CORRELATION OF BOTTOM HOLE SAMPLE DATA

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ABSTRACT

Laboratory data on bubble point pressures and reservoir volume factors have been correlated as functions of solution gas-oil ratio, calculated gas gravity of the pentanes-and-lighter fraction of the entire fluid, differential residual oil gravity, and reservoir temperatures.

INTRODUCTION

Several correlations of crude oil properties have appeared in the literature.

D. L. Katz[4] in 1942 presented five methods of predicting oil shrinkage, these being of decreasing accuracy for decreasing amounts of information available.

M. B. Standing[6] in 1947 published three correlations of laboratory flash vaporization data of California crudes. From values of GOR (gas-oil ratio), gas gravity, liquid gravity, and temperature, his correlations will predict bubble point pressure, formation volumes of bubble point liquids, and two-phase formation volumes.

Curtis and Brinkley[2] in 1949 presented several correlations. From the gas-oil ratio, an approximation of reservoir volume factor and barrels of condensate recoverable per barrel of reservoir space may be obtained; along with liquid gravity and reservoir temperature, the GOR will allow prediction of bubble point pressure. These last correlations seem to be more qualitative than quantitative.

Generally, laboratory bottom hole sample tests furnish information on solution gas-oil ratios, residual oil gravities, bubble point pressures, viscosities of oils, liquid shrinkages, and occasionally gas gravities. Each of these data has its own applications and use in reservoir engineering calculations. The particular uses of correlated bottom hole sample data are found in

(1) Providing a basis for obtaining estimates of formation crude properties in fields where bottom hole sampling is impractical or impossible.

(2) Greatly reducing the time in obtaining the desired information.

(3) Determining the applicability of the results from various bottom hole samples to particular field problems.

(4) Avoiding, in many cases, the uncertainties of sampling by replacing it with an element over which greater control can be exercised.

(5) Permitting use of preliminary field data in application of production procedures before a bottom hole sample can be obtained and analyzed in the laboratory.

(6) Serving as a check on data which may appear out of line.

(7) Estimating for a particular type crude the appropriate equilibrium constants by working backward from the bubble point pressure.

(8) Estimating original or other past history properties of reservoirs that were not sampled in the past.

PROCEDURE

Application of the published correlations[4,6] to Stanolind laboratory data indicated that the general scheme presented by Standing[6] could give desirable results if changes were made in parameter positions and scales. The correlation curves were drawn with all the variables having consistent gradations except the temperature increments which were drawn in to best fit the data.

The variables from available Stanolind laboratory data are defined below:

(1) Gas-oil Ratio: Gas is liberated at reservoir temperature by differential vaporization (or rather by a series of flashes, approaching differential vaporization) and measured at atmospheric pressure and temperature, at which the compressibility factor is assumed to be unity. The oil is the residual liquid remaining after the pressure has been reduced to atmospheric. For the gas-oil ratio both volumes are corrected to standard conditions of 14.7 psia and 60°F.

(2) Gas Gravity: It was decided to arbitrarily divide the hydrocarbons of the entire bottom hole sample into pentanes-and-lighter and hexanes-and-heavier, and use a calculated gas gravity of the pentanes-and-lighter for a correlating variable. (Sample calculation is shown in Table III.)

(3) Liquid Gravity: This is the API gravity of the residual liquid from the differential vaporization. The gravity is measured at room temperature and corrected to 60°F.

[1]References given at end of paper.

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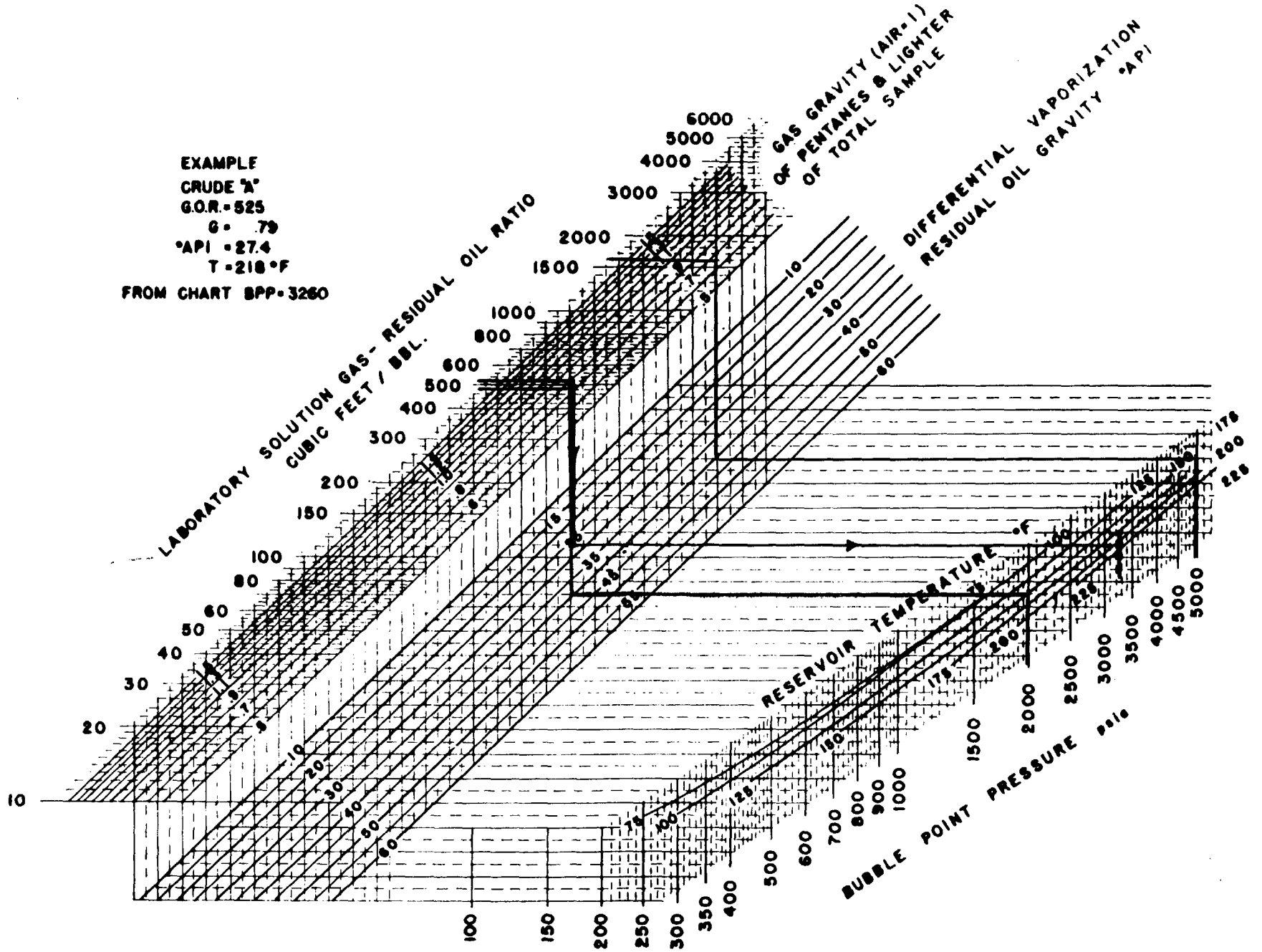


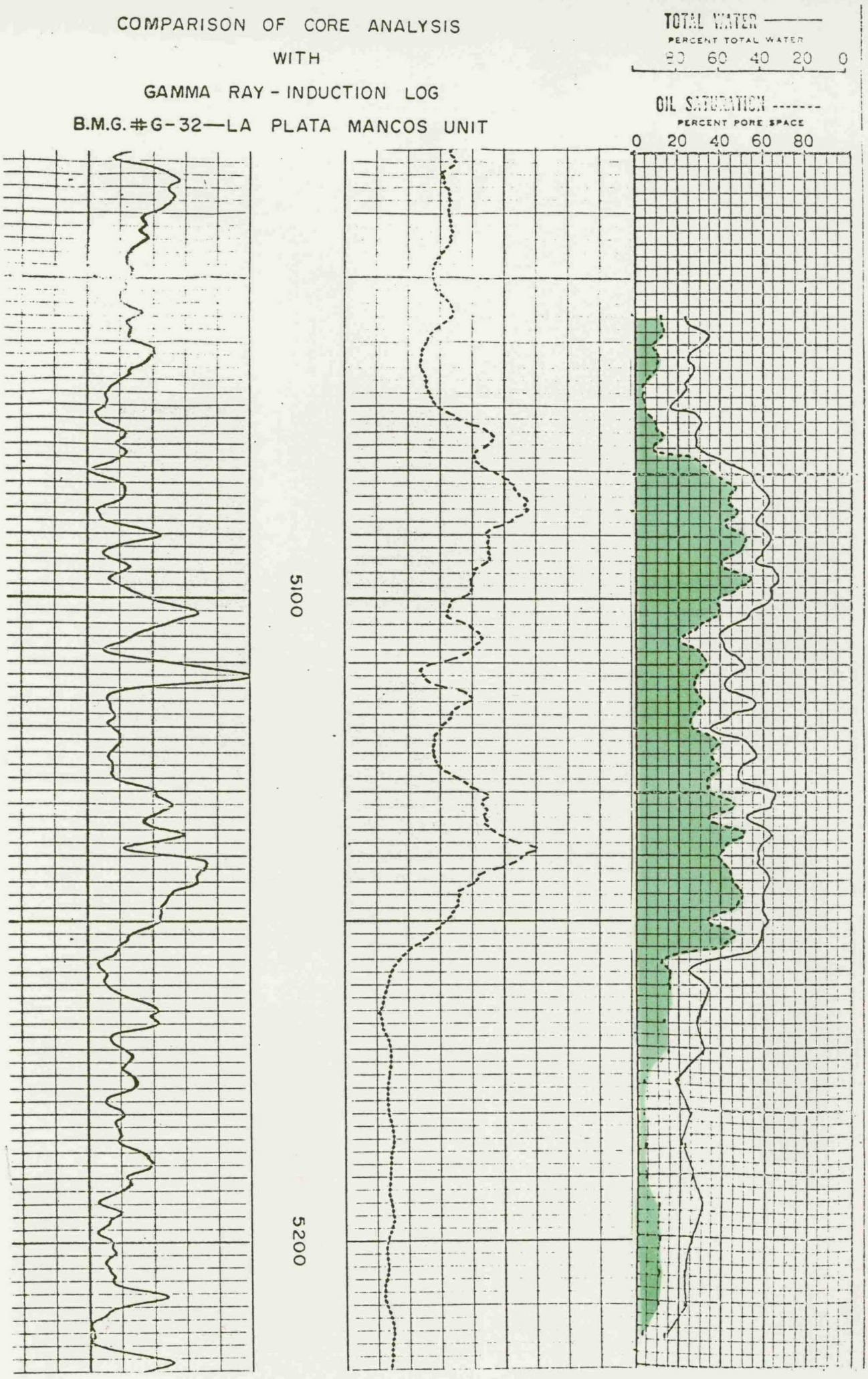
FIG. 1 — BUBBLE POINT PRESSURE CORRELATION.

COMPARISON OF CORE ANALYSIS

WITH

GAMMA RAY - INDUCTION LOG

B.M.G. #G-32—LA PLATA MANCOS UNIT



CANADA OJITOS UNIT #2 (K-13)

DRILLING HISTORY

1785' FSL, 2120' FWL, Sec. 13, Twp. 25N, Rge, 1W, Rio Arriba County, New Mexico.

7/21/62	6:00 AM	Rigging up rotary.
7/21/62	10:30 AM	Spudded in 17½" hole.
7/22/62	2:30 AM	TD 310' RKB. Set 9 joints 293' of 13-3/8" OD 48# H-40 casing at 305' RKB with 350 sacks cement, 2% calcium chloride.
7/23/62	2:30 AM	Tested casing to 500#. Tested O.K.
	6:00 AM	Drilling at 580' in sand and shale. Vis. 32, wt. 8.9. Pump pressure 1600#, 56 SPM, 6" liners.
7/24/62	6:00 AM	TD 2335' in sand and shale. Making trip for Bit #4. 1½° at 1424'. Vis. 31, wt. 9.0, WL 20, FC 2/32. Pump pressure 1300#, 52 SPM, 6" liners.
7/25/62	6:00 AM	TD 2497'. Circulating for Core #1. Vis. 48, wt. 9.0, WL 4.8, FC 2/32. 3-3/4° at 2327'. Show of gas and fluorescence in samples.
7/25/62	10:00 AM	TD 2499'. Went in hole with core barrel.
		Core barrel plugged. Made trip.
7/26/62	12:15 AM	On bottom with core barrel.
	6:00 AM	Coring (Core #1) at 2530'.
		1½° at 2499'. Vis. 70, wt. 9.0, WL 8, FC 1/32. Pump pressure 900#, 45 SPM, 6" liners.
7/26/62		Pulled Core #1 from 2499' to 2559'. Reamed core-hole. Drilled 16'. Circulated 1½ hours. Logged well.
7/27/62	6:00 AM	Waiting on orders. TD 2575'.
Core #1		Cored 2499' to 2559'. Cored 60', recovered 36'.
2499-2500'		Dark grey very fine silty very fossiliferous and finely micaceous shale.
2500-01'		Same, slightly fossiliferous, slightly sandy, very fine.
2501-03'		Same.
2503-04'		Same, abundant slicken sides, 45° vertical and horizontal fracture.
2504-05'		Same.
2505-06'		Same, very fossiliferous.
2506-08'		Same, slightly sandy, very fine.
2508-10'		Same, slightly sandy, very fine.
2510-15'		Same, non-fossiliferous.
2515-16'		Same, very very fossiliferous, snail, clams, etc.
2516-25'		Same, non-fossiliferous.
2525-30'		Same, few fossiliferous fragments.
2530-31'		Same, shale becomes much darker.
2531-36'		Dark grey black very very fine mica and silt.

