:
Data are not readily available.

Yates Sand:
Data are not readily available.

Yates Lime:

		Feet
Highest known elevation of oil		1,476
Elevation of bottom of oil	Between 1,060 &	1,090
Relief	Between 386 &	416

In their paper cited under SELECTED REFERENCES, Hennen and Metcalf say, "the water-table maintains a practically uniform level" and report that the elevation of the water-table was between 1,060 and 1,090 feet above sea-level.

COMPLETION TREATMENT

Toborg: No artificial completion treatments have been used.

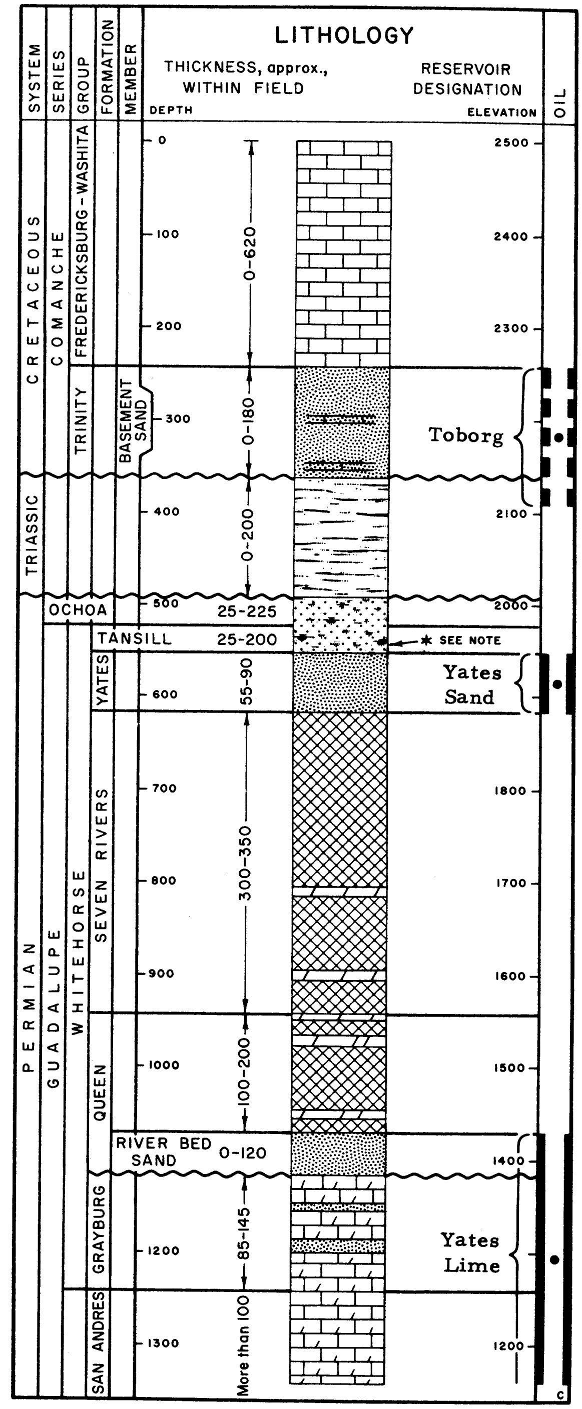
Yates Sand: No artificial completion treatments have been used.

Yates Lime: Of the total of about 600 wells completed in the Yates Lime reservoir, 109 were acidized and about 60 were shot with nitroglycerin.

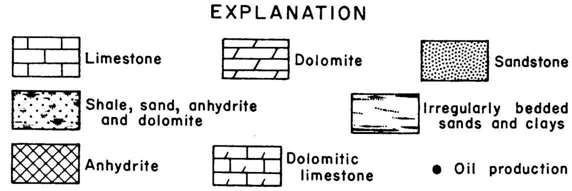
SECONDARY RECOVERY

Water injection projects are in operation in the Toborg reservoir and in the Yates Sand reservoir.

