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IMPROVED RECOVERY FROM GULF OF MEXICO RESERVOIRS

Volume III (of 4) Characterization and Simulation of Representative Reservoirs
{Task 2, Refine SMI 73 Reservoir Characterization (Subtask 2.1, 2.2, 2.3, 2.4), Task 3, Refine South Pelto Reservoir Characterization (Subtask 3.1, 3.2), Task 4, Identify and Characterize Additional Representative Reservoirs (Subtask 4.1, 4.2), Task 6, Simulate Attic Gas Injection Processes (Subtask 6.1, 6.2), Task 7, Simulate Gas Injection Processes Using N2, Flue Gas, and CO2 (Subtask 7.1, 7.2), Task 8, Simulate Advanced Waterflood Processes (subtask 8.1, 8.2, 8.3)}

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Louisiana State University
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Principal Investigator: W. Clay Kimbrell
Zaki A. Bassiouni
Adam T. Bourgoyne

Contracting Officer's Representative: Edith C. Allison

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Abstract

Significant innovations have been made in seismic processing and reservoir simulation. In addition, significant advances have been made in deviated and horizontal drilling technologies. Effective application of these technologies along with improved integrated resource management methods offer opportunities to significantly increase Gulf of Mexico production, delay platform abandonments, and preserve access to a substantial remaining oil target for both exploratory drilling and advanced recovery processes.

In an effort to illustrate the impact that these new technologies and sources of information can have upon the estimates of recoverable oil in the Gulf of Mexico, additional and detailed data was collected for two previously studied reservoirs: a South Marsh Island reservoir operated by Taylor Energy and a Gulf of Mexico reservoir operated by Mobil, whose exact location has been blind-coded at their request, and an additional third representative reservoir in the Gulf of Mexico, the KEKF-1 reservoir in West Delta Block 84 Field.

The new data includes reprocessed 2-D seismic data, newly acquired 3-D data, fluid data, fluid samples, pressure data, well test data, well logs, and core data/samples. The new data was used to refine reservoir and geologic characterization of these reservoirs. Further laboratory investigation also provided additional simulation input data in the form of PVT properties, relative permeabilities, capillary pressures, and water compatibility. Geological investigations were also conducted to refine the models of mud-rich submarine fan architectures used by seismic analysts and reservoir engineers. These results were also used, in part, to assist in the recharacterization of these reservoirs.

Executive Summary

B-65G Reservoir

The B-65G Reservoir is a long, north-south trending, steeply dipping sandstone, which pinches out just before encountering the piercement salt dome on its southeastern flank. Its dip rate averages 19 degrees. Structure and trapping are all results of the piercement salt dome. The location of the pinch-out of the sand along the salt face was the portion of the reservoir for which there was the least control. Overall, it is a clean sand that averages 66 feet in gross thickness and 53 feet in net sand thickness.

The reservoir has produced 6.2 MMSTB of oil, 8.5 BCF of gas (which also accounts for all gas injected back into reservoir) and 821 MBBLS of water. As previously characterized, four wells have produced from the reservoir; three injected 2 BCF of gas and one well injected no gas. A fifth downdip well, served as a primary gas injector and injected an additional 732 MMCF of gas. With the re-evaluation, two additional wells produced the reservoir.

Original oil-in-place calculations performed on the reservoir before 3-dimensional seismic data and other new information was incorporated assigned the reservoir approximately 10,100 acre-feet or an average net pay thickness of 38 feet over 267 acres. Porosity averages 28.5% and the original oil saturation was estimated at 73%, with an initial formation volume factor (FVF) of 1.3 res bbls/STB. Therefore, based on the old information and estimated volumetrically, the original in-place-oil was 12.6 MMSTB. Therefore, through March 1995, based upon volumetrics, 50% of the original oil-in-place had been produced.

A new structural and stratigraphic interpretation based upon the 3-dimensional seismic data was generated The faults which were previously believed to exist were apparent in the seismic data, with the exception of one east-west fault which was believed to exist based upon past production and pressure data. The major down-to-the-south fault, which is the northern boundary of the B65 sand production, appeared to have more curvature (concave towards the platform in the map view) than previously believed. The smaller fault which previously was believed to be sealing is evident in the 3-dimensional seismic data. However, it appears to be non-sealing and this was later confirmed with simulation. A major down to the north fault, which was the southern boundary for the sand production previously believed to be south of the seal, also has more curvature (concave towards the platform in the map view) than previously believed. It is also closer to a north-south trend which curves slightly east as opposed to the more east-west trend as it was previously mapped. The smaller east-west fault which dies out before reaching the salt dome appeared just as it was originally mapped. Two smaller faults which were believed to be under the platform were not visible due to the jumbled data image.

The reservoir appeared to shale out before actual contact with the salt dome was made. The shale out was fairly uniform along the boundary of the sand, yet seemed to push slightly away from the salt dome as it moved north along the salt dome. At the south end of the reservoir just north of the where the sand faults the salt dome contact shows the beginnings of a north-south trending steeply dipping down to the east fault. Overall, the reservoir was interpreted to be much larger than had previously been calculated by 6.4 million barrels, or an increase by a factor of 1.5.

A second reservoir simulation study was undertaken to incorporate new seismic data and confirm the new interpretations and characterizations for the B-65G Reservoir. Simulated vs. observed values for reservoirwide pressure, oil, water, and gas production matched very well, indicating the aquifer model and reservoir permeability were suitably chosen. In general, the well performance match was good as well, although some wells could not be matched satisfactorily. The results indicate that only 38% of the OOIP has been recovered.

Given the fluvial nature of the reservoir, drilling additional wells updip does not seem to hold much promise, as these wells are likely to fall outside of the channel system. As the reservoir re-pressurizes, existing wells should be periodically produced to recover newly segregated oil and gas.

The B-1 well was injected with 500 MCFD for 6 months and shut-in. The B-12 well was produced for an additional 54 months. Oil recovery over this time compared to the B-12 well producing with no enhancement, increased by 20%, for a ratio of 0.44 bbls of oil per MCF of gas injected. Water cut decreased by 3%. Additional gas injection improved the recovery proportionately. At a present gas price of $2.90/mcf and a present oil price of $25.00/bbl, and assuming no gas injected is recovered and operational costs are not increased dramatically, a profit increase (for use of the gas) of 3.8 times is realized by gas injection. Ultimate recovery was not increased in this particular reservoir, by using different gases.

U-8 Reservoir

Early interpretations of the reservoir were based on two dimensional (2-D) seismic lines shot in the 1970s and 1980s. The original structural interpretation of the area showed a saddle-shaped structure with a dome at each end. The productive wells were placed to produce from the crest of the northern dome and from an area just south of the low point on the saddle.

As the study area was developed, additional information was gathered, and three dimensional (3-D) seismic surveys were run. Using seismic workstations, Company B processed the data. The results showed a much more complicated picture than had originally been envisioned. The reservoir can be described as a relatively flat, totally isolated fault block (surrounded on all sides by faults) with several non-sealing interior minor faults which serve to decrease drainage of the reservoir.

The actual water production, as was the case in the original study, could not be modeled based upon the premise that each lobe was a reservoir unit, itself cut off from communication with the other lobes by the shale stringers running between them. It was necessary to put the two top layers, A and B, into communication with one another within the reservoir. The structure map and the isolations of the southwestern portions of the unit, Area C, were factored into the reservoir model as before. There was no new data to support modifications to the geological interpretations from the previous study.

Essentially, the major occurrence and new piece of information which was obtained since the last report was the fact that the #10-20 had been reworked. The workover consisted of squeezing off with cement the lower perforations in an attempt to eliminate or reduce the water cut. It was unsuccessful within this capacity, however. The well still produces at a high water cut. Originally, the simulation was run with the assumption that Layer B had been isolated from Layer A to account for a successful workover.

However, a history match was unattainable using this scenario. Therefore, Lobe A was put back into communication with Lobe B within the reservoir and a history match was attained. The updated history match supports the theory that Lobe A and Lobe B are in communication within the reservoir. Several prediction runs were then performed and the following conclusions were made:

- Evidence still indicates that layers A and B of the U-8 Sand are in communication.
- The relative permeabilities were modified, based on new and updated information, to enable a history match to be obtained.
- Based on the predictive designs for water injection (1,700 STB/D), the best possible production scenario is in area A and the best possible injection area is in area H.
- Any major increase in the water injection rate above 1700 BWPD does not greatly improve the recovery and therefore is not economically justified.
- The horizontal well injection scheme for area H recovered 3.2 times more oil than a background contnuing production scheme. However, the vertical well injection scheme for Area H recovered 3.15 times more oil. Therefore, a horizontal injector is not economically justified.

KEKF-1 Reservoir

The KEKF-1 reservoir is located in West Delta Block 84 Field. West Delta Block 84 Field is located off the coast of Plaquemines Parish, Louisiana, near the mouth of the Mississippi River. The field was discovered by Conoco in 1955. It was operated by Conoco until September, 1988 when S. Parish Oil Co. bought out Conoco's interest and took over operations. S. Parish Oil Co. resumed operations in the field for approximately one year when the lease was allowed to lapse. The field is presently being operated by West Delta Oil Co., which is in the process of re-working several wells to re-establish production. To date, however, the field is still shut-in. It is estimated that the total field originally contained 23.6 MMSTB of oil and 57.9 BCF of gas, from known productive sands. The field has produced 9.8 MMSTB of oil and 21 BCF of natural gas.

The KEKF-1 reservoir underwent a waterflood project during the 1970's, and is a good example of a reservoir which has undergone an expensive poorly designed waterflood which resulted in the loss of a large quantity of recoverable oil.

The KEKF-1 reservoir is limited on its north by a east-west trending normal fault, which dips to the south. It is bound on its east by a shale out. It is bound on its south by a partial sealing fault and a shale out. It is bound on its west by an original oil-water contact of 11,136 feet below sea level. It dips at approximately 6 degrees to the west and strikes north-south. The net effective sand thickness averages approximately 30 feet with a high of 66 feet penetrated in the #A3 well.
Original oil in place has been estimated to be 9.6 MMSTB or 1005 STB/ac-ft and original gas in place has been estimated to be KEKF-1 reservoir - 23.6 BCF.

The waterflood was targeting the KF-1 sand, not the KE-1 sand. It is believed that the operator at the time of the waterflood believed these two sands not to be in communication. Because of this, the waterflood was inefficient and poorly designed. If the possibility of communication between the KE and KF sands had been considered, the waterflood may have been more efficient. Assuming success from workovers a daily production rate of over 600 BOPD and 1.3 MMCFD of gas could be realized. At a 20% decline and a 15 year life, an additional 1.2 MMSTB of oil and 4.5 BCF of gas of proved developed reserves could be recovered from this reservoir.

SOUTH MARSH ISLAND 73 FIELD
REINTERPRETATION OF GEOLOGIC CHARACTERIZATION BY USE OF 3-DIMENSIONAL SEISMIC DATA

by W. Clay Kimbrell[1], Stephen Norris[2], Hunter Coates[3] and Jitendra Khandrika[4]

OVERVIEW

This is a continuation of a previous report, "Assist in the Recovery of Bypassed Oil From Reservoirs in the Gulf of Mexico - Volume III, Characterization of Representative Reservoirs - South Marsh Island 73, B35K and B65G Reservoirs" delivered under the U.S. Department of Energy (DOE) contract number DE-AC22-92BC14831.

Data

All necessary and available data were collected from Taylor Energy, which purchased the field from Exxon in 1993. All well logs, core analysis, historical, production and injection histories were available. Measured pressure-volume-temperature (PVT) data was calculated. Three-dimensional seismic data (3-D data) was acquired from a speculative survey performed by GECO-PRAKLA. Data acquired covered most of block 73 and portions of blocks 68,69,72 and 74 as shown in Figure 1. The 3-D data was processed by GECO-PRAKLA and provided to LSU via 8mm tape. Interpretation work was performed by LSU personnel primarily on a Sun Microsystems SPARC-20 workstation with some additional support provided by an Silicon Graphics INDIGO-2 workstation. The data was interpreted primarily using Landmark Graphics Seisworks 3D software.

Field History

The South Marsh Island Block 73 (SMI 73) Field is located approximately 77 miles south of Intercoastal City, LA in 135 feet of water in the Gulf of Mexico, Figure 2. The field was discovered in 1963 by Exxon when the #1 Well SMI 69 was drilled. Several other exploratory wells were drilled by Exxon and Shell on this block and the surrounding blocks. The field was subsequently developed by Shell (SMI 57 and 58) and Exxon (SMI 69, 72, and 73). Production from the field was initiated in 1964, and over time, a total of eight platforms were set and over 100 development wells were drilled. Taylor purchased the Exxon interest in SMI Blocks 69, 72, and 73 in 1993 and assumed operatorship.

The field is predominantly oil productive and production peaked in 1971 at a rate of 16,900 BOPD and 68.MMCFD. The field is currently producing almost 2,000 BOPD, 5 MMCFD and 2,600 BWPD, Figure 3. The productive zones have been established at depths between 5,000 feet and 11,500 feet. The cumulative production from the field as of January 92 totaled 67 million barrels of oil (MMBO), 276 billion cubic feet of gas (BCF), and 46 million barrels of water (MMBW). The gas from the field has not been sold; rather, it has been used for fuel or reinjected to improve oil recovery. The cumulative production from the Taylor blocks total 45 MMBO and 36 BCF.

[1] Louisiana State University, Department of Petroleum Engineering
[2] Ibid
[3] Ibid
[4] University of New Orleans, Department of Geology

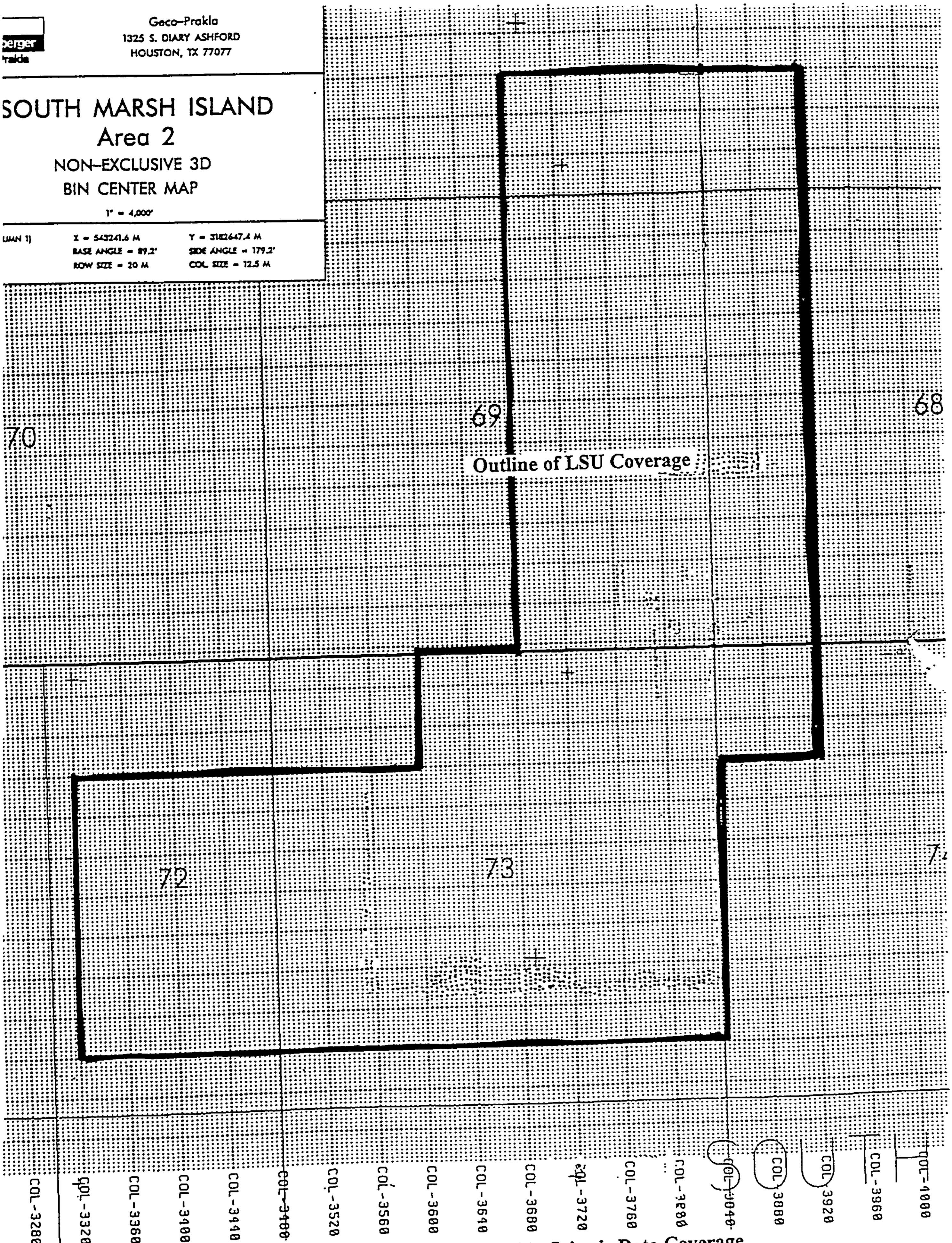
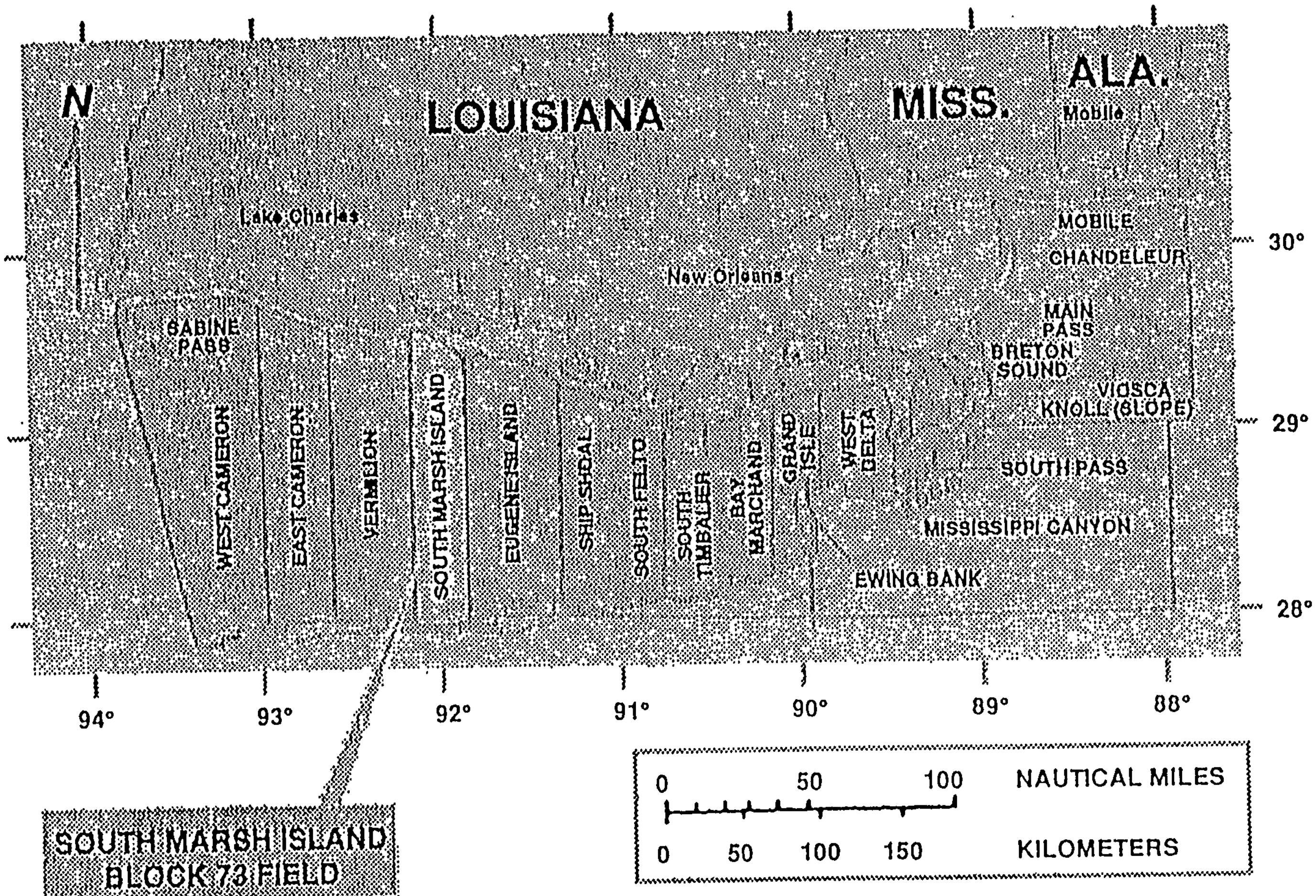


Figure 1 - LSU Acquired Geco-Prakla Seismic Data Coverage

LOCATION OF SMI BLOCK 73 FIELD IN THE GULF OF MEXICO



from Young, M. A., Salamy, S. P., Reeves, T. K., Kimbrell, W. C., Sawyer, W. K., "Characterization of Representative Reservoirs - South Marsh Island 73, B35K and B65G Reservoirs," Report prepared under U.S. Department of Energy DE-AC21-92BC14831 (October, 1993).

Figure 2 - Location Map of South Marsh 73

SOUTH MARSH ISLAND BLOCK 73
FIELD PRODUCTION STATISTICS

Discovery:	**1964**	**(Exxon, SMI 69 #1)**
Ownership:	**Taylor**	**(SMI 69, 72, 73)**
	Shell	**(SMI 57, 58)**
Initial Production:	**1964**	
Peak Production (1971):	**16,900 BOPD, 68 MCFD**	

Figure 3

Field and Reservoir Geology[5]

The SMI 73 Field is established by the simple piercement salt dome structure, as shown in Figure 4. The dome is relatively circular in shape, with a small area of overhang at the southeast corner. The current top-of-salt is approximately 364 feet below mean sea level. This dome formed in relatively shallow water, with salt movement having been initiated prior to the deposition of many of the key reservoir units. Sedimentation continued during the movement of the salt. The source for the main reservoir sands was apparently predominantly from the north and east. Drilling has been concentrated on the northern, eastern and southeastern portions of the structure, with twenty-five Miocene and Pliocene aged sands being productive from more than sixty reservoirs around those sides of the dome. Exploratory drilling on the western side of the structure indicates that area was on the lee side during deposition and was sheltered from most of the sand-laden currents. The rate of sediment influx appears to have been low and the material was very fine-grained during the deposition of most of the key reservoirs, with sands having been limited to deeper-water areas around the growing dome, and shale having been deposited atop the structure in a more-or-less starved environment. This helps to account for the facts that many of the reservoirs pinch out updip, toward the salt, and that most of the dome is wrapped in a shale sheath.

The B65G sand in the South Marsh Island area was deposited well offshore, in an open marine environment, in moderately deep water. The region had a hummocky, irregular bottom at the time of deposition, which controlled the flow of oceanfloor currents through the area. Salt movement took place concurrently with deposition of the reservoir sands and the enclosing shales. The syndepositional growth of the salt domes created a number of highs on the seafloor as sediments accumulated in the area.

Coarser-grained sediments were carried into the region by density currents, which spread out across the area, following channels along the deeper portions of the seafloor. Fine-grained sands were deposited in these deep areas between the domes, while shale and mud accumulated on the upslope areas and crests of the highs. The growing domes shielded some deeper portions

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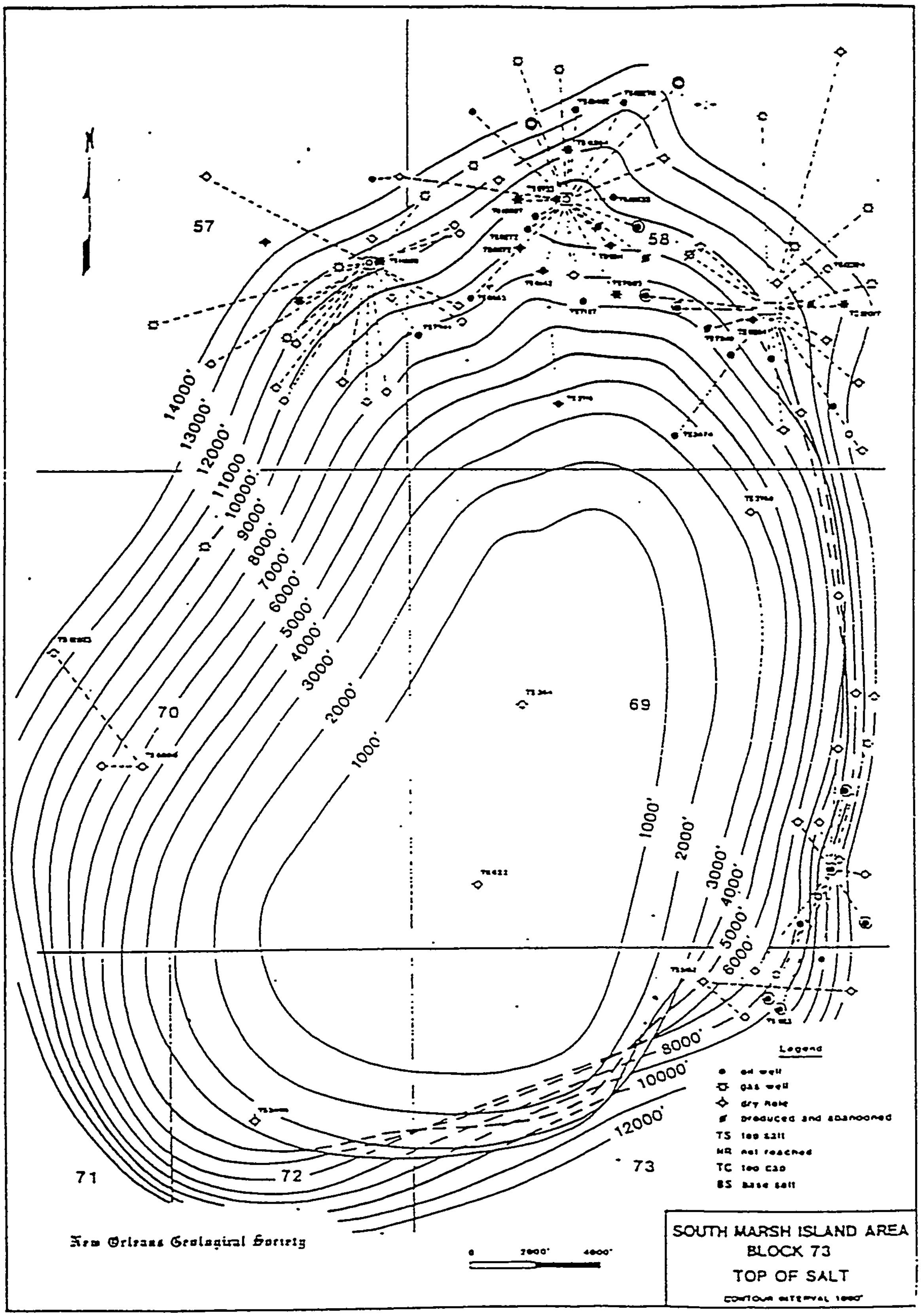
[5] "Assist in the Recovery of Bypassed Oil From Reservoirs in the Gulf of Mexico - Volume III, Characterization of Representative Reservoirs - South Marsh Island 73, B35K and B65G Reservoirs" delivered under the U.S. Department of Energy (DOE) contract number DE-AC22-92BC14831, December 31, 1995.



Waguespack, S.J., "Salt Domes of South Louisiana," The New Orleans Geological Society, Volume III, 1983, pp. 58-59.

Figure 4 - Structure Map on Top of Salt - South Marsh Island 73

of the seafloor from the density currents, with little sand reaching the lee side of the highs. Thus, sands and shale interfinger in a highly complex manner around the flanks of the domes, marking a period of sand pulses and density flows, alternating with periods of quiet deposition on the exposed side of the structure, and starved-basin conditions with fine-grained sediments on the sheltered side of the dome.

Reservoir Characteristics

The B-65G Reservoir is a long, north-south trending, steeply dipping sandstone, which pinches out just before encountering the piercement salt dome on its southeastern flank, as illustrated by the previously constructed structure map of the sand in Figure 5.[6] Its dip rate averages 19 degrees. Structure and trapping are all results of the piercement salt dome. The location of the pinch-out of the sand along the salt face was the portion of the reservoir for which there was the least control.

Overall it is a clean sand that averages 66 feet in gross thickness and 53 feet in net sand thickness. Material balance calculations indicated that the reservoir contained about 12 MMSTB of oil. Its original reservoir pressure was 3457 psi at 7351 feet subsea. These and other reservoir characteristics have been summarized in Table 1.

Table 1
South Marsh Island Block 73 Field
B-65-G Reservoir Characteristics

Original Reservoir Pressure	3457 psi
Datum	7351 feet subsea
Average Porosity	28.5%
Original Water Saturation	23%
Average Thickness	37 feet
Areal Extent	267 acres
Average Horizontal Permeability	620 md
Average Horizontal/Vertical Permeability Ratio	0.1
Initial Gas-Oil Ratio	867 SCF/STB
Initial FVF	1.3 Res bbl/STB

Reservoir Production and Injection History

The reservoir has produced 7.2 MMSTB of oil, 8.7 BCF of gas (which also accounts for all gas injected back into reservoir) and 946 MBBLS of water over. As previously characterized, four wells had produced from the reservoir; three injected 2 BCF of gas and one well injected no gas. A fifth downdip well, served as a primary gas injector and injected an additional 732 MMCF of gas. As re-evaluated and recharacterized within this study, two additional wells produced the reservoir.

The B-65G sand reservoir began production in October 1966 when the #B-1, #B-7, and #B-10D wells were put on line. The #B-12 was put on line in February 1967. The #B-9D (April

[6] Ibid

from Young, M. A., Salamy, S. P., Reeves, T. K., Kimbrell, W. C., Sawyer, W. K., "Characterization of Representative Reservoirs - South Marsh Island 73, B35K and B65G Reservoirs," Report prepared under U.S. Department of Energy DE-AC21-92BC14831 (October,1993).

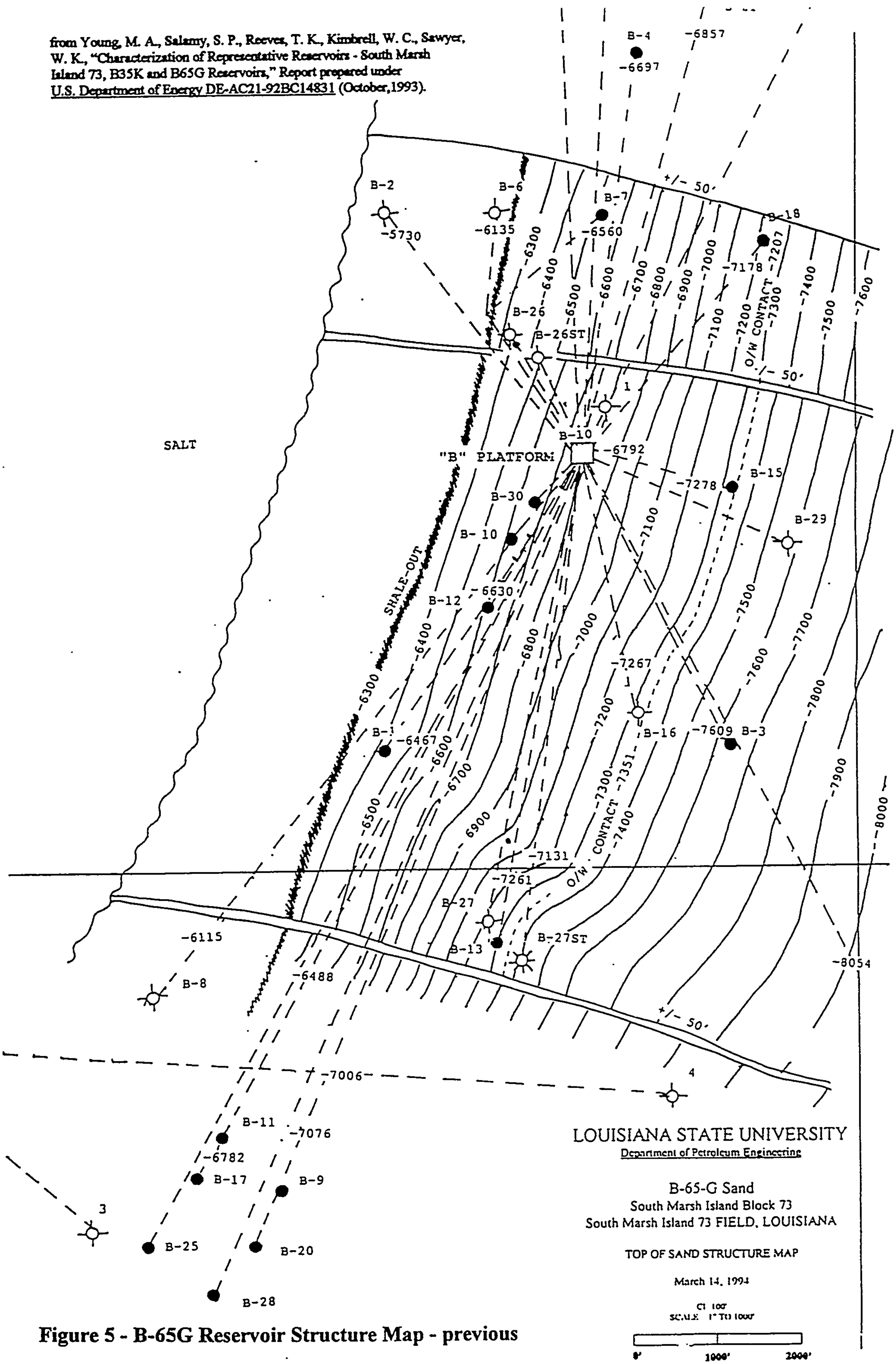


Figure 5 - B-65G Reservoir Structure Map - previous

1967), and #B-17 (April 1971) were all drilled south of what was previously considered to be a sealing fault. However, with the new 3-dimensional seismic interpretation and the confirming simulation it is now believed that all of these wells produced from the same reservoir. Presently, the #B-12 and #B-1 wells are active in the B-65G Reservoir. The B-1 well is currently going through a gas injection stage. Table 2 shows the cumulative production and gas injection values through March 1995.

Table 2

Cumulative Production and Gas Injection, B-65G Reservoir

WELL	OIL-MSTB	GAS-MMCF	WATER-MBBLS	GASINJ-MMCF
B-1	1827	2115	259	672
B-7	1020	1576	1	0
B-10D	1325	792	220	11
B-12	2108	3980	341	1348
B-15	0	0	0	732
B17	400	21	49	0
B9	547	230	76	0
TOTAL	*7227*	*8714*	*946*	*2763*

Original Oil-in-place Calculations

Original oil-in-place calculations performed on the reservoir before 3-dimensional seismic data and other new information was incorporated assigns the reservoir approximately 10,100 acre-feet or an average net pay thickness of 38 feet over 267 acres. Porosity averages 28.5% and the original oil saturation was estimated at 73%, with an initial formation volume factor (FVF) of 1.3 res bbls/STB. Therefore, based on the old information and estimated volumetrically, the original in-place-oil was 12.6 MMSTB. Based on re-evaluation and recharacterization, the original oil-in-place was 19 MMSTB. Therefore, through March 1995, based upon the previous study and volumetrics, 50% of the original oil-in-place had been produced. Based upon the re-evaluation and recharacterization, 38% of the original oil-in-place has been produced.

THREE-DIMENSIONAL DATA INTERPRETATION

Procedure

In general, the steps taken to interpret any 3-D data are six-fold: obtain the workstation, obtain the data, obtain interpretation software, load the data on the workstation, position or coordinate the data, and interpret the data. Amazingly for this study, due to the very high quality data obtained from Geco-Prakla and the superior software from Landmark, the last step - interpretation was the easiest task.