7/28/62	6:00 AM	Drilling at 3180' in 9-7/8" hole in shale. 3/4° at 2899'. Vis. 47, wt. 9.0, WL 5.0, FC 1/32. Pump pressure 1350#, 54 SPM, 6" liners.
7/29/62	6:00 AM	Drilling at 3640' in sand and shale. 1-3/4° at 3240'. Vis. 48. wt. 9.0, WL 4.0, FC 1/32. Pump pressure 1350#, 54 SPM, 6" liners.
7/30/62	6:00 AM	Drilling at 3940' in sand and shale. Bit #8 in the hole. Vis. 46, wt. 9.1, WL 4.4, FC 1/32. 2° at 2692'. Pump pressure 1400#, 54 SPM, 6" liners.
7/31/62	6:00 AM	TD 4123'. Making trip for core barrel. 1-3/4° at 3956'. Vis. 46, wt. 9.2, WL 4.5, FC 1/32. Pump pressure 1400#, 54 SPM, 6" liners.

CORE DESCRIPTION

Core #2	Cored 4123.3' to 4142.8'. Cored 19.5', recovered 19.5'.
4123.3-25'	Medium fine light grey salt and pepper varicolor sandstone, very very fine mica matrix, slight gas stain and fluorescence.
4125-26'	Same, harder, good stain and fluorescence.
4126-29'	Same, hard, slight stain and fluorescence.
4129-30'	Same, hard, heavy stain and fluorescence.
4130-31'	Same, hard, with thin fine varved sandstone, slightly carbonaceous streaks, stain and fluorescence.
4131-32'	Same.
4132-33'	Same, very fractured, good stain and fluorescence.
4133-35'	Same, good odor, good stain and fluorescence.
4135-36'	Same with black shale streaks, slightly carbonaceous, good odor, good stain and fluorescence.
4136-37'	Same with thin carbonaceous pyritic partings, good odor, good stain and fluorescence.
4137-40'	Same, heavy odor, good stain and fluorescence.
4140-41'	Same with thin slightly carbonaceous shale streaks, varved, good odor, good stain and fluorescence.
4141-42'	Same with thin brown shale streaks, varved, slicken sides, slight odor and fluorescence.
4142-42.8'	Dark grey very fine salt and pepper varicolor sandstone with thin brown grey silty shale streaks, slight bleed.

7/31/62		Pulled Core #2 from 4123.3' to 4142.8'.
8/1/62	6:00 AM	Coring (Core #3) at 4164'. 2-3/4° at 4154'. Vis. 50, wt. 9.9, WL 3.6, FC 1/32. Pump pressure 800#, 54 SPM, 6" liners.
8/1/62		Pulled Core #3 from 4154' to 4214'. Cored 60', recovered 46'.
8/2/62	5:00 AM	TD 4214'. Vis. 52, wt. 9.9, WL 5.8, FC 1/32. 2° at 4214'. Pump pressure 1400#, 41 SPM, 6" liners. Preparing to drill stem test.

8/2/62		DST #1 from 4076' to 4214'. Upper packer set at 4072', lower at 4076'. Tool open 10 minutes on initial flow. Good blow of air to surface immediately. Initial shut in 30 minutes. Second flow 60 minutes, final shut in 45 minutes. Initial hydrostatic pressure 2170#, initial FP 280#, initial SIP 810#. Final FP 590#, final SIP 810#. Bottom hole temperature 142°. Good blow throughout test. Gas to surface at end of test.
8/3/62	6:00 AM	Drilled to TD 4383'. Circulating for Core #4. Vis. 59, wt. 9.9, WL 5.8, FC 1/32. Pump pressure 1400#, 54 SPM, 6" liners.

CORE DESCRIPTIONS

Core #3	Cored 4154' to 4216'. Cored 62', recovered 46'.
4154-55'	Dark brown carbonaceous shale.
4155-56'	Same.
4156-57'	Same, amber specks.
4157-59'	Same, very carbonaceous.
4159-60'	Impure coal.
4160-61'	Dark grey brown carbonaceous shale.
4161-64'	Dark brown slightly carbonaceous sand, medium fine, very silty.
4164-64½'	Dark grey brown silty carbonaceous sand, thin laminations.
4164½-65'	Light grey medium fine varicolor silty sandstone.
4165-71'	Same with brown shale clay balls, very micaceous.
4171-72'	Light grey tan medium fine varicolor sandstone, micaceous.
4172-72½'	Dark grey brown shale, very very finely micaceous.
4172½-73'	Light grey tan medium fine varicolor sandstone, micaceous, with clay balls and brown shale.
4173-74'	Same with thin shale laminations.
4174-75'	Dark grey brown shale, very fine mica.
4175-76'	Light tan grey medium fine varicolor sandstone, micaceous.
4176-78'	Light tan grey medium varicolor sandstone, micaceous, compact.
4178-80'	Same, slight stain.
4180-81'	Same, slight stain, very silty.
4181-82'	Black very coaly shale.
4182-83'	Black slightly coaly shale.
4183-85'	Black very slightly coaly shale.
4185-87'	Dark brown coaly shale.
4187-97'	Dark brown grey slightly silty carbonaceous shale.
4197-97½'	Dark grey hard very slightly carbonaceous shale.
4197½-99'	Dark grey brown very silty carbonaceous sand with thin brown shale streaks.
4199-4199½'	Dark grey brown very silty carbonaceous sand with dark brown shale streaks.

Core #3 (continued)

4199½-4200'		Dark brown shale with thin medium fine to medium varicolor silty sandstone streaks.
Core #4		Cored 4491' to 4551'. Cored 60', recovered 54'.
4491-92'		Dark grey brown very fine silty slightly carbonaceous shale.
4492-93'		Dark grey brown very fine silty slightly carbonaceous shale and grey medium fine angular varicolor slightly carbonaceous sandstone.
4493-98'		Same.
4498-4502'		Dark grey brown shale, slightly carbonaceous.
4502-06'		Dark grey medium fine sub-angular sandstone, silty, slightly carbonaceous and micaceous.
4506-10'		Light grey medium fine sub-angular sand and pepper sandstone, slightly silty.
4510-12'		Dark grey brown very fine silty shale.
4512-13'		Dark grey brown very fine sandy micaceous shale.
4513-14'		Dark grey brown shale.
4514-15'		Coal.
4515-16'		Dark grey brown shale.
4516-17'		Light grey medium varicolor compact micaceous and slightly carbonaceous sandstone, kaolin clay cmt.
4517-27'		Light grey medium varicolor compact micaceous sand. Kaolin clay cmt.
4527-28'		Dark medium varicolor compact micaceous sand, kaolin clay cmt, thin carbonaceous partings.
4528-31'		Light grey medium varicolor compact micaceous sand, kaolin clay cmt.
4531-32'		Same with trace gilsonite.
4531-32'		Same, no gilsonite.
4532-39'		Same with dark grey brown clay balls.
4539-51'		Same.
8/4/62		Pulled Core #4 from 4491' to 4551'. Cored 60', recovered 54'.
8/6/62	6:00 AM	Drilled to TD 4900'. Circulating to run casing. Vis. 58, wt. 10, WL 8, FC 2/32. Pump pressure 1500#, 54 SPM, 6" liners. Lost 300 barrels mud at 4772'. Now have full returns.
8/6/62	8:00 PM	TD 4900' RKB. Set 155 joints 4904' of 7-5/8" OD 26.40# J-55 casing at 4898' RKB with 100 sacks cement, 2% gel, 12½# Gilsonite/sk, ¼# flocele/sk, followed by 300 sacks cement, 1% gel, 12½# Gilsonite/sk, ¼# flocele/sk.
8/7/62	6:00 AM	WOC
8/7/62	8:00 AM	TC 3700'. Ran temperature survey. Set slips. Cut off casing. Rigging up air drilling equipment while WOC.

8/8/62	6:00 AM	Nippled up. Picked up drill collars. Going in hole with drill pipe.
8/9/62	6:00 AM	TD 4911'. Drilled cement and 11' of formation. Formation wet. Blowing to dry up.
8/10/62	6:00 AM	Drilling at 5550' with air. Compressor pressure 150#. 6¼° at 5400'. 7° at 5480'. 7¼° at 5520'.
8/13/62	6:00 AM	TD 6022'. Preparing to run tubing.
		TD 6022'. Ran 184 joints tubing. Blew well 6:00 PM to 11:00 PM.
8/14/62	6:00 AM	Shut in.
8/15/62	6:00 AM	TD 6022'. Blowing well.
	8:00 AM	Released rotary rig.
8/16/62	6:00 AM	Shut down.
10/ 5/62		Moved in pulling unit to run Kobe pumping equipment. Rigged up and started pulling 2-3/8" tubing. Moved in D-6 cat to build pad for tank battery. Moved 1" tubing, 2-3/8" EUE tubing, Kobe equipment, power oil tank (300 bbl special) and one 210-barrel storage tank from B-M-G #1 Pilgrim.
10/ 6/62		Finished pulling 2-3/8" EUE tubing. Started in hole with Kobe bottom hole assembly. Ran as follows:

Perforated nipple:	6.60'
Kobe bottom hole assembly	14.40
1-2' 2-3/8" EUE sub	2.00
156 jts 2-3/8" EUE	4874.83
Total string	4897.83'

Start in hole with 1" Kobe tbg. Set power oil tank and 210 bbl. storage tank. Laid flow lines and set Kobe triplex pump.

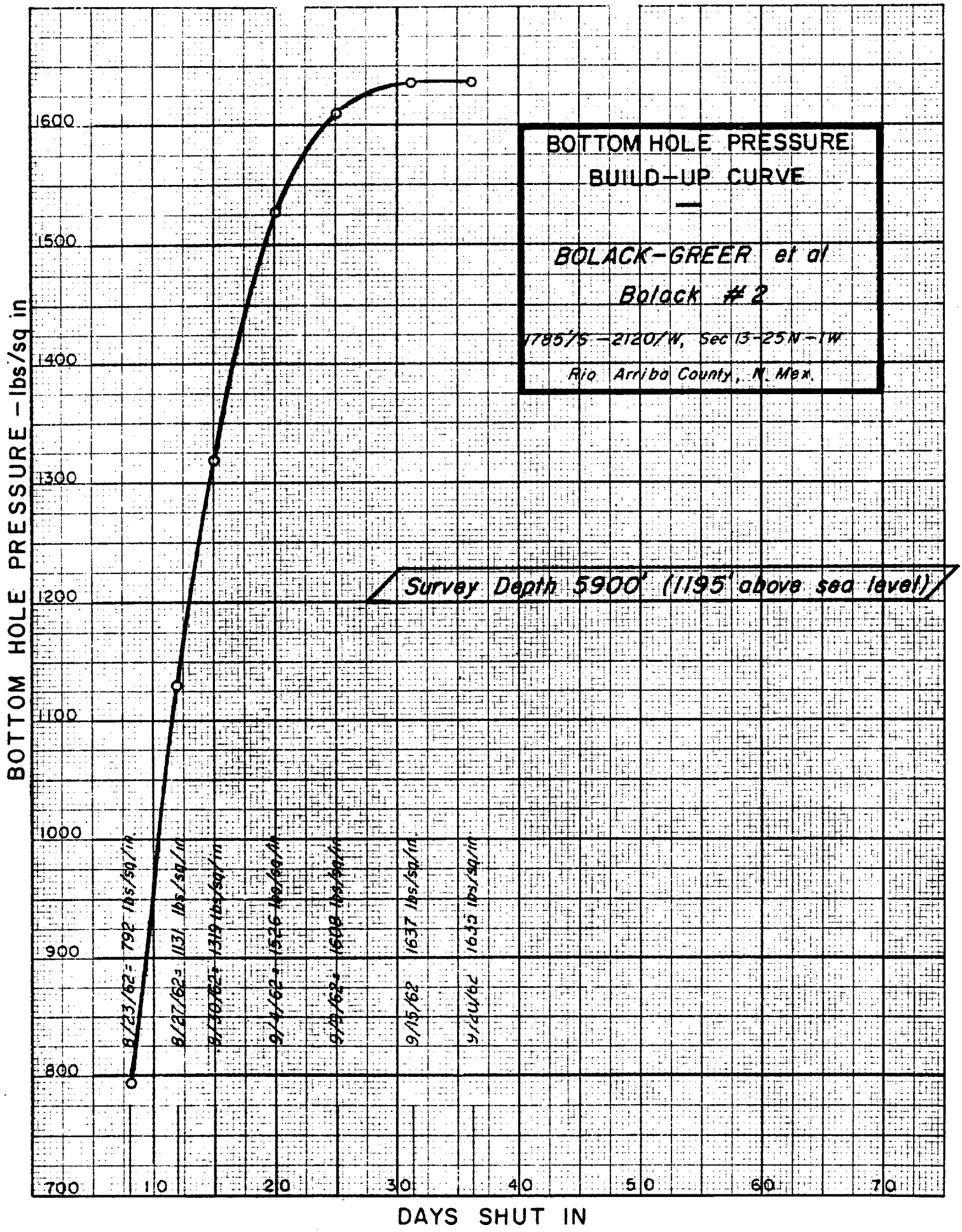
10/ 7/62 — Finished running 1" Kobe tubing. Tubing as follows:

