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Vol. 1, Part 1

TARGET RESERVOIRS FOR CO_2 MISCIBLE FLOODING
TASK TWO: SUMMARY OF AVAILABLE RESERVOIR AND GEOLOGICAL DATA

Task Two Final Report

Vol. 1: Permian Basin Geological and Reservoir Data
Part 1: Permian Basin Reservoir Selection Procedure, Geology, and Reservoir Data Summary

Work Performed for the Department of Energy
Under Contract No. DE-AC21-79MC08341

Date Published—October 1981

Gruy Federal, Inc.
Houston, Texas

National Energy Technology Laboratory
National Petroleum Technology Office
U.S. DEPARTMENT OF ENERGY
Tulsa, Oklahoma

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Vol. 1: Permian Basin Geological and Reservoir Data
Part 1: Permian Basin Reservoir Selection Procedure, Geology and Reservoir Data Summary

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Volume I, Part 1, Permian Basin Reservoir Selection Procedure, Geology and Reservoir Data Summary, is a continuation of work begun by Rodney W. Pease and Jerry A. Watson in 1979. The author acknowledges their significant contributions in compiling and interpreting data for a prior draft report, and the assistance of Raymond Marlow and Stephen A. Lohse in compiling and editing the data for Parts 2, 3, and 4 of Volume I of this report. John H. Goodrich, principal investigator for all tasks in this study, has provided invaluable guidance and assistance throughout the preparation of this report. Dr. W. D. Compton served as editor for this volume.

We gratefully acknowledge permission to reproduce copyrighted material granted by the following organizations: the West Texas Geological Society, the Abilene (Texas) Geological Society, the Roswell (N. Mex.) Geological Society, The University of Texas Bureau of Economic Geology, the Society of Petroleum Engineers, and the American Association of Petroleum Geologists.

ABSTRACT

This report describes work performed by Gruy Federal, Inc. as the second of six tasks under contract no. DE-AC21-79MC08341 with the U.S. Department of Energy. The stated objective of this study is to build a solid engineering foundation to serve as the basis for field mini- and pilot tests in both high and low oil saturation carbonate reservoirs for the purpose of extending the technology base in carbon dioxide miscible flooding.

The six tasks in this study are as follows:

I. Summary of available CO_2 field test data
II. Summary of existing reservoir and geological data
III. Selection of target reservoirs
IV. Selection of specific reservoirs for CO_2 injection tests
V. Selection of specific sites for test wells in carbonate reservoirs
VI. Drilling and coring activities.

The report for Task Two summarizes existing reservoir and geological data on carbonate reservoirs located in west Texas, southeast New Mexico, and the Rocky Mountain states. It is contained in two volumes, each with several parts. The present volume, in four parts, is a summary of reservoir data for fields in the Permian basin of west Texas and southeast New Mexico. Volume II contains data for fields in sedimentary basins in the Rocky Mountain states.

While a serious effort was made to obtain all publicly available data for the fields considered, sufficiently reliable data on important reservoir parameters were not always available for every field.

The data in Volume I show 216 carbonate reservoirs in the study area, of which 129 are of Permian age. In these Permian-age reservoirs, there are 61 giant fields having an aggregate initial oil in place of 45 billion barrels, 82 percent of the total oil in place in the carbonate reservoirs in the study area. The bulk of this oil is in San Andres and Grayburg (67 percent), Clear Fork (13 percent), Pennsylvanian (10 percent), and Devonian (5 percent) reservoirs.

Using a general estimate of enhanced oil recovery potential by CO_2 flooding of 10 percent of initial oil in place, some 5.5 billion barrels of oil could be recovered by widespread application of CO_2 flooding in the Permian basin. San Andres and Leonard (Clear Fork) reservoirs appear to be the most promising targets for the process. Pennsylvanian and Devonian reservoirs, however, also contain substantial initial oil in place, and should not be overlooked as candidates for CO_2 flooding.

1. INTRODUCTION AND SUMMARY

This report was prepared to fulfill part of the work required for Task Two of contract no. DE-AC21-79MC08341 between the U.S. Department of Energy (DOE) and Gruy Federal, Inc. (Gruy). Work under Task Two was directed toward identifying target reservoirs for carbon dioxide flooding and required compilation of geological, petrophysical, and reservoir engineering data for selected carbonate reservoirs in west Texas, southeast New Mexico, and the Rocky Mountain states. Reservoir selection was based on guideline values for key reservoir properties such as permeability (greater than 5 md) and oil gravity (equal to or greater than 36°API). In application, it was found that the guidelines needed to be relaxed to 2 md and 30°API to avoid screening out reservoirs in which field tests of carbon dioxide flooding (Task One of the contract--Goodrich, 1980) showed good potential for commercial applicability.

The methodology Gruy employed was:

1. Search of Petroleum Data System (PDS) computerized files for fields coded as having carbonate lithology and satisfying the other criteria, both original and relaxed;

2. Detailed research in regulatory commission records and publications to verify and correct PDS data and to obtain supplemental information not present in PDS files for some fields;

3. Literature search and review of geological and petroleum engineering technical journals for all available published data;

4. Comparison and verification of data from various sources and selection of "best" data.

Steps 2 through 4 proved laborious and very time-consuming, but essential because of inaccuracies or omissions in the (1979 vintage) PDS data base. By intent, no original geological or engineering studies were conducted by Gruy.

Because of the volume of material compiled for this study, it proved convenient to organize the report into two volumes, each containing several parts. This report is Volume I of the final Task Two report, and provides material for reservoirs in the Permian basin located in west Texas and southeast New Mexico. The Permian basin volume contains four parts:

Part 1: Permian Basin Reservoir Selection Procedure, Geology, and Reservoir Data Summary;

Part 2: Permian Basin Geological and Reservoir Data (ADAIR - San Andres through EUNICE MONUMENT - Grayburg/San Andres);

Part 3: Permian Basin Geological and Reservoir Data (FARMER - San Andres through NOLLEY - Wolfcamp)

Part 4: Permian Basin Geological and Reservoir Data (OCEANIC - Pennsylvanian through YATES - Yates Lime).

Part 1 of the Permian basin volume presents a discussion of the methodology and procedure and contains summary tabulations of geological and engineering data for the selected fields. Parts 2 through 4 are organized alphabetically by field name and contain as much detailed information for each field as was publicly available to Gruy from all of the sources consulted. This organization of the report is intended to provide for the needs of both the reader interested only in an overview (Part 1) and the reader interested in detailed data for specific fields (Parts 2 through 4). Volume II, published separately, contains data for carbonate reservoirs in the Williston and other geological basins in the Rocky Mountain states.

Data are presented in Volume I for 216 carbonate reservoirs in west Texas and southeast New Mexico, summarized as follows:

Geologic zone	Number of reservoirs: Total	Number of reservoirs: >100 MMbbl cum. prod.	Initial stock tank oil in place, MMbbl	Cumulative production through 1979, MMbbl
Permian				
Guadalupe	86	46	37,238	7,822
Leonard	29	15	7,366	1,214
Wolfcamp	14	0	655	286
Subtotal	129	61	45,259	9,322
Pennsylvanian	42	9	5,897	2,426
Mississippian	1	0	286	4
Devonian	25	8	3,054	686
Silurian	8	1	289	111
Ordovician	11	3	685	338
TOTALS	216	82	55,470	12,887

The predominance of Permian age reservoirs, especially Guadalupian (San Andres and Grayburg) is evident. These data show that there are 61 giant fields, having an aggregate initial oil in place of 45 billion barrels, in the 129 Permian age reservoirs selected. These reservoirs contain 82 percent of the 55 billion barrels total oil in place in all of the carbonate reservoirs listed in this report.

2. RESERVOIR SELECTION PROCEDURES

The statement of work for Task II gives the following guidelines:

> The following reservoir geology will be determined on carbonate reservoirs located in west Texas, southeast New Mexico, and the Rocky Mountain states: stratigraphy, structure, mineralogy, porosity, permeability, gross and net thickness, and any other geological properties deemed significant regarding CO_2 injection. Reservoir data will be collected on hydrocarbon content, composition and distribution; connate water content and composition; pressure and production data from primary and/or secondary recovery operations; PVT analysis; and well test data and analysis. Guidelines for selecting reservoirs to be included are as follows:
>
> average formation permeability - ≥ 5md
>
> average current oil saturation - ≥ 38%
>
> oil gravity - - - - - - - - - - - ≥ 36°API
>
> oil viscosity - - - - - - - - - - ≤ 10 cp.
>
> In addition, no extremely high-permeability, stratigraphic, thief zones should exist. However, no consideration should be given to the proximity of CO_2 sources at this point. The objective here is to "characterize the resource" for possible future CO_2 injection.

The starting point for locating fields that meet the specified criteria was the Petroleum Data System (PDS) computerized data base maintained by the University of Oklahoma. The PDS data bank, which contains information on more than 80,000 oil and gas fields in the United States and Canada, was searched for fields having carbonate lithology, oil with gravity greater than 35° API, average permeability greater than 4 md, and no descriptors indicating fractures.

The preliminary search yielded 244 reservoirs* in the Permian basin and Rocky Mountain states. This screening missed Wasson, Levelland, Slaughter, North McElroy, and North Cowden fields in the Permian basin, all currently undergoing tests by major oil companies for commercial application of the CO_2 displacement process. These fields, discussed in detail in the Task One report, were also added to the list considered in Task Two. Table 1 contains data for those fields summarized from the Task One report.

---

*The term reservoir, as used in this report, means a naturally occurring underground rock unit containing oil, gas, or water that constitutes a state reporting unit. For example, Dollarhide-Devonian is a continuous rock unit underlying the Dollarhide field in both Texas and New Mexico; however, in this study, the Dollarhide-Devonian, Texas, and Dollarhide-Devonian, New Mexico, are considered and reported as separate reservoirs, since each state separately reports production from its portion of the reservoir.

An examination of those data and data contained in the PDS file for the major reservoirs in these fields (Table 2) indicated that the current CO_2 pilot project fields were missed chiefly because of the criteria used for oil gravity and average permeability. In the interest of thoroughness, these criteria were relaxed slightly (to 30°API gravity and 2 md permeability) and the PDS data file was searched again. An additional 333 reservoirs were found in this search, most of them extremely small; only 60 had more than 50 wells. A minimum "size" limitation of more than 20 producing wells was applied to the west Texas and southeast New Mexico list, reducing the number of reservoirs under consideration. This size limitation is useful in this portion of the study area because the usual well spacing is 40 acres per well or less. In fields that have been under production for many years, spacings of 20 or even 10 acres per well are not uncommon. The use of a 20-well limit is not practical in the Rocky Mountain states because many fields in those states have well spacings of 160 to 320 acres. The majority of Rocky Mountain states reservoirs listed in this report were added after the PDS screenings based on a 20-well limit; therefore no size limitation was applied to the Rocky Mountain states reservoirs.

This volume of the Task Two report describes the 216 reservoirs in 174 fields identified in west Texas and southeast New Mexico. The reservoirs selected in the Rocky Mountain states are described in Volume II (in preparation). Table 3 lists by basin the number of candidate reservoirs included in this report.

The candidate reservoir list obtained through PDS screenings was developed using additional information from state and regional geological and engineering publications and other primary documents on oil and gas fields. The various data sources listed in Table 4 were searched for additional data on each reservoir defined in the PDS search. During the compilation of required data on these reservoirs, several other reservoirs were added to the list. The majority of these added reservoirs were other carbonate pay zones in previously identified fields or in fields adjacent to a previously identified field that produced from the same formation as a listed field. All reservoirs added to the list in this manner meet the revised screening criteria.

TABLE 1
RESERVOIR PARAMETER FROM CO_2 DISPLACEMENT
PROJECTS IN "CARBONATE" ROCKS

	KELLY SNYDER FIELD SACROC UNIT	WASSON FIELD	WILLARD UNIT	DENVER UNIT	CROSSETT FLD NORTH CROSS UNIT	SLAUGHTER FIELD SLAUGHTER ESTATE UNIT	LEVELLAND FLD LEVELLAND UNIT	ANETH FIELD	NORTH COWDEN FIELD	NORTH McELROY FIELD
PHYSICAL RESERVOIR FEATURES										
FORMATION	CANYON	SAN ANDRES			DEVONIAN	SAN ANDRES	SAN ANDRES	PARADOX	GRAYBURG	GRAYBURG/ SAN ANDRES
LITHOLOGY	LIMESTONE	DOLOMITE			(C)	DOLOMITE	(E)	(E)		
STRUCTURE	ANTICLINAL	ANTICLINAL			STRATIGRAPHIC		(G)	(G)		
DEPTH, FT.	6700	5100			5300		4900	~ 5500	~ 5100	3000
WATER-OIL CONTACT, FT.	-4500				-3040				~ -1300	
AVG. GROSS THICKNESS, FT.	268		50-230	137	40-180 (88 EFFECTIVE)		GROSS 250 NET 100	140		150(NET)
LITHOLOGIC TYPE	(A)	(B)			CHALKY			(H)		
POROSITY TYPE	(J)	(D)			(D)			(I)		
FLUID AND ROCK PROPERTIES										
INITIAL RES. PRESS., PSIG	3122 @ 4300'		1805	1805	2400				1750 (EST)	755
RESERVOIR TEMP, ^{0}F	130° @ 4300'			105	106°					
OIL GRAVITY, ^{0}API	41		33	33	44 @ 60° F		30		34	32
BUBBLE POINT, PSIA	1850		2-65		2328					
SOLUTION GOR, CUFT/BBL	1000		4382		NOV .76 6000	JUN 1050				
OIL VOLUME FACTOR	1.5		1.312							
OIL VISCOSITY, CPS	0.35		1.18		0.38		1.9			
AVG. POROSITY OVER GROSS THICK., %	3.93		8.5	12	22		10.2	RANGE 10-12	.8	15
AVG. PERMEABILITY, MD	19.4		3	5	5.5		2.1	RANGE 10-50	5	10
AVG. SWI, %	21.9				35		23.4			
WATER-OIL MOBILITY RATIO	0.3			15			(ENRICHED GAS) 1100			
CO_2 OIL MOBILITY RATIO	8.0				5					
CO_2 MISCIBLE PRESSURE, PSI		1250	1250		1650					
AVG. SOR, %		30	>30							
DRIVE MECHANISM										
PRIMARY	(M)	SOLUTION GAS			SOLUTION GAS		SOLUTION GAS		SOLUTION GAS	
SECONDARY	(N)	(O)			(P)	WATERFLOOD	(Q)	WATERFLOOD CO_2 TERTIARY	WATERFLOOD	
CURRENT STATUS	COMMERCIAL		(R)		COMMERCIAL	TESTING	CONT TESTING			

(A) CALCARENITE WITH MINOR AMOUNTS OF CALCIRUDITE & CALCILUTITE
(B) FINELY CRYSTALLINE
(C) SILICEOUS DOLOMITE
(D) PRIMARY-INTERGRANULAR
(E) LIMESTONE/DOLOMITE
(G) STRATIGRAPHIC/STRUCTURAL
(H) CALCARENITES/CHALKY DOLOMITE
(I) VUGGY/FINELY INTERCRYSTALLINE
(J) SECONDARY VUGGY
(M) FLUID EXPAN. & SOL. GAS
(N) CENTERLINE WATERFLOOD PATTERN AREA CO_2 - WAG
(O) LINE DRIVE WATERFLOOD SINCE 1965
(P) CO_2 INVERTED 9 SPOT
(Q) ENRICHED HYDROCARBON CO_2 TERTIARY
(R) REPORTED TERMINATED SPE EOR FIELD REPORT
v4 NO.2 9/78

TABLE 1 CONTINUED

	KELLY SNYDER FIELD SACROC UNIT	WASSON FIELD	WILLARD UNIT	DENVER UNIT	CROSSETT FLD NORTH CROSS UNIT	SLAUGHTER FIELD SLAUGHTER ESTATE UNIT	LEVELLAND FLD LEVELLAND UNIT	ANETH FIELD	NORTH COWDEN FIELD	NORTH McELROY FIELD
STATISTICAL DATA										
SURFACE AREA, AC	49,900	68,000	8010	27,8000	1120	(FF)	(Y)		38,000	30,000
PRODUCING WELLS	(S)				22	2 PILOT			2 PILOT	
SHUT-IN WELLS	394									
INJECTION WELLS	305		8		6	6 PILOT			6 PILOT	
TOTAL	1358				28	8 PILOT			8 PILOT	
ORIG. STOCK TANK OIL-IN-PLACE, STB	2113 MM	600 MM	(AA)	2,108 MM	53 MM					
CUM. OIL PRODUCTION, STB	JAN 937 MM	MAR 50.6 MM			(CC)			OCT 76 265 MM		
CUM. INJECTION	AS OF JAN-78		(BB)							
WATER, BBL	1,809 MM		1 MMB							
CO_2, SCF	346 MMM		3.8 MMM		27.7 MMM					
INCREMENTAL OIL FROM CO_2, STB					926 M	(GG)	(HH)			
CUM. CO_2 PRODUCTION, MMCF					363					
CURRENT PRODUCTION RATES	AS OF DEC-77									
OIL, BOPD	139,886	1974 31,500			(DD)	~ 80	OCT 76 23,700			
GAS, CF/D	136,847 M									
CO_2, CF/D	35,864 M	(T)			(EE)					
WATER, BBL/D	411,974					~ 320				
CURRENT INJECTION RATES	AS OF DEC-77									
WATER, BBL/D	596,191	1974 & 75 385 B WPD				~ 600				
CO_2, CF/D	146,903 M	1973 2300 RVBD			~ 17 MM					
OPERATOR	CHEVRON		ARCO	SHELL	SHELL	AMOCO	AMOCO		AMOCO	

(S) 648 (ART, LIFT)
11 (FLOWING)

(T) PEAK 100 RVBD 4% OF INJECTION

(AA) 55-70 MSTBO/AC

(BB) NOV. 72 TO FEB. 75

(CC) AP 1972 6.9 MM NOV. 76

(DD) AP 72 1480 NOV. 76 2000

(EE) NOV. 76 960 MCF/D
5.3% OF INJ.

(FF) PILOT - TWO 16.6 ACRE 5 SPOTS

(GG) TO JULY 11/AC FT.
PROJECTED 187/AC FT.

(HH) PROJECTED 99/AC FT.

(Y) LEVELLAND UNIT 13,600
PROJECT AREA 1190

TABLE 2

SUMMARY OF INFORMATION CONTAINED IN PDS ON FIELDS CURRENTLY BEING EXAMINED FOR CO_2 DISPLACEMENT

Field/Pool	Gravity, °API	Avg. permeability, md	Lithology	Porosity, %/type
Levelland/ San Andres	29.0	3	Lime	11
McElroy, North/ Ellenburger	51	---	Dolomite	Frac. Vuggy
Slaughter/ San Andres	32.0	11	Dolomite	12.2
Wasson/ San Andres	32.0	11	----	11.5
North Cowden/ San Andres	33	3	Dolomite	12.0

TABLE 3

NUMBER OF CANDIDATE RESERVOIRS BY BASIN

Basin	Number of Reservoirs
Permian and Anadarko	216
Williston	106
Paradox	17
Big Horn	7
Wind River	5
Sweetgrass Arch	3
Powder River, Great Divide, Uinta basins and Eastern Utah	4 (1 each)
Total	358

TABLE 4

DATA SOURCE CODE FOR TEXAS AND NEW MEXICO FIELDS

CODE	SOURCE OF INFORMATION
0	NOT DETERMINED
1	PETROLEUM DATA SYSTEM TEXS OR OILY DATA BASES
2	TEXAS RAILROAD COMMISSSION ENHANCED OIL RECOVERY PROJECTS REPORT (1-1978)
3	TEXAS RAILROAD COMMISSION ANNUAL REPORT (1-1980)
4a	TEXAS WATER DEVELOPMENT BOARD REPORT 157, A SURVEY OF THE SUBSURFACE SALINE WATER OF TEXAS (1972)
4b	OIL SCOUTS REPORT (1977-78)
5	OIL & GAS FIELDS IN WEST TEXAS - A SYMPOSIUM (1956 & 1965) and ABILENE GEOLOGICAL SOCIETY (1952, 1954, 1956, 1960, 1976) and PANHANDLE GEOLOGICAL SOCIETY, GENERAL INFORMATION
5a	OIL & GAS FIELDS IN WEST TEXAS - A SYMPOSIUM, West Texas Geological Society Pub. No. 66-52 (1966)
5b	OIL & GAS FIELDS IN WEST TEXAS - A SYMPOSIUM, West Texas Geological Society Pub. No. 69-57 (1969)
5c	ABILENE GEOLOGICAL SOCIETY, GEOLOGICAL CONTRIBUTIONS 1952, Monroe G. Cheney Memorial Volume
5d	ABILENE GEOLOGICAL SOCIETY, GEOLOGICAL CONTRIBUTIONS 1954
5e	ABILENE GEOLOGICAL SOCIETY, GEOLOGICAL CONTRIBUTIONS 1956
5f	ABILENE GEOLOGICAL SOCIETY, GEOLOGICAL CONTRIBUTIONS 1960
5g	ABILENE GEOLOGICAL SOCIETY, GEOLOGICAL CONTRIBUTIONS 1976
6	ROSWELL (NEW MEXICO) GEOLOGICAL SOCIETY, SYMPOSIUM OF OIL AND GAS FIELDS OF SOUTHEASTERN NEW MEXICO, 1956, 1960, 1967 1977 GENERAL INFORMATION
6a	A SYMPOSIUM OF OIL & GAS FIELDS OF SOUTHEASTERN NEW MEXICO, 1956, Roswell Geological Society
6b	A SYMPOSIUM OF OIL & GAS FIELDS OF SOUTHEASTERN NEW MEXICO, 1960, Roswell Geological Society
6c	A SYMPOSIUM OF OIL & GAS FIELDS OF SOUTHEASTERN NEW MEXICO, 1967, Roswell Geological Society
6d	THE OIL & GAS FIELDS OF SOUTHEASTERN NEW MEXICO, 1977 SUPPLEMENT, Roswell Geological Society
7	Landes, K.S., 1970, PETROLEUM GEOLOGY OF THE UNITED STATES: John Wiley & Sons, New York, New York.
8a	LEXICON OF PERMIAN STRATIGRAPHIC NAMES OF WEST TEXAS AND SOUTHEASTERN NEW MEXICO, 1976, West Texas Geological Society
8b	LEXICON OF PRE-PENNSYLVANIAN STRATIGRAPHIC NAMES OF WEST TEXAS AND SOUTHEASTERN NEW MEXICO, 1958, West Texas Geological Society
9a	Society of Petroleum Engineers ENHANCED RECOVERY FIELD REPORTS (Quarterly)
9b	Society of Petroleum Engineers Journal
9c	Journal of Petroleum Technology
10	Oil & Gas Journal
11	American Petroleum Institute
12a	American Association of Petroleum Geologist, Bulletin
12b	Society of Economic Paleontologists and Mineralogist, Journal of Sedimentary Petrology
12c	Other Geological Publications (Refrenced on Field Data Sheet)

DATA SOURCE CODE FOR TEXAS AND NEW MEXICO FIELDS, cont.

CODE	SOURCE OF INFORMATION
13a	Gulf Universities Research Consortium, THE STATE OF TEXAS GOVERNOR's ENERGY ADVISORY COUNCIL, ASSESSMENT OF ENHANCED RECOVERY TECHNOLOGY AS A MEANS FOR INCREASING TOTAL CRUDE OIL RECOVERY IN TEXAS, GURC Report 141, 1974
13b	Gulf Universities Research Consortium, APPENDICES 1-5 of PRELIMINARY FIELD TEST RECOMMENDATIONS AND PROSPECTIVE CRUDE OIL FIELDS OR RESERVOIRS FOR HIGH PRIORITY FIELD TESTING, GURC Report 148, 1976
13c	Gulf Universities Reserch Consortium, CANDIDATE RESERVOIRS FOR ENHANCED OIL RECOVERY, GUIDELINES FOR THEIR SELECTION AND APPRAISAL OF SIGNIFICANT TESTS TO DATE, GURC Report 153, 1977
14a	Energy Research and Development Administration, ANALYSIS AND ASSESSMENT OF ENHANCED OIL RECOVERY BASELINE DATA, ERDA 76-155/1 & ERDA 76-155/2, October, 1976, prepared by LaRue, Moore and Schafer, Dallas, Texas, including as Ehibit 2-3, Task II, p 1-51 and analysis and reproduction of Lewin & Associates, Inc., The Potential and Economics of Enhanced Oil Recovery (Data Base), April, 1976
14b	National Petroleum Council, ENHANCED OIL RECOVERY, AN ANALYSIS OF THE POTENTIAL FOR ENHANCED OIL RECOVERY FROM KNOWN FIELDS IN THE UNITED STATES--1976-2000, Appendix E, p.144-146, December, 1976
14c	Office of Technology Assessment, ENHANCED OIL RECOVERY POTENTIAL IN THE UNITED STATES, Appendix A-OTA Data Base p. 111-137, and Analysis of Reservoirs in Data Base to Determine Amount and Distribution of Remaining Oil, p. 139-141, January, 1978
14e	Energy Information Administration, EVALUATION OF TARGET OIL IN THE 50 MAJOR OILFIELDS OF THE PERMIAN BASIN FOR ENHANCED OIL RECOVERY, BETC/RI-78/15, October, 1978
15	PERMIAN BASIN FIELD MAP (1980 Edition), Midland Map Company
16a	TEXAS RAILROAD COMMISSION, MER HEARINGS SUMMARIES, 1965-66-67 Extracted from issues of the OIL REGULATION REPORT
16b	TEXAS RAILROAD COMMISSION, SECONDARY RECOVERY APPLICATION SUMMARIES, 1976, Extracted from issues of the OIL REGULATION REPORT
16c	MAXIMUM EFFICIENTY RATE (MER) HEARINGS IN TEXAS, Data supplied by the Energy Information Agency office in Dallas, 1979
17	GRUY Calculations for Missing Reservoir Properties Data (Explation of Calculations in Text), 1979-1980
18	New Mexico Oil & Gas Engineering Committee, ANNUAL REPORT, VOLUME 1 SOUTHEAST NEW MEXICO, 1979

3. DATA VERIFICATION

Data verification proved to be a tedious process, since data reported on a given field by different sources did not always agree. In the case of reservoir property data, some of these differences reflect a variation in reservoir properties within a field; in other cases, the differences are due to rounding or averaging data from an earlier study in a later report. In the case of geologic map data, the differences usually arise because later maps contain more data than earlier ones and reinterpretations have been made. For some fields, a thorough search of all sources listed in Table 4 did not yield sufficient data for proper evaluation.

To select the "right" number when multiple choices were available from different data sources, a value system was developed. For the Permian basin of Texas, Texas Railroad Commission Reports and Maximum Efficiency Rate Hearing data were taken as the most reliable "average" data. Professional papers on geology and reservoir engineering were also regarded as highly reliable. For New Mexico, the Oil and Gas Engineering Committee Reports for the southeastern portion of the state were used, along with geological society and professional papers, as the most reliable data. The least reliable information was that found in the PDS data file and in reports based on PDS data, which frequently proved to be inaccurate when compared with data from original source documents. The differences in Table 2 and Table 3 for the same fields illustrate some of the inaccuracies. PDS data on production tend to be several years out of date as well; when the PDS was searched in 1979, the latest available production data were from two to five years old.

4. DATA PRESENTATION

The data presented in this part of Volume I were chosen by the author as most accurately representing average reservoir conditions. All data determined for the 216 reservoirs considered in this volume are contained in individual field reports (including data sheets, maps, and logs) in Parts 2, 3, and 4 of Volume I. Table 4 lists the sources of information and the data source code used on field data sheets. A full explanation of the use of this code on the data sheets is contained in each of Parts 2, 3, and 4. It is recommended that the reader become familiar with the general contents of Parts 2, 3, and 4 of this report before proceeding with later sections of Part 1, since this part of Volume I is a summary of those data.

This part of Volume I groups fields according to the divisions of the Permian basin shown in Fig. 1. Within these groupings, fields are listed alphabetically and reservoirs are listed youngest to oldest, consistent with reading the correlation chart of the stratigraphic sections in different parts of the basin (Fig. 2) from top to bottom. Parts 2, 3, and 4 list the fields alphabetically; for multi-pay fields, reservoirs are listed in order of increasing geologic age (youngest to oldest).

The AAPG stratigraphic age code shown in Table 5, used by PDS and recorded on each data sheet, determines the listing of reservoirs by age in subsequent tables in this part of Volume I. This classification may not always be accurate; for example, Glorieta-San Angelo reservoirs may have been classified by PDS as Guadalupe (313) in some parts of the basin and Leonard (318) in others.

Data in Parts 2, 3, and 4 of this volume were reproduced from the original sources without significant editorial or graphic changes. This was done intentionally in order to eliminate the introduction of errors and to reduce the cost of preparing the report. The reader should refer to the primary data source for additional information. Although the numbers in Part 1 have been carefully checked, arithmetic errors in secondary calculations doubtless remain. The inclusion of primary source data in Parts 2, 3, and 4 is intended to allow the reader to trace the source of any errors or misinterpretations that may be discovered.

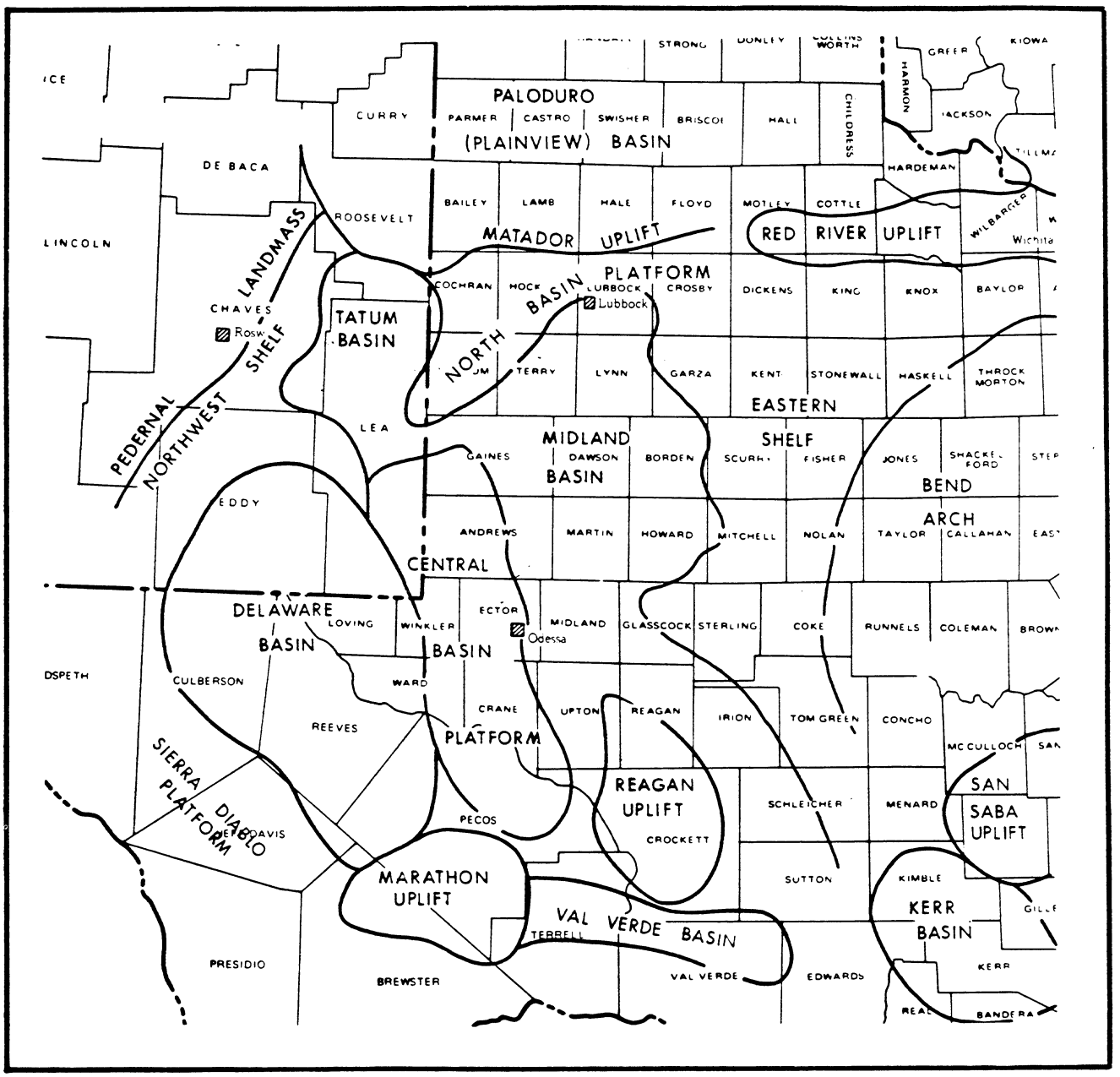


Figure 1

DIVISIONS AND BOUNDARIES

OF THE PERMIAN BASIN

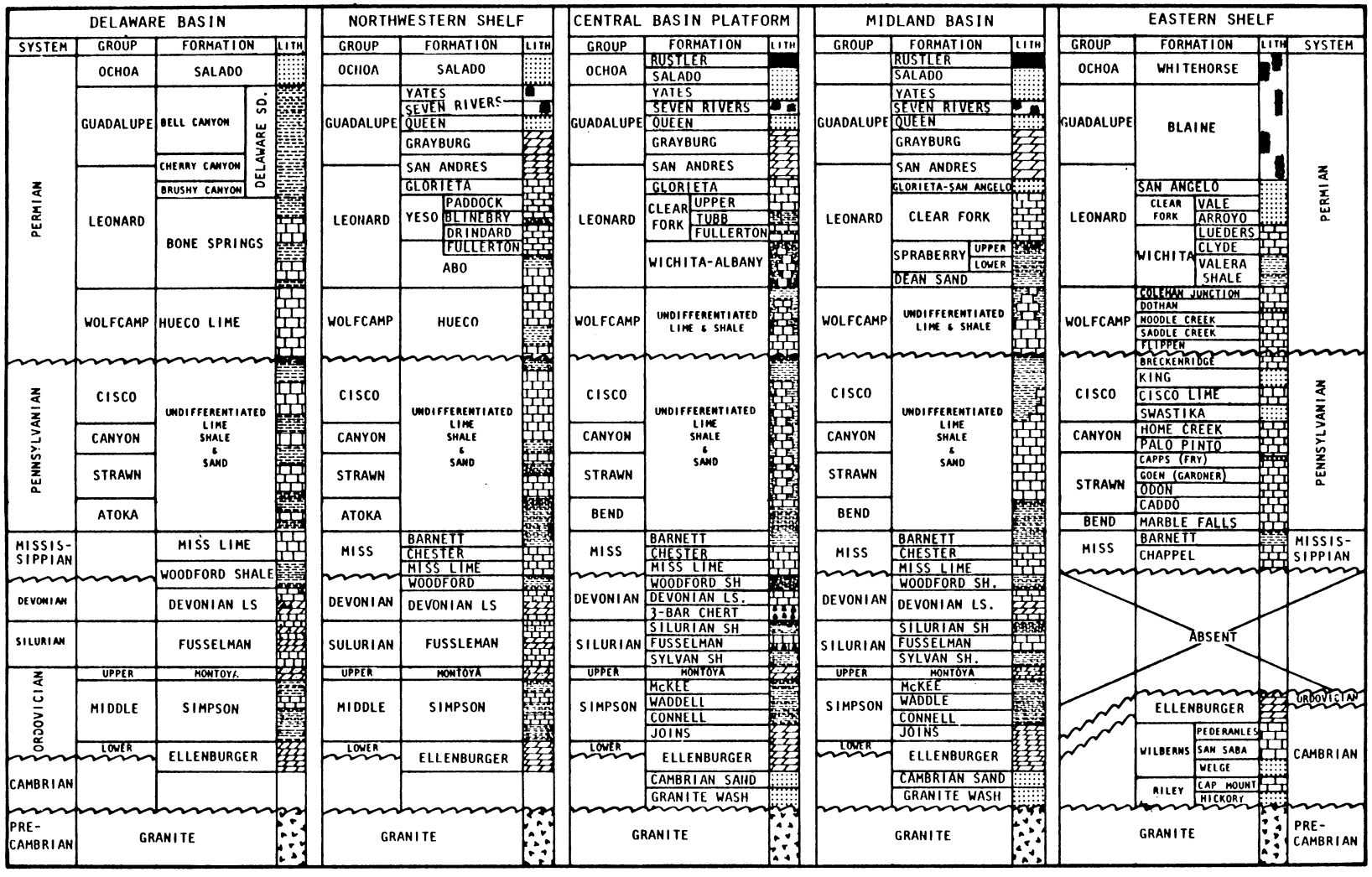


Figure 2

CORRELATION CHART WITH LITHOLOGIC SECTION FOR PERMIAN BASIN

TABLE 5

AAPG STRATIGRAPHIC CODING PROCEDURE

Era	System	Formal & Provincial Series	Code
Cenozoic			100
1			
	Quaternary 0		110
	1	1 Holocene	111
		2 Pleistocene	112
	Tertiary 0		120
	2	1 Pliocene	121
		2 Miocene	122
		3 Oligocene	123
		4 Eocene	124
		5 Paleocene	125
Mesozoic			200
2			
	Cretaceous 0		210
	1	1 Upper	211
		2 Gulf	212
		7 Lower	217
		8 Comanche	218
		9 Coahuila	219
	Jurassic 0		220
	2	1 Upper	221
		4 Middle	224
		7 Lower	227
	Triassic 0		230
	3	1 Upper	231
		4 Middle	234
		7 Lower	237
Paleozoic			300
3			
	Permian 0		310
	1	1 Upper	311
		2 Ochoa	312
		3 Guadalupe	313
		7 Lower	317
		8 Leonard	318
		9 Wolfcamp	319
	Pennsylvanian 0		320
	2	1 Upper	321
		2 Virgil	322
		3 Missouri	323
		4 Middle	324
		5 DesMoines	325
		6 Atoka	326
		7 Lower	327
		8 Morrow	328
	Mississippian 0		330
	3	1 Upper	331
		2 Chester	332
		3 Meramec	333
		7 Lower	337
		8 Osage	338
		9 Kinderhook	339
	Devonian 0		340
	4	1 Upper	341
		2 Chautauquan	342
		3 Senecan	343
		4 Middle	344
		5 Erian	345
		7 Lower	347
		8 Ulsterian	348

TABLE 5 (continued)

Era	System	Formal & Provincial Series	Code
	Silurian 0		350
	5	1 Upper	351
		2 Cayugan	352
		4 Middle	354
		5 Niagaran	355
		7 Lower	357
		8 Alexandrian	358
	Ordovician 0		360
	6	1 Upper	361
		2 Cincinnatian	362
		4 Middle	364
		5 Champlainian	365
		7 Lower	367
		8 Canadian	368
	Cambrian 0		370
	7	1 Upper	371
		2 Croixian	372
		4 Middle	374
		5 Albertan	375
		7 Lower	377
		8 Waucoban	378
Precambrian 4			400

5. AGE AND AREA DISTRIBUTION OF RESERVOIRS SELECTED BY SCREENING

5.1 Permian

Table 6, a summary of selected Permian basin reservoirs by age, area of the basin, and state, with cumulative production through 1979 and calculated initial stock tank oil in place, shows that 60 percent of the reservoirs selected are Permian in age. Guadalupe age reservoirs, totaling 86, make up 40 percent of all reservoirs selected. Of these, 51 (23 percent of all reservoirs selected) are San Andres, 18 are Grayburg or combined Grayburg-San Andres, 4 are Glorieta, 2 are Holt, 1 is Yates Lime and 6 are Deep (Yates-Queen-Seven Rivers). The distribution of San Andres fields in the Permian Basin is shown in Fig. 3 and the San Andres fields selected by screening in Fig. 4. Of the current CO_2 pilot projects listed in Table 2, four of the eight reservoirs are San Andres and two are Grayburg and Grayburg-San Andres combined. Using the calculated initial stock tank oil in place and 1979 cumulative production figures in Table 6, more than 29 billion barrels of oil is unrecovered from the Guadalupe age reservoirs considered in this study.

