SUN EXPLORATION AND PRODUCTION COMPANY
EXHIBITS
MANCOS POOL RESERVOIR SIMULATION STUDY
MARCH 30, 1987

MANCOS POOL

Reservoir Simulation Study

MODEL PROGRAM SOFTWARE

VIP (Vectorized Implicit Program)

° Developed by J. S. Nolen and Associates
   Houston, Texas

° Three dimensional, three-phase (oil, gas, water)

° Black oil; oil and gas properties described by input
   FVF, viscosity, and solution gas-oil ratio

° Accounts for gravity, viscous, and capillary forces
   Uses mathmatical equations for fluid flow common
   to all modern reservoir simulation programs

° Results compared against other industry products in
   Society of Petroleum Engineers comparitive test,
   (Journal of Petroleum Technology, March 1986)

° Used by other major oil companies including Conoco,
   Phillips, Standard Oil, and Unocal

SUN EXPLORATION AND PRODUCTION COMPANY'S EXPERIENCE

° Extensively tested and benchmarked program against
   other publicly available software

° Has been used to model numerous reservoirs of various
   types since acquisition in 1983

Exhibit 1

MANCOS POOL

Reservoir Simulation Study

ASSUMPTIONS

RESERVOIR CONDITIONS AND PROPERTIES

- ° Initial Pressure   1534 psia   @ +370'
- ° Initial Saturation Pressure   1534 psia   (C.O.U. L-11)
- ° Temperature   162° F
- ° Porosity   1.0%±
- ° Net Pay   2-30' Zones   (1 zone Modeled)
- ° Initial Water Saturation   10%
- ° Irreducible Water Saturation   10%
- ° Residual Oil Saturation   10%
- ° Critical Gas Saturation   1.0%
- ° OOIP   3000 STB/acre   (BMG Calculation, Others)
- ° Rock Compressibility 10×10^{-6} 1/psi
                                        (Gavilan Tech. Comm., Mobil Lindrith B Unit #38)
- ° Relative Permeability   See Exhibit 3
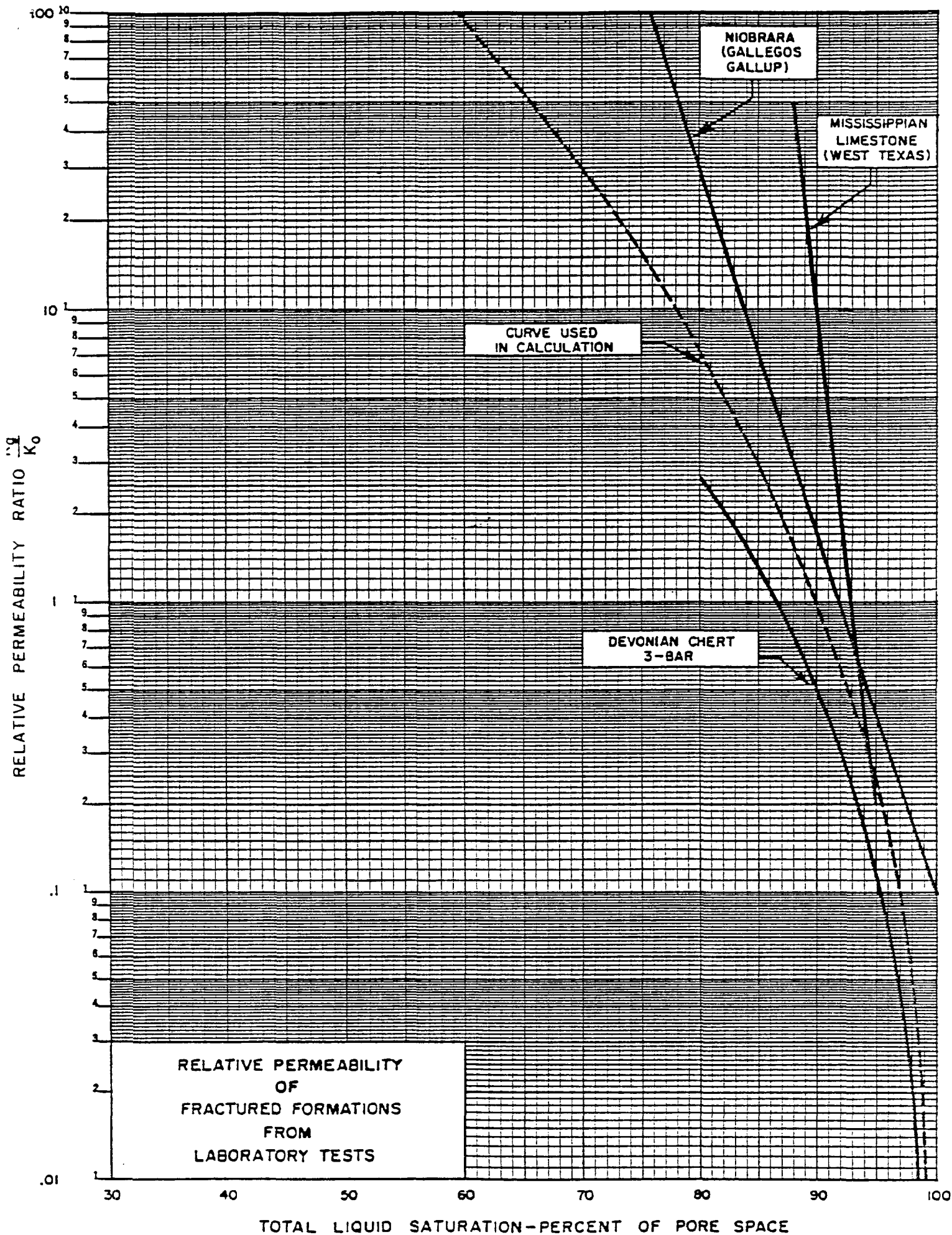- ° Permeability   10 Darcy-Feet (BMG, Sun Calculations)