162 joints	4853.67'
1 sub	10.00
1 sub	4.00
	4867.67
Kobe stinger on bottom of 1"	1.00
	4868.67'

Landed 1" with stinger seated in bottom hole assembly bowl and spaced out with two subs. Released pulling unit.

	3:00 PM	Started well pumping.
		Pressures of 1100# to 1200# while bringing fluid to surface. Pressure decreased to 250-500# during first few hours of pumping operations.
10/ 8/62		Well pumped 36 barrels in 16 hours. Triplex pressure 500#.
10/ 9/62		Pump down. (Apparently ran out of annulus gas).
10/10/62		Pumping with pressure of 550# on Triplex pump.
10/11/62		Well pumped 35 barrels in last 29 hours. Total new production to date 133 bbls. Pressure on Triplex 700#.

10/12/62		Pumped 50 barrels last 24 hours. Increased triplex speed to full throttle. Triplex pressure 1050#. Gravity of oil 38.5 at 70°.
10/13/62		Pumped 35 barrels in 24 hours. Triplex pressure 1000#. Gravity 37.2 at 65°.
10/14/62		Pumped 21 barrels last 24 hours. Triplex pressure 1000#.
10/15/62		Pumped 14 barrels last 24 hours. Triplex pressure 1000#.
10/16/62		Pumped 9 barrels last 24 hours. Triplex pressure 1000#.
10/17/62		Pumped 7 barrels last 24 hours. Triplex pressure 900#.
10/18/62	7:00 AM	Pump inoperative. No production last 24 hours.
	7:30 PM	Ran new pump.
10/19/62	7:00 AM	Well pumped 39 barrels oil last 11½ hours.
10/20/62	7:00 AM	Pumped 19 barrels last 24 hours.
10/21/62	7:00 AM	Pumped 14 barrels last 24 hours.
10/22/62	7:00 AM	Pumped 15 barrels last 24 hours.
10/22/62		Pumped 15 barrels oil in 12 hours.
10/23/62		Pumped 15 barrels oil in 12 hours.
10/24/62		Pumped 13 barrels oil in 12 hours.
10/25/62		Pumped 13 barrels oil in 12 hours.
10/26/62		Pumped 12 barrels oil in 12 hours.
10/27/62		Pumped 12 barrels oil in 12 hours.
10/28/62		Pumped 13 barrels oil in 12 hours.
10/29/62		Pumped 6 barrels in 12 hours.
10/30/62		Pumped 5 barrels in 6 hours.
10/31/62		Pumped 9 barrels oil in 6 hours.


BOTTOM HOLE PRESSURE BUILD-UP CURVE
BOLACK-GREER et al
Bolack #2
1785'S - 2120'W, Sec 13-25N-1W
Rio Arriba County, N. Mex.
Survey Depth 5900' (1195' above sea level)
BOTTOM HOLE PRESSURE - lbs/sq in
DAYS SHUT IN
1600
1500
1400
1300
1200
1100
1000
900
800
700
10
20
30
40
50
60
70
8/23/62 = 792 lbs/sq/in.
8/27/62 = 1131 lbs/sq/in
8/30/62 = 1319 lbs/sq/in
9/4/62 = 1526 lbs/sq/in
9/9/62 = 1600 lbs/sq/in
9/15/62 1637 lbs/sq/in
9/24/62 1639 lbs/sq/in

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

November 7, 1962

RESERVOIR FLUID DIVISION

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

Attention: Mr. Virgil Stoabs

Subject: Reservoir Fluid Study
Bolack No. 2 Well
Wildcat
Rio Arriba County, New Mexico
Our File Number: RFL 2302

Gentlemen:

Subsurface fluid samples were collected from the subject well by a representative of Core Laboratories, Inc. on October 2, 1962, and transported to our Dallas laboratory, where they arrived on October 15, 1962. Presented in this report are the results of a reservoir fluid study performed using these samples.

The saturation pressure of the fluid was measured to be 1524 psig at the reservoir temperature of 152° F. The reservoir pressure at the sampling depth was measured to be 1631 psig.

During differential pressure depletion the fluid evolved 481 standard cubic feet of gas per barrel of residual oil. The associated formation volume factor was measured to be 1.292 barrels of saturated fluid per barrel of residual oil. Under similar depletion conditions the viscosity of the fluid varied from a minimum of 0.625 centipoise at the saturation pressure to a maximum of 1.750 centipoises at atmospheric pressure.

Separator tests were performed at four operating pressures and atmospheric temperature to determine the effect of changes in surface

separation pressure upon the produced fluid. These tests indicate that the optimum separator pressure is approximately 90 psig; however, near optimum recovery will be obtained at pressures as low as 40 psig.

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

Very truly yours,

Core Laboratories, Inc.
Reservoir Fluid Division
P. L. Moses

A. C. Carnes, Jr.

A. C. Carnes, Jr.
Senior Engineer

ACC:dc
7 cc. - Addressee

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 2302

Company Benson-Montin-Greer Drilling Corporation — Date Sampled October 2, 1962
Well Bolack No. 2 — County Rio Arriba
Field Wildcat — State New Mexico

FORMATION CHARACTERISTICS

Formation Name	Gallup
Date First Well Completed	August 15, 1962
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	7100 KB Ft.
Total Depth	6022 Ft.
Producing Interval	4900-6022 OH Ft.
Tubing Size and Depth	2-3/8 In. to 6003 Ft.
Productivity Index	Bbl/D/PSI @ Bbl/Day
Last Reservoir Pressure	1631 PSIG @ 5975 Ft.
Date	October 2, 1962
Reservoir Temperature	152 °F. @ 5975 Ft.
Status of Well	Shut in
Pressure Gauge	Amerada (DO)
Normal Production Rate	Bbl/Day
Gas-Oil Ratio	SCF/Bbl
Separator Pressure and Temperature	PSIG, °F.
Base Pressure	PSIA
Well Making Water	% Cut

SAMPLING CONDITIONS

Sampled at	5975 Ft.
Status of Well	Shut in
Gas-Oil Ratio	SCF/Bbl
Separator Pressure and Temperature	PSIG, °F.
Tubing Pressure	0 PSIG
Casing Pressure	PSIG
Core Laboratories Engineer	NT
Type Sampler	Perco

REMARKS:

CL-518

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 2302
Well Bolack No. 2

VOLUMETRIC DATA OF Reservoir Fluid SAMPLE

1. Saturation pressure (bubble-point pressure) 1524 PSIG @ 152 °F.
2. Thermal expansion of saturated oil @ 5000 PSI = $\frac{V \text{ @ } 152 \text{ °F}}{V \text{ @ } 73 \text{ °F}}$ = 1.04245
3. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/PSI:

   From 5000 PSI to 3500 PSI = 7.92×10^{-6}

   From 3500 PSI to 2500 PSI = 8.93×10^{-6}

   From 2500 PSI to 1524 PSI = 10.34×10^{-6}
4. Specific volume at saturation pressure: ft^3/lb 0.02223 @ 152 °F.

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 152 °F.. RELATIVE VOLUME OF OIL AND GAS, V/VSAT.	VISCOSITY OF OIL @ 152 °F.. CENTIPOISES	DIFFERENTIAL LIBERATION @ 152 °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	0.9694	0.845			1.252
4500	0.9732	0.818			1.257
4005		0.787			
4000	0.9770				1.262
3500	0.9811	0.758			1.268
3000	0.9854	0.726			1.273
2505		0.691			
2500	0.9899				1.279
2100	0.9938				1.284
2000	0.9947	0.661			1.285
1900	0.9957				1.286
1800	0.9969				1.288
1700	0.9980	0.635			1.289
1600	0.9991				1.291
1524	1.0000	0.625	0	481	1.292
1516	1.0020				
1508	1.0041				
1483	1.0102				
1447	1.0204				
1400		0.631			
1381	1.0407				
1376			37	444	1.277
1299	1.0698				
1250		0.682			
1221			75	406	1.261
1201	1.1121				
1123			100	381	1.251
1100		0.720			
1090	1.1734				
971	1.2552				
968			139	342	1.235
950		0.760			
850	1.3679				
818			176	305	1.220

V = Volume at given pressure
$V_{SAT.}$ = Volume at saturation pressure and the specified temperature.
V_R = Residual oil volume at 14.7 PSI absolute and 60° F.

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 152 °F., RELATIVE VOLUME OF OIL AND GAS, V/VSAT.	VISCOSITY OF OIL @ 152 °F., CENTIPOISES	DIFFERENTIAL LIBERATION @ 152 °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		0.802			
728	1.5320				
669			213	268	1.204
650		0.858			
600	1.7783				
518			251	230	1.188
500		0.912			
469	2.1799				
365			290	191	1.170
354	2.7950				
350		0.977			
258	3.8098				
223			332	149	1.151
200		1.083			
112			371	110	1.130
0		1.750	481	0	1.044
				@ 60° F.	= 1.000

Gravity of residual oil = 38.6° 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.

Differential Pressure Depletion at 152° F.

Pressure PSIG	Oil Density Gms/Cc	Gas Gravity	Deviation Factor Z
1524	0.7206		
1376	0.7246	0.693	0.869
1221	0.7290	0.694	0.879
1123	0.7319	0.696	0.886
968	0.7367	0.699	0.895
818	0.7413	0.708	0.909
669	0.7462	0.720	0.920
518	0.7512	0.739	0.932
365	0.7566	0.783	0.945
223	0.7627	0.856	0.965
112	0.7688	1.014	
0	0.7957	1.589	

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, $V_R/V_{SAT.}$ See Foot Note (2)	FORMATION VOLUME FACTOR, $V_{SAT.}/V_R$ See Foot Note (3)	SPECIFIC GRAVITY OF FLASHED GAS
0	79	503		38.4	0.7645	1.308	0.997
40	77	414	32	39.7	0.7924	1.262	
80	76	371	61	39.9	0.7994	1.251	
160	77	328	117	39.7	0.7930	1.261	

(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 @ 1524 PSI gauge and 152 ° F.

