Update of Atlas of Major Texas Oil Reservoirs Data Base and Atlas of Major Texas Gas Reservoirs Data Base

Contract Report

By

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Prepared for the U.S. Geological Survey under Contract No. 1434-93-C-40079

Bureau of Economic Geology

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Austin, Texas 78713-7508

June 1993

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INTRODUCTION

Updating both the "Atlas of Major Texas Oil Reservoirs: Data Base" (Holtz and others, 1991) and the "Atlas of Major Texas Gas Reservoirs: Data Base" (Garrett and others, 1991) centered on updating cumulative production data current to December 31, 1992, for reservoirs already in the database and adding new significant-sized reservoirs (cumulative production greater than 1 million barrels of oil equivalent) to the databases. Addition of new reservoirs to the database resulted in the modification of existing plays or the determination of new plays. Play boundaries were also modified to accommodate the additional reservoirs.

Oil and gas production data used for the cumulative production update and the determination of significant sized reservoirs were obtained from Dwights Energy data. For reservoirs already included in the Atlas databases, annual production values were added to the cumulative production already determined by the Bureau of Economic Geology (BEG) or reported by the Railroad Commission of Texas. For new reservoirs, the cumulative production values reported by Dwights Energy data were applied. Oil reservoirs originally listed in both data bases because of large gas production were combined and now are listed only in the updated Oil Atlas data base.

Updating the "Atlas of Major Texas Oil Reservoirs: Data Base" (Holtz and others, 1991) resulted in a more than 7-fold increase in the number of reservoirs, changing the data set from 450 reservoirs to over 3,270. The addition of these reservoirs resulted in the recognition of 10 new oil plays and the modification of all play boundaries.

Updating the "Atlas of Major Texas Gas Reservoirs: Data Base" (Garrett and others, 1991) resulted in a more than 3-fold increase in the number of reservoirs, changing the data set from 1,578 reservoirs to over 4,821. Because of the inclusive nature of the original play scheme, no new plays were added; however, most play boundaries were modified.

DATA SOURCES

The information contained in these databases were derived primarily from the hearing files of the Railroad Commission of Texas. Files that proved particularly informative include unitization, injection, maximum efficient recovery (MER), field rules, and discovery files. Additional sources of numerical and descriptive data include the following:

1. Oil and gas reservoir files compiled by the U.S. Department of Energy (DOE), Energy Information Agency, Dallas Field Office.

2. Compilations of field studies published by various regional geological societies, the American Association of Petroleum Geologists, and the Society of Petroleum Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

3. Publications of the Railroad Commission of Texas, including annual reports and a recent survey of secondary and enhanced recovery operations.

4. Publications of the Rand Corporation and DOE on major oil and gas fields in the United States and evaluations of fields targeted for enhanced recovery.

5. Annual reservoir production data and cumulative production data were obtained from Dwights Energy data and supplemented or modified from Railroad Commission of Texas information. Reservoir location data were mapped by BEG and supplemented by latitude and longitude values from Dwights Energy data.

6. All of the above sources of data are listed in the selected references. Data were supplemented with information provided by individual operating companies.

The accuracy of publicly available quantitative reservoir data varies. Different sources commonly gave different values for the same type of data. Where great discrepancies existed, values were selected on the basis of known geologic criteria and within the context of the overall database of a play. Data were weighted in favor of records that reflected greater geological and engineering research efforts.