FLUID PROPERTIES

Oil

- ° Obtained from C.O.U. L-11)   See Exhibit 4
- ° Initial Saturation Pressure   1534 psia
- ° Initial FVF   1.297
- ° Initial Solution Gas-Oil Ratio   478 SCF/STB

Water

- ° Density   1.021 gm/cc
- ° FVF   1.021
- ° Viscosity   0.44 CP
- ° Compressiblity 3.2×10^{-6} 1/psi

Exhibit 2

RELATIVE PERMEABILITY RATIO $\frac{Kg}{Ko}$

TOTAL LIQUID SATURATION—PERCENT OF PORE SPACE

NIOBRARA
(GALLEGOS
GALLUP)

MISSISSIPPIAN
LIMESTONE
(WEST TEXAS)

CURVE USED
IN CALCULATION

DEVONIAN CHERT
3-BAR

RELATIVE PERMEABILITY
OF
FRACTURED FORMATIONS
FROM
LABORATORY TESTS

Exhibit 3

July 27, 1965

Benson-Montin-Greer Drilling Corporation
158 Petroleum Center Building
Farmington, New Mexico

Attention: Mr. Albert R. Greer

<div align="center">

Subject: Reservoir Fluid Study
Bolack-Greer Inc.
Canada Ojitos Unit No. 12-11 Well
Puerto Chiquito Field
Rio Arriba County, New Mexico
Our File Number: RFL 3366

</div>

Gentlemen:

Subsurface fluid samples were collected from the subject well by a representative of Core Laboratories, Inc. and were delivered to our laboratory in Dallas for use in a reservoir fluid study. The results of this study are presented on the following pages.

The saturation pressure of the fluid was found to be 1519 psig at the reservoir temperature of 162° F. The associated formation volume factor was found to be 1.297 barrels of saturated fluid per barrel of residual oil. By differential pressure depletion the fluid evolved 478 standard cubic feet of gas per barrel of residual oil. Under similar depletion conditions the viscosity increased from a minimum of 0.625 centipoise at the saturation pressure to a maximum of 1.704 centipoises at atmospheric pressure. The saturation pressure of the fluid was measured at several different temperatures as you requested.

It has been a pleasure to perform this study for you. If you have any questions or if we may assist you further in any way, please do not hesitate to contact us.

<div align="center">

Very truly yours,

Core Laboratories, Inc.
Reservoir Fluid Division

P. L. Moses (JB)

P. L. Moses
Operations Supervisor

</div>

PLM:JB:bjm
7 cc. - Addressee

Exhibit 4

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS. TEXAS

Company Benson-Montin-Greer Drilling Corporation   Date Sampled   July 1, 1965

Well   Canada Ojitos Unit No. 12-11   County   Rio Arriba

Field   Puerto Chiquito   State   New Mexico

FORMATION CHARACTERISTICS

Formation Name	Nio Braro (Gallup)
Date First Well Completed	October , 19 62
Original Reservoir Pressure	1631 PSIG @ 5957 Ft.
Original Produced Gas-Oil Ratio	SCF/Bbl
Production Rate	Bbl/Day
Separator Pressure and Temperature	PSIG, °F.
Oil Gravity at 60° F.	°API
Datum	Ft. Subsea
Original Gas Cap	

WELL CHARACTERISTICS

Elevation	7232 KB Ft.
Total Depth	6687 Ft.
Producing Interval	6648-6687 Ft.
Tubing Size and Depth	In. to Ft.
Productivity Index	Bbl/D/PSI @ Bbl/Day
Last Reservoir Pressure	1693 PSIG @ 6650 Ft.
Date	July 1 , 19 65
Reservoir Temperature	162 °F. @ 6650 Ft.
Status of Well	Shut in 27 days
Pressure Gauge	Amerada
Normal Production Rate	Bbl/Day
Gas-Oil Ratio	SCF/Bbl
Separator Pressure and Temperature	PSIG, °F.
Base Pressure	15.025 PSIA
Well Making Water	None % Cut