(3) Formation Volume Factor: $V_{SAT.}/V_R$ is barrels of saturated oil @ 1524 PSI gauge and 152 ° F. per barrel of stock tank oil @ 60° F.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 2302

Company Benson-Montin-Greer Drilling Corporation Formation Gallup

Well Bolack No. 2 County Rio Arriba

Field Wildcat State New Mexico

HYDROCARBON ANALYSIS OF Reservoir Fluid SAMPLE

COMPONENT	WEIGHT PER CENT	MOL PER CENT	DENSITY @ 60° F. GRAMS PER CUBIC CENTIMETER	° API @ 60° F.	MOLECULAR WEIGHT
Hydrogen Sulfide					
Carbon Dioxide	0.05	0.14			
Nitrogen	0.04	0.16			
Methane	3.68	26.38			
Ethane	1.70	6.48			
Propane	2.45	6.39			
iso-Butane	0.50	1.00			
n-Butane	2.23	4.41			
iso-Pentane	1.16	1.86			
n-Pentane	1.53	2.44			
Hexanes	3.33	4.45			
Heptanes plus	83.33	46.29	0.8449	35.8	207
	100.00	100.00			

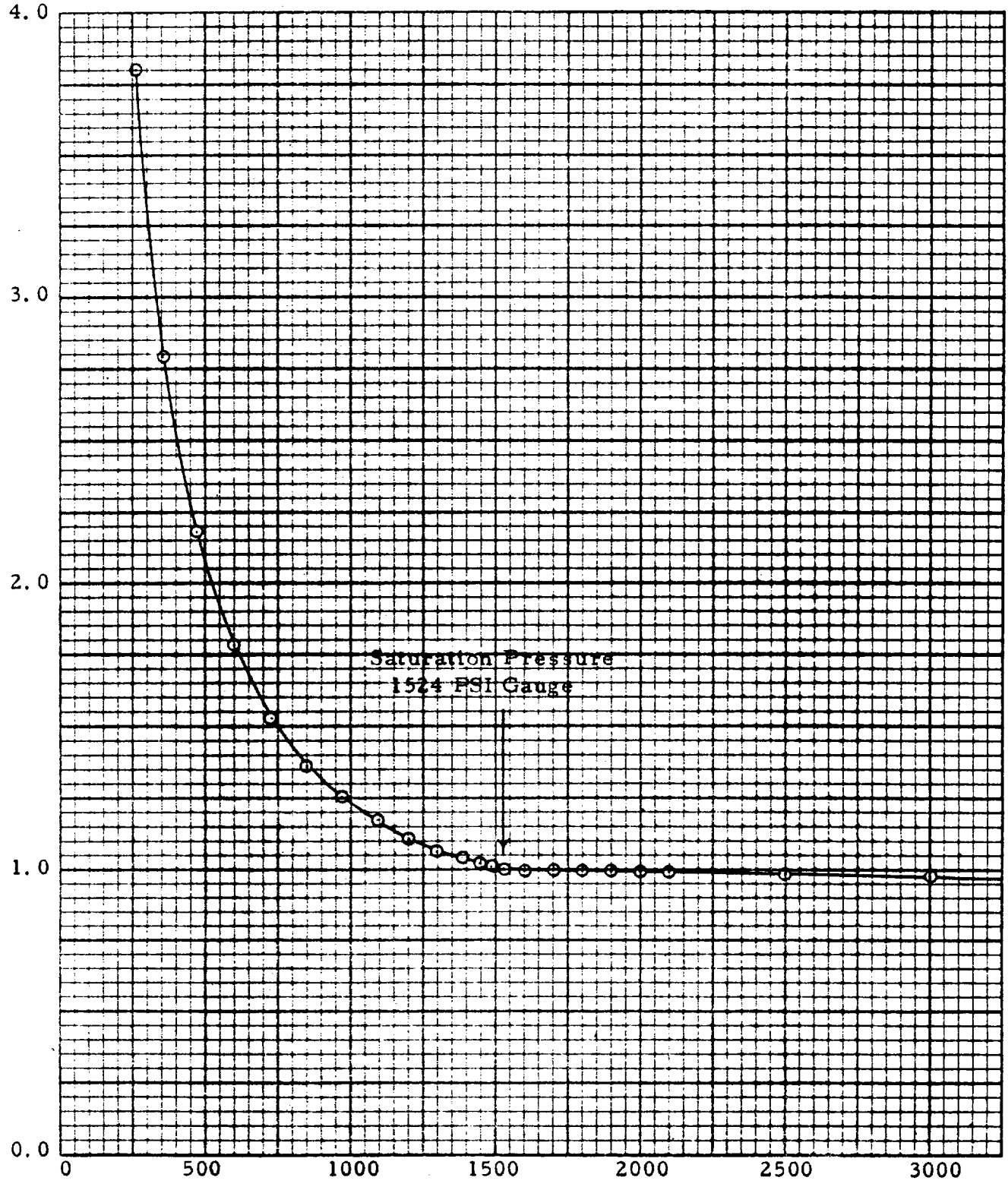
Core Laboratories, Inc.
Reservoir Fluid Division

A. C. Carnes, Jr.

A. C. Carnes, Jr.
Senior Engineer

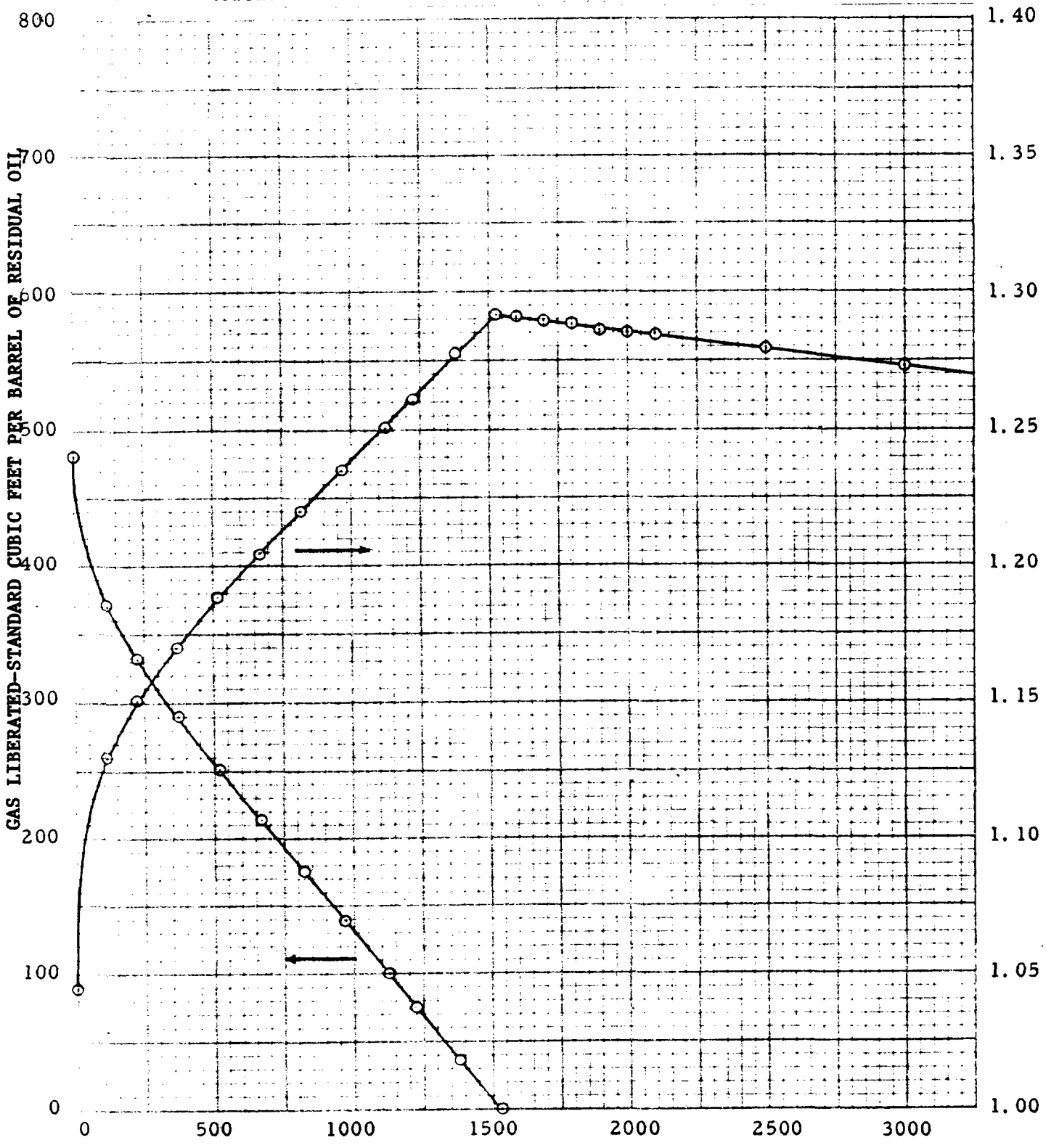
PRESSURE-VOLUME RELATIONS OF RESERVOIR FLUID

Company Benson-Montin-Greer Drilling Corporation — Formation Gallup
Well Bolack No. 2 — County Rio Arriba
Field Wildcat — State New Mexico



Benson-Montin-Greer
Drilling Corporation
Bolack No. 2
Wildcat

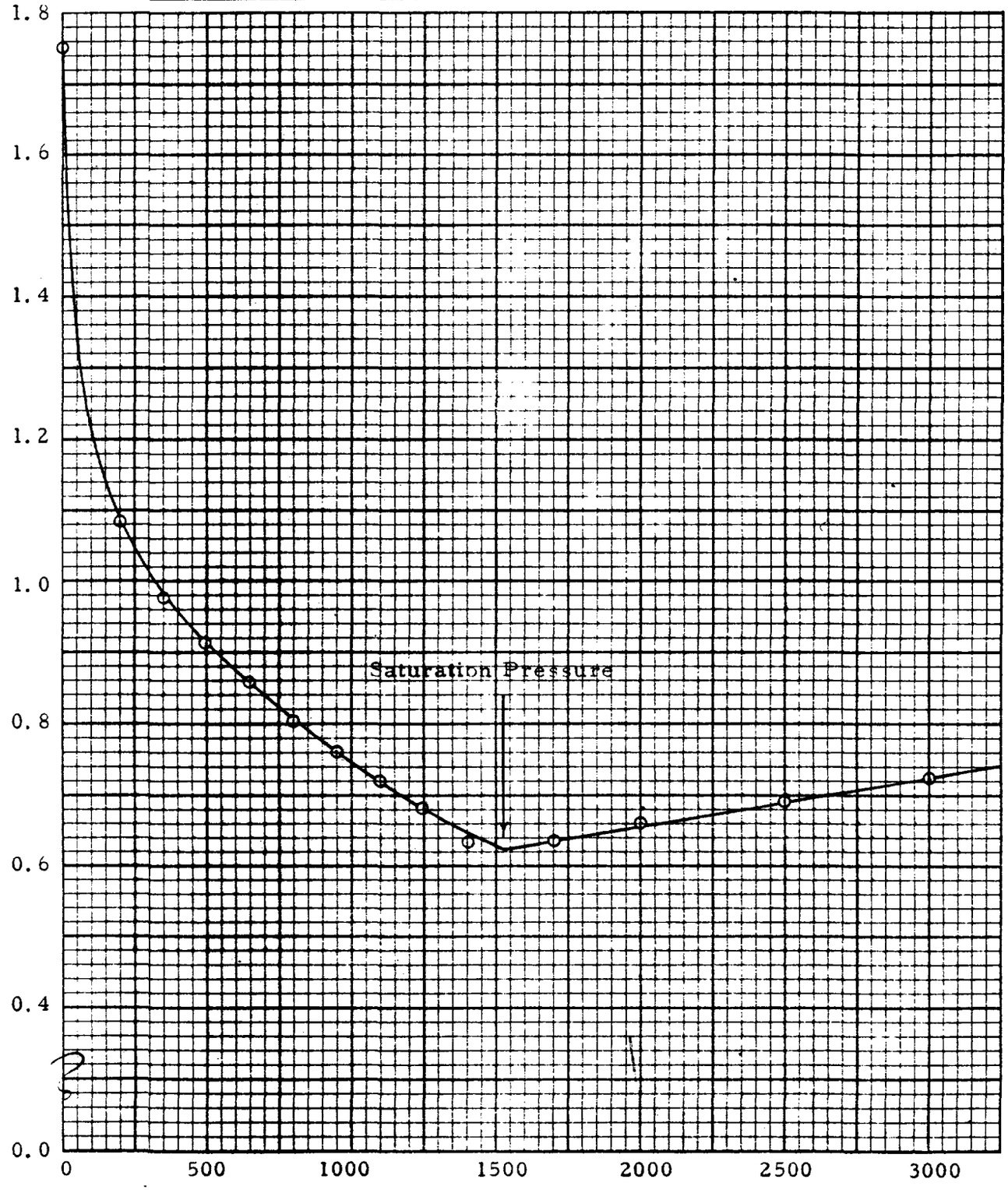
Gallup
Rio Arriba
New Mexico



CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Viscosity of Reservoir Fluid

Company Benson-Montin-Greer Drilling Corporation Formation Gallup
Well Bolack No. 2 County Rio Arriba
Field Wildcat State New Mexico

