

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/23/91

WELL NAME: ANDRIKOPOULOS 1

DATA SHEETS

INTERVAL: 14986-15209' MORROW

STIMULATED ? (Y/N): YES; 5000G BHPBU MATCH

FLOW RATE (MCF/D): 1,080

FLOW TIME (HRS.): 58

FLOWING BHP (psia): 1,058

GAS GRAVITY (Yg): 0.576

PAY HEIGHT: 19

TEMP. DEGREE F (T): 205

Z-FACTOR: 1.600

RESERVOIR PRESSURE (Pi): 11,421

GAS COMPRESSIBILITY: 0.00003

GAS POROSITY: 0.044

GAS VISCOSITY (cp): 0.0407

WELLBORE RADIUS (Ft): 0.333

SPACING ACRES: 320

SKIN FACTOR: 1.7

FORMATION VOLUME FACTOR (Bg): 0.454

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.1212

RADIUS OF DRAINAGE (Ft): 589.9

CALCULATED K (md): 0.1212

STEADY TIME (HRS.): 1,864.08

STABILIZED FLOW (MCF/D): 908.25

AOF PRESSURE (psia): 246

STABILIZED AOF (MCF/D): 979

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/23/91

WELL NAME: ANDRIKOPOULOS 1

INTERVAL: 14986-15209' MORROW

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FLOW RATE (MCF/D): 1,080

FLOW TIME (HRS.): 58

FLOWING BHP (psia): 1,058

GAS GRAVITY (Yg): 0.576

TEMP. DEGREE F (T): 205

RESERVOIR PRESSURE (Pi): 11,421

GAS POROSITY: 0.044

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 19

Z-FACTOR: 1.600

GAS COMPRESSIBILITY: 0.00003

GAS VISCOSITY (cp): 0.0407

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.454

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0945

RADIUS OF DRAINAGE (Ft): 520.9

CALCULATED K (md): 0.0945

STEADY TIME (HRS.): 2,389.68

STABILIZED FLOW (MCF/D): 891.46

AOE PRESSURE (psia): 246

STABILIZED AOE (MCF/D): 961

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/21/91

WELL NAME: ANDRIKOPOULOS 1  
INTERVAL: 14986-15209' MORROW  
STIMULATED ? (Y/N): NO; UNDERBALANCED  
FLOW RATE (MCF/D): 237  
FLOW TIME (HRS.): 11  
FLOWING BHP (psia): 260

GAS GRAVITY (Yg): 0.576  
TEMP. DEGREE F (T): 205  
RESERVOIR PRESSURE (Pi): 11,044  
GAS POROSITY: 0.044  
WELLBORE RADIUS (Ft): 0.333  
SKIN FACTOR: 0.0

PAY HEIGHT: 19  
Z-FACTOR: 1.546  
GAS COMPRESSIBILITY: 0.00003  
GAS VISCOSITY (cp): 0.0407  
SPACING ACRES: 320  
FORMATION VOLUME FACTOR (Bg): 0.454

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0146  
RADIUS OF DRAINAGE (Ft): 89.2  
CALCULATED K (md): 0.0146

STEADY TIME (HRS.): 15,464.61

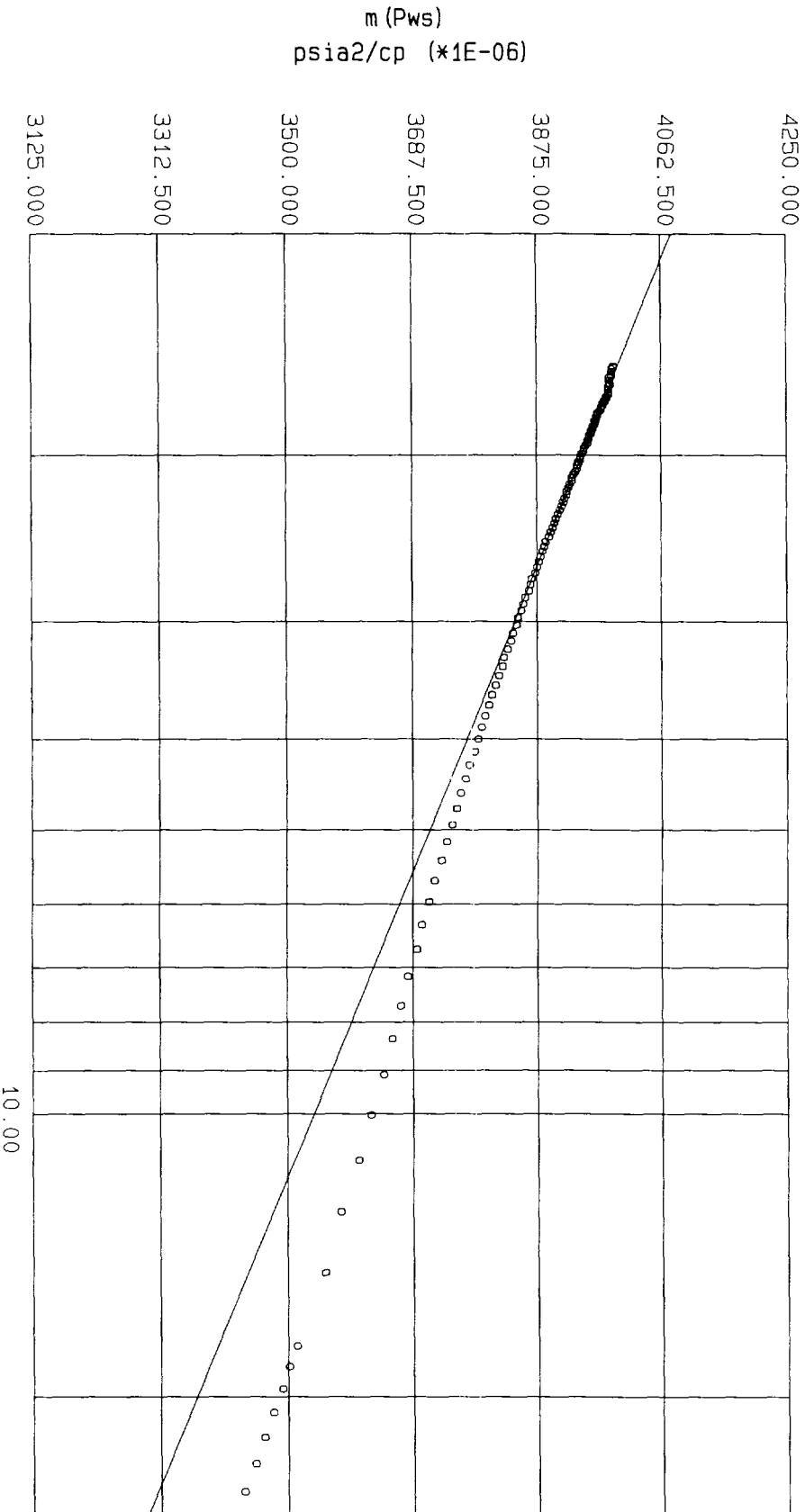
STABILIZED FLOW (MCF/D): 143.35  
AOF PRESSURE (psia): 246  
STABILIZED AOF (MCF/D): 144

# ANDRIKOPULOS FEDERAL NO. 1 - HORNER

|              |                            |               |                        |                |          |
|--------------|----------------------------|---------------|------------------------|----------------|----------|
| File.....    | AMAND.GAS                  | Location..... | LEA COUNTY, NEW MEXICO | Slope.....     | -576.724 |
| Company..... | AMOCO                      | Date.....     | 4/23/80 - 4/28/80      | Intercept..... | 4116.741 |
| Well.....    | ANDRIKOPULOS FEDERAL NO. 1 | Test.....     | BUILDUP PLUG @ 12128'  | Permeability.. | 0.1081   |
| Field.....   | UNDESIGNATED MORROW        | Gauge.....    | AMERADA                | Skin.....      | 1.738    |

Pseudo-time from start of test (hours)

8.00

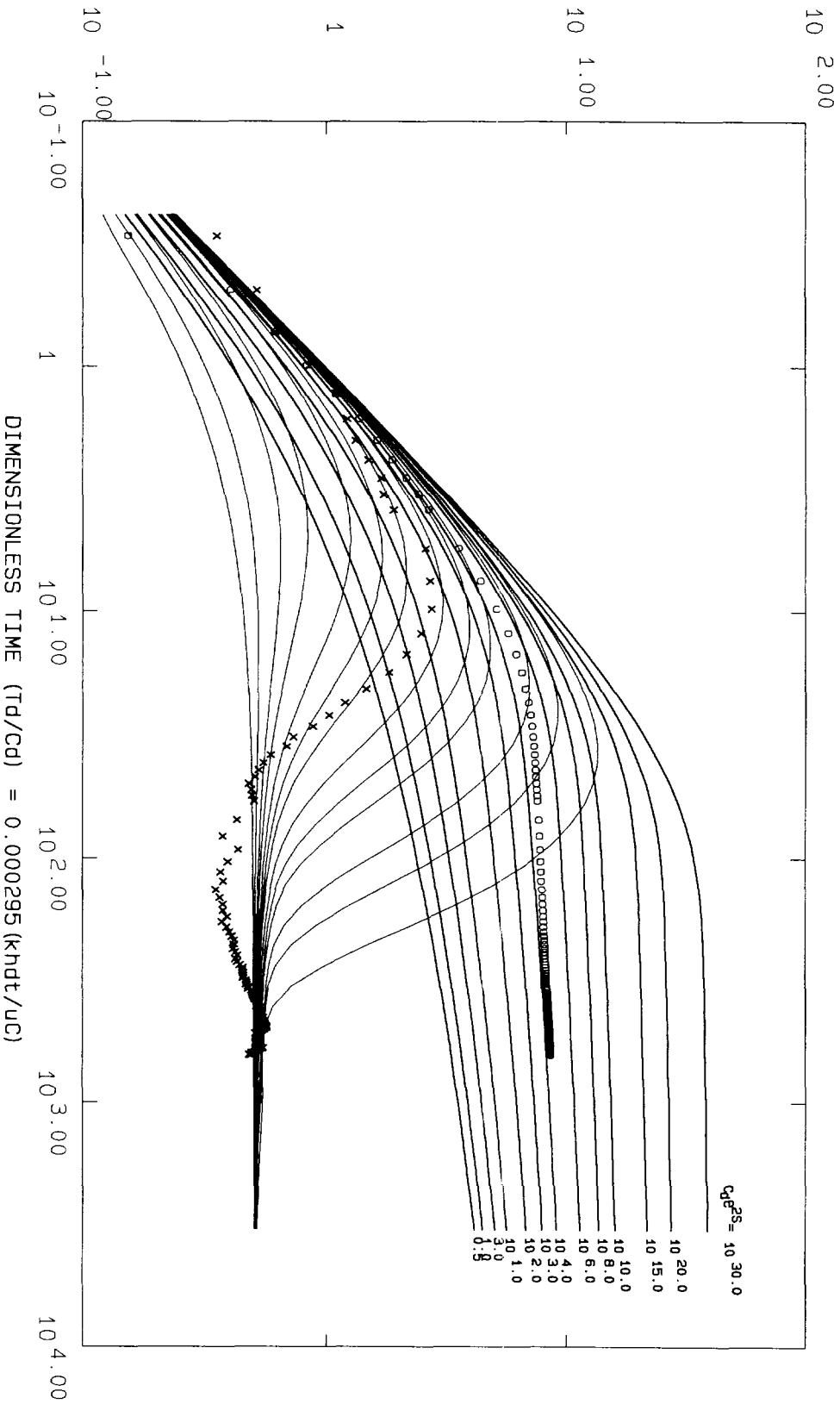


PANSYSTEM V1.8 (C) EPS 1991.