Leonard age reservoirs total 29 (13 percent of the total selected). Clear Fork or equivalent (Yeso/Tubb) is the predominant Leonard age reservoir, with 21 fields selected by screening. Abo fields total four, Glorieta three, and Holt one. The Glorieta and Holt fields listed as Leonard are in addition to those previously listed as Guadalupe. The age designation was determined by AAPG stratigraphic age code assigned in the original PDS data base query.

Fourteen Wolfcamp age reservoirs were selected.

5.2 Pennsylvanian

Forty-two Pennsylvanian age reservoirs were selected (19 percent of the total). Many of the Pennsylvanian age fields and several Wolfcamp fields produce from reef rocks in the Horseshoe Atoll of west Texas. Figures 5 and 6, isopachous and structure maps drawn on top of the Horseshoe reef complex, show the location of many of the Pennsylvanian fields described in this report. Figures 7 and 8 show the distribution of the major Pennsylvanian time-stratigraphic units (Strawn, Canyon, and Cisco) in area view and cross section. Figures 5, 6, 7, and 8 are reproduced from Vest (1970).

5.3 Mississippian

Only one Mississippian age reservoir, the SCHACKELFORD N.E. field on the Bend Arch, was selected in the PDS data sort. Insufficient data have been compiled for this field to determine whether it is suitable for CO_2 enhanced oil recovery. An Abilene Geological Society paper describes the reservoir as a limestone with poor continuity and the trapping mechanism as a stratigraphic trap--bioherm reef. This field was discovered in 1960 and as of 1978 no secondary recovery efforts had been initiated.

TABLE 6

SUMMARY PRODUCTION DATA FOR RESERVOIRS
IN S.E. NEW MEXICO AND WEST TEXAS

AGE	NO. RESERVOIRS			CUM. PROD-MMBLS (1)			EST. ISTOIP-MMBLS (2)		
Region	N.M.	TEX.	TOT.	N.M.	TEX.	TOT.	N.M.	TEX.	TOT.
GUADALUPE									
Cent. Basin Platform	5	35	40	613	3,308	3,921	3,554	18,636	22,190
Midland Basin	0	10	10	-	430	430	-	2,044	2,044
Reagan Uplift	0	3	3	-	136	136	-	332	332
Eastern Shelf	0	8	8	-	421	421	-	1,115	1,115
North Basin Platform	0	9	9	-	2,367	2,367	-	8,425	8,425
Tatum Basin	5	0	5	119	-	119	386	-	386
Northwest Shelf	10	0	10	426	-	426	2,712	-	2,712
Delaware Basin	0	1	1	-	2	2	-	34	34
TOTALS	20	66	86	1,158	6,664	7,822	6,652	30,586	37,238
LEONARD									
Cent. Basin Platform	4	13	17	126	521	647	1,503	4,020	5,523
Midland Basin	0	2	2	-	13	13	-	64	64
Eastern Shelf	0	2	2	-	110	110	-	630	630
North Basin Platform	0	2	2	-	77	77	-	314	314
Tatum Basin	0	2	2	-	42	42	-	93	93
Northwest Shelf	2	0	2	198	-	198	222?	-	222
Delaware Basin	1	0	1	3	-	3	5	-	5
Matador Uplift	0	1	1	-	124	124	-	515	515
TOTALS	7	22	29	327	887	1,214	1,730	5,636	7,366
WOLFCAMP									
Cent. Basin Platform	0	5	5	-	67	67	-	183	183
Midland Basin	0	5	5	-	135	135	-	324	324
Tatum Basin	2	0	2	54	-	54	118	-	118
Northwest Shelf	1	0	1	15	-	15	15?	-	15
Anadardo Basin	0	1	1	-	15	15	-	15?	15
TOTALS	3	11	14	69	217	286	133	522	655
PENNSYLVANIAN (UNDIF.)									
Tatum Basin	2	0	2	62	-	62	214	-	214
Anadarko Basin	0	3	3	-	14	14	-	64	64
TOTALS	2	3	5	62	14	76	214	64	278
PENNSYLVANIAN-CISCO									
Midland Basin	0	2	2	-	63	63	-	167	167
Eastern Shelf	1	3	4	16	59	75	31	168	299
Tatum Basin	1	0	1	16	-	16	16?	-	16
TOTALS	2	5	7	32	122	154	47	435	482

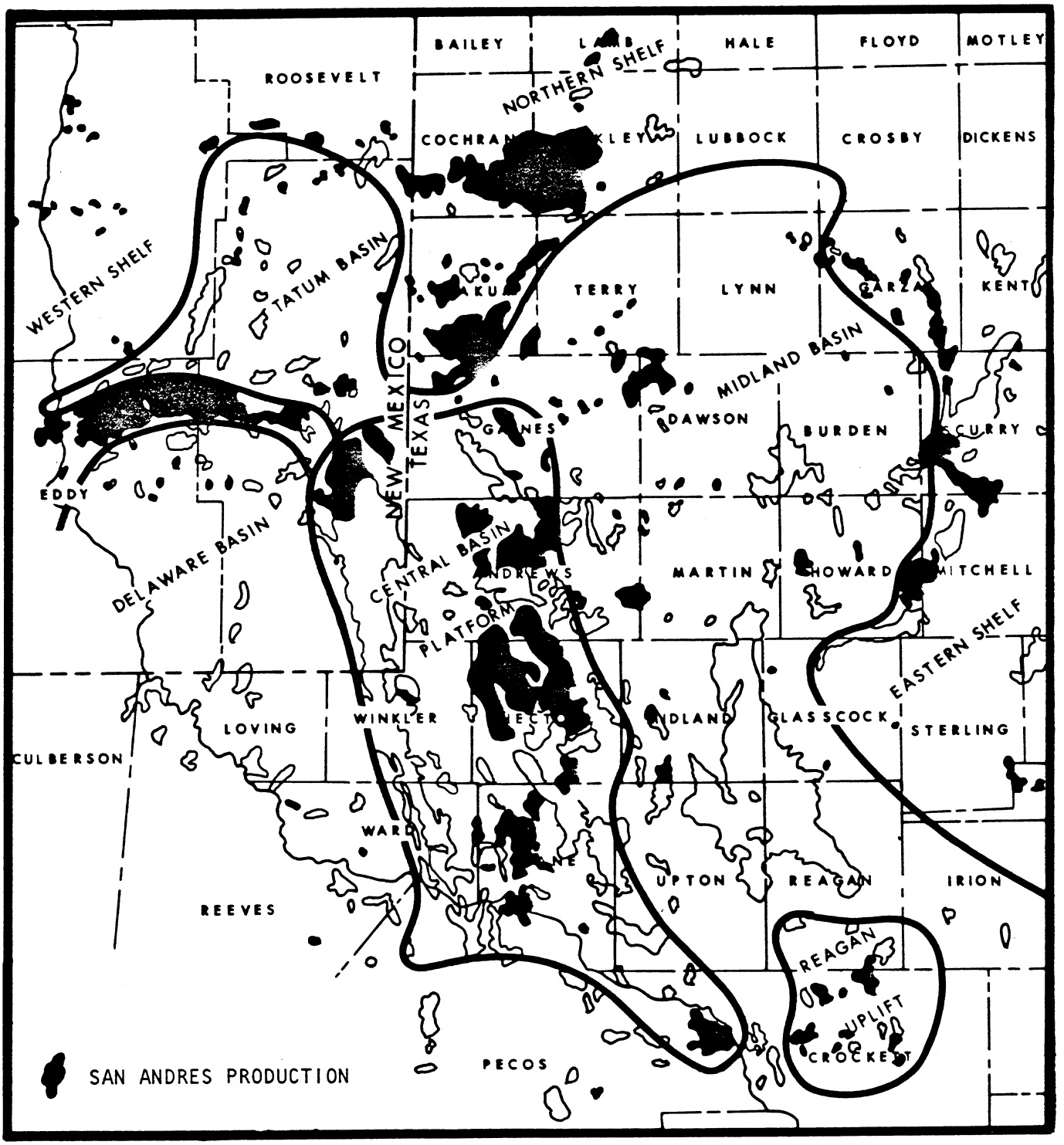
TABLE 6 (continued)

AGE / Region	NO. RESERVOIRS N.M.	NO. RESERVOIRS TEX.	NO. RESERVOIRS TOT.	CUM. PROD-MMBLS N.M.	CUM. PROD-MMBLS TEX.	CUM. PROD-MMBLS TOT.	EST. ISTOIP-MMBLS N.M.	EST. ISTOIP-MMBLS TEX.	EST. ISTOIP-MMBLS TOT.
PENNSYLVANIAN-CANYON									
Midland Basin	0	4	4	-	121	121	-	182	182
Eastern Shelf	0	7	7	-	1,748	1,748	-	3,651	3,651
Bend Arch	0	1	1	-	6	6	-	16	16
TOTALS	0	12	12	-	1,875	1,875	-	3,849	3,849
PENNSYLVANIAN-STRAWN									
Midland Basin	0	2	2	-	12	12	-	48	48
Reagan Uplift	0	2	2	-	38	38	-	105	105
Eastern Shelf	0	7	7	-	165	165	-	812	812
Northwest Shelf	1	0	1	19	-	19	81	-	81
TOTALS	1	11	12	19	215	234	81	965	1,046
PENNSYLVANIAN-BEND									
Cent. Basin Platform	0	1	1	-	11	11	-	49	49
Midland Basin	0	4	4	-	54	54	-	141	141
Eastern Shelf	0	1	1	-	22	22	-	52	52
TOTALS	0	6	6	-	87	87	-	242	242
MISSISSIPPIAN (UNDIF.)									
Bend Arch	0	1	1	-	4	4	-	286?	286
DEVONIAN									
Cent. Basin Platform	2	14	16	13	383	396	69	1,728	1,797
Midland Basin	0	5	5	-	101	101	-	632	632
North Basin Platform	0	1	1	-	73	73	-	73	73
Tatum Basin	3	0	3	116	-	116	552	-	552
TOTALS	5	20	25	129	557	686	621	2,433	3,054
SILURIAN									
Cent. Basin Platform	0	4	4	-	64	64	-	196	196
Midland Basin	0	4	4	-	47	47	-	93	93
TOTALS	0	8	8	-	111	111	-	289	289
ORDOVICIAN									
Cent. Basin Platform	4	3	7	34	190	224	62	251	313
Midland Basin	0	1	1	0	47	47	-	95	95
Reagan Uplift	0	3	3	-	67	67	-	277	277
TOTALS	4	7	11	34	304	338	62	623	685
Totals for all Reservoirs in all Regions of the Permian Basin:	44	172	216	1,830	11,057	12,887	9,540	45,930	55,470

Remaining Oil In Place for Selected Reservoirs: N.M. 11,414; TEX. 57,159; TOTAL 68,573

(1) Cum. Production through 1979

(2) ISTOIP = Initial Stock Tank Oil in Place calculated from reservoir parameters shown on Table



BASE MAP: MIDLAND MAP COMPANY, MIDLAND, TEXAS.

FIGURE 3

DISTRIBUTION OF FIELDS WHICH PRODUCE
FROM THE SAN ANDRES FORMATION

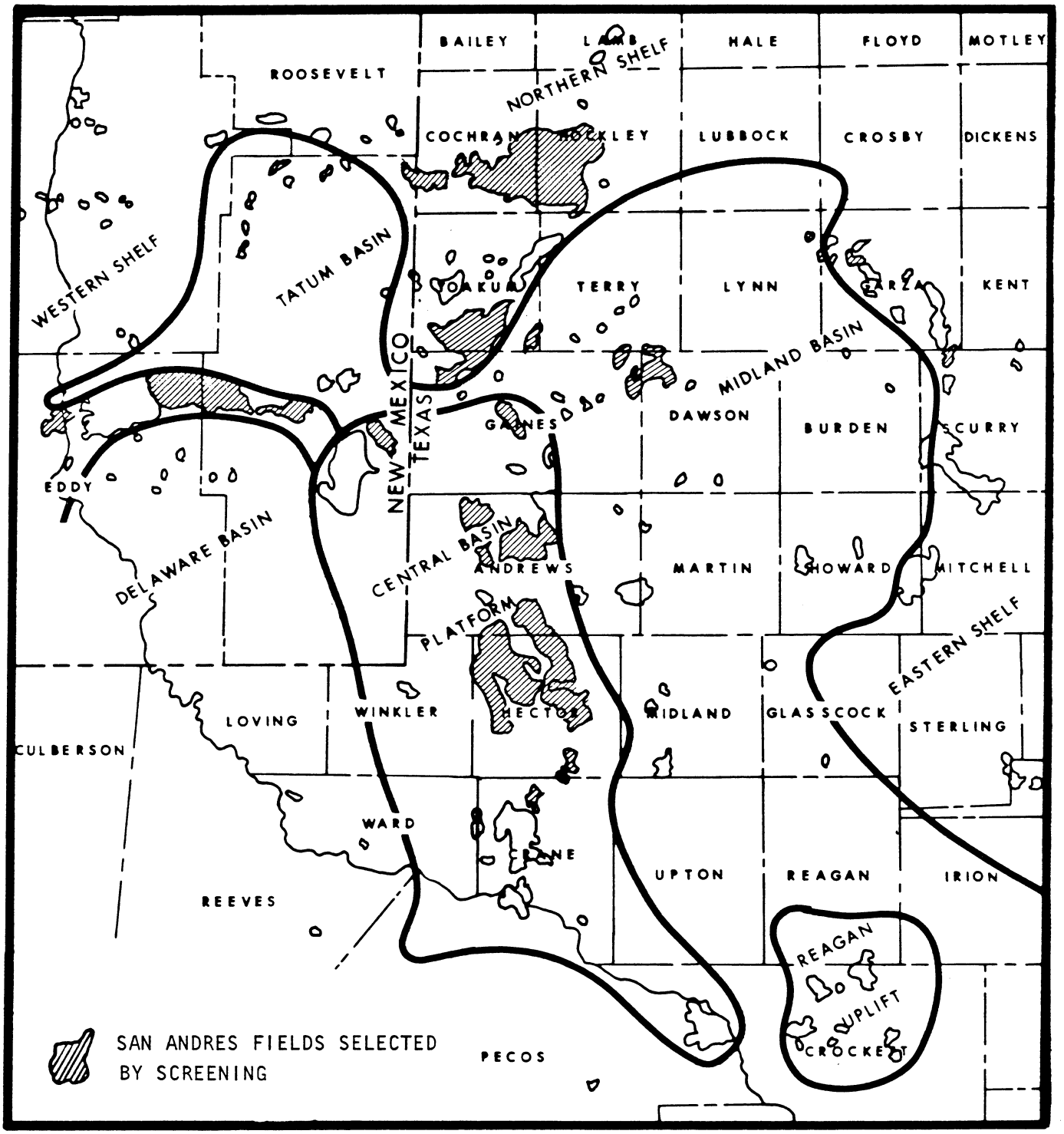


FIGURE 4

DISTRIBUTION OF SAN ANDRES FIELDS SELECTED BY SCREENING

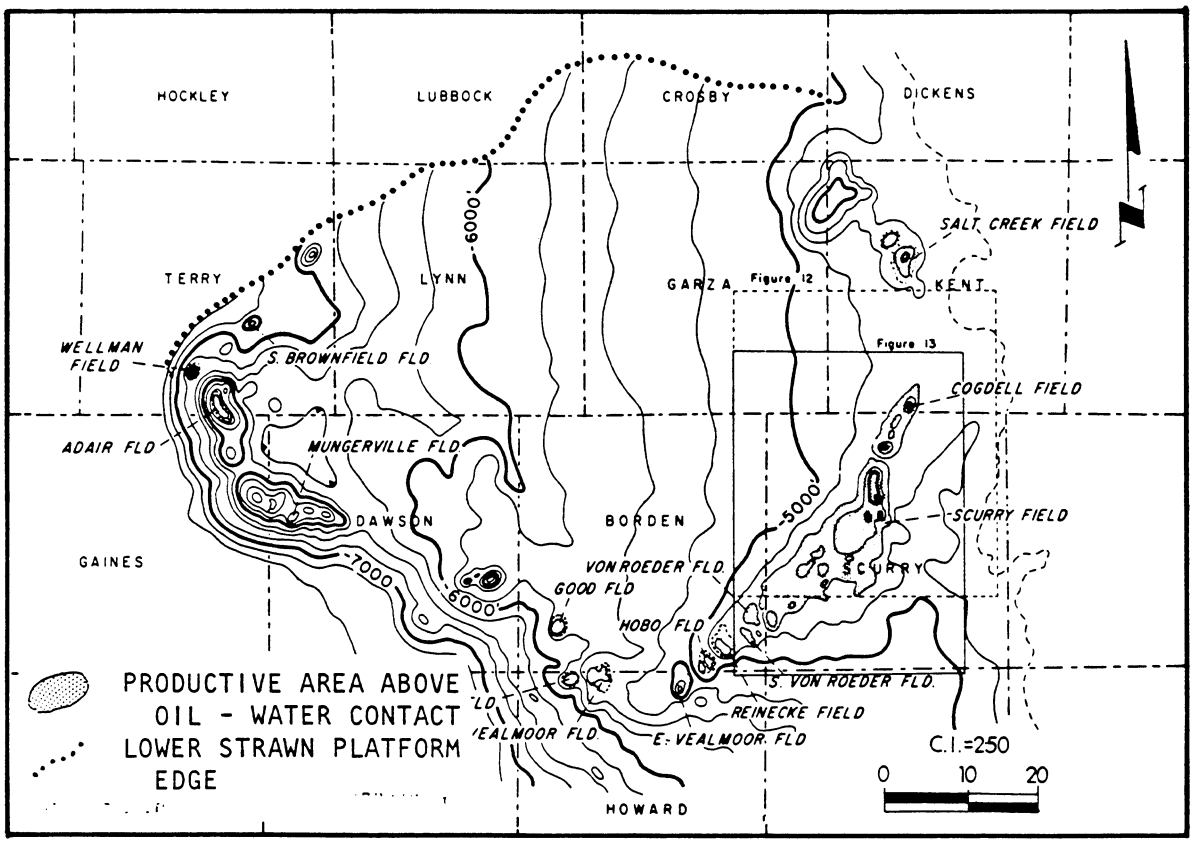


FIGURE 5

ISOPACHOUS MAP OF THE HORSESHOE REEF COMPLEX OF WEST TEXAS

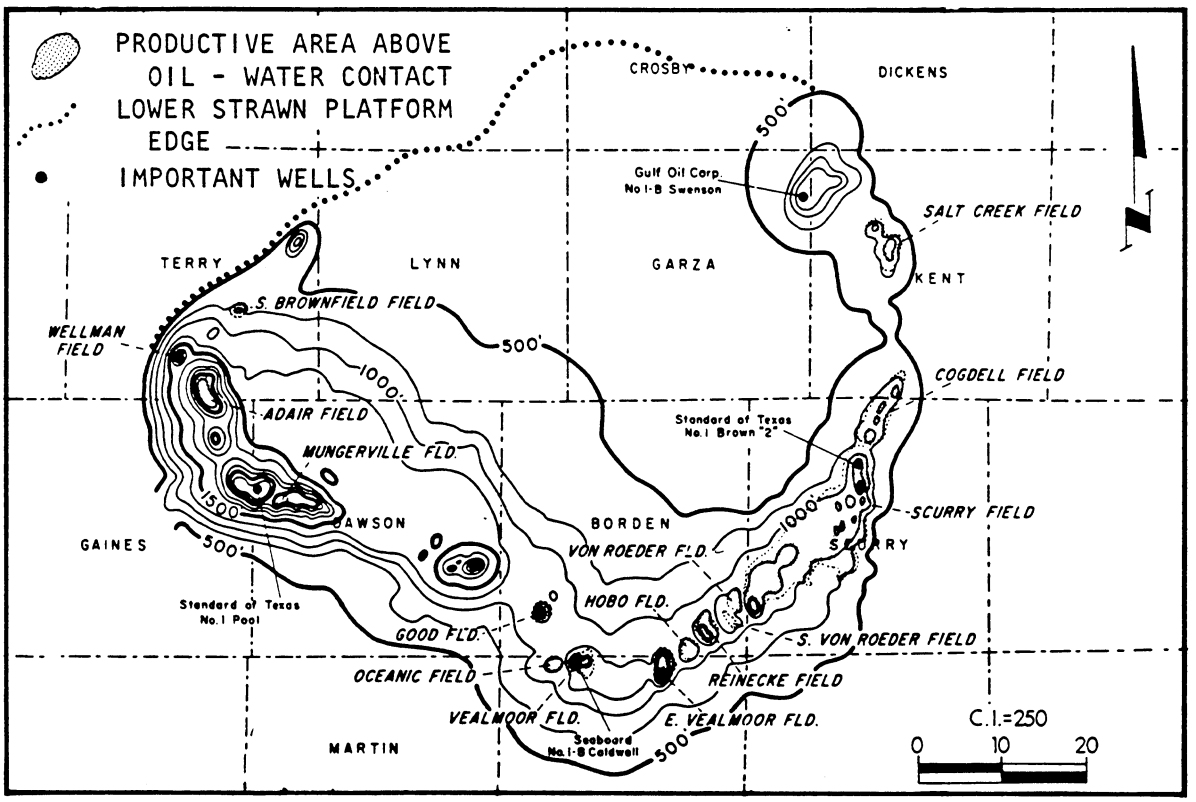


FIGURE 6

STRUCTURE MAP DRAWN ON TOP OF THE HORSESHOE REEF COMPLEX, WEST TEXAS

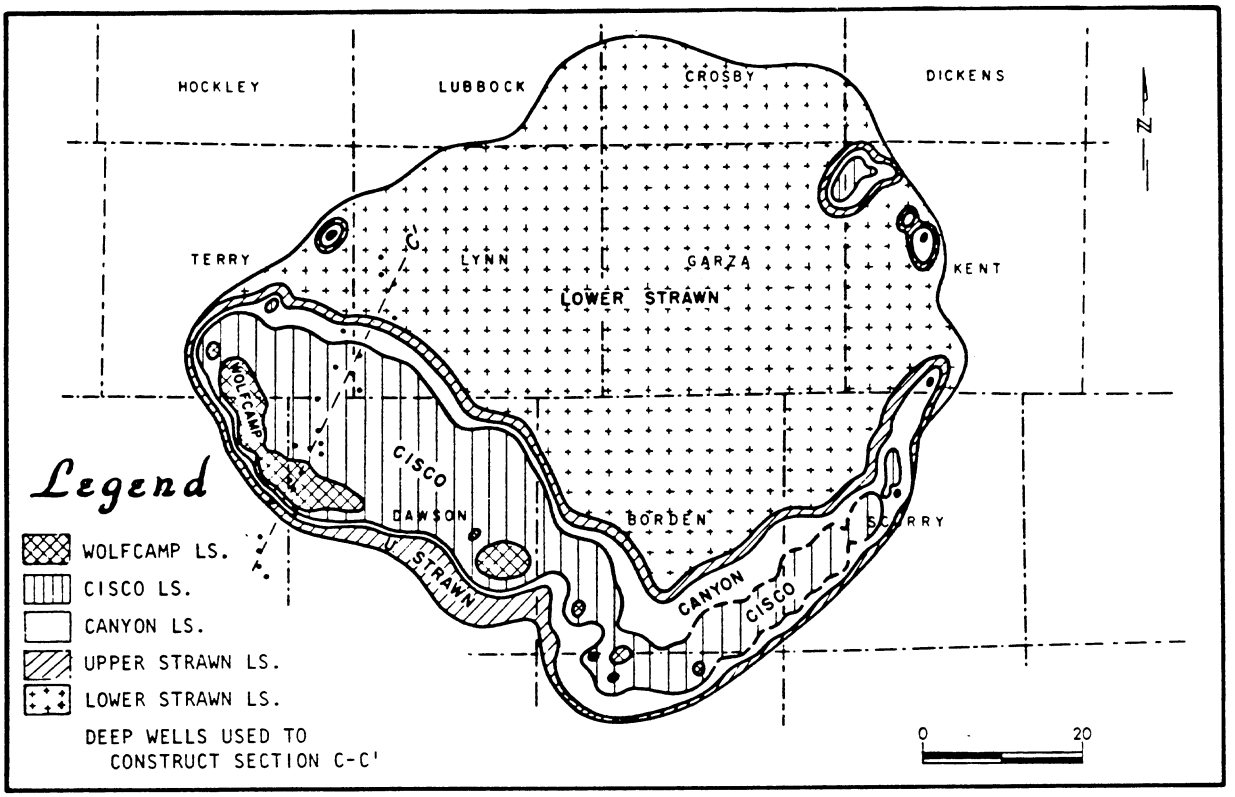


FIGURE 7

DISTRIBUTION OF MAJOR MEMBERS
OF THE HORSESHOE REEF COMPLEX

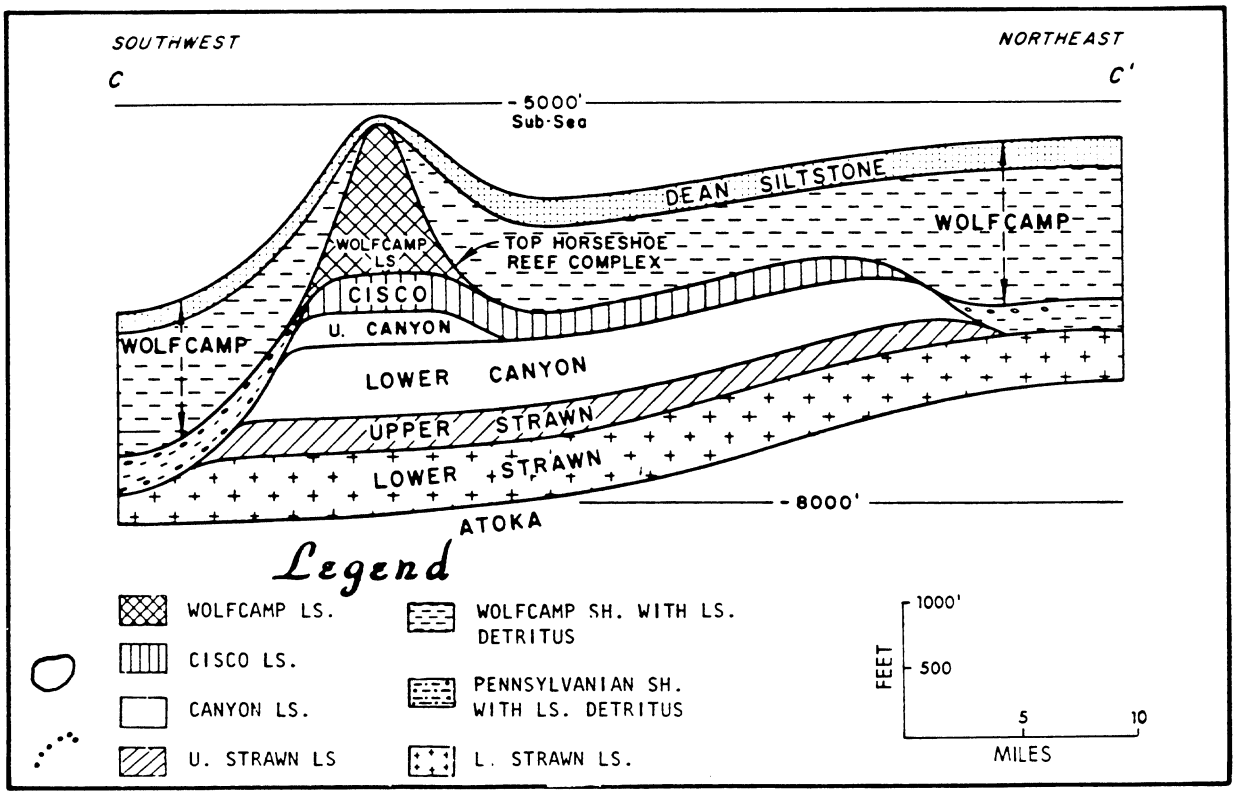


FIGURE 8

CROSS SECTION THROUGH THE SOUTHWEST CORNER
OF THE HORSESHOE REEF COMPLEX

5.4 Devonian

Devonian age reservoirs are third, after Guadalupe and Leonard Permian reservoirs, in number selected. Twenty-five Devonian age reservoirs (12 percent of the total) were selected for study. Of these, CROSSETT field has a CO_2 pilot project under way in the Devonian North Cross Unit.

The majority of the Devonian age reservoirs are on the Central Basin Platform region of the Permian basin, as are the Guadalupe and Leonard reservoirs.

5.5 Silurian

Eight Silurian age reservoirs were selected, four in the Central Basin Platform and four in the Midland basin. The Fusselman, generally a limestone in these areas, was the principal formation identified. Most of the Silurian reservoirs identified are in fields with multiple carbonate pay zones, which could enhance the economic favorability for a CO_2 pilot test if more than one pay zone in a field were suitable.

Figure 9 shows the distribution of Silurian and Devonian fields selected in this study.

5.6 Ordovician

All of the 11 Ordovician age reservoirs identified are Ellenburger. Throughout the Permian Basin the Ellenburger shows fracture and vuggy to cavernous porosity in pay zones and generally would be deemed unsuitable for CO_2 enhanced oil recovery. The exception to this general observation may be that since 10 of the 11 Ellenburger fields identified are in multiple pay fields, with several additional carbonate reservoirs, it might be economically feasible to use CO_2 flood in an Ellenburger reservoir if other carbonate reservoirs in the same field are under CO_2 flood. The Ellenburger would not of course constitute the primary justification for bringing CO_2 to a field.