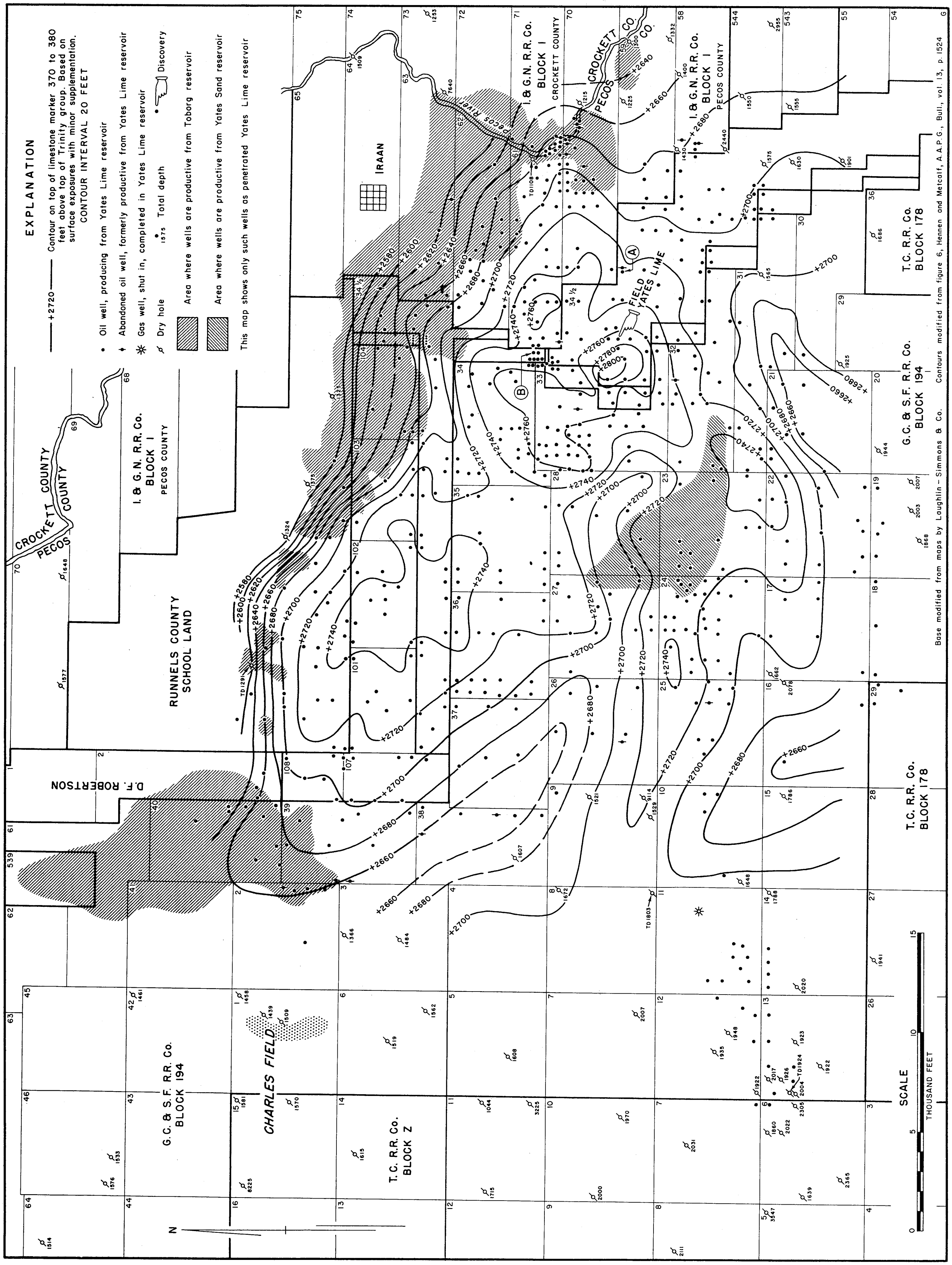
GENERALIZED COMPOSITE SECTION OF ROCKS PENETRATED

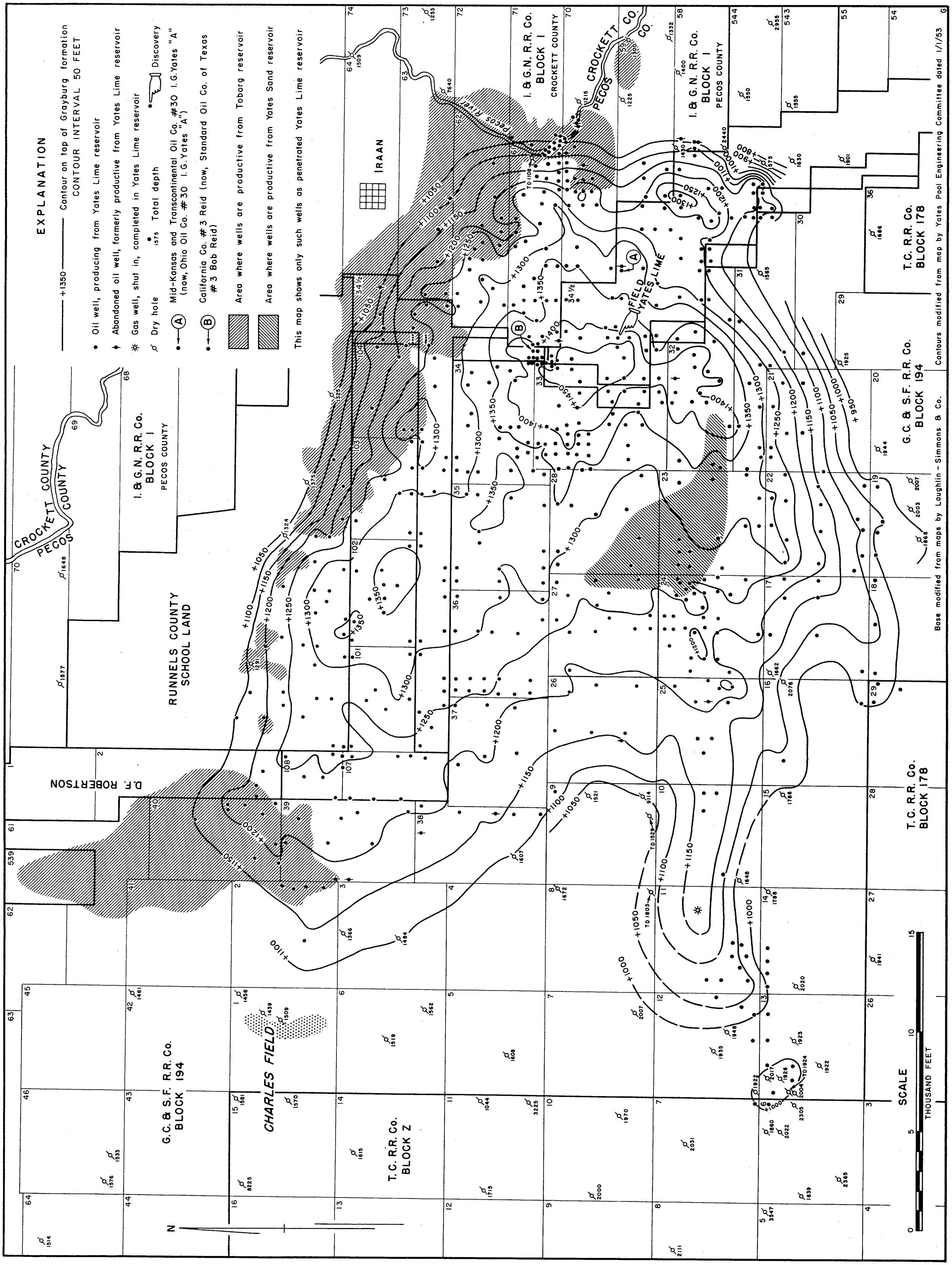


* The "BIG SALT" member of the Tansill formation, which is prominent in the surrounding area, thins toward the structural axis and is entirely absent in the central part of the field.



The above graph is representative of the lithology in the central portion of the field. Generally, each of the stratigraphic units is thicker around the periphery of the field than indicated in the above graph. The thickening away from the apex decreases upward in the section. Rugged topography occasions a wide variation in the amount of Cretaceous rocks penetrated.


EXPLANATION
+2720 Contour on top of limestone marker 370 to 380 feet above top of Trinity group. Based on surface exposures with minor supplementation. CONTOUR INTERVAL 20 FEET
Oil well, producing from Yates Lime reservoir
Abandoned oil well, formerly productive from Yates Lime reservoir
Gas well, shut in, completed in Yates Lime reservoir
Dry hole
1575 Total depth
Discovery
Area where wells are productive from Toborg reservoir
Area where wells are productive from Yates Sand reservoir
This map shows only such wells as penetrated Yates Lime reservoir
IRAAN
PECOS RIVER
CROCKETT CO.
PECOS CO.
CROCKETT COUNTY
PECOS COUNTY
I. & G. N. R.R. Co.
BLOCK I
RUNNELS COUNTY
SCHOOL LAND
D. F. ROBERTSON
YATES LIME
FIELD
CHARLES FIELD
G. C. & S. F. R.R. Co.
BLOCK 194
T. C. R.R. Co.
BLOCK Z
T. C. R.R. Co.
BLOCK 178
SCALE
THOUSAND FEET
0 5 10 15
N
Base modified from maps by Laughlin-Simmons & Co. Contours modified from figure 6, Hennen and Metcalf, A.A.P.G., Bull., vol. 13, p. 1524