During the project, there were hardware problems, software problems and data problems; all mechanical in nature. Several months were spent just in tackling and solving these mechanical problems. The interpretation actually begins with the positioning or coordination of the data, which is where this discussion will begin.

Positioning of 3-D Data

The 3-D data obtained for this project, unfortunately, failed to incorporate a position coordinate. Therefore, it was necessary to use some other means to position the data to a coordinate platform. Digitized well markers had previously been installed based on the UTM coordinate system and therefore it was desirous to have the 3-D data follow the same system so that the digitized well data and 3-D data would overlay one another properly. In order to position the seismic data, the location of the B-platform in South Marsh Island was found on a hardcopy that was created before the seismic shoot. Using the northeast corner of Block 73, the distance to the platform was measured. The scale was then converted to that of the hardcopy for the seismic shoot. The B-platform location was pinpointed on the seismic data by the lack of data in the area of the platform, characterized by a "dead zone" where no data is obtained due to the structure. When the B-platform was located on the seismic hardcopy, its location was converted into line and trace numbers.

The Sun SPARC-20 workstation was used to find the X-Y coordinates for the B-platform. Using the map view in SeisWorks 3D, with the "show position" mode (which displays the line and trace position of the seismic data activated), the X-Y coordinates of the cursor appear at the bottom of the screen, as do the line and trace numbers. When the cursor was located at the exact line and trace numbers where the B-platform was located, the X-Y coordinates of the platform were read off the screen and then manually put into the workstation as the surface location of all the wells that originate from the B- platform.

Once the position of the B-platform was determined on the seismic map, it was determined that the horizontal scale of the wells did not agree with that of the 3-D data. In order to locate the B65 sand in the seismic data, two methods were used. The first was the use of the time-depth conversion, the B-10 well (which is almost vertical) and the "show position" mode in the seismic display. By using the line and trace and the time depth conversion in combination with the log of the B-10 well, the sand was located. The second method simply consists of a check pick by a geologist experienced with the sand and area. This pick was marked on the B-10 borehole in the seismic display.

Sand (Horizon) Interpretation

After it was determined which reflector represented the B65 sand, a methodological approach was used to map it. First, the sand was marked using the "interpret horizon" feature in the SeisWorks 3D software. The cursor was then placed at a certain point on a line on the screen and at the press of the "expert key G", a trace passing through that exact point appeared on the screen with a marker on it indicating the selected reflector. With this method, the reflector that was marked in the first line can be switched back to a different line perpendicular and once again there will be markers on the reflector. This method was used to make a grid throughout the sand, which is very efficient because it effectively cuts down on jumping between reflectors unintentionally, as well as losing a reflector across a fault.

Once the grid was created, a SeisWorks 3D software function, "ZAP3",(which fills in any blank unmarked areas using a process called "autotracking") is used. Autotracking is the calculation of an output horizon from selected "seedpoints." Seedpoints are horizon interpretation picks that identify the event to be autotracked by location and seismic attribute. The autotracking software searches adjacent traces for picks with similar or identical seismic attributes. If the prospective picks meet user-defined tracking criteria, the new picks are converted to new seedpoints. In this manner, the horizon is propagated across the survey until no additional valid picks are found. There are two different seismic attributes which may be tracked, amplitude and phase. If tracking amplitude, the seed points are specified by their x, y and z locations and onset type. If tracking phase, the seed points are specified by x, y and z locations and phase angle. Amplitude was chosen to be tracked for this project.

The standard tracking mode was used in the "ZAP3" process. When tracking amplitudes, the standard mode autotracks in all four directions. It evaluates prospective picks in two ways:

1. A user-specified "Score" value that specifies how similar the prospective pick must be to the seedpoint.
2. A cross-check of the amplitudes to ensure that each prospective pick loop-ties with the initial seedpoint.

The score measures the difference in seismic attributes which are allowed for the points to be validated. For example, a score of 85 indicates that the new point must be about 85 percent the same as the seed point.

Fault Interpretation

Fault interpretation using SeisWorks 3D is similar in principle to that of horizon interpretation. A fault is picked in the seismic view and marked using the "fault interpretation" mode. Due to the nature of the faults in this area, the best method for interpretation was to mark the faults on every tenth trace. Once the faults and horizons were interpreted, the SeisWorks 3D software calculated the fault heaves using the specified horizon on both sides of the fault. This software also is useful in the creation of fault gaps because of the manner in which the fault heaves are displayed on the screen. They are displayed in the map view so that they appear as the horizontal displacement of the fault segments chosen. Once the fault was marked on every tenth line and the necessary heaves were calculated, the fault was triangulated using the "triangulate fault" function in the SeisWorks 3D software.

New Combined Three-Dimensional Seismic Interpretation

A new structural and stratigraphic interpretation based upon the 3-dimensional seismic data is shown in Figure 6. The faults which were previously believed to exist were apparent in the seismic data, with the exception of one east-west fault which was believed to exist based upon past production and pressure data. The major down-to-the-south fault which is the northern boundary of the B65 sand production appeared to have more curvature (concave towards the platform in the map view) than previously believed. The major down to the north fault which is the southern boundary for the sand production also has more curvature (concave towards the platform in the map view) than previously believed. It is also closer to a north-south trend which curves slightly east as opposed to the more east-west trend as it was previously mapped. The smaller east-west fault which dies out before reaching the salt dome appeared just as it was originally mapped. Two smaller faults which were believed to be under the platform were not visible due to the jumbled data image.

The reservoir appeared to shale out before actual contact with the salt dome was made. The shale out was fairly uniform along the boundary of the sand, yet seemed to push slightly away from the salt dome as it moved north along the salt dome. At the south end of the reservoir just north of the where the sand faults the salt dome contact shows the beginnings of a north-south trending steeply dipping down to the east fault. Overall, the reservoir was interpreted to be much larger than had previously been calculated by 6.4 million barrels, or an increase by a factor of 1.5.

B-65G RESERVOIR SIMULATION STUDY

A 2nd reservoir simulation study was undertaken to incorporate new seismic data and confirm the new intyerpretations and characterizations for the B-65G Reservoir.

Fluid Properties

PVT data were generated by the use of fluid correlation's and were given in the previous report. In this study, the same values were used and are given in Figures 7 and 8. In order to honor the fluid properties previously calculated, it was assumed that the bubble point was 3457 psia, and the reservoir pressure was adjusted to preserve equilibrium conditions. This adjustment will not adversely affect the simulation results.

Rock Properties

The relative permeability curves from the previous report were not the most representative of a water wet, Gulf of Mexico reservoir. In particular, the relative permeability to water was considered to be unrealistically high. A more reasonable curve was used, honoring the water saturation observed from well logs. The curves used in the simulation are given in Figures 9 and 10.

Well Data

Production data was given for each producing well by Taylor Industries.

Structure, Gross Thickness, Net Thickness, Porosity, and Permeability Maps

The structure-stratigraphic map shown in Figure 6 was overlain with a 26 x 30 grid as shown in Figure 11. The new map added additional area to the reservoir. Gross and net sand thickness maps were derived from an initial interpretation by Exxon, and are shown in Figures 12 and 13. The maps show a fluvial depositional environment, with channeling affecting the fluid

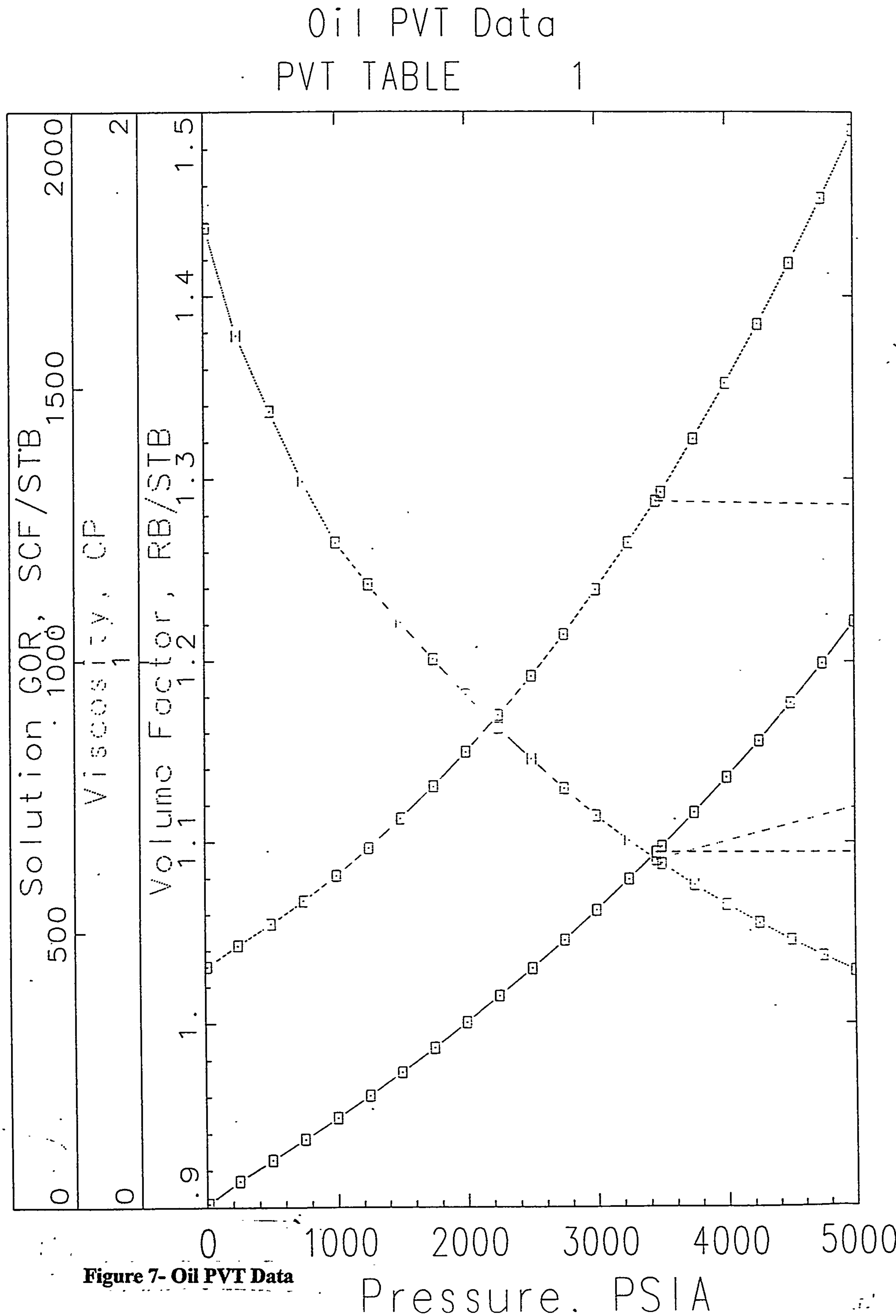


Figure 7- Oil PVT Data

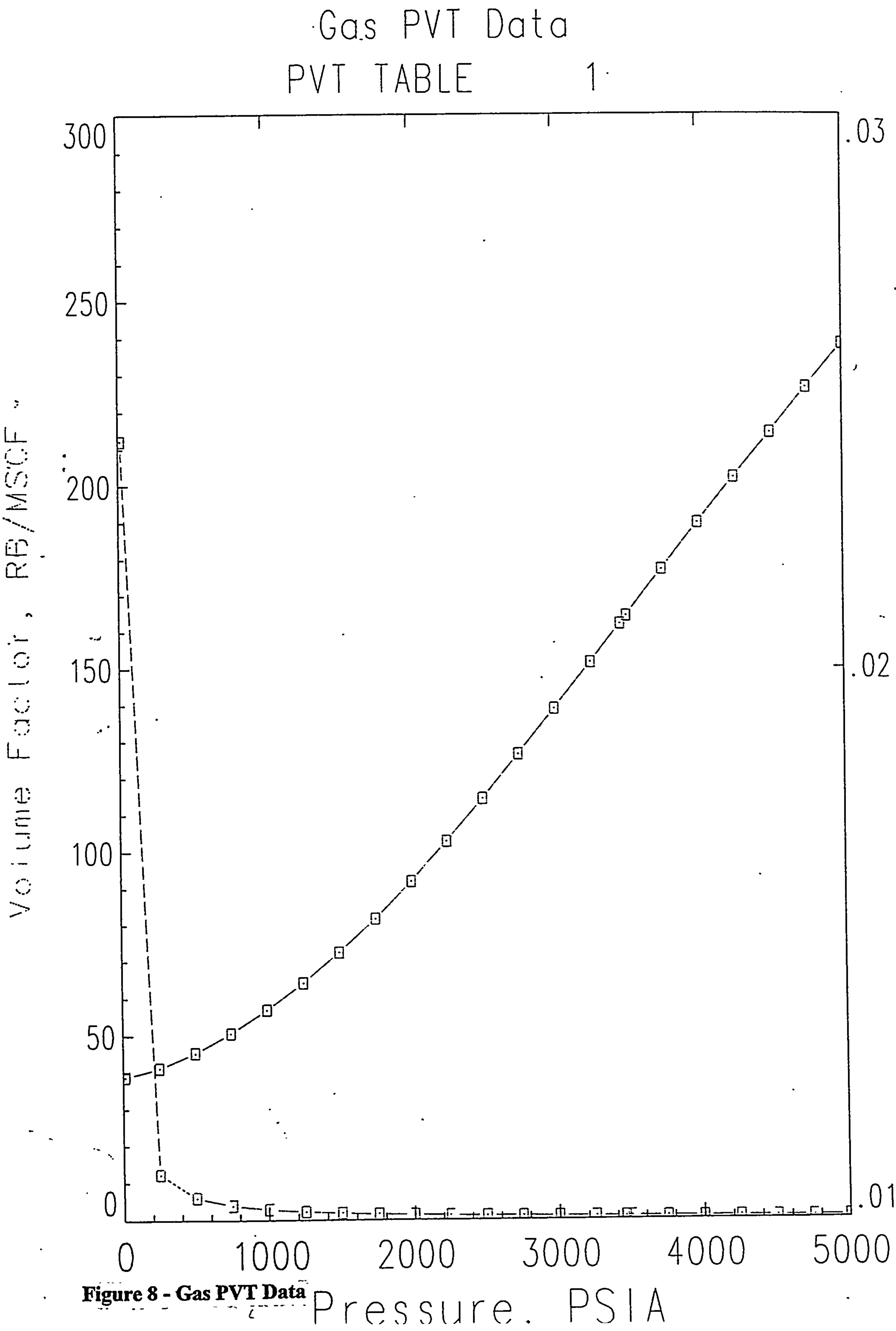


Figure 8 - Gas PVT Data

Figure 9 - Water-Oil Relative Permeability

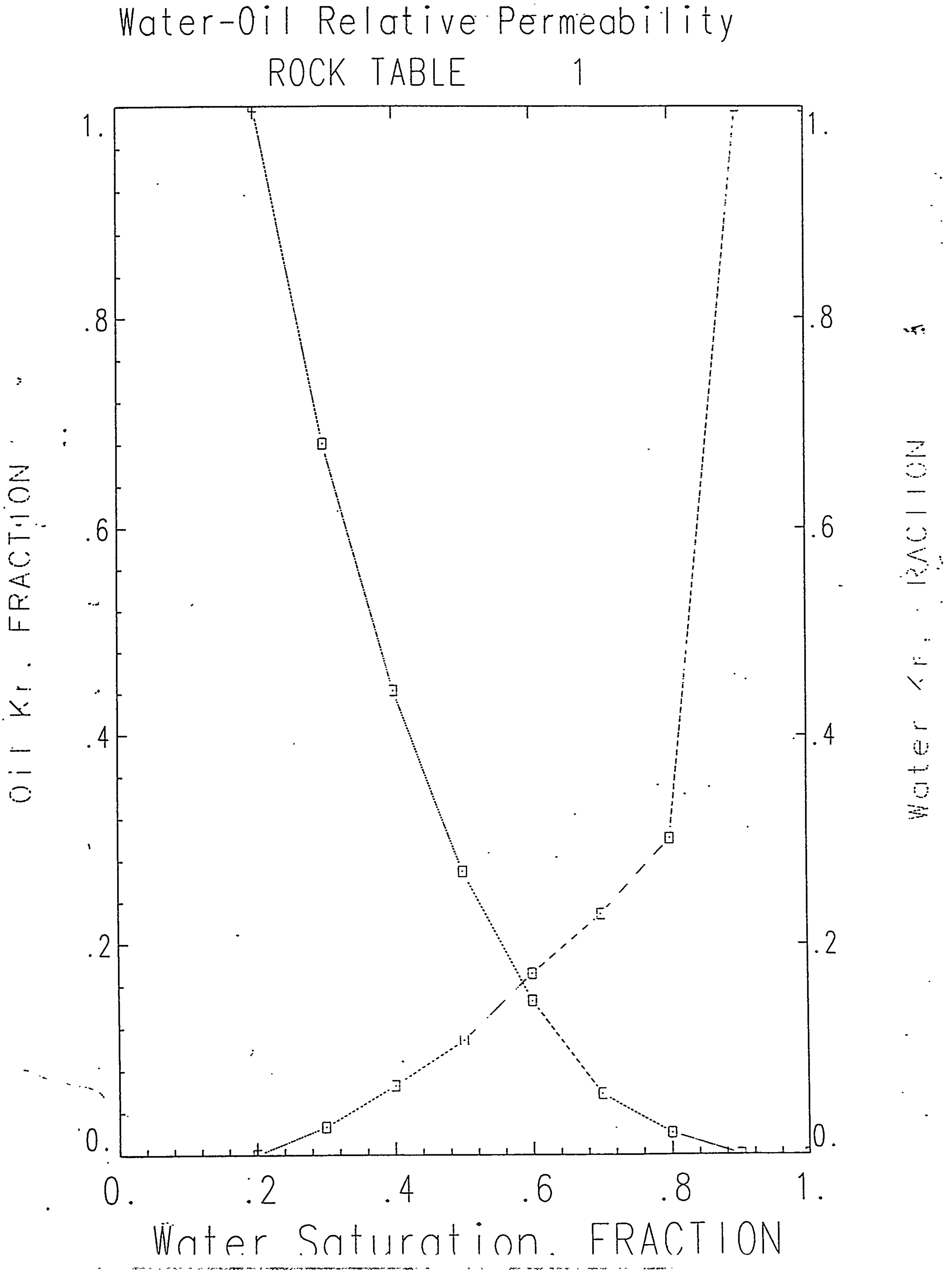
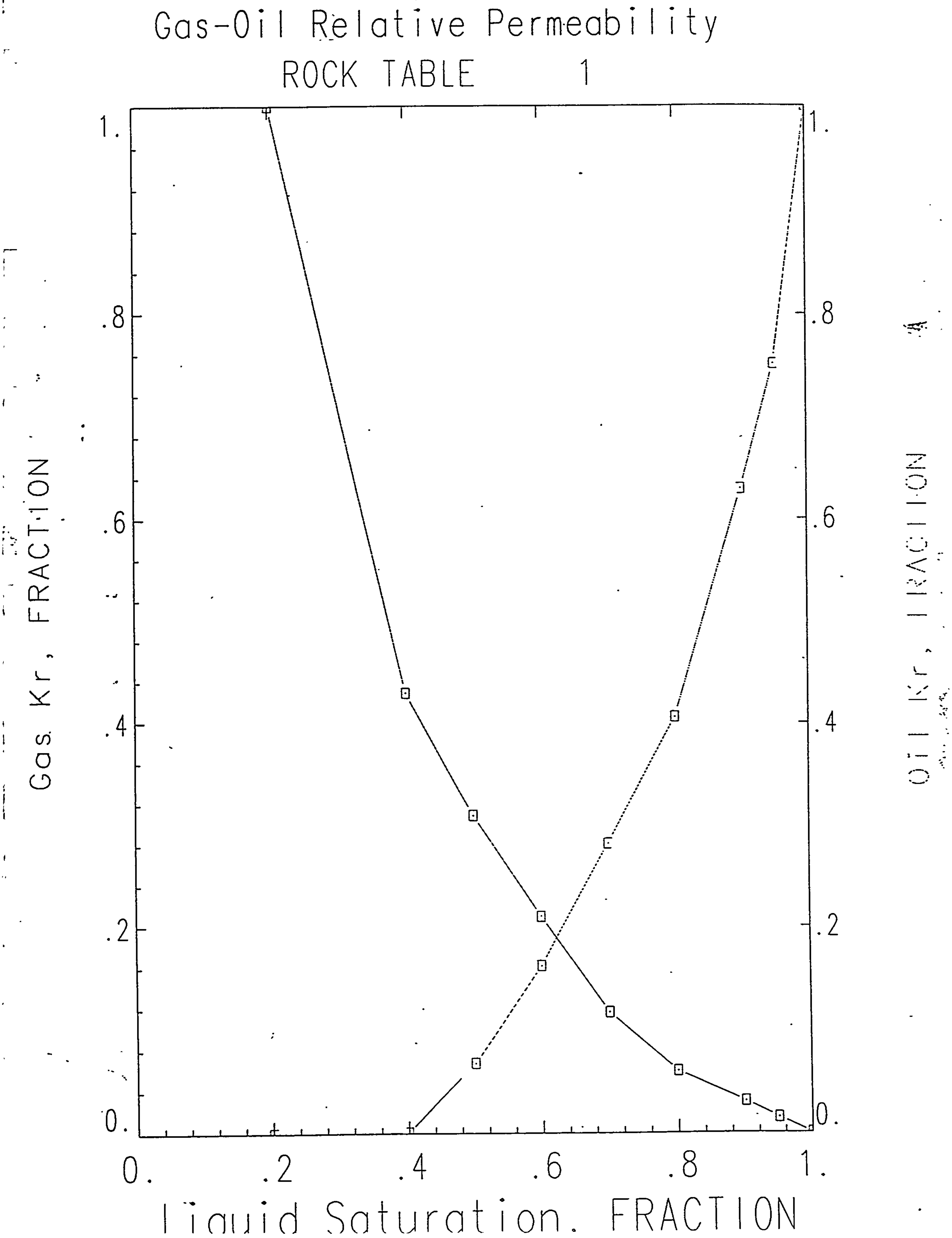


Figure 10 - Gas-Oil Relative Permeability



b65g sand/finegrid1:Layer 1/Structure Tops(FT)

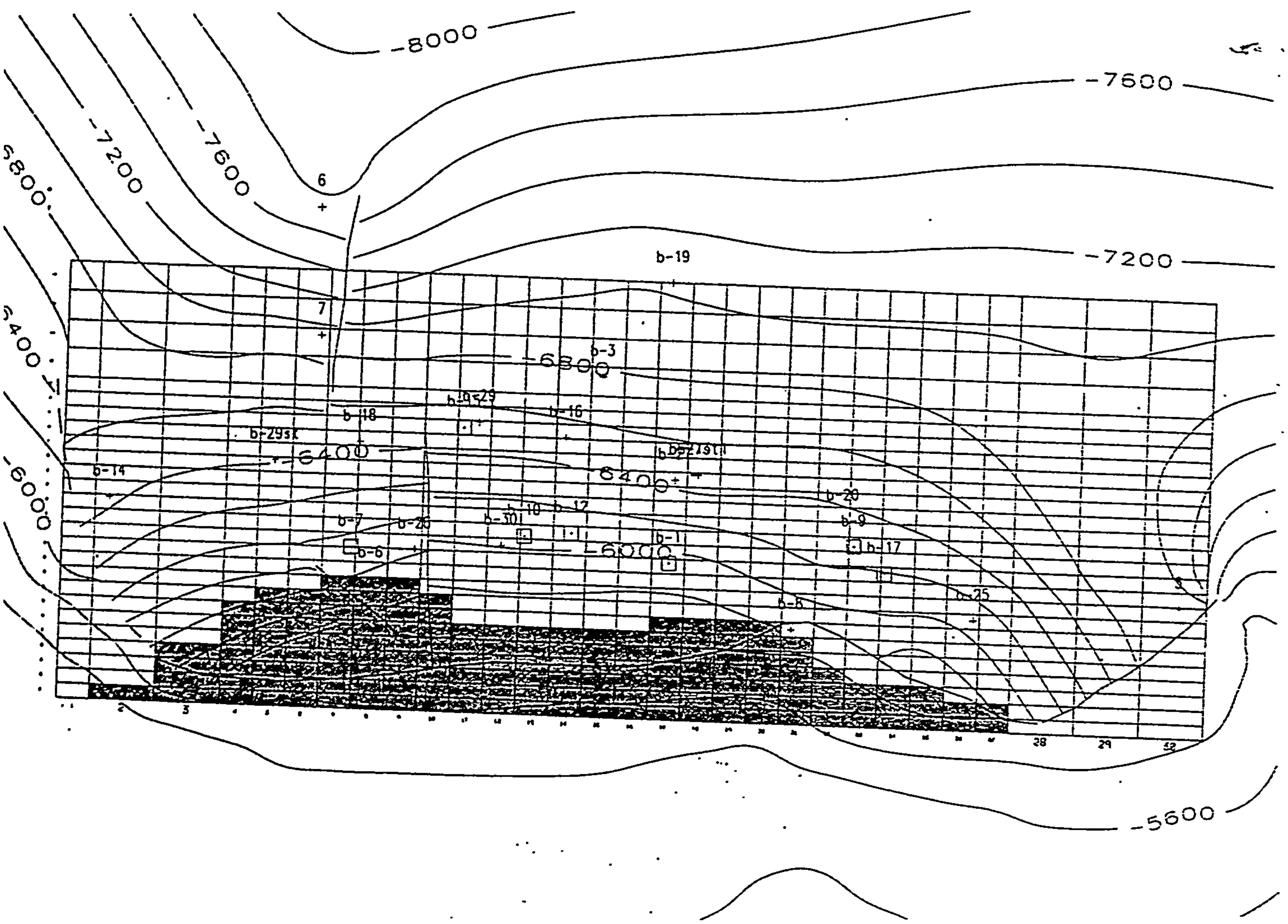


Figure 11 -Structure Map with Simulation Grid

b65g sand/finegrid1:Layer 1/Vertical Gross Thkn(FT)

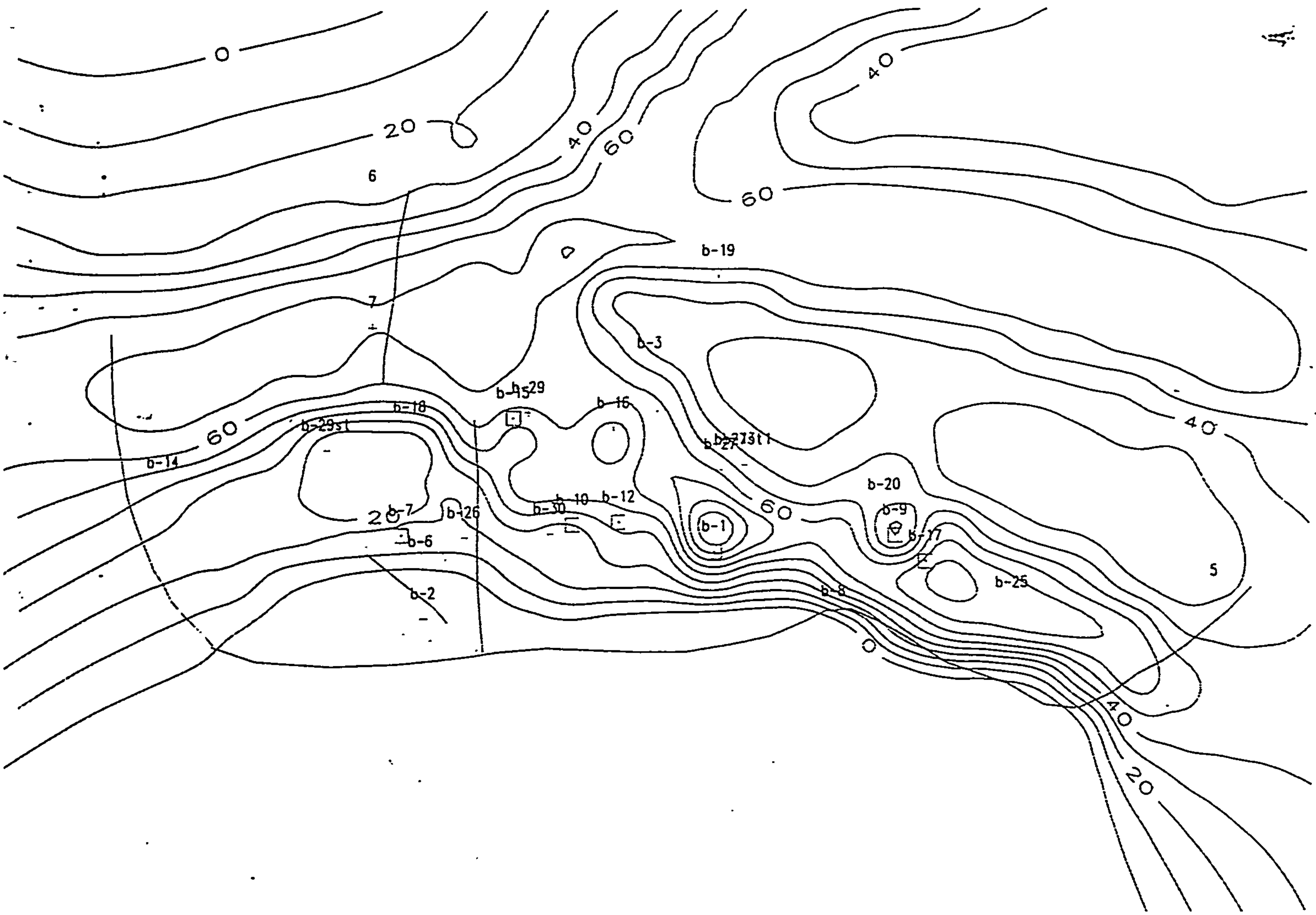


Figure 12 - Vertical Gross Thickness Map

b65g sand/finegrid1:Layer 1/Vertical Net Thkn(FT)

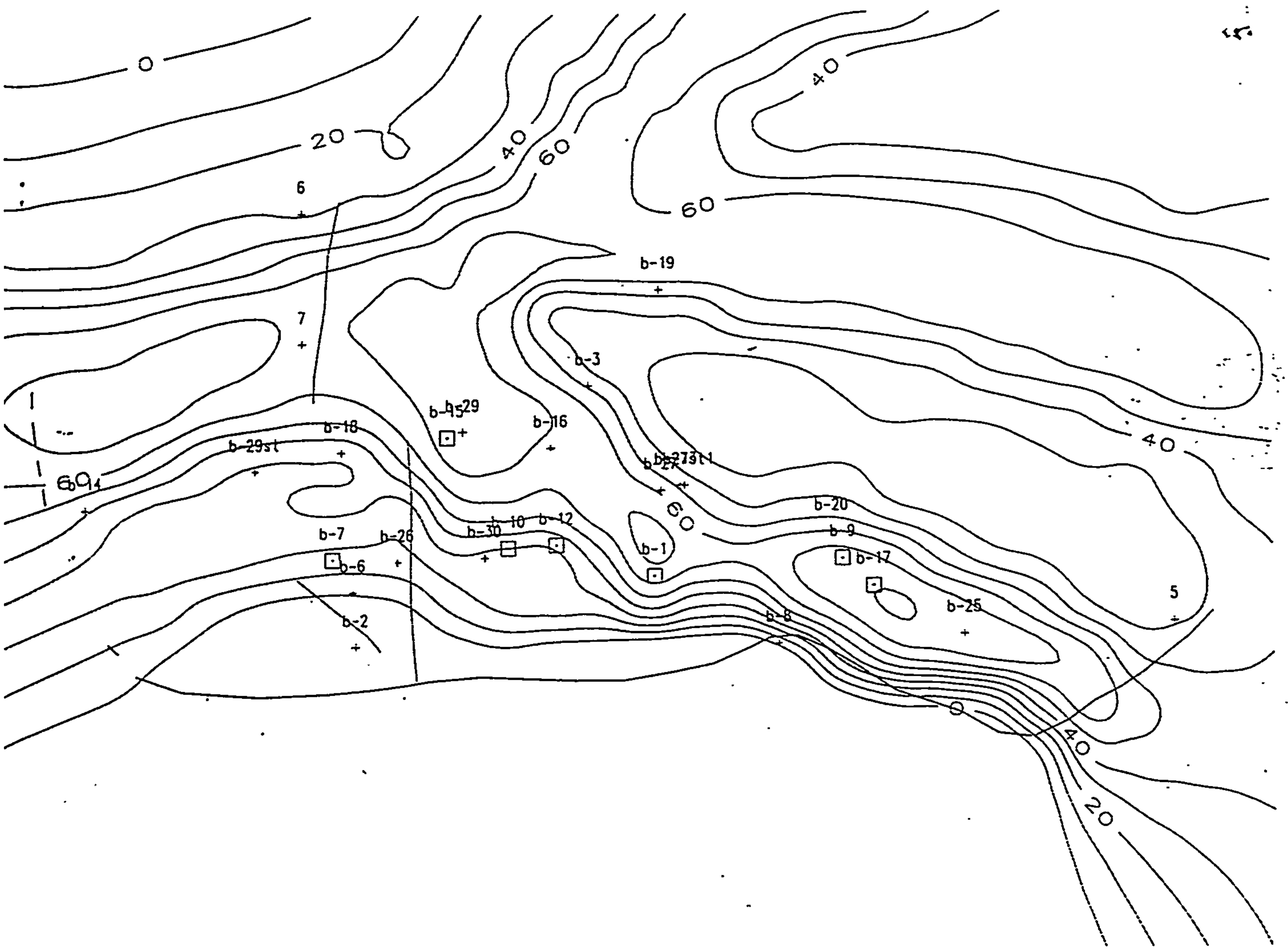


Figure 13 - Vertical Net Thickness Map

flow path. Porosity and permeability maps (Figures 14 and 15) were developed using observed values and the gross and net sand maps as a guide.

Aquifer

It was obvious from the observed pressure data that water influx was significant in this reservoir, as the pressure began to increase after peak production. A Carter-Tracy aquifer model was employed to simulate water influx, unlike the previous study which incorporated a steady-state aguifer influx model. Input values for the Carter-Tracy model can be found in the input data set in the Appendix. To honor the channeling, only the gridblocks in the last row in the upper left corner of the grid were permitted to influx water.

History-Match Results

Figure 16 shows simulated vs. observed values for pressure, oil, water, and gas production. Note the very good match of pressure, indicating the aquifer model and reservoir permeability were suitably chosen. Cumulative production is given in Figure 17. Individual well results are given in Figures 18 through 23. In general, the well performance match was good, although some wells could not be matched satisfactorily. The results indicate that almost 38% of the OOIP was recovered. The appendix contains the final fluids in place and cumulative production from the simulation model, as well as the initialization results.

Given the fluvial nature of the reservoir, drilling additional wells updip does not seem to hold much promise, as these wells are likely to fall outside of the channel system. As the reservoir re-pressurizes, existing wells should be periodically produced to recover newly segregated oil and gas. Figures 24 and 25 show the initial and final oil saturation maps. Based upon these results, several predictive sensitivity study simulation runs were performed.

Predictive Sensitivity Studies and Conclusions

Predictive sensitivity studies were performed on the B-65 reservoir for several scenarios including continued production with no additional changes or enhancement and additional gas injection with separate emphasis on methane, flue gas, CO2 and nitrogen. Results for the injection of different gases followed closely the results reached during laboratory investigations of these different injectants.

Continued Production with no Additional Enhancement

A simulation of the B-12 and B-1 wells was performed with no additional enhancement. The B-1 well recovered an additional 384,500 barrels of oil, while the B-12 well recovered an additional 89,600 barrels of oil.

