SUMMARY OF PORE VOLUME ESTIMATES *
FROM INTERFERENCE AND FRAC PULSE TESTS
WEST PUERTO CHIQUITO AND GAVILAN
AND FROM
PRESSURE DECLINE WITH PRODUCTION FROM GAVILAN

Date	Type Test	Observation Well	Observation Well Location Sec.-Twp-Rge	Zone(s) Open Obs. Well	Zone(s) Open Active Well(s)	Pore Volume Porosity Feet (øh)
Sept. 1965	Interference: Oil Production	COU A-14	14-25N-1W	C	C	.17 to .42
Aug. 1968	Interference: Gas Injection	COU A-23	23-25N-1W	C	C	.27
May 1986	Interference: Oil Production	COU E-6	6-25N-1W	A - B (&C)	A - B (&C)	.3
July 1987	Interference: Oil Production	Native Son 3	33-25N-2W	A - B (&C)	A - B (&C)	.18
Nov. 1987	Interference: Oil Production	COU D-17	17-25N-1W	A - B - C	A - B - C	.14

Date	Type Test	Observation Well	Observation Well Location Sec.-Twp-Rge	Treated Well	Zone(s) Open Obs. Well	Zone(s) Open Treated Well	Pore Volume Porosity Feet (øh)
Feb. 1986	Frac Pulse: Water Frac	COU E-6	6-25N-1W	Tapa. 4	A - B (&C)	A - B (&C)	.47
Apr. 1986	Frac Pulse: Water Frac	COU E-6	6-25N-1W	COU N-31	A - B (&C)	A - B (&C)	.25
Sept. 1986	Frac Pulse: Water Frac	COU B-32	32-25N-1W	COU F-30	A - B - C	A - B - C	.31
Apr. 1987	Frac Pulse: Water Frac	COU B-32	32-25N-1W	COU C-34	A - B - C	A - B	.19
July-Nov. 1987	Production with pressure decline (OCD test)						.20 to .25

Note: (&C) means C zone open, but questionable production.

* As used herein, "pore volume" means effective hydrocarbon pore space (believed to be essentially fracture porosity). It is not intended to mean "porosity" as in matrix porosity.

RECOMMENDED METHOD FOR SETTING ALLOWABLES

In view of the peculiar nature of this reservoir and the fact that the operators cannot agree among themselves as to proper allowables and oil recoveries, it is recommended that the allowable issue be approached from the standpoint of a gas limit.

This procedure would eliminate one of the fundamental arguments: the percent of the oil in place which is recoverable.

The amount of oil recoverable depends upon the producing mechanism; and the operators are not in agreement as to the producing mechanism nor as to the percentage of oil in place which can be expected to be recovered. On the other hand, the amount of gas which will ultimately be recovered is independent of the producing mechanism: when the reservoir pressure reaches the abandonment pressure, all gas in solution down to that pressure will have been produced, regardless of the oil producing mechanics.

A further benefit of using gas for the basic consideration: it makes little difference which sample analysis is used - the recoverable gas volume per acre is about the same.

On the facing page is a schedule showing the reasonable amount of gas recoverable on an average 640 acre tract. (In Case 8950, August 1986, barrels per acre of hydrocarbon pore space was estimated at 4500 barrels for all three Niobrara zones. It is now apparent that this figure was optimistically high.)

In the same case in March 1987 the figure of 3500 barrels per acre was used and noted then that it was probably high. Used here is 2300 barrels per acre - and this is probably representative of only the better parts of the reservoir.

Once a reasonable <u>minimum</u> length of time to produce the gas allowable is fixed (2.4 years by the schedule on the facing page), then the setting of a gas-oil ratio limit will provide the top oil allowable. This schedule indicates for a 600:1 gas-oil ratio limit that the top allowable should be 800 BOPD for a 640 acre proration unit.

ESTIMATE OF PER-ACRE RECOVERABLE GAS
BASED ON 2300 BARRELS PER ACRE HYDROCARBON PORE SPACE
(Approximately .3 porosity feet of hydrocarbon pore volume)

(ADAPTED FROM CASE 9113, MARCH 30, 1987, B-M-G EXHIBIT 1, SECTION T)

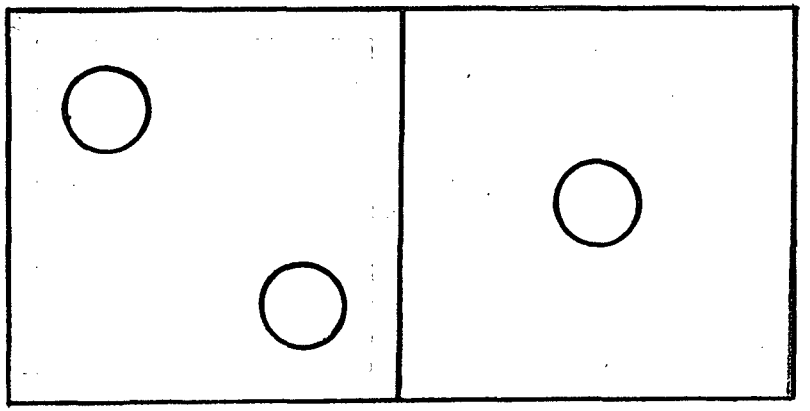
	Data from: Loddy Sample	Data from: COU L-11 Sample
1) Initial FVF	1.38	1.29
2) Initial Solution GOR, cf/bbl	588	480
3) Solution GOR at Abandonment 150 psig, cf/bbl	180	120
4) Gas Produced per Stock Tank Barrel (line 1 - line 3)	408	360
5) Oil in Place Stock tank barrels per acre (2300 divided by line 1)	1667	1783
6) Recoverable Gas per Acre, MCF (line 4 x line 5) divided by 1000	680	640
	(use 660 MCF/acre)	

	Spacing Unit 640 Acres	Spacing Unit 320 Acres
7) Recoverable Gas at ~~600~~ 660 MCF per Acre, MCF	420,000	210,000
8) Average Rate of Gas Production if Reserves are Produced in 2.4 Years (MCF/day)	480	240
9) Corresponding Oil Allowables at 600 cf/bbl Limiting GOR	800	400

DEPLETION RATES IN TERMS OF ACRES OF RESERVES PRODUCED PER DAY FOR DIFFERENT GAS ALLOWABLES

Per Well Allowable (MCF/D) 320 Acres Per Well	Per Well Allowable (MCF/D) 640 Acres Per Well	Reservoir Depletion Rate (Acres/Day) 320 Acres	Reservoir Depletion Rate (Acres/Day) 640 Acres	Time to Deplete Tract's Reserves
1400	2800	2.12	4.24	150 days
700	1400	1.06	2.12	300 days
350	700	0.53	1.06	1.6 years
240	480	0.36	0.72	2.4 years

ISSUE OF UNEQUAL DRAINAGE FOR MIXED SPACING UNITS FOR WELLS PRODUCING AT CAPACITY



If wells are producing at capacity, then one well on a 640-acre proration unit cannot produce the same volume as two wells on an adjoining 640-acre proration unit.

The higher the allowable, the greater the number of proration units affected and the worse this problem becomes.