EXPLANATION
+1350 Contour on top of Grayburg formation CONTOUR INTERVAL 50 FEET
Oil well, producing from Yates Lime reservoir
Abandoned oil well, formerly productive from Yates Lime reservoir
Gas well, shut in, completed in Yates Lime reservoir
Dry hole
Total depth
Discovery
Mid-Kansas and Transcontinental Oil Co. #30 I.G.Yates "A" (now, Ohio Oil Co. #30 I.G.Yates "A")
California Co. #3 Reid (now, Standard Oil Co. of Texas #3 Bob Reid)
Area where wells are productive from Toborg reservoir
Area where wells are productive from Yates Sand reservoir
This map shows only such wells as penetrated Yates Lime reservoir
IRAAN
YATES LIME FIELD
CROCKETT COUNTY
PECOS COUNTY
Pecos River
I. & G.N. R.R. Co. BLOCK I CROCKETT COUNTY
I. & G.N. R.R. Co. BLOCK I PECOS COUNTY
RUNNELS COUNTY SCHOOL LAND
D.F. ROBERTSON
T.C. R.R. Co. BLOCK 178
G.C. & S.F. R.R. Co. BLOCK 194
T.C. R.R. Co. BLOCK Z
CHARLES FIELD
SCALE
THOUSAND FEET
Base modified from maps by Laughlin-Simmons & Co.
Contours modified from map by Yates Pool Engineering Committee dated 1/1/53

CHARACTER OF GAS

The character of gas from the Toborg and Yates Lime reservoirs is essentially the same; the quantity from the Yates Sand reservoir is negligible. The gas from the Toborg and Yates Lime reservoirs contains 1% to 3% hydrogen sulphide — so much that the gas is not suitable for domestic consumption. The yield of gasoline in a casing-head gasoline plant which operated temporarily in 1930 and 1931 was 1.48 gallons per Mcf. Available annual reports of the Railroad Commission (1939-1954) do not report the marketing of any liquified products.

WATER PRODUCTION

Toborg: From the beginning of operations, water has always constituted a large percentage of the gross production of practically all Toborg wells.

Yates Sand: No water is produced by the wells completed in this reservoir.

Yates Lime: As indicated by entries in the following PRODUCTION HISTORY, large quantities of water have been produced from this reservoir. Although most of the water has been produced by edge wells, a considerable quantity has been produced by structurally high wells during occasions when rates of withdrawals through a well or a local group of wells were abnormally high. Reduction in rate of oil production has resulted in prompt decline in water production in such local areas.

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CHARACTER OF OIL

Toborg: In the area where Toborg production was initiated, the gravity of the oil is 19° to 22.5° A. P. I. and the sulphur content is about 2%. The oil produced from the presently extended Toborg area ranges in gravity from 15° to 30° A. P. I. The higher gravity oil has probably escaped from the Yates Lime reservoir. For complete analyses of Toborg oil, see the following cited references to analyses of samples Nos. 39259 and 51059.

Yates Sand: Gravity, A. P. I @ 60° F.: 35°. Sulphur content: Sweet.

Yates Lime: Gravity, A. P. I. @ 60° F.: 29°-30°. Sulphur content: 1.55%.

For analyses see:

Railroad Commission of Texas
Analyses of Texas Crude Oils (1940), pp. 34 and 61

U. S. Bureau of Mines	Laboratory reference No.	27865	31160	35245	39259	45039	48094	51059
Analyses of Crude Oils from the West Texas District. R. I. 2849 (1927)	Page	18						
Tabulated Analyses of Texas Crude Oils. R. I. 3252 (1934) Group 2,	Item	70	69					
Petroleum Engineering Report, Big Spring Field and Other Fields in West Texas and Southeastern New Mexico. R. I. 3316 (1936)	Page		110					
Tabulated Analyses of Texas Crude Oil. T. P. 607 (1939) Group 2,	Item	98	97	96				
Analyses of Crude Oils from Some Fields of Texas. R. I. 3699 (1943)	Item				81			
Analyses of Crude Oils from Some West Texas Fields. R. I. 3744 (1944)	Page			45	35			
Analyses of Crude Oils from 283 Important Oil Fields of the United States. R. I. 4289 (1948)	Item					274		
Analyses of Crude Oils from Some West Texas Fields. R. I. 4959 (1953)	Item						100	84