Methane, Flue Gas, CO2 and Nitrogen Injection

Simulations were performed to analyze the results of the injection of gases into the reservoir as an enhancement to its performance under conditions with not additional enhancement.

b65g sand/finegrid1:Layer 1/Porosity(FRACTION)

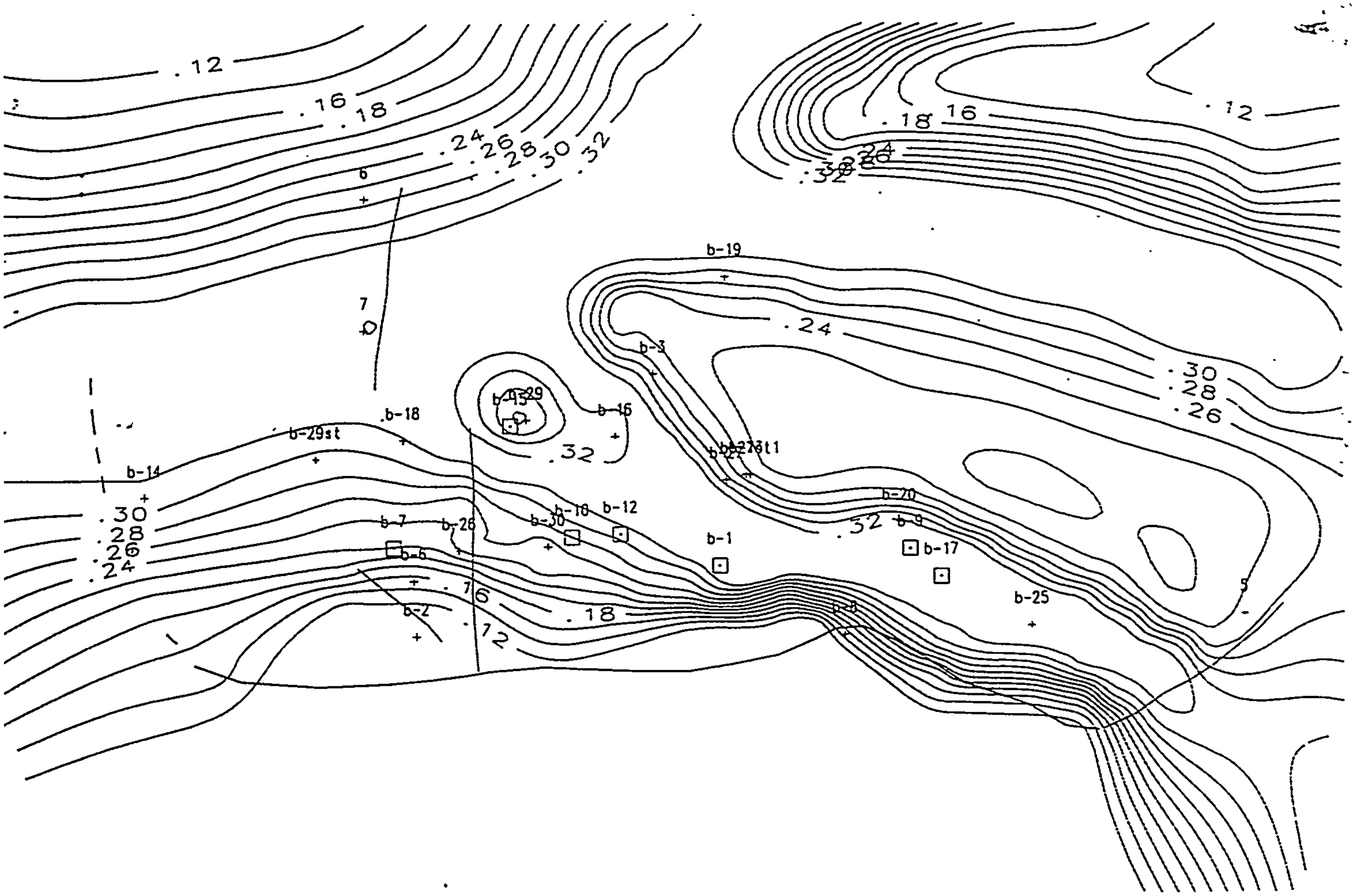


Figure 14 - Porosity Map

b65g sand/finegrid1:Layer 1/X(R)-Permeability(MD)