OIL RESERVOIR PLAYS

A complete listing of oil plays appears in appendix A. Several additional publications since the BEG Oil Atlas was published in 1983 and the analysis performed under this contract have led to the recognition of new oil reservoir plays and reorganization of existing plays. Reorganized plays have been renamed. Ten new plays have been determined: (1) Miocene Coastal-Plain and Barrier/Strandplain Sandstone, (2) Abo Reef, (3) Pennsylvanian Anadarko Fluvial Deltaic Sandstone, (4) Mississippian Pinnacle Reef, (5) Jurassic Shallow Shelf Carbonate, (6) Sabine Uplift Shallow Marine Sandstone, (7) Wolfcamp Carbonate Debris-Flow, (8) Pettet Shallow Platform Carbonate, (9) Hackberry Submarine-Fan Sandstone oil play, and (10) Piercement Salt Domes, Upper Gulf Coast. Three West Texas Silurian and Devonian plays have been reorganized into four plays as described by Ruppel and Holtz (in press). Along with this reorganization the Central Basin Platform Unconformity play has been renamed the Simpson Marine Sandstone play (Holtz and others, 1992a, 1992b). West Texas Ellenburger reservoirs have also been reorganized into two plays, as described by Holtz and Kerans (1992c). Eight plays have been renamed (Holtz and Garrett, 1990; Holtz and others, 1992a, 1992b; Holtz, 1993) to reflect original depositional system, including: (1) Yates Area changed to San Andres Karst-Modified Carbonate, (2) San Andres/Grayburg Carbonate Ozona Arch changed to Grayburg High Energy Carbonate-Ozona Arch, (3 & 4) San Andres/Grayburg North and South Central Basin Platform Carbonate plays changed to San Andres Platform Carbonate and Grayburg Platform Carbonate plays, (5) Permian Sandstone and Carbonate play changed to the Upper Guadalupian Platform Sandstone play, (6) Clear Fork Platform Carbonate play changed to the Leonardian Restricted Platform Carbonate play (Holtz and others, 1992), (7) Queen Platform/Strandplain Sandstone play changed to Queen Tidal Flat Sandstone play, and (8) Delaware Sandstone play changed to the Delaware Basin Submarine-Fan Sandstone play.

DESCRIPTION OF NEW OIL PLAYS

Miocene Coastal-Plain and Barrier/Strandplain Sandstone

The Miocene Coastal-Plain and Barrier/Strandplain Sandstone Play consists of a set of reservoirs extending from the lower Texas Gulf Coast in Willacy County (TRRC District 4) to the upper Coast in Jefferson County (TRRC District 3). Producing depths vary from 2,200 to 8,400 ft. Depositional environments include broadly defined coastal plain and barrier/strandplain systems flanked on both the north and south by fluvial-deltaic systems. Sandstone reservoirs in this play are differentiated from Miocene reservoirs included in Piercement Salt Domes (play 49) in that the principal trapping mechanism is rollover anticline from growth faults. Many of the reservoirs have long production histories; only one was discovered in the 1980's, two in the 1970's, three in the 1960's, nine in the 1950's, five in the 1940's, two in the 1930's, and one in the 1920's. This play is new because as of 1983 none of these Miocene reservoirs had produced more than 10 million stock-tank barrels (MMSTB).

Abo Reef

The Abo Reef play, Leonardian in age, exists principally in New Mexico, only two reservoirs [Kingdom (Abo) and Levelland (Abo)] extending into the Texas portion of the Permian Basin along the Midland Basin northern shelf. Depths of the two Texas Abo reservoirs are similar, 7,550 ft and 7,800 ft, whereas the New Mexico Abo production extends from 6,000 ft at Empire (Abo) reservoir to 9,600 ft in Double A' (Abo). Both limestones and dolomite in the Abo produce from back-reef, fore-reef, and reef crest portions of the reef complex. In addition to depositional topography traps, anticlinal and stratigraphic traps are also present. The presence of the reef is thought to have caused reservoir development in the overlying Guadalupian San Andres dolomites along the shelf margin.

Pennsylvanian Fluvial/Deltaic Sandstone, Anadarko Basin

The Pennsylvanian Fluvial/Deltaic Anadarko Basin sandstone play in the Anadarko Basin consists of reservoirs spread throughout seven Texas Panhandle counties: Hansford, Hemphill,

Lipscomb, Ochiltree, Roberts, Sherman, and Wheeler. Reservoir depths range from 4,850 ft to nearly 8,000 ft. Most of the reservoirs were discovered in the 1950's and 1960's; only three date from the 1970's and two from the 1980's. Reservoirs produce from both the Desmoinesian and Marmaton formations, with production being about evenly split. The producing sandstones were deposited in a fluvial to fluvial-deltaic environment.

