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TECHNICAL PROGRESS REPORT

Title: REVITALIZING A MATURE OIL PLAY:
STRATEGIES FOR FINDING AND
PRODUCING UNRECOVERED OIL IN FRIO
FLUVIAL-DELTAIC RESERVOIRS OF
SOUTH TEXAS

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OBJECTIVES

Advanced reservoir characterization techniques will be applied to selected reservoirs in the Frio Fluvial-Deltaic Sandstone (Vicksburg Fault Zone) trend of South Texas in order to maximize the economic producibility of resources in this mature oil play. More than half of the reservoirs in this depositionally complex play have already been abandoned, and large volumes of oil may remain unproduced unless advanced characterization techniques are applied to define untapped, incompletely drained, and new pool reservoirs as suitable targets for near-term recovery methods. This project will develop interwell-scale geological facies models of Frio fluvial-deltaic reservoirs from selected fields and combine them with engineering assessments to characterize reservoir architecture, flow unit boundaries, and the controls that these characteristics exert on the location and volume of unrecovered mobile and residual oil. The results of these studies are designed to lead directly to the identification of specific opportunities to exploit these heterogeneous reservoirs for incremental recovery by recompletion and strategic infill drilling.

Project objectives are divided into three major phases. Phase I, reservoir selection and initial framework characterization, includes the initial task of screening fields within the play to select representative reservoirs that have a large remaining oil resource and are in danger of premature abandonment (subtask 1), and subtasks performing initial characterization studies on selected reservoirs to identify the potential in untapped (2), incompletely drained (3), and new pool (4) reservoirs. Phase II will involve advanced characterization of specific reservoirs selected from the Phase I work to delineate incremental resource opportunities. Subtasks here will include the volumetric assessments of untapped and incompletely drained oil along with an analysis of specific targets for recompletion and strategic infill drilling. The third (III) and final phase of the project will consist of a series of tasks associated with final project documentation, technology transfer, and the extrapolation of specific results from reservoirs in this study to other heterogeneous fluvial deltaic reservoirs within and beyond the Frio play in South Texas.

SUMMARY OF TECHNICAL PROGRESS

During this second project quarter, screening of South Texas fields within the Frio Fluvial-Deltaic Sandstone/Vicksburg Fault Zone oil play was completed. Fields were screened to identify reservoirs that have a large remaining oil resource, are in danger of premature abandonment, and have geological and production data in sufficient quantity and of suitable quality to facilitate advanced reservoir characterization studies (subtask 1). Two fields have been selected for inclusion in this study: Tijerina-Canales-Blucher (T.C.B.) Field, located in the northern portion of the trend in Jim Wells County, and Rincon Field, located to the south in Starr County. Current plans are to incorporate data from both fields in our reservoir characterization and targeted resource addition studies. Project members met with operators of both fields to review available geologic and production field data and discuss our research plans. The collection of detailed geologic and production data required for the initial reservoir characterization studies (subtask 2) is currently underway. Details outlining specifics of project accomplishments for this quarter are provided below.

Screen Play for Suitable Fields

Criteria for the selection of specific South Texas Frio reservoirs for detailed study were established at the onset of this project. Reservoirs from fields with large infield reserve potential and sufficient data to provide the means for identifying additional reserves were deemed to be the most suitable candidates for detailed study. Specific considerations in our field selection process included the (1) size of reservoir producing area, (2) density of well completions in individual reservoirs, (3) quality and quantity of existing geologic and production data, (4) availability of 2-D or 3-D seismic coverage, and (5) the current level of drilling activity. Fields that contain reservoirs with large producing areas and numerous wellbores with a relatively wide completion spacing are

excellent candidates for this project because they present good possibilities for the identification of bypassed and untapped reservoir compartments. Fields with abundant, quality geologic, geophysical, and production field data, including conventional core and core analysis data, modern well logs, 3-D seismic coverage, and complete reservoir production histories will provide the best chance of success for identifying additional reserve potential through advanced reservoir characterization techniques. Recent drilling activity in a field is an indication of an operator's current strategy for reservoir re-exploration and additional field development, and therefore highlights fields with the best potential for near-term implementation of recommendations resulting from this project.

Data were screened from productive Frio reservoirs distributed among fields along the entire Vicksburg Fault Zone play in South Texas (Figure 1). There are currently 59 producing reservoirs distributed among at least 26 fields within the play. Screening was accomplished using various public data sources including Texas Railroad Commission hearing files, commercially available production data from Dwight's Energydata and Petroleum Information, The Bureau of Economic Geology's Texas Oil Reservoirs data base, miscellaneous trade and technical literature, and some additional non-public data contributed by companies.

Initial data screening was limited to the subset of fields that have both produced more than 1 MMSTB from the Frio and have wells that are currently producing oil from Frio zones. Geologic, engineering, and production data from fourteen major fields in the play, from Garcia field in southern Starr County northeastward to Agua Dulce field in Jim Wells and Nueces Counties were examined. Data that were summarized and compared among fields included the number and sizes of individual Frio reservoirs, cumulative past production, the present status of Frio production, and where available, completion densities for individual Frio reservoir units. Completion densities were determined from recent and past Texas Railroad Commission proration schedules, and are used as an indicator of the level of remaining potential of finding additional reserves. Preliminary estimates of potential infield reserve growth were analyzed by determining current reservoir recovery efficiencies.

Our screening criteria reduced the number of non-gas fields in the Frio Fluvial-Deltaic Sandstone/Vicksburg Fault Zone play suitable for our study to only a few. On the basis of our preliminary assessments of additional reserve growth potential and the availability of abundant geologic and production data, we have selected two field areas for inclusion in this project: the western portion of the Tijerina-Canales-Blucher Field, located in Jim Wells County and operated by Mobil, and the Rincon Field, located in Starr County and operated by Conoco.

