FEASIBILITY OF OPTIMIZING RECOVERY AND RESERVES FROM A MATURE AND GEOLOGICAL COMPLEX MULTIPLE TURBIDITE OFFSHORE CALIFORNIA RESERVOIR THROUGH THE DRILLING AND COMPLETION OF A TRILATERAL HORIZONTAL WELL

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Principal Investigator: Steven F. Coombs

C0-Participants: University of Southern California/ Coombs and Associates

Contracting Officer's Representative: Edith Allison

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Objectives

The main objective of this project is to devise an effective re-development strategy to combat producibility problems related to the Repetto turbidite sequences of the Carpinteria Field. The lack of adequate reservoir characterization, high-water cut production, and scaling problems have in the past contributed to the field's low productivity.

To improve productivity and enhance recoverable reserves, the following specific goals are proposed:

- Develop an integrated database of all existing data from work done by the former ownership group.
- Expand reservoir drainage and reduce sand problems through horizontal well drilling and completion.
- Operate and validate reservoir's conceptual model by incorporating new data from the proposed trilateral well.
- Transfer methodologies employed in geologic modeling and drilling multilateral wells to other operators with similar reservoirs.

Summary of Technical Progress

Pacific Operators Offshore, Inc. received pre-award authorization for this project effective May 9, 1995 and final approvals were obtained effective September 1, 1995 and as such began work on the database tasks set forth in the proposal. To date a significant amount of progress has been made on development of a database, which includes production data (project task 1.1.1), well log data (project task 1.1.2), well completion data (task 1.1.3) well test and PVT data (project task 1.1.4). As of this writing only preliminary efforts have been directed toward other tasks in budget period 1.

This report is an overview of the work that has been completed and is broken out by task

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number.

Task 1.1.1 - Database: Production Data

This project is employing production history management software called Production Analyst or "PA". This software, developed by OGCI (Oil and Gas Consultants International), allows production history by individual wells to be easily combined and grouped to prepare diagnostic plots for analysis of reservoir behavior. As of the effective date of this report, the software has been installed and all of the historical production history on a well by well basis have been imported electronically into a newly established PA production history data base. A total lease production history plot which was generated by the PA program is shown in figure 1.

Cumulative oil production for lease OCS-P-0166 as of August, 1995 is 44.96 MMbbls oil, 39.46 BCF gas and 58.01 MMbbls water. For standardization, the API number for each well is used as an identifier.

Because all the wells on the lease are drilled from one of two platforms (platform Hogan or Houchin), an X-Y coordinate system was used to show the reference datum well spots on the location map. This map interface accompanies the

PA program. The datum used was the F1 sand. One well, Hogan A-50 was completed only in the E sand, so the bottom hole location for this well was used.

A minor amount of programming was required to modify Pacific Operators existing production history database system into an ASCII format for loading into PA. In the future, production updates into the PA program will be accomplished using this same method (ASCII data import).

The only task that remains to complete this production history database is the quality control checking of the data to ensure that it compares with other data sources, i.e. historical hard copy reports and production history from public sources such as the Minerals Management Service. This effort should be completed by the end of January 1996. Figure 2 is a bubble map showing cumulative oil produced from lease OCS P-0166.

Task 1.1.2 - Database: Well Log Data

A considerable amount of progress has been made on the well log database. Much of this work was initiated prior to the pre-award date. The well log processing system being used for this task is LOGCALC II, by Scientific Software, running on a DEC Micro-VAX II system. The status of the well log database at the pre-award date (i.e. work completed prior to the pre-award authorization date) and as of 9/30/95 is shown in table 1 below:

Figure 2 - Bubble Map of lease OCS P-0166

TABLE 1
Carpinteria Well Log Status

Work Description	Pre-Award	As of 9/30/95
Wells with log traces in digital form	92	95
Directional survey data completed	94	98
Dipmeter or mapped dip data for TVT/TST logs	49	87
Marker/Zone data defined, tops only	62	44
Log correction / normalization / manipulation	57	87
Porosity/saturation calculations	28	42
Core/log verification/modeling	14	20
Saturation/porosity/OIP computer model	50	50
Output log TST & TVD logs	20	38

Task 1.1.3 - Database: Well Completion Database

A well completion database containing the completion history of all of the current producing wells was created prior to the start of the Class III. This information is maintained in a Paradox database and will be made available to the Class III project. A minor amount of database updating will be required for the Class III project. A sample wellbore diagram generated from the completion database is shown in figure 3.