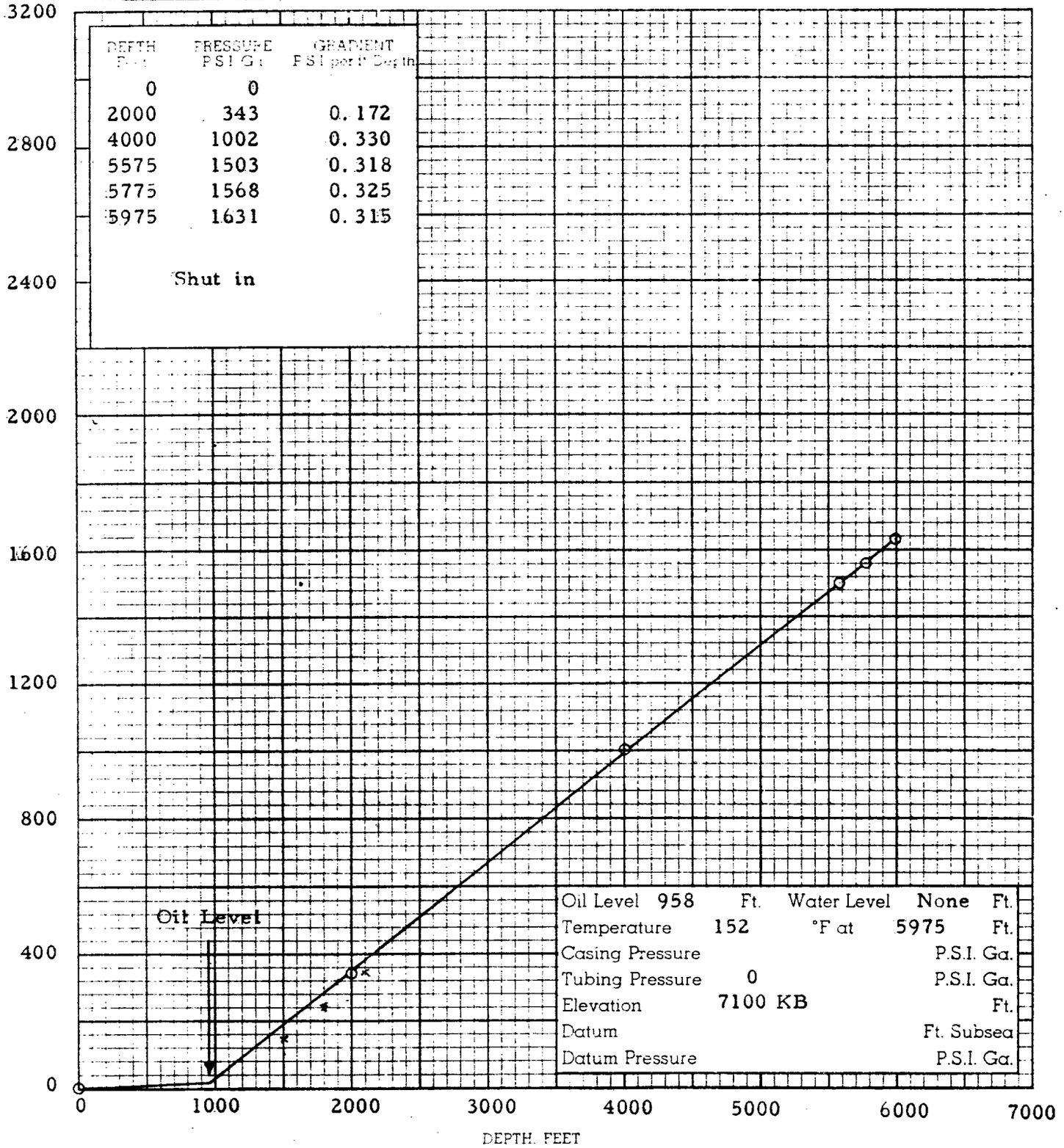


CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company Benson-Montin-Greer Drilling Corporation
Well Bolack No. 2
Field Wildcat
Formation Gallup
County Rio Arriba
State New Mexico

DEPTH Feet	PRESSURE P.S.I.G.	GRADIENT P.S.I. per Foot of Depth
0	0	
2000	343	0.172
4000	1002	0.330
5575	1503	0.318
5775	1568	0.325
5975	1631	0.315

Shut in



Oil Level	958	Ft.	Water Level	None Ft.
Temperature	152	°F at	5975	Ft.
Casing Pressure				P.S.I. Ga.
Tubing Pressure	0			P.S.I. Ga.
Elevation	7100 KB			Ft.
Datum				Ft. Subsea
Datum Pressure				P.S.I. Ga.

DRILLING STATUS

CANADA OJITOS UNIT L-11

1908' FSL, 523' FWL, Sec. 11, T-25N, R-1W, Rio Arriba County, New Mexico. Elevation 7220' GL.

8- 6-64 Spudded.

8- 7-64 TD 330' RKB. Set 10 joints 312' of 13-3/8" OD 48# H-40 casing at 324' RKB with 350 sacks regular cement, 2% calcium chloride.

8-10-64 Drilling at 1450'. 1° at 430'.

8-11-64 Drilling at 2783'.

8-12-64 Drilling at 3223'. 3/4° at 3223'

8-13-64 TD 3771'. Lost circulation. Vis. 45, wt. 9.3, WL 8.6, FC 2/32. Mixed lost circulation material.

8-14-64 Drilling at 4130'. 3° at 4105'

8-15-64 Drilling at 4380'. Vis. 49, wt. 9.2, WL 4.2, FC 2/32, tr. sand, 6% oil, 8.5 Ph. 2¼° at 4359'

8-19-64 Drilling at 5315'. Vis. 48, wt. 8.9, WL 5.0, FC 1/32, tr. sd., 22% oil. Lost 100 barrels mud at 5250'. 2° at 5298'

8-20-64 Drilling at 5515'. 2° at 5455'

Drilled to TD 5550'. Logged well. Drilled 145' to 5695'. Laid down drill pipe.

8-21-64 TD 5695'. 2¼° at 5550'.Ran 38 joints 1229.49' TO 7-5/8" OD N-80 LT&C casing (1 joint on top, balance on bottom) and 137 joints 4479.22' TO 7-5/8" J-55 ST&C casing, landed at 5694' RKB, cemented with 100 sacks, 2% gel, 12½# Gilsonite and ¼# flocele per sack, followed with 300 sacks, 1% gel, 4½# Gilsonite and ¼# flocele per sack.

8-22-64 Temperature survey showed top of cement at 4050'.

8-24-64 Drilled cement. Cement dusted.

8-25-64 Drilling at 5930' with 175# air pressure. 1-3/4° at 5843'.

8-26-64 Drilling at 6425' with 190# air pressure. 2¼° at 6272'

Drilled to TD 6526'. Logged well. Started back in hole with bit. Bit stopped 9' inside 7-5/8" casing. Casing parted.

8-27-64 Attempted to screw in to 7-5/8". Were unable to with regular joint. Ran die nipple and chased threads. Screwed in. Pulled 140,000#, set slips.

8-28-64 Went back to bottom, drilled to 6590'.

8-29-64 Drilled to TD 6660'. Circulated with air for 1 hour. Attempted to reverse circulate with air. Could not get dusting. Conventionally circulated for additional 2 hours. Rigged up to circulate with oil. Loaded hole with oil down drill pipe. When returns established. started reverse circulating oil. Reverse circulated for 2 hours. Came out of hole. Laid down square drill collar.

8-29-64 (contd.)	Picked up core barrel. Went back to bottom. Reverse circulated to clean up hole. Plugged pipe. Worked plug free. Attempted to reverse core. Plugged pipe again. Worked out plug. Commenced coring conventionally. Pulled Core #1 from 6660' to 6665.5'. Core barrel jammed. Came out of hole. Went in with core barrel. Plugged core barrel. Worked plug out. Pulled Core #2 from 6665.5' to 6687'. Recovered 21.5'.
8-30-64	Ran gamma ray induction log. Found cavings in hole at 6671'. Ran calseal plug from 6671' to 6648' using Schlumberger logging truck and dump bailer.
8-31-64	Started in hole with bit.
9- 1-64	Cleaned out to PBTD 6648'. Circulated 2 hours. Laid down drill pipe. Ran 40 joints 1296.16' TO 5-1/2" OD 17# J-55 casing, landed at 6648' RKB, cemented with 160 sacks regular cement. Top of liner 5348'.
9- 2-64	Temperature survey showed top of cement at 5350', plug at 6621'
9- 3-64	Ran tapered string of drill pipe (1500' of 2-7/8" on bottom, 4" on top). Pressure tested system with 2,000# with 75# pressure drop in 15 minutes. Pressure tested again with 1,000# with 25# pressure drop in 15 minutes. On both tests had surface leak which apparently accounted for pressure drop. Drilled cement plug and calseal and cleaned out to original TD 6687'. Circulated hole clean. Came out of hole and ran gamma ray induction log over zone below 5½" liner shoe.
9- 4-64	Started pumping oil into formation to determine injection rate. Pumped in a 3 BPM at 400# pressure. Pumped in at 6 BPM at 1300#. Dumped radioactive material to attempt to determine point of injection. Ran McCulloch gamma ray tracer log and determined injection point 6680-86'. Perforated with Schlumberger frac jets 2 per foot from 6668-6680'. System pressured up to 1500#. Would not take fluid at any measurable rate. Found cavings in hole. Circulated hole conventionally and reverse circulated. Pressured up on formation. Established new injection rate of 6 BPM at approximately 1150#.
9- 5-64	Laid down drill pipe. Rigged down rotary.

9-29-64	Sand-oil fraced 6648-87' using 12 Dowell Allison pump trucks and 4 blenders. Treated with 4,400 barrels oil, 150,000# 20/40 sand and 25,000# 10/20 sand, flushed with 260 barrels oil. Average overall injection rate 75 BPM. Breakdown pressure 2000#. Avg. TP 3000#, max. 3200#, min. 2900#. Inst. SIP 1300#, 1-min. SIP 1200#, 8-min. SIP 1100#, 12-min. SIP 1035#.
	After $3\frac{1}{2}$ hours well on vacuum.
	Total load oil 4,660 barrels.
10- 9-64	Moved in cable tools.
10-10-64	Rigged up.
10-26-64	Completed pressure survey. Lost bottom hole pressure bomb in hole.
10-27-64	Cleaning out and fishing for bomb at 6675' RKB. Top of cavings 6668'. Cleaned out shale and lost circulation material, no sand.
	Ran sand pump. Cleaned out small amount of shale, lost circulation material and rubber. Cleaned out to 6675' RKB.
10-29-64	Ran 169 joints 2-7/8" OD EUE tubing landed at 5323' RKB, with Kobe bottom hole assembly.
10-30-64	Ran $1\frac{1}{4}$" tubing.
11- 1-64	Pumped 635 barrels load oil in 25 hours.
11- 9-64	Pumped 476 barrels oil in 24 hours. 92 barrels balance of load, 384 barrels new oil.
	State Potential Test: 295 barrels oil in 15 hours.

DRILLING STATUS
CANADA QUITOS UNIT L-11 (12-11)

05/04/65 Shut well in to condition for taking bottom hole sample.

05/19/65 Moved in rig to pull tubing to condition well for bottom hole sample.

05/20/65 Pulled 1-1/4" and 2-7/8" OD EUE tubing.

05/21/65 7:00 AM Running 2-3/8" OD EUE tubing preparatory to swabbing to condition well for bottom hole sample.

Ran 2-3/8" tubing to 2002' with perforated nipple and bull plug on bottom. Commenced swabbing.

05/22/65 Swabbed for 5 hours at rate of 3 barrels oil per hour. Swabbed total of 15 barrels. Shut down.

05/23/65 7:00 AM Shut down.

05/24/65 7:00 AM Preparing to resume swabbing.

Swabbed at average rate of 4 barrels oil per hour. Total swabbed today 40 barrels. Total swabbed for conditioning 55 barrels.

05/25/65 Swabbed at average rate of 4 barrels oil per hour. Total swabbed this day 48 barrels. Total swabbed for conditioning 103 barrels.

05/26/65 Swabbed 49 barrels of oil in 8 hours. Approximate rate of 4-3/4 barrels oil per hour. Total swabbed for conditioning 141 barrels. Total subsequent to 12:00 noon 5/26 34 barrels.

05/27/65 Swabbed 39.5 barrels of oil in 11 hours. Approximate rate of 3-3/4 barrels of oil per hour. Total swabbed for conditioning 180.5 barrels. Total subsequent to 12:00 noon 5/26 73.5 barrels.

05/28/65 Swabbed 44.4 barrels oil in 11 hours at approximate rate of 4 barrels per hour. Total swabbed for conditioning 224.9 barrels. Total swabbed subsequent to 12:00 noon 5/26 117.9 barrels.

05/29/65 Swabbed 46 barrels oil in 11 hours at approximate rate of 4 barrels per hour. Total swabbed for conditioning 270.9 barrels. Total swabbed subsequent to 12:00 noon 5/26 163.9 barrels.