SAMPLING CONDITIONS

Sampled at	6650 KB Ft.
Status of Well	Shut in 27 days
Gas-Oil Ratio	SCF/Bbl
Separator Pressure and Temperature	PSIG, °F.
Tubing Pressure	0 PSIG
Casing Pressure	0 PSIG
Core Laboratories Engineer	NT
Type Sampler	Perco

REMARKS:

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

VOLUMETRIC DATA OF__Reservoir Fluid__SAMPLE

1. Saturation pressure (bubble-point pressure)   ___1519___ PSIG @ ___162_°F.

2. Thermal expansion of saturated oil @___5000___ PSI $= \dfrac{V\ @\ 162\ °F}{V\ @\ \ 76\ °F} =$ ____1.04528____

3. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/PSI:

           From _5000_ PSI to _3500_ PSI $=$ ___8.24×10^{-6}___

           From _3500_ PSI to _2500_ PSI $=$ ___9.49×10^{-6}___

           From _2500_ PSI to _1519_ PSI $=$ ___10.68×10^{-6}___

4. Specific volume at saturation pressure: ft^3/lb   ___0.02218___ @ _162_ °F.

5. Saturation pressure at various temperatures:

Temperature, °F.	Saturation Pressure, PSI	
	BHS No. 1	BHS No. 2
76	1203	1204
110	1351	
152	1491	1492
162	1519	1519
172	1540	

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 162 °F.. RELATIVE VOLUME OF OIL AND GAS, V/Vsat.	VISCOSITY OF OIL @ 162°F.. CENTIPOISES	DIFFERENTIAL LIBERATION @ 162 °F.		
			GAS/OIL RATIO LIBERATED PER BARREL OF RESIDUAL OIL	GAS/OIL RATIO IN SOLUTION PER BARREL OF RESIDUAL OIL	RELATIVE OIL VOLUME. V/Vr
5000	0.9680	0.841			1.256
4500	0.9718				1.260
4000	0.9759	0.781			1.266
3500	0.9801	0.751			1.271
3000	0.9847	0.719			1.277
2500	0.9895	0.686			1.283
2300	0.9916				1.286
2100	0.9936				1.289
2000	0.9947	0.652			1.290
1900	0.9957				1.291
1800	0.9968				1.293
1700	0.9981				1.294
1600	0.9991				1.296
1519	1.0000	0.625	0	478	1.297
1508	1.0028				
1498	1.0054				
1481	1.0101				
1457	1.0162				
1429	1.0254				
1389			32	446	1.284
1369	1.0458				
1350		0.684			
1288	1.0766				
1259			65	413	1.270
1250		0.696			
1196	1.1174				
1129			96	382	1.257
1100		0.731			
1084	1.1789				
968	1.2610				
963			136	342	1.239
950		0.780			
858	1.3638				
812			173	305	1.224

v = Volume at given pressure

Vsat. = Volume at saturation pressure and the specified temperature.

Vr = Residual oil volume at 14.7 PSI absolute and 60° F.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 162 °F.. RELATIVE VOLUME OF OIL AND GAS, V/Vsat.	VISCOSITY OF OIL @ 162°F.. CENTIPOISES	DIFFERENTIAL LIBERATION @ 162 °F.		
			GAS/OIL RATIO LIBERATED PER BARREL OF RESIDUAL OIL	GAS/OIL RATIO IN SOLUTION PER BARREL OF RESIDUAL OIL	RELATIVE OIL VOLUME, V/Vr
800		0.835			
750	1.4975				
658			211	267	1.207
657	1.6518				
650		0.900			
566	1.8577				
519			246	232	1.192
500		0.980			
479	2.1482				
413	2.4573				
359			287	191	1.175
350	2.8694				
298	3.3145				
250	3.8813	1.161			
218			328	150	1.156
108			367	111	1.133
0		1.704	478	0	1.049
				@ 60° F. =	1.000

Gravity of residual oil = 38.2° API @ 60° F.

v   = Volume at given pressure

Vsat. = Volume at saturation pressure and the specified temperature.

Vr   = Residual oil volume at 14.7 PSI absolute and 60° F.

CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

DALLAS. TEXAS

Differential Pressure Depletion at 162° F.