Task 1.1.4 -Well Test / PVT

Well Test Data

A total of 25 pressure buildup tests from wells A-1(3), A-3(3), A-4(1), A-6(4), A-9(2), A-15(2), A-16A(1), A-18(2), A-23(2), A-25(2), A-38(1) and B-28(2) with pertinent data necessary for pressure transient analysis have been digitized, and are now in ASCII format files.

PVT Data

A total of five oil samples were taken from lease OCS P-0166 for PVT analysis. The first oil sample was prepared from recombining a sample of separator liquid with a synthesized separator gas in order to obtain a fluid

having a bubble point equal to the original reservoir pressure of 1545 psig at 110 °F. This sample was taken on November 28, 1967 prior to start of lease production. Although the synthesized gas was not exact in its physical properties, it was felt to be within the practical limits for the recombination. The saturation pressure of the recombined sample was measured to be 1546 psig at a reservoir temperature of 110 °F. During differential pressure depletion at 110 °F the fluid evolved 223 SCF/STB. The viscosity of the liquid varied from a minimum of 14.4 centipoise at saturation pressure to a maximum of 46.5 centipoise at atmospheric pressure. The gravity of the residual oil was 22.0 °API at 60 °F.

Figure 3 - Sample Wellbore Diagram (Hogan Well A-36)

The second recombined sample was taken early in the producing life of the lease on July 12, 1968 from well A-4. The well was opened to the E, F and G zones. The separator gas oil ratio (GOR) was 436 SCF/STB. PVT analysis of this sample resulted in 460 SCF/STB of gas in solution at a saturation pressure of 2528 psig and reservoir temperature of 122 °F. It is worth noting that this pressure is approximately 400 psi higher than the hydrostatic pressure at the deepest oil bearing point in the well (4630 ft. subsea). The gravity of the residual oil was 26.2 °API at 60 °F.

The third sample is a subsurface sample taken from Well A-7 on Sept. 28, 1968 from the F zone. This sample established a saturation pressure of 2155 psig at a reservoir temperature of 122 °F and a solution GOR of 336 SCF/STB. The gravity of the residual oil was 25.2° API at 60 °F.

Subsurface samples 4 and 5 were taken April 24, 1969 during Drill Stem Test No. 1 (DST No. 1) on Well B-2A. The producing interval during the test was 5090-5115 ft. MD which corresponds to the G-5A sub-thrust sand. DST No.2 on the same well sampled the G-3A sand from a producing interval 3785-3805 ft. MD. These samples exhibited saturation pressures of 974 psig at 145 °F and 1271 psig at 126 °F with solution GORs of 273 and 212 SCF/STB respectively. The gravity of the residual oil samples were 32.4 and 25.8 API at 60 °F respectively.

Reservoir Pressure

The initial reservoir pressure on lease OCS P-0166 was calculated to be 1500 psig at a datum of 3300 ft subsea. A reservoir pressure database has been developed and is in the process of being updated with the pressure information from the last 5 years of operations that are derived from fluid level measurements. Figure 4 is a plot of reservoir pressure versus time for lease OCS P-0166.

1.2.1 -Stratigraphy and Micro lamination

Based on the well log correlations completed prior to the date of this project, and as of this date, a total of 28 sub-layers have been identified. For material balance studies, a database is being developed to relate cumulative production of oil and water

Figure 4 - Reservoir Pressure versus Time

to various sub-categories of producing horizons.

1.2.2 - Reservoir Performance

In the basic material balance study of field, the combined effects of reservoir compressibility, depletion and water influx need to be examined. From the review of the database, indications are that the reservoir pressure from its initial value of 1500 psig dropped to 870 psig in a matter of 3 years. Following this initial drop in pressure, a period of pressure stabilization indicates potential water influx. Cumulative production from various segments of the lease indicate considerable production of water. From diagnostic plots of water cut versus cumulative production, indications are that high water production may be caused from commingled production from oil and wet sands and aquifer influx. In order to better understand field producibility problems a transmissivity map representing the heterogeneity of the field will be created.

Task 1.2.3- Analysis of water production

Efforts are under way to construct the x-plots of individual wells for prediction of anticipated recoveries under water influx. Water chemistry data are being compiled for finger-printing of the source of water and variation of water composition across the field and in individual sands.

Task 1.3.1- Management and Administration

Monthly meetings of the steering committee has been held in Ventura office of POOI or at USC to monitor the progress of the individual tasks.

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