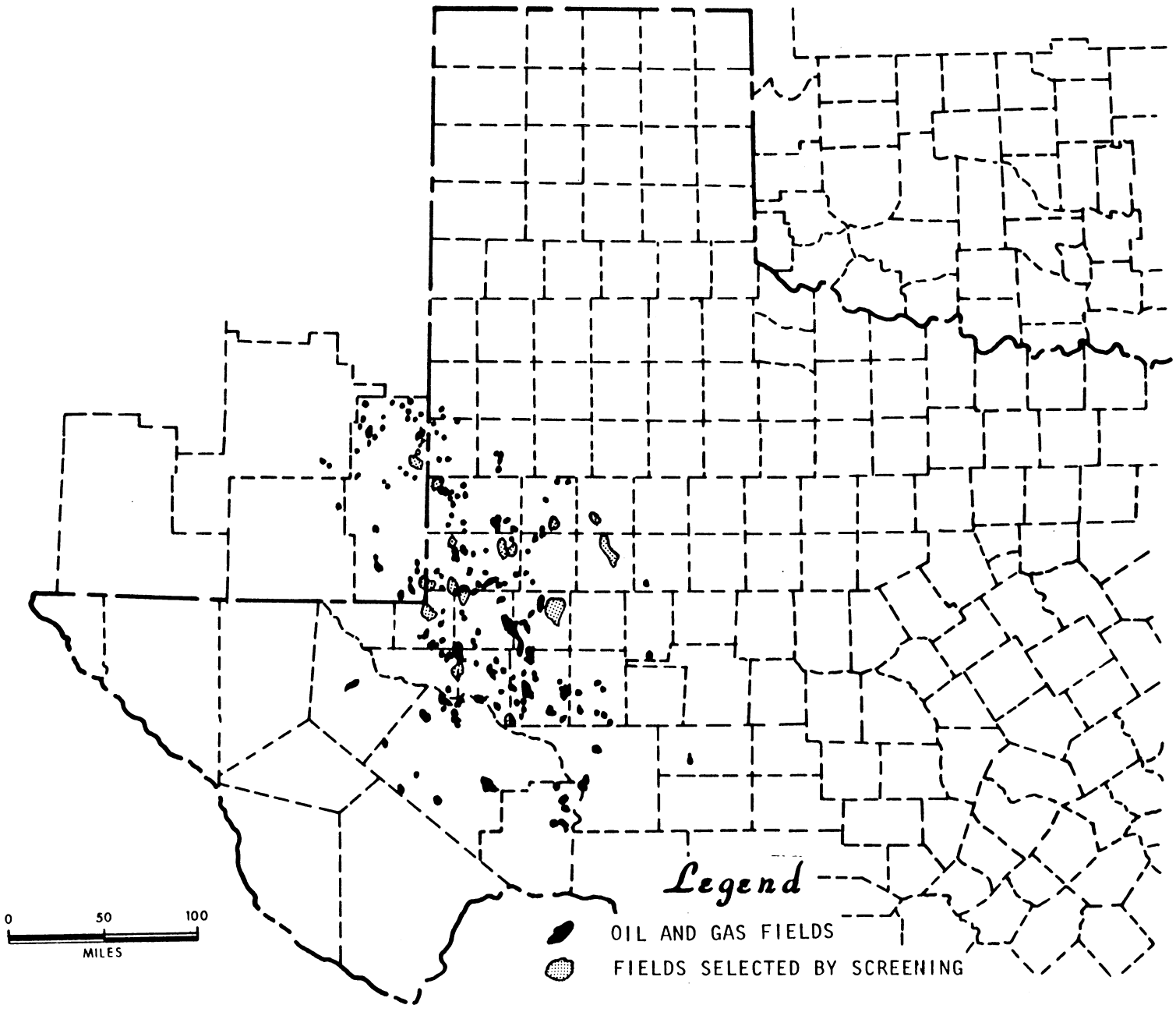


FIGURE 9
LOCATION OF SILURIAN-DEVONIAN OIL AND GAS FIELDS
AND LOCATION OF FIELDS SELECTED BY SCREENING

6. GEOLOGICAL AND RESERVOIR DATA SUMMARY

Table 7 summarizes selected data contained in Parts 2, 3, and 4 of this volume and the calculations of initial stock tank oil in place made by Gruy Federal using the selected reservoir parameters. Data in Table 7 were chosen from the multiple sources on each field data sheet as "conservatively" representing average reservoir conditions. In a few instances the selected data produced extremely large or small original-oil-in-place numbers (i.e., much larger or smaller than the quantity of oil already produced from that reservoir). If it could not be determined which parameter was at fault in the equation used to calculate original oil in place*, the calculated value was flagged with a question mark to indicate that further information is needed.

6.1 Reservoir Temperature

Important reservoir data not shown in Table 7 are reservoir temperature, pressure, and fluid content and composition. Reservoir temperature was seldom reported by any data source. Bottomhole temperatures from log data were available for a number of reservoirs; however, in many cases bottomhole temperature is not the same as reservoir temperature (e.g., if the well bottomed in a deeper formation). When necessary, Gruy calculated reservoir temperatures from published gradients (Texas Water Quality Board Report 157 (1972) for Texas fields and USGS-AAPG geothermal gradient maps for other states), using the equation

$$T_f = \Delta T \times D + T_s$$

where T_f = formation temperature (°F),
ΔT = geothermal gradient (°F/ft),
D = depth (ft),
and T_s = surface temperature (°F)

In Texas, the geothermal gradients for each county (Fig. 10) are available and depths of each reservoir were determined; calculations of reservoir temperatures in these cases can therefore be considered reasonable values.

---

*To calculate original oil in place, the equation

$$N = \frac{7758(Ah\phi)(1 - S_w)}{B_0}$$

was used, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_0 = formation volume factor. Where S_w and B_0 data were not available, S_w = 0.20 and B_0 = 1.3 were used.

TABLE 7

PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?, TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ARROWHEAD-Grayburg Lea, New Mexico	1938 3600'	8,320	50	.12	poor	--- ---	---	34	---	depletion	(238,325.8)	27,162.0			Queen SS with dolomite cemt.	Gas cap 13c - CO_2
BLOCK 31-Grayburg Crane, Texas	1956 3100'	1,710	7	.16	100	--- ---	---	26-27	---	---	10,500 (9,143.5)	3,499.8	Yes WF/SW, BW	1969 SW 1971 BW ICP	Devonian Ellenburger Connell McKee Clear Fork	No gas cap
C-BAR-San Andres Crane, Texas	1949 3500'	5,600	35	.08	5	.54 1.19	.35	33-34	---	---	27,540 (55,043.2)	15,455.8	Yes WF/SW, BW	1970 ICP	Connell Fusselman	
CORAZON-San Andres Scurry, Texas	1953 2140'	4,540	20	.08	1	.45 1.2	.44	35	---	---	------ (30,994.8)	3,738.9	Yes WF/SW	1967 ICP		
COWDEN, N.-Grayburg San Andres, Ector, Texas	1930 4150'	39,300	120	.09	10	.71 1.26	.287	30-34	1.75	depletion	401,333 (1,863,309.8)	314,161.0	Yes WF/SW, BW PM/Gas	1950-1978 WF-ICP PM-IPD	Holt Clear Fork Cisco	Gas cap 14e - CO_2
COWDEN, S.-Grayburg San Andres, Ector, Texas	1932 4600'	30,960	120	.09	4	--- 1.1	---	32-36	---	depletion	385,011 (1,886,565.1)	121,676.9	Yes WF/SW, FW BW & PM	1961-1971 WF-ICP	Canyon Cisco Devonian	14e - CO_2 Grayburg Gas cap
DONNELLY-San Andres Ector, Texas	1950 4300'	2,305	23	.07	10	.52 1.25	.312	35-36	---	depletion	18,600 (15,846.2)	7,512.6	Yes PM/SW, BW	1961-1962 ICP	Canyon Cisco Connell Devonian Grayburg Holt	
DUNE-Grayburg-San Andres, Crane, Texas	1938 3270'	29,760	80	.11	6	.58 1.12	.31	36	2.92	depletion	185,734 (1,251,689.0)	141,820.4	Yes PM/SW, WF/SW, BW	1960-1972 ICP	Clear Fork Waddell Wolfcamp	14e - CO_2

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

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[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

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TABLE 7
PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
EDWARDS-Grayburg-San Andres, Crane, Texas	1935 3400'	5,160	50	.058	8.5	.43 ---	.40	30-33	---	---	40,338 (53,401.7)	7,495.5	Yes WF/SW, BW	1965-1967 ICP	Atoka	
EMMA-San Andres, Andrews, Texas	1937 4240'	3,200	40	.08	33	--- 1.15	.84(?)	31.2-35.8	---	---	40,590 (11,052.8?)	17,601.5	Yes WF/BW	11-65 ICP	Connell Devonian Ellenburger Fusselman Glorieta Holt Miss. Strawn Wolfcamp	No gas cap
EMPEROR-Deep, Winkler, Texas	1937 2600'-3100'	4,000	61	.16	20	28.5 1.01	.45	32-36	---	---	31,423 (164,930.5)	22,798.5	Yes WF/SW, BW	1961-1965 ICP	Holt	
Deep includes Queen, Colby, Yates and Seven Rivers - all primarily sandstone reservoirs but listed by PDS as carbonate.																
EMPEROR-Holt, Winkler, Texas	1946 4765'	2,000	23	.183	4	.49 1.2	.33	36.3-40.6	---	---	14,395 (35,004.5)	6,366.7	Yes WF/SW, BW	1965-1970 ICP	Queen Colby Seven Riv. Yates	
EUNICE-San Andres Lea, New Mexico	1961 4100'	No data. Data source 13c (GURC report 153) recommended as suitable for CO_2.										32.0				
EUNICE-MONUMENT Grayburg-San Andres Lea, New Mexico	1929 3400'	39,680	250	--- (.05?)	35	--- ---	---	32	8	water drive	----- (2,367,980.3)	334,553.0	Yes (PM?)	---	Queen	6a-gas cap 14e-no gas cap, 14e-not suitable for CO_2
FOSTER-Grayburg, Ector, Texas	1936 4300'	31,000	91	.10	7	.39 1.239	.35	33-39	2.6	depletion	349,734 (1,148,140.2)	206,782.9	Yes WF/SW, BW	1956-1969 ICP		14e - CO_2

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CENTRAL BASIN PLATFORM
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
FULLERTON-San Andres, Andrews, Texas	1945 4500'	6,500	46	.105	1.5	.48 1.2	.385	32.5- 35.2	---	depletion	31,400 (124,825.7)	8,583.8	Yes WF/SW, FW	1966-1974 ICP	Clear Fork Connell Ellenburger Wichita	
GOLDSMITH-San Andres, Ector, Texas	1935 4250'	30,000	47.5	.098	11.7	--- 1.36	.143	35- 37	0.91	depletion	205,929 (682,704.3)	313,548.2	Yes WF/SW, BW Gas	1954-1967 WF-ICP Gas-IPD	Clear Fork Grayburg Holt Tubb Penn Fusselman Devonian Ellenburger	14e - suitable for polymer
GOLDSMITH, E.-San Andres, Ector, Texas	1952 4180'	2,760	90	.078	12	--- ---	---	37	---	---	52,690 (92,500.2)	7,322.7	Yes PM/SW	1970 ICP	Clear Fork Glorieta Grayburg Holt Penn	
GOLDSMITH, N.-San Andres, Ector & Andrews, Texas	1935 4300'	30,000?	49	.08	14	--- ---	---	32- 38	---	---	32,271 (561,440.5)	11,431.9	Yes WF/SW, BW	1973-1975 ICP	above	
GOLDSMITH, W.-San Andres, Ector, Texas	1956 4300'	4,800	30	.06	3.5	--- ---	---	34.5	---	---	10,520 (41,248.6)	5,476.5	Yes WF/SW	1971 ICP	above	
HARPER-San Andres Ector, Texas	1933 4300'	12,360	39	.10	4	--- ---	---	35- 37	---	depletion	109,000 (232,133.3)	38,945.2	Yes WF/SW, BW	1961-1968 ICP	Connell Devonian Ellenburger Fusselman Strawn	No gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

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PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
HOBBS-Grayburg San Andres, Lea, New Mexico	1928 3700'	12,160	--- (100)	.15	50	--- ---	.15	34	8	water drive	---- (925,231.0)	242,420.0	Yes ?	---		Gas cap 14e - not suitable for EOR due to water drive & gas cap
JOHNSON-Grayburg Ector, Texas	1934 4200'	8,000	56	.068	2.5	--- ---	.20	33-36	---	depletion	72,123 (145,439.8)	21,914.7	Yes WF/SW, FW, BW	1961-1977 ICP	Glorieta Holt Penn	
JORDON-San Andres, Crane, Texas	1937 3700'	25,400	53	.136	13.5	--- 1.2	.30	36	1.11	depletion	225,183 (828,543.0)	74,007	Yes WF-PM/ SW,BW	1966-1970 ICP		14e not suitable for CO_2 because of gas cap
KEYSTONE-Holt, Winkler, Texas	1943 4700'	6,200	52.5	.75	58	--- 1.49	.25	40	---	depletion	---- (953,316.3)	39,542.2	Yes WF/BW	1961-1968 ICP	Ellenburger Clear Fork Colby Devonian San Andres Silurian Waddell Wolfcamp	Gas cap
LAWSON-San Andres Ector, Texas	1950 4200'	4,800	33	.10	6.5	.568 1.06	.35	36-37.5	---	depletion	--- (75,355.1)	13,275.8	Yes PM/SW,BW	1963-1967 ICP	Simpson	
LEA-San Andres, Crane, Texas	1955 2925'	3,000	29	.09	2	--- 1.12	.24	29-38	---	---	--- (41,219.9)	4,378.0	Yes ?	---	Clear Fork Connell Ellenburger McKee Penn Tubb	

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[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

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TABLE 7
PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
McCAMEY-Grayburg Upton, Texas	1925 2200'	20,000	75(?)	.14(?)	18	--- ---	---	26-29.6	---	depletion & water drive	133,875 (1,002,572.3)	127,844.9	Yes WF/SW	1962 ICP	Ellenburger Silurian	14e - not suitable for CO_2 because of water drive, gas cap & frac.
McELROY-Grayburg, Crane, Texas	1926 3000'	30,000	129.2 (?)	.124	10.5	.60 1.15	.20	30-33	2.6	depletion	824,197 (2,593,865.0)	373,438.2	Yes WF/SW, BW	1962-1971 ICP		No gas cap. Rated as suitable for polymer and CO_2.
McFARLAND-Queen Andrews, Texas	1955 4790'	15,300	16	.12	12.3	.52 1.25	.25	30.2-32.6	---	---	105,249 (136,739.4)	34,680.5	Yes WF/SW, BW	1961-1976 ICP	Ellenburger Grayburg Penn Wolfcamp	
MEANS-San Andres, Andrews, Texas	1934 4400'	18,500	57.5	.077	20	--- 1.04	.35	29	---	depletion	448,700 (397,155.1)	129,997.7	Yes WF/SW, FW, BW	1963-1965 ICP	Queen SS Yates Grayburg Devonian	14e-rated as suitable for polymer and CO_2
PENWELL-San Andres Ector, Texas	1926 3800'	14,000	59.6	.095	2.75	.57 1.22	.25	32.4-37	---	---	329,392 (378,049.9)	66,142.9	Yes WF/SW, BW	1969 ICP	Clear Fork Devonian Ellenburger Fusselman Penn Waddell Wichita-Albany	

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TABLE 7

PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
SCARBOROUGH-Yates & Seven Rivers, Lea, New Mexico	1926 2895'	2,840	--- (100)	.141	4.6	.103 ---	.468	37	---	water drive	--- (127,132.2)	15,623.0	Yes ?			
These are sandstone reservoirs, although listed by PDS as carbonate																
SEMINOLE-San Andres, Gaines, Texas	1936 5032'	17,345	125	.132	31	.65 1.38	.174	37	.92	depletion	970,700 (1,328,951.0)	229,151.6	Yes PM/SW, FW Gas	1969 ICP-SW, FW; IPD-Gas	Devonian San Angelo Wolfcamp	Gas cap 14e - not suitable for EOR due to gas cap
SEMINOLE, EAST-San Andres, Gaines, Texas	1959 5400'	1,218	52	.08	5	--- ---	---	33	---	---	18,849 (24,190.1)	3,903.8	Yes PM/SW, FW	1971 ICP	No	
SEMINOLE, WEST-San Andres, Gaines, Texas	1948 5042'	2,960	100	.139	21	.617 1.382	.275	31.2-34.4	---	---	154,000 (167,450.4)	27,947.1	Yes WF/FW PM/Gas	1962-1968 ICP	Glorieta Devonian Leonard Wolfcamp	Gas cap
SHAFTER LAKE-San Andres, Andrews, Texas	1929 4482'	15,680	49	.065	5	.54 1.15	.30	30-35.1	.54	depletion	164,926 (235,833.5)	33,617.9	Yes WF/SW, FW	1967 ICP	Clear Fork Devonian Ellenburger Penn	No gas cap
SKAGGS-Grayburg Lea, New Mexico	1937 3750'	3,400	50	.027	7	.272 ---	.182	36	---	depletion	--- (22,406.4)	8,717.0	Yes	?	Queen	
WADDELL-San Andres Crane, Texas	1927 3500'	10,000	145	.10	7	--- 1.27	.50	33-35.5	---	---	--- (442,877.9)	89,942.1	Yes PM/SW, BW	1959-1964 ICP	Devonian Ellenburger Penn Silurian	
YATES-Yates Lime, Pecos, Texas	1926 1500'	26,420	120	.10	118	--- ---	---	30	---	weak water drive	4,000,000 (1,513,597.7)	768,661.0	Yes PM/SW, Gas	1976 ICP		14e - not suitable for CO_2 recovery because of large secondary gas cap

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TABLE 7
PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BLINEBRY-Yeso, Lea, New Mexico	1945 5600'	11,720	60	.084	4.5	.135 ---	.244	41	---	depletion	---- (266,493.3)	38,811.0	Yes ?	---		
BROWN & THORP-Clear Fork, Pecos, Texas	1951 3000'	3,900	42	.086	2.33	--- 1.16	.35	38.6	---	depletion	18,912 (61,237.5)	6,008.0	Yes WF/SW	1972 ICP	Ellenburger	
DOLLARHIDE-Clear Fork, Andrews, Texas	1949 6500'	3,500	40	.15	15	.53-.58 1.4	.25	35.6-38.9	---	depletion	101,987 (87,277.5)	29,743.6	Yes WF/SW, BW Gas	1959-1967 ICP	Tubb Drinkard	No gas cap
DOLLARHIDE-Tubb Drinkard (Yeso), Lea, New Mexico	1951 6580'	3,480	30	.08	10	--- ---	---	40	---	depletion	---- (39,873.7)	16,386.0	Yes ?		Devonian Fusselman Ellenburger	No gas cap
	Dollarhide-Clear Fork, Texas and Dollarhide-Tubb/Drinkard, New Mexico are equivalent and continuous															
DRINKARD-Yeso (Vivian & Andrews) Lea, New Mexico	1945 6490'	20,650	100(?) (PDS)	.116?	5.6	.137 ---	.162	40	3	depletion	---- (1,197,921.9)	76,136.0	Yes ?	---		Gas cap 14e not suitable for CO_2.
FULLERTON-Clear Fork, Andrews, Texas	1941 7000'	34,680	75	.085	2	--- 1.62	.22	40-43	---	depletion	751,685 (825,826.2)	199,544.3	Yes WF & PM/ SW, FW	1956-1975 ICP	Connell Ellenburger San Andres Wichita Wolfcamp Devonian	14e - CO_2
GOLDSMITH-Clear Fork, Ector, Texas	1946 5600'	65,000	32-100	.116?	14.4	.55 1.55	.26	37-41	1.1	depletion	294,906 (893,657.5)	55,610.5	Yes WF/SW, BW	1956-1973 ICP	San Andres Holt Penn Fusselman Devonian Ellenburger	No gas cap. 14e - list as suitable for CO_2 or polymer depending on availability

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PERMIAN-LEONARD (318)

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GOLDSMITH, EAST-Holt, Ector, Texas	1954 / 4950'	2,185	48	.086	1	--- / ---	---	38	---	---	48,650 (43,061.4)	6,161.7	Yes WF/SW	1968 ICP	above	
GOLDSMITH, WEST-Upper Clear Fork, Ector, Texas	1956 / 4925'	4480-65,000	35	.091	1.5	--- / ---	---	36-38	---	---	96,500 (68,121.5)	6,973.7	Yes WF/SW, BW	1969-1971 ICP	Devonian Ellenburger Fusselman San Andres Waddell Wolfcamp	
HARRIS-Glorieta, San Angelo, Gaines & Andrews, Texas	1949 / 5900'	5,200	60	.09	12.5	--- / 1.11	---	31	---	---	---- (157,005.2)	30,573.8	Yes WF/SW, FW	1964-1971 ICP	Queen	
HOBBS-Blinebry Yeso, Lea, New Mexico	1968 / 5800'	1,600	67	.10	16.5	.20 / ---	.42	37.4	---	partial water drive	----- (37,104.7)	4,807.0	No	---	Grayburg	
MONAHANS-Clear Fork Ward, Texas	1945 / 4750'	4,800	48	.107	2	.60 / 1.424	.25	37	---	depletion	50,000 (100,732.0)	8,677.8	Yes WF/SW, BW	1969 ICP	Devonian Ellenburger Fusselman Miss. Tubb Queen Waddell Wolfcamp	
RILEY, NORTH-Clear Fork, Gaines, Texas	1947 / 6930'	29,000	70	.077	12	.525 / 1.285	---	32	---	depletion	105,600 (754,372.0)	18,232.8	Yes WF/SW, FW	1977 ICP	No	
ROBERTSON, NORTH-Clear Fork, Gaines, Texas	1944 / 7220'	10,040	35	.068	12	.55 / 1.38	.25	34.5-36.5	---	---	275,000 (100,749.4)	30,719.4	Yes WF/SW, FW	1962-1971 ICP	San Andres	

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CENTRAL BASIN PLATFORM
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
SANDHILLS-Tubb, Crane, Texas	1930 4360'	17,040	50	.107	28.5	.44 1.229	.40	35	1.045	depletion	126,769 (345,280.9)	78,746.9	Yes WF/SW, BW PM/BW, Gas	1958-1974 ICP	McKnight Clear Fork Ordovician Wolfcamp San Andres	No gas cap 14e - suitable for CO_2.
TUBB-Tubb, Lea, New Mexico	1956 6105'	640	72	.19	5	--- ---	---	35	---	depletion	----- (41,798.7)	5,951.0	---	---	---	Insufficient data
TXL-Tubb, Ector Texas	1950 6100'	17,180?	57	.115	1	--- ---	---	35-40	---	---	191,000 (537,640.9)	33,480.4	Yes WF/SW, BW	1968 ICP	Ellenburger Waddell Clear Fork Devonian San Andres	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
CENTRAL BASIN PLATFORM
PERMIAN-WOLFCAMP (319)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ANDREWS-Wolfcamp, Andrews, Texas	1953 8596'	3,360	25	.088	18	--- 1.35	.17	37.5	---	depletion	---- (35,257.9)	17,560.0	---	---		
ANDREWS, SOUTH-Wolfcamp, Andrews, Texas	1953 9183'	4,960	-- (25)	.04	11	--- ---	---	40	---	---	---- (23,679.8)	12,089.0	---	---		
PECOS VALLEY-Wolfcamp, Pecos, Texas	1956 5200'	1,080	40	.173	4	--- ---	---	37.6-36	---	depletion	8,500 (1 SRP) (35,680.1)	2,240.8	Yes PM/BW	1961 ICP	Yates Whitehorse Dolomite Devonian Fusselman Montoya McKee Ellenburger	Gas cap
SHAFTER LAKE-Wolfcamp, Andrews, Texas	1951 8405'	4,980	13	.134	28	.167 1.46	.205	41-42	---	depletion	25,000 (36,647.3)	11,937.9	Yes WF/SW	1963 ICP	Clear Fork Devonian San Andres Ellenburger	No gas cap
UNIVERSITY -Block 9 - Wolfcamp, Andrews, Texas	1953 8430'	4,000	30	.10	14	.65 1.329	.268	38	.25	depletion	50,300 (51,276.4)	23,255.4	Yes WF/SW, BW Gas	1961 ICP-WF IPD-Gas	Devonian Penn	

PERMIAN BASIN
CENTRAL BASIN PLATFORM
PENNSYLVANIAN BEND (326)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
UNIVERSITY-Block 9 Pennsylvanian, Andrews, Texas	1954 8956'	2,800	40	.120	11	.66 1.489	.30	40.2-42.6	---	depletion	48,200 (49,017.6)	10,508.5	Yes WF/SW, BW	1970 ICP	Devonian Wolfcamp	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
CENTRAL BASIN PLATFORM
DEVONIAN (340)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ANDREWS, S.-Devonian, Andrews, Texas	1953 10,700'	7,840	22	.056	2	--- ---	---	47	---	---	11,200 (46,113.0)	9,920	Yes WF/SW	1964 IPD	Wolfcamp	
BLOCK 11-Devonian, Andrews, Texas	1951 8230'	1,735	45	.252	46.8	--- ---	---	42	.34	depletion	47,600 (93,931.0)	7,319	Yes WF/SW, BW	1967 ICP	Ellenburger Fusselman Wichita	
BLOCK 31-Lower Devonian, Crane, Texas	1945 8000- 8500'	8,700	170	.15	1	--- ---	---	41- 48	.25- .30	---	312,000 (529,573.0)	162,729.1	Yes MD/FG; PM/Gas-CO_2	MD-1966 PM-1969 ICP	Grayburg McVee Connell Ellenburger	No gas cap CO_2 candidate
CRAWAR-Devonian North, Crane, Texas	1958 6450'	480	30	.20	19	--- 1.36	.45	35.4	---	----	---- (9,035.8)	4,242.3	No	---	Devonian Ellenburger	Gas cap
CROSSETT-Devonian Crane, Texas	1944 5400'	1,120	60	.22	5	.57 1.98	.35	44	.37	depletion	51,000 (37,652.2)	12,183.7	Yes MD/Gas, NRG PM/Gas	1964-Gas 1972-NRG ICP	Clear Fork	Gas cap CO_2 Project
CROSSETT, S.-Devonian, Crockett, Texas	1956 5200'	3,450	37	.175	7	--- ---	.25	42- 43	---	depletion	98,530 (99,983.1)	13,572.1	Yes PM/Gas	1968-1971 ICP		
DOLLARHIDE-Devonian Andrews, Texas	1955 8051'	5,632	70	.135	17	.46- .67 1.65	.20- .27	38.2	---	water drive & depletion	114,101 (157,652.5)	69,418.5	Yes WF/SW, BW	1959-1965 ICP	Clear Fork Silurian Ellenburger	No gas cap
DOLLARHIDE-Devonian Lea, New Mexico	1952 8000'	720	75	.09	10	--- (1.65)	(.27)	40	---	water drive & depletion	----- (23,202.4)	6,608.0	Yes ?	---	Tubb/ Drinkard Fusselman Ellenburger	No gas cap
	Dollarhide-Devonian, Texas and New Mexico oil continuous reservoirs															
DOLLARHIDE, E.-Devonian, Andrews, Texas	1949 10,186'	1,120 (?)	15	.21	5	--- 1.67	.29	40- 42	---	depletion	10,786 (11,636.4)	5,478.4	Yes WF/SW, FW	1976 ICP	Ellenburger	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
CENTRAL BASIN PLATFORM
DEVONIAN (340)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
FULLERTON "8500"-(Devonian), Andrews, Texas	1944 8500'	6,500?	125	.09	---	--- 1.2	.20	43	---	---	---- (378,202.5)	42,937.5	No	---	San Andres Clear Fork Connell Wichita Ellenburger Wolfcamp	
GOLDSMITH, N.-Devonian, Ector, Texas	1946 8000'	1,050	37.5	.20	23.5	--- ---	---	39	---	---	1,875 (37,596.5)	6,785.8	Yes WF-PM/ SW, BW	1967 ICP	above	
HARPER-Devonian, Ector, Texas	1962 10100'	3,070	70	.088	1	--- ---	---	42-48	---	---	47,000 (90,285.0)	6,837.3	Yes PM/Gas	1968 ICP	Connell Devonian Ellenburger Fusselman Strawn	
LEA-Devonian, Lea, New Mexico	1960 14350'	1,440	124?	.065	50	.12 ---	.25	56	---	water drive	--- (51,947.6)	6,120	No	---		
PECOS VALLEY-Devonian, Pecos, Texas	1953 5500'	1,400	60	.20	4	--- ---	---	34-40	---	depletion	23,000 (82,497.4)	4,619.0	Yes PM/BW, Gas	1967 ICP	Yates Whitehorse Fusselman Montoya Ellenburger Wolfcamp	Gas cap
THREE BAR-Devonian Andrews, Texas	1945 8385'	1,700	70	.199	54	.70 1.6	.30	41	---	---	---- (80,376.3)	34,220.0	Yes PM/SW, FW, BW	1961-1970 ICP,IPD	San Andres Wichita	
YARBOROUGH & ALLEN Devonian, Ector, Texas	1954 8500'	1,600	80	.08	1	--- ---	---	37	---	---	---- (48,887.3)	2,536.9	Yes WF/SW	1968 ICP	Connell Ellenburger Fusselman Miss. Waddell Wolfcamp	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
CENTRAL BASIN PLATFORM
SILURIAN (350)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ARMER-Fusselman, Crane, Texas	1955 6340'	960?	34	.06	20	--- 1.4	---	38	---	---	--- (8,681.9)	3,915.0				
DOLLARHIDE-Fusselman, & Montoya, Andrews, Texas	1947 8500'	2,587	194	.058 to caver-nous	9	.64-.68 1.57	---	42-44	---	water drive	180,252 (115,071.1)	35,187.4	Yes? PM/SW	1968 ICP	Clear Fork Devonian Ellenburger Tubb/ Drinkard	locally cavernous porosity 2'-16' in height
DOLLARHIDE-Fusselman, Lea, New Mexico	1952	Continuous with Dollarhide-Fusselman, Andres County, Texas														NO GAS CAP
KEYSTONE-Silurian Winkler, Texas	1947 8100'	4,480	80	.06	4	.531 1.61	.30	31-39	---	---	--- (72,533.9)	25,199.4	Yes WF/BW	--- ICP	Yates SS Colby SS Holt Lm Devonian McKee SS Waddell SS Ellenburger	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
CENTRAL BASIN PLATFORM
ORDOVICIAN (360)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
DOLLARHIDE-Ellenburger, Andrews, Texas	1944 10500'	2,555	187	.022	5.9	--- 1.29	---	41-43	---	depletion	60,133 (50,571.4)	24,754.0	Yes PM/SW	1963 ICP	Clear Fork Fusselman Devonian	Fracture, porosity
DOLLARHIDE-Ellenburger, Lea, New Mexico	1951 10000'	705	(187)	.022	4.9	--- ---	---	42	---	depletion	---- (13,846.8)	3,306.0	---	---	Clear Fork Fusselman Devonian	
Dollarhide-Ellenburger, Texas and New Mexico are continuous reservoirs. New Mexico acreage is in addition to Texas acreage.																
GOLDSMITH, W.-Ellenburger, Ector, New Mexico	1954 9500'	450	100	.04	12	--- 1.3	.25	44	---	water drive	9,000 (8,056.4)	3,657.7	Yes PM/SW	1967 ITD	Clear Fork Devonian Fusselman San Andres Waddell Wolfcamp	
JUSTIS-Ellenburger Lea, New Mexico	1957 7700'	1,280	85	.025	2	.12 ---	.45	39.4	---	depletion & water drive	----- (8,927.7)	7,257.0	No	---	McKee	Fracture, porosity
LEA-Ellenburger, Crane, New Mexico	1953 8200'	2,066	40	.018	very high	--- ---	---	42-43	.62	water drive	----- (30,773.8)	19,323.3	No	---	Clear Fork Connell McKee Penn San Andres	Fracture, porosity
TXL-Ellenburger, Ector, Texas	1949 9600'	5,900	150	.045	39	--- 1.63	.15	44	.44	water drive	----- (161,115.3)	126,197.4	No	---	Waddell Clear Fork Devonian McKee Montoya Penn San Andres	14e-not suitable for CO_2 due to H_2O drive & fractures.
YARBOROUGH & ALLEN Ellenburger, Ector Texas	1947 10490'	3,040	24	.014	28	--- 1.36	.33	41	---	water drive	43,365 (4,486.6)	39,430.5	Yes PM/SW	1969 ICP	Connell Devonian Fusselman Miss Wolfcamp Waddell	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
MIDLAND BASIN
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ADAIR-San Andres Gaines, Texas	1947 4870'	5,338	50	.145	7	.65 1.12	.35	33	---	----	168,379 (174,245.5)	42,671.0	Yes WF/SW, FW	1963 ICP	Wolfcamp	
AZALEA-Grayburg Midland, Texas	1967 4088'	400+	18	.12	4	--- ---	---	30-32	---	depletion	----- (4,124.9)	816.5	No	---	Strawn Devonian	
CEDAR LAKE-San Andres, Gaines, Texas	1939 4800'	8,600	53	.12	6	.72 1.086	.28	29-36	---	depletion	3,750+ (281.324.8)	63,233.2	Yes WF/SW, FW BW; Gas	1959-1966 ICP-WF IPD-Gas		
G-M-K-San Andres Gaines, Texas	1957 5550'	1,280	86	.112	3	--- 1.18	.427	32-36	---	depletion	47,242 (46,446.1)	9,478.6	Yes PM/SW, BW, FW	1968-1969 ICP		
MABEE-San Andres Andrews, Texas	1943 4700'	13,500	4	.11	4	--- ---	---	31	---	---	---- (28,358.5)	59,604.9	Yes WF/SW, BW	1965 ICP-SW IPD-BW	Clear Fork Dean Strawn	
MIDLAND FARMS-Grayburg, Andrews, Texas	1944 4800'	16,300	56	.15	61	--- 1.097	.20	30	---	depletion & weak water drive	----- (774,640.2)	113,924.2	Yes WF/SW, BW	1961 ICP	Ellenburg. Fusselman Strawn	14e - not suitable for CO_2 because of fractures
MOORE-Grayburg San Andres, Howard, Texas	1927 3125'	5,200	14.5	.09	8	.66 1.07	.30	27-30	---	---	16,100 (34,441.2)	8,815.8	Yes WF/SW, BW	1963-1967 ICP		
REEVES-San Andres Yoakum, Texas	1957 5600'	6,840	45	.117	3	.55 1.17	.30	31-35	---	depletion	87,980 (167,153.9)	20,226.4	Yes WF/SW, BW	1976 ICP	Leonard Strawn 11,500'	
SUNILAND-San Andres Lynn, Texas	1956 4000'	160	110	.14	17	--- 1.2	.365	35.9	---	depletion	---- (10,115.4)	2,296.1	No	---	Glorieta	
WELCH-San Andres Dawson, Texas	1941 5000'	17,500	44.2	.110	4.6	.68 1.11	.173	33-38	2.32	depletion	508,813 (491,796.4)	109,507.0	Yes WF/SW, FW	1955-1968 ICP	---	No gas cap. 14e-suitable for CO_2.