PRODUCTION HISTORY

	Field totals		Toborg				Yates Sand			
	OIL PRODUCTION (barrels)		WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)		WELLS PRODUCING at end of year		OIL PRODUCTION (barrels)	
Year	Yearly	Cumulative	Flowing	Pumping	Yearly	Cumulative	Flowing	Pumping	Yearly	Cumulative
1927	5,176,313	5,176,313	None	None	None	None	None	None	None	None
1928	22,328,886	27,505,199	?	?	?	?	None	None	None	None
1929	41,336,913	68,842,112	?	?	?	?	None	None	None	None
1930	40,848,666	109,690,778	0	40	463,799	463,799	None	None	None	None
1931	27,718,733	137,409,511	0	54	591,544	1,055,343	None	None	None	None
1932	23,460,415	160,869,926	0	75	502,207	1,557,550	None	None	None	None
1933	20,682,979	181,552,905	0	76	454,702	2,012,252	0	3	4,255	4,255
1934	15,893,164	197,446,069	0	89	425,141	2,437,393	0	4	54,559	58,814
1935	15,905,892	213,351,961	0	118	632,488	3,069,881	0	7	75,585	134,399
1936	13,088,368	226,440,329	0	160	777,366	3,847,247	0	10	96,846	231,245
1937	11,402,653	237,842,982	0	197	772,297	4,619,544	0	10	71,868	303,113
1938	7,388,248	245,231,230	0	203	615,840	5,235,384	0	10	43,981	347,094
1939	8,383,512	253,614,742	0	215	608,361	5,843,745	0	10	37,280	384,374
1940	7,470,528	261,085,270	0	229	570,524	6,414,269	0	10	38,140	422,514
1941	6,167,859	267,253,129	0	252	517,938	6,932,207	0	10	44,375	466,889
1942	7,158,599	274,411,728	0	253	479,622	7,411,829	0	10	38,659	505,548
1943	9,189,967	283,601,695	0	257	474,641	7,886,470	0	10	38,646	544,194
1944	13,157,754	296,759,449	0	259	480,017	8,366,487	1	9	41,995	586,189
1945	13,828,271	310,587,720	0	260	437,567	8,804,054	2	15	62,887	649,076
1946	13,983,287	324,571,007	0	271	414,016	9,218,070	1	14	80,591	729,667
1947	17,030,210	341,601,217	31	371	522,182	9,740,252	0	19	75,935	805,602
1948	19,379,595	360,980,812	41	542	1,228,834	10,969,086	0	21	83,401	889,003
1949	13,575,640	374,556,452	41	658	1,671,036	12,640,122	0	21	62,940	951,943
1950	13,061,661	387,618,113	38	817	2,215,760	14,855,882	0	21	61,466	1,013,409
1951	16,952,235	404,570,348	0	938	2,977,249	17,388,131	0	24	118,084	1,131,493
1952	16,612,135	421,182,483	2	855	3,711,317	21,544,448	1	27	140,493	1,271,986
1953	14,317,548	435,500,031	0	783	2,236,939	23,781,387	0	31	301,645	1,573,631
1954	11,196,361	446,696,392	4	718	1,295,976	25,077,363	0	35	189,993	1,763,624
1955	10,853,134	457,549,526	2	678	976,195	26,053,558	0	36	187,013	1,950,637