# ANDRIKOPoulos FEDERAL NO. 1 - HOMOGENEOUS RESERVOIR

|              |                             |               |                        |                |        |               |           |
|--------------|-----------------------------|---------------|------------------------|----------------|--------|---------------|-----------|
| File.....    | AMAND GAS                   | Location..... | LEA COUNTY, NEW MEXICO | Pd(match)..... | 0.0221 | dp(match)...  | 10.000    |
| Company..... | AMOCO                       | Date.....     | 4/23/80 - 4/28/80      | Td(match)..... | 14.440 | dt(match)...  | 1.000     |
| Well.....    | ANDRIKOPoulos FEDERAL NO. 1 | Test.....     | BUILDUP PLUS @ 12128'  | Permeability.. | 0.1195 | dp (skin)...  | 3097.428  |
| Field.....   | UNDESIGNATED MORRON         | Gauge.....    | AMERADA                | Skin.....      | 2.120  | C(Storage)... | 1.315E-03 |

$$\text{DIMENSIONLESS PRESSURE } P_d = (khT_{sc}/50300qTP_{sc}) dm(P)$$



E.P.S. Ltd.

PANSYSTEM ANALYSIS PROGRAM

File: AMAND.GAS ,AMAND.PRO

Test type: CRB

Date: 23/11/91 Time: 12:02

RESULTS FROM HORNER ANALYSIS  
using Pseudo-pressure and Pseudo time

Line :

|                                    |                    |
|------------------------------------|--------------------|
| Intercept.....:                    | 4116.741           |
| Slope.....:                        | -576.724           |
| Start of line.....:(               | 0.4199 , 3875.355) |
| End of line.....:(                 | 0.2639 , 3964.815) |
| Coefficient of determination.....: | 0.9991             |
| Number of points.....:             | 44                 |

|                                   |           |                   |
|-----------------------------------|-----------|-------------------|
| m(p) at dt = 1 hr.....:           | 3042.311  | psia2/cp (*1E-06) |
| Extrapolated m(p).....:           | 4116.741  | psia2/cp (*1E-06) |
| Permeability-thickness (kh).....: | 2.054     | md.ft             |
| Permeability (k).....:            | 0.1081    | md                |
| Total skin factor (s).....:       | 1.738     |                   |
| dP skin (constant rate).....:     | 2872.779  | psi               |
| Radius of investigation.....:     | 217.004   | ft                |
| Extrapolated pressure.....:       | 11421.071 | psia              |
| Pressure at dt = 1 hour.....:     | 8844.791  | psia              |
| Flow efficiency.....:             | 0.7841    |                   |

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/23/91

WELL NAME: *BELL LAKE 2 ST 1*

INTERVAL: 14819-892

STIMULATED ? (Y/N): YES; 3500 GAL ACID

FLOW RATE (MCF/D): 356

FLOW TIME (HRS.): 297

FLOWING BHP (psia): 1,150

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,745

GAS POROSITY: 0.120

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 27

Z-FACTOR: 1.377

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0316

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.500

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0217

RADIUS OF DRAINAGE (Ft): 300.7

CALCULATED K (md): 0.0217

STEADY TIME (HRS.): 36,726.81

STABILIZED FLOW (MCF/D): 272.40

AOI PRESSURE (psia): 74

STABILIZED AOI (MCF/D): 306

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/23/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 14819-892

STIMULATED ? (Y/N): NO; NATURAL

FLOW RATE (MCF/D): 50

FLOW TIME (HRS.): 16

FLOWING BHP (psia): 74

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,745

GAS POROSITY: 0.120

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 27

Z-FACTOR: 1.377

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0316

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.500

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0015

RADIUS OF DRAINAGE (Ft): 18.3

CALCULATED K (md): 0.0015

STEADY TIME (HRS.): 526,283.35

STABILIZED FLOW (MCF/D): 21.39

AOE PRESSURE (psia): 74

STABILIZED AOE (MCF/D): 21

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/25/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15159-458

STIMULATED ? (Y/N): YES; 5000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 104

FLOWING BHP (psia): 1,630

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 8,996

GAS POROSITY: 0.063

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 68

Z-FACTOR: 1.250

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0302

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.498

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0295

RADIUS OF DRAINAGE (Ft): 292.9

CALCULATED K (md): 0.0295

STEADY TIME (HRS.): 13,579.25

STABILIZED FLOW (MCF/D): 838.19

AOF PRESSURE (psia): 264

STABILIZED AOF (MCF/D): 994

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 12/17/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15159-458

STIMULATED ? (Y/N): YES; 5000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 104

FLOWING BHP (psia): 1,630

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 8,996

GAS POROSITY: 0.063

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: -3.1

PAY HEIGHT: 68

Z-FACTOR: 1.250

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0302

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.498

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0134

RADIUS OF DRAINAGE (Ft): 197.4

CALCULATED K (md): 0.0134

STEADY TIME (HRS.): 29,868.77

STABILIZED FLOW (MCF/D): 785.83

AO F PRESSURE (psia): 264

STABILIZED AOF (MCF/D): 932

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/25/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15380-458'

STIMULATED ? (Y/N): YES; 3000 G ACID

FLOW RATE (MCF/D): 680

FLOW TIME (HRS.): 158

FLOWING BHP (psia): 6,168

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,335

GAS POROSITY: 0.057

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 36

Z-FACTOR: 1.380

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0330

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.496

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0983

RADIUS OF DRAINAGE (Ft): 662.7

CALCULATED K (md): 0.0983

STEADY TIME (HRS.): 4,022.02

STABILIZED FLOW (MCF/D): 585.15

AOF PRESSURE (psia): 284

STABILIZED AOF (MCF/D): 1,672

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/23/91

WELL NAME: ANDRIKOPOULOS 1

INTERVAL: 14986-15209' MORROW

STIMULATED ? (Y/N): YES; 5000G BHPBU MATCH

FLOW RATE (MCF/D): 1,080

FLOW TIME (HRS.): 58

FLOWING BHP (psia): 1,058

GAS GRAVITY (Yg): 0.576

TEMP. DEGREE F (T): 205

RESERVOIR PRESSURE (Pi): 11,421

GAS POROSITY: 0.044

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 19

Z-FACTOR: 1.600

GAS COMPRESSIBILITY: 0.00003

GAS VISCOSITY (cp): 0.0407

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.454

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0945

RADIUS OF DRAINAGE (Ft): 520.9

CALCULATED K (md): 0.0945

STEADY TIME (HRS.): 2,389.68

STABILIZED FLOW (MCF/D): 891.46

AO F PRESSURE (psia): 246

STABILIZED AOF (MCF/D): 961

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/21/91

WELL NAME: ANDRIKOPOULOS 1  
 INTERVAL: 14986-15209' MORROW  
 STIMULATED ? (Y/N): NO; UNDERBALANCED  
 FLOW RATE (MCF/D): 237  
 FLOW TIME (HRS.): 11  
 FLOWING BHP (psia): 260

GAS GRAVITY ( $\gamma_g$ ): 0.576  
 TEMP. DEGREE F (T): 205  
 RESERVOIR PRESSURE ( $P_i$ ): 11,044  
 GAS POROSITY: 0.044  
 WELLBORE RADIUS (Ft): 0.333  
 SKIN FACTOR: 0.0

PAY HEIGHT: 19  
 Z-FACTOR: 1.546  
 GAS COMPRESSIBILITY: 0.00003  
 GAS VISCOSITY (cp): 0.0407  
 SPACING ACRES: 320  
 FORMATION VOLUME FACTOR ( $B_g$ ): 0.454

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0146  
 RADIUS OF DRAINAGE (Ft): 89.2  
 CALCULATED K (md): 0.0146