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
MIDLAND BASIN
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
KETCHUM MT.-Clear Fork, Irion, Texas	1955 / 4548'	2,800	12	.13	13	.432 / 1.48	.30	36.4-38.5	---	depletion	16,386 (16,027.6)	2,381.1	Yes WF/SW, BW PM/Gas	1963-1975 1SRP-ICP 2SRP-IPD	---	---
REVILO-Glorieta, Scurry, Texas	1955 / 2600'	6,430	10	.140	3	.18 / 1.16	---	34	---	---	26,800 (48,163.8)	11,220.0	Yes WF/SW, FW	1965 ICP	Clear Fork	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
MIDLAND BASIN
PERMIAN-WOLFCAMP (319)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ADAIR-Wolfcamp Reef Terry-Gaines, Texas	1950 8500'	2,550	60	.124	28	.52 1.264	.245	43	---	water drive	101,500+ (87,914.9)	45,566.0	Yes WF/BW, FW	1956 BW-ICP FW-INS	San Andres	Fracture porosity
BAKKE-Wolfcamp, Andrews, Texas	1956 8500'	5,370	23	.115	40	--- ---	---	40.4	---	depletion	76,606+ (67,810.4)	18,030.8	Yes WF/SW, FW	1970 ICP		
FASKEN-Wolfcamp, Andrews, Texas	1952 8571'	560	25	.06	36	--- 1.42		39	---	depletion	----- (3,671.4)	5,807.6	No		Strawn Penn Ellenburg. Devonian Clear Fk.	
NOLLEY-Wolfcamp, Andrews, Texas	1951 9227'	4,476	59.75	.07	20	--- 1.22	.20	36-39.2	---	depletion	77,025 (95,237.1)	20,942.5	Yes WF/SW, FW	1970-1979 ICP	Canyon Clear Fk. Devonian Ellenburg Penn Witchita-Albany Queen	
WELLMAN-Wolfcamp Reef, Terry, Texas	1950 9712'	1,200	350 PDS (175)	.075	231	--- 1.39	---	41-44	---	water drive	---- (70,324.3)	44,709.9	No	---	Fusselman	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
MIDLAND BASIN
PENNSYLVANIAN-CISCO (322)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
REINECKE-Cisco, Borden, Texas	1950 / 6791'	2,800	90	.093	20	.57 / 1.795	.20	43.5-46.4	---	water drive	165,813 (81,032.4)	63,317.5	Yes PM & WF/SW	1950-1972 IRPE IPD	Clear Fork Wolfcamp	No gas cap
VEALMOOR, EAST-Cisco-Wolfcamp Reef Howard, Texas	1950 / 6960'	3,600	100 (50)	.102	267	--- / ---	---	40-46	---	------	----- (87,653.5)	19.2	No	---	Clear Fork	

PERMIAN BASIN
MIDLAND BASIN
PENNSYLVANIAN-CANYON (323)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ROPES-Canyon Reef Hockley, Texas	1950 / 9290'	1,803	100	.085	66	--- / 1.319	.24	41-42	---	depletion	---- (68,506.7)	22,272.8	Yes PM/SW, BW, FW	1959-1963 ICP	Leonard	
VEALMOOR-Canyon Reef, Howard, Texas	1948 / 7934'	280?	75-11-206	.10	32	--- / 1.695	.293	46	---	water drive	---- (6,795.5) (18,664.9)	33,749.8	No	---	Cisco	
VEALMOOR, EAST-Canyon Reef, Borden & Howard, Texas	1950 / 7414'	3,500	30	.15	102	.199 / 1.804	.163	47	---	water drive	2,858 (1 SRP) (56,691.7)	49,007.6	Yes WF/SW	1970-1975 ICP	Clear Fork Wolfcamp	
VON ROEDER-Canyon Reef, Borden, Texas	1959 / 6835'	1,730	45	.10	19	.60 / 1.653	.36	38.8-46	---	depletion	21,593 (23,383.8)	15,823.6	Yes PM/SW	1972 ICP	Clear Fork Wolfcamp	No gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
MIDLAND BASIN
PENNSYLVANIAN-STRAWN (325)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
AZALEA-Strawn, Midland, Texas	1966 / 10320'	8,000	up to 160	.08	7	--- / ---	---	58-60	---	depletion	---- (30,554.6)	49.0	---	---	Grayburg Devonian	
FLUVANNA-Strawn, Borden, Texas	1949 / 7769'	3,840	11?	.094	62	--- / 1.434	---	41.5-42	---	water drive & depletion	84,900 (17,184.7)	11,940.2	Yes PM/SW, Gas	1976 ICP	Ellenburg. Leonard Miss.	

PERMIAN BASIN
MIDLAND BASIN
PENNSYLVANIAN-BEND (326)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
AMACKER-TIPPET, S. Bend, Upton, Texas	1961 / 8596'	4,300	41	.06	10	--- / 2.4?	.33	52.5	---	depletion	---- (22,909.6)	6,116.5	----	----	Devonian Strawn Wolfcamp	
OCEANIC-Penn, Howard, Texas	1953 / 8140'	1,880	55	.12	84	--- / 1.52	.18	42.3	---	depletion	---- (51,930.4)	20,115.9	No	---		
PARKS-Penn Midland, Texas	1950 / 10500'	7,130	14	.067	3	--- / 2.067	.33	43-45	---	depletion	24,792 (16,818.1)	13,071.2	Yes MD/SW, FW MD/Gas, LPG	1955-1958 WF-IPD Gas-IPD MD-ICP	Devonian Ellenburg. Sprayberry Wolfcamp	No gas cap
PEGASUS-Bend, Upton/Midland, Texas	1951 / 10470'	10,000	28.5	.067	9	--- / 2.01	.33	44	---	depletion	39,744 (49,379.7)	14,287.9	Yes PM/SW, FW	1955 ICP	San Andres Sprayberry Ellenburg. Devonian Fusselman	No gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
MIDLAND BASIN
DEVONIAN (340)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
AZALEA-Devonian, Midland, Texas	1957 / 11520'	36,000	63	.04	6.3	--- / ---	.40	47-56	---	depletion	---- (324,833.4)	381.5 state designated gas field			Grayburg Strawn	Gas cap fractured
BREEDLOVE-Devonian Martin, Texas	1951 / 12078'	3,520	46	.09	62	--- / 1.09	.55	40.8-41.3	---	water drive	---- (46,674.4)	26,092.0	No	---	Strawn Wolfcamp	No gas cap
DORA ROBERTS-Devonian, Midland, Texas	1955 / 12010'	7,000	124? (62)	.066	1	--- / ---	---	45-53	---	----	92,000 (136,750.9)	1,928.8	Yes PM/Gas	1961 ICP	Penn Strawn Fusselman Ellenburg.	Gas reservoir
HUTEX-Devonian, Andrews, Texas	1953 / 12509'	4,480	60	.055	44	--- / ---	.34	34-44	---	depletion & water drive	---- (58,229.4)	33,687.4	No	---	Bend Canyon Dean	
MAGUTEX-Devonian, Andrews, Texas	1953 / 12504'	5,760	40	.065	41	--- / 1.41	.20	43.2-46	---	water drive	---- (65,919.9)	38,833.0	No	---	Queen SS Ellenburg. Miss Strawn Wolfcamp	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
MIDLAND BASIN
SILURIAN (350)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BIG SPRINGS-Fusselman, Howard, Texas	1955 9590'	1,840	14	.119	4.7	--- 1.5	.30	49	---	depletion	--- (11,098.2)	5,807.5	No	---	Strawn Canyon Lm	
GOOD, S.E.-Fusselman, Borden, Texas	1958 9692'	3,800	30	.055	78	--- 1.37	.35	43	---	water drive	---- (23,078.6)	8,293.2	No	---	Canyon Reef	
LUTHER, SE-Silurian Devonian, Howard, Texas	1953 9855'	3,600	25	.127	16	.59 1.63	.30	43.5	---	depletion	---- (38,080.8)	18,346.4	Yes PM/SW	1969 ICP		
TEX-HAMON - Fusselman, Dawson, Texas	1962 11574'	1,200	52	.070	25.3	.65 1.045	.35	40.2	---	water drive	---- (21,078.0)	14,999.9	No		Canyon Rf. Dean Miss Strawn	

PERMIAN BASIN
MIDLAND BASIN
ORDOVICIAN (360)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
DORA ROBERTS - Ellenburger, Midland, Texas	1954 12835'	4,062	204	.024	214	--- ---	---	52	---	---	145,000 (94,946.2)	47,349.6	Yes PM/SW, FW Gas	6-68 ICP	Devonian Fusselman Strawn Penn	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
REAGAN UPLIFT IN MIDLAND BASIN
GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BIG LAKE-Grayburg San Andres, Reagan Texas	1923 3000'	6,400+	30	.17	20	--- ---	---	40	1.5	depletion & water drive	---- (155,828.4)	125,388.1	No	---	Ellenburg. Fusselman	14e- not suitable for CO_2
FARMER-San Andres, Crockett, Texas	1953 2240'	5,700?	40	.12	5	.50 1.2	.218	30.4-33	---	----	---- (138,322.1)	7,789.6	Yes WF/SW	1967 ICP	---	---
HALFF-Grayburg, Crockett, Texas	1951 2000'	2,900	20	.158	1	.48 .06	.43	31-32	---	depletion	29,000 (38,230.0)	3,007.6	Yes WF.SW, BW	1966 ICP	---	

PERMIAN BASIN
REAGAN UPLIFT IN MIDLAND BASIN
PENNSYLVANIAN-STRAWN (323)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
TODD DEEP-Crinold Strawn, Crockett, Texas	1940 5778'	1,894	80	.117	4	--- 1.328	.19	40-41	---	depletion	117,500 (83,886.6)	29,437.3	Yes PM/SW	1950 ICP	Ellenburg. Canyon	
WORLD, WEST-Strawn Crockett, Texas	1954 8190'	2,940	33	.092	10	--- 2.618 ?	.20	41.1-46.6	---	depletion	15,500 (21,160.2)	8,103.4	Yes PM/SW Gas	1955-1968 ICP	Grayburg	No gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
REAGAN UPLIFT IN MIDLAND BASIN
ORDOVICIAN (360)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BARNHART-Ellen-burger, Reagan, Texas	1941 9000'	9,600	78	.032	6	--- ---	.20	44.2	---	depletion & water drive	---- (114,396.4)	15,856.9	Yes WF/SW	1967 IPD	Canyon Wolfcamp Grayburg	Fractured
ELKHORN-Ellenburger Crockett, Texas	1951 7185'	2,700	51-232	.024	22	--- 1.412	.355	37-39.7	---	water drive & depletion	---- (22,964.1)	11,368.1	No	---	No	Vuggy & fractured porosity
TODD DEEP- Ellen-burger, Crockett, Texas	1940 6232'	2,600	154	.09	5	--- 1.32	.342	40	---	water drive	---- (139,360.1)	40,258.1	No	---	Crinoidal Strawn	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
EASTERN SHELF
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
GARZA-San Andres Garza, Texas	1926 2900'	9,750	54	.20	8	.45 1.3	.54	35-37	---	depletion	337,093 (289,063.1)	67,099.2	Yes WF/SW, FW, BW	1967-1976 ICP	Glorieta	
HOWARD-Glasscock, Grayburg, San Andr Howard-Glassock, Texas	1925 2066'	21,160	76	.122	24.5	--- ---	.40	26-32	12.8	depletion & partial water drive	337,789 (702,500.7)	325,221.5	Yes WF/SW, FW	1961-1975 ICP	Clear Fork Glorieta Wolfcamp	
HUNTLEY-"3400"-Garza, Texas	1954 3400'	--- (640)	--- (7)	--- (.16)	---	.70 1.1	.20	37	---	---	---- (4,044.3)	6,570.5	No	---	---	
	Listed	by PDS,	using	initial	criteria											
HUNTLEY, EAST-San Andres, Garza, Texas	1956 3180'	850	26	.16	5	.48 1.15	.46	33-34.4	---	---	---- (14,312.5)	4,159.9	Yes WF/BW	1974 ICP	---	
HUNTLEY-Glorieta, Garza, Texas	1954 3966'	no data (640)	7	.16	81	--- ---	---	37.2	---	---	---- (3,422.1)	6,340.5	No	---		
P.H.D.-Glorieta, Garza, Texas	1944 3565'	2,720	30	.136	25	.549 1.2	.331	35.5-38.1	---	depletion	---- (47,998.6)	5,406.9	Yes WF/SW	1966 ICP	San Andres	
ROCKER A - Glorieta Garza, Texas	1955 3082'	1,120	40	.132	4.6	.385 1.16	.615	34-38	---	depletion	---- (15,226.7)	2,153.6	No	---	San Andres Clear Fork Ellenburg.	
ROCKER A-San Andres Garza, Texas	1950 2485'	2,375	15	.247	4	.17 1.14	.45	34-37	---	----	9,748 (32,935.1)	4,118.3	Yes WF/SW	1967 ICP	Glorieta Clear Fork Ellenburg.	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
EASTERN SHELF
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
IATAN, EAST-Clear Fork, Howard, Texas	1925 / 2700'	17,000	63	.12	2.5	--- / ---	---	28-32	2.3	---	272,210 (613,574.3)	107,268.7	Yes WF/SW, FW, BW	1952-1972 ICP	No	14e- CO_2 candidate
PAROCHIAL BADE-Clear Fork, Sterling, Texas	1954 / 2250'	1,080	20	.163	99	--- / ---	---	28-30	---	---	25 (16,808.8)	2,792.1	Yes WF/SW	1964 ICP	Cisco Fusselman Queen SS San Andres	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
EASTERN SHELF
PENNSYLVANIAN-CISCO (322)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
I.A.B.-Menielle, Coke, Texas	1957 5250'	4,903	45	.056	31	--- 1.825 ?	.25	44.4	---	depletion	47,683 (39,392.2)	17,596.8	Yes PM/SW, FW, BW	1962-1969 ICP	Harris SS Penn	
INBE-Cisco, Lea, New Mexico	1962 9858'	4,000	27	.06	104	.38 ---	---	44-47	---	water drive	---- (30,933.5)	16,040.8	No	---		Fracture porosity
JAMESON-Penn Reef, Coke, Texas	1946 6600'	6,000	71	.083	2	--- ---	---	46	---	---	112,750 (168,804.5)	39,778.5	Yes WF/SW, BW	1952-1963 ICP	Caddo Strawn	
SUSAN PEAK-Cisco Canyon, Tom Green, Texas	1948 4600'	2,240	43	.14	7	--- 1.41	.20	36-42	---	water drive	6,000 (59,356.1)	1,762.4	Yes WF/SW	1962 ICP	Susan Peak Shallow Upper Strawn	Gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
EASTERN SHELF
PENNSYLVANIAN-CANYON (323)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
CLAYTONVILLE-Canyon, Reef, Fisher, Texas	1952 5695'	3,360	19	.07?	9	--- ---?	.20	40-43	---	depletion	44,000 (21,334.7)	57,817.8	Yes PM/SW, FW & Gas	1960-1969 FW,SW-ICP Gas-IPD		
COGDELL AREA - Canyon Reef, Kent & Scurry, Texas	1949 6796'	15,050	40	.10	18	--- ---	.35	41.7-43	.44	depletion	---- (233,515.8)	232,033.0	Yes PM/SW, FW & Gas; WF/SW	1953-1956 ICP-SW,FW IPD-Gas	Strawn Wolfcamp	14e-polymer & CO_2.
DIAMOND M-Canyon Lime, Scurry, Texas	1948 6569'	13,712	96	.10	44	.72 1.53	.28	42-44	.46	depletion water drive	516,000 (480,756.9)	216,080.2	Yes PM/SW, FW BW	1950-1970 ICP		14e - not suitable for CO_2.
KELLY-SNYDER-Canyon Reef, Scurry, Texas	1948 6795'	52,925	139	.079	31	.61 1.51	.28	41-43	.40	depletion	2,123,000 2,149,849.6)	1,020,651.0	Yes PM & MD/ SW, FW,BW, & CO_2	1954-1976 ICP	Cisco SS Clear Fork Wichita-Albany	14e - 17, CO_2 pilot project
OCHO JUAN-Canyon Reef, Fisher, Texas	1955 6600'	1,160	45	.06	4	--- ---	.45	40-42.6	---	---	12,000 (10,279.9)	5,015.5	Yes WF/SW, FW	1965 ICP	Strawn	
ROUNDTOP-Palo Pinto Reef, Fisher, Texas	1947 4758'	3,121	55	.107	6	--- 1.4	.25	40.5-42	---	depletion & partial water drive	115,832 (76,334.9)	38,390.3	Yes PM/SW, Gas	1971 ICP	Canyon Flippen Noodle Creek Swastika	
SALT CREEK-Canyon Reef, Kent, Texas	1950 6200'	9,269	180	.09	11	.60 1.291	.29	39.2-40	.79	depletion	500,000 (642,529.4)	178,420.5	Yes PM/SW, BW	1952 ICP	Strawn	14e-suitable for CO_2

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
EASTERN SHELF
PENNSYLVANIAN-STRAWN (325)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
CLAIRMONT-Strawn, Kent, Texas	1950 6700'	5,900	23	.07	5	--- 1.33	.39	39	---	water drive	15,500 (33,799.2)	13,512.4	Yes PM/SW	1961 ICP	No	
FORT CHADBOURNE-Odom Lime, Coke, Runnels, Texas	1949 5600'	15,170	42	.05	35	--- ---	---	44-45	---	depletion	98,000 (152,090.2)	52,299.7	Yes PM/SW, Gas	1953-1954 SW-ICP Gas-IPD	Canyon Cook Gardner Gray Moors	
H-J - Strawn Reef, Tom Green (M), Texas	1954 5502'	3,500	30	.01 PDS (.07)	139	--- 1.35	.28	41	---	water drive	---- (30,411.4)	20,995.6	No	---		
JAMESON-Strawn Coke, Texas	1949 5745'	10,535	57	.116?	2.5	--- ---	---	47.8	---	---	41,755 (332,555.2)	35,798.2	Yes WF/SW, BW	1960-1965 ICP	Caddo	
NEILL, SOUTH-Odom Lime, Fisher, Texas	1955 5700'	8.975	12	.08	22	--- ---	---	44	---	depletion	---- (41,134.1)	6,988.1	Yes PM/SW	---- IPD-1974		
NENA LUCIA-Strawn Reef, Nolan, Texas	1955 6884'	14,650	52.5	.07	5	--- ---	.35	45-46.2	---	depletion & water drive	119,146 (208,840.5)	30,689.2	Yes PM/SW, FW, Gas	1962-1963 WF-ICP Gas-ITD	Caddo Ellenburger Odom Lime Wolfcamp	
PAGE-Strawn & Canyon Reef, Schleicher, Texas	1936 5725'	1,960	47	.075	5.3	.476 ---	---	37-42	---	depletion	25,022 (32,984.6)	4,804.2	Yes PM/SW	1961 ICP	---	Gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
EASTERN SHELF
PENNSYLVANIAN-BEND (326)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BOYD-Bend Conglomerate, Stonewall, Texas	1951 / 6000'	2,761	27	.147	17	--- / ---	---	40	---	depletion	40,115 (52,317.1)	21,970.0	Yes WF/SW	1975 ICP	Canyon Reef Ellenburger	Gas cap

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
NORTH BASIN PLATFORM
PERMIAN-GUADALUPE (313) AND LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BRAHANEY-San Andres Yoakum, Texas	1945 5300'	15,000	35	.08	2	.75 1.22	.25	32	---	---	158,156 (200,309.0)	30,686.2	Yes WF/SW, FW	1968 ICP	Devonian Miss. Wolfcamp	No gas cap
BUCKSHOT-San Andres Cochran, Texas	1956 5000'	12,800	22	.085	8	.41-.58 1.247	.248	21-31	---	---	47,261 (111,983.2)	9,421.0	Yes WF/SW, FW	1967 ICP		
LANDON-San Andres Yoakum, Texas	1945 5100'	1,440	50	.12	15	.82 ---	---	30-32	---	depletion	---- (41,248.7)	5,525.3	Yes WF/SW, BW	1962-1968 ICP	Bend Devonian Strawn	
LEVELLAND-San Andres, Cochran, Hockley, Texas	1945 4927'	90,000	40.6	.110	2.3	.664 1.209	.336	28.5-32.9	1.728	depletion	892,074 (1,712,587.5)	312,239.7	Yes WF/SW, FW PM/Gas, CO_2	1961-1977 ICP	Abo, Cisco, Clear Fork Strawn Wichita-Albany	CO_2 pilot project
OWNBY-San Andres Yoakum, Texas	1941 5300'	2,400	31	.12	3.5	.48 1.354	.38	30-36	---	depletion & water drive	48,300 (31,715.9)	8,612.4	Yes WF/SW, FW	1973-1977 ICP	Clear Fork Glorieta Wichita-Albany	Gas cap
RUSSELL-Glorieta, Gaines, Texas	1942 6100'	1,800	40	--- (.05)	---	--- 1.294	.184	34.2	---	---	---- (17,612.0)	6,290.2	No	---	Clear Fork San Andres Wichita-Albany	
SABLE-San Andres Yoakum, Texas	1957 5258'	1,200	39	.092	2	.50 1.2	.35	30.6-31.7	---	---	15,486 (18,093.2)	5,644.6	Yes WF/SW, FW	1967 ICP	Devonian Miss.	
SLAUGHTER-San Andres, Hockley, Cochran, Texas	1937 5000'	100,000	47.8	.098	11	.494 1.23	.30	27.5-32	1.38	depletion	1,115,809 (2,068,219.7)	797,157.9	Yes WF/SW, FW CO_2	1961-1973 ICP	Abo Clear Fork Wolfcamp	"Estate unit 4984" is CO_2 pilot project. No gas cap.

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
NORTH BASIN PLATFORM
PERMIAN-GUADALUPE (313) AND LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
WASSON-San Andres Yoakum/Gaines, Texas	1937 4900'	63,500	160	.095	4	.31 1.312	.26	30-34	1.1	depletion	3,262,483 (4,223,426.8)[5]	1,190,937	Yes WF/SW, FW CO_2 Pilot	1964-1965 ICP	Glorieta Penn. Wichita-Albany Wolfcamp	14e-suitable for CO_2
RUSSELL-Clear Fork, Gaines, Texas	1942 7350'	9,700	75	.052	1	--- 1.279	.238	34-37	---	---	206,037 (174,851.9)[5]	42,272.2	Yes WF/SW, FW	1971 ICP	San Andres Glorieta Wichita-Albany	
WASSON 72 - Clear Fork, Gaines, Texas	1941 7200'	8,320 480	74	--- 'low' (.05)	--- 'low'	.65 1.3	.24	31	---	---	---- (139,619.2) (8,055)[5]	35,192.2	No record	----	San Andres Clear Fork 66 and Clear Fork Bennett	No gas cap. See Wasson San Andres

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
NORTH BASIN PLATFORM
DEVONIAN (340)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
RUSSELL, NORTH-Devonian, Gaines, Texas	1948 / 11125'	1,322	65	.061	141	.715 / 1.08	.131	38.1-41.6	---	water drive	---- (32,720.6)	72,708.7	Yes PM/SW	11-72 IPD	Glorieta Clear Fork	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
TATUM BASIN
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
CAPROCK-Queen SS Chaves & Lea, New Mexico	1940 2871'	29,360	9.9	.21	200	.14 ---	.35	36-40	---	depletion	---- (127,492.6)	72,135.0	Yes?	---	Queen is not a carbonate	---
CHAVEROO-San Andres Chaves & Roosevelt, New Mexico	1965 4184'	11,000	40	.06	7	.16 ---	.25	26	---	depletion	---- (118,160.3)	19,519.0	Yes?	---	---	---
FLYING M-San Andres Lea, New Mexico	1964 4550'	3,000	15	.129	7.5	--- ---	.25	19.3-26	---	depletion	---- (25,981.8)	6,505.0	Yes?	---	---	---
LOVINGTON-San And. New Mexico	1939 4600'	7,040	40	--- (.06)	---	--- ---	---	33	---	water drive	---- (80,664.1)	12,270.0	Yes?	---	Paddock Abo Devonian	13c - recommended for CO_2 and polymer
MILNESAND-San Andres, Roosevelt, New Mexico	1958 4554'	5,880	40	.06	4	.137 ---	.60	28-30	---	depletion & water drive	---- (33,686.4)	8,782.0	Yes?	---	---	13c - recommended for polymer flood

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
TATUM BASIN
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
LOVINGTON-Paddock Lea, New Mexico	1952 6150'	4,480+	25	--- (.06)	---	--- ---	---	33	---	water drive	--- (32,082.3)	12,692.0	Yes?	---	San Andres Abo Devonian	13c - recommended for CO_2 and polymer
LOVINGTON-Abo Lea, New Mexico	1951 8117'	1,280	125	.08	med.	--- ---	---	39	---	water drive	---- (61,109.2)	29,648.0	No	---	San Andres Paddock Devonian	13c- recommended for CO_2 and polymer

PERMIAN BASIN
TATUM BASIN
PERMIAN-WOLFCAMP (319)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
DENTON-Wolfcamp Lea, New Mexico	1950 9150'	4,140	50	.098	9.8	.58 ---	.20	45.3	---	depletion	---- (96,848.5)	34,852.0	Yes?	---	Devonian	
TOWNSEND-Wolfcamp Lea, New Mexico	1952 10400'	2,480	29	.089	38	--- 1.851	---	40	---	depletion	---- (21,473.7)	18,786.0	Yes PM/Gas	---	---	---

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
TATUM BASIN
PENNSYLVANIAN (320)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ALLISON-Penn. Bough "C", Lea & Roosevelt, New Mexico	1954	12,175	10.5	.06-.09 (.07)	200	.10 ---	.358	47-49	---	water drive	---- (34,284.5)	21,291.0	No	---	---	---
VADA-Pennsylvanian Lea & Roosevelt, New Mexico	1966 9792'	56,320	10	.08	100	.10 ---	.33	45-47	---	water drive & depletion	---- (180,149.8)	40,942.0	No	---	---	---

PERMIAN BASIN
TATUM BASIN
PENNSYLVANIAN-CISCO (322)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
INBE-Cisco, Lea, New Mexico	1962 9658'	4,000	11	.06	104	.38 ---	---	44-47	---	water drive	---- (12,603.8)	16,040.0	No	---	---	Fracture porosity

PERMIAN BASIN
TATUM BASIN
DEVONIAN (340)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
CAPROCK EAST-Devonian, Lea, New Mexico	1951 11240'	1,920	30	F (.05)	---	--- ---	---	43	---	water drive	---- (13,749.7)	22,311.0	---	---	---	Fractured, but recommended for EOR in GURC 153.
DENTON-Devonian, Lea, New Mexico	1949 11950'	4,560	300?	.08	9.6	--- ---	---	45	7	water drive	---- (522,483.4)	92,722.0	---	---	---	No gas cap
LOVINGTON-Devonian Lea, New Mexico	1968 11476'	--- (640)	44	---- (.05)	44	--- ---	---	49	---	---	---- (6,722.0)	1,227.0	---	---	San Andres Paddock Abo	13c - recommended for CO_2 and polymer

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
NORTHWEST SHELF
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ARTESIA-San Andres Grayburg, Eddy, New Mexico	1923 1875'	17,760	25	.21	90	.30 ---	.20	36	---	depletion	---- (445,142.1)	24,572.0	Yes	---	---	---
BENSON, NORTH-Queen, Grayburg, Eddy, New Mexico	1954 2488'	1,760	24	.13	5	.17 ---	.42	32	---	water drive & depletion	---- (19,006.5)	2,360.0	Yes	---	---	---
CATO-San Andres, Chaves, New Mexico	1966 3450'	9,140	30	.075	5-40	.11 ---	.34	25-27	---	depletion & water drive	---- (81,885.1)	14,472.0	Yes	---	---	Fracture porosity
E-K - Yates/Seven Rivers, Queen, Lea, New Mexico	1954 4375'	640	60	.124	31	.13 ---	.392	37.5	---	depletion	---- (17,276.8)	5,636.0	Yes	---	Not a carbonate reservoir but listed by PDS sort	
LOCO HILLS-Grayburg San Andres, Eddy, New Mexico	1939 8900'	11,960	65	.20	49.9	.80 ---	.15	36.5	---	depletion	---- (784,721.7)	43,103.0	Yes?	---	Yates	
LOVINGTON, WEST-San Andres, Lea, New Mexico	1944 4700'	3,200	50	--- (.05)	---	--- ---	---	36	---	water drive	---- (38,193.2)	10,759.0	Yes?	---	---	13c -suitable for CO_2 and polymer
MALJAMAR-Grayburg San Andres, Lea & Eddy, New Mexico	1926 4050'	2,300	450 all zones	.116	47	.20 ---	.166	37	8	depletion	---- (597,545.3)	121,282.0	Yes CO_2	---	---	14e - CO_2 pilot project
PEARL-San Andres Lea, New Mexico	1967 5320'	no data (640)	--- (10)	--- (.05)	---	--- ---	---	35	---	----	---- (1,527.8)	62.0	---			13c - recommended for surfactant and CO_2 in GURC-153.

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
NORTHWEST SHELF
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
SQUARE LAKE-Grayburg, San Andres, Eddy, New Mexico	1941 / 2700'	12,880	15	.021	110	--- / ---	---	38.7	---	depletion	--- (19,369.7)	23,146.0	Yes?	?	---	Insufficient data
VACUUM-San Andres Lea, New Mexico	1929 / 4400'	19,200	95	.0875	404.5	.314 / 1.25	.290	35-40	20	water drive & depletion	---- (703,284.4)	180,997.0	Yes?	---	---	No gas cap. 14e - list as suitable for CO_2 EOR.

PERMIAN BASIN
NORTHWEST SHELF
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
CORBIN-Abo, Lea, New Mexico	1959 / 8400'	8,400	70	--- (.015)	---	.10 / ---	.30	37.8	---	depletion & water drive	---- (36,844.5)	13,052.0	---	---	---	---
EMPIRE-Abo, Eddy, New Mexico	1958 / 6022'	9,600+	16	.015-.183	985?	.40 / ---	.25	43-44	2.2	depletion & water drive	---- (125,808.5)	185,351.0	Yes?	---	---	13c-suitable for CO_2. 14e- not suitable for CO_2 due to water drive & fractured

PERMIAN BASIN
NORTHWEST SHELF
PERMIAN-WOLFCAMP (319)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
KEMITZ-Lower Wolfcamp, Lea, New Mexico	1956 / 10700'	1,320	38	.093	8.8	.73 / 1.8	.25	39	---	depletion	---- (15,079.2)	14,943.0	Yes?	---	---	---

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
NORTHWEST SHELF
PENNSYLVANIAN-STRAWN (325)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
LUSK-Strawn, Eddy & Lea, New Mexico	1960 / 11168'	10,240	38	.05	21.6	.412 / ---	.304	46	---	depletion	---- (80,810.8)	18,916.0	---	---	---	---

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
DELAWARE BASIN
PERMIAN-OCHOA (311)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
FORT STOCKTON-Yates, Pecos, Texas	1944 / 2892'	11,500?	37.5	.175	37	--- / 1.2	---	33-36	---	depletion	29,093 (562,067.1)	25,742.1	Yes WF/SW, BW	1961-1977 ICP	Seven Riv. Tansill	
Yates is primarily a sandstone reservoir with minor anhydritic sands and dolomite. Listed by PDS as dolomite.																

PERMIAN BASIN
DELAWARE BASIN
PERMIAN-GUADALUPE (313)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
PRIEST & BEAVERS-Queen SS, Pecos, Texas	1957 / 2290'	1,900	30	.145	22	.58 / 1.1	.42	31.4	---	depletion	---- (33,808.7)	1,932.9	Yes WF/SW	1966 ICP	---	
Sandstone pay with dolomite separating upper and lower pay zone.																

PERMIAN BASIN
DELAWARE BASIN
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
FOWLER-Upper Yeso, Lea, New Mexico	1950 / 6200'	1,200	75	.015	5	.20 / ---	.40	38-42	---	depletion	--- (4,833.8)	3,355	---	---		

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7

PERMIAN BASIN
BEND ARCH
PENNSYLVANIAN-CANYON (323)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
BOX-Palo Pinto Reef Callahan, Texas	1952 / 3300'	1,143	22	.13	150	--- / ---	---	40-42	---	water drive	11,844 (15,606.6)	6,174.5	Yes WF/SW	1967 IPD-72	---	Fracture porosity

PERMIAN BASIN
BEND ARCH
MISSISSIPPIAN (330)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
SHACKELFORD, N.E.-Mississippian, Shackelford, Texas	1960 / 4592'	10,000	100	.06	5	--- / ---	---	42-43	---	depletion	---- (286,449.2)	3,652.4	No	---	---	Insufficient data

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
MATADOR UPLIFT
PERMIAN-LEONARD (318)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
ANTON-IRISH - Clear Fork, Hale, Texas	1945	9,000	141	.085	7-16	--- / ---	---	29	---	solution gas	---- (514,964.1)	123,512.0	WF/SW, FW, Gas	1952-1969 SW,FW-ICP Gas-IPD		13c-polymer & CO_2

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

TABLE 7
PERMIAN BASIN
ANADARKO BASIN
PERMIAN-WOLFCAMP (319)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
QUINDUNO-Albany, Roberts, Texas	1952 / 4008'	no data (640)	25	.15	18	--- / 1.5	.35	47.6	---	depletion	---- (4,344.5)	14,797.4	No	---	LeCompton Penn Toronto	

PERMIAN BASIN
ANADARKO BASIN
PENNSYLVANIAN (320)

FIELD, COUNTY, STATE	DISC. DATE / DEPTH	PROVED ACREAGE	NET PAY (ft.)	AVG. POR. (dec.)	AVG. PERM (md)	S_o[1] / B_o	S_w[1]	OIL GRAV. °API	OIL VISC. (cp)	PRIMARY[2] DRIVE MECHANISM	EST. ORIG[3] OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	SECONDARY[4] RECOVERY?/ TYPE	YR BEGAN/[4] STATUS	ADDITIONAL RESERVOIRS	FRACTURED? GAS CAP? EOR CANDIDATE
HITCHLAND-4640, Collier, Hansford, Texas	1954 / 4640'	13,110	8	.09?	100	---	--- / 1.33	43-44.7	---	water drive	3,220 1SRP (44,047.7)	3,499.5	Yes WF/SW, FW	1969 ICP	---	Gas cap
TWIN-DesMoines, Hansford, Texas	1956 / 6135'	---- (640)	38	.06	7	--- / ---	---	41.8	---	depletion	---- (6,966.5)	7,791.8	No	---	Cherokee Morrow	Gas cap
TWIN-Morrow Hansford, Texas	1954 / 7082'	700	25	.145	47	--- / ---	---	39.5-40.2	---	---	6,000 (12,144.4)	2,660.8	Yes PM/Gas	1968 Gas-IPD	Cherokee DesMoines	

[1]Abbreviations: S_o = oil saturation; S_w = water saturation; B_o = formation volume factor (see footnote 3).

[2]For drive mechanism description, the term depletion is used instead of solution gas, dissolved gas, gas expansion, or volumetric drive.

[3]First number is the summation of estimates for individual secondary recovery projects given in data source 2. Second number (in parentheses) is calculated using the equation $N = [7758(Ah\phi)(1 - S_w)]/B_o$, where A = acreage, h = net pay, ϕ = porosity, S_w = water saturation, and B_o = formation volume factor. Where data were not available, S_w = 0.20 and B_o = 1.3 were used.

[4]Abbreviations: WF = waterflood; SW = salt water; BW = brackish water; FW = fresh water; PM = pressure maintenance; ICP = injection currently in progress; ITD = injection temporarily discontinued; IPD = injection permanently discontinued.

[5]Number in parentheses is probable minimum value used by Gruy for oil-in-place calculations.