05/30/65 Swabbed 42.3 barrels oil in 12 hours at approximate rate of 3.5 barrels per hour. Total swabbed for conditioning 313.2 barrels. Total swabbed subsequent to 12:00 noon 5/26 206.2 barrels.

05/31/65 Swabbed 47.1 barrels oil in 12 hours at approximate rate of 4 barrels per hour. Total swabbed for conditioning 360.3 barrels. Total swabbed subsequent to 12:00 noon 5/26 253.3 barrels.

06/01/65 7:00 AM CP 15#. Swabbed 27.9 barrels oil in 7 hours at approximate rate of 4 barrels oil per hour. Total swabbed for conditioning 388.2 barrels. Total swabbed subsequent to 12:00 noon 5/26 281.2 barrels.

06/02/65 7:00 AM CP 15#. Swabbed 46 barrels oil in 12 hours at approximate rate of 4 barrels per hour. Total swabbed for conditioning 434.2 barrels. Total swabbed subsequent to 12:00 noon 5/26 327.2 barrels.

06/03/65 Swabbed 48.2 barrels oil in 12 hours at approximate rate of 4 barrels per hour. Total swabbed for conditioning 482.4 barrels. Total swabbed subsequent to 12:00 noon 5/26 375.4 barrels.

06/04/65 6:00 AM CP zero. Started swabbing through separator.

12:00 noon CP 35#.

5:00 PM Swabbed 32.5 barrels oil in 11 hours. Shut down. Total swabbed for conditioning 514.9 barrels. Total swabbed subsequent to 12:00 noon 5/26 407.9 barrels.

06/07/65 Pulled tubing.

Ran Halliburton wire line. Found total depth at 6681' RKB.

Ran wooden float. Bailed clean oil off bottom. No water or sediment. Fluid level 1582' RKB.

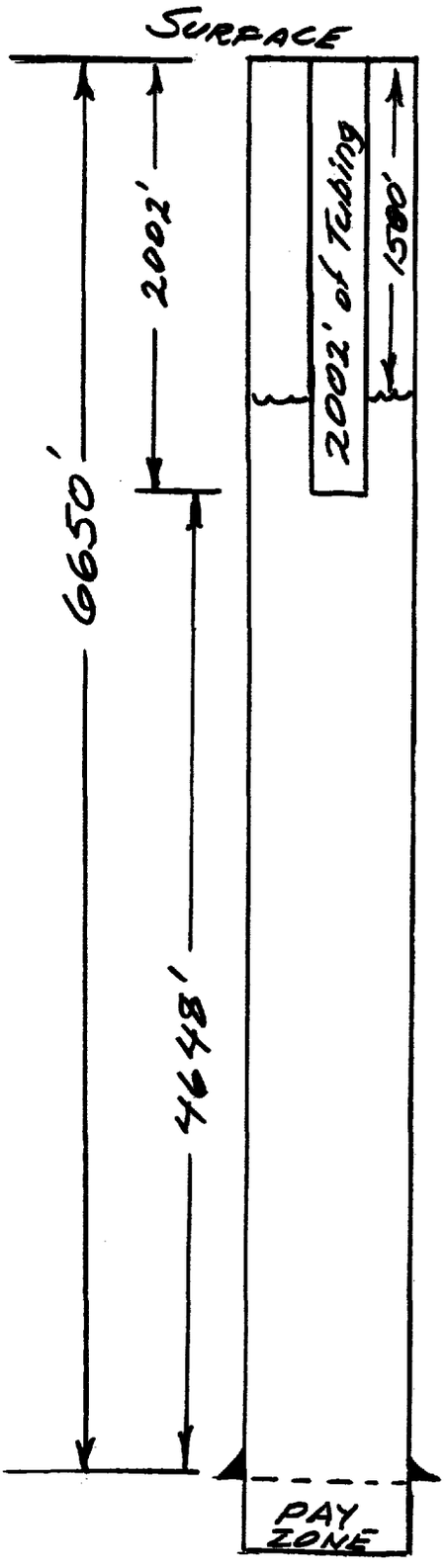
Ran bottom hole pressure bomb.

All wells shut in for interference test.

Report discontinued until operations resumed.

07/01/65 Took bottom hole sample.

CONDITIONING OF CANADA OJITOS UNIT L-11 (12-11)
MAY, 1965
PRIOR TO TAKING BOTTOM HOLE SAMPLE



Fluid Level 1580'

Swabbed at maximum rate of approximately 100 BOPD during daylight tour for 12 days for a total of 482 barrels.

At the well's PI of ± 2.25, drawdown pressure approximately 45#.

With static bottom hole pressure of ± 1670#, minimum bottom hole pressure while swabbing ± 1625#.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

July 27, 1965

RESERVOIR FLUID DIVISION

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

Attention: Mr. Albert R. Greer

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

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.

Very truly yours,

Core Laboratories, Inc.
Reservoir Fluid Division

P. L. Moses (B)

P. L. Moses
Operations Supervisor

PLM:JB:bjm
7 cc. - Addressee

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 3366

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, 1962
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, 1965
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:

CL-516

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 3366
Well Canada Ojitos Unit No. 12-11

VOLUMETRIC DATA OF Reservoir Fluid SAMPLE

1. Saturation pressure (bubble-point pressure) 1519 PSIG @ 162 °F.
2. Thermal expansion of saturated oil @ 5000 PSI $= \frac{V \text{ @ } 162\ ^\circ F}{V \text{ @ } 76\ ^\circ F} =$ 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	

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 162 °F., RELATIVE VOLUME OF OIL AND GAS, $V/V_{SAT.}$	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/V_R
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
$V_{SAT.}$ = Volume at saturation pressure and the specified temperature.
V_R = Residual oil volume at 14.7 PSI absolute and 60° F.

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.

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	

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, $V_R/V_{SAT.}$ See Foot Note (2)	FORMATION VOLUME FACTOR, $V_{SAT.}/V_R$ 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.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 3366

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

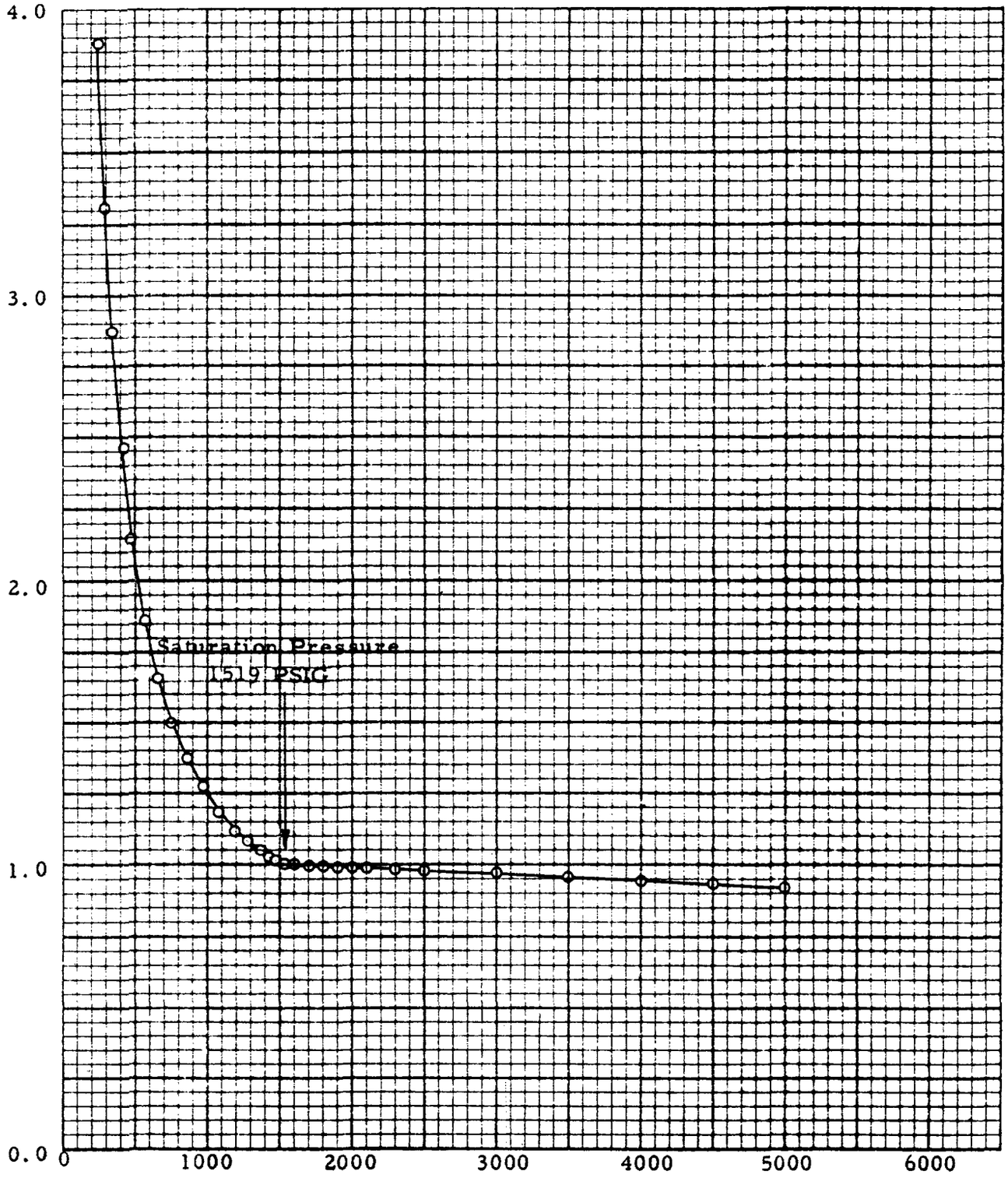
COMPONENT	MOL PER CENT	WEIGHT PER CENT	DENSITY @ 60° F. GRAMS PER CUBIC CENTIMETER	° API @ 60° F.	MOLECULAR WEIGHT
Hydrogen Sulfide					
Carbon Dioxide	0.20	0.08			
Nitrogen	0.13	0.03			
Methane	26.36	3.65			
Ethane	6.86	1.78			
Propane	6.19	2.36			
iso-Butane	1.20	0.60			
n-Butane	4.29	2.15			
iso-Pentane	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 (B)
P. L. Moses
Operations Supervisor

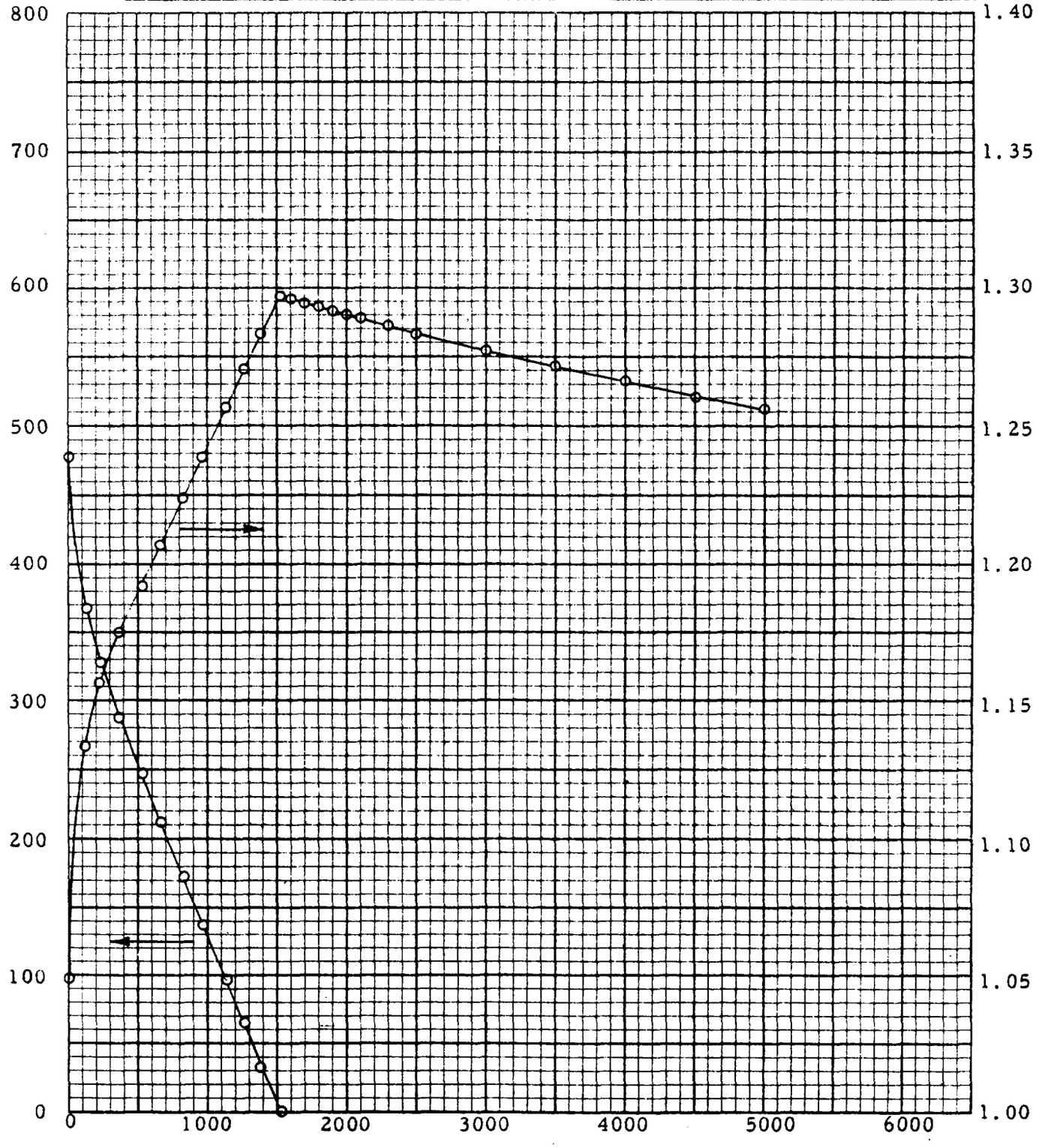
PRESSURE-VOLUME RELATIONS OF RESERVOIR FLUID

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



DIFFERENTIAL VAPORIZATION 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 Chiquito
State New Mexico