Mississippian Carbonate Buildup/Pinnacle Reef

The Mississippian Carbonate Buildup/Pinnacle Reef play is located in North-Central Texas, spanning the Fort Worth Basin, Bend Arch, and Hardeman Basins. The earliest discoveries were in the 1940's and most of the reservoirs were discovered in the 1950's and 1960's. Recent interest is evident in that three of the reservoirs included were discovered in the 1980's.

Carbonates of Mississippian age in Texas are interpreted as shallow-water inner platform or outer platform deposits. Most of the buildups responsible for the oil accumulations of this play occur in the outer platform deposits. They are surrounded by skeletal grainstone and packstone deposited as debris sheets derived from buildup cores, or by wackestone and mudstone that accumulated in the interbuildup areas. Buildups in the Hardeman Basin portion of the play are buried by shallow-water grainstone and packstone deposited in ooid and skeletal sand shoals that prograded from the inner platform area. Traps include both structural and stratigraphic elements.

Jurassic Shallow Shelf Carbonate

The Jurassic Shallow Shelf Carbonate play lies in a northeast to southwest trend in the northern portion of the East Texas Basin. The play consists of six reservoirs that produce predominantly from the Smackover Formation at depths ranging from 9,350 to 13,000 ft. The reservoir production is relatively recent and thus has small cumulative production values. The first reservoir in this play was discovered in 1968 and the cumulative production ranges from 1 to 3 MMSTB. Lithology varies from limestone to dolomite deposited in a shallow carbonate shelf environment. The Jurassic Shallow Shelf Carbonate oil play is analogous to the JC-1 gas play in the *Atlas of Major Texas Gas Reservoirs*.

Lower Cretaceous Shallow Marine Sandstone, Sabine Uplift

The Lower Cretaceous Shallow Marine Sandstone, Sabine Uplift play lies in the eastern portion of the East Texas Basin on or flanking the Sabine Uplift. Seventeen reservoirs make up this play primarily producing from the Travis Peak Formation and also from the Cotton Valley and Paluxy Formations. The play is analogous to the BEG Gas Atlas plays KJ-1 and KJ-2 and are small producers of oil, their cumulative production ranging from 1 to 7 MMSTB. Reservoir depths range widely from 2,350 to 10,600 ft. All produce from sandstone deposited in nearshore beach to shallow open shelf environments.

Wolfcamp Carbonate Debris-Flow

The Lower Permian Wolfcampian Series consists of an approximately 2,000-ft-thick sequence of carbonate and siliciclastic rocks that constitute a relatively small but productive play in West Texas. The Wolfcampian sequence accumulated during early stages of Late Pennsylvanian/Early Permian structural evolution that led to the development of the Midland Basin and the Central Basin Platform. By early Wolfcampian time, the Permian Basin area was differentiated into well-defined basins (Midland Basin, Delaware Basin) and platform (Central Basin Platform, Northern Shelf, Eastern Shelf) areas (Tyler and others, 1991). Reservoirs producing from Wolfcampian rocks constitute two plays, the Shallow-Water Banks and Reefs (Central Basin Platform) previously described in the *Atlas of Major Texas Oil Reservoirs* (Galloway and others, 1983), and a new play called the Wolfcamp Carbonate Debris-Flow (described by Holtz and others, 1992).

The Wolfcamp Carbonate Debris-Flow play rims the north and east margins of the Delaware Basin and the east margin of the Midland Basin. Currently producing reservoirs reside at depths between 5,310 and 10,742 ft, the deeper reservoirs being along the Delaware Basin margin. Lithology varies from limestone to mixed limestone and dolomite being deposited as carbonate grain-flows, debris flows, fore-reef debris fans, and large fractured slide blocks (Becker and Von Der Hoya, 1990; Van Der Loop, 1990). Reservoir studies (Mazzullo, 1982) show that the highest permeabilities in these deposits are in carbonate grainstone, although Hobson

and others (1985) reported significant intercrystalline, intergranular, moldic, and fracture porosity in skeletal wackestone and packstone.