(Average Temperature Increase, °F per 100 Feet of Depth)

Anderson	2.0
Andrews	0.7
Angelina	2.0
Aransas	1.6
Archer	1.4
Armstrong	1.0
Atascosa	2.0
Austin	1.9
Bailey	1.0
Bandera	2.0
Bastrop	2.5
Baylor	1.0
Bee	2.0
Bell	2.0
Bexar	2.0
Blanco	2.0
Borden	0.85
Bosque	2.0
Bowie	2.0
Brazoria	1.6
Brazos	2.3
Brewster	0.8
Briscoe	1.0
Brooks	1.9
Brown	1.8
Burleson	2.4
Burnet	2.0
Caldwell	2.0
Calhoun	1.6
Callahan	1.6
Cameron	1.6
Camp	1.9
Carson	1.0
Cass	1.8
Castro	1.0
Chambers	1.7
Cherokee	2.2
Childress	1.0
Clay	1.3
Cochran	0.6
Coke	1.15
Coleman	1.6
Collin	2.0
Collingsworth	1.0
Colorado	2.0
Comal	2.0
Comanche	1.8
Concho	1.4
Cooke	1.0
Coryell	1.8
Cottle	1.0
Crane	0.8
Crockett	1.0
Crosby	1.0
Culberson	0.8
Dallam	1.0
Dallas	2.0
Dawson	0.6
Deaf Smith	1.0
Delta	2.4
Denton	1.2
DeWitt	2.2
Dickens	0.9
Dimmit	2.0
Donley	1.0
Duval	2.35
Eastland	1.9
Ector	0.9
Edwards	1.8
Ellis	2.0
El Paso	0.8
Erath	1.8
Falls	2.0
Fannin	0.9
Fayette	2.2
Fisher	1.2
Floyd	1.0
Foard	0.8
Fort Bend	1.7
Franklin	2.0
Freestone	2.2
Frio	2.0
Gaines	0.6
Galveston	1.6
Garza	0.95
Gillespie	2.0
Glasscock	0.95
Goliad	1.9
Gonzales	2.4
Gray	1.0
Grayson	0.95
Gregg	2.0
Grimes	2.3
Guadalupe	2.0
Hale	1.0
Hall	1.0
Hamilton	1.8
Hansford	1.1
Hardeman	1.0
Hardin	2.2
Harris	1.8
Harrison	2.1
Hartley	1.0
Haskell	1.3
Hays	2.0
Hemphill	1.0
Henderson	2.0
Hidalgo	1.95
Hill	2.0
Hockley	0.7
Hood	1.8
Hopkins	2.0
Houston	2.0
Howard	0.95
Hudspeth	1.0
Hunt	2.0
Hutchinson	0.9
Irion	1.05
Jack	1.4
Jackson	1.9
Jasper	2.2
Jeff Davis	0.8
Jefferson	2.0
Jim Hogg	2.4
Jim Wells	1.9
Johnson	2.0
Jones	1.4
Karnes	2.3
Kaufman	2.4
Kendall	2.0
Kenedy	1.6
Kent	0.8
Kerr	2.0
Kimble	1:8
King	0.8
Kinney	2.0
Kleberg	1.8
Knox	0.8
Lamar	2.4
Lamb	1.0
Lampasas	1.8
La Salle	2.0
Lavaca	2.1
Lee	2.4
Leon	2.2
Liberty	2.0
Limestone	2.5
Lipscomb	1.0
Live Oak	2.3
Llano	2.0
Loving	0.5
Lubbock	1.0
McCulloch	1.8
McLennan	2.0
McMullen	2.0
Madison	2.4
Marion	1.9
Martin	1.0
Mason	1.8
Matagorda	1.6
Maverick	2.0
Medina	2.0
Menard	1.8
Midland	0.9
Milam	2.0
Mills	1.8
Mitchell	1.1
Montague	1.2
Montgomery	2.1
Moore	1.0
Morris	1.8
Motley	0.9
Nacogdoches	2.0
Navarro	2.4
Newton	1.6
Nolan	1.15
Nueces	1.8
Ochiltree	1.1
Oldham	1.0
Orange	1.6
Palo Pinto	1.9
Panola	2.2
Parker	1.6
Parmer	1.0
Pecos	0.6
Polk	2.2
Potter	1.0
Presidio	0.8
Reins	2.3
Randall	1.0
Reagan	1.0
Real	2.0
Red River	2.2
Reeves	0.6
Refugio	1.7
Roberts	1.0
Robertson	2.0
Rockwall	2.0
Runnels	1.3
Rusk	2.1
Sabine	2.0
San Augustine	2.0
San Jacinto	2.2
San Patricio	1.8
San Saba	1.8
Schleicher	1.6
Scurry	0.8
Shackelford	1.6
Shelby	2.0
Sherman	1.0
Smith	1.9
Somervell	2.0
Starr	2.4
Stephens	1.9
Sterling	1.1
Stonewall	0.9
Sutton	1.8
Swisher	1.0
Tarrant	1.4
Taylor	1.4
Terrell	1.5
Terry	0.8
Throckmorton	1.4
Titus	1.8
Tom Green	1.2
Travis	2.0
Trinity	2.0
Tyler	2.1
Upshur	1.8
Upton	1.0
Uvalde	2.0
Val Verde	1.8
Van Zandt	2.2
Victoria	1.85
Walker	2.0
Waller	1.9
Ward	0.5
Washington	2.1
Webb	2.0
Wharton	1.8
Wheeler	1.0
Wichita	0.95
Wilbarger	0.9
Willacy	1.6
Williamson	2.0
Wilson	2.0
Winkler	0.6
Wise	1.4
Wood	2.1
Yoakum	0.7
Young	1.55
Zapata	2.0
Zavala	2.0

FIGURE 10. GEOTHERMAL GRADIENTS BY COUNTY IN TEXAS.

The importance of reservoir temperature in selecting candidates for CO_2 miscible displacement is twofold: first, as shown in Fig. 11, the minimum miscible pressure seems to be related strongly to the reservoir temperature and to the bubble-point pressure of the crude (Yellig and Metcalf, 1978); second, temperature is a factor in determining the volume occupied by CO_2 at reservoir pressure.

6.2 Reservoir Pressure

Initial reservoir pressures and 1978 pressure data were available for virtually all reservoirs with secondary recovery records (approximately 65 percent of the reservoirs identified). In areas where little or no pressure data were available, the regional pressure gradient was determined using data from nearby fields when available; otherwise a pressure gradient of 0.465 psi/ft was assumed.

6.3 Minimum Miscibility Pressure

One of the critical requirements for effective displacement of oil by CO_2 is sufficiently high pressure. The pressure at which effective displacement occurs is commonly referred to as the miscible pressure, although the displacement may not be completely miscible in the strictest sense. Three correlations, none of them completely satisfactory, have been formulated for predicting miscible pressures: one by the National Petroleum Council (1976), one by Holms and Josendal (1974), and one by Yellig and Metcalfe (1978). The NPC correlation is not especially accurate (Fig. 12); that of Holms and Josendal requires a specialized chemical analysis of the crude and is limited to pressures above 1,400 psi (Fig. 13). The correlation of Yellig and Metcalfe (Fig. 14) shows the MMP to be highly dependent on temperature and bubble-point pressure, as was shown in Fig. 11. The composition of the crude oil is relatively unimportant (Fig. 15A).

6.4 Crude Oil

Important information on reservoir fluid was not always directly assignable to individual reservoirs. Information on the composition of oils is available from a crude oil file originally furnished by the Department of Energy and maintained by the Petroleum Data System. The file contains 4,540 Hemphill distillation analyses from the project area, including results for more than 45 percent of the reservoirs selected. Information on a significant number of the oils from reservoirs in the study area is available in a published study classifying 310 Permian basin crudes on the basis of compositional differences (Jones and Smith, 1964). A more recent study has pointed out that a combination of analytical techniques is best for basin-wide correlation and classification of oils: mass spectral (carbon isotope measurements), gas chromatography, optical rotation and infrared spectroscopy, and crude oil correlation index (Williams, 1974). Since the data available on the reservoirs selected in the present study are limited to Hemphill distillations, only the correlation index (which is derived from distillation analysis) will be considered here. Analyses are available from the PDS file and other sources for 62 of the 182 reservoirs selected.

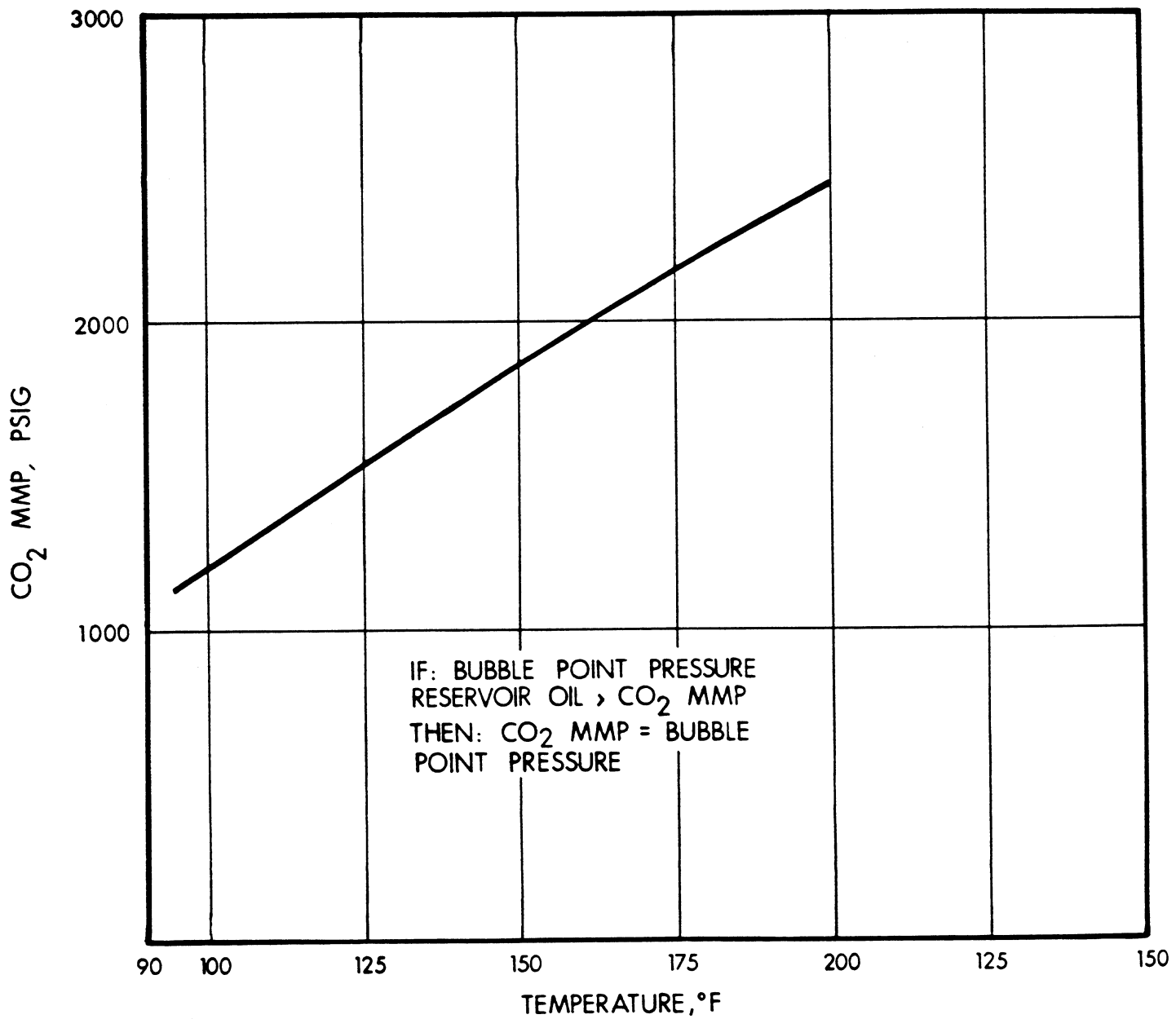


FIGURE 11

TEMPERATURE-BUBBLE POINT PRESSURE CORRELATION FOR PREDICTING CO_2 MINIMUM MISCIBILITY PRESSURE.

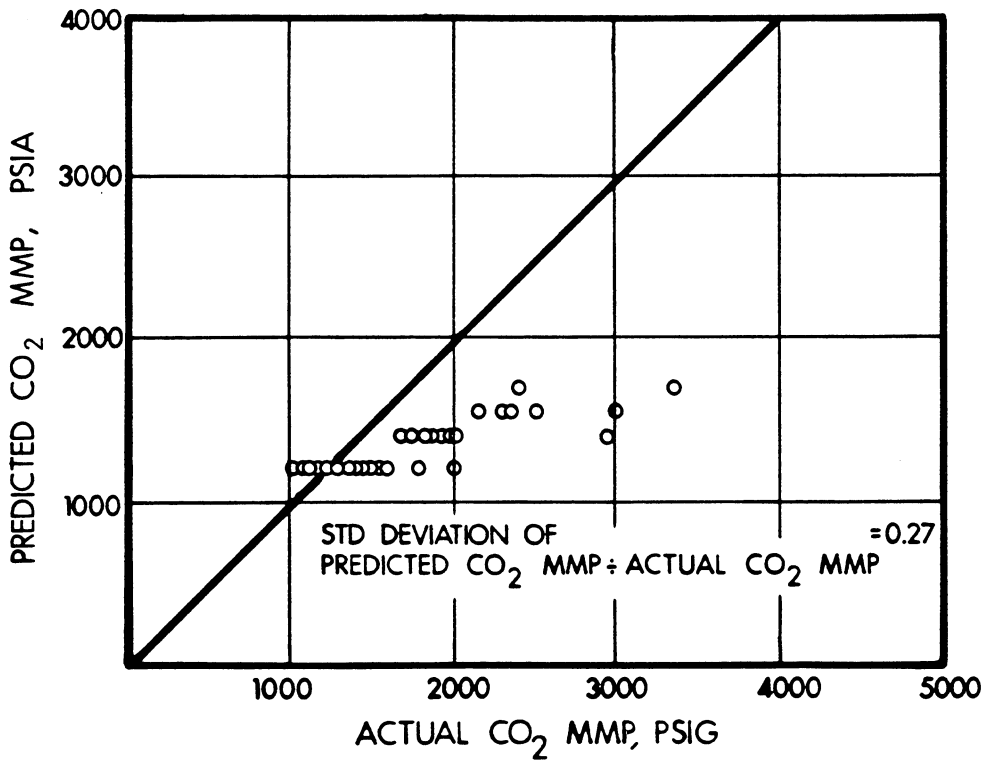


FIGURE 12

ACCURACY OF NPC CORRELATION FOR PREDICTING CO_2 MMP.

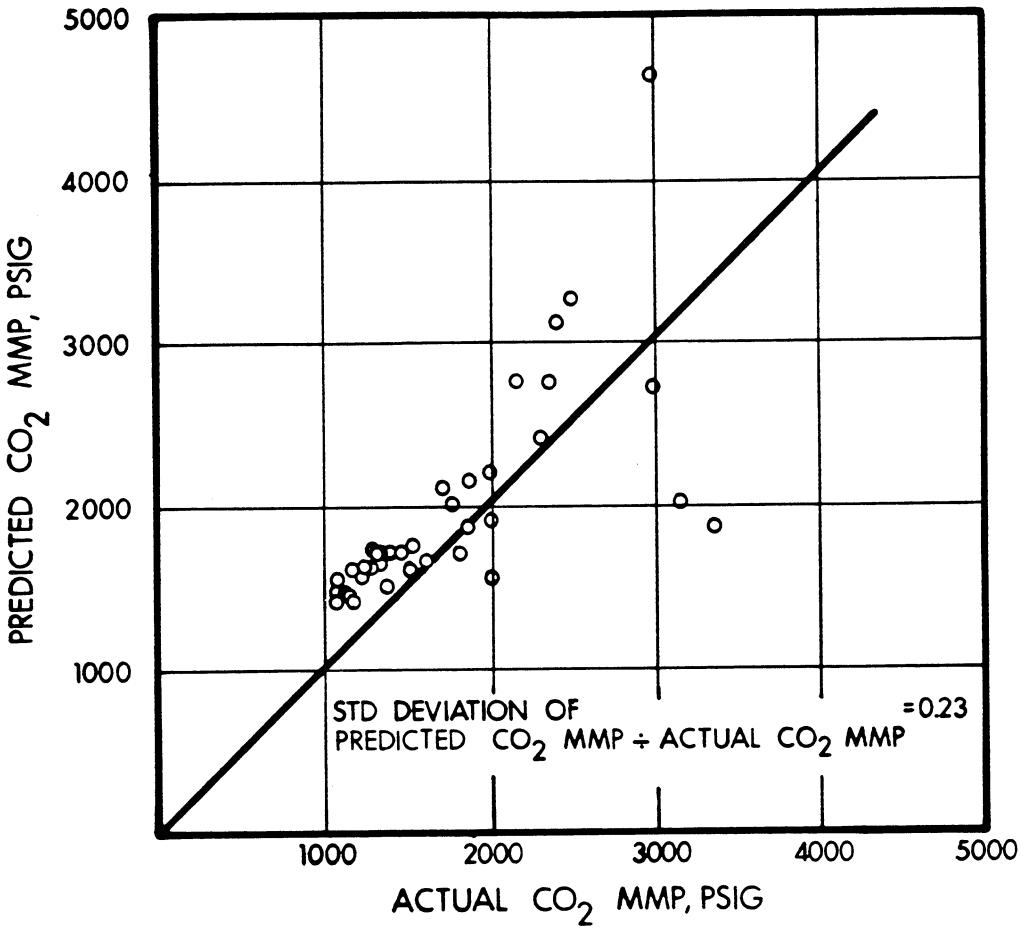


FIGURE 13

ACCURACY OF HOLM & JOSENDAL CORRELATION
FOR PREDICTING CO_2 MMP.

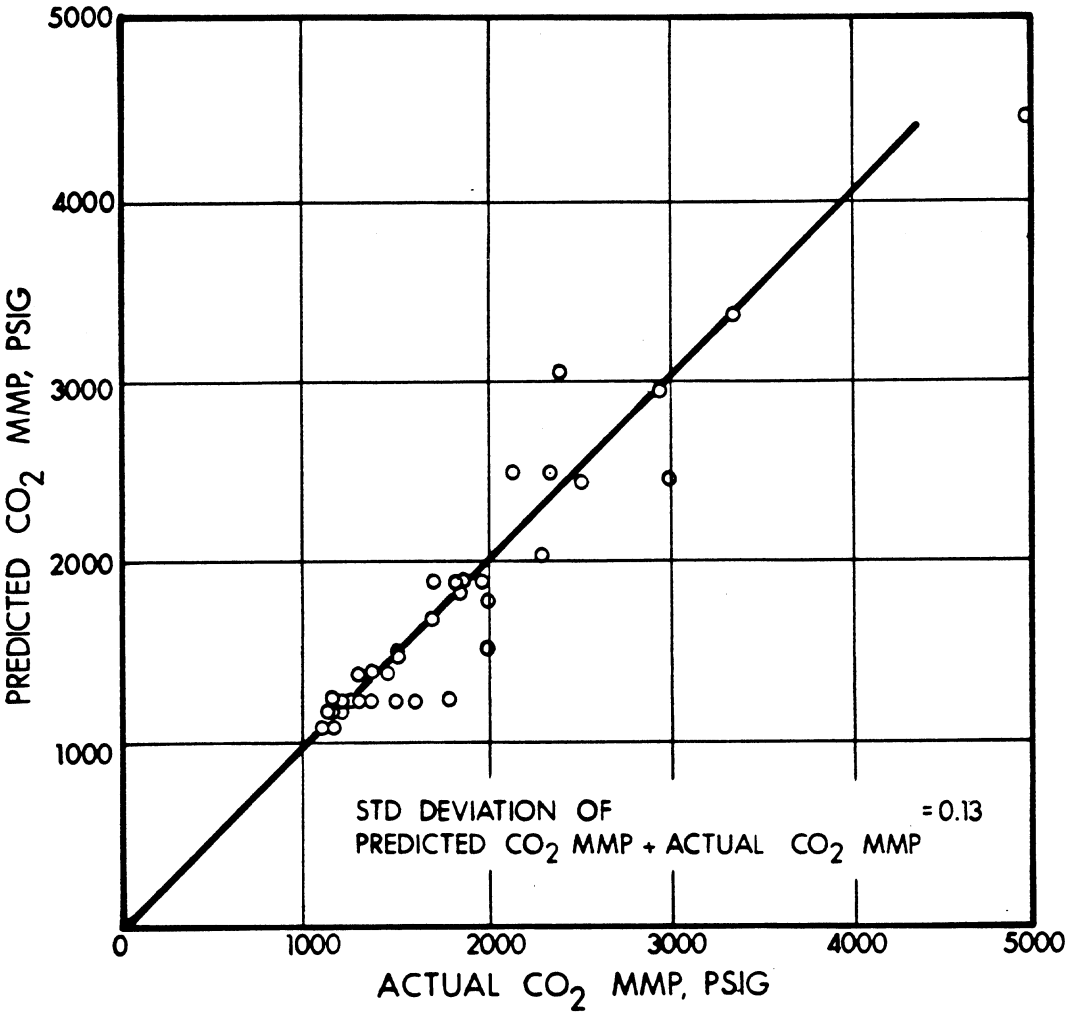
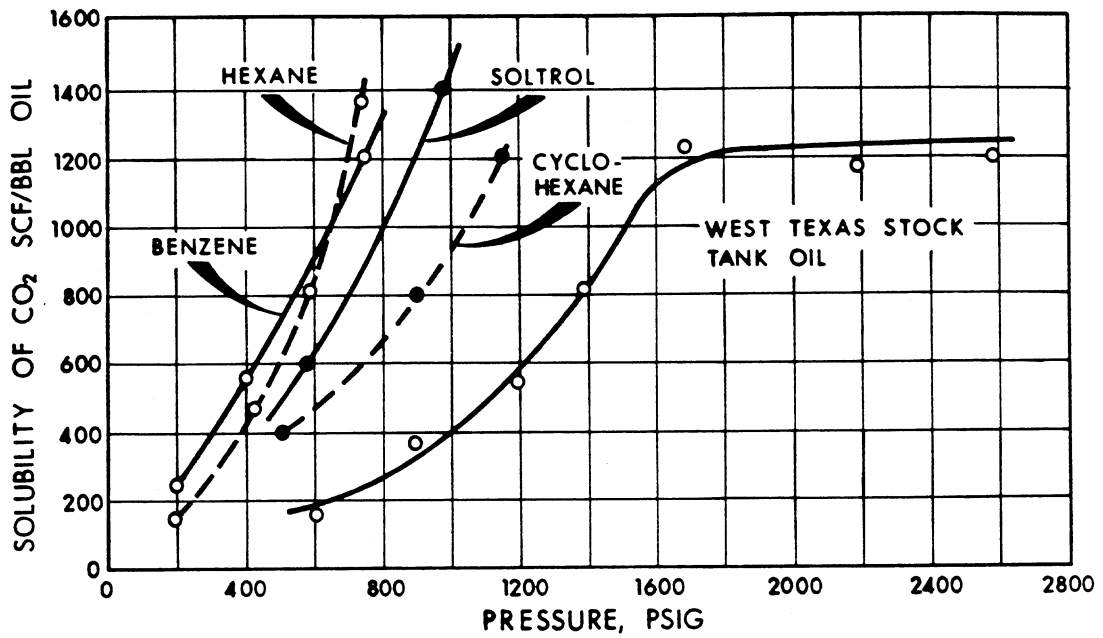
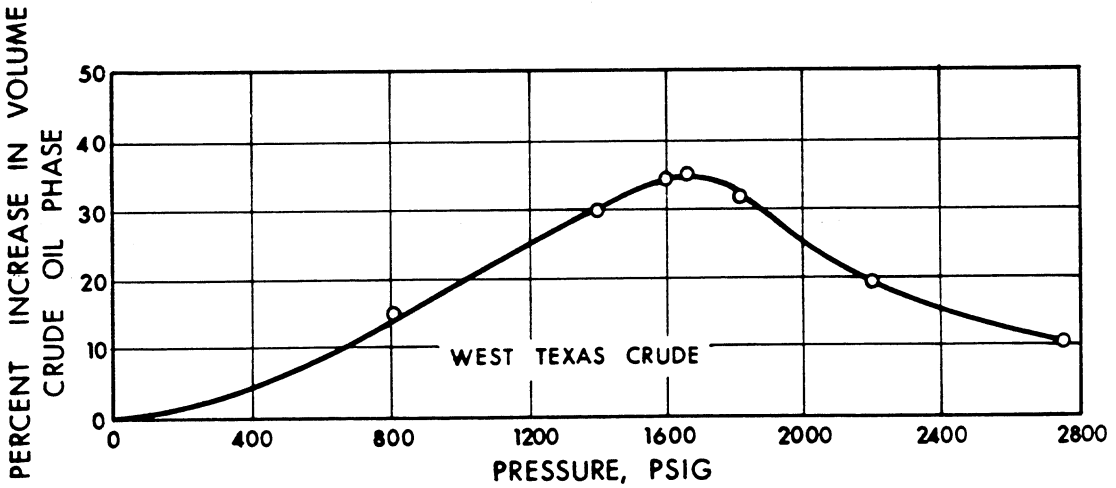


FIGURE 14

ACCURACY OF TEMPERATURE-BUBBLE POINT PRESSURE CORRELATION FOR PREDICTING CO_2 MMP.



A SOLUBILITY OF CO_2 IN VARIOUS HYDROCARBONS (125° F)



B VOLUMETRIC EXPANSION OF CRUDE OIL SATURATED WITH CO_2 (125° F).

FIGURE 15

CO_2 SOLUBILITY IN HYDROCARBONS AND RELATED SWELLING OF CRUDE OIL.

A cluster analysis was performed on the correlation index obtained from the Hemphill distillations. The results of this analysis are meaningful only in that it places oils in similar groups based on the correlation index (CI), which is a measure of the complexity of the fractions distilling over certain temperature ranges. Low CI numbers are expected for oils containing higher proportions of the normal paraffin hydrocarbons. Comparing the results of the cluster analysis on CI alone with the results of a more detailed analysis of Permian oils by Jones and Smith (1964) revealed that cluster analysis was inadequate to distinguish among the varieties of oils they observed. However, there was more than a random correspondence to the oils grouped by cluster analysis and the types of oils defined by Jones and Smith. For example, the San Andres D and E type oils of Jones and Smith, interpreted as near-shelf-edge and far-shelf-edge types, were found to be clustered together.

However, not enough overlap of samples existed between the Jones and Smith group and the group selected for this report to allow a more detailed comparison. The results of this effort suggest that cluster analysis based on more complete information would be extremely useful in characterizing crude oils. For CO_2 miscible displacement, however, the studies of Yellig and Metcalfe (1978) indicate that composition may be of relatively minor importance.

The excellent papers of Williams (1974), Jones and Smith (1964), and Dow (1974) are recommended for more thorough studies of the crude oil compositions for fields in the Williston and Permian Basins.

6.5 Water

The salinity of connate water in a reservoir being examined for CO_2 displacement is important as it affects the solubility of CO_2 in the water (Fig. 16). The solubility of CO_2 is lower in brine than in fresh water. The addition of any electrolyte to a gas-liquid solution normally decreases the solubility of the gas. This effect is commonly called "salting out" (Daniels and Alberty, 1955). The range of this effect was shown more fully in the report for Task One of this contract (Goodrich, 1980). For typical conditions for the fields selected, the equilibrium solubility of CO_2 in the reservoir water is 100 to 175 scf/bbl for fresh water and 50 to 125 scf/bbl for 100,000-ppm brine.

A water analysis file available in the PDS data system contains several thousand analyses (more that 16,000 in Texas), indexed by field and well name and containing relatively complete information for each analysis. Often there are many analyses for each reservoir; for example, a query for water analyses on 7 of the fields selected by the screening procedure produced more than 450 analyses. The major drawback to this vast store of information is that the purpose of the water analysis is not given. Water analyses can be performed for a number of reasons, and this file would not necessarily provide analyses of the original water or the water currently found in the fields selected. Hence, other sources, as discussed below, were used to develop water composition data for possible target reservoirs.

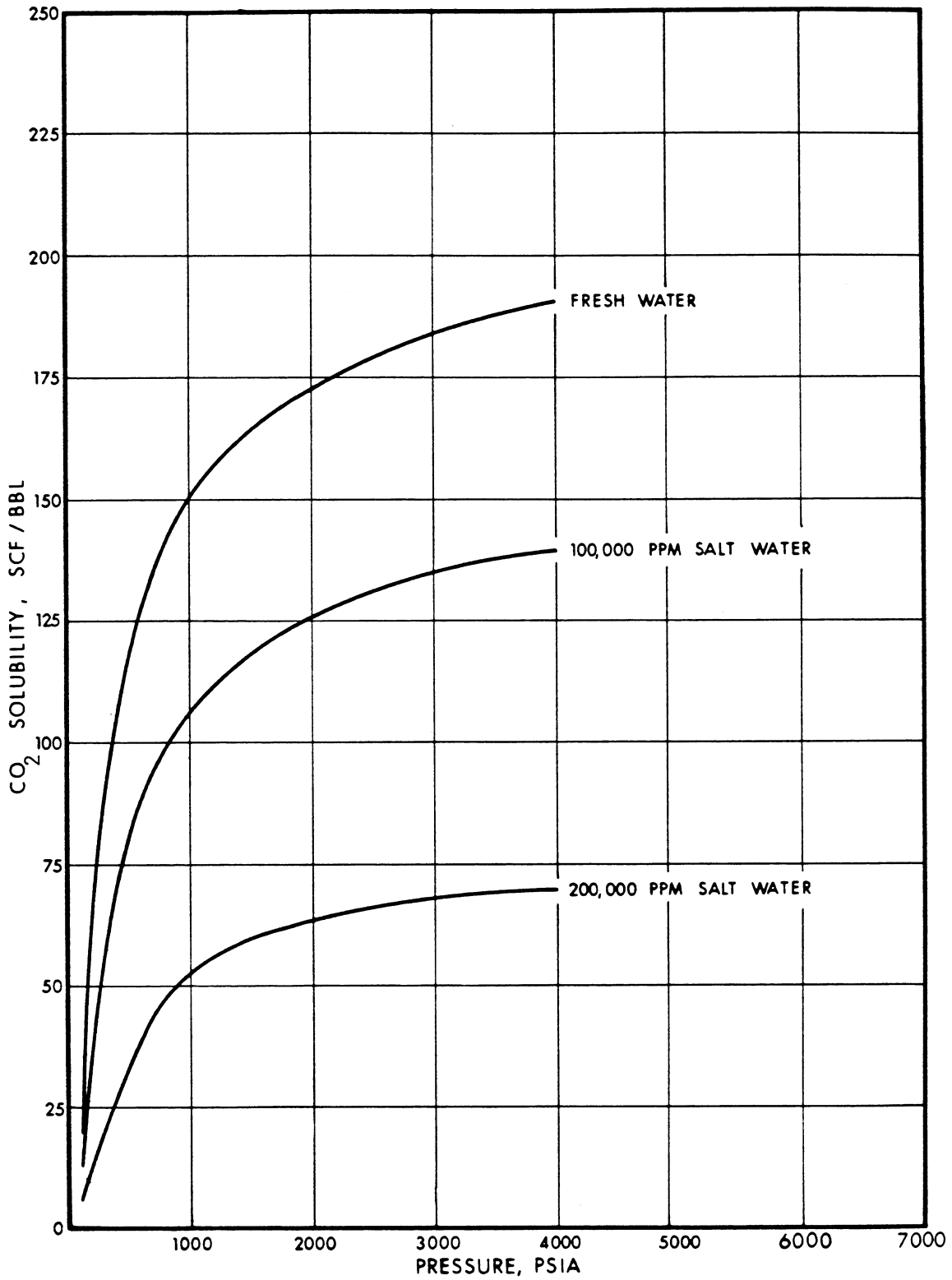


FIGURE 16

SOLUBILITY OF CO_2 IN WATER AT 100°F

Regional studies have been conducted on the original connate water salinities of most formations in the Williston and Permian basins (Texas Water Quality Board Report 157, 1972; McNeal, 1964). The result of these regional studies can give a good indication of the salinity of the original connate water of the reservoirs selected.

Two salinity maps for the San Andres formation, which dominates the list of reservoirs contained in this study, are given in Fig. 17. The range for the fields included in this study can be from 50,000 ppm to more than 200,000 ppm. In the large fields, i.e., Wasson and Levelland, the salinity varies significantly in different portions of the fields.

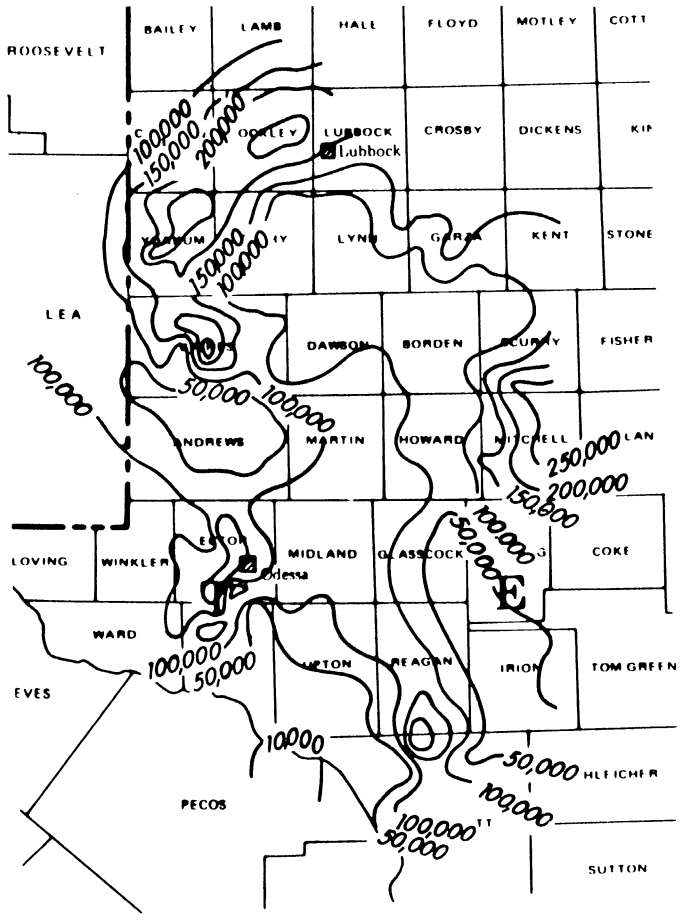
The salinity map for the Leonard series (mainly, the Clear Fork formation) is given in Fig. 18. The salinity of this formation is highly variable, ranging from 50,000 to more than 250,000 ppm, and the reservoirs included in this study could have exhibited original salinities anywhere within this range.

Figures 19 and 20 are salinity maps of the Permian Wolfcamp series. There are the usual minor differences in these maps, but they generally show the same features. The Wolfcamp reservoirs included in this study are characterized by a salinity of about 150,000 ppm.

Figures 21 and 22 are salinity maps of the Strawn series, found in the eastern Midland basin and eastern shelf-edge Bend Arch areas. The observed salinity ranges from 50,000 to 200,000 ppm and a value of about 20,000 ppm is characteristic of the general area of the reservoirs included in this study. In the northwest portion of the Midland basin and the Central Basin Platform area, the salinities of the water contained in undifferentiated Pennsylvanian rocks are shown in Fig. 23. The range of water salinities for this system is considerable, and the original salinity for the reservoirs from this system included in this study could be anywhere in the range from 50,000 to 250,000 ppm.

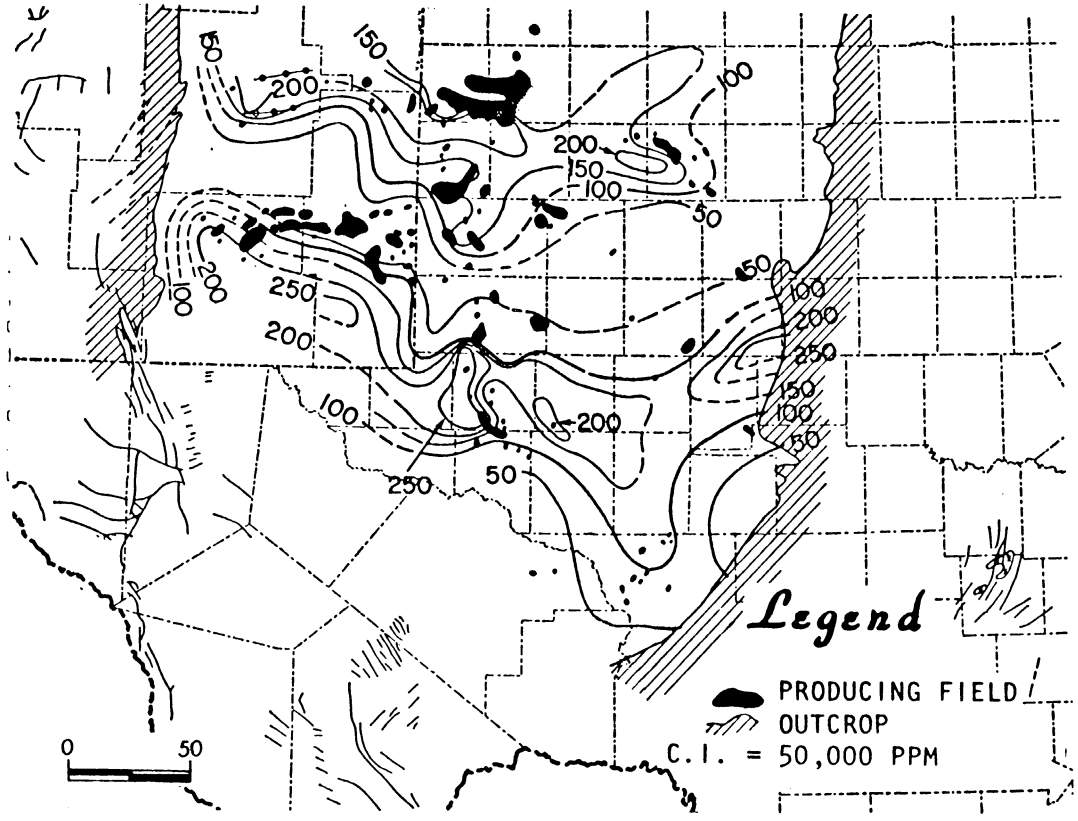
Figure 24 shows salinity maps for the Siluro-Devonian or Devonian throughout the Permian basin. Again, there are differences between the maps, but the general picture is the same. The salinity varies from very low values near the outcrops to a maximum of about 150,000 to 200,000 ppm in the deeper portions of the basin. The general area of the reservoirs included in this study is characterized by relatively low salinities, about 50,000 to 100,000 ppm.