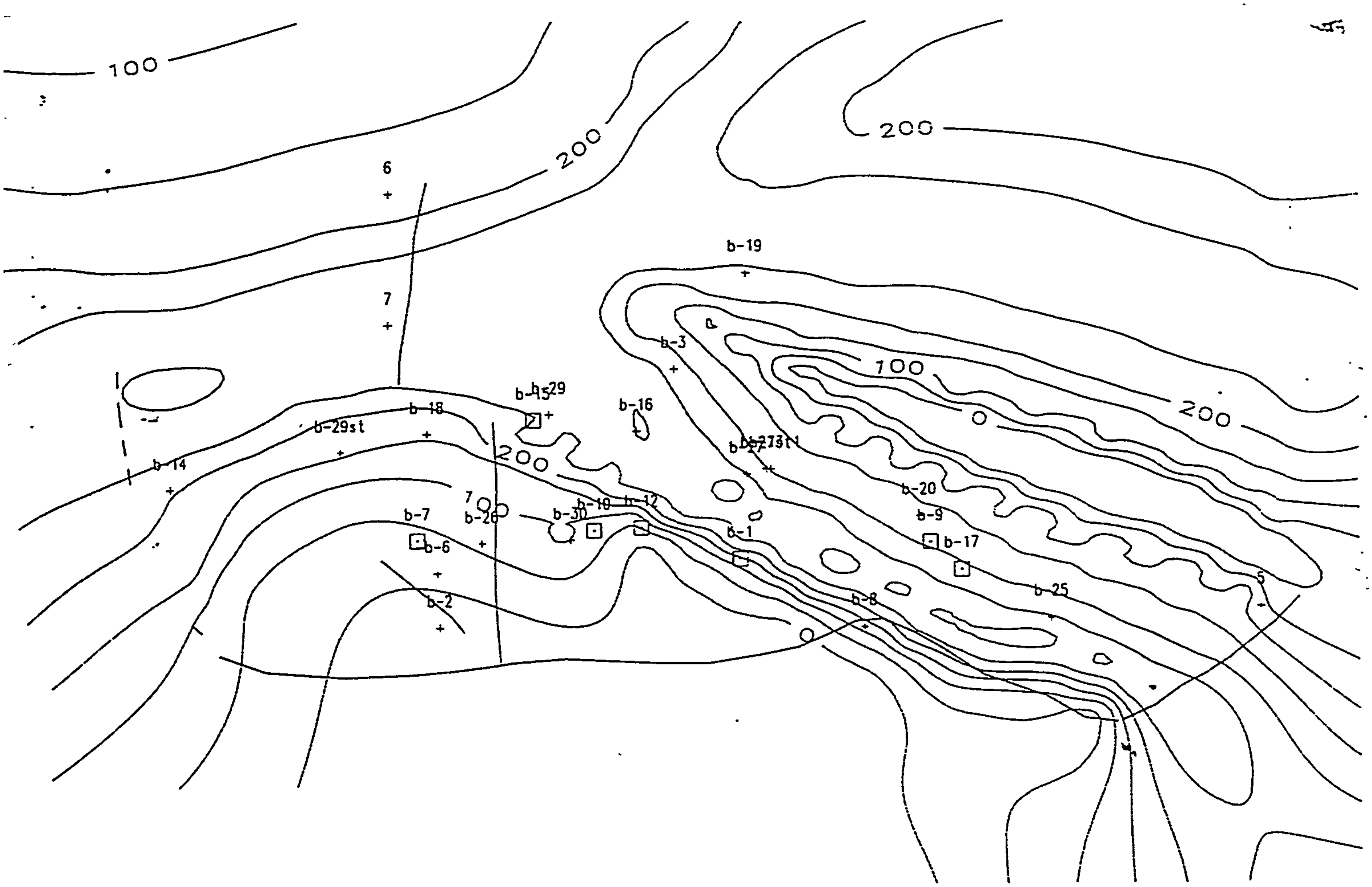


Figure 15 - Permeability Map

Figure 16 - Simulated versus Actual Fieldwide Production Rates

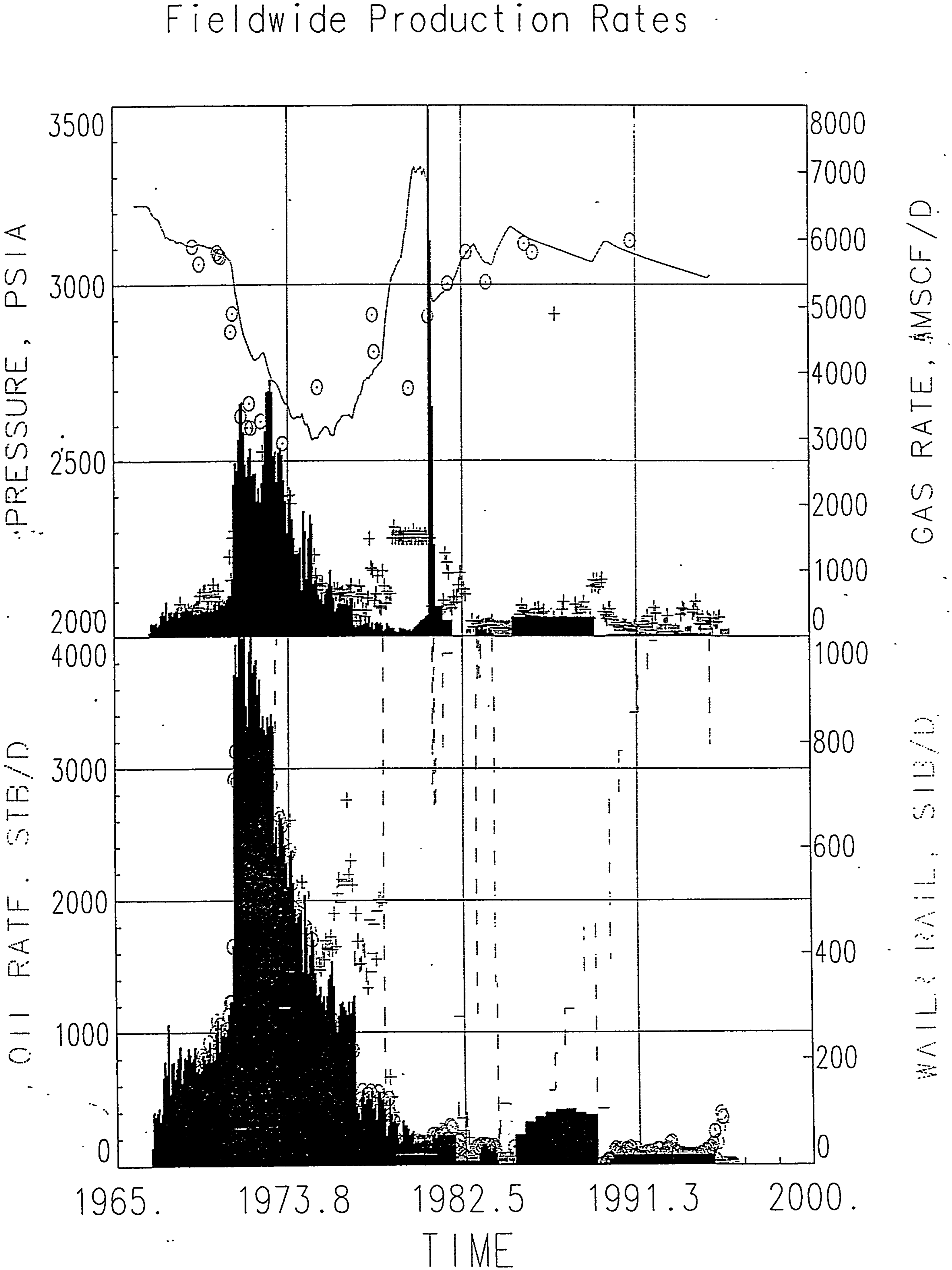


Figure 17 - Fieldwide Oil, Water, and Gas Cumulatives

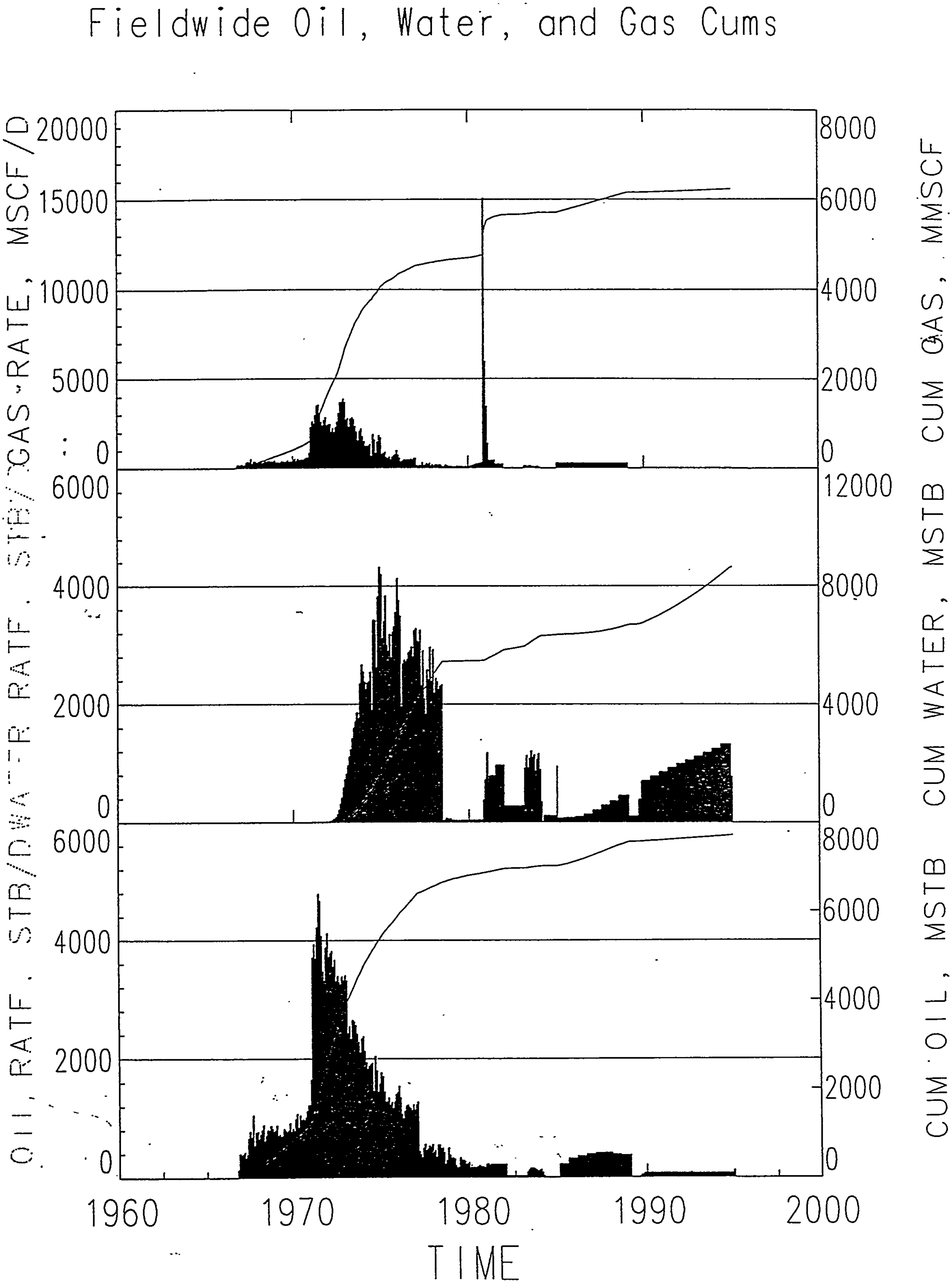


Figure 18 - Production Rates, Well B-1

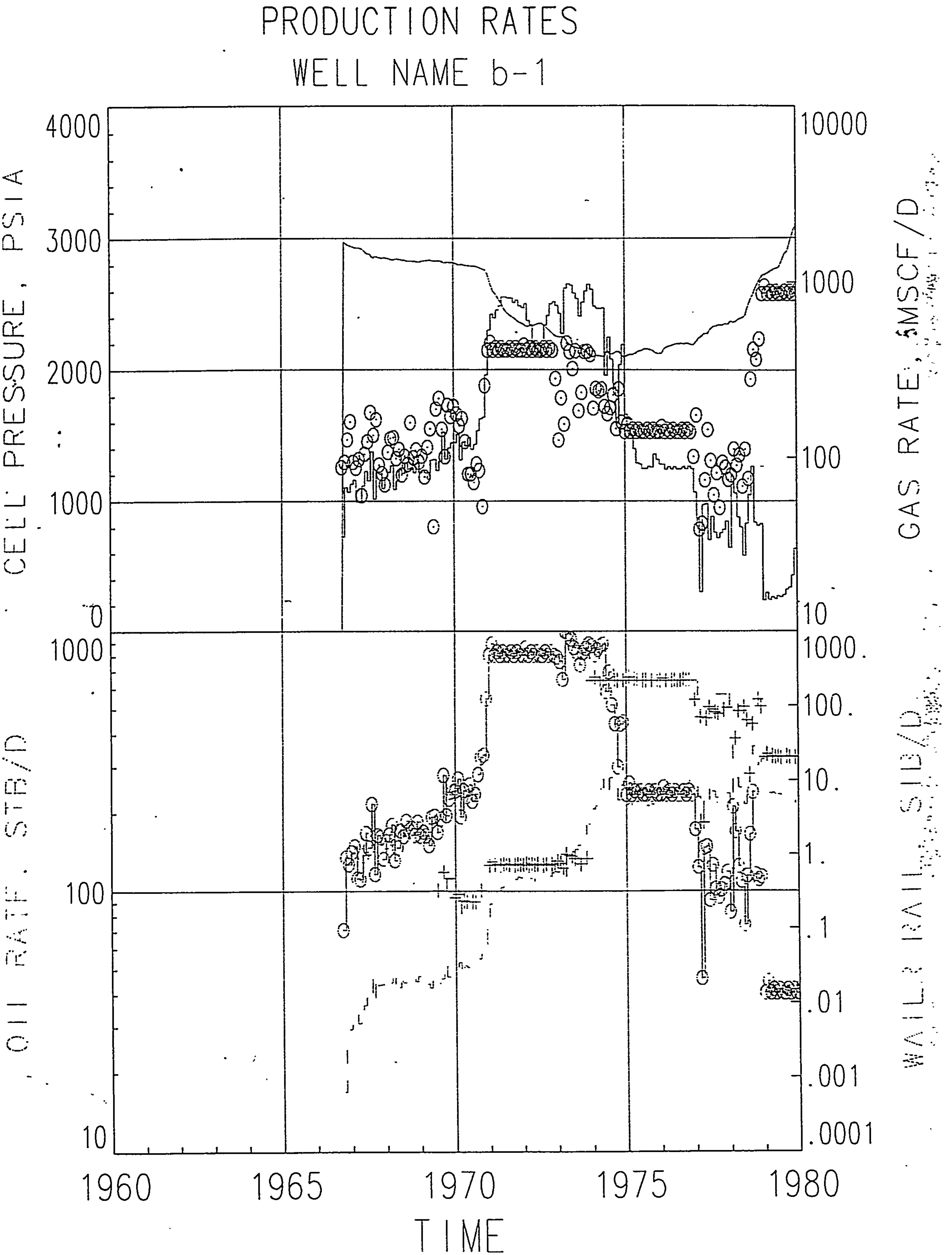


Figure 19 - Production Rates, Well B-12

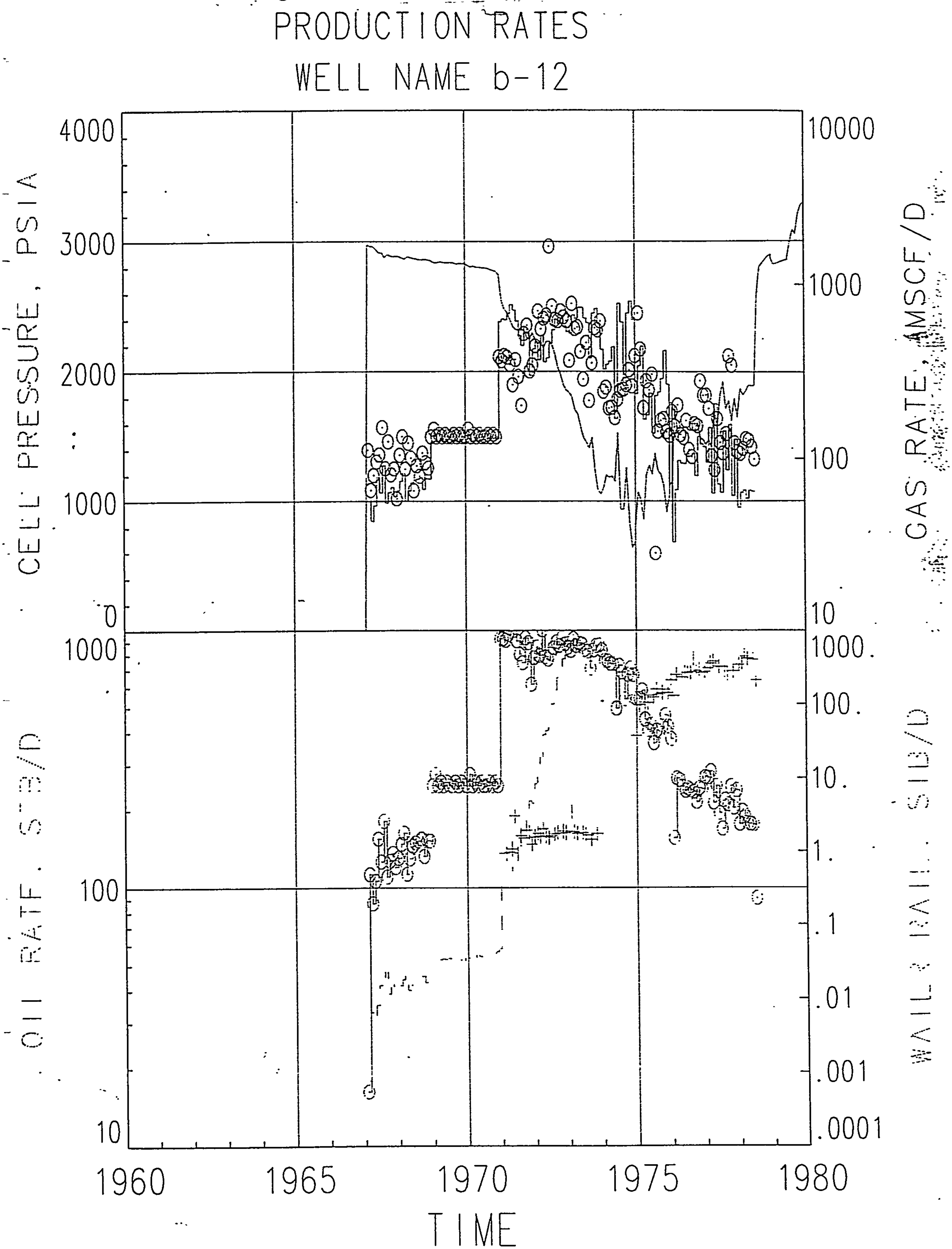


Figure 20 - Production Rates, Well B-7

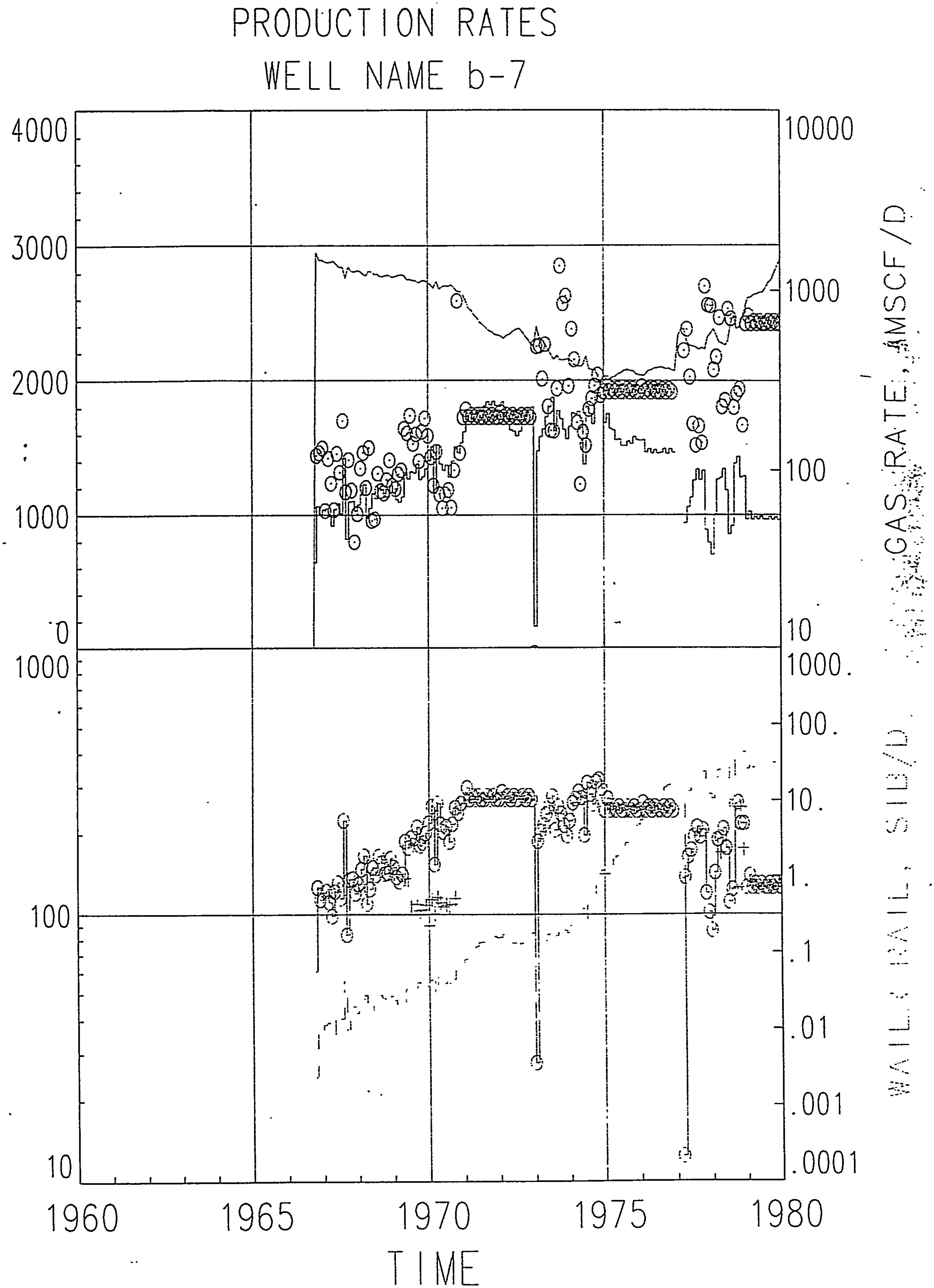


Figure 21 - Production Rates, Well B-9

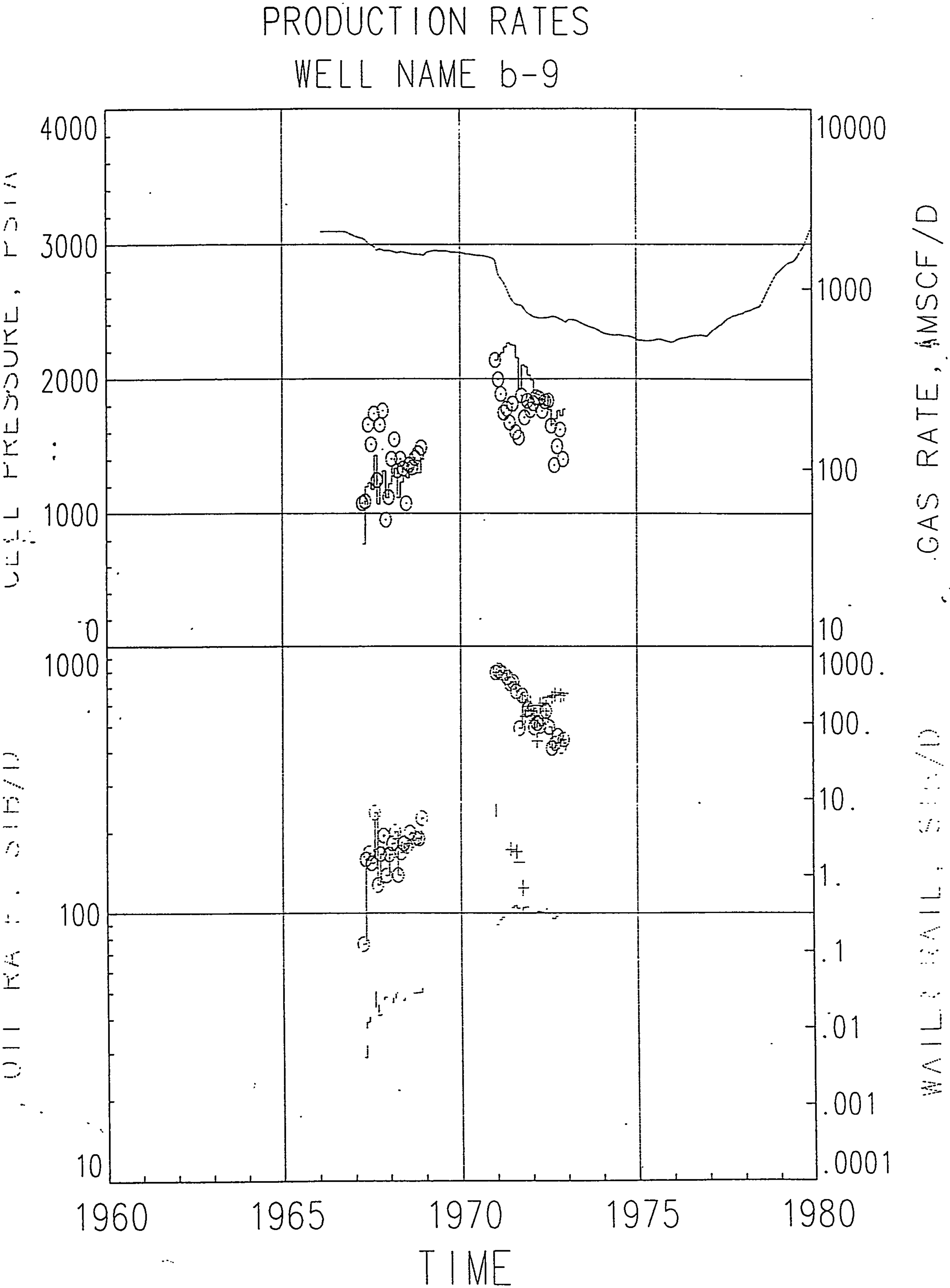


Figure 22 - Production Rates, Well B-10

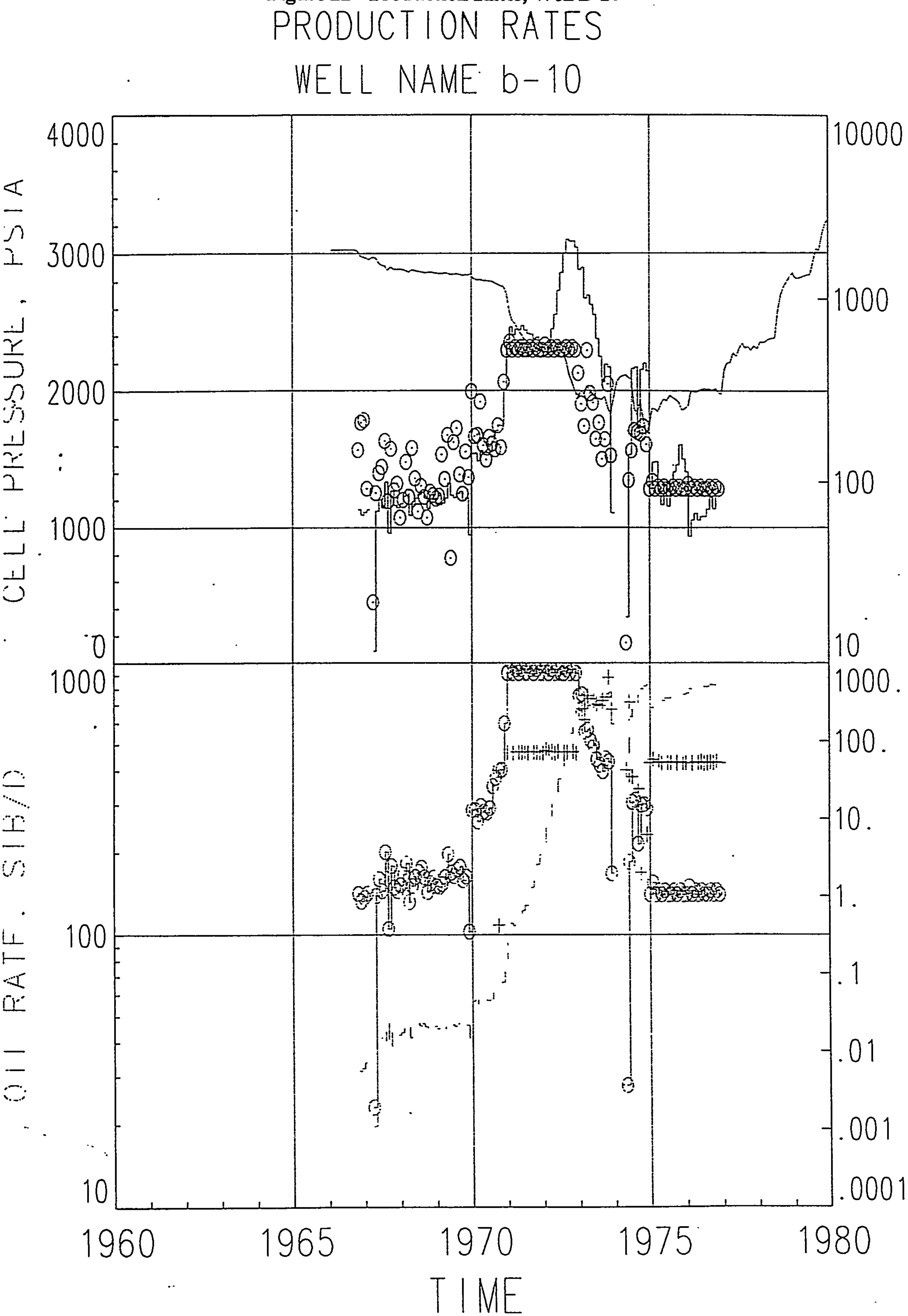


Figure 23 - Production Rates, Well B-17

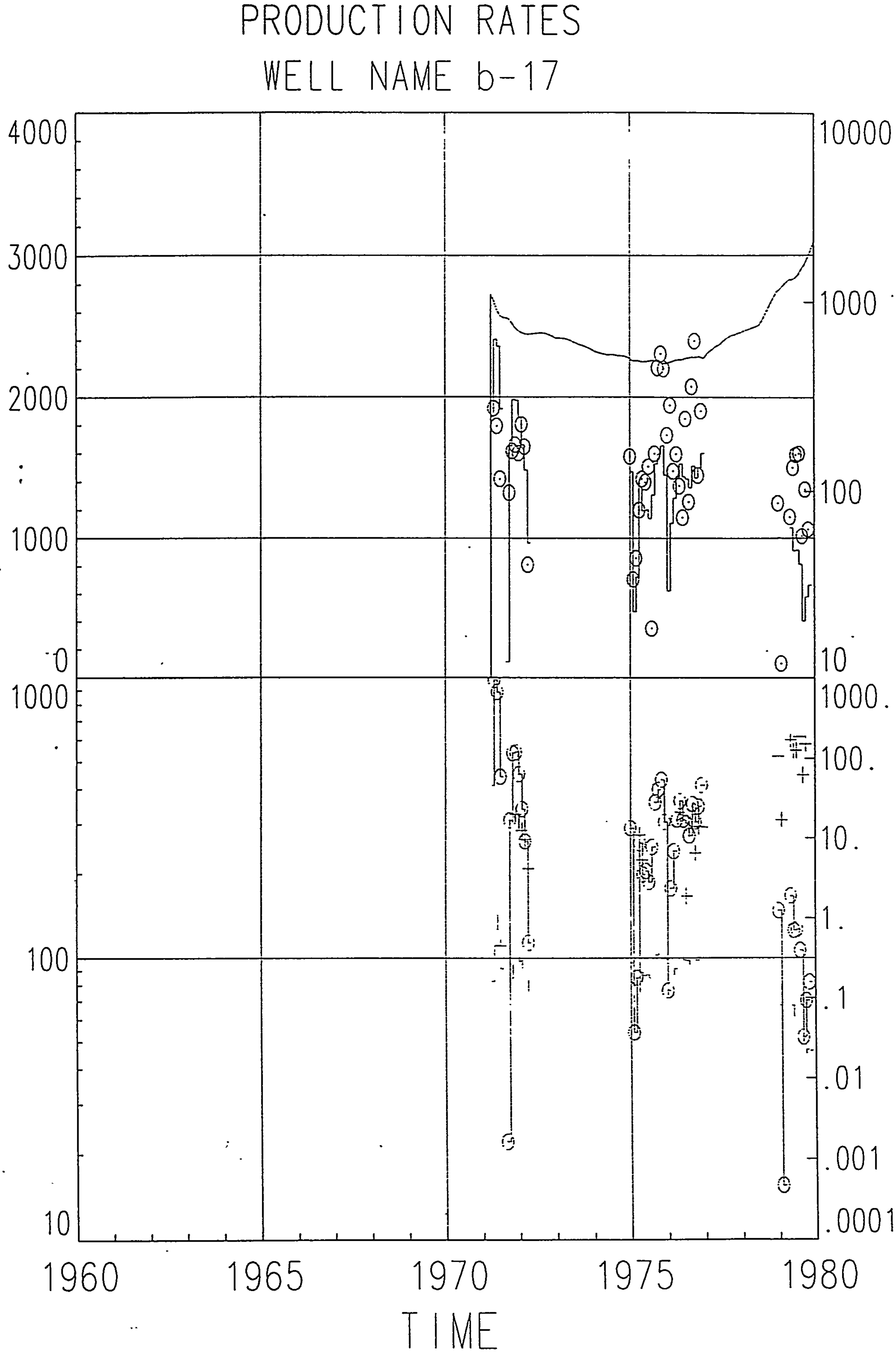


Figure 24 - Oil Saturation Map, Initial Conditions

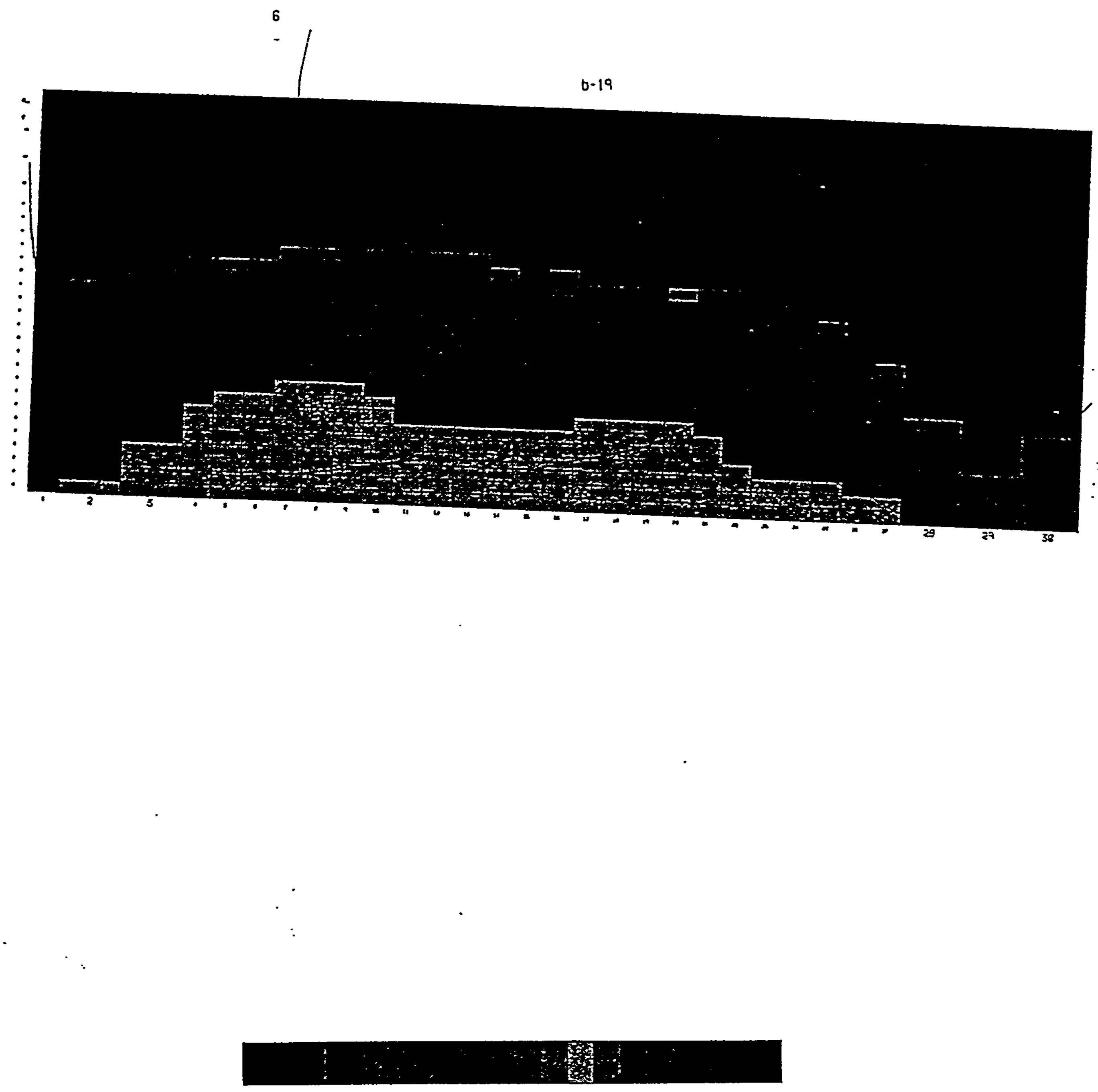
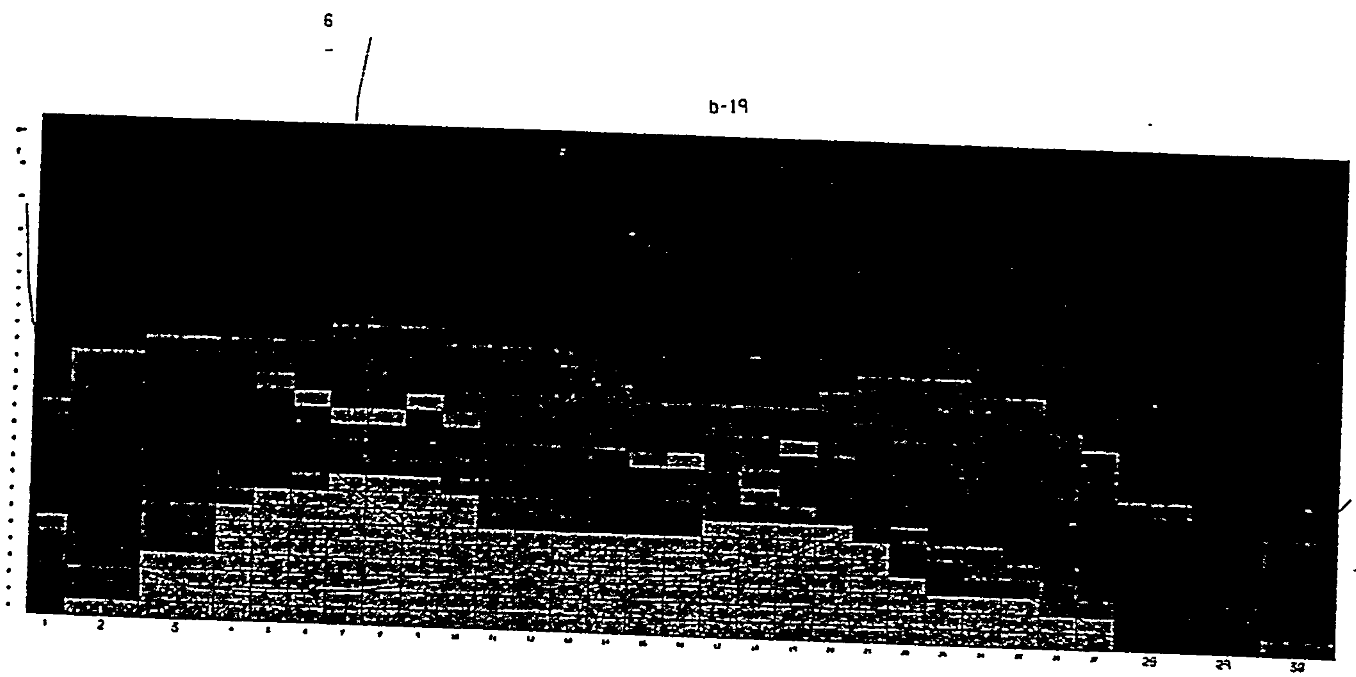
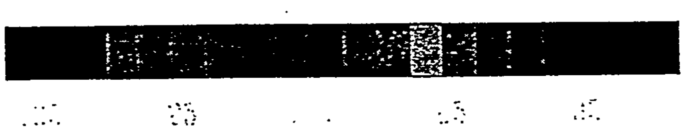


Figure 25 - Oil Saturation Map, Final Conditions





At present, the B-1 and B-12 wells are the only existing completions available to the B-65 reservoir. Therefore, predictive analyses were restricted to the use of these two wells.

Several different gas injection/production sceanrios were simulated, including each well used as a gas injector for different time periods, while the other produced, and both wells being used for different time periods as gas injectors/producers. The best increase in recovery of oil by use of gas injection enhancement for attic oil recovery were obtained with the B-1 well being used as a gas injector, while the the B-12 well was used as a producer. The B-1 well is the most updip well between the B-1 well and the B-12 well. Gas was injected into the B-1 well and the B-12 well was utilized as a production well to analyze the differences and affects seen by gas injection for up-dip oil recovery. The B-1 well was injected with 500 MCFD for 6 months and shut-in. The B-12 well was produced for an additional 54 months. Oil recovery over this time compared to the B-12 well producing with no enhancement, increased by 20%, for a ratio of 0.44 bbls of oil per MCF of gas injected. Water cut decreased by 3%. Additional gas injection improved the recovery proportionately. At a present gas price of $2.90/mcf and a present oil price of $25.00/bbl, and assuming no gas injected is recovered and operational costs are not increased dramatically, a profit increase (for use of the gas) of 3.8 times is realized by gas injection. Ultimate recovery was not increased in this particular reservoir, by using different gases. Increased speed of recovery as a result of using different gases could not be properly simulated. Therefore, laboratory results as presented in Volume IV, which used actual B-65 reservoir oil, should be referred to for this analysis. Based upon these laboratory and simulation results, a major increase in reserves may be recovered by updip gas injection. Unfortunately, detailed operational cost analyses were not within the scope of this report. It is strongly recommended, from these results, that further studies are made in the form of cost/economic analyses and pilot case studies

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Figure 6 - B-65G Reservoir Structure Map - New 3-Dimensional Interpretation

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niversity

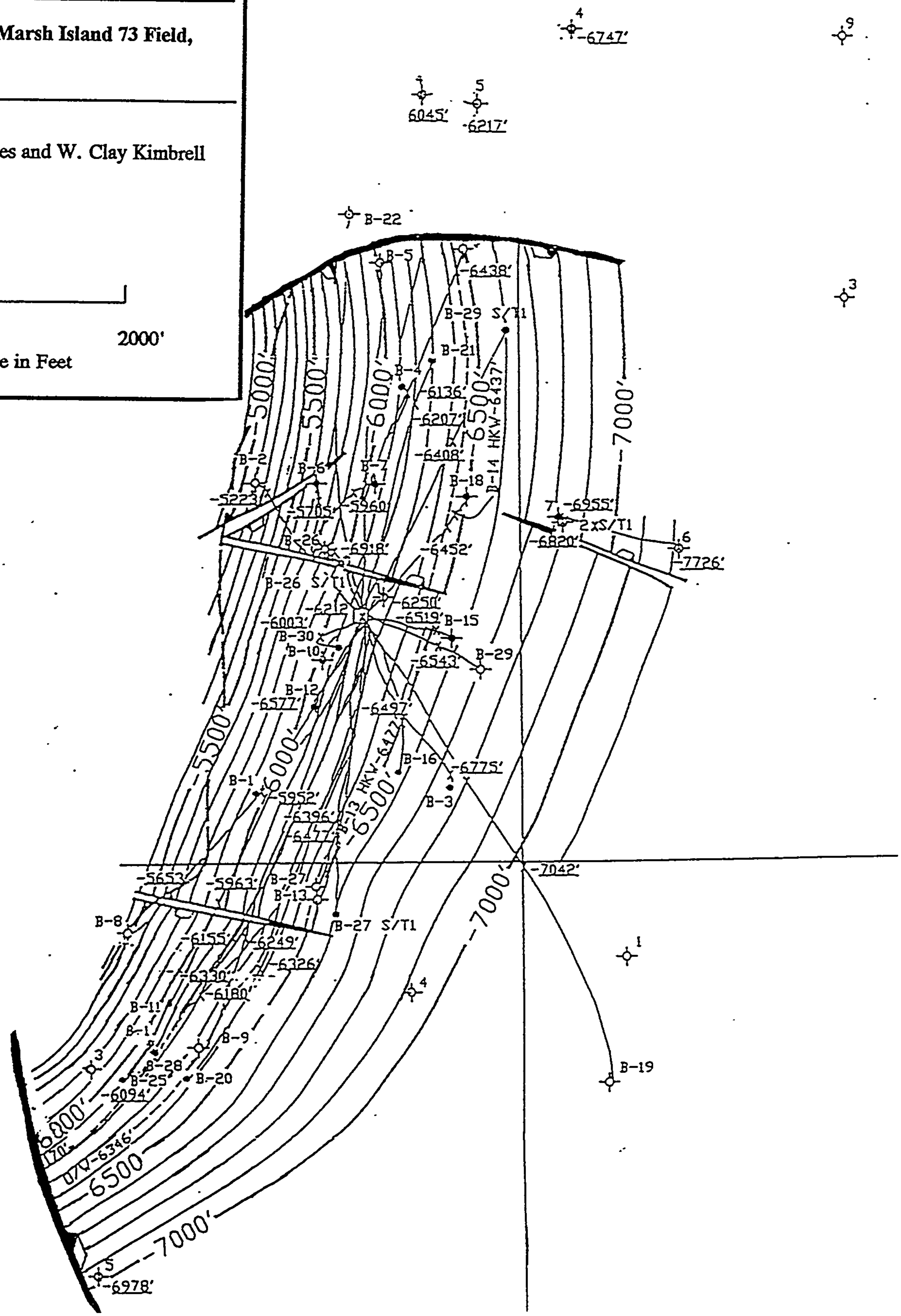
Department of Petroleum Engineering

65-G Reservoir, South Marsh Island 73 Field,
ouisiana

Geology by: Hunter Coates and W. Clay Kimbrell

ugust 12, 1996

0' 1000' 2000'
Scale in Feet



Appendix A - Final Results from Simulation Run

```
*****************************************************************************************************************************
 : SSI'S SIMBEST II SIMULATOR :                                   b65g sand                          : DATE 15-Aug-96  TIME 16:24 :
 : SCALAR VERSION 3.21I 9 S10 :                                   b65g sand                          : SIMULATION RUN  PAGE   958 :
 *****************************************************************************************************************************

+SIMULATION DATE   1 JAN 1995                                                                          SIMULATION TIME 10562.0 DAYS

                                                       MATRIX SYSTEM  -  TOTAL FIELD
                                                       ==============================

0VOL AVG PRESS (PSIA     )
      AT DEPTH                       3027.
0-------------------------------------
0FLUIDS IN PLACE
      OIL (MSTB      )              16354.
      TOT GAS (MMSCF     )           7975.
      FREE GAS (MMSCF     )          1170.
      INERT GAS (MMSCF     )            0.
      WATER (MSTB      )            84845.
0-------------------------------------
0CUMULATIVE PROD
      OIL (MSTB      )               7716.
      OIL (PCT IOIP)               32.050
      HC. GAS (MMSCF     )           6231.
      INERT GAS (MMSCF     )            0.
      WATER (MSTB      )             8656.
0-------------------------------------
0CUMULATIVE INJ
      HC. GAS (MMSCF     )           2230.
      INERT GAS (MMSCF     )            0.
      WATER (MSTB      )                0.
0-------------------------------------
0NET REGION INFLUX
      OIL (MSTB      )                 -4.
      HC. GAS (MMSCF     )             -3.
      INERT GAS (MMSCF     )            0.
      WATER (MSTB      )            17299.
0-------------------------------------
0BOUNDARY INFLUX
      OIL (MSTB      )                  0.
      HC. GAS (MMSCF     )              0.
      INERT GAS (MMSCF     )            0.
      WATER (MSTB      )            17289.
0-------------------------------------
```

Appendix B - Initialization Output

```
AMOUNT OF DYNAMIC MEMORY ALLOCATED(DOUBLE WORDS)      31203
AMOUNT OF DYNAMIC MEMORY ALLOCATED(INTEGER WORDS)      2340

                                     ***********************************************************
                                     *                                                         *
                                     *   SSSSSS                 BBBBBBB                        *
                                     *  SS    SS                BB    BB                       *
                                     *   SS        IIIII  M   M  BB    BB  EEEEE  SSSSS  TTTTT *
                                     *     SS        I    MM MM  BBBBBB    E      S        T   *
                                     *       SS      I    M M M  BB    BB  EEEEE   SSS     T   *
                                     *  SS    SS     I    M   M  BB    BB  E          S    T   *
                                     *   SSSSSS    IIIII  M   M  BBBBBBB   EEEEE  SSSSS    T   *
                                     *                                                         *
                                     *                       IIIII   IIIII                     *
                                     *                         I       I                       *
                                     *                         I       I                       *
                                     *                         I       I                       *
                                     *                       IIIII   IIIII                     *
                                     *                                                         *
                                     *                                                         *
                                     *             SCIENTIFIC SOFTWARE - INTERCOMP             *
                                     *                                                         *
                                     *                  INITIALIZATION MODULE                  *
                                     *                                                         *
                                     *     VERSION 3.21     APRIL ,  1993       UPDATE I 9      *
                                     *                                                         *
                                     ***********************************************************


                                                 ******************************
                                                 * MODEL STATISTICS           *
                                                 *                            *
                                                 *                            *
                                                 * MAX GRID CELLS     780     *
                                                 *                            *
                                                 * MAX FRAC CELLS       1     *
                                                 *                            *
                                                 * MAX COMPONENTS       3     *
                                                 *                            *
                                                 * MAX WELLS          100     *
                                                 *                            *
                                                 * MAX PERF / WELL     25     *
                                                 *                            *
                                                 ******************************
```

```
\f
****************************************************************************************************************************
: SSI'S SIMBEST II SIMULATOR :                          INITIALISATION MODULE                          : DATE 15-Aug-96  TIME 16:22 :
: VERSION  ====  3.21 I 9    :                              DATA SUMMARY                             : INITIALISATION  PAGE     1 :
****************************************************************************************************************************

     CARD                                  D A T A   C A R D S                                     E R R O R S   D E T E C T E D
     ====      ===========================================================================      ============================

       1  : *C
       2  : *C
       3  : *C               ********************************************
       4  : *C               *           W O R K B E N C H              *
       5  : *C               *        R E L E A S E  01.05.16          .*
       6  : *C               *   INITIALIZATION DECK FOR SIMBEST II     *
       7  : *C               ********************************************
       8  : *C               *                                          *
       9  : *C               *      PROJECT:  b65g sand                 *
      10  : *C               *                                          *
      11  : *C               *      CASE:      finegrid1                *
      12  : *C               *                                          *
      13  : *C               *      DATE:      15-Aug-96                *
      14  : *C               *                                          *
      15  : *C               *      TIME:      16:04:49                 *
      16  : *C               *                                          *
      17  : *C               ********************************************
      18  : *C
      19  : *C
      20  : *TITLE     b65g sand
      21  : *C
      22  : *C
      23  : *C
      24  : *C *PROJECT       b65g sand
      25  : *C *CASE          finegrid1
      26  : *C
      27  : *C
      28  : *CONTEXT     finegrid1
      29  : *C
      30  : *C
      31  : *C ------ START OF BASIC DATA
      32  : *C
      33  : *NOLIST
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```

```
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: VERSION  ==== 3.21 I 9      :                                                             : INITIALISATION   PAGE     2 :
*******************************************************************************************************************************

                                              ARRAY DATA : FURTHER CONSISTENCY CHECKS
                                              =======================================

         ** MULT EXPANSION **
          ARRAY KY       IS    1.000  *  ARRAY KX

\f
*******************************************************************************************************************************
: SSI'S SIMBEST II SIMULATOR :                    b65g sand                                 : DATE 15-Aug-96   TIME 16:22 :
: VERSION  ==== 3.21 I 9      :                                                             : INITIALISATION   PAGE     3 :
*******************************************************************************************************************************

                                                         SCALAR DATA SUMMARY
                                                         ===================

         GEOMETRY                    COORDINATE SYSTEM . . . . . . . . . . . . . . . CARTESIAN          X-Y-Z
         --------                    NUMBER OF BLOCKS IN X-DIRECTION . . . . . . . . . . . NX              30
                                     NUMBER OF BLOCKS IN Y-DIRECTION . . . . . . . . . . . NY              26
                                     NUMBER OF BLOCKS IN Z-DIRECTION . . . . . . . . . . . NZ               1
                                     TOTAL NUMBER OF BLOCKS . . . . . . . . . . . . . . . . NB             780


         OPTIONS                     PROBLEM TYPE  . . . . . . . . . . . . . . . . . . . . . .      BLK         .
         -------                     INPUT UNITS . . . . . . . . . . . . . . . . . . . . . . .      ENGLISH     .
                                     OUTPUT UNITS . . . . . . . . . . . . . . . . . . . . . . .     ENGLISH     .
                                     MATRIX   SATURATION INTEGRATION SELECTED . . . . . . . .      SATCORM     .


         MISCELLANEOUS DATA          WATER DENSITY AT STANDARD CONDITIONS  (GMS/CM3 )  DWSTD           1.000
         -----------------           WATER COMPRESSIBILITY . . . . . . . .  (1/PSI   )     CW      .3000E-05
                                     WATER FORMATION VOLUME FACTOR . . .  (RB/STB  )  BWINIT          1.001
                                     WATER VISCOSITY  . . . . . . . . . .  (CP      )   VISW            .500
                                     RESERVOIR TEMPERATURE. . . . . . . .  (DEG. F  )  TRSTD          160.00
                                     MATRIX   COMPRESSIBILITY . . . . . .  (1/PSI   )    CRM       .6000E-05
                                     INITIAL DATE . . . . . . . . . . . . . . . . . . . . . .     31-JAN-1966


         STANDARD CONDITIONS         STANDARD PRESSURE  . . . . . . . . .  (PSIA    )   PSTD          14.650
         ------------------          STANDARD TEMPERATURE . . . . . . . .  (DEG. F  )   TSTD           60.00
```

TABLES

NUMBER OF ROCK TYPES	NRTYPE	1
NUMBER OF FLUID TYPES	NOTYPE	1
NUMBER OF EQUILIBRATION REGIONS	NREGEQ	1

\f

FLUID PROPERTIES - INPUT PVT TABLE 1

OIL PROPERTIES

API 36.0
VISCOSITY COMPRESSIBILITY .1000E-03 1/PSI

PRESSURE PSIA	SOL. GAS SCF/STB	VISCOSITY CP	VOL. FAC RB/STB	OIL COMPRESSIBILITY 1/PSI
14.70	6.3	1.7914	1.0310	.1000E-05
250.00	47.3	1.5942	1.0429	.1000E-05
500.00	85.1	1.4568	1.0548	.1000E-05
750.00	123.1	1.3291	1.0676	.1000E-05
1000.00	162.3	1.2179	1.0815	.1000E-05
1250.00	203.0	1.1402	1.0966	.1000E-05
1500.00	245.4	1.0706	1.1129	.1000E-05
1750.00	289.6	1.0032	1.1306	.1000E-05
2000.00	335.7	.9381	1.1496	.1000E-05
2250.00	383.9	.8763	1.1699	.1000E-05
2500.00	434.2	.8183	1.1916	.1000E-05
2750.00	486.7	.7646	1.2147	.1000E-05
3000.00	541.4	.7148	1.2393	.1000E-05
3250.00	598.6	.6689	1.2653	.1000E-05
3457.00	647.8	.6336	1.2879	.1000E-05
3500.00	658.2	.6266	1.2928	.1000E-05
3750.00	720.4	.5875	1.3218	.1000E-05
4000.00	785.2	.5512	1.3523	.1000E-05
4250.00	852.8	.5176	1.3844	.1000E-05
4500.00	923.2	.4863	1.4180	.1000E-05
4750.00	996.6	.4570	1.4533	.1000E-05

5000.00	1073.2	.4295	1.4902	.1000E-05

\f

FLUID PROPERTIES - INPUT PVT TABLE 1

GAS PROPERTIES

GAS DENSITY .60

PRESSURE PSIA	VOL. FAC RB/MSCF	VISCOSITY CP
14.70	212.1994	.0126
250.00	12.2127	.0127
500.00	5.9771	.0130
750.00	3.9053	.0134
1000.00	2.8752	.0138
1250.00	2.2626	.0143
1500.00	1.8594	.0148
1750.00	1.5763	.0154
2000.00	1.3686	.0161
2250.00	1.2113	.0169
2500.00	1.0894	.0176
2750.00	.9930	.0184
3000.00	.9157	.0193
3250.00	.8528	.0201
3457.00	.8091	.0208
3500.00	.8008	.0210
3750.00	.7575	.0218
4000.00	.7209	.0226
4250.00	.6897	.0235
4500.00	.6628	.0243
4750.00	.6394	.0251
5000.00	.6188	.0259

\f

MATRIX SATURATION FUNCTIONS

MATRIX ROCK TYPE 1

WATER-OIL SATURATION FUNCTIONS

CONNATE WATER SATURATION .2000

THREE PHASE KRO CALCULATION METHOD IS MODIFIED STONE 2

GAS-OIL SATURATION FUNCTIONS

RESIDUAL GAS SATURATION .0000

SW	KRW	KROW	PCWOD PSIA	PCWOI PSIA	SL	KROG	KRG	PCGOD PSIA	PCGOI PSIA
.2000	.0000	1.0000	.0000	.0000	.2000	.0000	1.0000	.0000	.0000
.3000	.0264	.6808	.0000	.0000	.4000	.0008	.4293	.0000	.0000
.4000	.0657	.4431	.0000	.0000	.5000	.0677	.3094	.0000	.0000
.5000	.1089	.2700	.0000	.0000	.6000	.1620	.2100	.0000	.0000
.6000	.1718	.1462	.0000	.0000	.7000	.2819	.1168	.0000	.0000
.7000	.2289	.0579	.0000	.0000	.8000	.4057	.0598	.0000	.0000
.8000	.3015	.0205	.0000	.0000	.9000	.6298	.0304	.0000	.0000
.9000	1.0000	.0000	.0000	.0000	.9500	.7517	.0146	.0000	.0000
1.0000	1.0000	.0000	.0000	.0000	1.0000	1.0000	.0000	.0000	.0000

\f


```
*****************          0.1-          -0.9          TERNARY   KRO/KROCW
*               *                                       VALUE      VALUE
*   KRO/KROCW   *                                         9       .9<  <1.
*               *                                         8       .8<  <.9
*    TERNARY    *                                         7       .7<  <.8
*               *       0.2-                 -0.8         6       .6<  <.7
*    DIAGRAM    *                                         5       .5<  <.6
```

```
      *                *                                                    4      .4<   <.5
      *****************                                                     3      .3<   <.4
                                                                            2      .2<   <.3
                             0.3-                                  -0.7     1      .1<   <.2
                                                                            0      .0<   <.1
                                                                          BLANK          =0.

                        0.4-                                         -0.6

                    G                                                        O
                   A                                                          I
                  S                                                            L
                      0.5-                                              -0.5
                 S                                                               S
                A                                                                 A
               T                                                                   T
              N                                                                     N
             .   0.6-                                                       -0.4     .

             0.7-                                                                 -0.3

          0.8-                                                                      -0.2

       0.9-                                                                            -0.1

    1.0-                                                                                  -0.0
       |         |         |         |         |         |         |         |         |         |
      0.0       0.1       0.2       0.3       0.4       0.5       0.6       0.7       0.8       0.9       1.0
                                                      WATER SATN.
THREE PHASE OIL RELATIVE PERMEABILITY DATA FOR TABLE NUMBER    1
-----------------------------------------------------------------
```

	SG .0000	SG .0500	SG .1000	SG .2000	SG .3000	SG .4000	SG .5000	SG .6000	SG .8000
SW	KRO	KRO	KRO	KRO	KRO	KRO	KRO	KRO	KRO
.200	1.0000	.7517	.6298	.4057	.2819	.1620	.0677	.0008	.0000
.300	.6808	.5009	.4101	.2430	.1388	.0267	.0000	.0000	.0000
.400	.4431	.3096	.2398	.1114	.0204	.0000	.0000	.0000	.0000
.500	.2700	.1668	.1109	.0077	.0000	.0000	.0000	.0000	.0000
.600	.1462	.0573	.0078	.0000	.0000	.0000	.0000	.0000	.0000
.700	.0579	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.800	.0205	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.900	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1.000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

\f

EQUILIBRATION DATA TABLES

EQUILIBRATION REGION				WATER-OIL CONTACT		GAS-OIL CONTACT	
NUMBER	REFERENCE DEPTH-SUBSEA FEET	REFERENCE PRESSURE PSIA	BUBBLE-POINT PRESSURE PSIA	DEPTH-SUBSEA FEET	CAP PRESSURE PSIA	DEPTH-SUBSEA FEET	CAP PRESSURE PSIA
1	5400.000	2800.000	2800.000	6487.000	.000	.000	.000

\f

AQUIFER DATA SUMMARY

AQUIFER NUMBER	AQUIFER TYPE	THREE PHASE	AUTOMATIC COEFFICIENT GENERATION	TOTAL AQUIFER INFLUX COEF.	PERMEABILITY THICKNESS (MD-FEET)	POROSITY THICHNESS (FEET)	EQUIVALENT AQUIFER RAD. (FEET)	ANGLE OF INFLUENCE (DEGREES)
1	CTAQ	NO	EDGE		25000.00	20.00	1000.00	45.00

AQUIFER INFLUX-EFFLUX INFORMATION

AQUIFER NUMBER	TYPE	THREE PHASE	INFLUX (PER CENT)		EFFLUX ALWAYS
1	CTAQ	NO	100.0	WATER	FLUID IN
			.0	OIL	GRID CELL
			.0	GAS	

\f

CARTER-TRACY AQUIFER INFLUENCE FUNCTION FOR AN INFINITE AQUIFER

AQUIFER NUMBER 1	
DIMENSIONLESS TIME	DIMENSIONLESS PRESSURE
.0000	.0000
.0100	.1120
.0500	.2290
.1000	.3150

.1500	.3760
.2000	.4240
.3000	.5030
.5000	.6160
.7000	.7020
1.0000	.8020
1.5000	.9270
2.0000	1.0200
3.0000	1.1690
5.0000	1.3620
7.0000	1.5000
10.0000	1.6510
15.0000	1.8290
20.0000	1.9600
30.0000	2.1470
40.0000	2.2820
50.0000	2.3880
60.0000	2.4760
70.0000	2.5500
80.0000	2.6150
90.0000	2.6720
100.0000	2.7230
200.0000	3.0640
300.0000	3.2630
500.0000	3.5160
700.0000	3.6840
1000.0000	3.8580
2000.0000	4.2050
5000.0000	4.6630
10000.0000	5.0100

\f

CARTER-TRACY AQUIFER INFLUENCE COEFFICIENTS FOR AQUIFER NUMBER 1 : (DIM.LESS)

Y-DIR I X-DIR
I 1 2 3 4 5 6 7 8 9 10

```
---------I----------------------------------------------------------------------------------------------------------------
         I
       1 I  .3449E-01  .3938E-01  .4785E-01  .2701E-01  .2891E-01  .3022E-01  .3149E-01  .3292E-01  .3436E-01  .3392E-01
       2 I
       3 I
       4 I
       5 I
       6 I
       7 I
       8 I
       9 I
      10 I
      11 I
      12 I
      13 I
      14 I
      15 I
      16 I
      17 I
      18 I
      19 I
      20 I
      21 I
      22 I
      23 I
      24 I
      25 I
      26 I

  Y-DIR  I  X-DIR
         I     11         12         13         14         15         16         17         18         19         20
---------I----------------------------------------------------------------------------------------------------------------
         I
       1 I  .3320E-01  .3313E-01  .2541E-01  .1979E-01  .2035E-01  .2092E-01  .2116E-01  .2117E-01  .2477E-01  .2683E-01
       2 I
       3 I
       4 I
       5 I
       6 I
       7 I
       8 I
       9 I
      10 I
      11 I
```

```
      12 I
      13 I
      14 I
      15 I
      16 I
\f
****************************************************************************************************************************
: SSI'S SIMBEST II SIMULATOR :                           b65g sand                              : DATE 15-Aug-96  TIME 16:22 :
: VERSION  ==== 3.21 I 9     :                                                                  : INITIALISATION  PAGE    12 :
****************************************************************************************************************************

                        CARTER-TRACY AQUIFER INFLUENCE COEFFICIENTS FOR AQUIFER NUMBER   1  :  (DIM.LESS)
                        ============================================================================

  Y-DIR  I  X-DIR
         I    11         12         13         14         15         16         17         18         19         20
---------I-------------------------------------------------------------------------------------------------------------
         I
      17 I
      18 I
      19 I
      20 I
      21 I
      22 I
      23 I
      24 I
      25 I
      26 I

  Y-DIR  I  X-DIR
         I    21         22         23         24         25         26         27         28         29         30
---------I-------------------------------------------------------------------------------------------------------------
         I
       1 I  .2709E-01  .2693E-01  .2733E-01  .2829E-01  .2994E-01  .3050E-01  .3060E-01  .6179E-01  .6348E-01  .8676E-01
       2 I
       3 I
       4 I
       5 I
       6 I
       7 I
       8 I
       9 I
      10 I
      11 I
```

```
  12 I
  13 I
  14 I
  15 I
  16 I
  17 I
  18 I
  19 I
  20 I
  21 I
  22 I
  23 I
  24 I
  25 I
  26 I

\f
******************************************************************************************************************************************
 : SSI'S SIMBEST II SIMULATOR :                              b65g sand                            : DATE 15-Aug-96  TIME 16:22 :
 : VERSION  ==== 3.21 I 9     :                                                                   : INITIALISATION  PAGE    13 :
******************************************************************************************************************************************

                                        MATRIX SYSTEM  -  SUMMARY OF INITIAL CONDITIONS
                                        ===============================================

          TOTAL FIELD
          -----------

        INITIAL WATER IN PLACE     =      76201730. STB

        INITIAL OIL IN PLACE       =      24073582. STB

        INITIAL GAS IN PLACE       =      11979641. MSCF

        INITIAL FREE GAS IN PLACE  =             0. MSCF

        INITIAL HYDROCARBON VOLUME =      29353067. RB

        INITIAL AVERAGE PRESSURE   =          3221. PSIA

        FIELD MATRIX PORE VOLUME   =     105519909. RB
```

\f

AVERAGE - MAXIMUM AND MINIMUM RESERVOIR PROPERTIES

PROPERTY	AVERAGE VALUE	MAXIMUM VALUE (I J K)	MINIMUM VALUE LOCATIONS
PORE VOLUME	.16749E+06	.96595E+06 (3, 4, 1)	.52367E+03 (26, 24, 1)
GROSS THICKNESS	.42076E+02	.97999E+02 (17, 14, 1)	.38980E+00 (26, 24, 1)
X DIRECTION TRANSMISSIBILITY	.51931E+01	.21268E+02 (10, 2, 1)	.67584E-02 (13, 20, 1)
Y DIRECTION TRANSMISSIBILITY	.19936E+02	.11041E+03 (2, 6, 1)	.20699E-01 (19, 5, 1)
ELEVATION	.64360E+04	.72955E+04 (6, 1, 1)	.55308E+04 (1, 26, 1)

USER PLEASE NOTE:

THE GREATER THE DISCREPANCY BETWEEN ANY MINIMUM AND MAXIMUM VALUE THE HARDER THE PROBLEM MAY RUN

CARTER-TRACY TYPE AQUIFER DIAGNOSTICS
PROGRAM DEFAULT INFLUENCE FUNCTIONS

AQUIFER NUMBER	MAXIMUM TIME THAT THE AQUIFER WILL BE VALID - DAYS	MAXIMUM DIMENSIONLESS TIME

```
    1            5680.          10000.