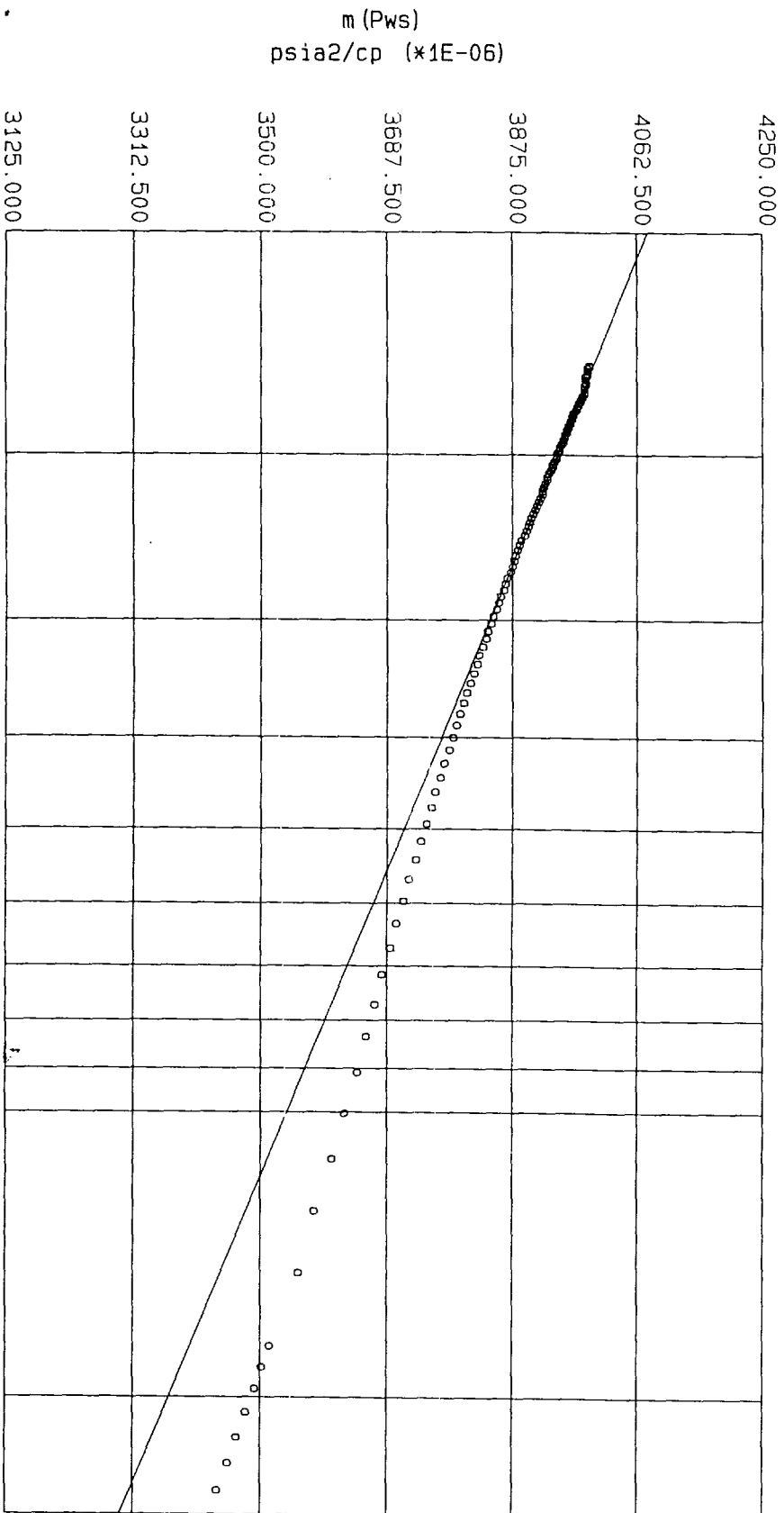
STEADY TIME (HRS.): 15,464.61

STABILIZED FLOW (MCF/D): 143.35  
 AOF PRESSURE (psia): 246  
 STABILIZED AOF (MCF/D): 144

# ANDRIKOPoulos FEDERAL NO. 1 - HORNER

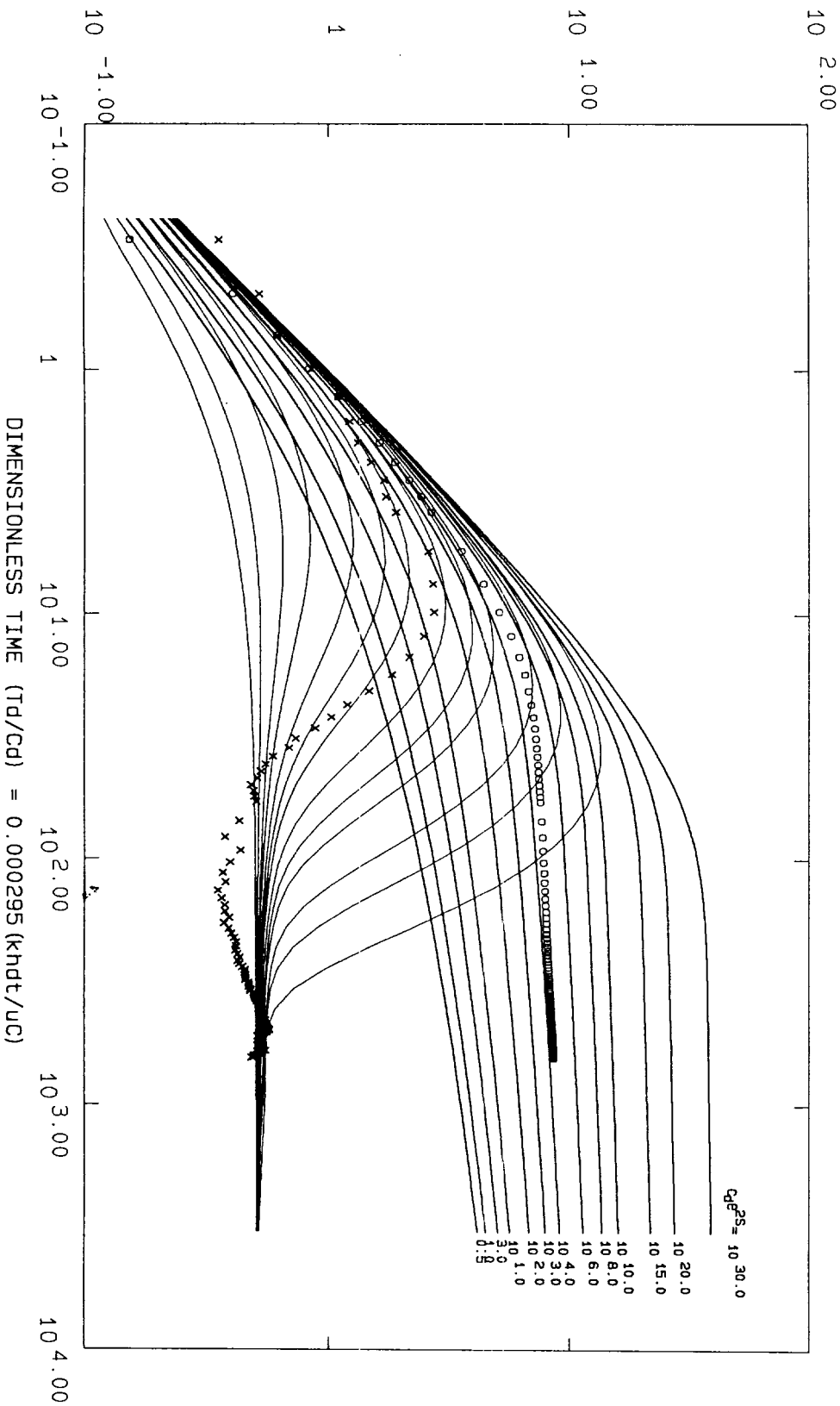
|              |                             |               |                        |                |          |
|--------------|-----------------------------|---------------|------------------------|----------------|----------|
| File.....    | AMAND GAS                   | Location..... | LEA COUNTY, NEW MEXICO | Slope.....     | -576.724 |
| Company..... | AMOCO                       | Date.....     | 4/23/80 - 4/28/80      | Intercept....  | 4116.741 |
| Well.....    | ANDRIKOPoulos FEDERAL NO. 1 | Test.....     | BUILDUP PLUG @ 12128'  | Permeability.. | 0.1081   |
| Field.....   | UNDESIGNATED MORRON         | Gauge.....    | AMERADA                | Skin.....      | 1.738    |

Pseudo-time from start of test (hours)  
8.00



ANDRIKOPoulos FEDERAL NO. 1 - HOMOGENEOUS RESERVOIR

Field..... UNDESIGNATED MORROW



File: AMAND.GAS ,AMAND.PRO

Test type: CRB

Date: 23/11/91 Time: 12:02

RESULTS FROM HORNER ANALYSIS  
using Pseudo-pressure and Pseudo time

Line :

|                                    |                    |
|------------------------------------|--------------------|
| Intercept.....:                    | 4116.741           |
| Slope.....:                        | -576.724           |
| Start of line.....:(               | 0.4199 , 3875.355) |
| End of line.....:(                 | 0.2639 , 3964.815) |
| Coefficient of determination.....: | 0.9991             |
| Number of points.....:             | 44                 |

|                                   |           |                   |
|-----------------------------------|-----------|-------------------|
| m(p) at dt = 1 hr.....:           | 3042.311  | psia2/cp (*1E-06) |
| Extrapolated m(p).....:           | 4116.741  | psia2/cp (*1E-06) |
| Permeability-thickness (kh).....: | 2.054     | md.ft             |
| Permeability (k).....:            | 0.1081    | md                |
| Total skin factor (s).....:       | 1.738     |                   |
| dP skin (constant rate).....:     | 2872.779  | psi               |
| Radius of investigation.....:     | 217.004   | ft                |
| Extrapolated pressure.....:       | 11421.071 | psia              |
| Pressure at dt = 1 hour.....:     | 8844.791  | psia              |
| Flow efficiency.....:             | 0.7841    |                   |

# HIGH GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/23/91

WELL NAME: BELL LAKE 2 ST 1  
 INTERVAL: 14819-892  
 STIMULATED ? (Y/N): YES; 3500 GAL ACID  
 FLOW RATE (MCF/D): 356  
 FLOW TIME (HRS.): 297  
 FLOWING BHP (psia): 1,150

GAS GRAVITY (Yg): 0.604  
 TEMP. DEGREE F (T): 194  
 RESERVOIR PRESSURE (Pi): 9,745  
 GAS POROSITY: 0.120  
 WELLBORE RADIUS (Ft): 0.250  
 SKIN FACTOR: 0.0

PAY HEIGHT: 27  
 Z-FACTOR: 1.377  
 GAS COMPRESSIBILITY: 0.00005  
 GAS VISCOSITY (cp): 0.0316  
 SPACING ACRES: 320  
 FORMATION VOLUME FACTOR (Bg): 0.500

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0217  
 RADIUS OF DRAINAGE (Ft): 300.7  
 CALCULATED K (md): 0.0217

STEADY TIME (HRS.): 36,726.81

STABILIZED FLOW (MCF/D): 272.40  
 AOF PRESSURE (psia): 74  
 STABILIZED AOF (MCF/D): 306

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/23/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 14819-892

STIMULATED ? (Y/N): NO; NATURAL

FLOW RATE (MCF/D): 50

FLOW TIME (HRS.): 16

FLOWING BHP (psia): 74

GAS GRAVITY ( $\gamma_g$ ): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,745

GAS POROSITY: 0.120

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 27

Z-FACTOR: 1.377

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0316

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.500

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0015

RADIUS OF DRAINAGE (Ft): 18.3

CALCULATED K (md): 0.0015

STEADY TIME (HRS.): 526,283.35

STABILIZED FLOW (MCF/D): 21.39

AO F PRESSURE (psia): 74

STABILIZED AOF (MCF/D): 21

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/25/91

WELL NAME: *BELL LAKE 2 ST 1*

INTERVAL: 15159-458

STIMULATED ? (Y/N): YES; 5000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 104

FLOWING BHP (psia): 1,630

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 8,996

GAS POROSITY: 0.063

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 68

Z-FACTOR: 1.250

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0302

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.498

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0295

RADIUS OF DRAINAGE (Ft): 292.9

CALCULATED K (md): 0.0295

STEADY TIME (HRS.): 13,579.25

STABILIZED FLOW (MCF/D): 838.19

AOF PRESSURE (psia): 264

STABILIZED AOF (MCF/D): 994

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 12/17/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15159-458

STIMULATED ? (Y/N): YES; 5000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 104

FLOWING BHP (psia): 1,630

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 8,996

GAS POROSITY: 0.063

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: -3.1

PAY HEIGHT: 68

Z-FACTOR: 1.250

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0302

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.498

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0134

RADIUS OF DRAINAGE (Ft): 197.4

CALCULATED K (md): 0.0134

STEADY TIME (HRS.): 29,868.77

STABILIZED FLOW (MCF/D): 785.83

AOF PRESSURE (psia): 264

STABILIZED AOF (MCF/D): 932

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/25/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15380-458'

STIMULATED ? (Y/N): YES; 3000 G ACID

FLOW RATE (MCF/D): 680

FLOW TIME (HRS.): 158

FLOWING BHP (psia): 6,168

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,335

GAS POROSITY: 0.057

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 36

Z-FACTOR: 1.380

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0330

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.496

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0983

RADIUS OF DRAINAGE (Ft): 662.7

CALCULATED K (md): 0.0983

STEADY TIME (HRS.): 4,022.02

STABILIZED FLOW (MCF/D): 585.15

AOE PRESSURE (psia): 284

STABILIZED AOE (MCF/D): 1,672

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/25/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15380-458'

STIMULATED ? (Y/N): YES; 3000 G ACID

FLOW RATE (MCF/D): 680

FLOW TIME (HRS.): 158

FLOWING BHP (psia): 6,168

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,335

GAS POROSITY: 0.057

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: -2.4

PAY HEIGHT: 36

Z-FACTOR: 1.380

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0330

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.496

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0621

RADIUS OF DRAINAGE (Ft): 526.7

CALCULATED K (md): 0.0621

STEADY TIME (HRS.): 6,370.77

STABILIZED FLOW (MCF/D): 566.31

AOE PRESSURE (psia): 284

STABILIZED AOE (MCF/D): 1,618

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 12/17/91

WELL NAME: *BELL LAKE 2 ST 1*

INTERVAL: 15380-458'

STIMULATED ? (Y/N): YES; 3000 G ACID

FLOW RATE (MCF/D): 680

FLOW TIME (HRS.): 158

FLOWING BHP (psia): 6,168

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,335

GAS POROSITY: 0.057

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: -2.4

PAY HEIGHT: 36

Z-FACTOR: 1.380

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0330

SPACING ACRES: 80

FORMATION VOLUME FACTOR (Bg): 0.496

SPACING RADIUS (Ft): 1,053

ASSUMED K (md): 0.0621

RADIUS OF DRAINAGE (Ft): 526.7

CALCULATED K (md): 0.0621

STEADY TIME (HRS.): 1,592.69

STABILIZED FLOW (MCF/D): 617.99

AOF PRESSURE (psia): 284

STABILIZED AOF (MCF/D): 1,766

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 12/17/91

WELL NAME: BELL LAKE 2 ST 1

INTERVAL: 15380-458'