Maps of the salinity (total chlorides) of the Ellenburger formation in the Permian basin, taken from two sources, are shown in Fig. 25. While there are some differences, salinities generally range from 50,000 ppm to 250,000 ppm in the deeper parts of the basin. The general area containing the reservoirs selected by the screening is characterized by salinities of 50,000 to 150,000 ppm.



TEXAS WATER QUALITY BOARD REPORT 157 DATA

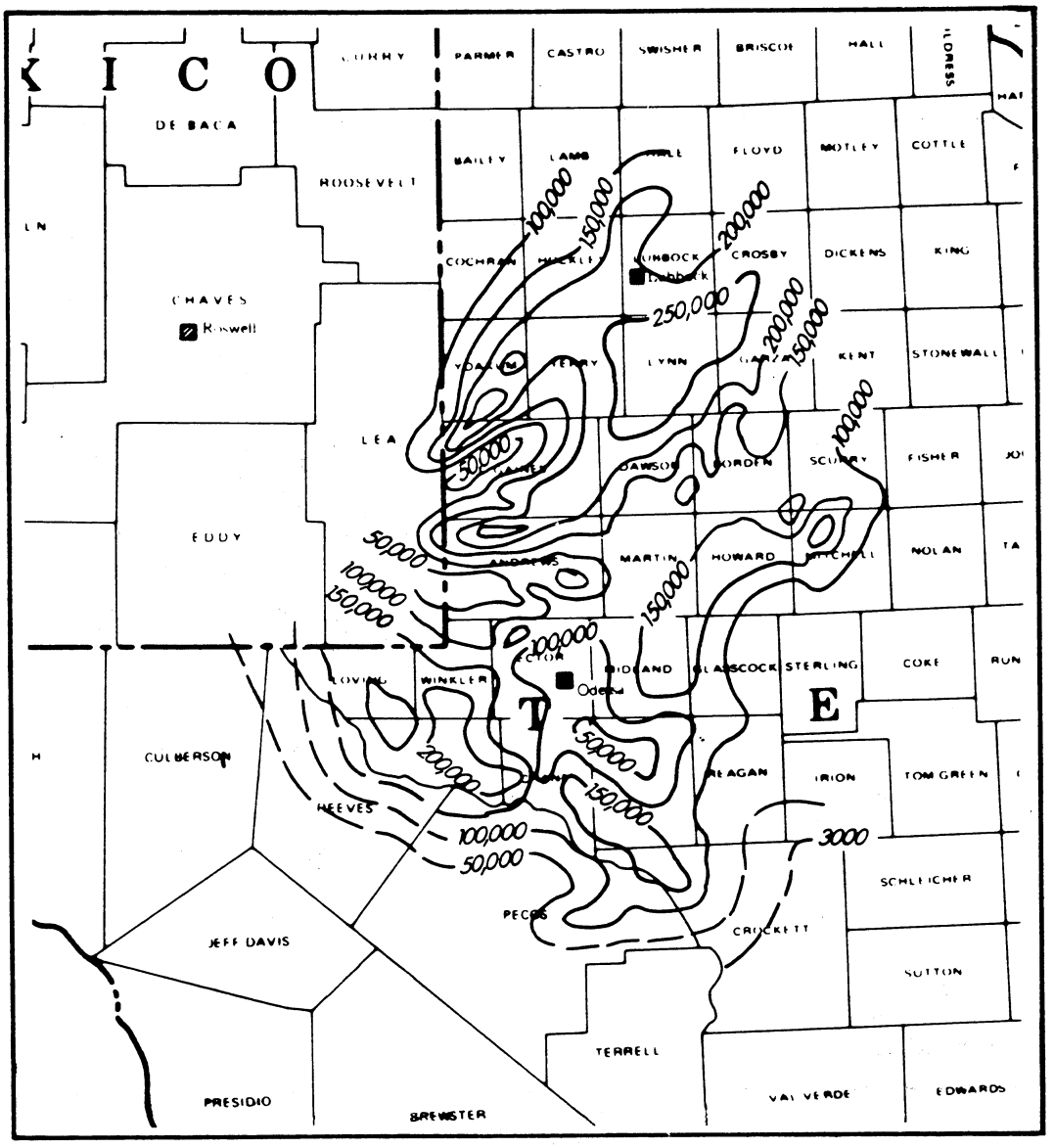
C.I=50,000



McNEAL, R.P., 1964

FIGURE 17

SALINITY MAP OF SAN ANDRES FORMATION
(FROM McNEAL, 1964 AND TEXAS WATER QUALITY BOARD REPORT 157)

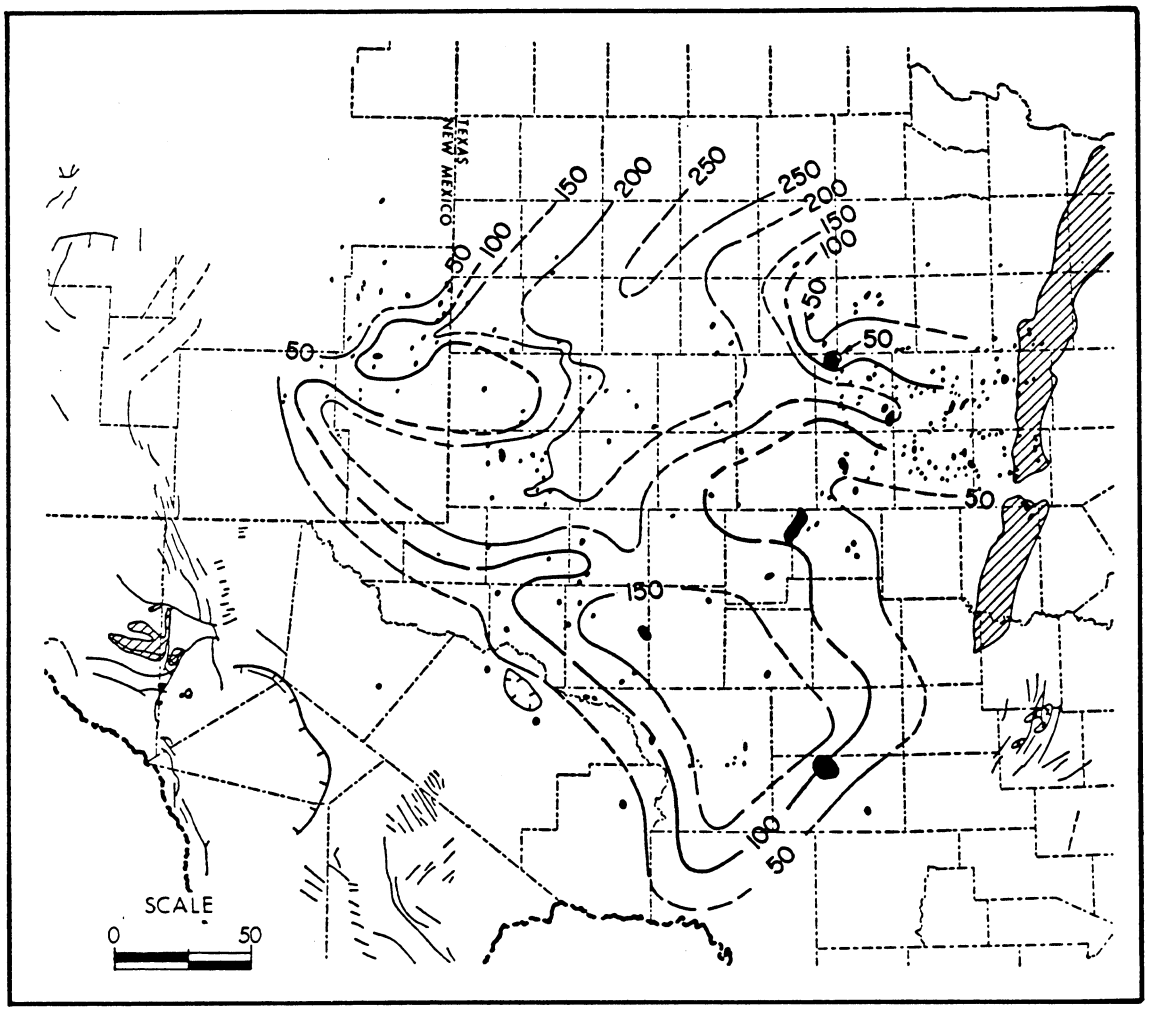


C.I. = 50,000

FIGURE 18

SALINITY MAP OF PERMIAN LEONARD SERIES, MAINLY CLEARFORK FROMATION

(TEXAS WATER QUALITY BOARD REPORT 157 DATA)

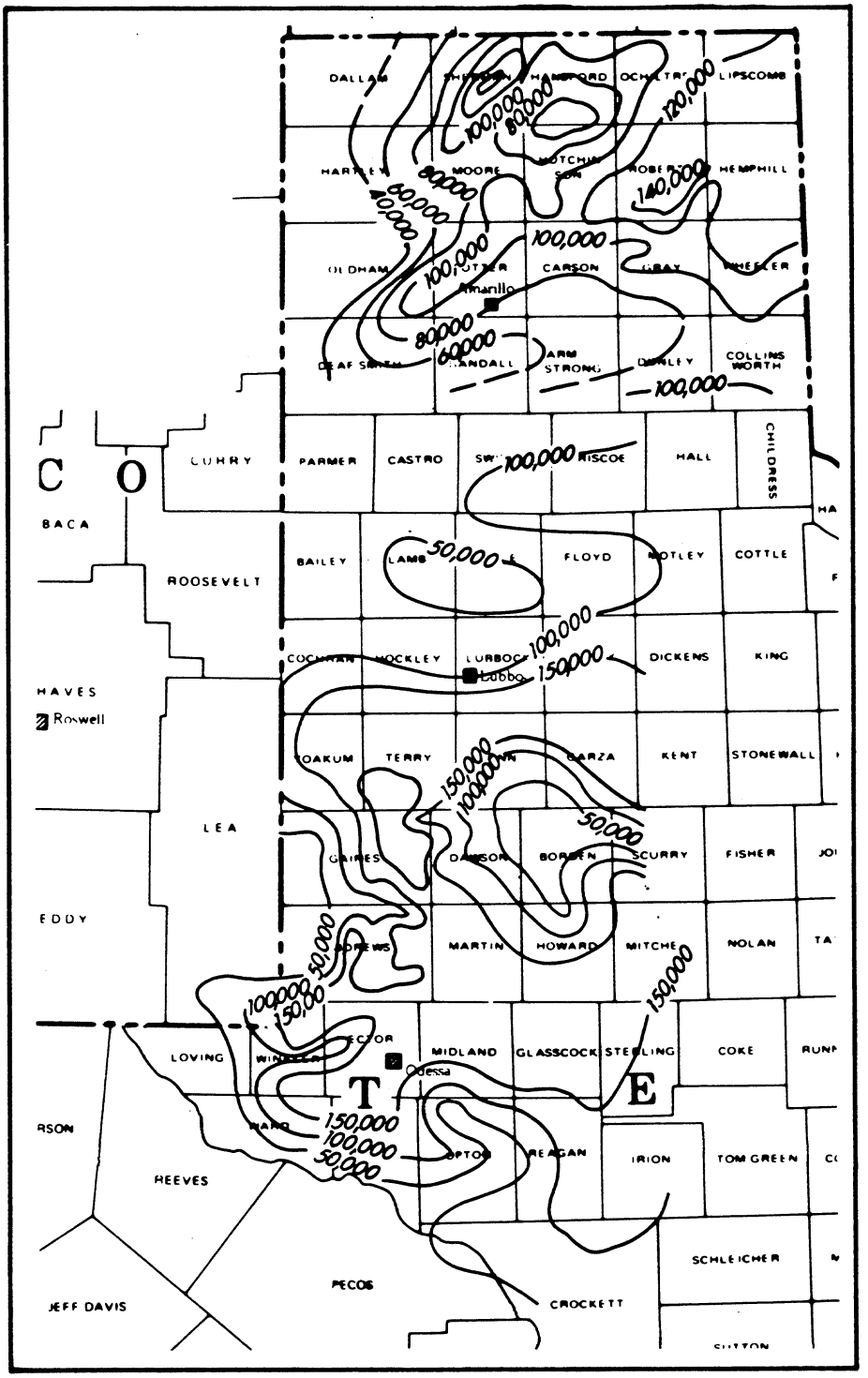


Legend

PRODUCING FIELD
OUTCROP
ERODED EDGE
C.I. = 50,000 PPM

FIGURE 19

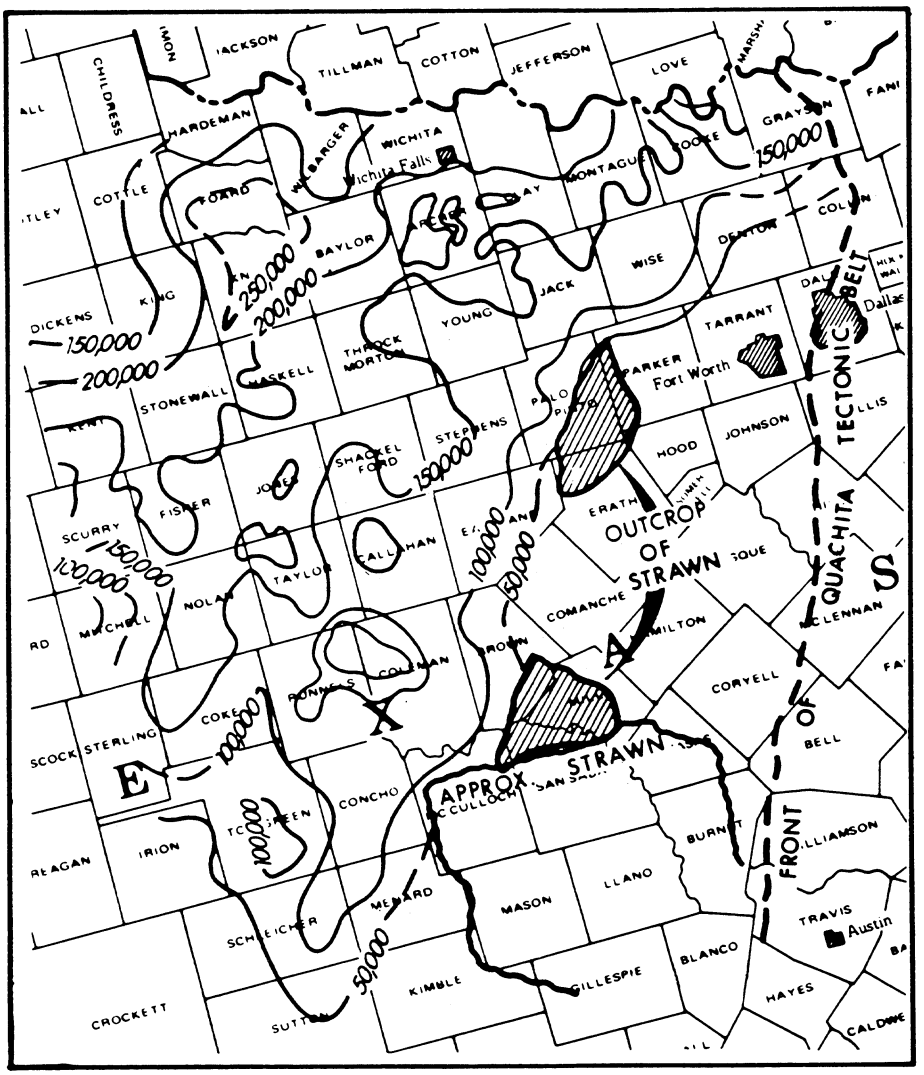
SALINITY MAP OF WOLFCAMP SERIES PERMIAN BASIN (FROM McNEAL, R.P., 1964)



C.I.=50,000

FIGURE 20

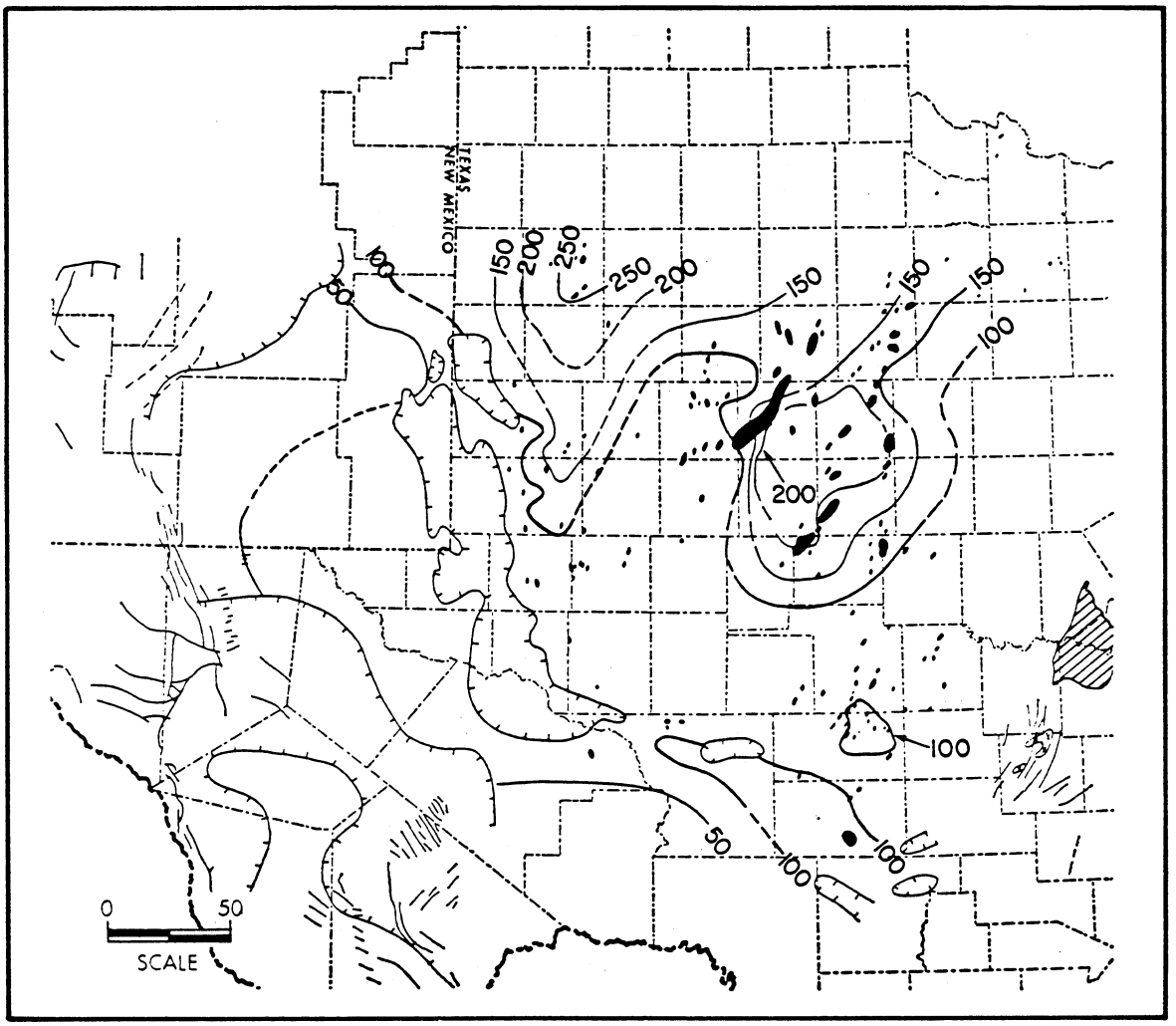
SALINITY MAP OF LOWERMOST
PERMIAN WOLFCAMP SERIES
(TEXAS WATER QUALITY BOARD REPORT 157)



C.I. = 50,000

FIGURE 21

SALINITY MAP OF STRAWN SERIES
EASTERN PORTION OF PERMIAN BASIN
(FROM TEXAS WATER QUALITY BOARD REPORT 157)



Legend

- PRODUCING FIELD
- OUTCROP
- ERODED EDGE

C.I. = 50,000 PPM

FIGURE 22

SALINITY MAP OF STRAWN SERIES PERMIAN BASIN (FROM McNEAL, R.P., 1964)

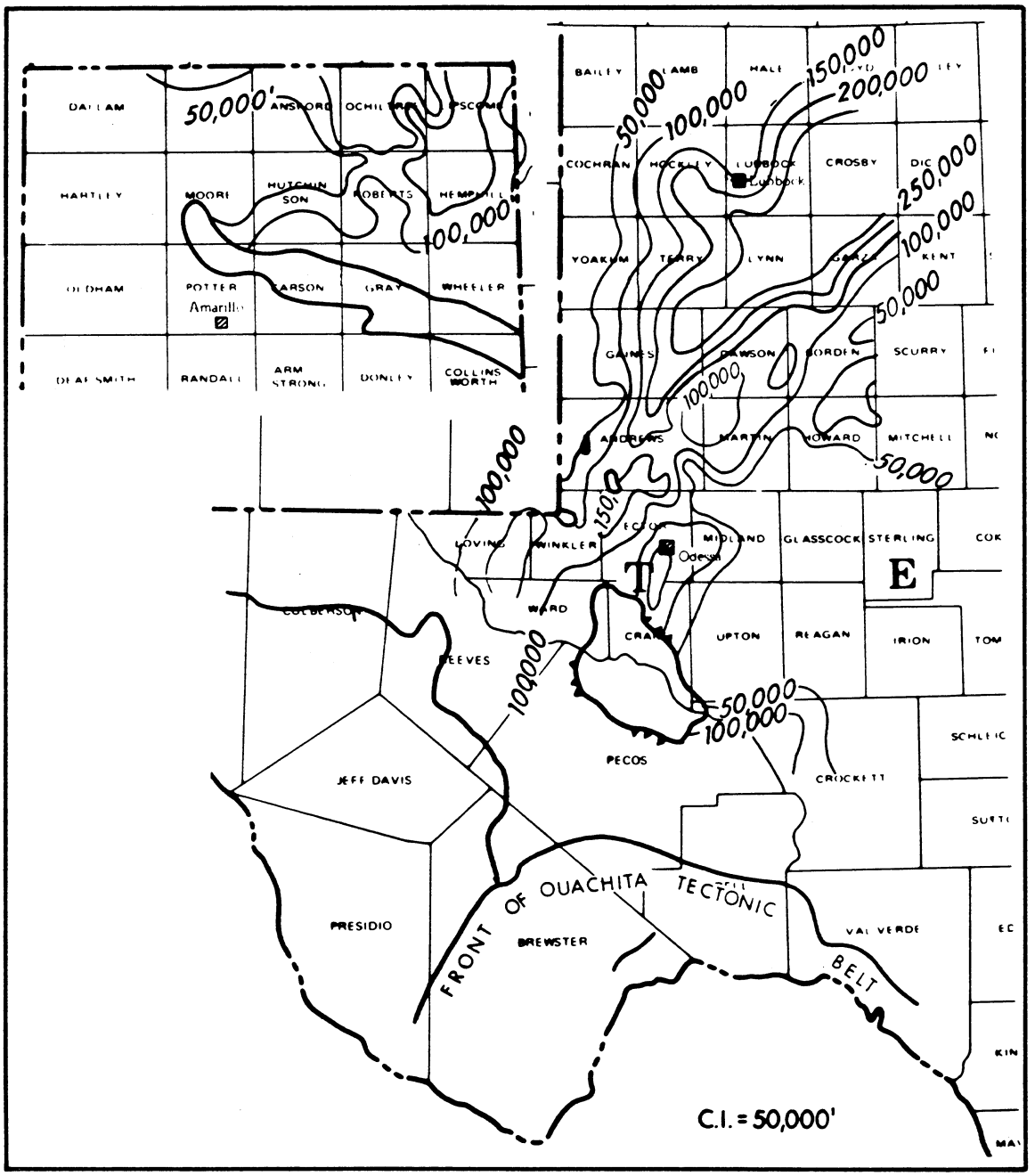


FIGURE 23

SALINITY MAP OF UNDIVIDED PENNSYLAVANIAN SERIES
NORTHWEST SHELF AND CENTRAL BASIN PLATFORM IN PERMIAN BASIN
(FROM TEXAS WATER QUALITY BOARD REPORT 157)

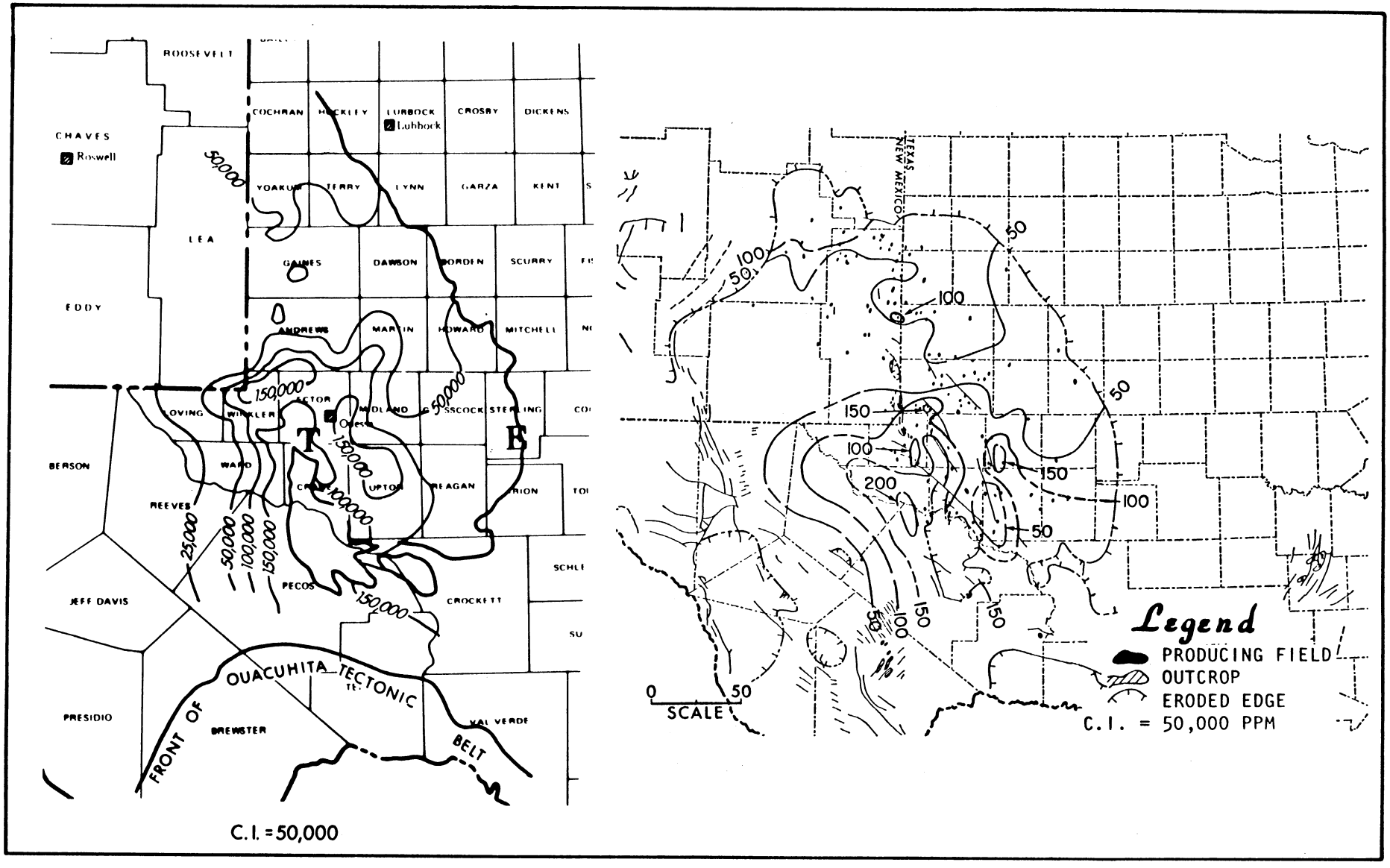


FIGURE 24

SALINITY MAPS OF THE DEVONIAN OR SILURO-DEVONIAN SERIES IN THE PERMIAN BASIN
(FROM TEXAS WATER QUALITY BOARD REPORT 157 AND McNEAL, 1964)

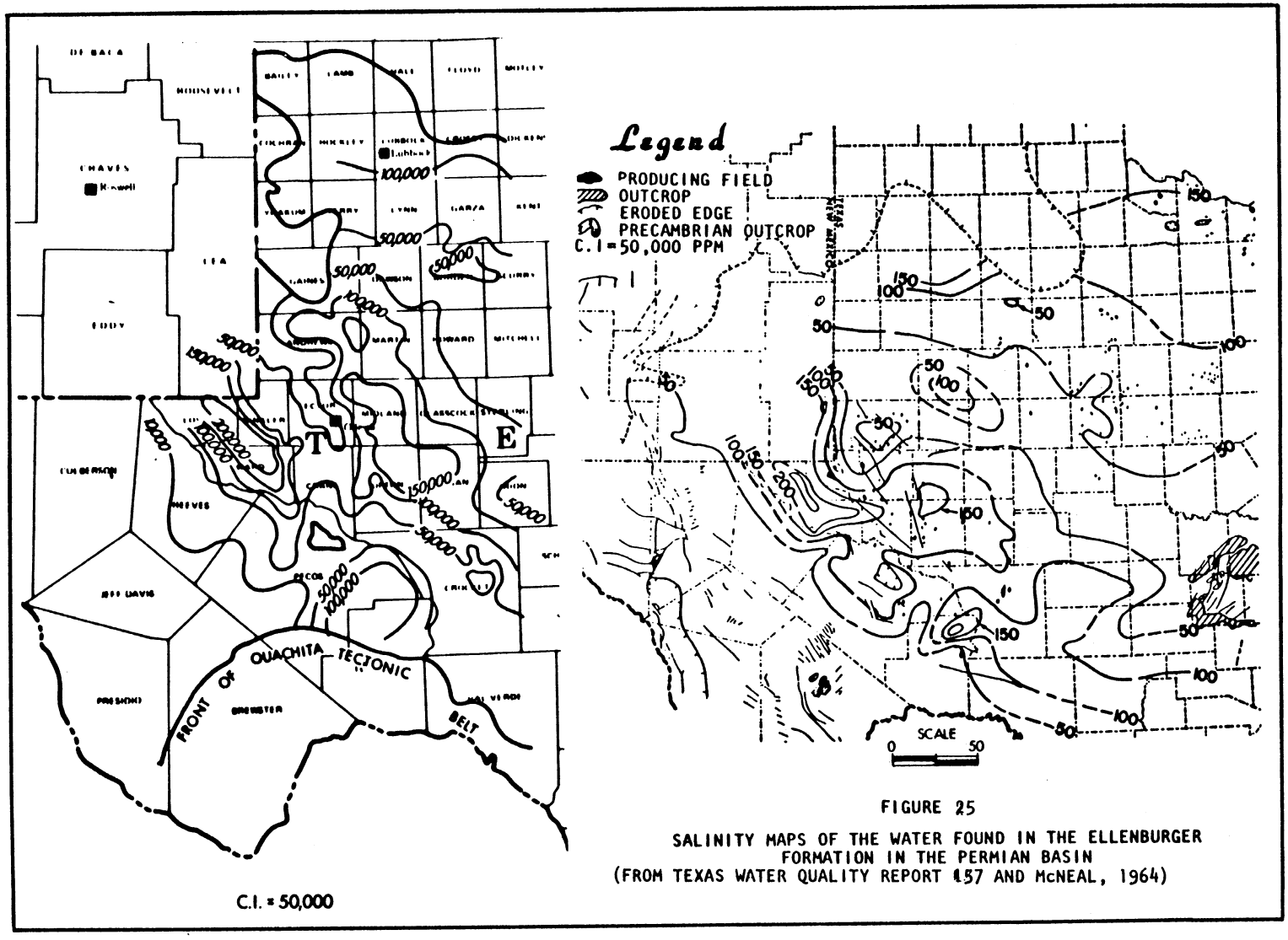


FIGURE 25

SALINITY MAPS OF THE WATER FOUND IN THE ELLENBURGER FORMATION IN THE PERMIAN BASIN (FROM TEXAS WATER QUALITY REPORT #57 AND McNEAL, 1964)

7. EVALUATION OF SELECTED FIELDS

The following is an evaluation of reservoir and geologic data contained in Table 7 on an area-by-area and field-by-field basis and considers the evaluation of previous investigators for each of the named reservoirs.

7.1 Central Basin Platform

7.1.1 PERMIAN-GUADALUPE (313). Forty reservoirs, 6 in New Mexico and 34 in Texas, are shown in Table 7 as being Guadalupe in age. Eleven of these produce from the Grayburg or combined Grayburg and San Andres, 23 from the San Andres, 2 from the Holt, 1 from the Yates Lime, and 3 from the Deep. The Deep includes the Queen, Colby, Yates, and Seven Rivers pay zones; all are primarily sandstones, although they grade into dolomitic and anhydritic sands and dolomites in parts of the basin. The Deep, listed by PDS as a carbonate, was included in the data search and sufficient data were obtained to warrant its inclusion in this report. Of the fields listed, ARROWHEAD-Grayburg, COWDEN, NORTH-Grayburg, COWDEN, SOUTH-Grayburg, FOSTER-Grayburg, McELROY-Grayburg, and MEANS-San Andres were listed in data sources 13c and 14e (GURC Report 153 and BETC/R1-78/15 Report in Table 4) as suitable for CO_2 enhanced oil recovery. EUNICE MONUMENT-Grayburg-San Andres, HOBBS-Grayburg-San Andres, JORDAN-San Andres, McCAMEY-Grayburg, SEMINOLE-San Andres, and YATES-Yates Lime were all rated by data source 14e as unsuitable for CO_2 flooding because of a large gas cap; however, some of the fields rated suitable for CO_2 by 14e also have gas caps. These ratings should therefore be considered carefully.

7.1.2 PERMIAN-LEONARD (318). Seventeen fields are Leonard in age, 5 in New Mexico and 12 in Texas. Eight of the reservoirs listed produce from the Clear Fork; three are designated as Yeso and four as Tubb. The Clear Fork and Yeso are equivalent time-stratigraphic units, the term Yeso being used in New Mexico and Clear Fork in Texas. The Tubb is a unit within the Yeso-Clear Fork. One field produces from the Glorieta-San Angelo and another from the Holt. GOLDSMITH-Clear Fork and SAND HILLS-Tubb have been rated by data source 14e as suitable for CO_2 or polymer flooding, depending on availability, while DRINKARD-Yeso was listed by 14e as unsuitable for CO_2 because of a gas cap.