IF YOU PLAN ON RUNNING SIMULATION TIMES LONGER
THAN THE MAXIMUM TIME SHOWN HERE, YOU WILL HAVE
TO READ IN AN INFLUENCE FUNCTION TABLE THAT
COVERS A LONGER TIME SPAN
\f

                    ***  END OF INITIALISATION ***
Dynamic Allocation OK.
```

Appendix C - Initialization Input

```
*C
*C
*C              ******************************************
*C              *             W O R K B E N C H          *
*C              *          R E L E A S E  01.05.16       *
*C              *    INITIALIZATION DECK FOR SIMBEST II  *
*C              ******************************************
*C              *                                        *
*C              *      PROJECT:  b65g sand               *
*C              *                                        *
*C              *      CASE:                             *
*C              *                                        *
*C              *      DATE:     06-Aug-96               *
*C              *                                        *
*C              *      TIME:     09:18:54                *
*C              *                                        *
*C              ******************************************
*C
*C
*TITLE     b65g sand
*C
*C
*C
*C *PROJECT       b65g sand
*C *CASE
*C
*C
*CONTEXT     b65g sand
*C
*C
*C ------ START OF BASIC DATA
*C
*NOLIST
*C
*SATCORM
*C
*BLK
*C
*GRID     *XYZ       30      15       1
*C
*C             DWSTD           CW       BWINIT          VISW         TRRES
*MISC        .99955      3.00000E-06   1.0010        .50000        160.00
*C
*STDCON      14.650        60.000
*C
*IDATE       31 01 66
*C
*C
*OUTPUT   *TABLES
*C
*C
*WINIT    *SKIP
*C
*CRVAR    *MATRIX   *CONSTANT   6.00000E-06
*C
*C
*C ------ END OF BASIC DATA
*C
*C
*C
*C ------ START OF TABULAR DATA
*C
*C
*C
*C        ROCK TABLE      1
*C
*C
```

```
*SATWO  *MATRIX     1
*C
*C           SW          KRW        KROW
*C       ---------  ---------  ---------
           .2000      .0000      1.000
           .3000      2.6402E-02  .6808
           .4000      6.5663E-02  .4431
           .5000      .1089      .2700
           .6000      .1718      .1462
           .7000      .2878      5.7866E-02
           .8000      .4372      2.0520E-02
           .9000      1.000      .0000
           1.000      1.000      .0000
*C
*SATGO  *MATRIX     1
*C
*C           SL          KROG        KRG
*C       ---------  ---------  ---------
           .2000      .0000      1.000
           .4000      8.2079E-04  .4293
           .5000      6.7715E-02  .3094
           .6000      .1620      .2100
           .7000      .2819      .1168
           .8000      .4057      5.9781E-02
           .9000      .6298      3.0369E-02
           .9500      .7517      1.4637E-02
           1.000      1.000      .0000
*C
*C
*C
*PVTO        1    3457.0
*API      36.000      *CO   1.00000E-06  *VCO  1.00000E-04
*C
*C            PRES       RSO        VO        BO
*C           ------     ------    ------    ------
              14.7       6.33     1.7914    1.0310
             250.0      47.31     1.5942    1.0429
             500.0      85.08     1.4568    1.0548
             750.0     123.10     1.3291    1.0676
            1000.0     162.28     1.2179    1.0815
            1250.0     202.96     1.1402    1.0966
            1500.0     245.35     1.0706    1.1129
            1750.0     289.56     1.0032    1.1306
            2000.0     335.71      .9381    1.1496
            2250.0     383.89      .8763    1.1699
            2500.0     434.18      .8183    1.1916
            2750.0     486.67      .7646    1.2147
            3000.0     541.45      .7148    1.2393
            3250.0     598.60      .6689    1.2653
            3457.0     647.78      .6336    1.2879
            3500.0     658.21      .6266    1.2928
            3750.0     720.38      .5875    1.3218
            4000.0     785.20      .5512    1.3523
            4250.0     852.78      .5176    1.3844
            4500.0     923.22      .4863    1.4180
            4750.0     996.65      .4570    1.4533
            5000.0    1073.17      .4295    1.4902
*C
*C
*PVTG *BG     1    .60000
*C
*C              PRES        BG        VISG
*C            --------   --------   --------
                14.7   212.19940     .01259
               250.0    12.21265     .01275
               500.0     5.97714     .01302
               750.0     3.90531     .01337
```

```
                1000.0     2.87524      .01379
                1250.0     2.26263      .01428
                1500.0     1.85938      .01483
                1750.0     1.57626      .01545
                2000.0     1.36856      .01613
                2250.0     1.21130      .01686
                2500.0     1.08938      .01763
                2750.0      .99305      .01843
                3000.0      .91572      .01926
                3250.0      .85277      .02010
                3457.0      .80910      .02080
                3500.0      .80084      .02095
                3750.0      .75749      .02179
                4000.0      .72090      .02263
                4250.0      .68968      .02346
                4500.0      .66277      .02427
                4750.0      .63937      .02508
                5000.0      .61884      .02586
*C
*C
*C ------ END OF TABULAR DATA
*C
*C
*C ------ START OF GRID DATA
*C
*C
*C
*DXH      *XVAR
   413.525   413.525   413.525   413.525   413.525   413.525   413.525
   413.525   413.525   413.526   413.525   413.525   413.525   413.525
   413.525   413.525   413.525   413.525   413.525   413.525   413.526
   413.525   413.526   413.526   413.526   413.526   413.525   413.526
   413.526   413.526
*C
*DYH      *YVAR
   270.708   270.708   270.708   270.708   270.708   270.708   270.708
   270.708   270.708   270.708   270.708   270.708   270.708   270.708
   270.708
*C
*C
*HTOP     *LAYER
*C
*C        *HTOP     FOR LAYER   1    J =    1
   6652.67   6790.19   6898.14   6979.15   7034.27   7060.12   7084.88   7100.63
   7066.92   7022.96   6982.30   6953.13   6934.44   6922.26   6911.73   6913.82
   6930.10   6945.27   6955.40   6960.15   6961.90   6963.31   6966.47   6971.61
   6982.56   6999.26   7010.51   7008.70   6990.87   6961.08
*C        *HTOP     FOR LAYER   1    J =    2
   6594.09   6735.44   6829.06   6887.52   6919.96   6923.46   6928.63   6934.21
   6921.26   6898.81   6869.40   6852.05   6846.22   6847.17   6850.65   6858.05
   6867.94   6876.21   6881.33   6883.70   6886.79   6892.83   6902.73   6915.50
   6934.18   6957.53   6971.47   6966.54   6939.30   6895.23
*C        *HTOP     FOR LAYER   1    J =    3
   6546.37   6697.22   6764.71   6800.27   6813.43   6800.11   6797.66   6790.02
   6787.72   6777.90   6757.30   6749.88   6754.91   6766.67   6781.41   6793.50
   6799.24   6801.95   6802.43   6802.56   6807.43   6819.42   6838.90   6865.54
   6897.36   6927.52   6942.12   6931.40   6891.88   6829.72
*C        *HTOP     FOR LAYER   1    J =    4
   6507.58   6671.61   6702.34   6716.71   6714.54   6692.51   6687.58   6693.65
   6673.72   6664.14   6651.17   6649.22   6658.02   6673.74   6693.27   6709.92
   6718.73   6720.53   6717.94   6716.41   6723.60   6742.53   6773.11   6816.35
   6864.16   6902.89   6919.98   6904.47   6851.29   6765.86
*C        *HTOP     FOR LAYER   1    J =    5
   6456.33   6642.02   6642.85   6637.72   6625.62   6606.33   6595.06   6581.09
   6566.62   6556.37   6548.56   6548.79   6555.63   6571.17   6592.22   6613.29
   6628.68   6632.16   6627.33   6624.30   6633.94   6659.76   6700.03   6757.31
   6821.76   6876.46   6903.30   6886.38   6818.32   6704.17
```

```
*C        *HTOP      FOR LAYER    1     J =     6
   6392.89   6606.50   6583.27   6558.86   6537.50   6520.92   6501.62   6472.88
   6451.17   6435.06   6434.02   6438.61   6442.86   6458.65   6481.79   6508.14
   6532.33   6538.43   6530.08   6524.02   6536.52   6570.39   6619.34   6688.16
   6769.28   6845.83   6890.01   6878.07   6797.01   6648.16
*C        *HTOP      FOR LAYER    1     J =     7
   6330.28   6566.68   6519.09   6474.31   6441.13   6418.85   6392.14   6352.28
   6320.14   6293.51   6304.19   6317.64   6319.86   6336.93   6361.78   6391.54
   6423.03   6433.16   6426.23   6423.69   6440.51   6477.95   6530.33   6606.00
   6701.28   6801.14   6875.70   6886.05   6794.28   6600.31
*C        *HTOP      FOR LAYER    1     J =     8
   6192.98   6447.48   6449.75   6383.80   6337.27   6304.96   6271.75   6226.52
   6185.02   6146.70   6171.19   6197.82   6199.62   6214.04   6232.55   6254.18
   6280.89   6299.26   6313.35   6334.49   6358.54   6387.29   6433.81   6510.21
   6616.56   6740.62   6856.84   6906.27   6810.29   6565.98
*C        *HTOP      FOR LAYER    1     J =     9
   6057.00   6315.02   6368.04   6283.40   6222.68   6181.03   6146.02   6103.40
   6055.18   6001.86   6039.95   6084.61   6088.07   6093.21   6095.06   6097.62
   6110.36   6141.13   6190.05   6244.88   6277.60   6292.40   6327.07   6399.04
   6513.01   6658.60   6810.23   6901.24   6842.47   6563.41
*C        *HTOP      FOR LAYER    1     J =     10
   6010.74   6246.96   6270.18   6172.28   6097.00   6045.96   6012.92   5980.03
   5929.55   5861.77   5911.47   5972.13   5976.85   5972.66   5960.52   5949.79
   5954.75   5993.33   6061.14   6131.53   6170.69   6181.48   6203.98   6266.61
   6383.89   6547.78   6725.00   6855.24   6872.36   6526.38
*C        *HTOP      FOR LAYER    1     J =     11
   5954.05   6142.65   6163.43   6049.48   5958.39   5892.21   5839.30   5835.48
   5807.66   5734.43   5790.33   5856.42   5859.37   5850.69   5834.57   5822.09
   5827.54   5865.37   5930.10   5997.10   6040.58   6057.73   6070.01   6122.52
   6244.36   6425.14   6623.11   6789.74   6890.10   6501.97
*C        *HTOP      FOR LAYER    1     J =     12
   5843.84   5988.71   6023.11   5911.29   5804.79   5716.97   5631.61   5574.52
   5629.86   5618.75   5676.32   5739.30   5738.62   5727.70   5711.40   5700.41
   5707.54   5741.98   5862.53   5971.99   5956.52   5931.58   5933.53   5985.43
   6120.00   6311.76   6521.60   6716.80   6697.61   6131.16
*C        *HTOP      FOR LAYER    1     J =     13
   5712.83   5833.67   5866.63   5764.49   5646.02   5533.34   5421.38   5303.49
   5308.40   5457.69   5559.59   5622.61   5618.60   5605.11   5587.47   5576.33
   5670.31   5780.57   5950.05   6023.95   6000.90   5846.22   5765.38   5853.84
   6007.47   6204.20   6420.38   6504.44   6165.96   5930.44
*C        *HTOP      FOR LAYER    1     J =     14
   5617.44   5722.82   5812.79   5677.37   5490.67   5353.99   5208.44   5056.21
   5151.75   5295.04   5590.64   5680.94   5672.55   5655.55   5645.22   5742.71
   5829.12   5910.94   5913.43   5930.24   5973.28   5942.17   5913.23   5824.65
   5893.51   6096.08   6240.98   6107.01   5975.19   5896.41
*C        *HTOP      FOR LAYER    1     J =     15
   5555.77   5626.04   5750.90   5798.61   5597.93   5511.96   5398.71   5278.01
   5428.09   5706.79   5853.19   5856.03   5845.07   5829.24   5825.91   5833.07
   5819.97   5801.00   5797.93   5834.87   5896.40   5953.85   6005.11   5959.71
   5923.70   5990.41   5987.80   5946.10   5911.83   5855.66
*C
*TH       *VALUE
*C
*C        *TH        FOR LAYER    1     J =     1
   47.3487   49.0786   52.4403   57.7045   63.3255   67.9106   69.5521   69.9811
   72.4462   74.4799   73.0174   68.9446   57.2122   42.1081   35.9308   34.9664
   34.6264   36.3880   39.2908   40.8850   42.7618   44.6845   46.7226   51.2336
   56.3109   59.2207   62.6002   64.0965   63.8319   63.2773
*C        *TH        FOR LAYER    1     J =     2
   58.4442   60.0958   62.8514   67.0627   70.9804   73.4504   72.5374   70.8284
   72.8523   74.9284   73.2918   68.7136   60.4045   48.3161   37.1734   31.8079
   29.2581   27.7982   28.1751   30.8478   34.4641   37.0253   38.4601   41.8272
   46.3616   49.2663   52.2831   56.6821   60.5795   62.1823
*C        *TH        FOR LAYER    1     J =     3
   65.3701   67.2157   69.2392   72.1129   73.6167   73.7289   71.1447   68.1270
   70.0533   73.1960   72.1453   68.5884   64.0558   56.4457   46.3669   34.9510
   27.1605   24.0943   24.1242   27.3860   31.4189   33.5199   33.6322   34.1300
```

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   36.1672   38.8918   41.6643   47.1134   52.8191   55.8300
*C        *TH        FOR LAYER   1    J =    4
   69.6962   71.8564   73.2402   74.0413   72.1116   69.7015   66.0991   61.9009
   63.6014   68.8110   68.9579   66.9649   65.4849   61.3422   56.2389   41.7139
   28.9183   24.2536   23.9953   27.5455   31.4696   31.7049   29.5373   28.2319
   29.0783   31.8715   34.9919   37.6857   41.0436   44.9431
*C        *TH        FOR LAYER   1    J =    5
   71.3468   73.5712   73.9546   71.7295   65.5449   58.3424   51.5625   46.3966
   48.2292   59.2006   61.5980   60.0799   60.4461   56.1623   59.1755   49.0939
   34.6912   27.9948   26.9094   30.5347   34.1899   31.8539   26.9820   24.4771
   24.4719   26.7730   29.5563   30.4149   32.7989   38.0567
*C        *TH        FOR LAYER   1    J =    6
   69.9589   71.7171   70.2881   63.9159   53.3028   39.3679   27.5317   23.7390
   27.2532   45.6665   52.5603   52.7531   55.1695   50.9415   60.4155   57.4745
   43.9798   34.6179   31.9888   35.7211   39.9401   34.7407   26.6784   23.3350
   22.1909   23.2645   24.7118   25.5377   28.8884   35.1220
*C        *TH        FOR LAYER   1    J =    7
   65.3444   65.4522   61.5536   52.1873   40.4578   25.7685   14.0424   13.2953
   18.0186   33.2104   45.8647   53.6706   56.3717   54.1891   63.4446   66.3768
   56.3009   43.9724   39.3661   42.4252   44.8856   39.5489   31.9995   26.6780
   23.4939   22.8377   22.3181   22.1777   25.4460   31.7718
*C        *TH        FOR LAYER   1    J =    8
   56.9960   53.4521   46.7560   37.5081   29.6382   21.0971   14.0349   14.9754
   18.6164   24.3008   38.6324   52.2195   53.1433   53.3185   60.5861   73.1686
   72.8662   58.7816   52.1521   51.3760   42.3489   43.5122   46.6147   36.1230
   29.2728   26.3373   23.1465   20.7308   22.7829   28.7161
*C        *TH        FOR LAYER   1    J =    9
   48.0211   41.9484   34.6047   27.8908   24.4495   21.1480   17.5176   18.1811
   19.6077   20.6939   29.8543   38.4332   37.9719   42.7286   49.2140   73.9195
   86.2433   70.5658   61.9857   59.0989   43.4932   50.7980   63.2274   50.8852
   41.7007   35.4284   27.8146   21.7191   21.9804   27.3940
*C        *TH        FOR LAYER   1    J =    10
   41.1341   35.2694   29.6585   26.0100   24.5487   22.5560   19.7295   18.4887
   17.3086   16.5051   20.8205   25.2109   26.1068   33.0487   38.2360   61.1353
   73.7795   59.1652   53.7218   59.2974   58.1088   67.2951   76.5181   68.1104
   58.9394   49.0296   36.8083   26.6650   24.1600   28.3127
*C        *TH        FOR LAYER   1    J =    11
   35.1524   30.0080   25.7817   23.4017   20.5535   15.9517   11.7064    8.6505
    6.7103    6.1045   10.7923   18.3686   22.9996   26.4998   28.2384   38.9192
   43.1242   32.8616   32.4794   46.2758   60.8440   73.5678   80.0305   76.9755
   71.8270   63.6207   52.1055   39.2069   31.2946   32.2433
*C        *TH        FOR LAYER   1    J =    12
   29.6222   24.9318   21.1862   18.4449   12.8127    5.4370    1.7971     .4418
     .0000     .0921    2.3031    9.4519   14.6441   14.1834   12.0992   13.5607
   13.1780    8.5858    8.5141   18.4157   38.1919   59.1296   70.1751   72.4817
   73.6586   71.5786   65.6702   53.1472   40.4478   37.6412
*C        *TH        FOR LAYER   1    J =    13
   24.2361   19.7184   15.8345   11.9384    5.8122     .7688     .0000     .0000
     .0103     .0103     .0121    1.3423    2.8975    2.1704     .7037     .0565
     .0000     .0000     .0000    1.6816   14.1129   34.1772   45.0797   47.6657
   51.3719   58.7880   65.4367   60.7333   48.7329   43.2301
*C        *TH        FOR LAYER   1    J =    14
   18.8588   14.3084   10.0548    5.2360    1.0858     .0000     .0000     .0000
     .0103     .0103     .0000     .0000     .0000     .0000     .0000     .0000
     .0000     .0000     .0000     .0000    2.4477    8.5729   12.9993   13.3539
   17.6223   34.1353   54.6146   60.7459   52.8041   46.6259
*C        *TH        FOR LAYER   1    J =    15
   13.6155    9.1460    4.9933    1.2425     .0000     .0000     .0000     .0000
     .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
     .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
    1.7259   12.6271   36.3274   52.1148   50.4880   46.4884
*C
*THNET    *VALUE
*C
*C        *THNET     FOR LAYER   1    J =    1
   47.3434   49.0786   52.4403   57.6823   63.2045   67.0888   67.8986   67.8241
   69.9846   72.5392   72.7142   68.9446   57.2122   41.8303   35.7548   34.7945
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 34.5375  36.3770  39.2802  40.8850  42.7618  44.6845  46.7226  51.2336
 56.3109  59.2197  62.5998  64.0962  63.8311  63.2750
*C     *THNET   FOR LAYER   1   J =   2
 58.4442  60.0774  62.7938  66.9744  70.5461  71.8249  69.9108  67.8159
 69.4013  72.2804  73.2918  68.7136  60.4045  48.1375  36.9415  31.8079
 29.2581  27.6257  27.8140  30.2543  33.7792  36.7093  38.4375  41.8057
 46.3466  49.2604  52.2831  56.6821  60.5794  62.1807
*C     *THNET   FOR LAYER   1   J =   3
 65.3701  67.1661  69.1104  72.0564  73.0096  71.5418  67.9744  64.8660
 66.2011  70.1539  72.1453  68.5884  64.0558  56.4457  46.3629  34.7921
 27.1379  23.5492  22.9600  25.4633  29.1745  32.3490  33.3975  34.0431
 36.1585  38.8918  41.6643  47.1130  52.8191  55.8289
*C     *THNET   FOR LAYER   1   J =   4
 69.6962  71.8564  73.2402  74.0413  71.9256  67.6896  63.1994  59.4800
 60.5069  65.9954  68.9579  66.9649  65.4849  61.3422  56.2389  41.3655
 28.7531  23.3349  22.0947  24.2204  27.1533  28.8585  28.6360  28.0768
 29.0783  31.8715  34.9919  37.6786  41.0436  44.9422
*C     *THNET   FOR LAYER   1   J =   5
 71.3468  73.5712  73.9546  71.7295  65.5449  58.3424  51.5625  46.3966
 48.2292  58.3866  61.5980  60.0799  60.4461  56.1623  59.1755  48.8402
 34.2978  26.8313  24.6512  26.3092  28.1529  27.4130  25.5000  24.4124
 24.4719  26.7730  29.5563  30.4102  32.7989  38.0567
*C     *THNET   FOR LAYER   1   J =   6
 69.9589  71.7171  70.2881  63.9159  53.2577  39.3679  27.5317  23.7390
 27.2532  45.6665  52.5603  52.7531  55.1695  50.9415  60.4155  57.2488
 43.7619  34.0811  30.4153  31.9952  33.3021  29.8452  25.6849  23.3350
 22.1909  23.2645  24.7118  25.5377  28.8884  35.1220
*C     *THNET   FOR LAYER   1   J =   7
 65.3444  65.4522  61.5536  52.1873  40.4578  25.7685  14.0424  13.2953
 18.0186  33.2104  45.8647  53.6706  56.3717  54.1891  63.4446  65.5035
 55.8244  43.9724  39.0169  41.1927  42.9694  38.1778  31.6789  26.6780
 23.4939  22.8377  22.3181  22.1777  25.4460  31.7718
*C     *THNET   FOR LAYER   1   J =   8
 56.9960  53.4521  46.7560  37.5081  29.6382  21.0971  14.0349  14.9754
 18.6164  24.3008  38.6324  52.2195  52.8751  51.3736  59.3223  68.1786
 65.3216  55.3046  51.7851  51.3760  42.3489  43.5122  46.3784  36.1230
 29.2728  26.3373  23.1163  20.7120  22.7778  28.7108
*C     *THNET   FOR LAYER   1   J =   9
 48.0211  41.9484  34.6047  27.8908  24.4495  21.1480  17.5176  18.1811
 19.6077  20.6939  29.0208  37.9835  36.2395  35.7049  46.4414  63.5099
 68.4962  61.6547  60.7911  59.0989  43.4932  50.7980  62.7744  50.5863
 41.6755  35.3763  27.7664  21.7038  21.9784  27.3857
*C     *THNET   FOR LAYER   1   J =   10
 41.1341  35.2694  29.6585  26.0100  24.5487  22.5560  19.7295  18.2809
 15.9911  15.4129  20.4592  25.2109  25.1454  26.2892  35.6389  53.0921
 59.7028  52.2816  52.6963  59.2974  58.1088  67.2951  75.2270  67.2581
 58.8118  49.0296  36.7953  26.6650  24.1600  28.3001
*C     *THNET   FOR LAYER   1   J =   11
 35.1524  30.0080  25.7817  23.3524  20.5535  15.9517  11.1735   7.2291
  5.2987   5.4292  10.7434  18.3686  22.7082  24.5582  27.3867  37.4001
 40.5286  31.6196  32.2685  46.2758  60.8440  73.3360  78.4268  76.1336
 71.6847  63.6207  52.1055  39.2069  31.2937  32.2198
*C     *THNET   FOR LAYER   1   J =   12
 29.6222  24.9318  21.1862  18.2688  12.8127   5.4370   1.7971    .3897
   .0000    .0921   2.3031   9.4519  14.6441  14.1834  12.0992  13.5607
 13.1780   8.5858   8.5141  18.3948  37.8388  58.4189  69.5538  72.1635
 73.5883  71.5786  65.6702  53.1465  40.4354  37.6015
*C     *THNET   FOR LAYER   1   J =   13
 24.2361  19.7184  15.8345  11.8344   5.8122    .7688    .0000    .0000
   .0000    .0000    .0000   1.3337   2.8975   2.1704    .7037    .0565
   .0000    .0000    .0000   1.6816  14.1129  34.1772  45.0797  47.6376
 51.3566  58.7880  65.4367  60.7313  48.7066  43.1694
*C     *THNET   FOR LAYER   1   J =   14
 18.8308  14.3084  10.0548   5.2360   1.0858    .0000    .0000    .0000
   .0000    .0000    .0000    .0000    .0000    .0000    .0000    .0000
   .0000    .0000    .0000    .0000   2.4378   8.5614  12.9993  13.3515
 17.6198  34.1353  54.6146  60.7311  52.7547  46.5379
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*C        *THNET    FOR LAYER   1    J =    15
  13.3156    9.1348    4.9933    1.2382     .0000     .0000     .0000     .0000
    .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
    .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
   1.7250   12.6148   36.2995   52.0630   50.4024   46.3664
*C
*PHI      *VALUE
*C
*C        *PHI      FOR LAYER   1    J =     1
    .2127     .2173     .2274     .2445     .2628     .2782     .2925     .3065
    .3183     .3288     .3333     .3168     .2533     .1901     .1806     .1848
    .1863     .1869     .1921     .1992     .2057     .2122     .2203     .2296
    .2382     .2473     .2569     .2624     .2649     .2682
*C        *PHI      FOR LAYER   1    J =     2
    .2473     .2524     .2614     .2769     .2923     .3030     .3117     .3195
    .3264     .3348     .3395     .3298     .2763     .2156     .1915     .1771
    .1712     .1673     .1688     .1756     .1823     .1881     .1942     .2026
    .2125     .2223     .2335     .2429     .2511     .2612
*C        *PHI      FOR LAYER   1    J =     3
    .2773     .2836     .2901     .3004     .3100     .3120     .3097     .3087
    .3137     .3239     .3332     .3383     .3128     .2646     .2161     .1820
    .1663     .1570     .1560     .1611     .1664     .1701     .1737     .1796
    .1880     .1967     .2057     .2159     .2287     .2441
*C        *PHI      FOR LAYER   1    J =     4
    .2980     .3055     .3085     .3102     .3059     .2947     .2811     .2703
    .2772     .2959     .3088     .3257     .3272     .3034     .2492     .1969
    .1703     .1533     .1496     .1534     .1565     .1571     .1575     .1609
    .1676     .1753     .1826     .1902     .2011     .2157
*C        *PHI      FOR LAYER   1    J =     5
    .3084     .3137     .3097     .3005     .2775     .2497     .2293     .2126
    .2202     .2591     .2718     .2896     .3143     .3142     .2887     .2244
    .1803     .1544     .1490     .1525     .1535     .1502     .1466     .1472
    .1522     .1591     .1654     .1710     .1785     .1902
*C        *PHI      FOR LAYER   1    J =     6
    .3054     .3055     .2919     .2717     .2377     .2024     .1810     .1657
    .1672     .2157     .2544     .2705     .2961     .3108     .3225     .2664
    .1988     .1643     .1584     .1633     .1634     .1550     .1451     .1413
    .1431     .1482     .1533     .1580     .1646     .1757
*C        *PHI      FOR LAYER   1    J =     7
    .2867     .2803     .2586     .2284     .1950     .1712     .1565     .1448
    .1377     .1681     .2343     .2667     .2738     .2859     .3164     .3104
    .2435     .1972     .1871     .1972     .2019     .1847     .1617     .1488
    .1435     .1438     .1461     .1494     .1566     .1687
*C        *PHI      FOR LAYER   1    J =     8
    .2599     .2452     .2167     .1853     .1632     .1535     .1483     .1428
    .1355     .1442     .1899     .2296     .2299     .2263     .2688     .3256
    .3085     .2645     .2430     .2593     .2766     .2534     .2124     .1776
    .1580     .1491     .1448     .1445     .1526     .1671
*C        *PHI      FOR LAYER   1    J =     9
    .2330     .2128     .1860     .1629     .1507     .1481     .1483     .1482
    .1468     .1483     .1610     .1963     .2043     .1790     .2048     .3006
    .3471     .3286     .3065     .3199     .3301     .3252     .2877     .2332
    .1934     .1708     .1535     .1444     .1517     .1694
*C        *PHI      FOR LAYER   1    J =    10
    .2104     .1901     .1691     .1546     .1490     .1489     .1497     .1502
    .1500     .1494     .1534     .1932     .2008     .1592     .1640     .2541
    .3294     .3164     .2920     .3070     .3216     .3322     .3271     .2976
    .2600     .2207     .1789     .1538     .1560     .1757
*C        *PHI      FOR LAYER   1    J =    11
    .1929     .1747     .1597     .1518     .1499     .1501     .1501     .1500
    .1498     .1487     .1471     .1583     .1663     .1523     .1532     .2004
    .2375     .2101     .1953     .2222     .2663     .2968     .3168     .3231
    .3135     .2846     .2315     .1848     .1724     .1886
*C        *PHI      FOR LAYER   1    J =    12
    .1798     .1641     .1533     .1494     .1494     .1500     .1499     .1495
    .0000     .1494     .1489     .1478     .1501     .1510     .1506     .1526
    .1505     .1388     .1353     .1582     .2026     .2505     .2806     .2947
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      .3045     .3073     .2859     .2454     .2083     .2114
*C      *PHI      FOR LAYER   1    J =    13
      .1704     .1574     .1496     .1479     .1491     .1500     .0000     .0000
      .0000     .0000     .0000     .1488     .1492     .1472     .1403     .1244
      .0000     .0000     .0000     .1352     .1581     .1875     .2147     .2247
      .2384     .2689     .2940     .2893     .2534     .2403
*C      *PHI      FOR LAYER   1    J =    14
      .1641     .1539     .1489     .1485     .1501     .0000     .0000     .0000
      .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      .0000     .0000     .0000     .0000     .1370     .1484     .1605     .1633
      .1644     .1913     .2492     .2868     .2756     .2627
*C      *PHI      FOR LAYER   1    J =    15
      .1601     .1526     .1495     .1498     .0000     .0000     .0000     .0000
      .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      .0000     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      .1335     .1451     .1944     .2601     .2742     .2727
*C
*KX     *VALUE
*C
*C      *KX       FOR LAYER   1    J =    1
    213.13    218.02    227.92    243.75    258.75    268.66    274.81    279.17
    283.98    288.64    288.72    276.86    241.63    186.16    149.34    137.38
    153.33    169.92    184.52    196.22    205.11    215.79    227.11    234.10
    239.64    248.89    257.76    262.87    267.39    274.76
*C      *KX       FOR LAYER   1    J =    2
    246.83    251.37    258.20    268.72    276.85    280.89    281.94    282.20
    285.44    290.38    292.03    285.14    258.44    213.33    169.89    114.99
     78.37     80.26     98.01    125.97    146.53    160.38    178.89    199.37
    214.07    226.75    237.43    244.67    251.86    265.62
*C      *KX       FOR LAYER   1    J =    3
    270.77    274.78    277.57    281.46    283.69    283.54    279.26    275.10
    279.62    288.79    294.45    295.80    288.30    261.33    213.60    158.39
     79.15     17.46     12.48     31.62     56.18     91.21    120.73    142.24
    166.64    186.98    203.86    218.17    229.06    247.22
*C      *KX       FOR LAYER   1    J =    4
    282.09    287.11    287.64    285.55    280.68    275.77    266.33    257.45
    263.84    280.83    292.87    300.96    305.05    288.05    244.09    195.08
    138.35     64.79     24.33     11.16     10.50     22.58     43.82     67.55
     98.13    129.06    156.71    180.40    198.77    217.82
*C      *KX       FOR LAYER   1    J =    5
    284.87    290.16    288.41    280.58    265.62    246.37    228.67    214.19
    220.44    258.42    283.28    296.02    304.38    295.60    264.62    221.58
    174.30    121.69     82.84     67.40     64.30     50.16     28.40     21.82
     29.76     55.39     89.43    129.99    159.27    179.51
*C      *KX       FOR LAYER   1    J =    6
    280.14    284.23    279.64    264.10    236.68    203.96    184.82    172.03
    176.21    223.63    266.20    281.86    291.52    288.13    272.76    246.88
    200.46    161.80    142.53    140.41    143.78    129.87     98.77     68.95
     38.78     11.22     15.63     48.87     93.12    129.17
*C      *KX       FOR LAYER   1    J =    7
    267.95    268.11    255.35    228.09    196.45    177.84    170.14    165.11
    171.07    215.61    252.51    264.16    268.18    265.25    266.36    276.61
    245.68    199.70    189.20    196.21    199.91    184.87    156.61    123.02
     92.50     46.15      8.24      2.55     19.38     56.83
*C      *KX       FOR LAYER   1    J =    8
    249.41    241.43    217.37    187.50    169.23    166.98    168.79    168.40
    175.20    206.93    239.28    249.54    250.95    249.79    256.35    286.74
    288.00    253.34    239.36    250.98    262.55    244.21    208.15    172.25
    141.36    104.11     53.49     15.52      2.41      6.78
*C      *KX       FOR LAYER   1    J =    9
    228.55    213.63    190.51    171.13    162.56    164.32    166.31    164.03
    162.26    172.33    198.96    200.19    208.05    234.13    246.88    272.52
    296.79    295.64    291.20    298.45    308.98    300.98    273.64    230.26
    191.92    155.62    111.80     68.09     27.38      2.98
*C      *KX       FOR LAYER   1    J =    10
    209.65    194.76    177.47    165.16    160.43    158.75    153.36    144.80
    137.07    135.14    150.30    140.01    153.24    203.06    229.86    255.76
```

```
*C
*C                          INITIAL
*C    REGION    DATUM       PRESSURE      WOC        PCWOC         GOC        PCGOC       BPINI
*C
          1   5400.00    3057.00   6477.00        .00         .00         .00   2500.00
*C
*C ------ END OF EQUIL DATA
*C
*ENDJOB
```