Yates Lime

	WELLS PRODUCING at end of year			OIL PRODUCTION (barrels)				GAS PRODUCTION (Mcf)		WATER PRODUCTION (barrels)
				Yearly			Cumulative			
Year	Flowing	Art. Lift	Total	Regular	Seepage	Total	Total	Yearly	Cumulative	
1926	1	0	1	Negligible	None	Negligible	Negligible	Negligible	Negligible	None
1927	?	?	103	5,176,313	None	5,176,313	5,176,313	9,525,000	9,525,000	Negligible
1928	?	?	284	22,328,886	?	22,328,886	27,505,199	23,150,000	32,675,000	1,090,000
1929	?	?	354	39,629,924	1,706,989	41,336,913	68,842,112	21,543,000	54,218,000	2,190,000
1930	?	?	403	39,406,445	978,422	40,384,867	109,226,979	20,053,000	74,271,000	2,550,000
1931	?	?	408	26,748,584	378,605	27,127,189	136,354,168	13,226,000	87,497,000	2,190,000
1932	380	25	405	22,801,042	157,166	22,958,208	159,312,376	6,336,000	93,833,000	2,010,000
1933	?	?	423	20,123,435	100,587	20,224,022	179,536,398	6,838,000	100,671,000	1,820,000
1934	440	16	456	15,353,585	59,879	15,413,464	194,949,862	4,741,000	105,412,000	1,715,952
1935	446	27	473	15,144,300	53,519	15,197,819	210,147,681	3,202,300	108,614,300	1,525,957
1936	481	33	514	12,177,164	36,992	12,214,156	222,361,837	2,827,900	111,442,200	1,609,916
1937	509	33	542	10,521,849	36,639	10,558,488	232,920,325	2,162,602	113,604,802	1,551,381
1938	518	34	552	6,696,436	31,991	6,728,427	239,648,752	1,459,970	115,064,772	1,317,925
1939	527	29	556	7,708,405	29,466	7,737,871	247,386,623	1,497,445	116,562,217	1,381,690
1940	529	29	558	6,838,357	23,507	6,861,864	254,248,487	1,422,149	117,984,366	1,289,768
1941	521	38	559	5,591,977	13,569	5,605,546	259,854,033	1,173,587	119,157,953	956,853
1942	521	38	559	6,634,068	6,250	6,640,318	266,494,351	1,331,780	120,489,733	1,087,385
1943	508	43	551	8,672,557	4,123	8,676,680	275,171,031	1,650,526	122,140,259	1,243,838
1944	513	54	567	12,632,159	3,583	12,635,742	287,806,773	2,293,900	124,434,159	359,514
1945	513	48	561	13,320,581	7,236	13,327,817	301,134,590	2,452,543	126,886,702	441,865
1946	520	53	573	13,473,761	14,919	13,488,680	314,623,270	2,456,741	129,343,443	386,464
1947	512	67	579	16,407,509	24,584	16,432,093	331,055,363	3,369,216	132,712,659	335,845
1948	511	78	589	18,035,302	32,058	18,067,360	349,122,723	3,410,667	136,123,326	476,473
1949	525	66	591	11,816,278	25,386	11,841,664	360,964,387	2,273,600	138,396,926	293,621
1950	516	86	602	10,756,562	27,873	10,784,435	371,748,822	2,275,518	140,672,444	361,420
1951	509	95	604	13,828,468	28,434	13,856,902	385,605,724	2,729,810	143,402,254	582,460
1952	506	89	595	12,744,813	15,512	12,760,325	398,366,049	2,220,296	145,622,550	625,748
1953	498	97	595	11,769,788	9,176	11,778,964	410,145,013	2,273,341	147,895,891	671,490
1954	497	98	595	9,705,085	5,307	9,710,392	419,855,405	1,786,712	149,682,603	492,154
1955	498	100	598	9,687,061	2,865	9,689,926	429,545,331	?	?	?
Totals				425,730,694	3,814,637	429,545,331				

APPENDIX

SUGGESTIONS TO AUTHORS OF FIELD PAPERS

Purpose of Project:

"Occurrence of Oil and Gas in Texas" is compiled for the purpose of making readily available to exploration geologists, exploitation geologists and petroleum engineers, as nearly as practicable, all available information relative to conditions of nature which may be of assistance in finding new fields and in accomplishing maximum recovery from known fields everywhere. It must be recognized that certain practical limitations will preclude accomplishment to the full extent desired by the group for whom the data are especially compiled.

Check-list:

Herewith is a check-list of items of information. It is hoped that each author will include in his paper such of these items as are reasonably available. Many items germane to the project have been omitted to keep the project on a practical basis under the existing set of conditions -- conditions which will probably prohibit most authors giving as much time to the preparation of their papers as they would like. So far as we are concerned, a paper complete as to the reasonably available items on this list will be regarded as complete for the project. However, there is no intention to limit authors to the information on this list. To the extent that any additional information is within the purpose of this project and presented in a manner consistent with the aims of the project, it will be gratefully included in the publication. Our goal is to do a good job for our readers as to the items on the list -- with that done, we feel that the cooperative efforts will have been justified. It will be recognized that this list is designed for state-wide usage; that it will be of only minor service in designing papers for certain special areas and conditions.

Exclude confidential information:

Each author will, of course, take due precaution to avoid inclusion of any information which he has obtained only in confidence.

Conciseness is essential:

Even with the best possible planning, the compilation will necessarily be voluminous. It should not be so voluminous as to seriously impair its usefulness as a source for basic data. Choose manners of presentation which preclude misinterpretation and which facilitate accuracy, availability and compactness. Avoid verbosity.