7.1.3 PERMIAN-WOLFCAMP (319). Five Wolfcamp fields, all in Texas, are shown in Table 7. SHAFTER LAKE-Wolfcamp is one of several carbonate pays in this field. It has no gas cap and may have good potential for CO_2 flooding. PECOS VALLEY-Wolfcamp and UNIVERSITY BLOCK 9-Wolfcamp should also be considered.

7.1.4 PENNSYLVANIAN-BEND (326). One Pennsylvanian field, UNIVERSITY BLOCK 9, is listed in Table 2. The UNIVERSITY BLOCK 9 field also has production from the Wolfcamp and Devonian, both potentially suitable carbonate reservoirs.

7.1.5 DEVONIAN (340). Sixteen fields produce from Devonian age formations, 14 in Texas and 2 in New Mexico. CROSSETT-Devonian is

recommended in data source 14e as a CO_2 candidate. Both the CRAWAR-North and PECOS VALLEY-Devonian fields have gas caps. DOLLARHIDE-Devonian in Texas and New Mexico has no gas cap.

7.1.6 SILURIAN (350). Four fields having Silurian age reservoirs are shown in Table 7. DOLLARHIDE-Fusselman & Montoya has locally cavernous porosity with caverns 2 to 16 feet in height, but no gas cap. The cavernous porosity may make the DOLLARHIDE-Fusselman unsuitable for CO_2 enhanced oil recovery; however, other reservoirs in this field (Clear Fork, Devonian, Tubb/Drinkard) may be suitable.

7.1.7 ORDOVICIAN (360). Seven Ordovician age-Ellenburger reservoirs are shown in Table 7. As indicated on the DOLLARHIDE-Ellenburger, JUSTIS-Ellenburger, LEA-Ellenburger, and TXL-Ellenburger field reports, the Ellenburger is generally fractured and has vuggy to cavernous porosity throughout the Permian basin. TXL-Ellenburger is noted by data source 14e as unsuitable for CO_2 flooding because of water drive and fractures; the other fields would also be unsuitable because of fractures.

7.2 Midland Basin

7.2.1 PERMIAN-GUADALUPE (313). Ten Guadalupe age reservoirs are shown in Table 7: two Grayburg, seven San Andres, and one Grayburg-San Andres combined. MIDLAND FARMS-Grayburg and WELCH-San Andres were rated as unsuitable for CO_2 flooding by data source 14e.

7.2.2 PERMIAN-LEONARD (318). Two Leonard age reservoirs are listed, KETCHUM MT-Clear Fork and REVILO-Glorieta. Neither field can be excluded from consideration on the basis of available data. REVILO also has production from the Clear Fork.

7.2.3 PERMIAN-WOLFCAMP (319). Five Wolfcamp age reservoirs are listed in Table 7; two of these, ADAIR and WELLMAN, are described in the literature as Wolfcamp Reef and the others have a similar lithology. ADAIR also has fracture porosity.

7.2.4 PENNSYLVANIAN (320). Two Cisco (322), four Canyon (323), two Strawn (325) and four Bend (326) reservoirs are listed in Table 7. Most of these reservoirs are in reef limestones.

7.2.5 DEVONIAN (340). AZALEA-Devonian, one of the five Devonian reservoirs listed in Table 7, is fractured and has a gas cap. DORA ROBERTS, also listed by PDS as a carbonate oil reservoir, is a state-designated gas reservoir at present.

7.2.6 SILURIAN (350). Four Silurian age reservoirs are listed in Table 7. Three of these, BIG SPRINGS-Fusselman, GOOD S.E.-Fusselman, and TEX-HAMON-Fusselman, are in multi-pay fields. All three have production from the Canyon Reef. LUTHER S.E.-Silurian-Devonian had an unsuccessful saltwater pressure-maintenance program which was discontinued in 1969.

7.2.7 ORDOVICIAN (360). DORA ROBERTS-Ellenburger is the only Ordovician age reservoir listed for the Midland basin. The DORA ROBERTS, in addition to producing from the previously mentioned Devonian, produces from the Fusselman and Strawn.

7.3 Reagan Uplift In The Midland Basin

7.3.1 PERMIAN-GUADALUPE (313). Three fields are listed as having Guadalupe age reservoirs. BIG LAKE and HALFF produce from the Grayburg and FARMER produces from the San Andres. BIG LAKE is listed by data source 14e as unsuitable for CO_2 because of water drive. Since most fields in the Permian basin have undergone waterflood and hence have "secondary" water drive, this may not be a valid reason for exclusion.

7.3.2 PENNSYLVANIAN-STRAWN (323). Two fields, TODD DEEP and WORLD, WEST produce from the Strawn, which is a limestone reef rock. Both fields also have pay zones in other carbonate formations.

7.3.3 ORDOVICIAN (360). Three Ellenburger fields are listed in Table 7. BARNHART and ELKHORN have vuggy and fracture porosity. TODD DEEP, which also has Strawn production, may also be fractured.

7.4 Eastern Shelf

7.4.1 PERMIAN-GUADALUPE (313). Eight Guadalupe age reservoirs are shown in Table 7. Three produce from the San Andres, one from the Grayburg-San Andres, three from the Glorieta; one (HUNTLEY) has insufficient data to determine whether the "3400" is Grayburg or San Andres. Formation depths in the area indicate that the "3400" is San Andres. The three Glorieta fields, HUNTLEY, P.H.D., and ROCKER, may be incorrectly listed as Guadalupe in age and as carbonate reservoirs; this grouping is based on PDS data giving the 313 age code. Lithology of the Glorieta varies from sandstone to dolomitic sands to dolomite, and it has not been determined whether the Glorieta pay zones in these reservoirs are sandstone or dolomite. However, each of the three fields has other carbonate reservoirs that may be potentially suitable for CO_2 flood.

7.4.2 PERMIAN-LEONARD (318). Two Leonard age reservoirs are listed. IATAN EAST-Clear Fork is listed by data source 14e as suitable for CO_2 flooding. PAROCHIAL BADE has Clear Fork in addition to the production from the Cisco, Fusselman, San Andres and Queen sandstone.

7.4.3 PENNSYLVANIAN (320). Four Cisco (322) reservoirs, seven Canyon (323), seven Strawn (325), and one Bend (326) are listed in Table 7. The Cisco, Canyon, and Strawn reservoirs are all primarily reef limestone; all the Canyon reservoirs are reefs. KELLY-SNYDER has a CO_2 pilot project currently under way and both COGDELL and SALT CREEK were rated by data source 14e as suitable for CO_2. DIAMOND M was rated as unsuitable by 14e because of its strong water drive. BOYD field has principal production from the Bend Conglomerate but also has pay zones in the Canyon Reef and Ellenburger carbonate formations.

7.5 North Basin Platform

7.5.1 PERMIAN-GUADALUPE (313) and -LEONARD (318). The North Basin Platform Permian reservoirs include seven San Andres (Guadalupe), one Glorieta (Guadalupe-Leonard), and two Clear Fork (Leonard). LEVELLAND,

SLAUGHTER, and WASSON are currently undergoing CO_2 pilot tests in the San Andres.

7.5.2 DEVONIAN (340). RUSSELL NORTH is the only Devonian field shown in Table 7. RUSSELL NORTH also has production from the Glorieta and Clear Fork.

7.6 Tatum Basin

7.6.1 PERMIAN (310). All Tatum Basin fields are in New Mexico. Five Guadalupe, two Leonard, and two Wolfcamp fields are shown in Table 7. Four of the five Guadalupe reservoirs are in the San Andres; the other is in the Queen, which may be a dolomite sandstone. LOVINGTON-San Andres was recommended by data source 13c (GURC Report 153) as suitable for CO_2 and polymer flood; MILNESAND-San Andres was recommended as suitable for polymer flood. Both LOVINGTON-Paddock and Abo (Leonard) were recommended for CO_2 and polymer in GURC report 153. DENTON and TOWNSEND are the two Wolfcamp fields listed; however, TOWNSEND-Wolfcamp is currently undergoing gas pressure maintenance.

7.6.2 PENNSYLVANIAN (320). Two fields, ALLISON and VADA, have Pennsylvanian age reservoirs. INBE, Cisco (322) in age, has fracture porosity.

7.6.3 DEVONIAN (340). Three Devonian age reservoirs are shown in Table 7. CAPROCK, EAST has fracture porosity, but was nevertheless recommended as being suitable for CO_2, as was LOVINGTON. LOVINGTON and DENTON have additional productive carbonate zones.

7.7 Northwest Shelf

7.7.1 PERMIAN (310). Ten Guadalupe reservoirs are listed in Table 7. Six are San Andres, two are Grayburg-San Andres, one is Queen-Grayburg, and one is Yates-Queen-Seven Rivers. BENSON NORTH-Queen-Grayburg, and E-K-Yates, Queen-Seven Rivers are primarily sandstones although minor dolomite is present. MALJAMAR-Grayburg-San Andres is undergoing a CO_2 pilot test and LOVINGTON WEST-San Andres and PEARL-San Andres were recommended for CO_2 and polymer flood in GURC report 153. Leonard age fields include CORBIN-Abo and EMPIRE-Abo. EMPIRE is listed in GURC report 153 as suitable for CO_2, but also listed by data source 14e (BETC/RI-78/15 report) as not suitable for CO_2 because of water drive and fractures. KEMITZ is a Wolfcamp field.

7.7.2 PENNSYLVANIAN (320). LUSK-Strawn is the only Pennsylvanian reservoir listed.

7.8 Delaware Basin

7.8.1 PERMIAN (310). FORT STOCKTON is listed as a carbonate by PDS; however, production is from the Yates sandstone, Ochoa (311) in age. PRIEST & BEAVERS produces from the Queen, Guadalupe in age, which may also be a sandstone. FOWLER produces from the Upper Yeso, Leonard in age, which is a fractured dolomite. None of the listed Delaware Basin fields is suitable for CO_2 enhanced oil recovery using stated criteria.

7.9 Bend Arch

7.9.1 PENNSYLVANIAN (320). The BOX-Palo Pinto Reef is a Pennsylvanian age reservoir. The Palo Pinto reef has fracture porosity and has undergone unsuccessful waterflood. These factors may make the BOX field unsuitable for CO_2 flood.

7.9.2 MISSISSIPPIAN (330). The SCHACKELFORD N.E. field was listed in the PDS sort; however, insufficient data are available to determine the suitability of this field for CO_2.

7.10 Matador Uplift

7.10.1 PERMIAN-WOLFCAMP (319). The ANTON-IRISH-Clear Fork field, shown in Table 7, is listed as suitable for both polymer and CO_2 flood in GURC report 153 (data source 13c).

7.11 Anadarko Basin

7.11.1 PERMIAN (310). The QUINDUNO-Albany field, Wolfcamp age, is the only Permian age Anadarko basin field listed.

7.11.2 PENNSYLVANIAN (320). The HITCHLAND-4640 and TWIN-Des Moines fields have gas caps, which may decrease their suitability for CO_2 flooding. TWIN-Morrow has had an unsuccessful gas pressure maintenance program.

8. PRODUCTION AND REMAINING OIL IN PLACE FOR SELECTED RESERVOIRS

Table 8, in the same order as Table 7, is a listing by reservoir of the estimated original oil in place, cumulative production through 1979, and the calculated remaining oil in place in each reservoir. These calculated values were used to determine the quantity of oil that could be recovered through continued secondary recovery (waterflood or pressure maintenance) or enhanced oil recovery projects in the listed reservoirs. In some cases our calculations produced numbers which are much larger or smaller than the figure for oil produced to date. We have flagged these numbers with a question mark; the questionable data that went into the calculation are similarly flagged in Table 7.

The total initial oil in place in the selected Permian basin reservoirs was calculated to be more than 55 billion barrels. Estimating the enhanced oil recovery potential from CO_2 flooding at 10 percent of initial oil in place (Doscher and Wise, 1976), 5.5 billion barrels of oil could be recovered from the listed reservoirs by widespread application of CO_2 flooding in the Permian basin. This estimate is slightly less than half the 12.8 billion barrels produced to date from the listed reservoirs, many of which have been in production over 30 years. It could be expected that additional amounts could be recovered from other fields not selected in this study.

Data developed in Section 5 of this report (Table 6) show that 60 percent of the reservoirs selected were Permian age, 23 percent were Guadalupe age San Andres, and 10 percent were Leonard age Clear Fork. Nineteen percent of selected reservoirs were Pennsylvanian in age; many of these are part of multiple-pay-zone fields along the Horseshoe Atoll. Twelve percent of the selected reservoirs were Devonian in age.

Of the selected reservoirs, those of Guadalupe age (principally San Andres and Grayburg) contain over 37 billion barrels of oil in place (67 percent of the estimated 55 billion calculated oil in place for all reservoirs). Over 7 billion barrels (13 percent) is contained in Leonard age reservoirs. Nearly 6 billion barrels (10 percent) is in Pennsylvanian age reservoirs, and over 3 billion barrels (5 percent) is in Devonian age reservoirs.

TABLE 8

CENTRAL BASIN PLATFORM

PERMIAN-GUADALUPE (313)

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
1. ARROWHEAD-Grayburg, NM	238,325.8	27,162.0	211,163.8
2. BLOCK-31-Grayburg, TX	9,143.5	3,499.8	5,643.7
3. C-BAR-San Andres, TX	55,043.2	15,455.8	42,587.4
4. CORAZON-San Andres, TX	30,994.8	3,738.9	27,255.9
5. COWDEN, NORTH-Grbg./San And.,TX	1,863,309.8	314,161.0	1,549,148.8
6. COWDEN, SOUTH-Grbg./San And.,TX	1,886,565.1	121,676.9	1,764,888.2
7. DONNELLY-San Andres, TX	15,846.2	7,512.6	8,333.6
8. DUNE-Grayburg/San Andres, TX	1,251,689.0	141,820.4	1,109,868.6
9. EDWARDS-Grayburg/San Andres, TX	53,401.7	7,495.5	45,906.2
10. EMMA-San Andres, TX	17,601.5(?)	17,601.5	-
11. EMPEROR-DEEP (Sandstones), TX	164,930.5	22,798.5	142,132.0
12. EMPEROR-HOLT, TX	35,004.5	6,366.7	28,637.8
13. EUNICE-San Andres, NM	-	-	-
14. EUNICE-MONUMENT, Grbg/S.A.,NM	2,367,980.3	334,553.0	2,033,427.3
15. FOSTER-Grayburg, TX	1,148,140.2	206,782.9	941,357.3
16. FULLERTON-San Andres, TX	124,825.7	8,583.8	116,241.9
17. GOLDSMITH-San Andres, TX	682,704.3	313,548.2	369,156.1
18. GOLDSMITH, EAST-San Andres, TX	92,500.2	7,322.7	85,177.5
19. GOLDSMITH, NORTH-San Andres, TX	561,440.5(?)	11,431.9	550,008.6
20. GOLDSMITH, WEST-San Andres, TX	41,248.6	5,476.5	35,772.1
21. HARPER-San Andres, TX	230,133.5	38,945.2	191,188.3
22. HOBBS-Grayburg/San Andres, NM	925,231.0	242,420.0	682,811.0
23. JOHNSON-Grayburg, TX	145,439.8	21,914.7	123,525.1
24. JORDAN-San Andres, TX	828,543.0	74,007.0	754,536.0
25. KEYSTONE-Holt, TX	953,316.3	39,542.2	913,774.1
26. LAWSON-San Andres, TX	75,355.1	13,275.8	62,079.3
27. LEA-San Andres, TX	41,219.9	4,378.0	36,841.9
28. McCAMEY-Grayburg, TX	1,002,572.3(?)	127,844.9	874,727.4
29. McELROY-Grayburg, TX	2,593,865.0(?)	373,438.2	2,220,426.8
30. McFARLAND, Queen, TX	136,739.4	34,680.5	102,058.9
31. MEANS-San Andres, TX	397,155.1	129,977.7	267,177.4

TABLE 8

CENTRAL BASIN PLATFORM

PERMIAN-GUADALUPE (313)

(continued)

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
32. PENWELL-San Andres, TX	378,049.9	66,142.9	311,907.0
33. SCARBOROUGH-Yates & Seven Rivers (Sandstone), TX	127,132.2	15,623.0	111,509.2
34. SEMINOLE-San Andres, TX	1,328,951.0	229,151.6	1,099,799.4
35. SEMINOLE, EAST-San Andres, TX	24,190.1	3,903.8	20,286.3
36. SEMINOLE, WEST-San Andres, TX	167,450.4	27,947.1	139,503.3
37. SHAFTER LAKE-San Andres, TX	235,833.5	33,617.9	202,215.6
38. SKAGGS-Grayburg, NM	22,406.4	8,717.0	13,689.4
39. WADDELL-San Andres, TX	422,877.9	89,942.1	332,935.8
40. YATES-Yates Lime, TX	1,513,597.7	768,661.0	744,936.7
TOTALS	22,190,754.9	3,921,119.2	18,269,635.7

TABLE 8

CENTRAL BASIN PLATFORM

PERMIAN-LEONARD (318)

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
1. BLINEBRY-Yeso, NM	226,493.3	38,811.0	187,682.3
2. BROWN & THORP-Clear Fork, TX	61,237.5	6,008.0	55,229.5
3. DOLLARHIDE-Clear Fork, TX	87,277.5	29,743.6	57,533.9
4. DOLLARHIDE-Tubb/Drinkard, TX	39,873.7	16,386.0	23,487.7
5. DRINKARD-Yeso-NM	1,197,921.9(?)	76,136.0	1,121,785.9
6. FULLERTON-Clear Fork, TX	825,826.2	199,544.3	626,281.9
7. GOLDSMITH-Clear Fork, TX	893,657.5	55,610.5	838,047.0
8. GOLDSMITH, EAST-Holt, TX	43,061.4	6,161.7	36,899.7
9. GOLDSMITH, WEST-Upper Cl.Fk.,TX	68,121.5	6,973.7	61,147.8
10. HARRIS-Glorieta/San Angelo, TX	157,005.2	30,573.8	126,431.4
11. HOBBS-Blinebry, NM	37,104.7	4,807.0	32,297.7
12. MONAHANS-Clear Fork, TX	100,732.0	8,677.8	92,054.2
13. RILEY, NORTH-Clear Fork, TX	759,372.0(?)	18,232.8	741,139.2
14. ROBERTSON, NORTH, TX	100,749.4	30,719.4	70,030.0
15. SAND HILLS-Tubb, TX	345,280.9	78,746.9	266,534.0
16. TUBB-Tubb, NM	41,798.7	5,951.0	35,847.7
17. TXL-Tubb, TX	537,640.9(?)	33,480.4	504,160.5
TOTALS	5,523,154.3	646,563.9	4,876,590.4

TABLE 8

CENTRAL BASIN PLATFORM

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-WOLFCAMP (319)			
1. ANDREWS-Wolfcamp, TX	35,257.9	17,560.0	17,697.9
2. ANDREWS, SOUTH-Wolfcamp, TX	23,679.8	12,089.0	11,590.8
3. PECOS VALLEY-Wolfcamp, TX	35,680.1	2,240.8	33,439.3
4. SHAFTER LAKE-Wolfcamp, TX	36,647.3	11,937.9	24,709.4
5. UNIVERSITY-BLOCK 9-Wolfcamp, TX	51,276.4	23,255.4	28,021.0
TOTALS	182,541.5	67,083.1	115,458.4
PENNSYLVANIAN-BEND (326)			
1. UNIVERSITY-BLOCK 9-Penn, TX	49,017.6	10,508.5	38,509.1
TOTALS	49,017.6	10,508.5	38,509.1
DEVONIAN (340)			
1. ANDREWS, SOUTH-Devonian, TX	46,113.0	9,920.0	36,193.0
2. BLOCK-11-Devonian, TX	93,931.0	7,319.0	86,612.0
3. BLOCK 31-L. Devonian, TX	529,573.0	162,729.1	366,843.9
4. CRAWAR-Devonian, TX	9,035.8	4,242.3	4,793.5
5. CROSSETT-Devonian, TX	37,652.2	12,183.7	25,468.5
6. CROSSETT, SOUTH-Dev.,TX	99,983.1	13,572.1	86,411.0
7. DOLLARHIDE-Devonian, TX	182,676.7	69,418.5	113,258.2
8. DOLLARHIDE-Devonian, NM	16,681.1	6,608.0	10,073.1
9. DOLLARHIDE, EAST-Dev., TX	11,636.4	5,478.4	6,158.0
10. FULLERTON-8500'-Devonian, TX	378,202.5	42,937.5	335,265.0
11. GOLDSMITH, NORTH-Devonian, TX	37,596.5	6,785.8	30,810.7
12. HARPER-Devonian, TX	90,285.0	6,837.3	83,447.7
13. LEA-Devonian, NM	51,947.6 (?)	6,120.0	45,827.6
14. PECOS VALLEY-Devonian, TX	82,497.4 (?)	4,619.0	77,878.4
15. THREE BAR-Devonian, TX	80,376.3	34,220.0	46,156.3
16. YARBOROUGH & ALLEN-Dev.,TX	48,887.3	2,536.9	46,350.4
TOTALS	1,797,074.9	395,527.6	1,401,547.3

TABLE 8

CENTRAL BASIN PLATFORM

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
	SILURIAN (350)		
1. ARMER-Fusselman, TX	8,681.9	3,915.0	4,766.9
2. DOLLARHIDE-Fusselman, TX	115,071.1	35,187.4	79,883.7
3. DOLLARHIDE-Fusselman, TX	above	above	above
4. KEYSTONE-Silurian, TX	72,533.9	25,199.4	47,334.5
TOTALS	196,286.9	64,301.8	131,985.1
	ORDOVICIAN (360)		
1. DOLLARHIDE-Ellenburger, TX	50,571.4	24,754.0	25,817.4
2. DOLLARHIDE-Ellenburger, NM	13,846.8	3,306.0	10,540.8
3. GOLDSMITH, WEST-Ellenburger, NM	8,056.4	3,657.7	4,398.7
4. JUSTIS-Ellenburger, NM	8,927.7	7,257.0	1,670.7
5. LEA-Ellenburger, NM	30,773.8	19,323.3	11,450.5
6. TXL-Ellenburger, TX	161,115.3	126,197.4	34,917.9
7. YARBOROUGH & ALLEN-Ellenb.,TX	39,430.5(?)	39,430.5	-
TOTALS	312,721.9	223,925.9	88,796.0

TABLE 8

MIDLAND BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-GUADALUPE (313)			
1. ADAIR-San Andres, TX	174,245.5	42,671.0	131,574.5
2. AZALEA-Grayburg, TX	4,124.9	816.5	3,308.4
3. CEDAR LAKE-San Andres, TX	281,324.8	63,233.2	218,091.6
4. GMK-San Andres, TX	46,446.1	9,478.6	36,967.5
5. MABEE-San Andres, TX	59,604.9(?)	59,604.9	-
6. MIDLAND FARMS-Grbg.,S.A.,TX	774,640.2	113,924.2	660,716.0
7. MOORE-Grayburg-San Andres, TX	34,441.2	8,815.8	25,625.4
8. REEVES-San Andres, TX	167,153.9	20,226.4	146,927.5
9. SUNILAND-San Andres, TX	10,115.4	2,296.1	7,819.3
10. WELCH-San Andres, TX	491,796.4	109,507.0	382,289.4
TOTALS	2,043,893.3	430,573.7	1.613.319.6
PERMIAN-LEONARD (318)			
1. KETCHUM MT-Clear Fork, TX	16,027.6	2,381.1	13,646.5
2. REVILO-Glorieta, TX	48,163.8	11,220.0	36,943.8
TOTALS	64,191.4	13,601.1	50,590.30
PERMIAN-WOLFCAMP (319)			
1. ADAIR-Wolfcamp-Reef, TX	87,915.0	45,566.0	42,349.0
2. BAKKE-Wolfcamp, TX	67,810.4	18,030.8	49,779.6
3. FASKEN-Wolfcamp, TX	5,807.6(?)	5,807.6	-
4. NOLLEY-Wolfcamp, TX	92,237.1	20,942.5	71,294.6
5. WELLMAN-Wolfcamp-Reef, TX	70,324.3	44,709.9	25,614.4
TOTALS	324,094.4	135,056.8	189,037.6
PENNSYLVANIAN-CISCO (322)			
1. REINECKE-Cisco, TX	81,032.4	63,317.5	17,714.9
2. VEALMOOR, EAST-Cisco/Wlfcp Reef,TX	87,653.5(?)	19.2	87,634.3
TOTALS	168,685.9	63,336.7	105,349.2

TABLE 8

MIDLAND BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PENNSYLVANIAN-CANYON (323)			
1. ROPES-Canyon Reef, TX	68,506.7	22,272.8	46,233.9
2. VEALMOOR-Canyon Reef, TX	33,749.8(?)	33,749.8	-
3. VEALMOOR, EAST-Canyon Reef, TX	56,691.7	49,007.6	7,684.1
4. VON ROEDER-Canyon Reef, TX	23,383.8	15,823.6	7,560.2
TOTALS	182,332.0	120,853.8	61,478.2
PENNSYLVANIAN-STRAWN (325)			
1. AZALEA-Strawn, TX	30,554.6 (?)	49.0	30,505.6
2. FLUVANNA-Strawn, TX	17,184.7 (?)	11,940.2	5,244.5
TOTALS	47,739.3	11,989.2	35,750.1
PENNSYLVANIAN-BEND (326)			
1. AMACKER-TIPPETT, SOUTH-Bend, TX	22,906.6	6,116.5	16,790.1
2. OCEANIC-Pennsylvanian, TX	51,930.4	20,115.9	31,814.5
3. PARKS-Pennsylvanian, TX	16,818.1	13,071.2	3,746.9
4. PEGASUS-Bend, TX	49,379.7	14,287.9	35,091.8
TOTALS	141,034.8	53,591.5	87,443.3
DEVONIAN (340)			
1. AZALEA-Devonian, TX	324,833.4 (?)	381.5	324,451.9
2. BREEDLOVE-Devonian, TX	46,674.4	26,092.0	20,582.4
3. DORA ROBERTS-Devonian, TX	136,750.9 (?)	1,928.8	134,822.1
4. HUTEX-Devonian, TX	58,229.4	33,687.4	24,542.0
5. MAGUTEX-Devonian, TX	65,919.9	38,833.0	27,086.9
TOTALS	632,408.0	100,922.7	531,485.3

TABLE 8

MIDLAND BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
	SILURIAN (350)		
1. BIG SPRINGS-Fusselman, TX	11,098.2	5,807.5	5,290.7
2. GOOD, S.E.-Fusselman, TX	23,078.6	8,293.2	14,785.4
3. LUTHER, S.E.-Silurian/Devonian, TX	38,080.8	18,346.4	19,734.4
4. TEX-HAMON-Fusselman, TX	21,078.0	14,999.9	6,078.1
TOTALS	93,335.6	47,447.0	45,888.6
	ORDOVICIAN (360)		
1. DORA ROBERTS-Ellenburger, TX	94,946.2	47,349.6	47,596.6
TOTALS	94,946.2	47,349.6	47,596.6

TABLE 8

REAGAN UPLIFT IN MIDLAND BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-GUADALUPE (313)			
1. BIG LAKE-Grayburg/San Andres,TX	155,828.4	125,388.1	30,440.3
2. FARMER-San Andres, TX	138,322.1(?)	7,789.6	130,532.5
3. HALFF-Grayburg, TX	38,230.0	3,007.6	35,222.4
TOTALS	332,380.5	136,185.3	196,195.2
PENNSYLVANIAN-STRAWN (323)			
1. TODD DEEP-Crinoidal Strawn, TX	83,886.6	29,437.3	54,449.3
2. WORLD, WEST-Strawn, TX	21,160.2	8,103.4	13,056.8
TOTALS	105,046.8	37,540.7	67,506.1
ORDOVICIAN (360)			
1. BARNHART-Ellenburger, TX	114,396.4(?)	15,856.9	98,539.5
2. ELKHORN-Ellenburger, TX	22,964.1	11,368.1	11,596.0
3. TODD DEEP-Ellenburger, TX	139,360.1(?)	40,258.1	99,102.0
TOTALS	276,720.6	67,483.1	209,237.5

TABLE 8

EASTERN SHELF

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-GUADALUPE (313)			
1. GARZA-San Andres, TX	289,063.1	67,099.2	221,963.9
2. HOWARD-GLASSCOCK-Grbg./S.A., TX	702,500.1	325,221.5	377,278.6
3. HUNTLEY-"3400", TX	6,570.5(?)	6,570.5	-
4. HUNTLEY, EAST-San Andres, TX	14,312.5	4,159.9	10,152.6
5. HUNTLEY, Glorieta, TX	6,340.5(?)	6,340.5	-----
6. P.H.D. - Glorieta, TX	47,998.6	5,406.9	42,591.7
7. ROCKER-A-San Andres, TX	32,935.1	4,118.3	28,816.8
8. ROCKER-A-Glorieta, TX	15,226.7	2,153.6	13,073.1
TOTALS	1,114,947.1	421,070.4	693,876.7
PERMIAN-LEONARD (318)			
1. IATAN, EAST-Clear Fork, TX	613,574.3(?)	107,268.7	506,305.6
2. PAROCHIAL-BADE-Clear Fork, TX	16,808.8	2,792.1	14,016.7
	630,383.1	110,060.8	520,322.3
PENNSYLVANIAN-CISCO (322)			
1. I.A.B.-Menielle, TX	39,392.2	17,596.8	21,795.4
2. INBE-Cisco, NM	30,933.5	16,040.8	14,892.7
3. JAMESON-Pennsylvanian, TX	168,804.5	39,778.5	129,026.0
4. SUSAN PEAK-Cisco/Canyon, TX	59,356.1	1,762.4	57,593.7
	298,486.3	75,178.5	223,307.8

TABLE 8

EASTERN SHELF

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PENNSYLVANIAN-CANYON (323)			
1. CLAYTONVILLE-Canyon Reef, TX	57,817.8(?)	57,817.8	-
2. COGDELL AREA-Canyon Reef, TX	233,515.8	232,033.0	1,482.8
3. DIAMOND M-Canyon Lime, TX	480,756.9	216,080.2	264,676.7
4. KELLY-SNYDER-Canyon Reef, TX	2,149,849.6	1,020,651.0	1,129,198.6
5. OCHO JUAN-Canyon Reef, TX	10,280.0	5,015.5	5,264.5
6, ROUNDTOP-Palo Pinto Reef, TX	76,334.9	38,390.3	37,944.6
7. SALT CREEK-Canyon Reef, TX	642,529.4	178,420.5	464,108.9
TOTALS	3,651,084.4	1,748,408.3	1,902,676.1
PENNSYLVANIAN-STRAWN (325)			
1. CLAIRMONT-Strawn, TX	33,799.2	13,512.4	20,286.8
2. FORT CHADBOURNE-Odom Lime, TX	152,090.2	52,299.7	99,790.5
3. H-J-Strawn Reef, TX	30,411.4	20,995.6	9,415.8
4. JAMESON-Strawn, TX	332,555.2(?)	35,798.2	296,757.0
5. NEILL, SOUTH-Odom Lime, TX	41,134.1	6,988.1	34,146.0
6. NENA LUCIA-Strawn Reef, TX	208,840.5	30,698.2	178,142.3
7. PAGE-Strawn & Canyon Reef, TX	32,984.6	4,804.2	28,180.4
TOTALS	831,815.2	165,096.4	666,718.8
PENNSYLVANIAN-BEND (326)			
1. BOYD-Bend Conglomerate, TX	52,317.1	21,970.0	30,347.1
TOTALS	52,317.1	21,970.0	30,347.1

TABLE 8

NORTH BASIN PLATFORM

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-GUADALUPE (313)			
1. BRAHANEY-San Andres, TX	200,309.0	30,686.2	169,622.8
2. BUCKSHOT-San Andres, TX	111,983.2 (?)	9,421.0	102,562.2
3. LANDON-San Andres, TX	41,248.7	5,525.3	35,723.4
4. LEVELLAND-San Andres, TX	1,712,587.5	312,239.7	1,400,347.8
5. OWNBY-San Andres, TX	31,715.9	8,612.4	23,103.5
6. RUSSELL-Glorieta, TX	17,612.0	6,290.2	11,321.8
7. SABLE-San Andres, TX	18,093.2	5,644.6	12,448.6
8. SLAUGHTER-San Andres, TX	2,068,219.7	797,157.1	1,271,062.6
9. WASSON-San Andres, TX	4,223,426.8	1,190,937.0	3,032,489.8
TOTALS	8,425,196.0	2,366,513.5	6,058,682.5
PERMIAN-LEONARD (318)			
1. RUSSEL-Clear Fork, TX	174,852.0	42,272.2	132,579.8
2. WASSON-72-Clear Fork, TX	139,619.2	35,192.2	104,427.0
TOTALS	314,471.2	77,464.4	237,006.8
DEVONIAN (340)			
1. RUSSELL, NORTH-Devonian, TX	72,708.7(?)	72,708.7	-
TOTALS	72,708.7	72,708.7	---

TABLE 8

TATUM BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-GUADALUPE (313)			
1. CAPROCK-Queen (Sandstone), NM	127,492.6	72,135.0	55,357.6
2. CHAVEROO-San Andres, NM	118,160.3(?)	19,519.0	98,641.3
3. FLYING M-San Andres, NM	25,981.8	6,505.0	19,476.8
4. LOVINGTON-San Andres, NM	80,664.1	12,270.0	68,394.1
5. MILNESAND-San Andres, NM	33,686.4	8,782.0	24,904.4
TOTALS	385,985.2	119,211.0	266,774.2
PERMIAN-LEONARD (318)			
1. LOVINGTON-Paddock, NM	32,082.3	12,692.0	19,390.3
2. LOVINGTON-Abo, NM	61,109.2	29,648.0	31,461.2
TOTALS	93,191.5	42,340.0	50,851.5
PERMIAN-WOLFCAMP (319)			
1. DENTON-Wolfcamp, NM	96,848.5	34,852.0	61,996.5
2. TOWNSEND-Wolfcamp, NM	21,473.7	18,786.0	2,687.7
TOTALS	118,322.2	53,638.0	64,684.2
PENNSYLVANIAN (320)			
1. ALLISON-Penn-Bough "C", NM	34,284.5	21,291.0	12,993.5
2. VADA-Pennsylvanian, NM	180,149.8	40,942.0	139,207.8
TOTALS	214,434.3	62,233.0	152,201.3
PENNSYLVANIAN-CISCO (322)			
1. INBE-Cisco, NM	16,603.8	16,040.0	563.8
TOTALS	16,603.8	16,040.0	563.8

TABLE 8

TATUM BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
	DEVONIAN (340)		
1. CAPROCK, EAST-Devonian, NM	22,311.0(?)	22,311.0	-
2. DENTON-Devonian, NM	522,483.4(?)	92,722.0	429,761.4
3. LOVINGTON-Devonian, NM	6,772.0	1,227.0	5,545.0
	551,566.4	116,260.0	435,306.4

TABLE 8

NORTHWEST SHELF

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-GUADALUPE (313)			
1. ARTESIA-San Andres/Grbg.,NM	445,142.1	24,572.0	420,570.1
2. BENSON, NORTH-Queen/Grbg., NM	19,006.5	2,360.0	16,646.5
3. CATO-San Andres, NM	81,885.1	14,472.0	67,413.1
4. E-K-Yates/Queen/Seven Rivers, NM	17,276.8	5,636.0	11,640.8
5. LOCO HILLS-Grbg./San Andres, NM	784,721.7	43,103.0	741,618.7
6. LOVINGTON, WEST-San Andres, NM	38,193.2	10,759.0	27,434.2
7. MALJAMAR-Grayburg/San Andres, NM	597,545.3	121,282.0	476,263.3
8. PEARL-San Andres, NM	1,527.8	62.0	1,465.8
9. SQUARE LAKE-Grbg./San Andres, NM	23,146.0(?)	23,146.0	-
10. VACUUM-San Andres, NM	703,284.4	180,997.0	522,287.4
TOTALS	2,711,728.9	426,389.0	2,285,339.9
PERMIAN-LEONARD (318)			
1. CORBIN-Abo, NM	36,844.5	13,052.0	23,792.5
2. EMPIRE-Abo, NM	185,351.0(?)	185,351.0	-
TOTALS	222,195.5	198,403.0	23,792.5
PERMIAN-WOLFCAMP (319)			
1. KEMITZ-L. Wolfcamp, NM	15,079.2	14,943.0	136.2
TOTALS	15,079.2	14,943.0	136.2
PENNSYLVANIAN-STRAWN (325)			
1. LUSK-Strawn, NM	80,810.8	18,916.0	61,894.8
TOTALS	80,810.8	18,916.0	61,894.8

TABLE 8

DELAWARE BASIN

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
PERMIAN-OCHOA (311)			
1. FORT STOCKTON-Yates (Sdstn),TX	562,067.1(?)	25,742.1	536,325.0
TOTALS	562,067.1	25,742.1	536,325.0
PERMIAN-GUADALUPE (313)			
1. PRIEST & BEAVERS-Queen-(Sandstone), TX	33,808.7	1,932.9	31,875.8
TOTALS	33,808.7	1,932.9	31,875.8
PERMIAN-LEONARD (318)			
1. FOWLER-Upper Yeso, NM	4,833.8	3,355.0	1,478.8
TOTALS	4,833.8	3,355.0	1,478.8

TABLE 8

FIELD, STATE	EST.ORIGINAL OIL IN PLACE (mbbls)	CUM. PROD. THRU 1979 (mbbls)	REMAINING OIL IN PLACE (mbbls)
BEND ARCH			
PENNSYLVANIAN-CANYON (323)			
1. BOX-Palo Pinto Reef, Tx	15,606.6	6,174.5	9,432.1
TOTALS	15,606.6	6,174.5	9,432.1
MISSISSIPPIAN (330)			
1. SHACKELFORD, N.E.-Miss., TX	286,449.2 (?)	3,652.4	282,796.8
TOTALS	286,449.2	3,652.4	282,796.8
MATADOR UPLIFT			
PERMIAN-LEONARD (318)			
1. ANTON-IRISH-Clear Fork, TX	514,964.1	123,512.0	391,452.1
TOTALS	514,964.1	123,512.0	391,452.1
ANADARKO BASIN			
PERMIAN-WOLFCAMP (319)			
1. QUINDUNO-Albany, TX	14,797.4(?)	14,797.4	-
TOTALS	14,797.4	14,797.4	-----
PENNSYLVANIAN (320)			
1. HITCHLAND-4640, Collier, TX	44,047.7 (?)	3,499.5	40,548.2
2. TWIN-Des Moines, TX	7,791.8(?)	7,791.8	-
3. TWIN-Morrow, TX	12,144.4	2,660.8	9,483.6
TOTALS	63,983.9	13,952.1	50,031.8

9. GEOLOGY OF THE PERMIAN BASIN

A discussion of the geologic history of the Permian basin has not been included in prior sections of this part of Volume I although the regional framework and stratigraphic column (Figs. 1 and 2) were presented to aid the reader in the data presentations which followed. A discussion of Permian basin geology is pertinent to understanding the environmental conditions that existed in the Permian basin through time which caused the deposition and later diagenesis of the carbonate rock units considered in this report. The depositional environment of a reservoir and its later environment are important to an understanding of the origin of both the reservoir rock unit and the fluids contained within the pore systems of that rock unit. For these reasons, the following classic articles on the geology and hydrodynamics of the Permian basin are recommended for further reading:

"Oil and Geology in the Permian Basin of Texas and New Mexico," by John Galley, published in Habitat of Oil, AAPG Symposium, 1958;

"Oil and Gas in Southwestern Region-Geologic Framework," by George R. Gibson, published in Fluids in Subsurface Environments, AAPG Memoir 4, 1965;

"Hydrodynamics of the Permian Basin," by Robert P. McNeal, published in Fluids in Subsurface Environments, AAPG Memoir 4, 1965.