Appendix D - Recurrent Data Input

```
*C
*RESTART       0  15  16
*C
*C
*C            *******************************************
*C            *           W O R K B E N C H             *
*C            *         R E L E A S E  01.05.16         *
*C            *         RUN DECK FOR SIMBEST II         *
*C            *******************************************
*C            *                                         *
*C            *      PROJECT:  b65g sand                *
*C            *                                         *
*C            *      CASE:                              *
*C            *                                         *
*C            *      DATE:      02-Aug-96               *
*C            *                                         *
*C            *      TIME:      14:23:21                *
*C            *                                         *
*C            *******************************************
*C
*C
*RTITLE  b65g sand
*C
*C
*C
*C *PROJECT       b65g sand
*C *CASE
*C
*C
*CONTEXT     b65g sand
*C
*C
*WPLOT    3
*C
*WMAP    10
*C
*C ------ START OF WELLBORE HYDRAULICS DATA
*C
*C ------ END OF WELLBORE HYDRAULICS DATA
*C
*NOLIST
*C
*CENTRE     99      *GCNM__99
*C
*PRINT    *WELL     *REGION   *TIME
*WELL     2    *b-29      *MULT   99
*PERF  *S    2       *IJK  1  12   5   1    20607.
*WI          2        1000.0
*WELL     3    *b-3       *MULT   99
*PERF  *S    3       *IJK  1  15   3   1    12319.
*WI          3        1000.0
*WELL     5    *b-13      *MULT   99
*PERF  *S    5       *IJK  1  17   7   1    16356.
*WI          5        1000.0
*WELL     6    *b-27      *MULT   99
*PERF  *S    6       *IJK  1  17   7   1    16356.
*WI          6        1000.0
*WELL     9    *b-10      *MULT   99
*PERF  *S    9       *IJK  1  13   9   1    5870.6
*WI          9        1000.0
*WELL    10    *b-30      *MULT   99
*PERF  *S   10       *IJK  1  12  10   1    4379.4
*WI         10        1000.0
*WELL    11    *b-26      *MULT   99
*PERF  *S   11       *IJK  1  10  10   1    2899.9
*WI         11        1000.0
*WELL    13    *b-2       *MULT   99
```

```
*PERF  *S   13        *IJK  1   9   13   1     .00000
*WELL    14    *b-8        *MULT   99
*PERF  *S   14        *IJK  1  20   12   1    3521.8
*WELL    16    *b-18       *MULT   99
*PERF  *S   16        *IJK  1   9    6   1    6601.3
*WELL    18    *b-16       *MULT   99
*PERF  *S   18        *IJK  1  14    5   1    17644.
*WI         18         1000.0
*WELL    19    *b-6        *MULT   99
*PERF  *S   19        *IJK  1   9   11   1    857.81
*WELL    31    *b-25       *MULT   99
*PERF  *S   31        *IJK  1  24   12   1    23844.
*WELL    32    *b-9        *MULT   99
*PERF  *S   32        *IJK  1  21    9   1    14317.
*WELL    33    *b-20       *MULT   99
*PERF  *S   33        *IJK  1  21    8   1    12571.
*WELL    35    *b-14       *MULT   99
*PERF  *S   35        *IJK  1   3    9   1    8246.2
*WELL    37    *b-29st     *MULT   99
*PERF  *S   37        *IJK  1   7    7   1    3139.5
*WELL    38    *b-27st1    *MULT   99
*PERF  *S   38        *IJK  1  17    7   1    16356.
*WELL    40    *7          *MULT   99
*PERF  *S   40        *IJK  1   8    2   1    21926.
*WELL    43    *5          *MULT   99
*PERF  *S   43        *IJK  1  30   11   1    7428.4
*PROD  *O    9
*C
*TIME                  1.0000
*C    ----------------------       01 02 66
*C
*TIME                  28.000
*C    ----------------------       28 02 66
*C
*TIME                  242.00
*C    ----------------------       30 09 66
*C
*WELL     7    *b-1        *MULT   99
*PERF  *S    7        *IJK  1  17   10   1    18029.
*WI          7         1000.0
*WELL    17    *b-7        *MULT   99
*PERF  *S   17        *IJK  1   9   10   1    3038.1
*PROD  *O    7
*PROD  *O    9
*PROD  *O   17
*Q           7       70.7742
*Q           9       4.09677
*Q          17       60.9032
*C
*TIME                  273.00
*C    ----------------------       31 10 66
*C
*Q           7       134.700
*Q           9       141.533
*Q          17       126.267
*C
*TIME                  303.00
*C    ----------------------       30 11 66
*C
*Q           7       126.613
*Q           9       132.548
*Q          17       113.581
*C
*TIME                  334.00
*C    ----------------------       31 12 66
*C
*Q           7       140.968
```

```
*Q          9        136.968
*Q         17        120.839
*C
*TIME                 365.00
*C    ----------------------     31 01 67
*C
*WELL     8     *b-12       *MULT   99
*PERF   *S    8        *IJK  1  14    9    1     7053.4
*WI           8         1000.0
*PROD   *O    8
*Q            7        148.679
*Q            8        16.2500
*Q            9        141.679
*Q           17        122.536
*C
*TIME                  393.00
*C    ----------------------     28 02 67
*C
*Q            7        111.677
*Q            8        112.710
*Q            9        1.32258
*Q           17        111.258
*C
*TIME                  424.00
*C    ----------------------     31 03 67
*C
*PROD   *O   32
*Q            7        110.700
*Q            8        86.9000
*Q            9        23.2667
*Q           17        98.5000
*Q           32        76.5333
*C
*TIME                  454.00
*C    ----------------------     30 04 67
*C
*Q            7        137.484
*Q            8        106.161
*Q            9        139.065
*Q           17        121.806
*Q           32        159.194
*C
*TIME                  485.00
*C    ----------------------     31 05 67
*C
*Q            7        167.067
*Q            8        154.967
*Q            9        160.133
*Q           17        131.533
*Q           32        167.800
*C
*TIME                  515.00
*C    ----------------------     30 06 67
*C
*Q            7        146.806
*Q            8        126.194
*Q            9        144.839
*Q           17        115.000
*Q           32        153.839
*C
*TIME                  546.00
*C    ----------------------     31 07 67
*C
*Q            7        216.194
*Q            8        181.581
*Q            9        201.387
*Q           17        224.774
```

```
*Q          32        237.774
*C
*TIME                  577.00
*C    -----------------------       31 08 67
*C
*Q           7        116.000
*Q           8        110.400
*Q           9        105.100
*Q          17        83.7333
*Q          32        127.500
*C
*TIME                  607.00
*C    -----------------------       30 09 67
*C
*Q           7        163.774
*Q           8        127.097
*Q           9        178.903
*Q          17        135.032
*Q          32        166.387
*C
*TIME                  638.00
*C    -----------------------       31 10 67
*C
*Q           7        160.967
*Q           8        136.100
*Q           9        149.167
*Q          17        136.167
*Q          32        195.200
*C
*TIME                  668.00
*C    -----------------------       30 11 67
*C
*Q           7        132.839
*Q           8        120.129
*Q           9        144.774
*Q          17        120.000
*Q          32        138.194
*C
*TIME                  699.00
*C    -----------------------       31 12 67
*C
*Q           7        155.097
*Q           8        130.097
*Q           9        152.194
*Q          17        129.806
*Q          32        165.710
*C
*TIME                  730.00
*C    -----------------------       31 01 68
*C
*Q           7        164.897
*Q           8        147.586
*Q           9        166.414
*Q          17        147.414
*Q          32        182.138
*C
*TIME                  759.00
*C    -----------------------       29 02 68
*C
*Q           7        179.581
*Q           8        163.419
*Q           9        182.613
*Q          17        165.710
*Q          32        201.581
*C
*TIME                  790.00
*C    -----------------------       31 03 68
```

```
*C
*Q           7        131.000
*Q           8        113.067
*Q           9        131.733
*Q          17        109.633
*Q          32        138.700
*C
*TIME                  820.00
*C    ----------------------          30 04 68
*C
*Q           7        146.903
*Q           8        129.774
*Q           9        151.000
*Q          17        124.516
*Q          32        168.645
*C
*TIME                  851.00
*C    ----------------------          31 05 68
*C
*Q           7        170.600
*Q           8        145.100
*Q           9        163.067
*Q          17        149.833
*Q          32        182.100
*C
*TIME                  881.00
*C    ----------------------          30 06 68
*C
*Q           7        162.097
*Q           8        149.613
*Q           9        170.581
*Q          17        140.516
*Q          32        178.452
*C
*TIME                  912.00
*C    ----------------------          31 07 68
*C
*Q           7        186.258
*Q           8        151.968
*Q           9        176.355
*Q          17        165.161
*Q          32        200.452
*C
*TIME                  943.00
*C    ----------------------          31 08 68
*C
*Q           7        171.800
*Q           8        154.800
*Q           9        162.433
*Q          17        156.333
*Q          32        187.367
*C
*TIME                  973.00
*C    ----------------------          30 09 68
*C
*Q           7        175.032
*Q           8        132.548
*Q           9        143.387
*Q          17        141.871
*Q          32        190.419
*C
*TIME                  1004.0
*C    ----------------------          31 10 68
*C
*Q           7        163.833
*Q           8        152.833
*Q           9        154.633
```

```
*Q          17        193.774
*C
*TIME                  1277.0
*C   ----------------------        31 07 69
*C
*Q           7        189.774
*Q           9        173.161
*Q          17        192.742
*C
*TIME                  1308.0
*C   ----------------------        31 08 69
*C
*Q           7        279.600
*Q           8        257.067
*Q           9        177.733
*Q          17        212.433
*C
*TIME                  1338.0
*C   ----------------------        30 09 69
*C
*Q           7        195.806
*Q           8        248.774
*Q           9        158.613
*Q          17        180.968
*C
*TIME                  1369.0
*C   ----------------------        31 10 69
*C
*Q           7        226.433
*Q           8        257.067
*Q           9        163.833
*Q          17        185.333
*C
*TIME                  1399.0
*C   ----------------------        30 11 69
*C
*Q           7        242.097
*Q           8        248.774
*Q           9        102.677
*Q          17        201.710
*C
*TIME                  1430.0
*C   ----------------------        31 12 69
*C
*Q           7        243.355
*Q           9        287.161
*Q          17        220.064
*C
*TIME                  1431.0
*C   ----------------------        01 01 70
*C
*Q          17        220.065
*C
*TIME                  1461.0
*C   ----------------------        31 01 70
*C
*Q           7        270.857
*Q           8        275.429
*Q           9        288.071
*Q          17        254.000
*C
*TIME                  1489.0
*C   ----------------------        28 02 70
*C
*Q           7        193.548
*Q           8        248.774
*Q           9        260.839
```

```
*Q          17        153.968
*C
*TIME                  1520.0
*C   ----------------------       31 03 70
*C
*Q           7        243.933
*Q           8        257.067
*Q           9        298.067
*Q          17        260.233
*C
*TIME                  1550.0
*C   ----------------------       30 04 70
*C
*Q           7        232.097
*Q           8        248.774
*Q           9        283.742
*Q          17        218.226
*C
*TIME                  1581.0
*C   ----------------------       31 05 70
*C
*Q           7        257.167
*Q           8        257.067
*Q           9        281.000
*Q          17        203.833
*C
*TIME                  1611.0
*C   ----------------------       30 06 70
*C
*Q           7        222.161
*Q           8        248.774
*Q           9        292.194
*Q          17        212.968
*C
*TIME                  1642.0
*C   ----------------------       31 07 70
*C
*Q           7        236.290
*Q           9        351.774
*Q          17        187.194
*C
*TIME                  1673.0
*C   ----------------------       31 08 70
*C
*Q           7        281.600
*Q           8        257.067
*Q           9        377.367
*Q          17        217.800
*C
*TIME                  1703.0
*C   ----------------------       30 09 70
*C
*Q           7        326.387
*Q           8        248.774
*Q           9        403.581
*Q          17        250.774
*C
*TIME                  1734.0
*C   ----------------------       31 10 70
*C
*Q           7        333.267
*Q           8        257.067
*Q           9        404.167
*Q          17        239.533
*C
*TIME                  1764.0
*C   ----------------------       30 11 70
```

```
*C
*Q          7        547.484
*Q          8        248.774
*Q          9        598.710
*Q         17        260.065
*C
*TIME                  1795.0
*C   ----------------------      31 12 70
*C
*Q          7        805.226
*Q          8        925.613
*Q          9        916.719
*Q         17        269.184
*Q         32        796.355
*C
*TIME                  1826.0
*C   ----------------------      31 01 71
*C
*Q          7        891.500
*Q          8        926.107
*Q          9        1014.94
*Q         17        298.025
*Q         32        810.464
*C
*TIME                  1854.0
*C   ----------------------      28 02 71
*C
*Q          7        805.226
*Q          8        912.226
*Q          9        916.719
*Q         17        269.184
*Q         32        793.548
*C
*TIME                  1884.0
*C   ----------------------      30 03 71
*C
*WELL    29    *b-17     *MULT   99
*PERF  *S   29       *IJK  1  22  10   1    23100.
*PROD  *O   29
*Q         29        412.677
*C
*TIME                  1885.0
*C   ----------------------      31 03 71
*C
*Q          7        832.067
*Q          8        961.433
*Q          9        947.277
*Q         17        278.157
*Q         32        790.733
*C
*TIME                  1915.0
*C   ----------------------      30 04 71
*C
*Q          7        805.226
*Q          8        1057.32
*Q          9        916.719
*Q         17        269.184
*Q         29        979.387
*Q         32        762.742
*C
*TIME                  1946.0
*C   ----------------------      31 05 71
*C
*Q          7        832.067
*Q          8        999.367
*Q          9        947.277
*Q         17        278.157
```

```
*Q          29        888.633
*Q          32        724.200
*C
*TIME                  1976.0
*C    ----------------------        30 06 71
*C
*Q           7        805.226
*Q           8        908.903
*Q           9        916.719
*Q          17        269.184
*Q          29        444.000
*Q          32        733.806
*C
*TIME                  2007.0
*C    ----------------------        31 07 71
*C
*Q           8        806.935
*Q          29        .000000
*Q          32        677.548
*C
*TIME                  2038.0
*C    ----------------------        31 08 71
*C
*Q           7        832.067
*Q           8        746.933
*Q           9        947.277
*Q          17        278.157
*Q          29        22.1667
*Q          32        492.767
*C
*TIME                  2068.0
*C    ----------------------        30 09 71
*C
*Q           7        805.226
*Q           8        932.323
*Q           9        916.719
*Q          17        269.184
*Q          29        309.903
*Q          32        654.129
*C
*TIME                  2099.0
*C    ----------------------        31 10 71
*C
*Q           7        832.067
*Q           8        894.100
*Q           9        947.277
*Q          17        278.157
*Q          29        538.000
*Q          32        632.833
*C
*TIME                  2129.0
*C    ----------------------        30 11 71
*C
*Q           7        805.226
*Q           8        615.387
*Q           9        916.719
*Q          17        269.184
*Q          29        541.903
*Q          32        580.968
*C
*TIME                  2160.0
*C    ----------------------        31 12 71
*C
*Q           8        780.452
*Q          29        453.194
*Q          32        560.806
*C
```

```
*TIME                    2189.0
*C   ----------------------       29 01 72
*C
*WELL     1    *b-15      *MULT    99
*PERF  *S    1       *IJK  1  11   5   1    20104.
*WI          1       1000.0
*INJ   *G    1
*Q           1       666.194
*C
*TIME                    2191.0
*C   ----------------------       31 01 72
*C
*Q           7       860.759
*Q           8       860.034
*Q           9       979.941
*Q          17       287.748
*Q          29       339.655
*Q          32       496.000
*C
*TIME                    2220.0
*C   ----------------------       29 02 72
*C
*Q           1       1489.06
*Q           7       805.226
*Q           8       796.323
*Q           9       916.719
*Q          17       269.184
*Q          29       260.516
*Q          32       514.484
*C
*TIME                    2251.0
*C   ----------------------       31 03 72
*C
*Q           1       1395.73
*Q           7       832.067
*Q           8       1002.37
*Q           9       947.277
*Q          17       278.157
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*Q          32       502.467
*C
*TIME                    2281.0
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*Q           7       805.226
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*Q          29       .000000
*Q          32       535.871
*C
*TIME                    2312.0
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```

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*C
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*C
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```
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```

FURTHER CHARACTERIZATION OF THE GULF OF MEXICO U-8 RESERVOIR

by W. Clay Kimbrell, *Louisiana State University*

Introduction

This report presents the information gained from the continued study of the U-8 reservoir in the Gulf of Mexico. A verbal agreement was reached with the operator of this reservoir to blindcode the name and location of the reservoir. In return, the operator supplied data and assistance in regards to the technical aspects of the research. A previous report was made on this reservoir under the U.S. Department of Energy (DOE) contract number DE-AC22-92BC14831, primarily in the form of a master's thesis by George Koperna.[1] The purpose of this continued research of this reservoir are as follows:

1. Refine the reservoir and geologic characterization of the U-8 reservoir by obtaining and analyzing additional data. Additional reservoir and geologic data includes updated fluid data, pressure data, well test data, and any newly available well logs and/or core data/samples. Laboratory investigations were included where necessary to improve simulator input.

2. Based on new data and characterization, simulate the performance of an advanced waterflooding project and perform predictive sensitivity studies to assess recovery potential and process improvements.

New data was obtained for this reservoir in the form of updated production records, well test data (which includes pressure, GOR, fluid data, and water cut), and core data.

Reservoir History

The subject field is located on the north side of a large salt tongue. This tongue has risen diagonally through the surrounding sediments, creating an extremely complex fault pattern.

The reservoir lies on the northeast side of a major fault radiating from a large salt tongue. Several smaller faults splay out from this major fault, forming the boundaries of the reservoir unit. Two minor faults cut the interior of the reservoir block. These minor faults partially isolate portions of the reservoir block, creating long migration pathways from sections of the reservoir to the producing wells. The U-8 Sand reservoir has produced 2,115 MSTB of oil, 8,044 MMSCF of gas, and 1,379 MSTB of water, through November, 1995.

Reservoir Interpretation