GAS LIBERATED, STANDARD CUBIC FEET PER BARREL OF RESIDUAL OIL

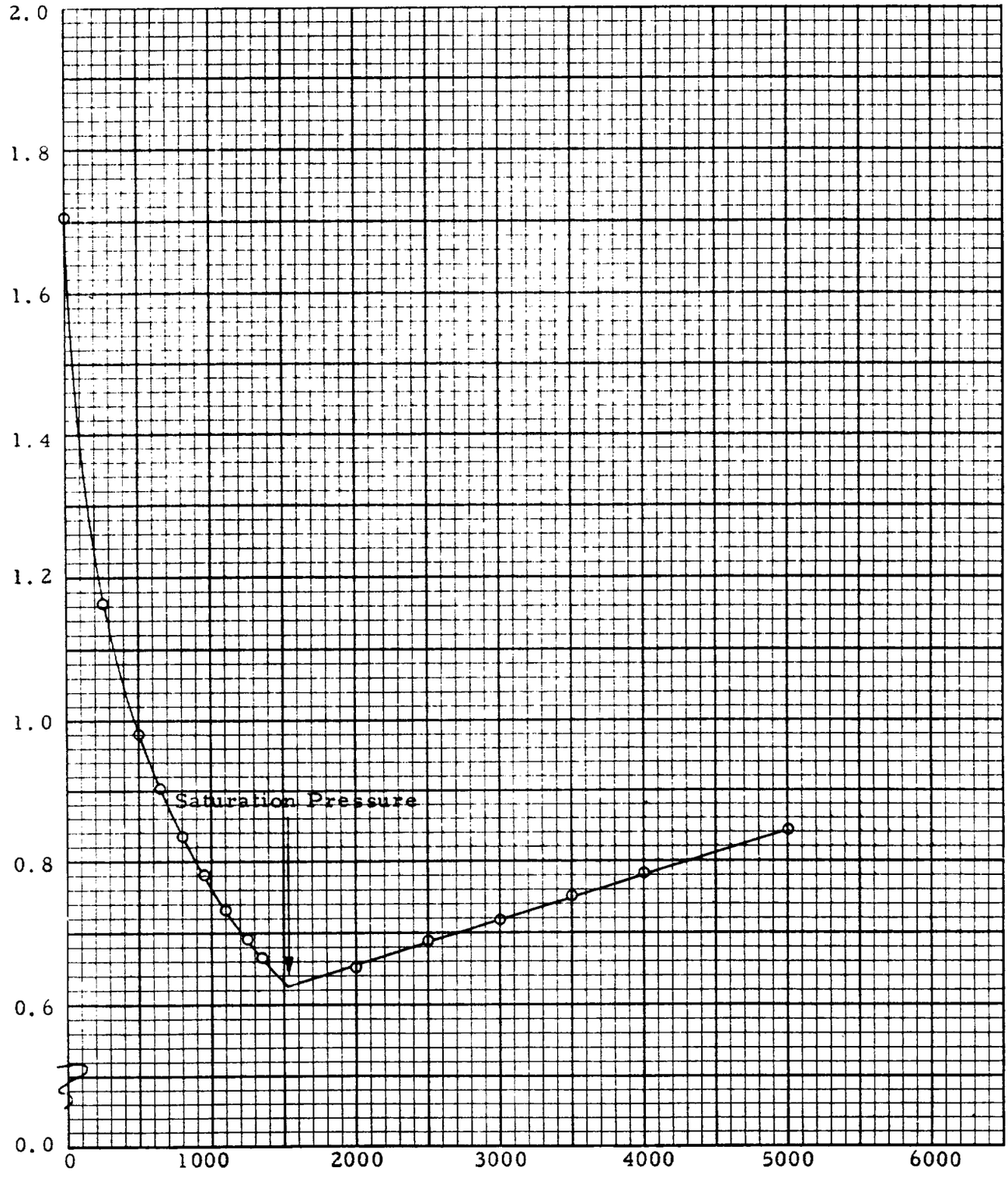
RELATIVE LIQUID VOLUME, V/V_R

PRESSURE, POUNDS PER SQUARE INCH GAUGE

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

VISCOSITY OF RESERVOIR FLUID

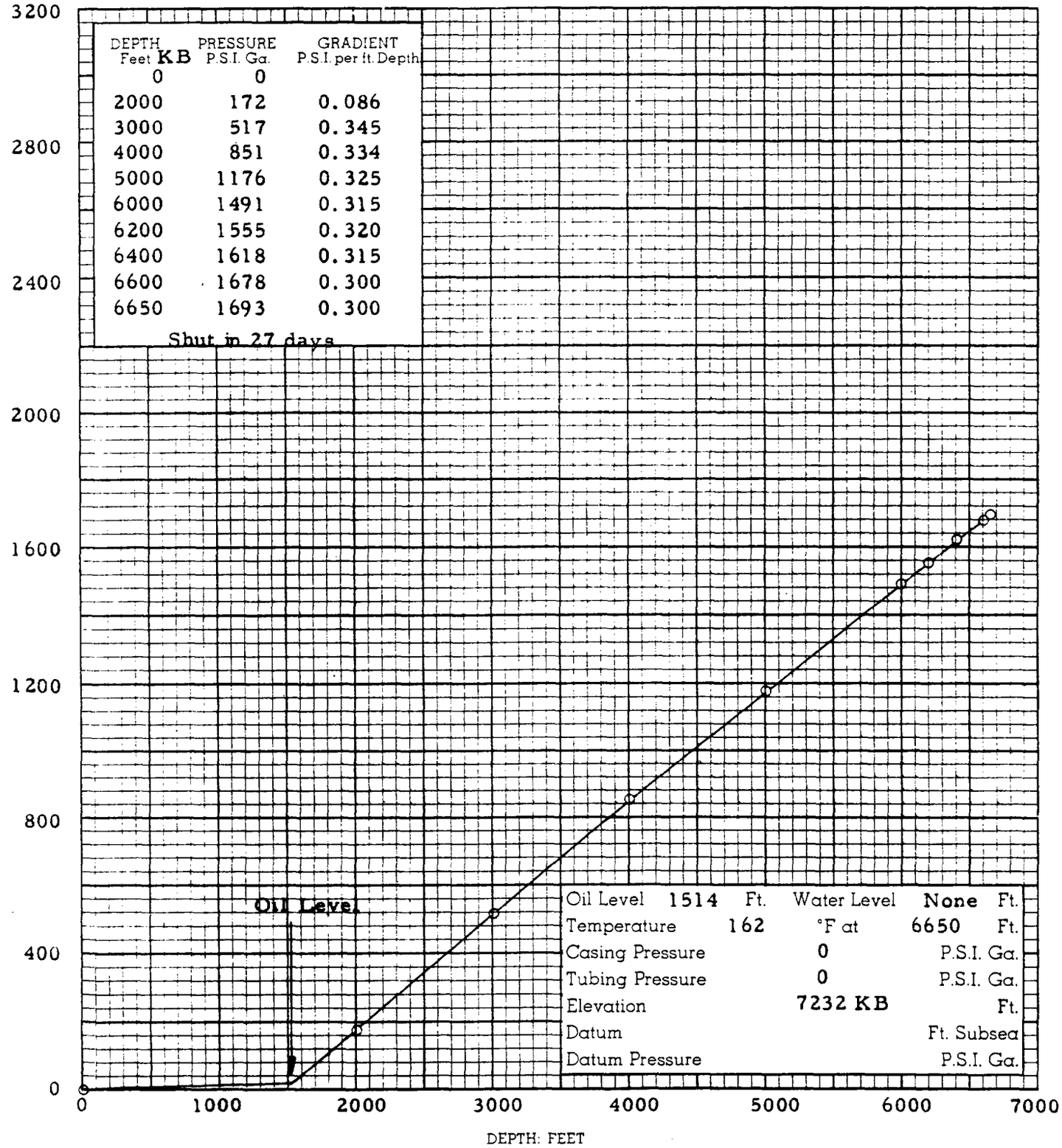
Company Benson-Montin-Greer Drilling Corporation
Well Canada Ojitos Unit No. 12-11
Field Puerto Chiquito
Formation Nio Braro (Gallup)
County Rio Arriba
State New Mexico



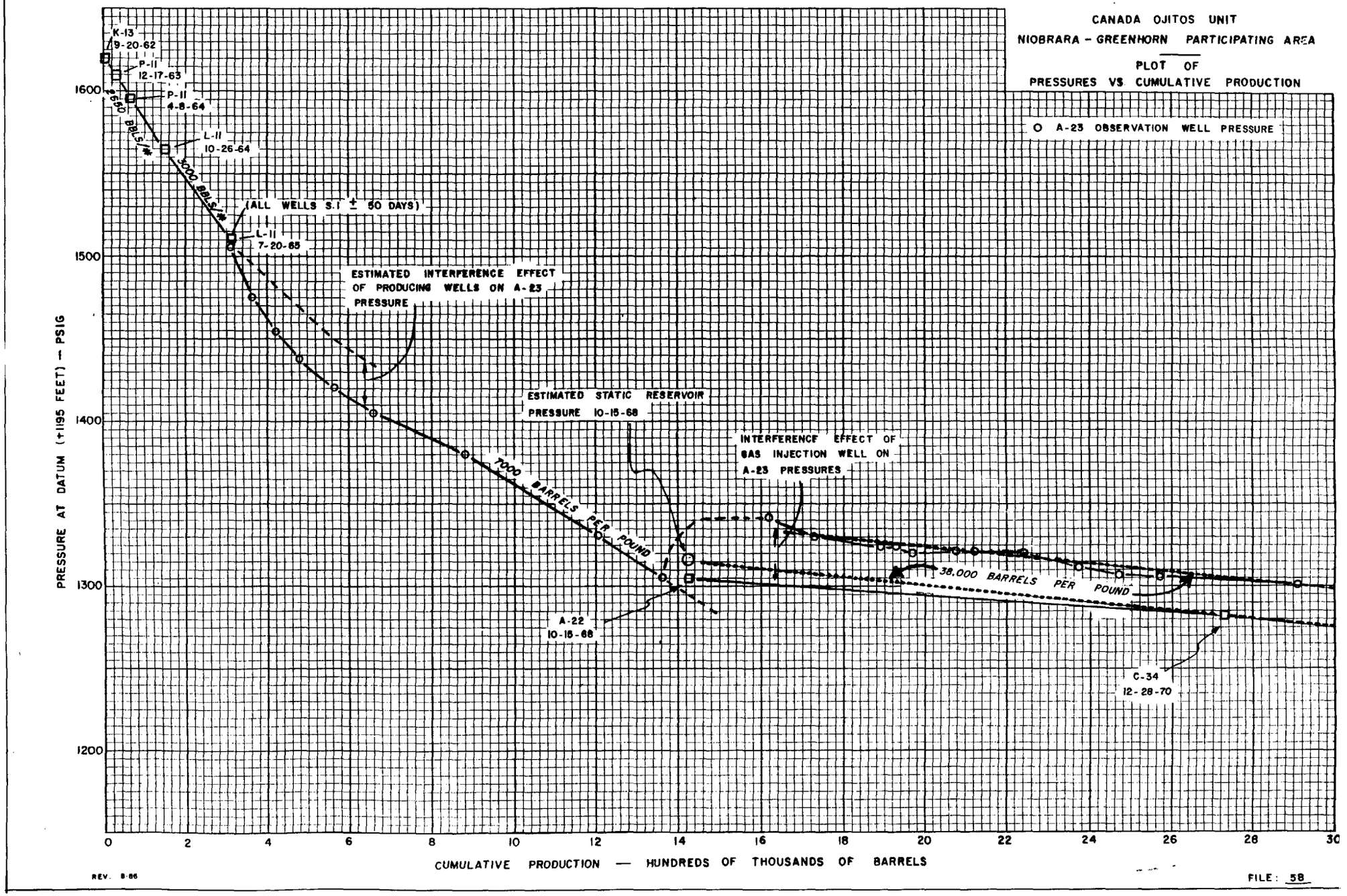
Company Benson-Montin-Greer Drilling Corporation
Well Canada Ojitos Unit No. 12-11
Field Puerto Chiquito
Formation Nio Braro (Gallup)
County Rio Arriba
State New Mexico

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.