A bibliography of publications referenced in the preparation of this volume is included in Section 11, pp. 112-125.

10. CONCLUSIONS AND RECOMMENDATIONS

Calculations of potential quantities of oil to be recovered using enhanced oil recovery techniques were made using the initial oil in place and cumulative production statistics for each reservoir. The data show that the Permian basin target reservoirs contained an estimated 55 billion barrels of oil initially in place. Using a general estimate of enhanced oil recovery potential from CO_2 flooding equal to 10 percent of initial oil in place, some 5.5 billion barrels of oil could be recovered by widespread application of CO_2 flooding in the Permian basin.

Data developed in this volume show that the bulk of the oil in the carbonate reservoirs of the Permian basin is contained in San Andres and Grayburg (67 percent), Clear Fork (13 percent), Pennsylvanian (10 percent), and Devonian (5 percent) reservoirs.

From this distribution, it might be argued that the San Andres should be the principal target reservoir for future work.

The information compiled and reported in our Task One report (Goodrich, 1980) shows that CO_2 pilot flooding projects have been done or are ongoing in the San Andres reservoirs of the Wasson, Levelland, Slaughter, and North Cowden fields in Texas. In addition, as part of the "early wells" work under Tasks Three through Six of this contract, Gruy Federal has recently completed field operations on a DOE-funded pressure-coring project in a well drilled by the Texas Pacific Oil Company in the Bennett Ranch unit of the Wasson field. Data from the pilot projects, all conducted by major operators, will be widely disseminated to the other working interest owners, both major and independent, of the large waterflood units in which the projects are being conducted. Data from the Texas Pacific pressure-coring project will be made public via Government publication shortly; a draft of the final report has been submitted for DOE review. It thus seems that a large body of information will soon be available on the CO_2 flooding potential and pilot performance in the San Andres dolomite reservoirs on the North and Central Basin platforms.

The other target reservoirs are in the Leonard group, principally the Clear Fork. A CO_2 flooding target volume of at least 700 million barrels is projected for the 29 reservoirs identified in this geologic grouping. A lower priority could be given to Pennsylvanian and Devonian reservoirs, which also contain substantial initial oil in place. We reason that the present concentration of effort on the San Andres may overshadow CO_2 flooding possibilities in these other reservoirs. Publication of data on CO_2 flooding potential would tend to encourage earlier application in these reservoirs by operators who may have little or no vested interest in San Andres projects.

11. BIBLIOGRAPHY

GENERAL REFERENCES

AAPG, Geothermal Gradient Maps

Doscher, T. M., and Wise, F. A., 1976, Enhanced Crude Oil Recovery Potential--An Estimate: Jour. Petroleum Technology, May,v. 28.

Goodrich, J. H., 1979, Target Reservoirs for Carbon Dioxide Miscible Flooding: U.S. DOE/MC/08431-17.

Midland Map Company, 1979, Permian Basin Map: Midland, Texas.

Management Plan for Enhanced Oil Recovery, Vol. 1, Program Strategy, 1976: ERDA 77-15/1, February.

National Petroleum Council, 1976, Enhanced Oil Recovery, An Analysis of the Potential for Enhanced Oil Recovery from Known Fields in the United States--1976 to 2000: NPC, Washington, D.C.

Petroleum Information Energy Map Services: San Antonio, Texas.

Petroleum Information, 1979, Electrical, Radioactivity and Hydrocarbon Surveys in West Texas and New Mexico, West Texas Electrical Log Service, Vol. 3, 669 pp.

Petroleum Information System (PDS): data from OILY, TEXS, SECREC, COIL files, Univ. of Oklahoma, Information Systems Programs, Energy Resources Center, P.O. Box 3030, Norman, Oklahoma 73070.

TEXAS MAXIMUM EFFICIENCY RATE HEARINGS (MER): data collected through the DOE Energy Information Agency in Dallas, Texas under contract to the University of Oklahoma, not yet entered into the PDS data base.

TEXAS WATER QUALITY BOARD REPORT, No. 157, 1972, Survey of the Subsurface Saline Waters of Texas, October, International Oil Scouts Report.

RESERVOIR AND FLUID PROPERTIES

Daniels, F., and Alberty, R. A., 1955, Physical Chemistry, 3rd Edition: John Wiley and Sons, 767 pp.

Holm, L. W., and Josendal, V. A., 1974, Mechanism of Oil Displacement by Carbon Dioxide: Jour. Pet. Technology, December, v. 26, p. 1427-1438.

McNeal, R. P., 1965, Hydrodynamics of the Permian Basin in Fluids in Subusrface Environments: AAPG Memoir 4, pp. 308-326.

Vulhalovitch, M. P., and Altunin, V. V., 1968, Thermophysical Properties of Carbon Dioxide: Collets Publishers, London.

Yellig, W. F., and Metcalfe, R. S., 1978, Determination and Prediction of CO_2 Minimum Miscibility Pressure: Society Petroleum Engineers Paper 7477 presented at SPE-AIME 53rd Annual Fall Technical Conference and Exhibition, Houston.

ORIGIN OF CARBONATES

Blatt, H. Middleton, G., and Murray, R., 1972, Origin of Sedimentary Rocks: Prentice-Hall, Englewood Cliffs, N. J.

Chilinger, G. V., 1956, Use of Ca/Mg Ratio in Porosity Studies: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 2489-2493.

Davies, G. R., 1976, Dolomite Reservoir Rocks: Processes, Control, Porosity Development, in Geology of Carbonate Porosity: Am. Assoc. Petroleum Geologists Continuing Education Course Notes #11, p. C1-C17.

Dean, W. E., Davis, G. R., Anderson, R. Y., 1975, Sedimentalogical Significance of nodular and laminated anhydrite: Geology, July, p. 367-372.

Dean, W. E., and Schreiber, B. C., 1978, Marine Evaporites, SEPM Continuing Education Short Coarus #4, Lecture Notes.

Jacka, A. D., and Franco, L. A., 1975, Deposition and Diagenesis of Permian Evaporites and Associated Carbonates and Clastics on Shelf Areas of the Permian Basin, in Fourth Symposium on Salt: Northern Ohio Geological Society, p. 67-89.

Lucia, F. J., 1972, Recognition of Evapority-Carbonate Shoreline Sedimentation, in J. K. Rigby and W. K. Hamblin (eds.) Recognition of Ancient Sedimentary Environments: Soc. Econ. Paleontologists and Mineralogists Spec. Publ. #16, p. 160-191.

Lucia, F. J., 1962, Diagenesis of a Crinoidal Sediment: Jour. Sedimentary Petrology, v. 32, p. 848-865.

Murray, R. C., 1960, Origin of Porosity in Carbonate Rocks: Jour. Sedimentary Petrology, v. 30, p. 59-84.

Wardlaw, N. C., 1976, Pore Systems in Carbonate Rocks and Their Influence on Hydrocarbon Recovery Efficiency, in Geology of Carbonate Porosity: Am. Assoc. Petroleum Geologists Continuing Education Coarse Notes #11, p. E1-E24.

Wilson, J. L., 1975, Carbonate Facies in Geologic History: Springer Verlag Publishing Company, Berlin.

CLASSIFICATION OF CARBONATES

Baria, L. R., 1976, Desiccation Features and the Reconstruction of Paleo Salinities, Jour. Sedimentary Petrology, v. 47, p. 908-914.

Choquette, P. W., and Pray, L. C., 1970, Geologic Nomenclature and Classification of Porosity in Sedimentary Carbonates: Am. Assoc. Petroleum Geologists, v. 54, p. 207-250.

Ham, W. E., and Pray, L. C., 1963, Modern Concepts and Classifications of Carbonate Rocks: Am. Assoc. Petroleum Geologists Mem. 1, p. 2-19.

Nurmi, R. D., 1978, Use of Well Logs in Evaporite Sequence in SEPM Short Course #4 Notes, edited by W. Dean and C. Schreifer, p. 144-178.

GEOLOGY OF PERMIAN, PALO DURO, ANADARKO BASINS

Adams, J. E., 1965, Stratigraphic-Tectonic Development of Delaware Basin: Am. Assoc. Petroleum Geologists Bull., v. 49, no. 11, p. 2140-2148.

Barnes, V. E., et al, 1953, Stratigraphy of Pre-Simpson Paleozoic Rocks of Texas and New Mexico: Univ. Texas, Bureau of Econ. Geol. Publ. No. 5924.

Brokow, A. L., Jones, C. L., Cooley, M. E., and Hays, W. H., 1972, Geology and hydrology of the Carlsbad potash area, Eddy and Lea counties, New Mexico: U.S. Geol. Survey Open-File Report 4339-1, 86 p.

Darton, N. H., 1922, Geological Structure of Parts of New Mexico: U.S. Geol. Survey Bull. No. 726-E, p. 173-275.

Dutton, S. P., Finley, R. J., Galloway, W. E., Gustavson, T. C., Handford, C. R., Presley, M. D., 1979, Geology and Geohydrology of the Palo Duro Basin, Texas Panhandle: Bureau of Economic Geology, Geological Circular 79-1.

Elam, J. G., 1973, Tectonic Evolution of Val Verde--Delaware Basin (Abstract): Am. Assoc. Petroleum Geologists Bull., v. 57, no. 2, p. 420.

Galley, J. E., 1958, Oil and Geology in the Permian Basin of Texas and New Mexico, in Habitat of Oil: Am. Assoc. Petroleum Geologists Symposium, p. 395-446.

Hills, J. M. et al, 1949, Pre-Permian Rocks of Trans-Pecos Area and Southern New Mexico: West Texas Geol. Soc. Guidebook, Field Trip No. 5.

Hills, J. M., 1963, Late Paleozoic Tectonics--Western Texas to Southern Colorado: Am. Assoc. Petroleum Geologists Bull., v. 47, no. 9, p. 1709-1725.

Hills, J. M., 1970, Late Paleozoic-Structural Directions in Southern Permian Basin: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 10, p. 1809-1827.

Huffington, Roy M., et al, 1951, Petroleum Geology of Permian Basin of West Texas and Southeastern New Mexico: West Texas Geol. Soc. Publ.

Irwin, J. H., and Morton, R. B., 1969, Hydrogeologic information on the Glorieta Sandstone and the Ogallala Formation in the Oklahoma Panhandle and adjoining areas as related to underground waste disposal: U.S. Geol. Survey Circular 630, 26 p.

Jordan, Louise, and Vosburg, D. L., 1963, Permian salt and associated evaporites in the Anadarko basin of the western Oklahoma-Texas Panhandle region: Oklahoma Geol. Survey Bull. 102, 76 p.

Johnson, K. S., 1976, Evaluation of Permian Salt Deposits in the Texas Panhandle and Western Oklahoma for Underground Storage of Radioactive Waste: Union Carbide Nuclear Division Document No. Sub-4496/1, April.

Landes, K. S., 1970, Petroleum Geology of the United States: John Wiley & Sons, New York, New York.

McKee, E. D., Oriel, S. S., and others, 1967a, Paleotectonic maps of the Permian System: U.S. Geol. Survey Misc. Geol. Inv. Map I-450, 164 p.

_____, 1976b, Paleotectonic investigations of the Permian System on the United States: U.S. Geol. Survey Prof. Paper 515, 271 p.

Silver, B. A., and Todd, R. G., 1969, Permian Strata, Midland and Delaware Basins: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 11, p. 2223-2251.

Walkschmidt, W. A., 1966, Geologic Framework of the Permian Basin, in Oil and Gas Fields in West Texas: West Texas Geol. Soc. Publ. 66-52, p. 7-9.

Vertrees, C. D., et al, 1960, Paleozoic Geology of the Delaware and Val Verde Basins, Corpus Christi Geol. Soc. 10th Annual Field Trip Guidebook, p. 32-41. (Also in Geology of the Val Verde Basin Guidebook: West Texas Geol. Soc., p. 64-73.)

Young, Addison, et al, 1960, Geology of the Delaware Basin: West Texas Geol. Soc. Guidebook.

STRATIGRAPHY

Adams, J. E., Cheney, M. G., DeFord, R. K., Dickey, R. I., Dunbar, C. O., Hills, J. M., King, R. E., Lloyd, E. R., Miller, A. K., and Needham, C. E., 1939, Standard Permian Section of North America: Am. Assoc. Petroleum Geologists Bull., v. 23, p. 1673-1681.

Adams, J. E., 1962, Foreland Pennsylvanian Rocks of Texas and Eastern New Mexico, in Pennsylvanian System in the United States, Am. Assoc. Petroleum Geologists, p. 372-384.

Anderson, R. V., Dean, W. E., Jr., Kirkland, D. W., Snider, H. I., 1972, Permian Castile Varved Evaporite Sequence, West Texas and New Mexico: Geol. Soc. America Bull., v. 83, p. 59-86.

Barone, W. E., 1976, Depositional Environments and Diagenesis of the Lower San Andres Formation (Curry County) New Mexico: unpublished Master's thesis, Texas Tech University.

Bergenback, R. E., and Terriere, R. T., 1953, Petrography and Petrology of Scurry Reef, Scurry County, Texas: Am. Assoc. Petroleum Geologists Bull., v. 37, p. 1014-1029.

Brown, L. F., Jr., Cleaves, A. W., II, and Erxleben, A. W., 1973, Pennsylvanian Depositional Systems in North-Central Texas: Univ. Texas Bureau of Econ. Geol. Guidebook No. 14.

Chuber, S., and Pusey, W. C., 1967, Cyclic San Andres Facies and Their Relationship to Diagenesis, Porosity, and Permeability in the Reeves Field, Yoakum County, Texas, in J. G. Elam and S. Chuber (eds.) Cyclic Sedimentation in the Permian Basin, A Symposium: West Texas Geol. Soc., p. 136-151.

Flawn, P. T., 1961, The Ouachita System: Univ. Texas Publ. 6120, p. 49-58, and 65-81.

Flower, R. H., 1958, Cambrian-Mississippian Beds in Southern New Mexico: Roswell Geol. Soc. 11th Field Conference Guidebook, p. 61-78.

Gratton, P. J. F., and LeMay, W. J., 1957, San Andres formation in southeastern New Mexico: Oil and Gas Journal, March 20, p. 207-212.

Hansford, C. R., and Dutton, S. P., 1980, Pennsylvanian-Early Permian Depositional Systems and Shelf-Margin Evolution, Palo Duro Basin, Texas: Am. Assoc. Petroleum Geologists Bull., v. 64, p. 88-106.

Hills, J. M., and Hoenig, M. A., 1979, Proposed Type Section for Upper Silurian and Lower Devonian Subsurface Units in Permian Basin, West Texas: Am. Assoc. Petroleum Geologists Bull., v. 63, no. 9, p. 1510-1521.

Jacka, A. D., and St. Germain, L. C., 1967, Deep-Sea Fans in the Permian Delaware Mountain Group, Delaware Basin, West Texas and New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 51, p. 471-472.

Jacka, A. D., 1967, Guadalupian Depositional Cycles of Delaware Basin, in Cyclic Sedimentation in the Permian Basin: West Texas Geol. Soc. Publ. 69-56, p. 152-196.

Jardine, D., Andrews, D. P., Wishart, J. W., and Young, J. W., 1977, Distribution and Continuity of Carbonate Reservoirs: Jour. Petroleum Technology, v. 29, p. 873-885.

Johnson, K. S., and Gonzales, Serge, 1978, Salt Deposits in the United States and Regional Geologic Chacteristics Important for Storage of Radioactive Waste: Office of Waste Isolation, Union Carbide Nuclear Division document no. Y/OWI/Sub-7417/1.

Kottlowski, F. E., et al, 1956, Stratigraphic Studies of the San Andres Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources Mem. 1, p. 1-132.

Laporte, L. F., 1971, Paleozoic Carbonate Facies of the Central Appalachian Shelf, Jour. Petroleum Technology, v. 41, p. 724-740.

Lee, W. T., and Girty, G. H., 1909, Manzano Group of the Rio Grand Valley, New Mexico: U. S. Geol. Soc. Bull. No. 389, p. 1-141.

LeMay, W. J.,1977, Abo Reefing in Southeastern New Mexico, in The Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc. Symposium Supplement, p. xvii-xxi.

Malek-Aslani, Morad, 1970, Lower Wolfcamp Reef in Kemnitz Field, Lea County, New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 54, p. 2317-2335.

McGlasson, E. H., 1967, The Siluro-Devonian of West and Southeast New Mexico, in International Symposium on the Devonian System, Calgary, ed. by D. Oswald, p. 937-949.

Meyer, R. R., 1966, Geology of Pennsylvanian and Wolfcampian Rocks in Southeastern New Mexico: New Mexico Bur. Mines and Minerals Resources, Mem. 17, p. 123.

Meissner, F. F., 1972, Cyclic Sedimentation in Middle Permian Strata of The Permian Basin, West Texas and New Mexico, in Cyclic Sedimentation in the Permian Basin, 2nd ed., West Texas Geol. Soc. Publ. 72-60, p. 203-232.

Miller, A. K., and Furnish, W. M., 1940, Permian Ammonoids of the Guadalupe Mountain Region and Adjacent Areas: Geol. Soc. America Spec. Paper 26, 242 p.

Milner, S., 1976, Carbonate Petrology and Syndepositional Facies of the Lower San Andres Formation (Middle Permian), Lincoln County, New Mexico: Jour. Petroleum Technology, v. 46, p. 463-482.

Muri, N., 1978, Depositional Environments and Diagenesis of Lower San Andres Formation, Quay and Roosevelt Counties, New Mexico: unpublished Master's thesis, Texas Tech University.

Needham, C. E., and Bates, R. L., 1943, Permian Type Sections in Central New Mexico: Geol. Soc. America Bull., v. 54, p. 1653-1668.

Plummer, F. B., and Scott, G., 1937, Upper Paleozoic Ammonities in Texas, in The Geology of Texas: Univ. Texas, Bureau of Econ. Geol. Bull. 3701, v. 3, p. 1-516.

Sellands, E. H., Adkins, W. S., and Plummer, F. B., 1932, The Geology of Texas: Volume I, Stratigraphy: Univ. Texas, Bureau of Econ. Geol. Bull. 3232, 1007 p.

Silver, B. A., and Todd, R. G., 1969, Permian Cyclic Strata, Northern Midland and Delaware Basins, West Texas and Southeastern New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 53, p.2223-2251.

Skinner, J. W., 1946, Correlation of Permian of West Texas and Southeast New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 30, p.1857-1874.

Sloss, L. L., Dupples, E. C., and Krumbein, W. C., 1960, Lithofacies Maps, An Atlas of the United States and Southern Canada, 108 p.

Thornton, D. E., and Gaston, H. H., Jr., 1968, Geology and Development of Lusk Strawn Field, Eddy and Lea Counties, New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 52, p. 66-81.

Todd, R. G., 1976, Oolite-Bar Progradation, San Andres Formation, Midland Basin, Texas: Am. Assoc. Petroleum Geologists Bull., v. 60, p.907-925.

Tully, S. A., 1979, Lithofacies and Diagenetic Relationships within the San Andres Formation, Quay and DeBaca Counties, New Mexico: unpublished Master's thesis, Texas Tech. University.

Young, A. 1964, The Penwell-to-Means Upper San Andres Reef of West Texas, in Fluids in Subsurface Environments: Am. Assoc. Petroleum Geologists, p. 280-293.

FIELD INVESTIGATIONS

Babcock, C. V., 1956, Eunice-Monument field, in Oil and Gas Fields of Southeast New Mexico: Roswell Geol. Soc., p. 165.

Barrett, D. D., Harpole, K. J., and Zaaza, M. W., 1977, Reservoir Data Pays Off: West Seminole San Andres Unit, Gaines County, Texas: Paper SPE 6738 presented at SPE-AIME 52nd Annual Fall Technical Conference and Exhibition, Denver, Oct. 9-12.

Bartram, J. G., Imbt, W. C., and Shea, E. F., 1950, Oil and Gas in Arbuckle and Ellenburger Formations, Mid-Continent Region: Am. Assoc. Petroleum Geologist Bull., v. 34, p. 682-700.

Berg, J. W., Jr., et al, 1960, Seismic Investigations-Eastern Part of Basin and Range Province: Seis. Soc. America Bull., v. 50, p. 511-535.

Bergenback, R. E., and Terriere, R. T., 1953, Petrography and petrology of Scurry reef, Scurry County, Texas: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 5, p. 1014-1029.

Best, J. B., Jr., 1964, Oil and gas prospects in the Palo Duro basin: World Oil, December, p. 97-113.

Blanchard, K., 1977, Puckett field, in Gas Fields of West Texas: West Texas Geol. Soc. Publ. No. 1977-67, p. 76-78.

Burke, J. A., Curtis, M. R., and Cox, J. T., 1967, Computer Processing of Log Data Improves Production in Chaveroo Field: Jour. Petroleum Technology, v. 19, p. 889-895.

Burnside, R. J., 1959, Geology of part of the Horseshoe atoll in Borden and Howard counties, Texas, in Pennsylvanian and Lower Permian rocks of parts of West and Central Texas: U.S. Geol. Survey Prof. Paper 315-B, p. 21-35.

Cafee, E. C., and Dubitzky, R. H., 1967, Vacuum Abo reef, in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc., p.179.

Cloud, P. E., Jr., and Barnes, V. E., 1948, The Ellenburger Group of Central Texas, Univ. Texas, Bureau of Econ. Geol. Circ. 4621, 473 p.

Conselman, F. B., 1960, Pennsylvanian reef patterns in West-Central Texas: Univ. Texas, Bureau of Econ. Geol. Publ. 6017, p. 1-3.

Cook, V. O., 1966, Regional geology of the Delaware basin: Jour. Petroleum Technology, October, p. 1260-1266.

Cooper, C. G., and Ferris, B. J., 1957, TXL field, in Occurrence of Oil and Gas in West Texas: Univ. Texas Publ. 5716, p. 358-368.

Davis, M. J., 1929, Artesia field, Eddy County, New Mexico, in Structure of Typical American Oil Fields: Am. Assoc. Petroleum Geologists Bull., v. 1, p. 112-113.

Day, W., and Galbraith, G., 1950, Notes on the Round Top field, Fisher County, Texas in Geological Contribution: Abilene Geol. Soc., p. 66-67.

DeFord, R. K., and Wahlstrom, E. A., 1932, Hobbs field, Lea County, New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 16, no. 1, p. 51-90.

Denham, R. L.,and Dougherty, W. E., 1941, "Sand Belt" area of Ward and Winkler Counties, Texas and Lea County, New Mexico, in Stratigraphic Type Oil Fields: Am. Assoc. Petroleum Geologists Bull., p. 750-759.

Donoghue, D., and Gupton, W. L., Jr., 1957, Yates field, in Oil Fields of West Texas: Univ. Texas Publ. 5716, p. 426-433.

Doss, A. K., Jr. and Spiva, F. J., Jr., 1968, Palo Pinto limestone production, Western Runnels County, Texas: Am. Assoc. Petroleum Geologists Bull., v. 52, no. 1, p. 82-91.

Dowling, P. L., 1970, Application of Carbonate Environmental Concepts to Secondary Recovery Projects, Paper SPE 2987 presented at the SPE-AIME 45th Annual Fall Meeting, Houston, Oct. 4-7.

Driscoll, V. J., 1974, Recovery Optimization Through Infill Drilling Concepts, Analysis and Field Results, Paper SPE 4977 presented at SPE-AIME 49th Annual Fall Meeting, Houston, Oct. 6-9.

Dunn, D. A., 1956, Caprock Queen field, Chaves and Lea Counties, in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc., p. 91.

Ellison, S. P., Jr., 1948, Apco field, Pecos County, Texas, in Structure of Typical American Oil Fields: Am. Assoc. Petroleum Geologists Bull., v. 3, p. 399-418.

Ellison, S. P., Jr., 1957, Page field, Schleicher County, Texas, in Occurrence of Oil and Gas in West Texas: Univ. Texas Publ. 5716, p. 247-251.

Fryman, A. D., 1956, Artesia and Empire fields, in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc., p.55.

Fikes, J. C., 1966, Lea Field (Ellenburger), Crane County, Texas, in Oil and Gas Fields in West Texas: West Texas Geol. Soc. Publ. No. 66-52, p. 226-229.

Ghauri, W. K., Osborne, A. F., and Magnuson, W. L., 1974, Changing Concepts in Carbonate Waterflooding, West Texas Denver Unit Project--An Illustrative Example, Jour. Petroleum Technology, June, p. 595-666.

Gibson, G. R., 1965, Oil and Gas in Southwestern Region-Geologic Framework, in Fluid in Subsurface Environments, ed. by A. Young and J. E. Galley, Am. Assoc. Petroleum Geologists Memoir 4, p. 66-100.

Giesey, S. C., and Falk, F. F., 1941, North Cowden Field, Ector County, Texas, Am. Assoc. Petroleum Geologists Bull., v. 25, p. 593-629.

Grimes, D. N., 1966, Fluvanna Field, in Oil and Gas Fields of West Texas, West Texas Geol. Soc., p. 134-139.

Harbison, R. R., 1957, Pegasus field, in Occurrence of Oil and Gas in West Texas: Univ. Texas Publ. 5716, p. 271-276.

Hardy, D. G., 1969, Azalea Field, in Oil and Gas Fields of West Texas: West Texas Geol. Soc. Publ. 69-57, v. II, p. 9-22.

Hennen, R. V. , 1929, Big Lake oil field, Reagan County, Texas, in Structure of Typical American Oil Fields: Am. Assoc. Petroleum Geologists Bull., v. 2, p. 500-541.

Herald, F. A., ed., 1951, Occurrence of Oil and Gas in West Texas: Univ. Texas Publ. 5716, p. 442.

Hills, John M., 1961, Tippett field, Crockett and Pecos Counties, Texas: Am. Assoc. Petroleum Geologists Bull., v. 26, no. 2, p. 217-255.

Hills, John M., 1968, Permian basin field area, West Texas and Southeastern New Mexico: Geol. Soc. America Spec. Paper 88, p. 17-27.

Holmgnest, H. J., 1965, Deep Pays in Delaware and Val Verde Basins, in Fluids in Subsurface Environments: Am. Assoc. Petroleum Geologist Mem. 4, p. 257-279.

Horak, R. L., 1966, East Dollarhide Field (Silurian), Andrews County, Texas, in Oil and Gas Fields in West Texas: West Texas Geol. Soc. Publ. No. 66-52, p. 120-121.

Imbt, R. F., and McCollum, S. V., 1950, Tood Deep field, Crockett County, Texas: Am. Assoc. Petroleum Geologists Bull., v. 34, no. 2, p. 239-262.

Jackson, W. E., 1964, Depositional topography and cyclic deposition in West Central Texas: Am. Assoc. Petroleum Geologist Bull., v. 48, no. 3, p. 317-328.

Jones, T. S., 1951, Plainview basin, Texas and New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 35, no. 2, p. 344-352.

Jones, T. S., 1953, Stratigraphy of the Permian Basin of West Texas: West Texas Geol. Soc., February, p. 1-57.

Jones, T. S., and Smith, H. M., 1965, Relationships of oil composition and stratigraphy in the Permian basin of West Texas and New Mexico: Am. Assoc. Petroleum Geologists Mem. 4, p. 104-224.

Kenner, M. H. L., 1957, Dollarhide field, in Occurrence of Oil and Gas in West Texas: Univ. Texas Publ. 5716, p. 87-96.

Kendrick, Frank E., and Russell, Philip G., 1935, Natural Gas in Bend Arch district, Texas, in Geology of Natural Gas: Am. Assoc. Petroleum Geologists, p. 609-649.

Kinney, E. E., et al, 1967, Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc. Symposium.

Little, C. E., 1961, Quinduno field, in Oil and Gas Fields of Texas and Oklahoma Panhandles: Panhandle Geol. Soc., p. 184-196.

Marshall, L. R., and Foltz, G. A., 1960, Justis field, in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc., p. 110-123.

McInnis, A. B., and Hartman, F. H., 1957, McElroy field, in Occurrence of Oil and Gas in West Texas: Univ. Texas Publ. 5716, p. 203.

McPeters, K. D., and Kelly, J. M., 1956, Hobbs Grayburg-San Andres field in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc., p. 207.

Milks, Roy, 1956, Vacuum Grayburg-San Andres field, in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc., p. 33.

Mooney, T. D., 1966, Howard-Glasscock field, Howard and Glasscock counties, in Oil and Gas Fields of West Texas, a Symposium: West Texas Geol. Soc., p. 183-191.

Myers, D. A., Stafford, P. T., and Burnside, R. J., 1956, Geology of the late Paleozoic Horseshoe atoll in West Texas: Univ. Texas Publ. 5607, 113 p., Summary in Oil and Gas Jour., June 18, 1956, p. 248-252.

Nicholson, J. H., 1960, Geology of the Texas Panhandle, in Aspects of the Geology in Texas, a Symposium: Univ. Texas, Bureau of Econ. Geol. Publ. 6017, p. 51-64.

Nottingham, M., 1960, Recent Upper Bell Canyon Exploration in the North Delaware Basin, in Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc. Symposium.

Panhandle Geological Society, 1961, Oil and Gas Fields of the Texas and Oklahoma Panhandles: Amarillo, Texas.

Pontius, S. B., and Tham, M. J., 1978, North Cross (Devonian) Unit CO_2 Flood-Review of Flood Performance and Numerical Simulation Model, Jour. Petroleum Technology, December, p. 1706-1714.

Robinson, J. D., 1966, Anton-Irish field, in Oil and Gas Fields in West Texas, a Symposium: West Texas Geol. Soc., p. 25-28.

Schneider, W. T., 1957, Wasson field, Yoakum and Gaines Counties, in Herald, Occurrence of Oil and Gas in West Texas, p. 377-384.

Stenzel, W. K., 1965, Time of migration and accumulation of petroleum in Abo reef of southeastern New Mexico--a hypothesis, in Fluids in Subsurface Environments: Am. Assoc. Petroleum Geologists Mem. 4, p. 243-256.

Stevens, Curtis, 1962, Major play shaping up in Palo Duro: World Oil, February 1, p. 94-95.

Swanson, Donald C., 1967, Major functions controlling Anadarko basin production: World Oil, January, p. 81-92.

Sweeny, H. N., et al, 1960, Oil and Gas Fields of Southeastern New Mexico: Roswell Geol. Soc. Symposium.

Stipp, T. F., et al, 1956, Oil and Gas Fields of Southeastern New Mexico, a Symposium: Roswell Geol. Soc., p. 376.

Thorton, D. W., and Gaston, H. H., Jr., 1968, Geology and development of Lusk Strawn field, Eddy and Lea counties, New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 52, no. 1, p. 66-81.

Vest, E. L., Jr., 1966, Kelly-Snyder Canyon reef, Western Scurry county, Texas, in Oil and Gas Fields in West Texas, a Symposium: West Texas Geol. Soc., p. 213-217.

Vest E. L., Jr., 1970, Oil Fields of Pennsylvanian-Permian Horseshoe Atoll, West Texas, in Geology of Giant Petroleum Fields, M. T. Halbouty, ed., Am. Assoc. Petroleum Geologists.

Wright, W. F., 1962, Abo reef--prime West Texas target: Oil and Gas Jour., July 30, p. 226-235; August 6, p. 188-194.

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