Early interpretations of the reservoir were based on two dimensional (2-D) seismic lines shot in the 1970s and 1980s. The original structural interpretation of the area showed a saddle-

[1] Koperna, G., "Reservoir Characterization and Performance Predictions For The U-8 Sand Reservoir," Master's Thesis, West Virginia University Department of Petroleum and Natural Gas Engineering, (June, 1994).

shaped structure with a dome at each end. The productive wells were placed to produce from the crest of the northern dome and from an area just south of the low point on the saddle.

As the study area was developed, additional information was gathered, and three dimensional (3-D) seismic surveys were run. Using seismic workstations, Company B processed the data. The results showed a much more complicated picture than had originally been envisioned. The structural and geological characterization of the U-8 reservoir is depicted in Figure 1. Also, shown on this figure are the well locations and areas which will be referred to later in this report. The reservoir can be described as a relatively flat, totally isolated fault block (surrounded on all sides by faults) with several non-sealing interior minor faults which serve to decrease drainage of the reservoir.

The U-8 was divided into three layers, with two intervening shaley zones as shown in Figure 2, which a log section from the 10-20 well. The top, or A, layer was a relatively uniform blanket sand, between 12 and 15 feet thick. A shaley zone separates this unit from the underlying B sand, a much thicker, but more irregular, sand body. The actual water production, as was the case in the original study, could not be modeled based upon the premise that each lobe was a reservoir unit, itself cut off from communication with the other lobes by the shale stringers running between them. It was necessary to put the two top layers, A and B, into communication with one another within the reservoir. The structure map and the isolations of the southwestern portions of the unit, Area C, were factored into the reservoir model as before. There was no new data to support modifications to the geological interpretations from the previous study.

U-8 Reservoir Development History

The U-8 reservoir has been developed with three production wells and one exploration well penetrating nearly 12,000 ft into the U-8 Sand formation. Company A's well (further reference herein to this well will be to A-1), located in the north side of the field, was drilled in January 1981 as a exploratory well. Field operations for this well included coring and geophysical well logging only.

In November 1982, the first production well was completed in the U-8 sand reservoir. Company B's well (further reference herein to this well will be to #10-15) was a straight hole drilled to 12,324 feet. In February 1991, Well 10-15 was shut-in due to high water and gas production rates.

Company A drilled the second production well (further reference herein to this well will be to #A-4) in the U-8 Sand in February 1988. The #A-4 well was drilled to a total depth of 12,140 feet. In November 1992, this well was shut-in due to high water and gas production rates and diminishing reservoir pressure.

Company B's second well (further reference herein to this well will be to #10-20) was drilled as a straight hole to a depth of 11,957 feet in July 1988. This well is currently the only well producing the U-8 reservoir. The plug-back depth was 11,920 feet. The U-8 Sand was perforated from 11,844 feet to 11,862 feet, with 12 four-inch perforations allowing production from both the upper lobe, LobeA, and the middle lobe, Lobe B. The U-8 reservoir originally did not flow in this well. Therefore, the perforations were washed, and a gravel pack was installed.

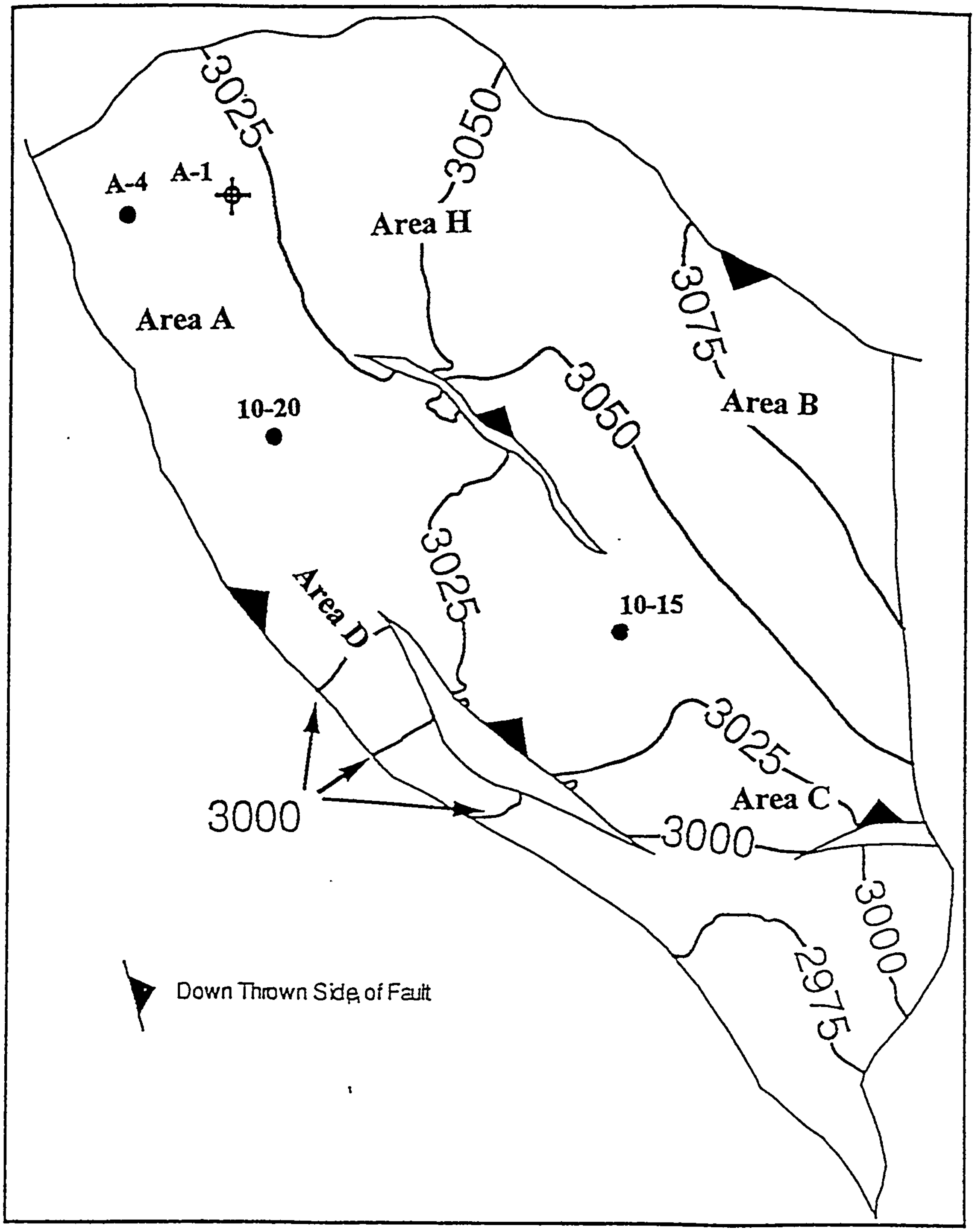
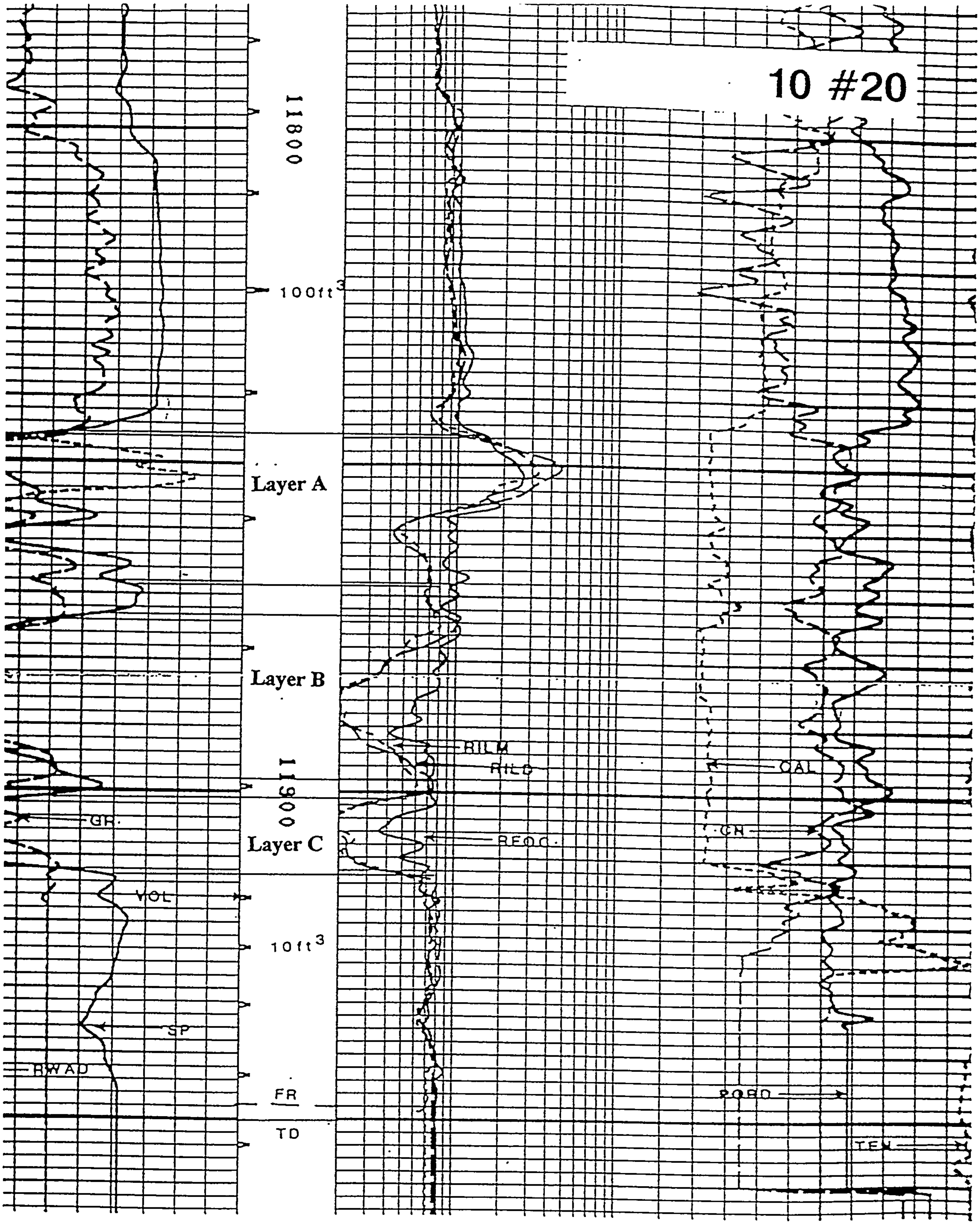


Figure 1 - U-8 Reservoir with well locations and areas of interest
(modified from Koperna, June 1994)



gure 2 - Log of the 10-20 well depicting layers A through C

U-8 Reservoir Production History

In February 1991, well #10-15 was shut-in due to limited oil production and excessive gas and water production. To date, well #10-15 has produced 218 MBO, 836 MMSCF, and 330 MBW. Wells #A-4 and #10-20 produced until November and December 1992 when they were shut-in. Well #A-4 produced 517 MBO, 3101 MMCF, 356 MBW. Well #10-20 was put back on line January, 1993. It is presently the only well producing from the U-8 reservoir. To date, it has produced 1,380 MBO, 4,107 MMSCF, 693 MBW. Table 1 contains the cumulative reservoir fluid production. The production histories by well may be found in Figures 3 through 5.

Table 1: Cumulative Production for the U-8 Reservoir

WELL	CUMULATIVE OIL, MSTB	CUMULATIVE GAS, MMCF	CUMULATIVE WATER,MSTB
10-15	218	836	330
A-4	517	3,101	356
10-20	1,380	4,107	693
TOTAL	2,115	8,044	1,379

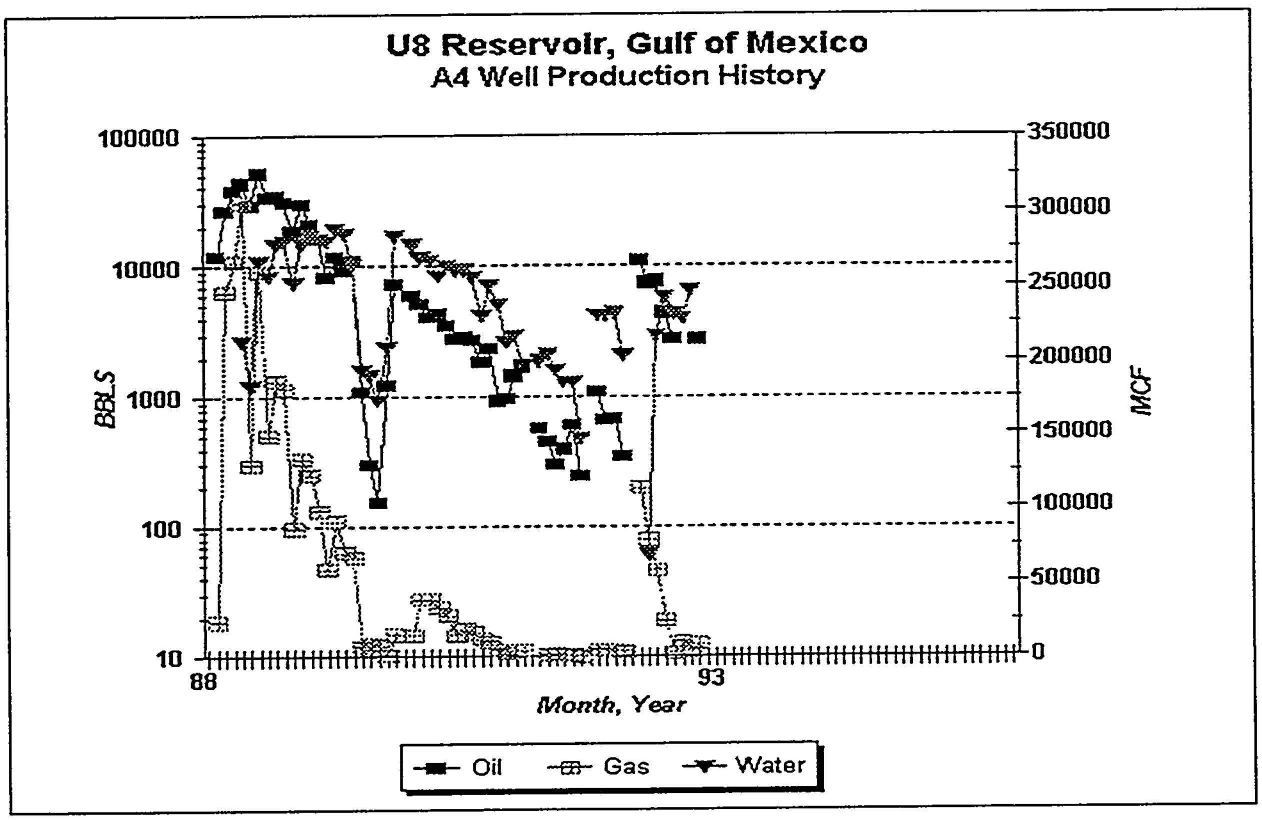


Figure 3 - A-4 Production History

Simulation of Well Histories

Using the oil production rate as an input, or the known parameter, an implicit rate calculation scheme was used to accurately simulate past reservoir history. The oil rate was averaged over designated periods of time for each of the three producing wells with each time period represented by an individual recurrent data set. Reservoir pressure, water production, and gas production were predicted and compared to actual field history.

Essentially, the major occurrence and new piece of information which was obtained since the last report was the fact that the #10-20 had been reworked. The workover consisted of squeezing off with cement the lower perforations in an attempt to eliminate or reduce the water cut. It was unsuccessful within this capacity, however. The well still produces at a high water cut. Originally, the simulation was run with the assumption that Layer B had been isolated from Layer A to account for a successful workover. However, a history match was unattainable using this scenario. Therefore, Lobe A was put back into communication with Lobe B witin the reservoir and a history match was attained. A copy of the final history match data set is found in Appendix A. History match results are illustrated in Figures 6 and 7. Figure 6 the simulated production values for oil, gas and water to the actual production values. Oil production was input as the control. Figure 7 compares the simulated reservoir pressure to the actual reservoir pressure. Both graphs illustrate a fair to good match.

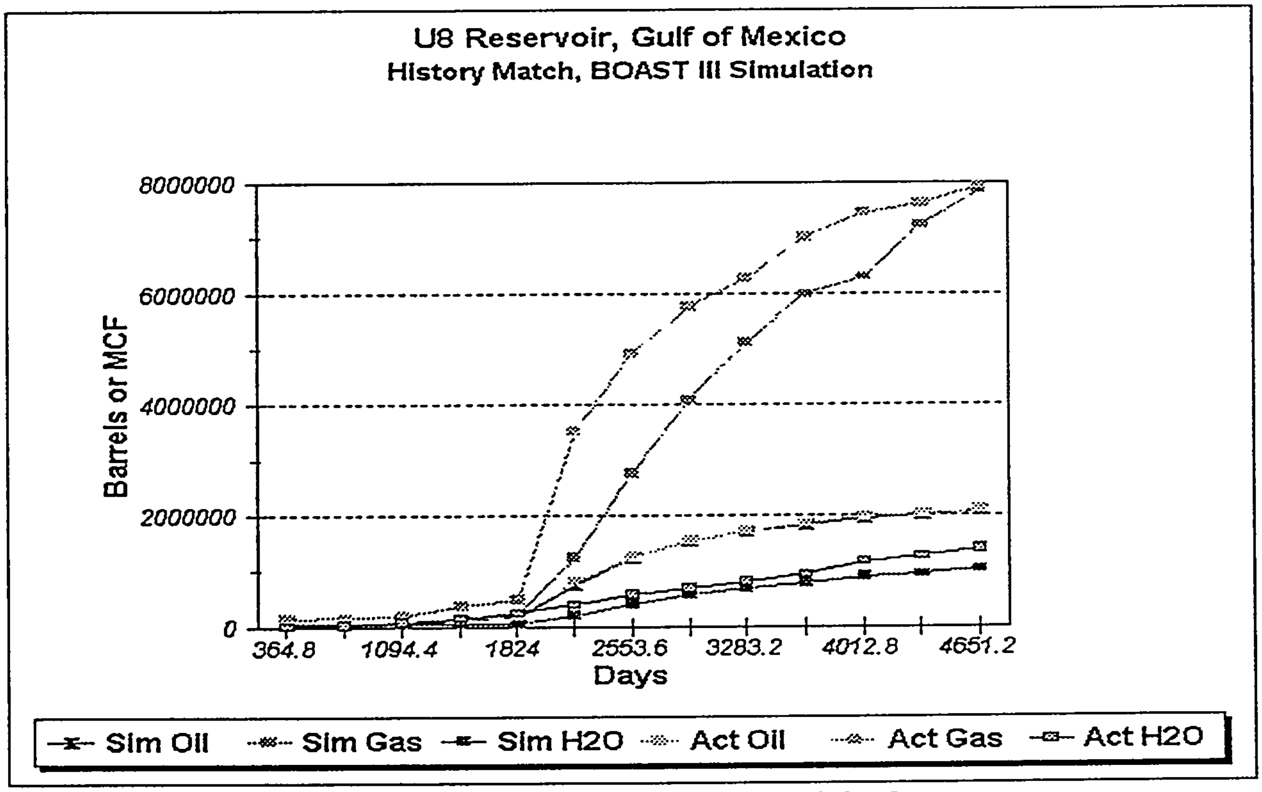


Figure 6 - U8 Production History Match

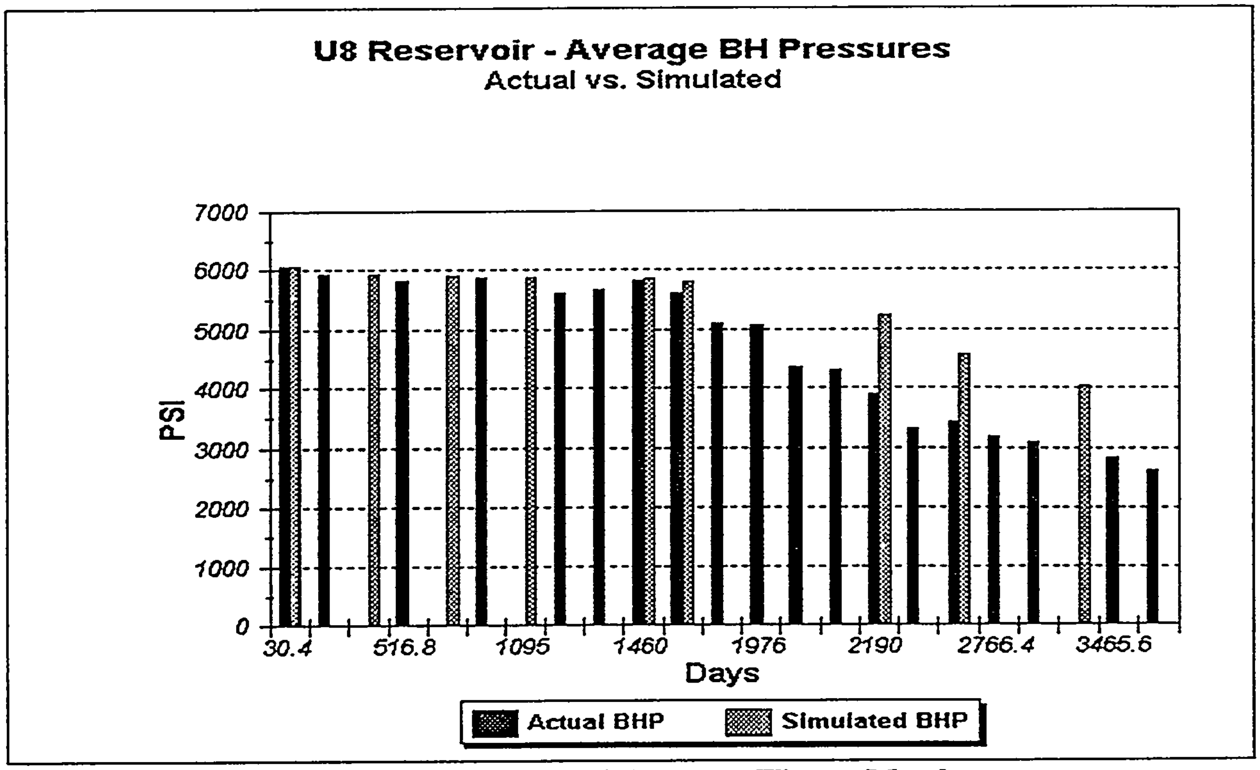


Figure 7 - U8 Reservoir Pressure History Match

Predictive Study

This study targeted an enhanced recovery process which is commonly used in the Gulf of Mexico: waterflooding. All predictive study simulations were performed based on the updated history match achieved.

Predictive Study Setup

The following scenarios were made during the predictive study:

1. the maximum producing water-oil ratio was set at a maximum of 10 to allow the production wells to stay on-line for a reasonable amount of time

2. the maximum producing gas-oil ratio was set at 500,000 SCF/STB to allow the production wells to stay on-line for a reasonable amount of time

3. the minimum bottom hole pressure was set at 150 psi to allow the production wells to stay on-line for a reasonable amount of time

4. the field's water injection rate was set at a consistent level for both vertical and horizontal situations in order to compare and contrast the results

Waterflooding

Figures 8, 9 and 10 depict the ending oil, gas and water saturations, respectively, at the end of the BOAST III history match. Also, noted in these figures are zones as outlined in the previous study, Zones A through H. The highest amounts of remaining oil is found in the updip area A and the directly downdip area H. It was therefore decided to simulate an advanced waterflood concentrating on these two areas.

The initial predictive run, P1, was simply a continuation of the field production as it is presently, with only the 10-20 well producing. A second predictive run, P2, added the A-4 well to the 10-20 well. Both of these simulations, as well as the advanced waterflood simulations, were run with implicit pressure control. Therefore, comparisons for these different predictive scenarios will concentrate on qualitative rather than quantitative results.

After the first two predictive runs (P1 and P2), where there is no secondary production application, several advanced waterflood scenarios were simulated for comparison. The third and fourth simulation runs (P16 and P17) simulated a vertical injector well, injecting 1700 barrels of water per day, from grid block x-6, y-13, with two and one producing wells (10-20 + A-4 and 10-20), respectively. The fifth and sixth simulation runs (P18 & P19) simulated a horizontal injector well, injecting 1700 barrels of water per day, from grid block x-5-7, y-13, with two and one producing wells (10-20 + A-4 and 10-20), respectively. The seventh and eighth runs (P20 & P21) simulated a vertical injector well, injecting 1700 barrels of water per day, from grid block x-5, y-6, with two and one producing wells (10-20 + A-4 and 10-20), respectively. The ninth and tenth runs (P22 & P23) simulated a horizontal injector well, injecting 1700 barrels of water per day, from grid block x-5, y-5-7, with two and one producing wells (10-20 + A-4 and 10-20), respectively.

Results from these prediction runs have been depicted in Table 2. Interestingly, the best scenario for this particular reservoir, from this simulation study, is a vertical well injecting in Area H and producing from Area A from the 10-20 well. Oil recovery increases by a factor of 3.2 in comparison to the scenario of continuing as present with one well, the 10-20. Oil recovery increases by a factor of 2.6 in comparison to the scenario of continuing as present with two well, the 10-20 and the A-4.

A horizontal injector in the same area, is a close second in respect to oil recovery. However, when viewing the major increase in cost between putting a vertical well in place versus a horizontal well, the vertical injector is, by far, the most advantageous scenario.

Vertical and horizontal injectors placed between the 10-20 and A-4 wells, in Area A, resulted in the producing wells to reach a water/oil ratio of 10 very early. This resulted in a lower overall oil recovery and therefore a poor candidate scenario. Comparison results are illustrated in Figure 11.

ıure 8 - U8 Reservoir Oil Saturation at Present

1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.357	0.3347	0.4108	0.2748	0.2554	0.2664	0.2604	0.2608	0.2613	0.2609	0.2674	0	0	0	0	0
2	0.4584	0.4268	0.471	0.4109	0.2633	0.275	0.2664	0.2749	0.2746	0.2727	0.2583	0.1617	0.1492	0.1488	0	0
3	0.5851	0.5128	0.5413	0.4716	0.4035	0.3523	0.2836	0.3615	0.3821	0.3932	0.5251	0.1619	0.1492	0.1487	0	0
4	0.5456	0.4803	0.4792	0.5368	0.3887	0.5555	0.4311	0.4258	0.4236	0.4438	0.249	0.1623	0.1492	0.1487	0	0
5	0.5602	0.5903	0.5193	0.5601	0.4776	0.6202	0.5546	0.5091	0.4647	0.4659	0.4502	0	0	0	0	0
6	0.5	0.5398	0.5322	0.6119	0.622	0.6254	0.5493	0.4884	0.4667	0.4706	0.4455	0.3138	0.2958	0.2807	0.1551	0
7	0.4393	0.4997	0.5461	0.5686	0.5721	0.553	0.4659	0.459	0.4897	0.4799	0.4872	0.3795	0.3628	0.3586	0.3383	0.1995
8	0.3196	0.5218	0.5559	0.5812	0.5818	0.5091	0.3042	0.3298	0.314	0.3171	0.5327	0.4287	0.4015	0.4203	0.4531	0.2615
9	0.2988	0.4937	0.5202	0.5472	0.5573	0.4636	0.4195	0.4357	0.4175	0.3945	0.4751	0.5302	0.2874	0.3259	0.5233	0.243
10	0	0.4763	0.5061	0.4991	0.5138	0.4893	0.4031	0.4178	0.4038	0.417	0.4886	0.5504	0.2899	0.3536	0.5611	0.1944
11	0	0.4476	0.5108	0.5047	0.4659	0.5136	0.4147	0.4448	0.4559	0.1592	0.5122	0.5819	0.3352	0.3753	0.6078	0.265
12	0	0.5218	0.541	0.5314	0.4707	0.4873	0.4204	0.4635	0.4852	0.5509	0.4863	0.571	0.5724	0.5659	0.5477	0.5562
13	0	0	0	0.5758	0.4218	0.3921	0.4453	0.4566	0.4589	0.4558	0.3895	0.3849	0.3456	0.3301	0.3084	0.6101
14	0	0	0	0	0	0	0.2804	0.2848	0.2857	0.2962	0.2975	0.216	0.2107	0.1726	0.1104	0.2648
15	0	0	0	0	0	0	0	0	0	0	0.2457	0.1993	0.473	0	0	0

2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.6257	0.6041	0.5818	0.626	0.5038	0.4769	0.4708	0.4882	0.4868	0.4747	0.4836	0	0	0	0	0
2	0.5986	0.5694	0.5662	0.5984	0.5421	0.5643	0.5272	0.5987	0.5989	0.5908	0.5842	0.2942	0.1681	0	0	0
3	0.5411	0.5538	0.5432	0.5775	0.6118	0.6261	0.6146	0.6084	0.5889	0.5561	0.4043	0.3008	0.1824	0.1622	0	0
4	0.5471	0.5957	0.5728	0.5555	0.6239	0.5971	0.6251	0.542	0.5054	0.4394	0.3887	0.3192	0.1824	0.1616	0	0
5	0.4474	0.547	0.5874	0.5703	0.579	0	0.5496	0.4513	0.4306	0.3801	0.434	0.2538	0	0.163	0	0
6	0.3557	0.4448	0.6263	0	0	0	0	0	0.4335	0.3772	0.4261	0.424	0.4249	0.3265	0.1608	0
7	0.3064	0.4037	0	0	0	0	0	0	0	0.3665	0.4053	0.237	0.2868	0.3166	0.4051	0
8	0.2505	0	0	0	0	0	0	0	0	0	0.414	0.2608	0.2761	0.2951	0.2987	0.4437
9	0	0	0	0	0	0	0	0	0	0.2506	0.2742	0.3162	0.5055	0.4981	0.3975	0.4077
10	0	0	0	0	0	0	0	0	0	0	0	0.4094	0.5588	0.5378	0.4319	0.3445
11	0	0	0	0	0	0	0	0	0	0	0.3235	0.4075	0.6198	0.6051	0.476	0.5051
12	0	0	0	0	0	0	0	0	0	0	0.2661	0.4151	0.3512	0.3134	0.2783	0.4618
13	0	0	0	0	0	0	0	0	0	0	0.1047	0.0562	0.0175	0.0006	0.0011	0.4203
14	0	0	0	0	0	0	0	0	0	0	0.0087	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0.014	0	0.3538	0	0	0

3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.2043	0.13	0.0702	0.1184	0.1827	0.1409	0.1611	0.1216	0.1185	0.144	0.1654	0	0	0	0	0
2	0.3235	0.0675	0.0694	0.0889	0.246	0.1304	0.1536	0.1109	0.1225	0.1102	0.1058	0.0963	0.3397	0.1664	0	0
3	0.0857	0.1071	0.0654	0.0852	0.1553	0.1288	0.1348	0.0561	0.0696	0.0681	0.0084	0.0331	0.1928	0.284	0.2858	0
4	0.1884	0.2129	0.1242	0.0888	0.2232	0.0971	0.1062	0.0232	0.0766	0.0421	0.1924	0.0229	0.1793	0.2864	0.2747	0
5	0.0725	0.1645	0.1654	0.1162	0.1645	0.1067	0.0808	0.0686	0.1301	0.0433	0.0415	0.4824	0.179	0	0.1126	0
6	0.0693	0.0805	0.2855	0.2609	0.2038	0.1738	0.1296	0.0816	0.115	0.044	0.0529	0.0169	0.0241	0.2143	0	0
7	0.1067	0.0985	0.0709	0.0646	0.0607	0.0495	0.0411	0.1718	0.1646	0.0624	0.0659	0.0391	0.0395	0.0346	0.0557	0
8	0.1225	0.0682	0.0806	0.0838	0.1054	0.0596	0.0157	0.0237	0.0235	0.0144	0.0392	0.0383	0.0329	0.021	0.0341	0.0486
9	0.0383	0.0585	0.0433	0.0373	0.038	0.0236	0.0389	0.0223	0.045	0.0328	0.0066	0.0127	0.076	0.0856	0.0277	0.0816
10	0	0.0469	0.0433	0.0455	0.0438	0.0097	0.0173	0.0227	0.0089	0.0039	0.0612	0.0335	0.1393	0.0531	0.0268	0.1543
11	0	0.0273	0.0573	0.0397	0.0293	0.0547	0.0189	0.0269	0.0026	0.153	0.0605	0.0023	0.2064	0.0998	0.0219	0.0254
12	0	0.0862	0.0384	0.0373	0.0303	0.0341	0.0176	0.0239	0.0122	0.0156	0.0229	0.0564	0.0326	0.0276	0.0221	0.0182
13	0	0	0	0.1224	0.0334	0.0261	0.0133	0.0381	0.0446	0.0276	0.0185	0.0275	0.0233	0.0129	0.0139	0.0208
14	0	0	0	0	0	0	0.0219	0.02	0.0095	0.0182	0.0207	0.0111	0.0105	0	0.0068	0.011
15	0	0	0	0	0	0	0	0	0	0	0.0117	0.0013	0.032	0	0	0

Figure 9 - U-8 Reservoir Gas Saturation at Present

1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.3279	0.3613	0.2695	0.4372	0.4769	0.4558	0.4678	0.467	0.4661	0.4668	0.4539	0	0	0	0	0
2	0.2112	0.2514	0.1932	0.2695	0.4595	0.438	0.4554	0.4389	0.4393	0.4433	0.4715	0.6013	0.6138	0.6142	0	0
3	0.0429	0.1431	0.0987	0.1863	0.273	0.3359	0.4247	0.3118	0.2796	0.2585	0.0308	0.6011	0.6138	0.6143	0	0
4	0.098	0.194	0.1758	0.1009	0.2947	0.099	0.2554	0.2022	0.1791	0.1167	0.4839	0.6007	0.6138	0.6143	0	0
5	0.0241	0.0475	0.1343	0.0765	0.162	0.0337	0.0711	0.0446	0.0774	0.0489	0.1406	0	0	0	0	0
6	0.0283	0.0132	0.1472	0.0666	0.0522	0.0345	0.0393	0.0351	0.0741	0.0392	0.1352	0.3134	0.3952	0.4271	0.6079	0
7	0.0289	0.0207	0.0131	0.0104	0.0138	0.0091	0.0017	0.1658	0.0914	0.0292	0.0726	0.0847	0.1534	0.1759	0.2382	0.5635
8	0.0303	0.0174	0.0261	0.019	0.0279	0.0091	0.0006	0.0045	0.0005	0.0003	0.0427	0.0797	0.1254	0.1232	0.0895	0.4659
9	0.0007	0.0079	0.0192	0.0078	0.0117	0.0057	0.0032	0.0143	0.0013	0.0357	0.0111	0.0245	0.4144	0.375	0.0797	0.5008
10	0	0.006	0.0189	0.0041	0.0055	0.0116	0.0012	0.0027	0.0001	0.0307	0.0168	0.0553	0.4182	0.3517	0.0629	0.5609
11	0	0.0047	0.0229	0.0079	0.0034	0.0165	0.0016	0.0031	0.0001	0.6038	0.0267	0.0252	0.3782	0.3366	0.0482	0.4586
12	0	0.0425	0.0184	0.0122	0.0039	0.0074	0.0019	0.0023	0.0003	0.0046	0.0109	0.0416	0.0143	0.0064	0.0035	0.0782
13	0	0	0	0.0309	0.0023	0.0032	0.0143	0.0129	0.0124	0.0092	0.0065	0.0059	0.0067	0.0017	0.0006	0.0161
14	0	0	0	0	0	0	0.0014	0.0011	0.0009	0.0015	0.004	0.0012	0.0054	0.0006	0.0002	0.0008
15	0	0	0	0	0	0	0	0	0	0	0.0034	0.0002	0.0395	0	0	0

2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.0001	0	0	0.0001	0.1713	0.1932	0.22	0.1956	0.1942	0.2051	0.1831	0	0	0	0	0
2	0	0	0	0	0.1297	0.0885	0.1624	0.0588	0.0494	0.0374	0.0693	0.4387	0.5949	0	0	0
3	0	0	0	0	0	0	0.0339	0.0002	0	0	0	0.4279	0.578	0.6008	0	0
4	0	0	0	0	0	0	0	0	0.0001	0	0.2342	0.4065	0.5777	0.6014	0	0
5	0	0	0	0	0.0002	0	0.0001	0	0	0	0	0.5006	0	0.6	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0.2766	0.6022	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1892
9	0	0	0	0	0	0	0	0	0	0	0	0	0.0001	0.0001	0	0.2649
10	0	0	0	0	0	0	0	0	0	0	0	0	0.0002	0.0001	0	0.3598
11	0	0	0	0	0	0	0	0	0	0	0	0	0.0001	0.0001	0	0.0833
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.2093	0.0047	0.0003	0.0014	0.0121	0.1432	0.2292	0.1625	0.1474	0.1262	0.137	0	0	0	0	0
2	0.0247	0.0003	0.0008	0.0009	0.051	0.1004	0.1594	0.0349	0.0081	0.0016	0.0007	0.0007	0.348	0.5966	0	0
3	0.0013	0.002	0.0006	0.0014	0.015	0.0666	0.1055	0.001	0.0026	0.0007	0	0.0002	0.2104	0.4387	0.4428	0
4	0.0047	0.0566	0.0238	0.0103	0.1263	0.0343	0.0392	0.0003	0.0039	0.0003	0.0224	0.0103	0.2049	0.4081	0.4187	0
5	0.0011	0.0055	0.0126	0.0133	0.0938	0.0276	0.021	0.0034	0.0074	0.0006	0.0024	0.0582	0.584	0	0.3901	0
6	0.0021	0.0021	0.0163	0.0519	0.0531	0.0112	0.0315	0.0085	0.0056	0.0011	0.0048	0.0002	0.0002	0.1326	0	0
7	0.0074	0.0035	0.002	0.0018	0.0027	0.0012	0.0002	0.0185	0.0135	0.0016	0.0064	0.0005	0.0005	0.0001	0.0263	0
8	0.0239	0.0011	0.0022	0.0029	0.0053	0.0014	0.0001	0.0003	0.0001	0	0.0024	0.0008	0.0002	0.001	0.0003	0.0781
9	0.0004	0.0004	0.0011	0.0007	0.001	0.0007	0.0003	0.0011	0.0001	0.0003	0.0016	0.0001	0.1884	0.1673	0.0004	0.0107
10	0	0.0002	0.0012	0.0003	0.0004	0.0009	0.0001	0.0003	0	0	0.048	0.0043	0.2225	0.1809	0.0005	0.0065
11	0	0.0001	0.0014	0.0007	0.0003	0.0022	0.0001	0.0005	0	0.2151	0.0027	0.0015	0.2141	0.1971	0.0008	0.0006
12	0	0.0509	0.0005	0.0008	0.0003	0.0008	0.0001	0.0003	0.0001	0.0003	0.0008	0.0041	0.0006	0.0003	0.0002	0.0006
13	0	0	0	0.1176	0.0004	0.0003	0.0021	0.0044	0.0066	0.0024	0.0005	0.0004	0.0002	0.0001	0.0001	0.0006
14	0	0	0	0	0	0	0.0003	0.0002	0	0.0002	0.0004	0.0001	0.0001	0	0	0.0001
15	0	0	0	0	0	0	0	0	0	0	0.0003	0	0.0165	0	0	0

Figure 10 - U8 Reservoir Water Saturation at Present

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.3151	0.3039	0.3197	0.288	0.2676	0.2777	0.2718	0.2722	0.2727	0.2723	0.2787	0	0	0	0	0
2	0.3303	0.3217	0.3357	0.3197	0.2772	0.287	0.2782	0.2862	0.2862	0.284	0.2702	0.237	0.237	0.237	0	0
3	0.372	0.3441	0.36	0.3421	0.3235	0.3118	0.2918	0.3267	0.3383	0.3482	0.4442	0.237	0.237	0.237	0	0
4	0.3564	0.3258	0.345	0.3623	0.3165	0.3455	0.3135	0.372	0.3973	0.4395	0.2671	0.237	0.237	0.237	0	0
5	0.4157	0.3622	0.3464	0.3635	0.3604	0.3461	0.3743	0.4464	0.4579	0.4852	0.4092	0	0	0	0	0
6	0.4717	0.447	0.3206	0.3214	0.3258	0.3401	0.4113	0.4764	0.4591	0.4902	0.4193	0.3728	0.309	0.2922	0.237	0
7	0.5318	0.4797	0.4408	0.421	0.4141	0.4379	0.5324	0.3752	0.4189	0.491	0.4402	0.5358	0.4838	0.4655	0.4236	0.237
8	0.6502	0.4608	0.418	0.3998	0.3903	0.4818	0.6951	0.6657	0.6855	0.6825	0.4247	0.4915	0.473	0.4564	0.4574	0.2726
9	0.7005	0.4984	0.4606	0.445	0.431	0.5307	0.5773	0.55	0.5812	0.5698	0.5138	0.4452	0.2982	0.2991	0.397	0.2562
10	0	0.5177	0.475	0.4968	0.4807	0.4991	0.5957	0.5795	0.5961	0.5524	0.4945	0.3943	0.2919	0.2947	0.3761	0.2447
11	0	0.5477	0.4663	0.4874	0.5307	0.4699	0.5837	0.5521	0.544	0.237	0.4611	0.393	0.2866	0.2881	0.344	0.2763
12	0	0.4357	0.4406	0.4564	0.5254	0.5053	0.5778	0.5343	0.5145	0.4444	0.5028	0.3874	0.4132	0.4277	0.4488	0.3656
13	0	0	0	0.3934	0.5758	0.6046	0.5404	0.5306	0.5287	0.535	0.604	0.6092	0.6477	0.6683	0.691	0.3738