Tijerina-Canales-Blucher Field, Kleberg County, Texas

Tijerina-Canales-Blucher (TCB) Field is located in Kleberg and Jim Wells counties, approximately 55 miles southwest of Corpus Christi, in southern Texas. The field was discovered and first developed by Sun in 1944. Multiple reservoirs in various portions of the field area have subsequently been discovered and produced by Sun (now Oryx), Humble (now Exxon), Texaco, and Mobil. The majority of drilling activity took place in the late 1940's, and intermittent development activity has continued through the 1980's. The field has produced significant volumes of oil and gas from Oligocene Frio and Vicksburg fluvial-deltaic sandstones; cumulative oil production from Frio zones alone is more than 50 MMSTB. The field is still under primary production, although there are only four wells that are currently producing from Frio zones.

The portion of the TCB Field chosen for study consists of the western "Blucher" portion of the field operated by Mobil Exploration and Producing U.S. The primary data set available from Mobil includes well log, sidewall core, and detailed production data from more than 65 wells. Many modern (mid to late 1980's) log suites are available, including high-resolution dipmeter (SHDT) data. There is an extensive 2-D seismic grid over the acreage. Well spacing and reservoir

completion densities within T.C.B. Field indicate that there may be significant infill potential, more than many of the other Frio-producing fields in South Texas. There are numerous productive reservoir zones. More than 30 oil reservoirs have production reported from the Frio interval that ranges from 5000-7600 feet in depth. Production data available from public sources indicates that no reservoir has been drilled at closer than a 40 acre spacing.

Rincon Field, Starr County, Texas

Rincon Field is located in eastern Starr County, Texas, 120 miles southwest of Corpus Christi and approximately 20 miles north of the United States-Mexico border. The field was discovered in 1939. Conoco took over field development in 1940, and is currently the principle operator for most of the Rincon area, which includes producing acreage from the Boyle, Cameron, Rincon-Vicksburg, North Rincon, and Urshel fields, as well as the formerly productive Davenport and East Rincon fields. More than 65 MMSTB of oil have been produced from fluvial-deltaic sandstone reservoirs over the combined Frio-Vicksburg stratigraphic interval. Production from 38 separate Frio reservoirs has yielded over 45 MMSTB oil. Development from Frio reservoirs peaked in the mid 1940's. Production continues today, though at much reduced, consistently declining rates, and all future field development plans are presently focused on deeper Vicksburg objectives. The field also has a well-documented waterflood history.

Rincon Field is densely drilled and has been extensively cored. Approximately 200 wells have been drilled in the central Rincon area, and conventional core analysis data exist for over 650 individual reservoir sand intervals. More than 50 individual reservoir sands within the Frio interval from 3000-5000 feet have been identified and mapped across the field. The large volume of conventional core analysis data and archived core available for study makes this field an excellent candidate for detailed reservoir characterization studies. Flow unit parameters and permeability architecture of individual reservoir units can be directly quantified by both new measurements and re-interpretation and synthesis of existing subsurface data. The quantity of available core data also provides an excellent opportunity to test and apply outcrop-derived constraints on flow units and permeability structure from analogous fluvial-deltaic reservoirs.

Planned Activities

Initial reservoir characterization efforts that comprise the remainder of *Phase I* for the project will be tailored to take advantage of the different kinds and quality of data available from both T.C.B. and Rincon fields. The demonstration of additional potential in the T.C.B. Field will first be accomplished through the construction of cross-sections illustrating sandstone geometry within some of the more productive Frio reservoir zones, comparison of data from available sidewall cores by individual reservoir zone, and volumetric calculations of remaining reserves. Available engineering data, including production rates and formation pressure tests, will be examined to identify the presence of compartmentalized reservoirs and quantify additional reserve growth potential.

In the Rincon Field, a geographic subset of the entire field area will be selected for detailed study. The decision on where to focus within the field will be based on where the most core data are available as well as where there is better potential for additional reserve growth. This work is currently underway. The geometries of individual reservoir zones will be examined by cross-section construction and detailed stratigraphic correlation within Rincon Field. In addition, reservoir data from core analyses will be synthesized, and available core will be studied and sampled for detailed sedimentologic, petrographic, and petrophysical analyses.

Frio Fluvial-Deltaic Oil Reservoirs

Vicksburg Fault Zone, South Texas

FRIO RESERVOIRS

Field Production and Completion Density
(Fields currently producing from Frio zones)

Field	Zone ¹ Name	Acre ² Spacing	No. ³ Wells
Agua Dulce	31219	40	16
Alta Mesa	garcia	20	12
Borregos	combined	40	37
Clara Driscoll	2 zones	10,20	2,3
Garcia	4 zones	40	7
Jay Simmons	1 zone	20	13
Kelsey	M-2	40	1
La Gloria	5 zones	40	14
Rincon	17334	20	15
Rincon North	2 zones	40	8
Seeligson	4 zones	40	37
Stratton	4 zones	40	17
Sun	2 zones	20,40	18
Sun East	F-4 sand	20	1
Sun North	3 zones	40	5
T-C-B	4 zones	40	8?

¹Producing reservoir zone as reported to the Texas Railroad Commission

²Completion densities for individual reservoir zones based on acre-spacings from January 1993 proration schedules

³ Number of producing wells as of December 1992

Legend

- Major Oil Field (> 1 MMBO from Frio)
- Field (> 1 MMBO from Frio) Selected for Detailed Reservoir Characterization
- Approximate trace Vicksburg Fault Zone
- County Line
- International Border

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