Coordination with regional papers:

Your field is one unit in a region concerning which there will be several regional papers. The plan for complemental regional papers should obviate repetition in several field papers. Please check with your regional committee to determine that any available significant data omitted from your paper are incorporated in one or more regional papers. If this procedure is not convenient, please attach to your paper a list of the items which you are presuming to be treated in regional papers.

Uniformity:

Field papers generally should be essentially uniform in style and arrangement and also uniform in contents to the extent consistent with pertinence and availability of data. The data should be so presented that, as to any particular item, a reader can either quickly find it or determine that it is not presented. Your reader interest will be generally by items rather than in the paper as a whole.

Deviation from uniformity:

Conditions of nature preclude absolute uniformity, but they do not preclude the primary objective of presenting all available material facts in such manner that each particular item is readily available for every field throughout the State of Texas to the extent that it is presented by the several authors. Presentation of facts is of first importance; manner of presentation is secondary. Manner of presentation is of such importance, however, that an author should deviate from the standard only to the extent required for adequate presentation of the data pertaining to his field. In no case should the effort to attain uniformity defeat the primary objective of best presentation in view of the aims of the project.

Headings:

Headings will be standardized to the greatest extent practicable. This is essential not only to accomplish maximum usableness, but also to facilitate preparation of copy for printing by the offset process, which is to be used for this project. Capitalization on the accompanying check-list indicates contemplated headings in the text. Please use those headings to the extent that they include your data. However, if those headings do not include all your data, be free to enter additional headings. Please do not enter any data under a heading which does not comprehend such data. Over-comprehensive headings are undesirable.

Page size:

Your paper will be printed on pages $8\frac{1}{2}$ x 11 inches. Tabulations, maps, cross sections, charts, diagrams, etc., should be so designed that they will come within 7.25 x 9.675 inches when printed. Only in very special cases will it be permissible for any page of a field paper to exceed these dimensions when printed. Necessarily, a few items in the regional papers will be so large that they will have to be folded, but we hope that this will be exceedingly rare for field papers. Some figures may well be designed for placement of two or more on a single page. You need not solve the problems of arrangement of your material on the printed page -- merely bear in mind the general limitations.

Tabulations:

In designing your tabulations, please endeavor to stay within an area 14 x 24 inches with pica typewriter type (ten spaces per inch) or within 12 x 21 inches with elite type (twelve spaces per inch). Slightly larger tabulations can be used, but we prefer to avoid them. Small tabulations will be arranged by the Bureau to make best use of the page area consistent with order of presentation, convenience in reading, etc. You may forward your tabulations in any size type convenient to you, but if the boundaries exceed the above measurements, please bear in mind that the Bureau will probably have to either modify your arrangement or print in very small type.

Final drafting to be done by Bureau:

Your maps, etc., may be forwarded in rough draft, and in any size convenient for you. The Bureau will standardize symbols, lettering, etc., and will prepare drawings appropriately for reduction. Please see that your legends are clear and that all lettering is legible. Bear in mind the ratio of 7.25 to 9.675 when choosing your boundaries for full-page maps. The most convenient size for the Bureau would be anywhere between 9.06 x 12.09 inches (for 20% reduction) and 14.5 x 19.35 inches (for 50% reduction).

Expression of approximations:

In entries under definite headings where the correct figure is known only approximately, the author should enter "x" in the position of each unknown digit and enter in the position next leftward the figure believed nearest correct for that position. For example, if the correct figure is known to be between 1,800,000 and 1,850,000, the entry should be either "1,82x,xxx" or "1,83x,xxx".

Commonly where production is from more than one sand, you cannot determine accurately the quantity from each sand, yet you can make a better guess than your readers. Such guesses are worth while, particularly in view of this system of using "x", which permits sufficient range to cover your uncertainties and yet go a long way in assisting readers in estimating total quantities from traps of different types, rocks of different ages, etc. The definite total which would be reported for all sands can be allocated by you better than by your readers. Of course, if the various sands are of the same character, of about the same geologic age, occur at near the same depths, and yield oil of the same character from traps of the same type, then estimates of quantities of production from each become less important. There are cases where important facts of nature are different for different sands, even though the sands are not far separated vertically, and, of course, in such cases segregation of quantities is important. The many probable uses for your data will justify your reporting as completely as possible.

Nature of trap:

Our readers will appreciate special care in presenting information relative to the nature of the trap. The trap-forming factors should be sufficiently clearly stated that each reservoir may be assigned to the appropriate place in any good classification, published or unpublished. It is suggested that you read "Classification of Petroleum Reservoirs" by O. Wilhelm, A. A. P. G. Vol. 29, pp. 1537-1580, and check to see that you have presented data which will enable a reader to correctly place the reservoir in that classification.