14	0	0	0	0	0	0	0.7182	0.714	0.7134	0.7022	0.6986	0.7828	0.7839	0.8268	0.8894	0.7344
15	0	0	0	0	0	0	0	0	0	0	0.7509	0.8006	0.4876	1	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.3742	0.3959	0.4182	0.3739	0.3248	0.3299	0.3092	0.3162	0.3189	0.3201	0.3333	0	0	0	0	0
2	0.4014	0.4306	0.4338	0.4016	0.3281	0.3472	0.3104	0.3425	0.3517	0.3717	0.3466	0.2671	0.237	0	0	0
3	0.4589	0.4462	0.4568	0.4225	0.3882	0.3739	0.3515	0.3914	0.4111	0.4439	0.5957	0.2713	0.2396	0.237	0	0
4	0.4529	0.4042	0.4272	0.4445	0.3761	0.4028	0.3749	0.4579	0.4945	0.5606	0.3771	0.2742	0.2399	0.237	0	0
5	0.5526	0.4529	0.4125	0.4297	0.4207	0	0.4503	0.5487	0.5694	0.6199	0.5659	0.2456	0	0.237	0	0
6	0.6443	0.5552	0.3737	0	0	0	0	0	0.5665	0.6228	0.5739	0.576	0.5701	0.3969	0.237	0
7	0.6935	0.5963	0	0	0	0	0	0	0	0.6335	0.5947	0.763	0.7132	0.6834	0.5949	0
8	0.7495	0	0	0	0	0	0	0	0	0	0.586	0.7392	0.7239	0.7049	0.7013	0.3671
9	0	0	0	0	0	0	0	0	0	0.7494	0.7258	0.6838	0.4944	0.5018	0.6024	0.3275
10	0	0	0	0	0	0	0	0	0	0	0	0.5906	0.4411	0.4621	0.5681	0.2957
11	0	0	0	0	0	0	0	0	0	0	0.6765	0.5925	0.38	0.3948	0.524	0.4117
12	0	0	0	0	0	0	0	0	0	0	0.7338	0.5849	0.6488	0.6866	0.7217	0.5382
13	0	0	0	0	0	0	0	0	0	0	0.8953	0.9438	0.9825	0.9994	0.9989	0.5797
14	0	0	0	0	0	0	0	0	0	0	0.9913	1	1	1	1	1
15	0	0	0	0	0	0	0	0	0	0	0.986	1	0.6462	1	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.5864	0.8653	0.9295	0.8802	0.8052	0.7159	0.6097	0.7159	0.7341	0.7298	0.6976	0	0	0	0	0
2	0.6518	0.9322	0.9298	0.9103	0.703	0.7692	0.687	0.8542	0.8694	0.8883	0.8935	0.903	0.3123	0.237	0	0
3	0.913	0.8909	0.934	0.9134	0.8298	0.8046	0.7597	0.9429	0.9278	0.9312	0.9916	0.9666	0.5968	0.2773	0.2714	0
4	0.8069	0.7305	0.852	0.9008	0.6505	0.8686	0.8546	0.9766	0.9195	0.9576	0.7852	0.9669	0.6158	0.3055	0.3067	0
5	0.9263	0.83	0.822	0.8705	0.7417	0.8657	0.8981	0.9281	0.8625	0.9562	0.9561	0.4594	0.237	0	0.4973	0
6	0.9287	0.9174	0.6982	0.6871	0.7432	0.815	0.8389	0.9099	0.8794	0.955	0.9422	0.983	0.9757	0.6531	0	0
7	0.8859	0.898	0.9271	0.9336	0.9366	0.9493	0.9587	0.8097	0.8219	0.9361	0.9277	0.9604	0.9601	0.9653	0.918	0
8	0.8536	0.9307	0.9172	0.9133	0.8893	0.939	0.9843	0.976	0.9765	0.9856	0.9585	0.9609	0.9669	0.978	0.9655	0.8734
9	0.9613	0.9412	0.9555	0.962	0.961	0.9757	0.9609	0.9766	0.9548	0.9668	0.9918	0.9872	0.7356	0.7472	0.972	0.9076
10	0	0.9529	0.9555	0.9542	0.9558	0.9893	0.9826	0.977	0.9911	0.9961	0.8908	0.9622	0.6382	0.766	0.9726	0.8392
11	0	0.9725	0.9413	0.9595	0.9704	0.9432	0.981	0.9726	0.9974	0.6319	0.9368	0.9962	0.5796	0.7031	0.9773	0.974
12	0	0.8629	0.961	0.9619	0.9694	0.9651	0.9823	0.9758	0.9877	0.9841	0.9763	0.9395	0.9668	0.9721	0.9777	0.9812
13	0	0	0	0.76	0.9663	0.9736	0.9846	0.9575	0.9488	0.97	0.981	0.9722	0.9765	0.987	0.986	0.9786
14	0	0	0	0	0	0	0.9778	0.9799	0.9905	0.9816	0.9789	0.9888	0.9894	1	0.9932	0.9889
15	0	0	0	0	0	0	0	0	0	0	0.988	0.9987	0.9515	1	0	0

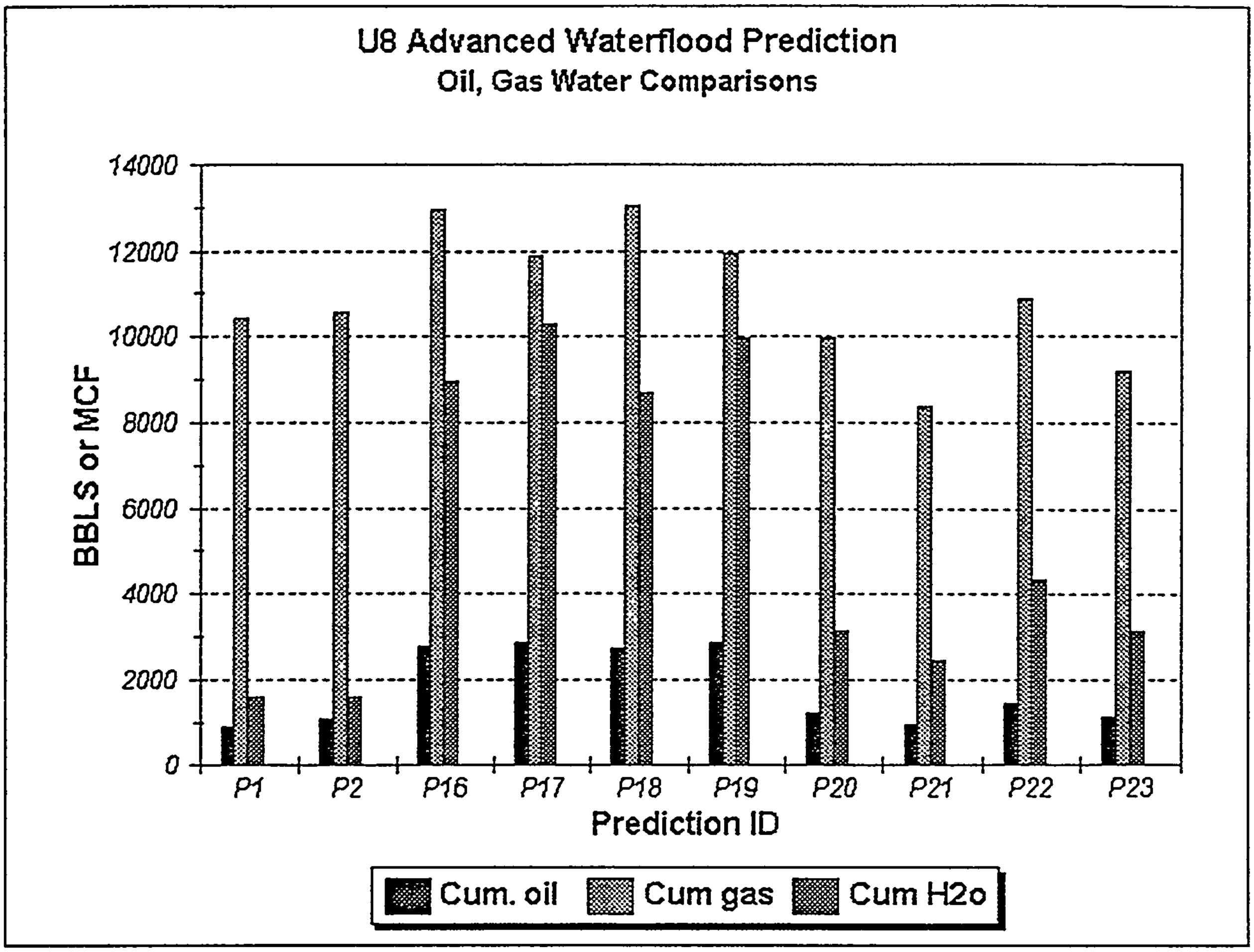


Figure 11 - Comparison of Predictive Runs

Conclusions

Prior to October 1996, the #10-20 well was producing with an 800 psi pressure drop across the gravel pack. Because the reservoir is pressure depleted, the well could not flow on gas lift without removing the damaged gravel pack. The well was also producing large quantities of water and it was believed that the water was coming from the lower perforations, or Lobe B.

Lobe A calculated low water saturations and should have been producing water free, while Lobe B calculated high water saturations on the original openhole logs. Recent TDT logs confirmed this belief by revealing a high gamma ray spike at the base of the perforations. The TDT logs did not show an increasing water saturation with time from the bottom of the sand, either. Therefore, in October, 1996 this well was worked over to remove the gravel pack, squeeze the lower perforations and return the well to production. However, after the workover, well #10-20 continued to produce high water rates. Therefore, the debate is whether the two lobes are in communication within the reservoir or if they are in communication through the wellbores only.

Recall that the previous simulation study, could not obtain a history match without putting Lobe A in communication with Lobe B within the reservoir. This has been the case for this updated, continuation study as well. A history match could not be obtained without having Lobe

A and Lobe B in communication. This explanation supports the continued high water cuts and the unsuccessful squeeze jobs.

Well #10-15 was block squeezed with 100 sacks of cement from 11,900 feet to 11,904 feet to separate the water-bearing lobes, B and C, from the hydrocarbon-bearing lobe, A. Although the block squeezed was tested successfully, the well still produced large amounts of water; water that could not be produced from the A lobe alone. This may have been caused by the block squeeze breaking down because of decreasing reservoir pressure around the 2,600 day of production. This corresponds to a large increase in the water production rate of well #10-15. It could also be because Lobes A and B are in communication within the well bore.

Also, well #A-4 produced high water rates and it is the furthest well from high water saturation in Lobe A. This well also had a cement squeeze at the Lobe B depth from 12,013 feet to 12,022 feet. It is possible that this cement squeeze broke down as well because of diminishing pressure, but it is also possible that Lobes A and B are in communication within the reservoir.

The updated history match supports the theory that Lobe A and Lobe B are in communication within the reservoir. To summarize:

- Evidence still indicates that layers A and B of the U-8 Sand are in communication.
- The relative permeabilities were modified, based on new and updated information, to enable a history match to be obtained.
- Based on the predictive designs for water injection (1,700 STB/D), the best possible production scenario is in area A and the best possible injection area is in area H.
- Any major increase in the water injection rate above 1700 BWPD does not greatly improve the recovery and therefore is not economically justified.
- The horizontal well injection scheme for area H recovered 3.2 times more oil than a background contnuing production scheme. However, the vertical well injection scheme for Area H recovered 3.15 times more oil. Therefore, a horizontal injector is not economically justified.

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WEST DELTA BLOCK 84 OFFSHORE, PLAQUEMINES PARISH, LOUISIANA
KE-KF-1 RESERVOIR CHARACTERIZATION

by W. Clay Kimbrell, *Louisiana State University*

Introduction

This report presents the information gained from a characterization of a representative reservoir where an advanced waterflood project has been performed. The reservoir, KEKF-1, is located in West Delta Block 84 Field. West Delta Block 84 Field is located off the coast of Plaquemines Parish, Louisiana, near the mouth of the Mississippi River as shown in Figure 1. The field was discovered by Conoco in 1955. It was operated by Conoco until September, 1988 when S. Parish Oil Co. bought out Conoco's interest and took over operations. S. Parish Oil Co. resumed operations in the field for approximately one year when the lease was allowed to lapse. The field is presently being operated by West Delta Oil Co., which is in the process of re-working several wells to re-establish production. To date, however, the field is still shut-in. It is estimated that the total field originally contained 23.6 MMSTB of oil and 57.9 BCF of gas, from known productive sands. The field has produced 9.8 MMSTB of oil and 21 BCF of natural gas.

This report will attempt to describe and characterize the KEKF-1 reservoir, which underwent a waterflood project during the 1970's, in order to define potential proven remaining oil and gas reserves which may be recovered with minimal work and expense. It is a very good example of a reservoir which has undergone an expensive poorly designed waterflood which resulted in the loss of a large quantity of recoverable oil.

Available Data

The majority of the data was obtained from the Louisiana Department of Natural Resources (DNR) and the current and past operators. Data which was retrieved and included within this report are as follows;

- Production data - reported on a unit basis (several wells and reservoirs may be included in one report). Information includes oil and gas production for the unit.
- Individual well tests - taken approximately every quarter. Information includes daily production rates, gravities, flowing tubing pressures and sometimes shut-in tubing pressures and bottom hole pressures.
- Well histories - Information includes perforated intervals, directional surveys, casing programs, initial tests and other miscellaneous information.
- Electric well logs (primarily 1" scale)
- Various reports filed in regards to the KF-1 reservoir waterflood - Information included various information and maps on the KF-1 reservoir characteristics. Reports refer to the KF-1 reservoir, however, communication is believed to exist between the KF and KE sands at this particular locale and was treated as such. All future reference will be made to the KE-KF-1 reservoir.

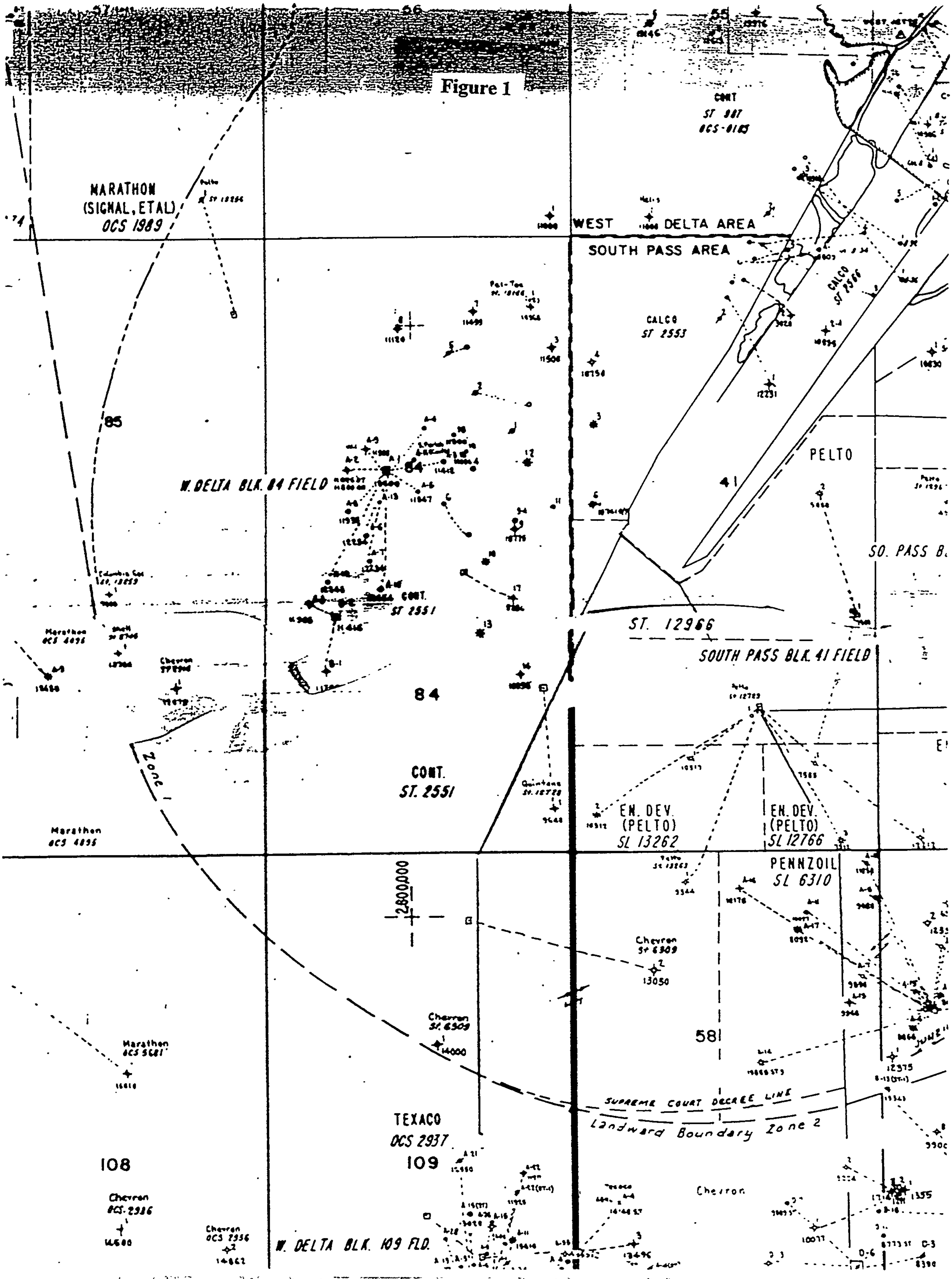

MARATHON
(SIGNAL, ETAL)
OCS 1989
WEST DELTA AREA
SOUTH PASS AREA
CONT
ST 987
OCS-0185
CALCO
ST 2553
CALCO
ST 2566
85
W. DELTA BLK. 84 FIELD
CONT.
ST 2551
84
41
PELTO
SO. PASS B
ST. 12966
SOUTH PASS BLK. 41 FIELD
Marathon
OCS 4896
Chevron
CONT.
ST. 2551
Zone 1
EN. DEV.
(PELTO)
SL 13262
EN. DEV.
(PELTO)
SL 12766
Marathon
OCS 4895
PENNZOIL
SL 6310
2800000
Chevron
St 6309
13050
Chevron
St. 6309
14000
58
Marathon
OCS 5681
SUPREME COURT DECREE LINE
Landward Boundary Zone 2
TEXACO
OCS 2937
108
109
Chevron
OCS 2936
Chevron
OCS 2936
W. DELTA BLK. 109 FLD.
Chevron

Figure 1

For ease in discussion, the aforementioned data will be taken as accurate except as noted. Production information was manipulated in order to obtain an idea of the performance of individual reservoirs and wells. As much as a 40% error between the actual well production and the estimated well production from manipulation is possible when performing these manipulations. However, there was a fair amount of control and accurate test data for this case and so the error is believed to be at lease within +/- 15%. In any case, these values should be viewed with caution and used in more of a qualitative manner rather than quantitative.

General Field Overview

The field contains four productive sands, which produce from 8 individual reservoirs containing a total 30 completions. Two of the sands in the area of the subject reservoir, the KE and KF, have been grouped together because they are considered to be in communication. There also exists numerous sands above and below these four known producing sands which have never been fully evaluated, leaving a large amount of upside potential to this acreage. The four sands from shallowest to deepest (7700' to 11900') and their separate reservoirs are as follows:

- GR sand - GR reservoir - 5 completions
- KE-KF sand - KE-KF-1 reservoir - 12 completions
  KE-2 reservoir - 1 completion
  KE-KF-5 reservoir - 2 completions
  KE-6 reservoir - 6 completions
  KE-8 reservoir - 1 completion (was included in KE-KF-1production totals)
- KE-9 reservoir - 2 completions
- 11617 sand - 11617 reservoir - 2 completions

The reservoirs are trapped by structure, faulting and stratigraphic mechanisms. Drive mechanisms within all reservoirs consist of solution and gas cap expansion and some natural water drive. The reservoir which this report concentrates on, the KEKF-1, was waterflooded. It is not believed that the waterflooding was totally successful however, due to its design and length of flood. Data taken obtained for the KEKF-1 reservoir, are as follows:

- porosity is 30%,
- avg permeability is 600 md. (with a range of 1700 md to 10 md),
- avg initial water saturation 24.4%,
- avg API gravity is 36.1
- avg viscosity of the oil is 1.596 at 206 degrees F (average reservoir temperature),
- avg bubble point pressure is 5950 psi,
- avg initial solution GOR at bubble point is 1200 SCF/STB

Reservoir Description

The KEKF-1 reservoir is limited on its north by a east-west trending normal fault, which dips to the south. It is bound on its east by a shale out. It is bound on its south by a partial sealing fault and a shale out. It is bound on its west by an original oil-water contact of 11,136 feet below sea level. It dips at approximately 6 degrees to the west and strikes north-south. The net effective sand thickness averages approximately 30 feet with a high of 66 feet penetrated in the #A3 well. A structural-stratigraphic map of the KEKF-1 reservoir is depicted in Figure 2 and a type log, the #A-3 well, is shown in Figure 3.

Volumetrics and original Oil and Gas in Place - KEKF-1 Reservoir

Oil-water and gas-oil contacts were estimations based on all available data. There was not sufficient core and other data for exact placement of these depths in all cases. The contacts for the KEKF-1, KE-2 and KE-5 reservoirs were all taken from an old operator map obtained from DNR records. All other contacts are estimates only based on the performance of individual wells. Both the operator map and maps constructed from data are found at the end of this report. Acre-feet of bulk reservoir volume was obtained by planimeter and use of *Simpson's rule* as follows:

$$Vb = 10/3 * (Ao + 4(A1) + 2(A2) + 4(A3) +.....+ 4(An-1) + An) + Havgcap(An)$$

where Vb is in acre-feet

Original oil in place was calculated by

$$N = (Vbo * 7758 * Porosity * (1 - Sw))/Boi$$

where N is in Stock tank barrels (STB) at standard conditions 14.7 psi and 60 degrees F

Original gas in place was calculated by

$$G = Vbg * 1539.846 * Pri/(z*Tf) + (N*Rsi)$$

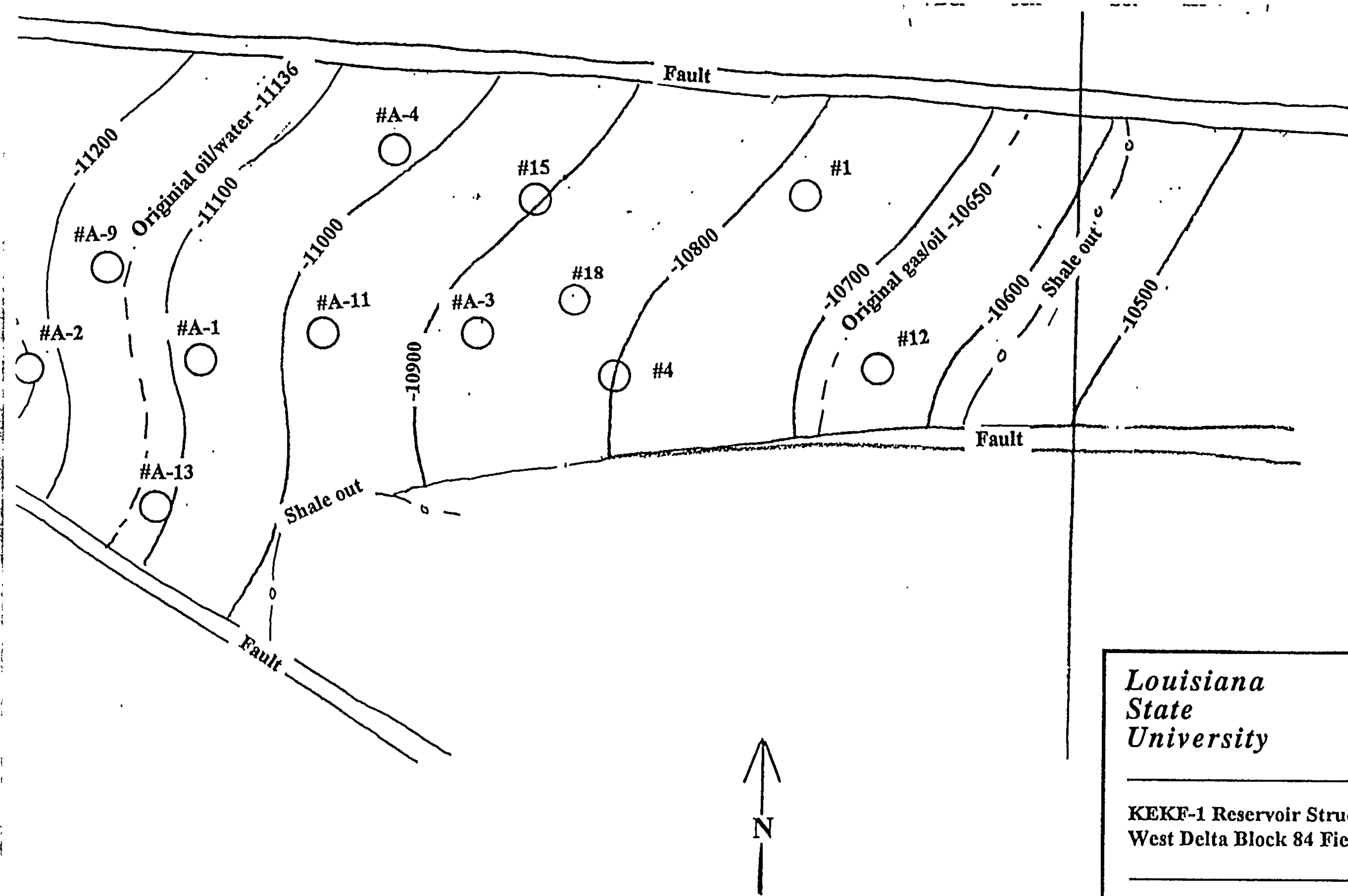
where G is in MCF of gas at standard conditions
*Vbg * 1539.846 * Pri/(z*Tf) is free gas (gas cap) volume and*
*N*Rsi is solution gas volume*

Original oil in place is as follows:

KEKF-1 reservoir - 9.6 MMSTB or 1005 STB/ac-ft

Original gas in place is as follows:

KEKF-1 reservoir - 23.6 BCF (assuming an original gas-cap)



Louisiana State University

Department of Petroleum Engineering

KEKF-1 Reservoir Structure-Stratigraphic Map
West Delta Block 84 Field, Louisiana

Geology by: W. Clay Kimbrell

August 12, 1996

0' 1000' 2000'
Scale in Feet

Figure 2

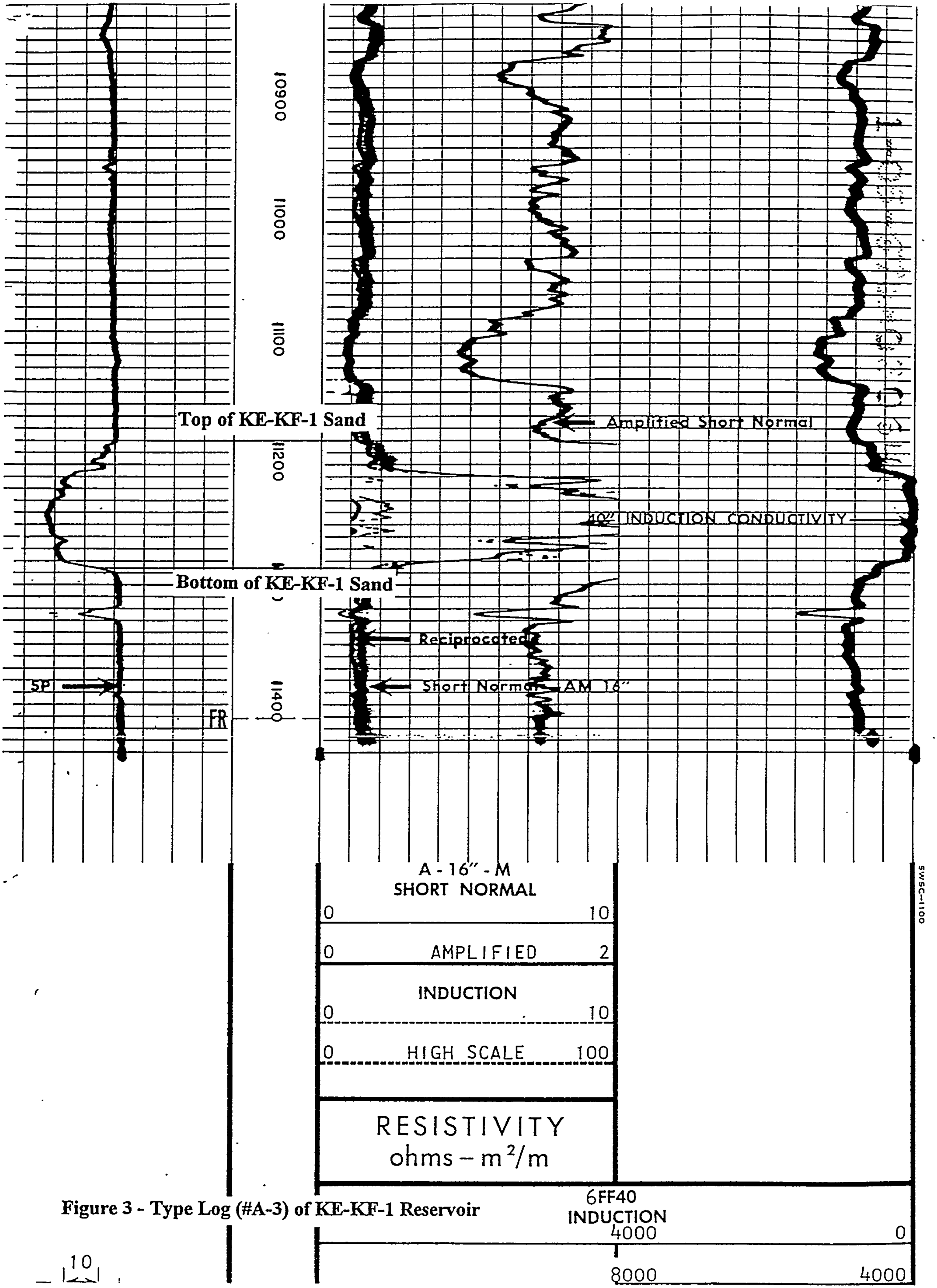


Figure 3 - Type Log (#A-3) of KE-KF-1 Reservoir

Well Completions and Production

The KE-KF-1 reservoir has produced from the following wells:

- SL 2551 #1 serial # 55866
- SL 2551 #A1 serial # 112378
- SL 2551 #A3 serial # 117925
- SL 2551 #4 serial # 62347
- SL 2551 #12 serial #86079
- SL 2551 #15 serial #108695
- SL 2551 #A1D serial #117237
- SL 2551 #A4 serial #118328
- SL 2551 #A5 serial #118869
- SL 2551 #A11 serial #121874
- SL 2551 #A13 serial #122936
- SL 2551 #18 serial #167657
- SL 2551 #A8D serial #120630 (believed to be in separate reservoir)

Perforations and completion dates are shown in Table 1. Last tests for each of these wells are shown in Table 2. Corrected historical production for the overall reservoir is illustrated in graph form in Figure 4.

Estimated total production from this reservoir is 4.6 MMSTB of oil and 9.7 BCF of gas. This is 48% recovery of the in-place oil and 41% of the in-place gas. An efficient waterflood should recover at least 60% of the in-place oil and in some cases higher. This leaves 12% of the oil in place which should still be recoverable. In addition, because there is a known gas cap as well as dissolved gas associated with this reservoir, gas recovery should be near 60% also. Therefore, remaining *proved developed* reserves are estimated to be **1.2 MMSTB of oil and 4.5 BCF of gas from this reservoir.**

Conclusions

The waterflood was targeting the KF-1 sand, not the KE-1 sand. It is believed that the operator at the time of the waterflood believed these two sands not to be in communication. Because of this, it is believed that the waterflood was inefficient and poorly designed. If the possibility of communication between the KE and KF sands had been considered, the waterflood may have been more efficient. The oil cut% vs cumulative oil production graphs for the #18 and #15 wells illustrated in Figures 5 and 6. There is no real evidence of water response in these wells. This would support the theory that no water from the downdip injection had reached these wells, much less swept the area around them.

Please refer to Table 2 once again. The last test on the #15 well on 6/87 was 98 BOPD, 806 SCF/STB, 225 psi FTP and 60% BS&W. After that, there is no additional production from this well and no explanation as to why. The last test on the #18 well on 2/90 is 350 BOPD, 110 psi FTP, and 40% BS&W. The last test on the well when Conoco operated was 319 BOPD. That's a total of 417 BOPD from these two wells alone. Assuming success from other additional

TABLE

VEST DELTA BLOCK 84
LL LIST - KE-KF-1

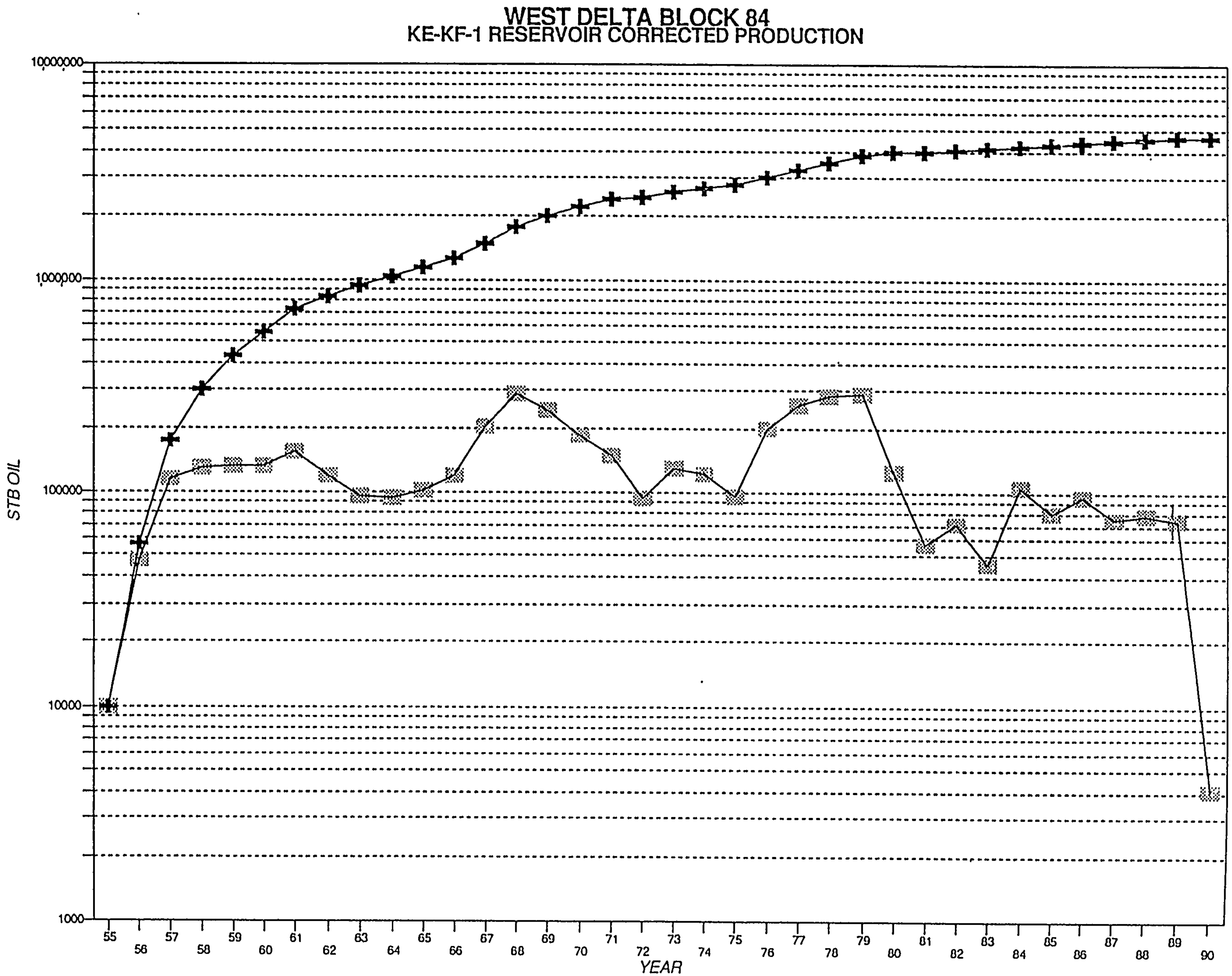
VELL	SERIAL #	INITIAL COMPLETION DATE	SAND	PERFS
L2551 #1	55866	6/55	KE-KF-1	10857-864
2551 #15	108695	5/65	KE-KF-1	10960-986
L2551 #A1	112378	10/66	KE-KF-1	11173-178
L2551 #A1C	117237	10/66	KE-KF-1	11123-133
2551 #A3	117925	1/67	KE-KF-1	11264-269, 11227-32
L2551 #A4	118328	2/67	KE-KF-1	11360-374
L2551 #A5	118869	3/67	KE-KF-1	11147-156
'2551 #A8C	120630	7/67	KE-KF-1	11324-30
2551 #A11	121874	11/67	KE-KF-1	11182-273
L2551 #A13	122936	2/68	KE-KF-1	11422-61
L2551 #18	167657	7/80	KE-KF-1	10941-964
2551 #4	62347	12/56	KE-KF-1	10913-35

TABLE 2

WEST DELTA BLOCK 84
LAST WELL TEST - KE-KF-1

WELL	SERIAL #	STATUS	DATE	SAND	PERFS	TEST DATA BOPD	CHOKE	BS&W%	GOR	FTP	CP	API	PM	REASON OFF
L2551 #1	55866	P&A	9/64	KE-KF-1	10857-86	166	10	3	4175	1950	PKR	38.8	F	SANDED UP
L2551 #15	108695	SI	6/87	KE-KF-1	10960-98	98	128	60	806	225		34.6	GL	?
L2551 #A1	112378	SI	5/70	KE-KF-1	11173-17.	231	15	12	182	600	PKR	35	F	ATTEMPTED TO PERF. UPPER LOBE IN 1973; UNSUCCESSFUL?; POSSIBLE REPERF?
L2551 #A1D	117237	SI	11/66	KE-KF-1	11123-13	53	11	6	838	315	PKR	37.3	F	LEFT KE PERFS OPEN(FELT TO BE UNPRODUCTIVE)
L2551 #A3	117925	SI	6/81	KE-KF-1	11264-26	2	64	99	4105	0		35.1	GL	?; SANDED UP OR WATER CONE?
			4/81	KE-KF-1	11264-26	2	64	93	950	0		35.1	GL	
			2/81	KE-KF-1	11264-26	64	64	80	950	250		35.1	GL	
			?	KE-KF-1	11227-32									
L2551 #A4	118328	SI	2/90	KE-KF-1	11360-37	45	OPEN	50	0	110		34.1	GL	VOORHIES STATES WELL DOWN FOR LONG TIME; TEST INCORRECT
L2551 #A5	118869	SI	3/67	KE-KF-1	11147-15	102	10	0	592	450		36	F	NEVER PRODUCED; CONVERTED TO WATER SOURCE
L2551 #A8D	120630	SI	9/69	KE-KF-1	11357-63	74	7	46	552	850		33.1		?; REPERFED UPPER 12/71
			12/71	KE-KF-1	11324-30									SHUT-IN; LOOKS GOOD ON LOG, BUT NO TEST DATA; NO PROD.
L2551 #A11	121874	SI	12/82	KE-KF-1	11182-27	30	64	90	1450	250		30.1		DOWNDIP IN KF, LOW PROD.?
L2551 #A13	122936	SI		KE-KF-1	11422-61									WATER INJ. WELL
L2551 #18	167657	SI	2/90	KE-KF-1	10941-96	350	54	65	0	110		32	GL	STILL ACTIVE; PARISH REPORT, BOGUS?
			10/88	KE-KF-1	10941-96	271	442	40	62	300		35.5	GL	COMPARISON CONOCO REPORT
L2551 #4	62347	SI	3/79	KE-KF-1	10913-25	40	12	6	10400	1250		52.7		HIGH GOR?

Figure 4


WEST DELTA BLOCK 84
KE-KF-1 RESERVOIR CORRECTED PRODUCTION
10000000
1000000
100000
10000
1000
STB OIL
55
56
57
58
59
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61
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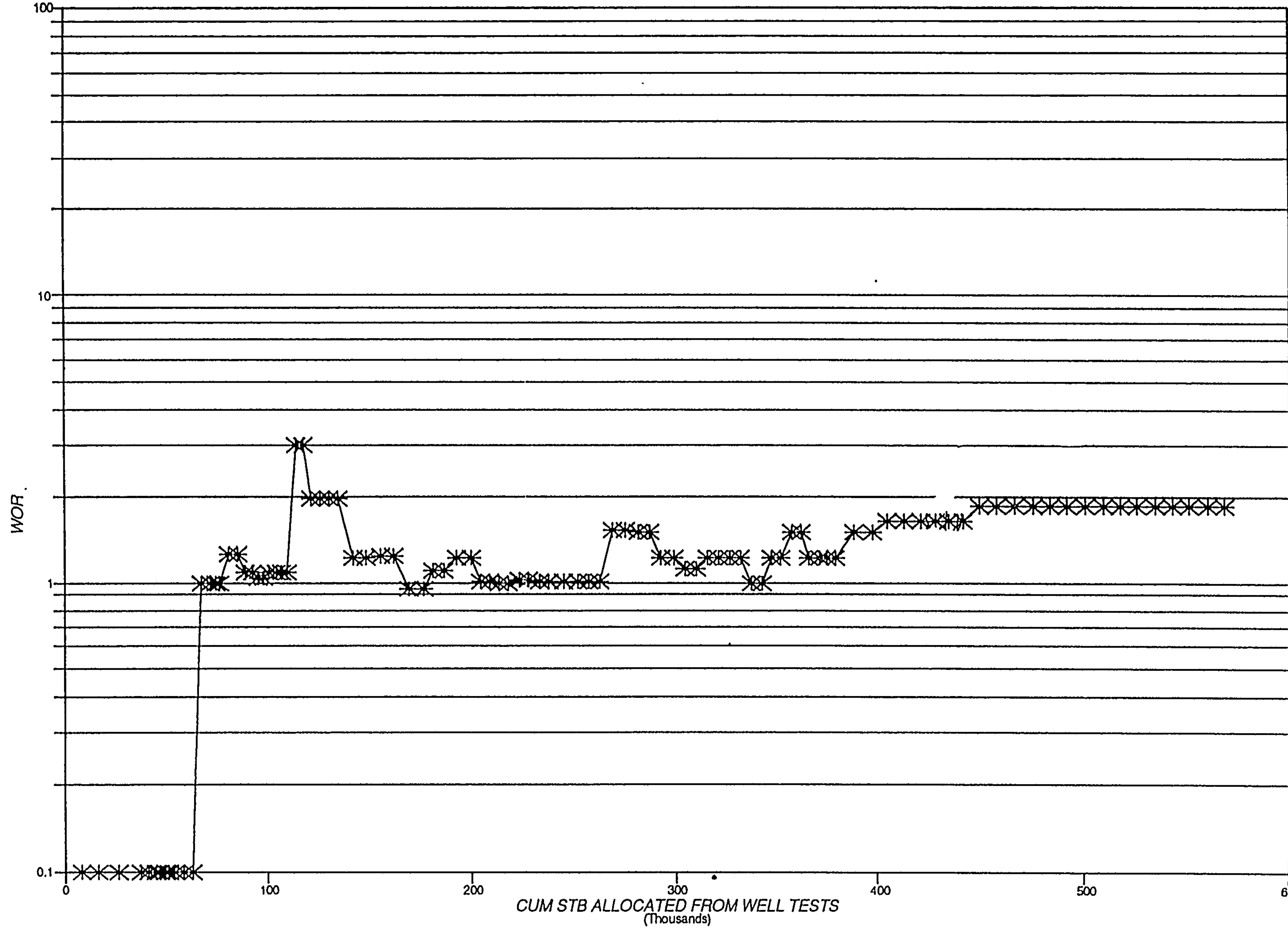
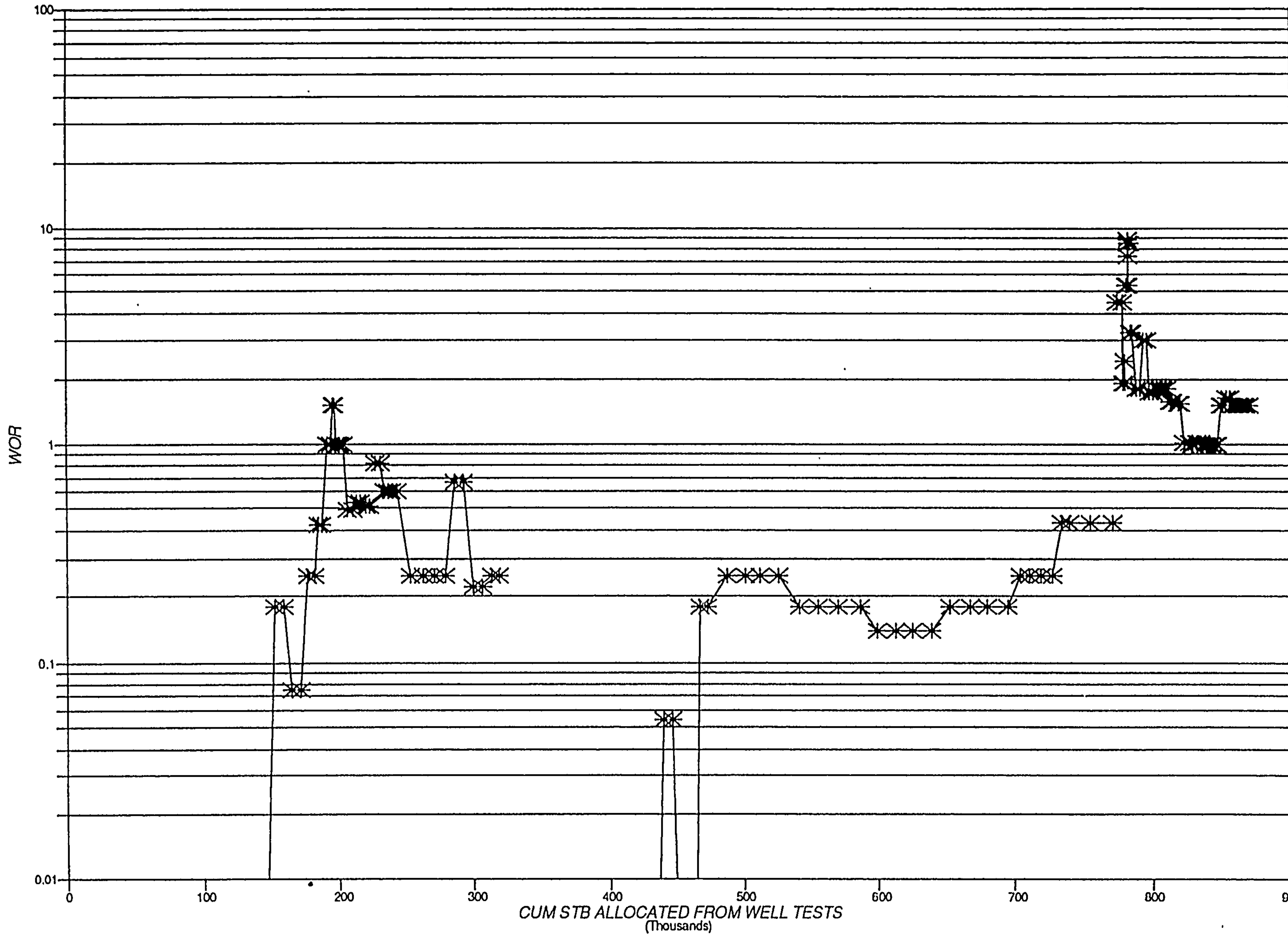
89
90
YEAR

WEST DELTA BLOCK 84
WOR VS. CUM OIL - SL#18 SN 167657





100
10
1
0.1
0.01
WOR
0
100
200
300
400
500
600
700
800
900
CUM STB ALLOCATED FROM WELL TESTS
(Thousands)

workovers on the #A-3, #4, #A4 and #12 a conservative daily production rate of over **600 BOPD and 1.3 MMCFD** of gas could be realized. At a **20% decline and a 15 year life, an additional 1.2 MMSTB of oil and 4.5 BCF of gas** of *proved developed reserves* could be recovered from this reservoir.

References

Craft B.C. and Hawkins M.F., Applied Petroleum Reservoir Engineering, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1959.