STIMULATED ? (Y/N): YES; 3000 G ACID

FLOW RATE (MCF/D): 680

FLOW TIME (HRS.): 158

FLOWING BHP (psia): 6,168

GAS GRAVITY (Yg): 0.604

TEMP. DEGREE F (T): 194

RESERVOIR PRESSURE (Pi): 9,335

GAS POROSITY: 0.057

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: -2.4

PAY HEIGHT: 36

Z-FACTOR: 1.380

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0330

SPACING ACRES: 160

FORMATION VOLUME FACTOR (Bg): 0.496

SPACING RADIUS (Ft): 1,489

ASSUMED K (md): 0.0621

RADIUS OF DRAINAGE (Ft): 526.7

CALCULATED K (md): 0.0621

STEADY TIME (HRS.): 3,184.67

STABILIZED FLOW (MCF/D): 591.03

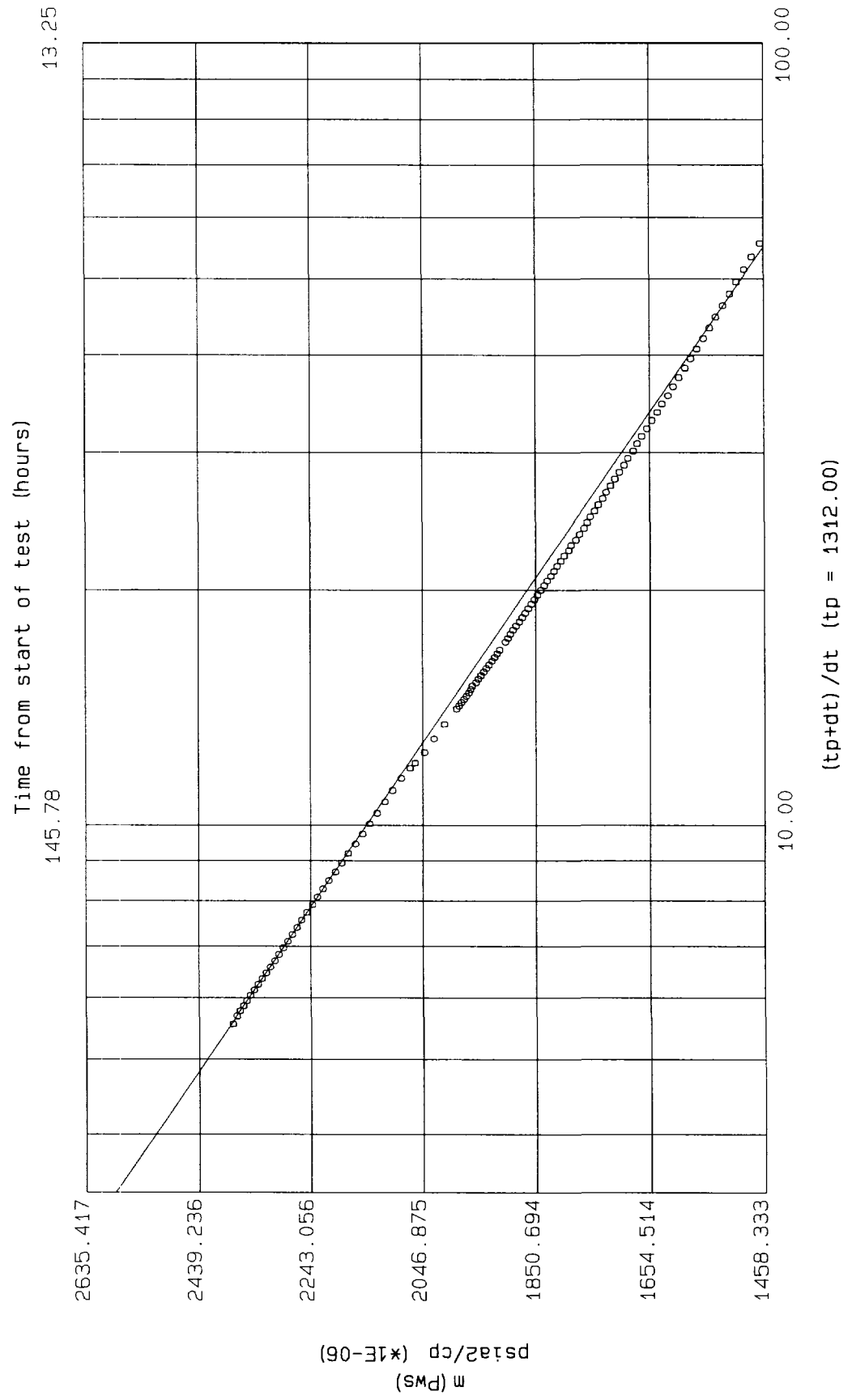
AOF PRESSURE (psia): 284

STABILIZED AOF (MCF/D): 1,689

# BELL LAKE 2 STATE - HORNER

PANSYSTEM V1.8 (C) EPS 1991.

|              |                    |               |                        |                |           |
|--------------|--------------------|---------------|------------------------|----------------|-----------|
| File.....    | BELL2B.GAS         | Location..... | LEA COUNTY, NEW MEXICO | Slope.....     | -927.909  |
| Company..... | HNG                | Date.....     | 5/26/82 - 6/7/82       | Intercept..... | 3073.555  |
| Well.....    | BELL LAKE 2 STATE  | Test.....     | BUILDUP                | Permeability.. | 9.794E-03 |
| Field.....   | VACA DRAW (MORROW) | Gauge.....    | AMERADA                | Skin.....      | -3.046    |

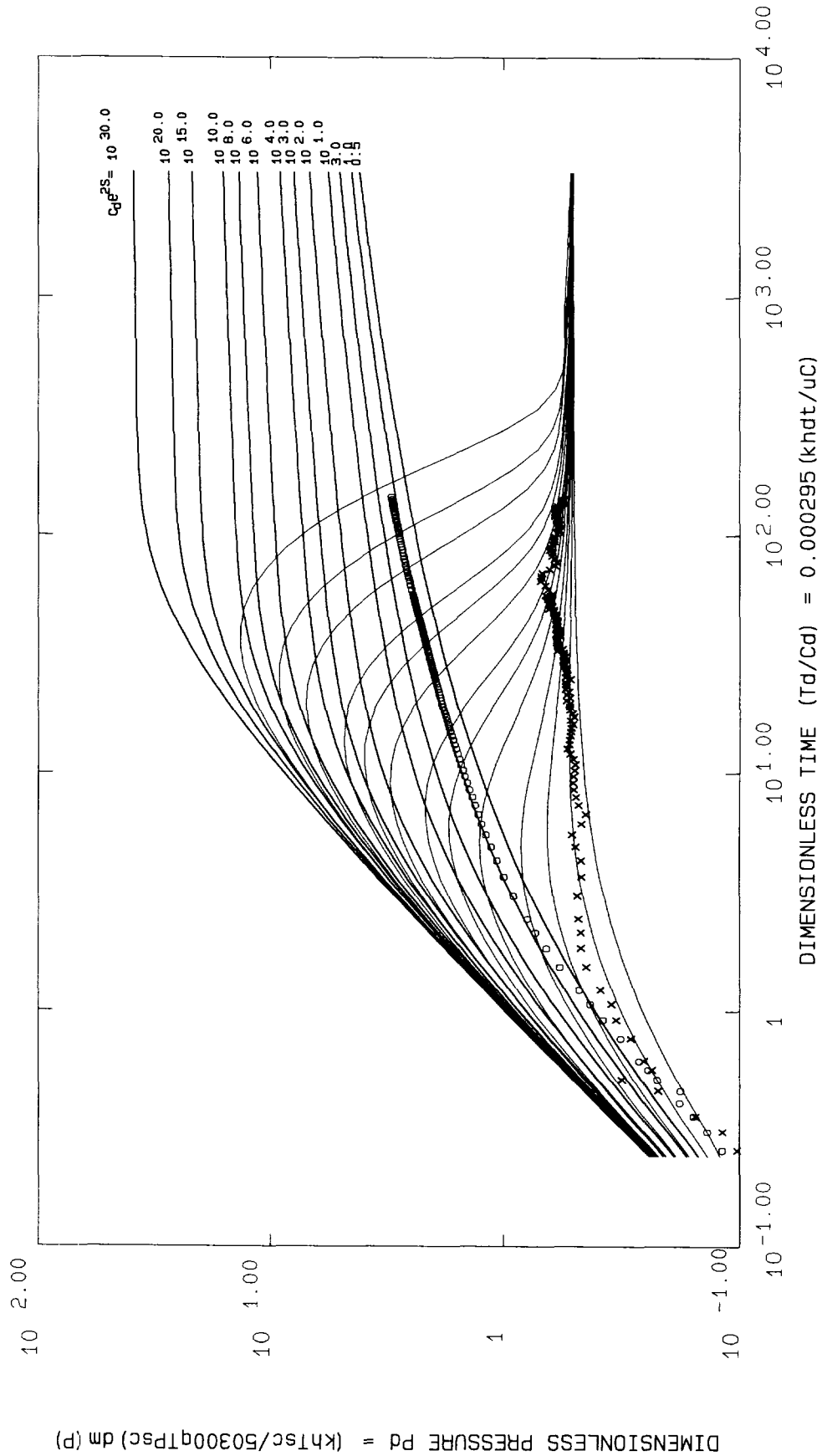


PANSYSTEM V1.8 (C) EPS 1991.

# BELL LAKE 2 STATE - HOMOGENEOUS RESERVOIR

|              |                    |               |                        |                |        |              |           |
|--------------|--------------------|---------------|------------------------|----------------|--------|--------------|-----------|
| File.....    | BELL2B.GAS         | Location..... | LEA COUNTY, NEW MEXICO | Pd(match)..... | 0.0147 | dp(match)... | 10.000    |
| Company..... | HNG                | Date.....     | 5/26/82 - 6/7/82       | Td(match)..... | 0.5127 | dt(match)... | 1.000     |
| Well.....    | BELL LAKE 2 STATE  | Test.....     | BUILDUP                | Permeability.. | 0.0116 | dp(skin).... | -1.00E+12 |
| Field.....   | VACA DRAW (MORROW) | Gauge.....    | AMERADA                | Skin.....      | -2.788 | C(Storage).. | 0.0129    |

Data plotted using Real Elapsed Time and m (p)



File: AMAND.GAS ,AMAND.PRO

Test type: CRB

Date: 22/11/91 Time: 15:45

RESULTS FROM HORNER ANALYSIS  
using Pseudo-pressure and Real time

First Line :

|                                   |                   |
|-----------------------------------|-------------------|
| Intercept.....:                   | 3127.577          |
| Slope.....:                       | -340.601          |
| Start of line.....:(              | 1.389 , 2653.476) |
| End of line.....:(                | 1.222 , 2711.111) |
| Coefficient of determination....: | 0.9984            |
| Number of points.....:            | 7                 |