Pressure PSIG	Oil Density Gms/Cc	Gas Gravity	Deviation Factor Z
1519	0.7223		
1389	0.7258	0.696	0.882
1259	0.7298	0.698	0.887
1129	0.7336	0.701	0.894
963	0.7389	0.709	0.902
812	0.7438	0.718	0.914
658	0.7487	0.731	0.929
519	0.7534	0.753	0.943
359	0.7589	0.791	0.958
218	0.7642	0.886	0.976
108	0.7716	1.067	
0	0.7939	1.702	

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

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File RFL 3366

Well Canada Ojitos Unit
No. 12-11

SEPARATOR TESTS OF Reservoir Fluid SAMPLE

SEPARATOR PRESSURE, PSI GAUGE	SEPARATOR TEMPERATURE, ° F.	SEPARATOR GAS/OIL RATIO See Foot Note (1)	STOCK TANK GAS/OIL RATIO See Foot Note (1)	STOCK TANK GRAVITY, ° API @ 60° F.	SHRINKAGE FACTOR, VR/VSAT. See Foot Note (2)	FORMATION VOLUME FACTOR, VSAT./VR See Foot Note (3)	SPECIFIC GRAVITY OF FLASHED GAS
0	74	483		38.1	0.7639	1.309	0.986
40	74	386	27	39.6	0.7943	1.259	
80	74	354	55	39.6	0.7968	1.255	
160	74	300	110	39.4	0.7943	1.259	

(1) Separator and Stock Tank Gas/Oil Ratio in cubic feet of gas @ 60° F. and 14.7 PSI absolute per barrel of stock tank oil @ 60° F.

(2) Shrinkage Factor: $V_R/V_{SAT.}$ is barrels of stock tank oil @ 60° F. per barrel of saturated oil @ 1519 PSI gauge and 162 ° F.

(3) Formation Volume Factor: $V_{SAT.}/V_R$ is barrels of saturated oil @ 1519 PSI gauge and 162 ° F. per barrel of stock tank oil @ 60° F.

Company__Benson-Montin-Greer Drilling Corporation__   Formation__Nio Braro (Gallup)__

Well____Canada Ojitos Unit No. 12-11_____   County____Rio Arriba__

Field____Puerto Chiquito_____   State_____New Mexico__

HYDROCARBON ANALYSIS OF__Reservoir Fluid__SAMPLE

COMPONENT	MOL PER CENT	WEIGHT PER CENT	DENSITY @ 60° F. GRAMS PER CUBIC CENTIMETER	° API @ 60° F.	MOLECULAR WEIGHT
Hydrogen Sulfide					
Carbon Dioxide	0.20	0.08			
Nitrogen	0.13	0.03			
Methane	26.36	3.65			
Ethane	6.86	1.78			
Propane	6.19	2.36			
iso-Butane	1.20	0.60			
n-Butane	4.29	2.15			
iso-Pentane	1.80	1.12			
n-Pentane	2.14	1.33			
Hexanes	4.49	3.34			
Heptanes plus	46.34	83.56	0.8474	35.3	209
	100.00	100.00			

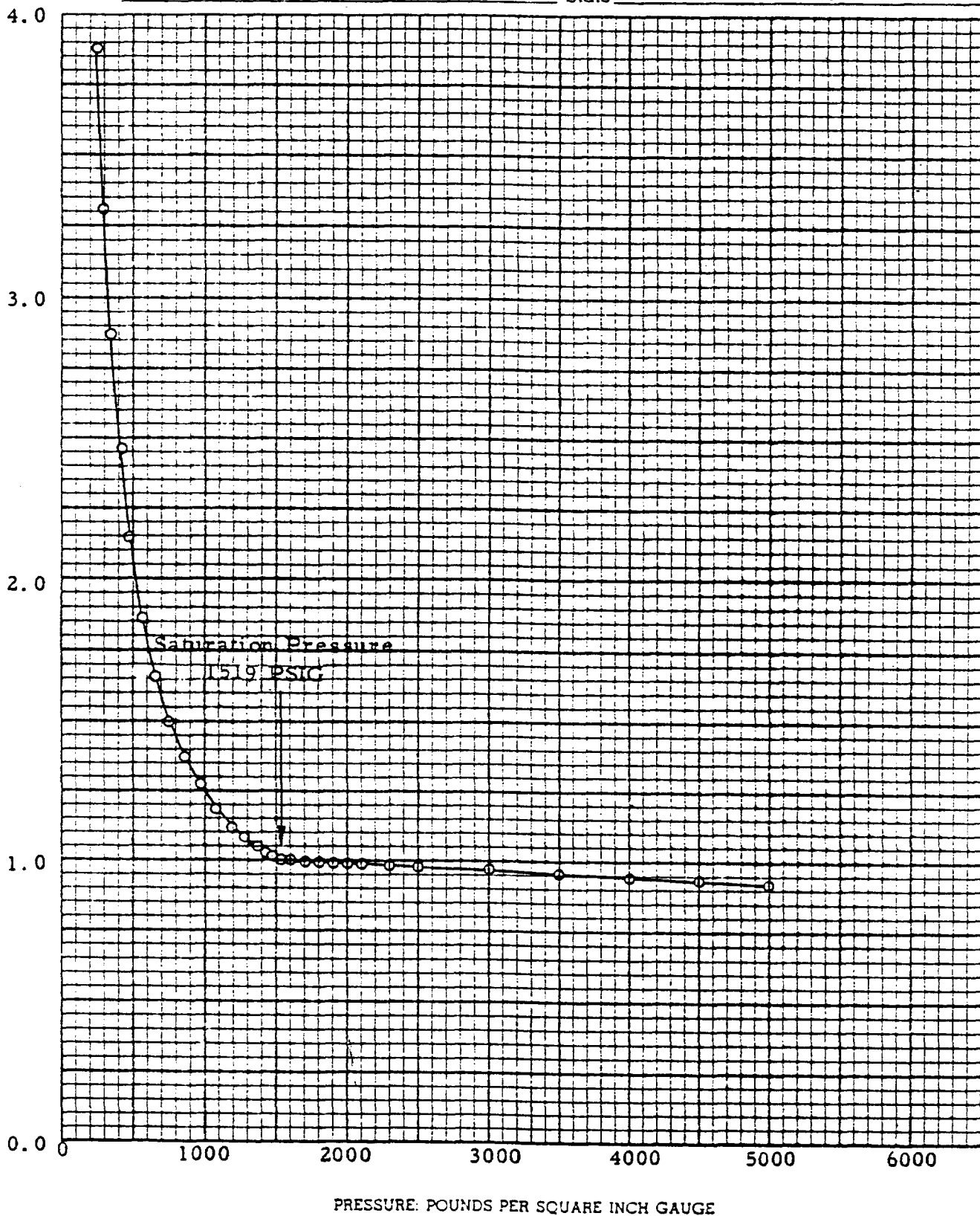Core Laboratories, Inc.
Reservoir Fluid Division