CANADA OJITOS UNIT
NIOBRARA - GREENHORN PARTICIPATING AREA
PLOT OF
PRESSURES VS. CUMULATIVE PRODUCTION
O A-23 OBSERVATION WELL PRESSURE
K-13
9-20-62
P-11
12-17-63
P-11
4-8-64
L-11
10-26-64
5000 BBLS/#
(ALL WELLS S.I. ± 50 DAYS)
L-11
7-20-65
ESTIMATED INTERFERENCE EFFECT
OF PRODUCING WELLS ON A-23
PRESSURE
ESTIMATED STATIC RESERVOIR
PRESSURE 10-15-68
INTERFERENCE EFFECT OF
GAS INJECTION WELL ON
A-23 PRESSURES
7000 BARRELS PER POUND
38,000 BARRELS PER POUND
A-22
10-15-68
C-34
12-28-70
PRESSURE AT DATUM (+1195 FEET) — PSIG
1600
1500
1400
1300
1200
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
CUMULATIVE PRODUCTION — HUNDREDS OF THOUSANDS OF BARRELS
REV. 8-66
FILE: 58

ESTIMATED BUBBLE POINT
FOR
GAVILAN

From Canada Ojitos Unit K-13	1524# (@ 152°)	+ 54# *	= 1578#
From Canada Ojitos Unit L-11	1519# (@ 162°)	+ 24# *	= 1543#

* At 3 psi/degree (from Core Lab tests)

GAVILAN MANCOS FIELD, RIO ARRIBA CO., N.M.
J.P. MCHUGH, NATIVE SUN #1 (NE 34-25N-2W) NATIV1
Working Interest: 1.000000 Net Interest: 1.000000

Mo	Year	Status	Oil/Cond Bbls Daily*	Oil/Cond Bbls Month	Oil/Cond Bbls Cum	Gas MCF Daily*	Gas MCF Month	Gas MCF Cum	GOR	Water Bbls Daily*	Water Bbls Month	Water Bbls Cum	WC	Days Prod
7	1984		191.2	5927.	5927.	0.	0.	0.	0.	1.2	38.	38.	0.6	19.0
8	1984		286.4	8879.	14806.	0.	0.	0.	0.	2.0	62.	100.	0.7	30.0
9	1984		422.0	12658.	27464.	2.	48.	48.	4.	0.3	10.	110.	0.1	30.0
10	1984		299.5	9284.	36748.	2.	50.	98.	5.	0.3	10.	120.	0.1	30.0
11	1984		398.1	11944.	48692.	2.	48.	146.	4.	0.0	0.	120.	0.0	30.0
12	1984		2.0	42.	48839.	0.	2.	148.	32.	0.0	0.	120.	0.0	1.0
Subtotal 1984				48839.			148.				120.			140.0
1	1985	SI	0.0	0.	48839.	0.	0.	148.	0.	0.0	0.	120.	0.0	0.0
2	1985	SI	0.0	0.	48839.	0.	0.	148.	0.	0.0	0.	120.	0.0	0.0
3	1985		40.1	1244.	50083.	0.	6.	154.	5.	0.0	1.	121.	0.1	4.0
4	1985		156.2	4686.	54769.	167.	5004.	5158.	1068.	0.0	0.	121.	0.0	30.0
5	1985		184.0	5703.	60474.	11.	331.	5489.	58.	0.0	0.	121.	0.0	31.0
6	1985		415.1	12454.	72928.	20.	586.	6075.	47.	0.0	0.	121.	0.0	0.0
7	1985		347.1	11461.	84389.	175.	5428.	11503.	477.	0.0	0.	121.	0.0	31.0
8	1985		421.9	13075.	97464.	195.	6039.	17542.	462.	0.6	20.	141.	0.2	31.0
9	1985		357.1	10714.	108178.	134.	4009.	21551.	374.	0.0	0.	141.	0.0	30.0
10	1985		371.0	11500.	119678.	121.	3828.	25379.	333.	0.0	0.	141.	0.0	31.0
11	1985		419.2	12575.	132253.	147.	4395.	29774.	350.	0.0	0.	141.	0.0	27.0
12	1985		382.3	11528.	141781.	81.	2514.	32288.	268.	0.0	0.	141.	0.0	31.0
Subtotal 1985				92704.			32140.				21.			246.0
1	1986		371.6	11521.	153864.	117.	3623.	35911.	314.	0.0	0.	141.	0.0	27.0
2	1986		419.6	11750.	165614.	173.	4851.	40762.	413.	0.0	0.	141.	0.0	27.0
3	1986		379.9	11776.	176390.	136.	4216.	44978.	358.	0.0	0.	141.	0.0	31.0
4	1986		287.8	8634.	185024.	81.	2432.	47410.	282.	0.0	0.	141.	0.0	30.0
5	1986		334.5	10370.	195394.	62.	1912.	49322.	184.	0.0	0.	141.	0.0	31.0
Subtotal 1986				54053.			17034.				0.			146.0

* Per Calendar Day

Initial Potential: 6/84 198 BOPD, 324 MCFD, IPF

MALLON & MESA GRANDE
EXHIBIT MARKED
PRODUCING HISTORY
CASE NO. 8946

GAVILAN MANCOS FIELD, RIO ARRIBA CO.
J.P. MCHUGH, HOMESTEAD RANCH #2, (SW 34-25N-2W) HORA2
Working Interest: 1.000000 Net Interest: 1.000000

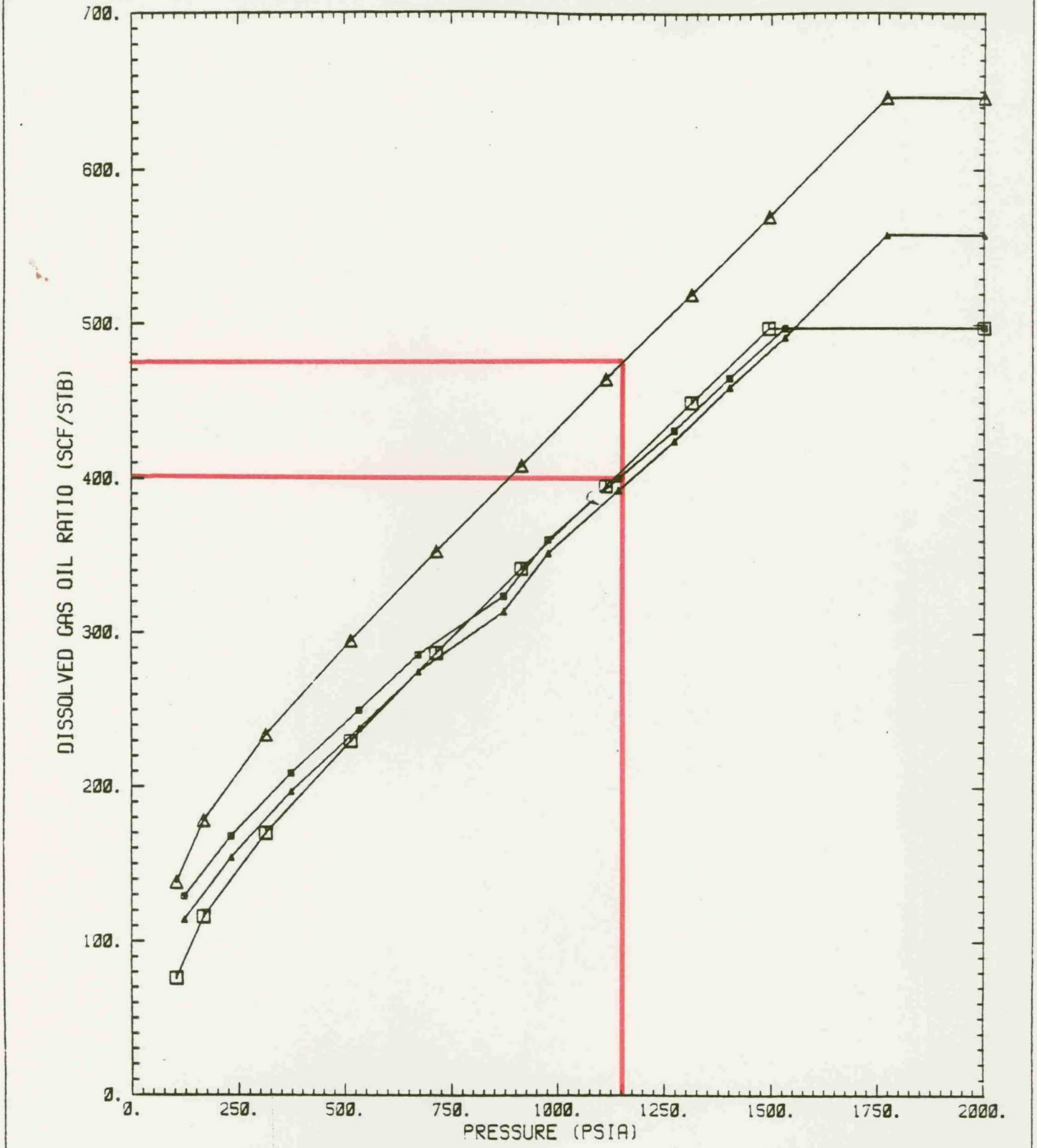
			Oil/Cond Bbls			Gas MCF				Water Bbls				Days
o	Year	Status	Day#	Month	Cum	Day#	Month	Cum	GOR	Day#	Month	Cum	WC	Prod
5	1985	O	533.4	2667.	2667.	122.	610.	610.	229.	0.0	0.	0.	0.0	5.0
6	1985	SI	0.0	0.	2667.	0.	0.	610.	0.	0.0	0.	0.	0.0	0.0
7	1985	O	323.0	646.	3313.	120.	240.	850.	372.	5.0	10.	10.	1.5	2.0
8	1985	SI	0.0	0.	3313.	0.	0.	850.	0.	0.0	0.	10.	0.0	0.0
9	1985	SI	0.0	0.	3313.	0.	0.	850.	0.	0.0	0.	10.	0.0	0.0
10	1985	O	517.1	4654.	7967.	192.	1727.	2577.	371.	0.6	5.	15.	0.1	9.0
11	1985	O	670.2	20105.	28072.	249.	7460.	10037.	371.	0.3	10.	25.	0.0	30.0
12	1985	O	648.7	12973.	41045.	241.	4814.	14851.	371.	0.5	10.	35.	0.1	20.0
Subtotal		1985		41045.			14851.				35.			66.0
1	1986	SI	0.0	0.	41045.	0.	0.	14851.	0.	0.0	0.	35.	0.0	0.0
2	1986	SI	0.0	0.	41045.	0.	0.	14851.	0.	0.0	0.	35.	0.0	0.0
3	1986	SI	0.0	0.	41045.	0.	0.	14851.	0.	0.0	0.	35.	0.0	0.0
4	1986	SI	0.0	0.	41045.	0.	0.	14851.	0.	0.0	0.	35.	0.0	0.0
5	1986	O	570.0	14249.	55294.	120.	2992.	17843.	210.	0.0	0.	35.	0.0	25.0
Subtotal		1986		14249.			2992.				0.			25.0

Per Producing Day

Initial Potential: 5/85 700 BOPD, 260 Mcfd, IPF

GREER NOTE:
1st delivery into
M&H P/L system

MALLON & MESA GRANDE
EXHIBIT MARKED
PRODUCING HISTORY
CASE NO. 8946



MALLON/MGR

GAVILAN MANCOS POOL
DISSOLVED GAS OIL RATIO PLOTS

SCALE: NTS	DATE: 04-AUG-86
SOURCE:	DRAWING NO. 1

Jerry R. Bergeson & Associates Inc.