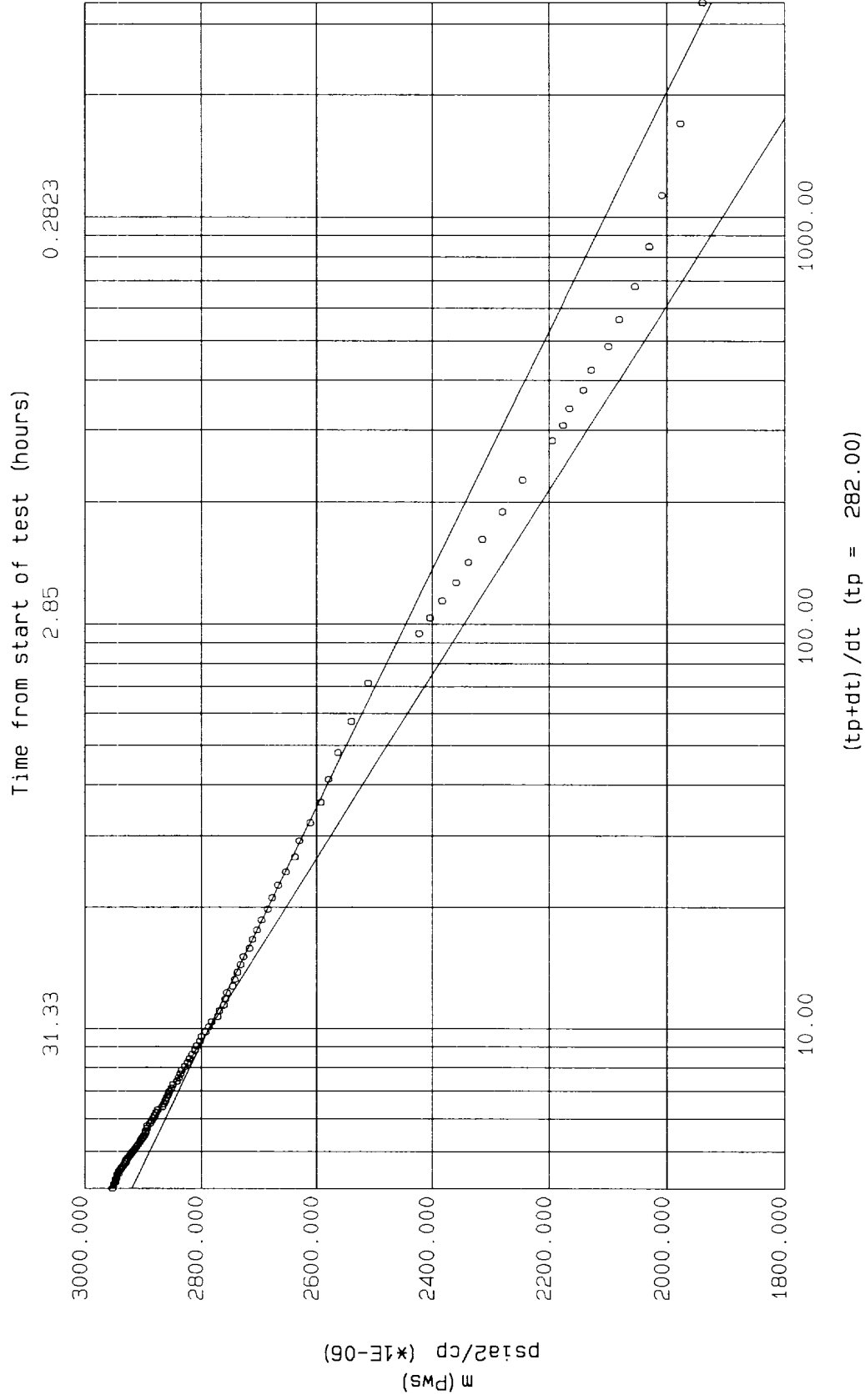
|                                   |           |                   |
|-----------------------------------|-----------|-------------------|
| m(p) at dt = 1 hr.....:           | 2292.646  | psia2/cp (*1E-06) |
| Extrapolated m(p).....:           | 3127.577  | psia2/cp (*1E-06) |
| Permeability-thickness (kh).....: | 2.199     | md.ft             |
| Permeability (k).....:            | 0.0611    | md                |
| Total skin factor (s).....:       | -2.398    |                   |
| dP skin (constant rate).....:     | -1692.540 | psi               |
| Radius of investigation.....:     | 165.134   | ft                |
| Extrapolated pressure.....:       | 9100.490  | psia              |
| Pressure at dt = 1 hour.....:     | 7126.403  | psia              |
| Flow efficiency.....:             | 1.571     |                   |

PANSYSTEM V1.8 (C) EPS 1991.

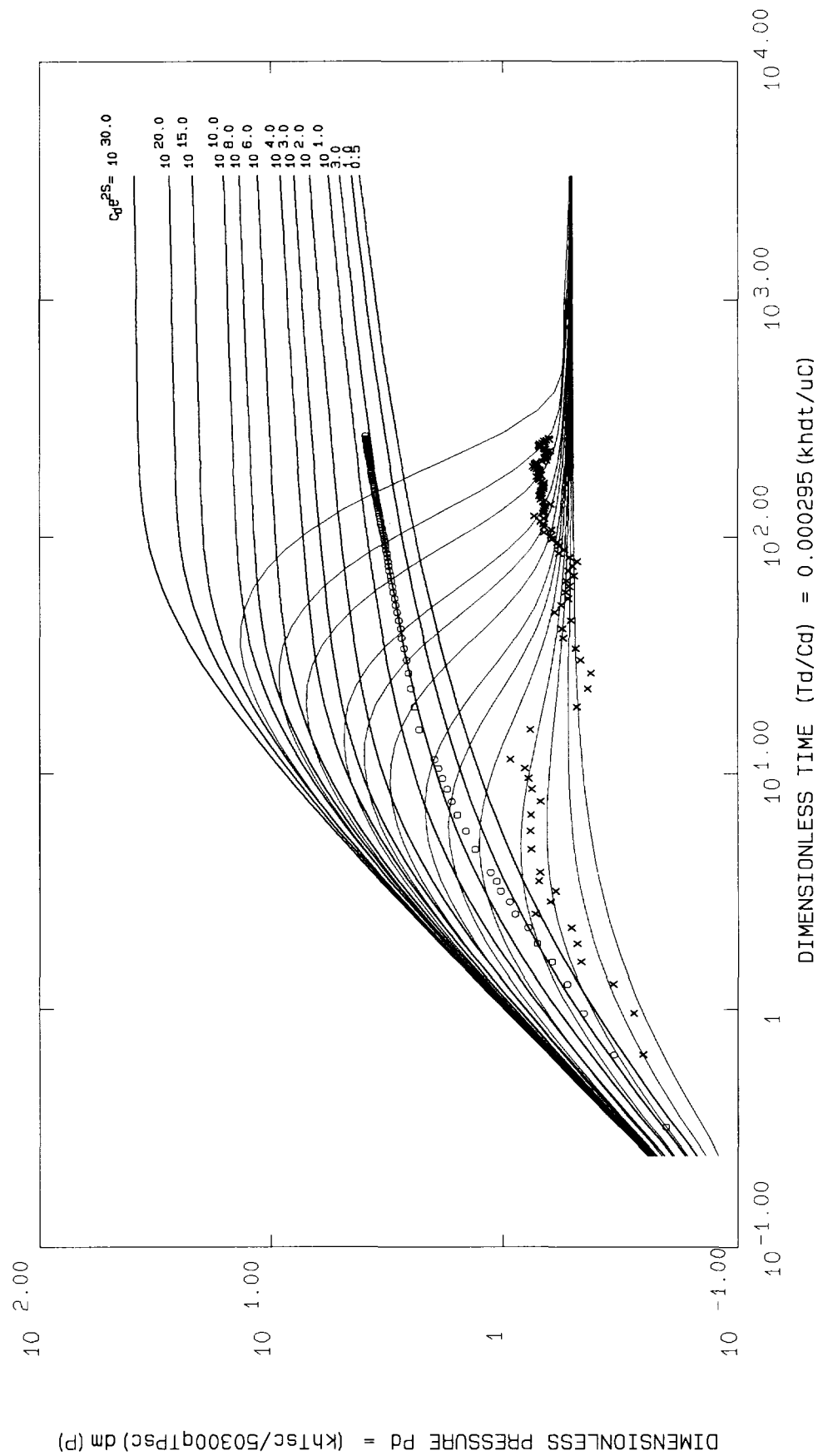
# BELL LAKE 2 STATE - HORNER

Line 1 Line 2

|              |                    |                 |                        |                |          |          |
|--------------|--------------------|-----------------|------------------------|----------------|----------|----------|
| File.....    | AMAND GAS          | Location.....   | LEA COUNTY, NEW MEXICO | Slope.....     | -340.601 | -439.812 |
| Company..... | HNG                | Date.....       | 4/23/81 - 4/27/81      | Intercept..... | 3127.577 | 3225.567 |
| Well.....    | BELL LAKE 2 STATE  | Test.....       | BUILDUP                | Permeability.. | 0.0611   | 0.0473   |
| Field.....   | VACA DRAW (WOPROW) | Instrument..... | AMERADA                | Skin.....      | -2.398   | -2.962   |



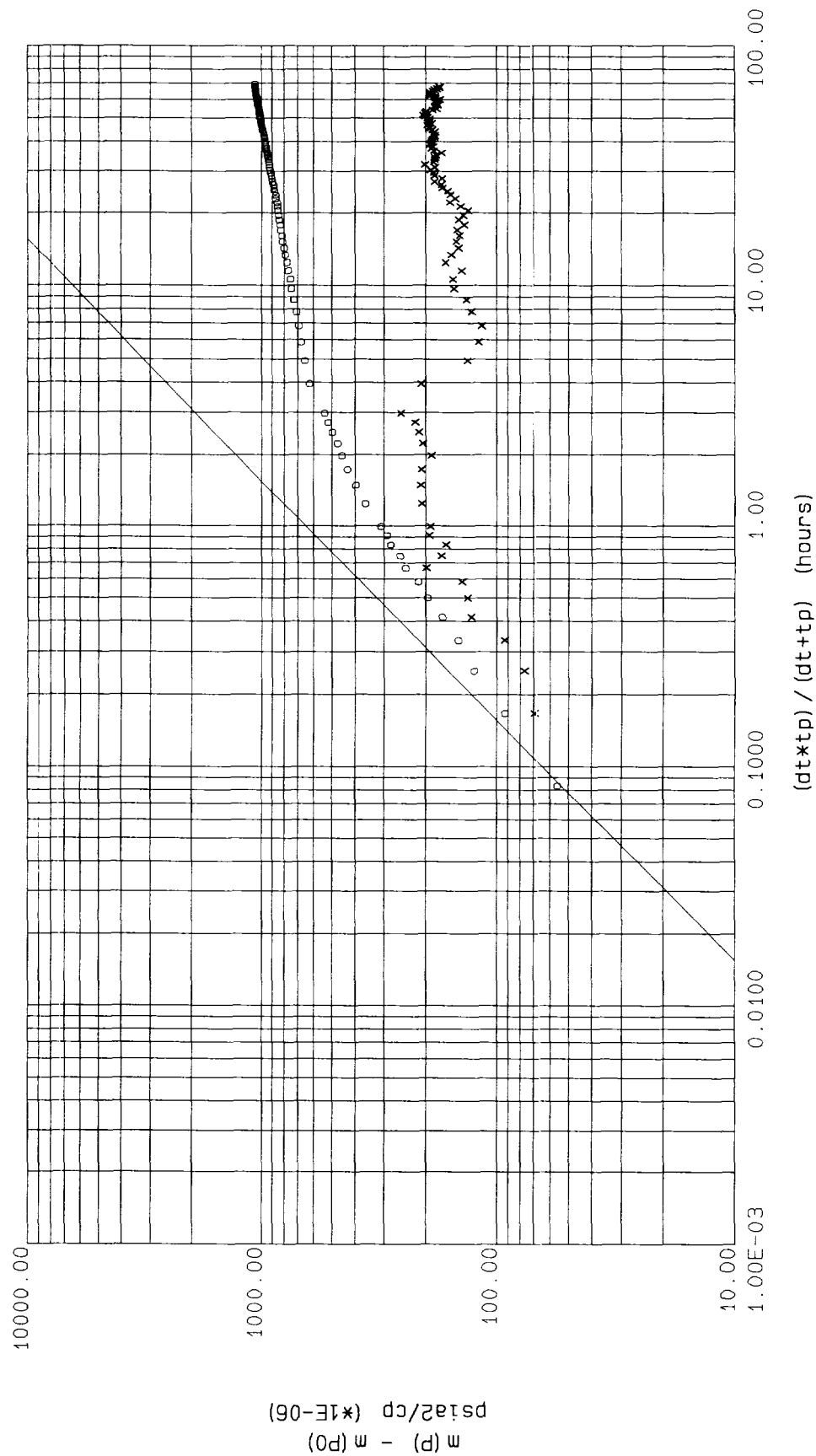
Data plotted using Real Elapsed Time and m(p)



PANSYSTEM V1.8 (C) EPS 1991.