P. L. Moses (R)

P. L. Moses
Operations Supervisor

PRESSURE-VOLUME RELATIONS OF RESERVOIR FLUID

Benson-Montin-Greer

Company __Drilling Corporation__   Formation __Nio Braro (Gallup)__

Well __Canada Ojitos Unit No. 12-11__   County __Rio Arriba__

Field __Puerto Chiquito__   State __New Mexico__

Saturation Pressure
1519 PSIG

RELATIVE VOLUME: V/Vs

PRESSURE: POUNDS PER SQUARE INCH GAUGE

DIFFERENTIAL VAPORIZATION OF RESERVOIR FLUID

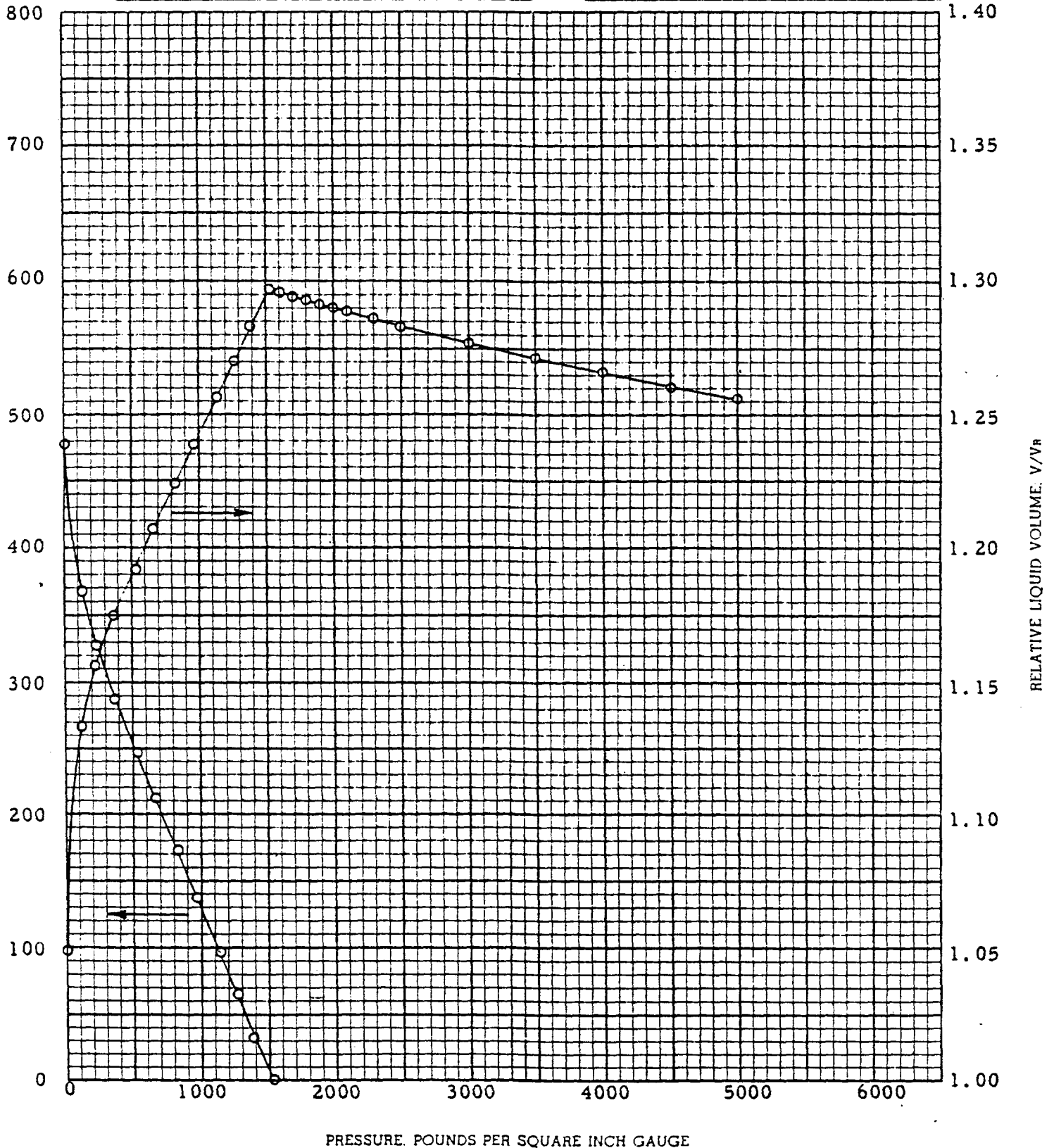|	Benson-Montin-Greer		
Company	Drilling Corporation	Formation	Nio Braro (Gallup)
Well	Canada Ojitos Unit No. 12-11	County	Rio Arriba
Field	Puerto Chiquito	State	New Mexico