Change in field name:

If the field has been known by another name, and particularly if such other name has been used in publications, make appropriate entry under some such heading as above.

Acknowledgment of source of data:

It is our belief that our authors will secure their data from reliable sources and that the readers will be satisfied with the authenticity without citing sources. We think it better that the usual form of acknowledgment be omitted. We believe that most employers would prefer only such acknowledgment as indicated on the first page of each of the following papers. Of course, if any operator who supplies data or contributes services desires specific acknowledgment, then the author should enter appropriate acknowledgment. The footnote form used in recent A. A. P. G. bulletins is favored.

Items to be excluded:

Following is a list of items commonly included in field papers but which generally should be excluded from papers for this project:

- Estimates of reserves
- Prospects for deeper production
- Cost data
- Outlets (Market)
- Railroad Commission allowables and rules
- Drilling practices
- Completion practices
- Casing records
- Description of physical equipment
- Supply of fresh water
- Drill-stem tests
- Initial production tests
- Daily average production

Design for specific use by specific readers:

"Occurrence of Oil and Gas in Texas" is compiled for use by exploration geologists, exploitation geologists and petroleum engineers and is designed primarily to afford them a source of data for basic research. All problems in the preparation of your paper should be resolved in view of such usage by this group.

Delivery of completed paper:

Your completed paper should be delivered to a member of the geological society committee in charge of the project for the region in which your field is located.

BUREAU OF ECONOMIC GEOLOGY
University Station, Box 8022
Austin 12, Texas

APPENDIX

CHECK-LIST FOR FIELD PAPERS

FIELD NAME, County, State; Name of Author with title or occupation, employer and place; Date

LOCATION

METHODS OF EXPLORATION LEADING TO DISCOVERY of field (First reservoir only)

DISCOVERY (Each reservoir)
Reservoir designation; Date of completion of discovery well; Well designation

ELEVATION OF SURFACE: Maximum and minimum at well locations

Stratigraphic section, with names of system, series, group, formation, member. Generally, the papers will contain no word descriptions of rocks other than indicated below relative to reservoir rocks. The preferable manner of presentation of the stratigraphic section in the vicinity of productive zones is by a combination electric and graphic log. Generally, a tabulation will best serve for presenting the section from the surface to the deepest horizon penetrated within the field. (Various other items on this check-list will be entered on the same sheet with the graphic log or in the tabulation, or perhaps occasionally in both if both are used.)

SURFACE FORMATION (Name of formation, or formations, at surface within area of field)

OLDEST STRATIGRAPHIC HORIZON PENETRATED within area of field

Stratigraphic positions of occurrences of oil and gas

Important variations in thicknesses of formations or members (cross section or text, or both)

Areal distribution of oil and gas, by reservoirs (Generally on the same map as contours)

Structure (Preferable presentation: structural contour map and cross section)

NATURE OF TRAP (Trap-forming factors) (Each reservoir)

PRODUCTIVE AREA, in acres (Each reservoir and field total)

THICKNESS OF RESERVOIR ROCKS (Each reservoir)

LITHOLOGY OF RESERVOIR ROCKS (Each reservoir)

CONTINUITY OF RESERVOIR ROCKS (Each reservoir)

ELEVATION AND RELIEF OF PRODUCTIVE ZONE (Each reservoir)

CHARACTER OF OIL (Each reservoir)

CHARACTER OF GAS (Each important gas reservoir)

WATER PRODUCTION, brief statement

ACID TREATMENT

SELECTED REFERENCES

PRODUCTION HISTORY (For field as a whole, then by reservoirs)
Number of wells producing at end of each year (Columns: Each fluid and each manner of operation)
Number of wells injecting into reservoir, by years (Column for each fluid)
Oil production, by years
Gas production, by years
Liquid products of gas processing plants, by years

CAPITALIZATION indicates headings anticipated in text. Items without capitalization generally will be presented on log, map, cross section or in tabulation of stratigraphic section.

FIELD NAME INDEX

Names of fields used as titles of papers are in CAPITAL type. Other names for those fields, and names for parts of those fields, are in lower case type followed by title names in parentheses. Also, names for other fields located entirely or partly within map areas are entered in lower case type followed by title names in parentheses.

FIELD NAME INDEX

FIELD NAME INDEX

FIELD NAME INDEX

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