# BELL LAKE 2 STATE - LOG-LOG

|              |                    |                 |                        |                 |           |
|--------------|--------------------|-----------------|------------------------|-----------------|-----------|
| File.....    | AMAND.GAS          | Location.....   | LEA COUNTY, NEW MEXICO | Slope.....      | 1.000     |
| Company..... | HNG                | Date.....       | 4/23/81 - 4/27/81      | Intercept.....  | 2.809     |
| Well.....    | BELL LAKE 2 STATE  | Test.....       | BUILDUP                | Wellbore Vol.:: | 184.471   |
| Field.....   | VACA DRAW (MORROW) | Instrument..... | AMERADA                | Storage coef.:: | 9.913E-03 |



# PANSYSTEM ANALYSIS PROGRAM

Test: type: CRB

[illegible]

Test type - Constant rate buildup

|                                         |           |           |
|-----------------------------------------|-----------|-----------|
| Gas flow rate at surface (Q).....       | 0.6803    | MMscf/day |
| Pressure prior to shut-in (p(dt=0)).... | 6168.0000 | psia      |
| Time when dt=0.....                     | 0.0000    | hr        |
| Equivalent production time (Tp).....    | 282.0000  | hr        |

E.P.S. Ltd.

PANSYSTEM ANALYSIS PROGRAM

File: AMAND.GAS ,AMAND.PRO

Test type: CRB

Date: 22/11/91 Time: 15:41

RESERVOIR CONSTANTS

|                                      |           |
|--------------------------------------|-----------|
| Formation thickness (h).....:        | 36.000 ft |
| Average formation porosity (0).....: | 0.1100    |
| Well radius (rw).....:               | 0.3300 ft |

GAS COMPOSITION Mol percent (Optional)

|              |      |              |      |              |      |             |                    |
|--------------|------|--------------|------|--------------|------|-------------|--------------------|
| Nitrogen...: | .255 | CO2.....:    | .884 | H2S.....:    | .000 | Methane...: | .000               |
| Ethane....:  | .000 | Propane...:  | .000 | Iso-Butane:  | .000 | n-Butane..: | .000               |
| IsoPentane:  | .000 | n-Pentane..: | .000 | Hexanes....: | .000 | C 7 +.....: | .000               |
|              |      |              |      |              |      |             | C7+ mol wt:100.198 |

RESERVOIR VARIABLES

|                                           |           |         |
|-------------------------------------------|-----------|---------|
| Reservoir pressure.....:                  | 8700.000  | psia    |
| Temperature (T).....:                     | 213.000   | deg F   |
| Water saturation (Sw).....:               | 0.1800    |         |
| Water compressibility (Cw).....:          | 2.766E-06 | psi-1   |
| Formation compressibility (Cf).....:      | 4.674E-06 | psi-1   |
| Gas gravity.....:                         | 0.6000    | sp grav |
| Initial gas viscosity (ui).....:          | 0.0320    | cp      |
| Initial z-factor (zi).....:               | 1.294     |         |
| Gas compressibility (Cg).....:            | 5.374E-05 | psi-1   |
| Initial system compressibility (Ct).....: | 4.924E-05 | psi-1   |

E.P.S. Ltd.

PANSYSTEM ANALYSIS PROGRAM

File: AMAND.GAS ,AMAND.PRO

Test type: CRB

Date: 22/11/91 Time: 15:45

RESULTS FROM HORNER ANALYSIS  
using Pseudo-pressure and Real time

Second Line :

|                                   |                    |
|-----------------------------------|--------------------|
| Intercept.....:                   | 3225.567           |
| Slope.....:                       | -439.812           |
| Start of line.....:(              | 0.7743 , 2886.028) |
| End of line.....:(                | 0.6822 , 2927.302) |
| Coefficient of determination....: | 0.9877             |
| Number of points.....:            | 18                 |

|                                   |           |                   |
|-----------------------------------|-----------|-------------------|
| m(p) at dt = 1 hr.....:           | 2147.437  | psia2/cp (*1E-06) |
| Extrapolated m(p).....:           | 3225.567  | psia2/cp (*1E-06) |
| Permeability-thickness (kh).....: | 1.703     | md.ft             |
| Permeability (k).....:            | 0.0473    | md                |
| Total skin factor (s).....:       | -2.962    |                   |
| dP skin (constant rate).....:     | -2762.970 | psi               |
| Radius of investigation.....:     | 145.320   | ft                |
| Extrapolated pressure.....:       | 9335.470  | psia              |
| Pressure at dt = 1 hour.....:     | 6785.350  | psia              |
| Flow efficiency.....:             | 1.844     |                   |

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/26/91

WELL NAME: BELL LAKE 11 NO. 1

INTERVAL: 14883-977'

STIMULATED ? (Y/N): YES; 3000 GAL ACID

FLOW RATE (MCF/D): 1,300

FLOW TIME (HRS.): 215

FLOWING BHP (psia): 5,789

GAS GRAVITY (Yg): 0.573

TEMP. DEGREE F (T): 239

RESERVOIR PRESSURE (Pi): 10,391

GAS POROSITY: 0.080

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 20

Z-FACTOR: 1.416

GAS COMPRESSIBILITY: 0.000046

GAS VISCOSITY (cp): 0.0323

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.480

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.2352

RADIUS OF DRAINAGE (Ft): 1063.7

CALCULATED K (md): 0.2352

STEADY TIME (HRS.): 2,125.13

STABILIZED FLOW (MCF/D): 1192.87

AO F PRESSURE (psia): 294

STABILIZED AO F (MCF/D): 2,617

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/25/91

WELL NAME: BELL LAKE 11 NO. 1

INTERVAL: 14883-977'

STIMULATED ? (Y/N): YES; 3000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 166

FLOWING BHP (psia): 3,852

GAS GRAVITY (Yg): 0.573

TEMP. DEGREE F (T): 239

RESERVOIR PRESSURE (Pi): 10,391

GAS POROSITY: 0.080

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 20

Z-FACTOR: 1.416

GAS COMPRESSIBILITY: 0.000046

GAS VISCOSITY (cp): 0.0323

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.480

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.1324

RADIUS OF DRAINAGE (Ft): 701.3

CALCULATED K (md): 0.1324

STEADY TIME (HRS.): 3,775.43

STABILIZED FLOW (MCF/D): 954.06

AO F PRESSURE (psia): 264

STABILIZED AOF (MCF/D): 1,478

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/22/91

WELL NAME: BRINNINSTOOL NO. 1

INTERVAL: 15759-65

STIMULATED ? (Y/N): NO; 20 BBL ACID SPOT

FLOW RATE (MCF/D): 2,574

FLOW TIME (HRS.): 14

FLOWING BHP (psia): 5,302

GAS GRAVITY (Yg): 0.571

TEMP. DEGREE F (T): 208

RESERVOIR PRESSURE (Pi): 10,734

GAS POROSITY: 0.085

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 7

Z-FACTOR: 1.448

GAS COMPRESSIBILITY: 0.00004

GAS VISCOSITY (cp): 0.0337

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.454

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 1.0227

RADIUS OF DRAINAGE (Ft): 576.5

CALCULATED K (md): 1.0227

STEADY TIME (HRS.): 471.07

STABILIZED FLOW (MCF/D): 2171.67

AO F PRESSURE (psia): 354

STABILIZED AO F (MCF/D): 4,150

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 12/17/91

WELL NAME: BRINNINSTOOL NO. 1

INTERVAL: 15170-765'

STIMULATED ? (Y/N): NO; NATURAL

FLOW RATE (MCF/D): 1,600

FLOW TIME (HRS.): 9

FLOWING BHP (psia): 6,476

GAS GRAVITY (Yg): 0.571

TEMP. DEGREE F (T): 208

RESERVOIR PRESSURE (Pi): 8,500

GAS POROSITY: 0.060

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 34

Z-FACTOR: 1.275

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0306

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.512

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.3245

RADIUS OF DRAINAGE (Ft): 290.9

CALCULATED K (md): 0.3245

STEADY TIME (HRS.): 1,189.42

STABILIZED FLOW (MCF/D): 1217.87

AOE PRESSURE (psia): 404

STABILIZED AOE (MCF/D): 4,871

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/21/91

WELL NAME: DIAMOND 6 FED 1

INTERVAL: 14897-15556' MORROW

STIMULATED ? (Y/N): YES; 5000 GAL ACID

FLOW RATE (MCF/D): 5,300

FLOW TIME (HRS.): 8

FLOWING BHP (psia): 8,215

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 222

RESERVOIR PRESSURE (Pi): 9,824

GAS POROSITY: 0.062

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 61

Z-FACTOR: 1.376

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0322

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.482

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.7871

RADIUS OF DRAINAGE (Ft): 409.6

CALCULATED K (md): 0.7871

STEADY TIME (HRS.): 533.21

STABILIZED FLOW (MCF/D): 4253.04

AO F PRESSURE (psia): 314

STABILIZED AOF (MCF/D): 25,138

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/21/91

WELL NAME: DIAMOND 6 FED 1

INTERVAL: 14897-15556' MORROW

STIMULATED ? (Y/N): NO; 4 BBL SPOT ACID

FLOW RATE (MCF/D): 2,000

FLOW TIME (HRS.): 13

FLOWING BHP (psia): 1,087

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 222

RESERVOIR PRESSURE (Pi): 9,824

GAS POROSITY: 0.062

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 61

Z-FACTOR: 1.376

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0322

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.482

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.045

RADIUS OF DRAINAGE (Ft): 124.8

CALCULATED K (md): 0.0449

STEADY TIME (HRS.): 9,341.27

STABILIZED FLOW (MCF/D): 1318.25

AOF PRESSURE (psia): 246

STABILIZED AOF (MCF/D): 1,445

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/22/91

WELL NAME: HALF 6 FED 1

INTERVAL: 15238-360'

STIMULATED ? (Y/N): NO; NATURAL

FLOW RATE (MCF/D): 1,700

FLOW TIME (HRS.): 249

FLOWING BHP (psia): 1,828

GAS GRAVITY (Yg): 0.607

TEMP. DEGREE F (T): 200

RESERVOIR PRESSURE (Pi): 4,574

GAS POROSITY: 0.085

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 36

Z-FACTOR: 0.989

GAS COMPRESSIBILITY: 0.000135

GAS VISCOSITY (cp): 0.0240

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.719

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.3099

RADIUS OF DRAINAGE (Ft): 863.2

CALCULATED K (md): 0.3099

STEADY TIME (HRS.): 3,736.05

STABILIZED FLOW (MCF/D): 1517.09

AO OF PRESSURE (psia): 284

STABILIZED AOF (MCF/D): 2,370

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/24/91

WELL NAME: JAVELINA BASIN 1

INTERVAL: 15154-420

STIMULATED ? (Y/N): YES; 5000 G ACID +N2

FLOW RATE (MCF/D): 1,231

FLOW TIME (HRS.): 4

FLOWING BHP (psia): 4,577

GAS GRAVITY (Yg): 0.577

TEMP. DEGREE F (T): 218

RESERVOIR PRESSURE (Pi): 9,014

GAS POROSITY: 0.057

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 18

Z-FACTOR: 1.321

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0302

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.500

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.1859

RADIUS OF DRAINAGE (Ft): 151.6

CALCULATED K (md): 0.1859

STEADY TIME (HRS.): 1,946.48

STABILIZED FLOW (MCF/D): 840.20

AOF PRESSURE (psia): 284

STABILIZED AOF (MCF/D): 1,653

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/22/91

WELL NAME: JAVELINA BASIN 1

INTERVAL: 14594-604'