PRESSURE, POUNDS PER SQUARE INCH GAUGE

RELATIVE LIQUID VOLUME, V/V$_R$

VISCOSITY OF RESERVOIR FLUID

Company __Benson-Montin-Greer Drilling Corporation__   Formation ___Nio Braro (Gallup)___

Well ___Canada Ojitos Unit No. 12-11___   County _____Rio Arriba_____

Field ___Puerto Cniquito___   State _____New Mexico_____

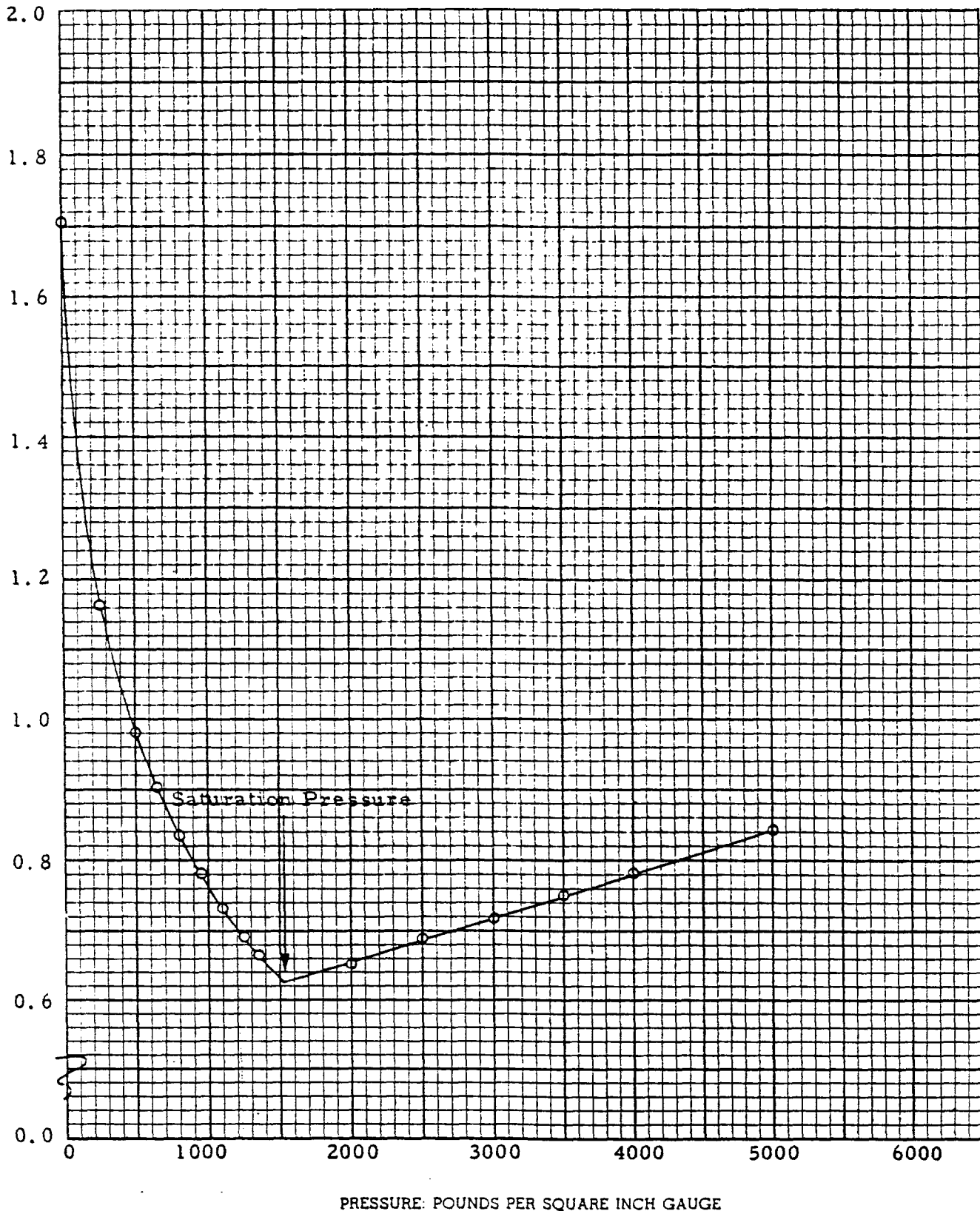VISCOSITY, CENTIPOISES

Saturation Pressure

Benson-Montin-Greer

Company __Drilling Corporation__   Formation __Nio Braro (Gallup)__

