

JEROME P. McHUGH EXHIBITS
IN CASE NO. 7980
BEFORE THE OIL CONSERVATION DIVISION OF THE
NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

NOVEMBER 16, 1983

INDEX OF
JEROME P. McHUGH EXHIBITS
IN CASE NO. 7980
BEFORE THE OIL CONSERVATION DIVISION OF THE
NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

NOVEMBER 16, 1983

PART I

EFFECTIVE HYDROCARBON PORE SPACE IN THE NIOBRARA MEMBER OF
THE MANCOS FORMATION IN BOULDER AND WEST PUERTO CHIQUITO
POOLS AND IN ITS EQUIVALENT ("GALLUP") FORMATION OF
THE WEST LINDRITH GALLUP-DAKOTA POOL

SECTION A: Maps and Summary Statistics

1. Plat showing well spacing and drilled density of pools in the vicinity of the lands of the subject application
2. Plat showing for Boulder, West Puerto Chiquito and Lindrith Gallup-Dakota the per-acre effective hydrocarbon pore space volumes for the Mancos formation
3. Summary of analyses of effective hydrocarbon pore space for Boulder and West Puerto Chiquito Mancos
4. Summary of analyses of effective hydrocarbon pore space for West Lindrith Gallup-Dakota

SECTION B: Methods of Interpretation

1. Reference to study being Exhibit I, NMOCD Case 3455, November 16, 1966
2. Values of K/ϕ for sandstone and fracture system
3. Sketch showing compressible reservoir fluids
4. Graph: Compressibility of formation water
5. Graph: Reservoir rock compressibilities
6. Graph: Gas compressibility factors
7. Graph: Formation volume factors
8. Graph: Compressibility of saturated oil

SECTION B: Continued

9. Graph: Initial pressure production history, Canada Ojitos Unit

SECTION C: Effective Hydrocarbon Pore Space for Boulder

1. Boulder: Pressure vs. Production
2. Boulder: Oil in Place vs. Percent Undersaturated Oil for Production Pressure Coefficient of 1200 bbl/pound
3. Boulder: Oil in Place vs. Percent Understaurated Oil for Production Pressure Coefficient of 3000 bbl/pound
4. Boulder: Oil in Place From Combination of 2 and 3 above

SECTION D: Effective Hydrocarbon Pore Space for Canada Ojitos Unit

1. Graph: Pressure vs. Cumulative Production (green)
2. Graph: Oil in Place for Pressure Production Coefficient of 3000 bbls/pound (Plate marked IV-3)
3. Graph: Oil in Place for Pressure Production Coefficient of 6000 bbls/pound (Plate marked IV-4)
4. Graph: Oil in Place as Function of Change in Amount of Undersaturated Oil (Plate marked IV-8)
Note: Items identified in NMCCD Case 7075, November 24, 1980 (blue book, Section C)

SECTION E: Extension of Individual Transient Flow Data to Interference Test Analyses

1. Exponential integral values
2. Pressure gradients before and after induced fracture in a well
3. Reservoir average permeability characteristics

SECTION E: Continued

4. Plate showing variation in pressure in observation wells with wellbore size in producing wells

SECTION F: 1965 and 1968 Interference Test Canada Ojitos Unit

1. Plate of phases - 1965 test
2. Sketch of fluid level measurement - 1965 test
3. Sketch showing method of obtaining working bottom hole pressure - 1965 test
4. Plot of fluid levels - 1965 test
5. Plot of portion of fluid level test - 1965 test
6. Plots of fluid level decline - 1965 test
7. Table of calculated oil in place volumes - 1965 test
8. 1968 Interference test - plot of fluid levels with calculated curves
9. 1968 Interference test - plot of fluid levels with estimated curves
10. Plat showing area of interference test - 1968

SECTION G: Analyses of Production Statistics

1. Title page
2. Types of decline curves
3. Rate-time method introduction
- 3A Graph: rate vs. time and rate vs. cumulative (blue)
4. Infirmities of rate-time methods

SECTION H: Analyses of Production Statistics

1. Introduction
2. Tank battery sketch (blue)

SECTION I: Analyses of Production Statistics

1. Introductory page
2. Graph of two wells (yellow)
3. Introduction to rate-cumulative method
4. Graph: rate vs. cumulative (green)
5. Item 3 above continued
6. Plot of rate vs. cumulative (green)
7. Example of rate vs. cumulative production

SECTION J: Example of Problem With Rate-Time Method

1. Introduction
2. Statistics tabulated (gold)
3. Plot of statistics (blue)
4. Rate-cumulative introduction
5. Graph of rate-cumulative (pink)