STIMULATED ? (Y/N): YES; 2500 GAL ACID

FLOW RATE (MCF/D): 101

FLOW TIME (HRS.): 24

FLOWING BHP (psia): 1,293

GAS GRAVITY (Yg): 0.577

TEMP. DEGREE F (T): 218

RESERVOIR PRESSURE (Pi): 9,210

GAS POROSITY: 0.110

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 4

Z-FACTOR: 1.330

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0306

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.493

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0367

RADIUS OF DRAINAGE (Ft): 118.0

CALCULATED K (md): 0.0367

STEADY TIME (HRS.): 19,264.84

STABILIZED FLOW (MCF/D): 65.88

AOE PRESSURE (psia): 76

STABILIZED AOE (MCF/D): 76

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/24/91

WELL NAME: LONGWAY DRAW 1

INTERVAL: 14829-15289'

STIMULATED ? (Y/N): YES; 2000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 152

FLOWING BHP (psia): 713

GAS GRAVITY (Yg): 0.583

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 9,986

GAS POROSITY: 0.054

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 39

Z-FACTOR: 1.376

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0322

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.481

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0429

RADIUS OF DRAINAGE (Ft): 446.6

CALCULATED K (md): 0.0429

STEADY TIME (HRS.): 8,518.27

STABILIZED FLOW (MCF/D): 886.82

AOF PRESSURE (psia): 234

STABILIZED AOF (MCF/D): 933

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/24/91

WELL NAME: LONGWAY DRAW 1

INTERVAL: 14829-15289'

STIMULATED ? (Y/N): YES; 2000 GAL ACID

FLOW RATE (MCF/D): 1,100

FLOW TIME (HRS.): 152

FLOWING BHP (psia): 713

GAS GRAVITY (Yg): 0.583

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 9,986

GAS POROSITY: 0.054

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: -0.6

PAY HEIGHT: 39

Z-FACTOR: 1.376

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0322

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.481

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0387

RADIUS OF DRAINAGE (Ft): 424.2

CALCULATED K (md): 0.0387

STEADY TIME (HRS.): 9,442.59

STABILIZED FLOW (MCF/D): 879.74

AOE PRESSURE (psia): 234

STABILIZED AOE (MCF/D): 925

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/24/91

WELL NAME: LONGWAY DRAW 1

INTERVAL: 15047-289'

STIMULATED ? (Y/N): YES; 5000 GAL ACID + CO2

FLOW RATE (MCF/D): 504

FLOW TIME (HRS.): 24

FLOWING BHP (psia): 635

GAS GRAVITY (Yg): 0.583

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 9,039

GAS POROSITY: 0.056

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 28

Z-FACTOR: 1.350

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0318

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.493

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0249

RADIUS OF DRAINAGE (Ft): 133.6

CALCULATED K (md): 0.0249

STEADY TIME (HRS.): 15,056.07

STABILIZED FLOW (MCF/D): 330.31

AOF PRESSURE (psia): 104

STABILIZED AOF (MCF/D): 351

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/24/91

WELL NAME: LONGWAY DRAW 1

INTERVAL: 15605-10

STIMULATED ? (Y/N): NO, SPOT; YES, 2000 GAL ACID +CO2

FLOW RATE (MCF/D): 141

FLOW TIME (HRS.): 48

FLOWING BHP (psia): 147

GAS GRAVITY (Yg): 0.583

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 8,500

GAS POROSITY: 0.045

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 14

Z-FACTOR: 1.275

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0306

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.512

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0145

RADIUS OF DRAINAGE (Ft): 164.0

CALCULATED K (md): 0.0145

STEADY TIME (HRS.): 19,916.59

STABILIZED FLOW (MCF/D): 96.02

AOF PRESSURE (psia): 74

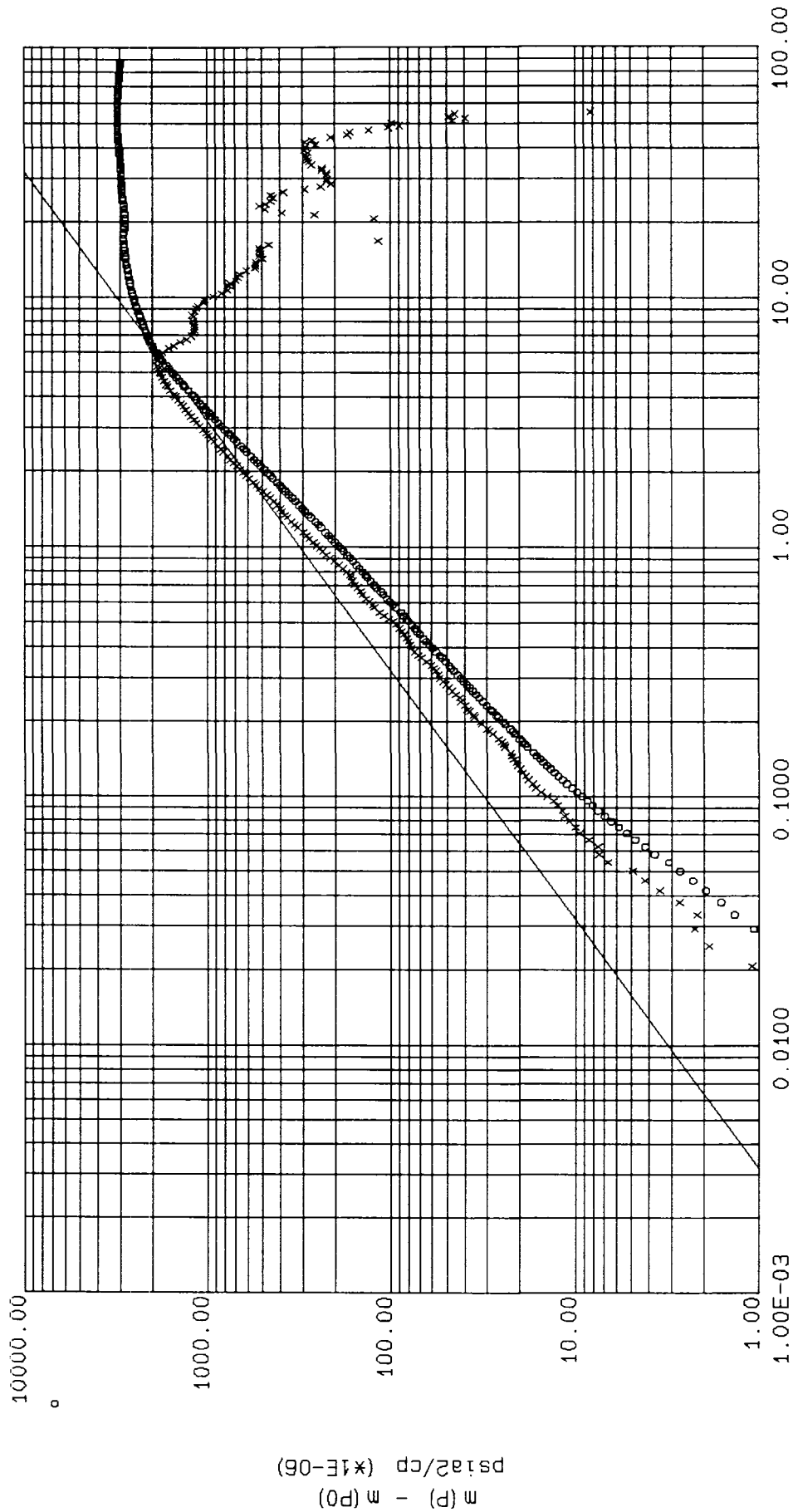
STABILIZED AOF (MCF/D): 97



PANSYSTEM V1.7 (C) EPDS 1990.

LOG-LOG

File.....: BZT GAS  
COUNTY, STATE.....: LEA COUNTY, NEW MEXICO  
Slope.....: 0.0000  
COMPANY.....: ENRON OIL & GAS COMPANY  
TEST TYPE.....: PRESSURE BUILDUP TEST  
Intercept.....: 0.0000  
LEASE & WELL #: LONGWAY DRAW FED. CON. #1  
TEST DATES.....: 6/27-7/5/90  
FIELD (FORMATION).....: PITCHFORK RANCH (MORRISON)  
GAUGE TYPE & NO. ....: QUARTZ TRANSDUCER



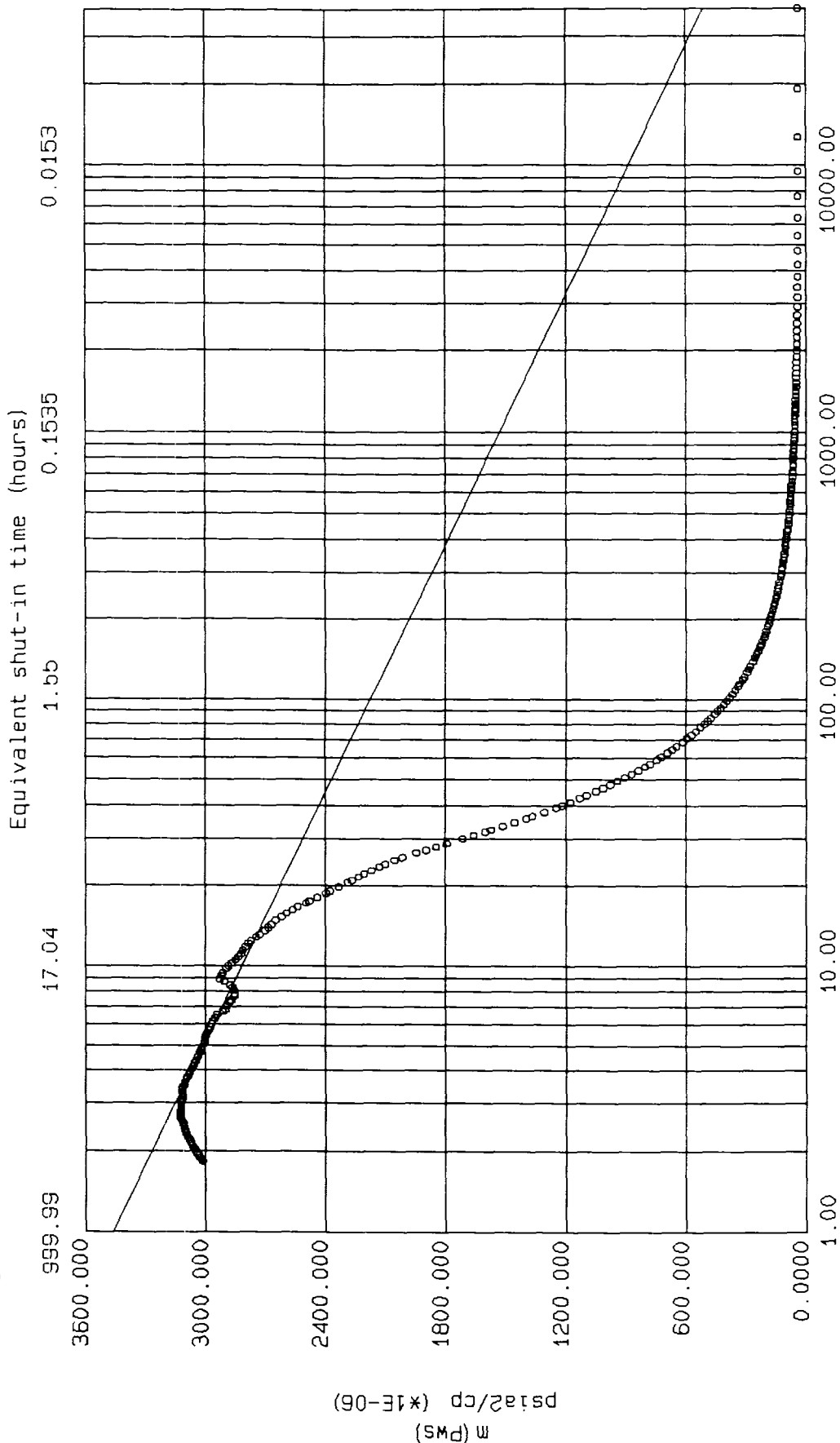
ARC

PANSYSTEM V1.7 (C) EPOS 1990.