Well __Canada Ojitos Unit No. 12-11__   County __Rio Arriba__
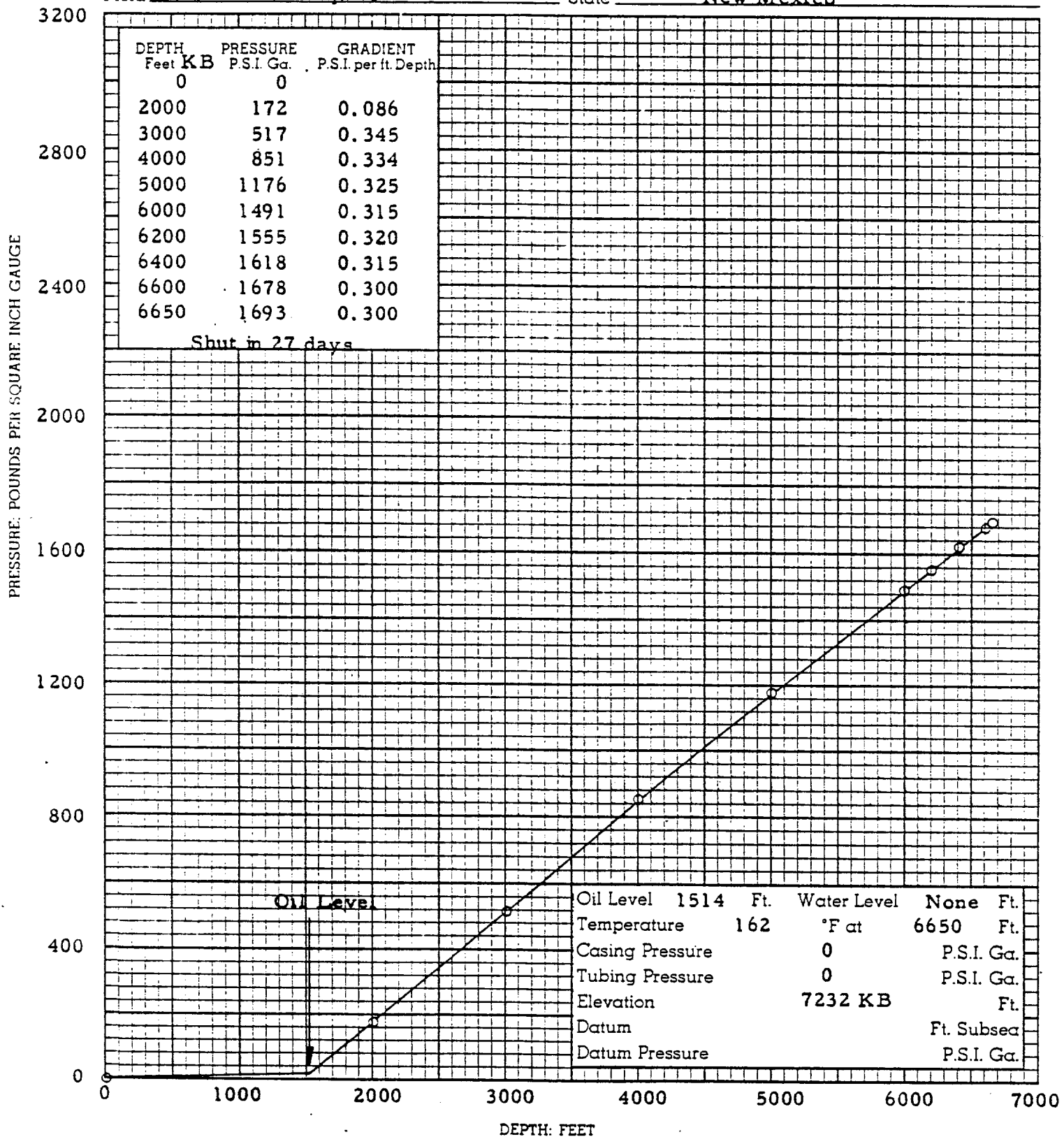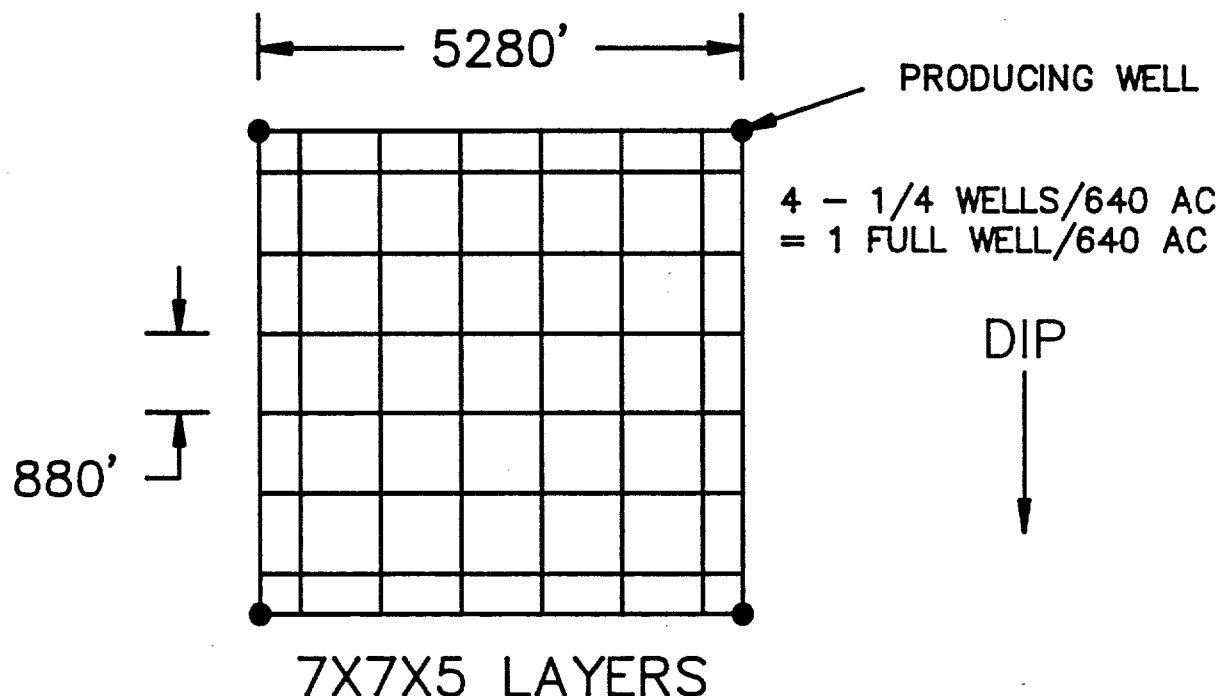
Field __Puerto Chiquito__   State __New Mexico__

DEPTH Feet KB	PRESSURE P.S.I. Ga.	GRADIENT P.S.I. per ft. Depth
0	0	
2000	172	0.086
3000	517	0.345
4000	851	0.334
5000	1176	0.325
6000	1491	0.315
6200	1555	0.320
6400	1618	0.315
6600	1678	0.300
6650	1693	0.300

Shut in 27 days

Oil Level 1514 Ft.	Water Level None Ft.
Temperature 162 °F at	6650 Ft.
Casing Pressure 0	P.S.I. Ga.
Tubing Pressure 0	P.S.I. Ga.
Elevation 7232 KB	Ft.
Datum	Ft. Subsea
Datum Pressure	P.S.I. Ga.

Oil Level

PRESSURE: POUNDS PER SQUARE INCH GAUGE

DEPTH: FEET

MANCOS POOL
RESERVOIR SIMULATION STUDY
MODEL GRID DESCRIPTION
640 ACRE SPACING SYMMETRY ELEMENT

← 5280' →

PRODUCING WELL

4 – 1/4 WELLS/640 AC
= 1 FULL WELL/640 AC

DIP

880'

7X7X5 LAYERS

320 ACRE SPACING SYMMETRY ELEMENT

← 2640' →

DIP

440'

2 – 1/4 WELLS/160 AC
= 1 FULL WELL/320 AC

7X7X5 LAYERS

EXHIBIT 5