SECTION K: Problem of First Well Draining More Than its Spacing Unit

1. Introduction
2. Graph (buff)

SECTION L: Statistical Analyses Continued (Variable Rates of Development)

1. Introduction
2. Graph of first 3 wells (green)
3. Graph showing second 3 wells drilled in rapid sequence (yellow)

SECTION M: Hyperbolic Decline Characteristics

1. Introduction
2. Plate I of hyperbolic decline (blue)
3. Plate II of hyperbolic decline (pink)

SECTION N: West Lindrith Gallup-Dakota Selected
Properties of Arco, Cotton and Conoco

1 & 2: Arco leases (yellow)

3, 4 & 5: Cotton leases (green)

6: Conoco leases (pink)

SECTION O: Plot of Production History

1. Graph: Arco properties (yellow)

2. Graph: Cotton properties (green)

SECTION P: Plot of Production History - Conoco Leases

1. Graph: Lease total production vs. time

2. Graph: Per-well production rate vs. time

3. Graph: Per-well production rate vs.
cumulative Plate I (pink)

4. Graph: Per-well production rate vs.
cumulative Plate II (pink)

SECTION Q: Effective Hydrocarbon Porosity

1. Title page

2 & 3: Lindrith Gallup-Dakota, West
description (yellow)

4: Graph: comparison volumetric analyses vs.
production decline extrapolation (blue)

SECTION R: Interference Effects and Drainage - West
Lindrith Gallup-Dakota Pool

1. Graph of production rate vs. cumulative -
Conoco leases (pink)

2. Plat showing Conoco leases in drilled
locations - 1975 (pink)

3. Plat showing Conoco leases in drilled
locations - 1982 (pink)

4. Plat of selected interference test well
(Conoco 3-J-22-25-4)

5. Graph of above selected interference test
well (blue)

SECTION R: Continued

6. Plate of 3 selected interference test wells (Conoco 4-K-18-25-4, 3-K-20-25-4 and 5-P-20-25-4 wells)
7. Graph of above 3 selected interference test wells (gold)
8. Summary of statistical analyses - West Lindrith Gallup-Dakota pool

SECTION S: Characteristics of Reservoir Rock Showing Reservoirs to be of Fracture Porosity

1. Introduction
2. Boulder Mancos description (yellow)
3. Puerto Chiquito Mancos West description (pink)
- 3A. Type log
4. Characteristics of the reservoir rock introduction
5. Lithology
6. Cores
7. Core data (yellow)
8. Interference test
9. Canada Ojitos Unit C-34 introduction
10. Graph: Canada Ojitos Unit C-34 production (pink)
11. Completion and drill stem testing
12. Sketch of drilling fluid distribution in sand
13. Sketch of drilling fluid distribution in a fracture reservoir

SECTION T: Solution Gas Drive Recovery

1. Sketch of solution gas vs. depth
2. Sketch of relative permeability - sandstone - Phase I

SECTION T: Continued

3. Sketch of relative permeability - sandstone - Phase II
4. Sketch of relative permeability - sandstone - Phase III
5. Sketch of relative permeability - fracture reservoir - Phase I
6. Sketch of relative permeability - fracture reservoir - Phase II
7. Sketch of relative permeability - fracture reservoir - Phase III
8. Sketch - effect of cementing of sand grains
9. Graph: K_g/K_o
10. Comparison of oil recoveries: fractured reservoir vs. sand

SECTION U: Gravity Drainage Recoveries

1. Introductory page referring to Exhibit 2 of NMOCD Case 3455, December, 1969
2. Sketch showing variable gas-oil ratios for well locations (yellow)
3. Graph of gravity drainage rates
4. K/ϕ graph locating Empire Abo characteristics
5. Graph of gravity drainage rates showing Empire Abo

SECTION V: Production Graphs Showing Large Cumulative Recoveries Under Gravity Drainage with Low Gas-Oil Ratios Compared with Gavilan Reported Gas-Oil Ratios

1. E-10 graph (pink)
2. P-11 graph (green)
3. L-11 graph (blue)
4. L-27 graph (buff)

SECTION W: Production Performance First Well in Gavilan
Extension of West Puerto Chiquito

1. 4-well east-west cross-section
2. Northwest Exploration #1 Gavilan production statistics
3. Average production rates from previous page
4. Comparison of Northwest Exploration #1 Gavilan 15 months' production with cumulative production in West Lindrith Gallup-Dakota Mancos formation
5. Graph comparing West Lindrith Gallup-Dakota production with first well in West Puerto Chiquito and first well in Gavilan extension of West Puerto Chiquito