Pettet Shallow Platform Carbonate

The Pettet Shallow Platform Carbonate play lies in the northern half of the East Texas Basin. Reservoirs produce from the Lower Cretaceous Pettet Formation and occur at depths ranging from 5,600 to 8,200 ft. Reservoir lithology is shallow-marine platform limestone. The trapping mechanism can be updip porosity pinch-outs or combination structural and stratigraphic in nature. The Pettet Shallow Platform Carbonate play is analogous to the KC-1 and KC-2 plays in the *Atlas of Major Texas Gas Reservoirs*.

Hackberry Submarine-Fan Sandstone

Deep-water sandstones of the Oligocene-age Hackberry unit of the Frio Formation comprise this play, which is located in extreme southeast Texas. Several Hackberry reservoirs in Orange and Newton Counties have each produced more than 1 million barrels of oil. These reservoirs range in depth from 7,200 to 8,650 ft. The lower Hackberry sandstones are submarine canyon fill deposits (Tyler and others, 1987) and range from a few feet to more than 150 ft thick. An additional 38 Hackberry oil reservoirs have been identified by the Railroad Commission of Texas, but production from these was less than our 1 million barrel cut-off. Trapping mechanisms include both structural (normal faults and rollover) and stratigraphic (updip pinch-out, as at Port Acres) (Ewing and Reed, 1984).

Piercement Salt Domes, Upper Gulf Coast

The Piercement Salt Domes, Upper Gulf Coast play includes reservoirs in the Houston Salt Basin that produce oil from traps associated with the diapiric intrusion of Jurassic salt after being loaded by a thick sequence of Mesozoic and Tertiary sediments. Spindletop, most famous of these fields, was discovered in 1901 and was the catalyst for the explosive growth of the oil industry in Texas. Because of the many fault-bounded reservoirs associated with the salt migration, individual reservoirs may not contain large quantities of oil; however, the cumulative

production from the multitude of traps made this one of the most important producing plays in the Gulf Coast area.

Piercement salt domes occur within the Houston Salt Basin in a broad belt that extends from Matagorda County northeast into Louisiana. Major production from these fields has been from strata of Paleo/Eocene through Pliocene age and from salt-dome cap rock. Reservoirs placed in separate plays due to their size compose the cap rock and Yegua salt-dome-flank plays that are defined in the *Atlas of Major Texas Oil Reservoirs*.

GAS PLAYS

The addition of over 3,240 gas reservoirs did not necessitate the definition of new gas plays due to the completeness of the 73 plays in the original data base. Gas plays were not subdivided into subplays. Appendix B lists the gas plays and gives the play codes that correspond to the data base. Although a large number of the newly added reservoirs resided within fields already in the original data base most of the 73 gas play boundaries needed some modification to accommodate reservoirs in new locations.

DATA TAPE FORMAT

Oil and gas reservoir locations are identified with Railroad Commission of Texas reservoir ID numbers that relate the item to the relational database. The INFO relational database contains the reservoir number and several other data items including field name, reservoir name, Railroad Commission district, county, latitude and longitude, discovery year, depth to top of reservoir, cumulative production, and play code. Oil and gas play coverages contain only locational data depicting each play boundary. All data are in ARC/INFO format and Albers projection.

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APPENDIX A

TEXAS GEOLOGIC OIL PLAYS

PLAY CODE	GEOLOGIC PLAY
1	Eocene Deltaic Sandstone
2	Yegua Deep-Seated Salt Domes
3	Yegua Salt-Dome Flanks
4	Cap Rock
5	Frio Deep Seated Salt Domes
6	Frio (Buna) Barrier/Strandplain Sandstone
7	Frio Barrier/Strandplain Sandstone
8	Wilcox Fluvial/Deltaic Sandstone
9	Jackson Barrier/Strandplain Sandstone
10	Frio Fluvial/Deltaic Sandstone
11	San Miguel/Olmos Deltaic Sandstone
12	Edwards Restricted Platform Carbonates
13	Austin/Buda Fractured Chalk
14	Glen Rose Carbonate (Strat/structrl Traps)
15	Paluxy Fault-Line Sandstone
16	Cretaceous Sandstone (Salt Related Structrl)
17	Glen Rose Carbonate (Salt-Related Structures)
18	Woodbine Wave-Dominated Deltaic Sandstone, East Texas
19	Woodbine Fluvial/Deltaic/Strandplain Sandstone
20	Woodbine Fault Line
21	Strawn Fluvial/Deltaic Sandstone
22	Bend Conglomerate
23	Caddo Reef
24	Upper Pennsylvanian Shelf Sandstone
25	Pennsylvanian Reef/Bank
26	Upper Pennsylvanian Slope Sandstone
27	Eastern Shelf Permian Carbonate
28	Horseshoe Atoll
29	Spraberry/Dean Submarine-Fan Sandstone
30	Simpson Marine Sandstone
31	Devonian Thirtyone Deep-Water Chert
32	Devonian Thirtyone Ramp Carbonate
33	Wristen Buildups and Platform Carbonates
34	Fusselman Shallow-Platform Carbonate
35	San Andres Karst-Modified Carbonate
36	Grayburg High Energy Carbonate- Ozona Arch
37	Grayburg Platform Carbonate
38	San Andres Platform Carbonate
39	Upper Guadalupian Platform Sandstone
40	Leonardian Restricted Platform Carbonate
41	Queen Tidal Flat Sandstone
42	Wolfcamp Platform Carbonate
43	Pennsylvanian Platform Carbonate

44	Northern Shelf Permian Carbonate
45	Delaware Basin Submarine-Fan Sandstone
46	Panhandle Granite Wash/Dolomite
47	Panhandle Morrow Sandstone
48	Miscellaneous
49	Piercement Salt Domes, Upper Gulf Coast
50	Hackberry Submarine-Fan Sandstone
51	Ellenburger Karst-Modified Restricted Ramp Carbonate
52	Ellenburger Selectively Dolomitized Ramp Carbonate
53	Miocene Coastal-Plain and Barrier/Strandplain Sandstone
54	Abo Reef
55	Pennsylvanian Fluvial Deltaic Sandstone Anadarko Basin
56	Mississippian Carbonate Buildup/Pinnacle Reef
57	Jurassic Shallow Shelf Carbonate
58	Lower Cretaceous Shallow Marine Sandstone, Sabine Uplift
59	Wolfcamp Carbonate Debris-Flow
63	Pettet Shallow Platform Carbonate

APPENDIX B

TEXAS GEOLOGIC GAS PLAYS

PLAY CODE	GEOLOGIC PLAY
EO-01	Reklaw Marine Transgressive Sandstone
EO-02	Queen City Deltaic Sandstone in the Rio Grande Embayment
EO-03	Yegua (Cockfield) Fluvial/Deltaic Sandstone in the Houston Embayment
EO-04	Yegua/Jackson Barrier/Strandplain Sandstone in the Rio Grande Embayment
FR-01	Distal Frio Deltaic Sandstone in the Rio Grande Embayment
FR-02	Frio Delta-Flank Shoreline Sandstone in the Rio Grande Embayment
FR-03	Proximal Frio Deltaic Sandstone in the Rio Grande Embayment
FR-04	Frio Fluvial/Deltaic Sandstone along the Vicksburg Fault Zone
FR-05	Updip Frio Fluvial Sandstone in the Rio Grande Embayment
FR-06	Downdip Frio Barrier/Strandplain Sandstone on the San Marcos Arch
FR-07	Updip Frio Barrier/Strandplain Sandstone on the San Marcos Arch
FR-08	Frio Fluvial /Coastal Plain Sandstone on the San Marcos Arch
FR-09	Deltaic Sandstone in the Houston Embayment
FR-10	Frio Barrier/Strandplain and Slope Sandstone in the Hackberry Embayment
JC-01	Smackover Shallow-Marine Carbonate
JC-02	Gilmer-Haynesville (Cotton Valley Lime)-Shallow-Marine Carbonate
KC-01	Lower Cretaceous Trinity Group Carbonate-Sabine Uplift Area
KC-02	Lower Cretaceous Trinity Group Carbonate-Salt Structures-Eastern Margin-East Texas Basin
KC-03	Lower Cretaceous Trinity Group Carbonate-Salt Structures-Western Margin-East Texas Basin
KG-01	Lower Cretaceous Shallow-Marine Carbonate
KG-02	Upper Cretaceous Fractured Austin Chalk
KG-03	Upper Cretaceous San Miguel Deltaic Sandstone
KG-04	Upper Cretaceous Olmos Deltaic and Delta-Flank Sandstone
KJ-01	Lower Cretaceous-Jurassic Sandstone, Travis Peak Formation-Cotton Valley Group
KJ-02	Lower Cretaceous-Jurassic Sandstone, Travis Peak Formation-Cotton Valley Group -Salt Structures-Eastern Margin, East Texas Basin
KJ-03	Lower Cretaceous-Jurassic Sandstone, Travis Peak Formation-Cotton Valley Group -Salt Structures-Western Margin, East Texas Basin
KS-01	Upper Cretaceous Sandstone-Sabine Uplift Area
KS-02	Upper Cretaceous Sandstone-Salt Related Structures
KS-03	Upper Cretaceous Sandstone-Downdip Shelf Margin
MC-01	Miocene Deltaic Sandstone in the Rio Grande Embayment
MC-02	Miocene Fluvial Sandstone in the Rio Grande Embayment
MC-03	Miocene Lower Coastal-Plain Sandstone on the San Marcos Arch
MC-04	Miocene Barrier/Strandplain Sandstone on the San Marcos Arch
MC-05	Miocene Fluvial, Deltaic, and Delta-Flank Sandstone in the Houston Embayment
MS-01	Mississippian Carbonate, Deep Delaware Basin
MS-02	Mississippian Pinnacle Reef Limestone
OR-01	Ellenburger Fractured Dolostone
OR-02	Ellenburger Karst Dolostone
OR-03	Simpson Group Marine Sandstone, Central Basin Platform
OR-04	Oilcreek (Simpson Group) Strandplain Sandstone
PM-01	Wolfcamp Carbonate
PM-02	Spraberry and Dean Sandstone, Midland Basin

PM-03	Clear Fork Platform Carbonate
PM-04	San Andres and Grayburg Platform Carbonate
PM-05	Delaware Sandstone
PM-06	Upper Guadalupian Platform Sandstone
PM-07	Wolfcampian Platform Dolostone, Texas Panhandle
PN-01	Atoka Group Sandstone and Limestone
PN-02	Strawn Group Shallow-Marine Carbonate
PN-03	Strawn Group Fluvial/Deltaic Sandstone, Eastern Shelf
PN-04	Upper Pennsylvanian Carbonate
PN-05	Upper Pennsylvanian and Lower Permian Slope and Basinal Sandstone
PN-06	Upper Marble Falls Platform Carbonate-Bank Limestone
PN-07	Lower and Middle Pennsylvanian Fan-Delta Sandstone and Conglomerate
PN-08	Lower and Middle Pennsylvanian Deltaic Sandstone, Marietta Foreland Basin
PN-09	Panhandle Morrow Sandstone
PN-10	Pennsylvanian Shallow-Marine Carbonate, Texas Panhandle
PN-11	Desmoinesian/Missourian Deltaic and Basinal Sandstone, Anadarko Basin
PN-12	Virgilian Basinal and Deltaic Sandstone
PN-13	Pennsylvanian Fan-Delta Sandstone, Anadarko Basin
PP-01	Permian/Pennsylvanian Shallow-Marine Carbonate and Siliciclastics, Texas Panhandle
SD-01	Siluro-Devonian Carbonate-Deep Delaware and Val Verde Basins
SD-02	Siluro-Devonian Erosional Truncation
SD-03	Siluro-Devonian Shelf Carbonate
SD-04	Silurian Carbonate Pinch Out
SD-05	Pre-Pennsylvanian Shallow-Marine Carbonate
VK-01	Vicksburg Deltaic Sandstone in the Rio Grande Embayment
VK-02	Vicksburg Sandstone updip from the Vicksburg Fault Zone
VK-03	Vicksburg Deltaic Sandstone in the Houston Embayment
WX-01	Wilcox Deltaic Sandstone in the Houston Embayment
WX-02	Lower Wilcox Lobo Trend
WX-03	Updip Lower Wilcox Sandstone in the Rio Grande Embayment
WX-04	Wilcox Deltaic Sandstone in the Rio Grande Embayment