VRB

|                        |                           |                       |                        |                |          |
|------------------------|---------------------------|-----------------------|------------------------|----------------|----------|
| File.....              | BZI GAS                   | COUNTY, STATE.....    | LEA COUNTY, NEW MEXICO | Slope.....     | -643.069 |
| COMPANY.....           | ENRON OIL & GAS COMPANY   | TEST TYPE.....        | PRESSURE BUILDUP TEST  | Intercept..... | 3461.505 |
| LEASE & WELL #.....    | LONGWAY DRAN FED. COM. #1 | TEST DATES.....       | 6/27-7/5/90            | Permeability.. | 0.0673   |
| FIELD (FORMATION)..... | PITCHFORK RANCH (MCCORM)  | GAUGE TYPE & NO. .... | QUARTZ TRANSDUCER      | Skin.....      | -0.5861  |

$19' / 39' = .024 \text{ ml}$



Superposition Function

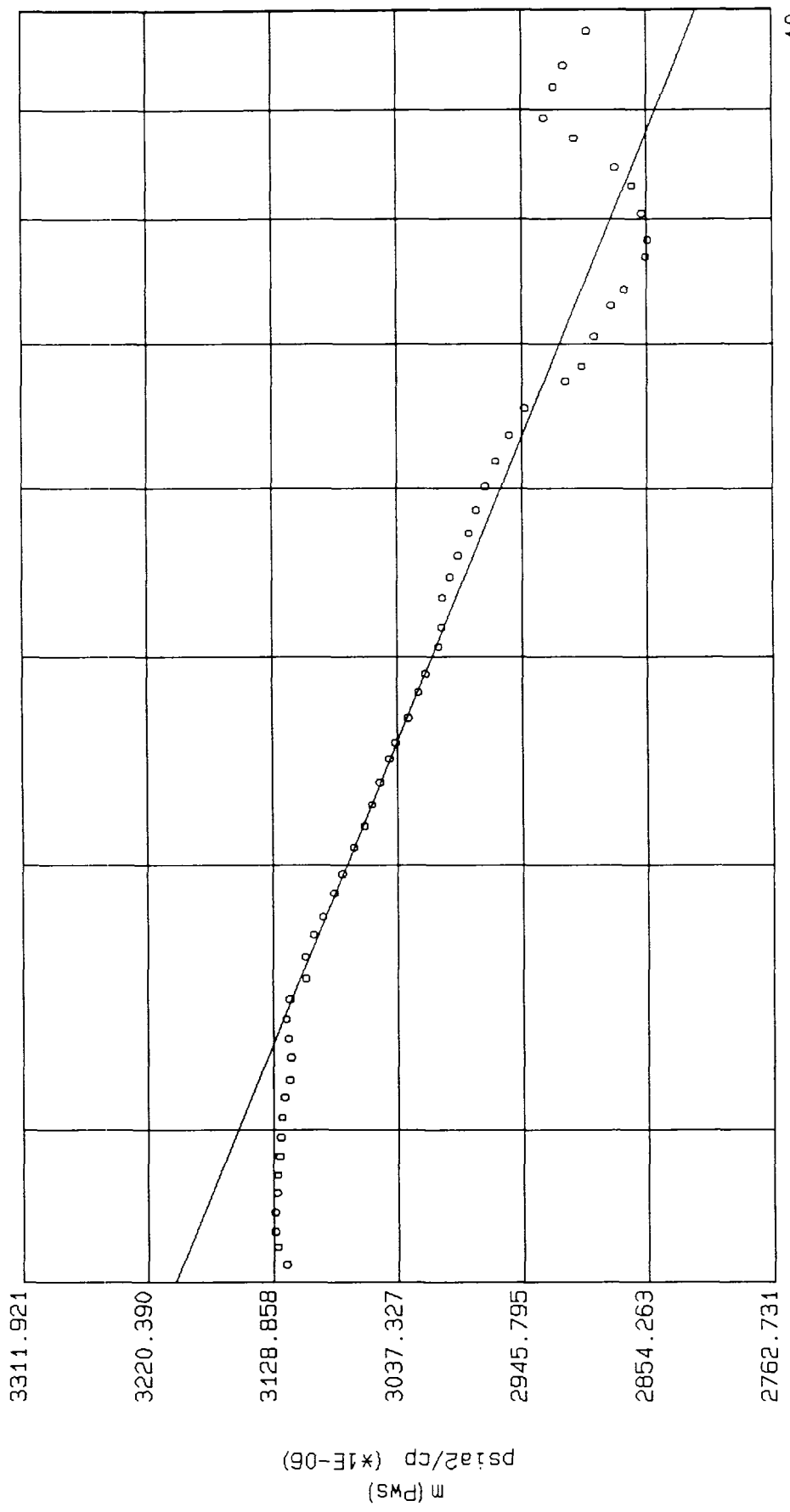


PANSYSTEM V1.7 (C) EPDS 1990.

VRB

|                        |                           |                       |                        |                |                                        |
|------------------------|---------------------------|-----------------------|------------------------|----------------|----------------------------------------|
| File.....              | BZT.GAS                   | COUNTY, STATE.....    | LEA COUNTY, NEW MEXICO | Slope.....     | -643.069                               |
| COMPANY.....           | ENRON OIL & GAS COMPANY   | TEST TYPE.....        | PRESSURE BUILDUP TEST  | Intercept..... | 3461.506                               |
| LEASE & WELL #.....    | LONGWAY DRAW FED. CON. #1 | TEST DATES.....       | 6/27-7/5/90            | Permeability.. | $0.0669 \times 10^{-14} \text{ Darcy}$ |
| FIELD (FORMATION)..... | PITCHFORK RANCH (MORROW)  | GAUGE TYPE & NO. .... | QUARTZ TRANSDUCER      | Skin.....      | -0.5837                                |

Equivalent shut-in time (hours) 17.04



Superposition Function

ARC

RESERVOIR PRESSURE DATA

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## ARC PRESSURE DATA, INC.

RESULTS FROM SEMILOG ANALYSIS  
using Pseudo-pressure and Superposition Time

Line :

|                                   |                    |
|-----------------------------------|--------------------|
| Intercept.....:                   | 3461.506           |
| Slope.....:                       | -643.069           |
| Start of line.....:(              | 0.6825 , 3022.086) |
| End of line.....:(                | 0.6199 , 3061.857) |
| Coefficient of determination....: | 0.9965             |
| Number of points.....:            | 7                  |

|                                   |                                         |
|-----------------------------------|-----------------------------------------|
| m(p) at dt = 1 hr.....:           | 2054.344 psia <sup>2</sup> /cp (*1E-06) |
| Extrapolated m(p).....:           | 3461.506 psia <sup>2</sup> /cp (*1E-06) |
| Permeability-thickness (kh).....: | 0.9372 md.ft                            |
| Permeability (k).....:            | <del>0.0669 md</del> 0.024 md           |
| Total skin factor (s).....:       | -0.5837                                 |
| dP skin (constant rate).....:     | -713.098 psi                            |
| Radius of investigation.....:     | 288.463 ft                              |
| Extrapolated pressure.....:       | 9986.699 psia                           |
| Pressure at dt = 1 hour.....:     | 6582.620 psia                           |



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## ARC PRESSURE DATA, INC.

### RESERVOIR CONSTANTS

|                                      |                      |        |
|--------------------------------------|----------------------|--------|
| Formation thickness (h).....:        | <del>14.000</del> ft | 39 ft. |
| Average formation porosity (0).....: | 0.0682               |        |
| Well radius (rw).....:               | 0.3000 ft            |        |
| Gauge depth.....:                    | 14693 ft             |        |
| Datum depth.....:                    | 15030 ft             |        |

### GAS COMPOSITION Mol percent (Optional)

|              |       |              |      |              |      |              |                    |
|--------------|-------|--------------|------|--------------|------|--------------|--------------------|
| Nitrogen...: | .490  | CO2.....:    | .900 | H2S.....:    | .000 | Methane....: | 94.590             |
| Ethane....:  | 2.470 | Propane...:  | .450 | Iso-Butane:  | .060 | n-Butane...: | .080               |
| IsoPentane:  | .020  | n-Pentane..: | .150 | Hexanes....: | .790 | C 7 +.....:  | .000               |
|              |       |              |      |              |      |              | C7+ mol wt:100.198 |

### RESERVOIR VARIABLES

|                                           |           |         |
|-------------------------------------------|-----------|---------|
| Estimated initial pressure.....:          | 9039.000  | psia    |
| Temperature (T).....:                     | 200.000   | deg F   |
| Water saturation (Sw).....:               | 0.2740    |         |
| Water compressibility (Cw).....:          | 2.654E-06 | psi-1   |
| Formation compressibility (Cf).....:      | 5.699E-06 | psi-1   |
| Gas gravity.....:                         | 0.6054    | sp grav |
| Initial gas viscosity (ui).....:          | 0.0332    | cp      |
| Initial z-factor (zi).....:               | 1.316     |         |
| Gas compressibility (Cg).....:            | 5.427E-05 | psi-1   |
| Initial system compressibility (Ct).....: | 4.583E-05 | psi-1   |

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/25/91

WELL NAME: OCHOA FED 1

INTERVAL: 15082-236'

STIMULATED ? (Y/N): NO; NATURAL

FLOW RATE (MCF/D): 2,400

FLOW TIME (HRS.): 24

FLOWING BHP (psia): 7,244

GAS GRAVITY (Yg): 0.575

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 9,311

GAS POROSITY: 0.060

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 21

Z-FACTOR: 1.335

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0312

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.490

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.8692

RADIUS OF DRAINAGE (Ft): 769.9

CALCULATED K (md): 0.8692

STEADY TIME (HRS.): 452.77

STABILIZED FLOW (MCF/D): 2108.63

AOF PRESSURE (psia): 1200

STABILIZED AOF (MCF/D): 8,274

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/24/91

WELL NAME: OCHOA FED 1

INTERVAL: 15594-908

STIMULATED ? (Y/N): NO;110 BBL H2O + METH

FLOW RATE (MCF/D): 450

FLOW TIME (HRS.): 96

FLOWING BHP (psia): 998

GAS GRAVITY (Yg): 0.575

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 9,311

GAS POROSITY: 0.060

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 18

Z-FACTOR: 1.335

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0312

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.490

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0419

RADIUS OF DRAINAGE (Ft): 338.1

CALCULATED K (md): 0.0419

STEADY TIME (HRS.): 9,384.92

STABILIZED FLOW (MCF/D): 350.69

AOE PRESSURE (psia): 114

STABILIZED AOE (MCF/D): 388

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/26/91

WELL NAME: RED HILLS UNIT 1

INTERVAL: 14840-64'

STIMULATED ? (Y/N): YES; 5000 GAL ACID

FLOW RATE (MCF/D): 2,300

FLOW TIME (HRS.): 12

FLOWING BHP (psia): 790

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 210

RESERVOIR PRESSURE (Pi): 7,419

GAS POROSITY: 0.030

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 10

Z-FACTOR: 1.190

GAS COMPRESSIBILITY: 0.000074

GAS VISCOSITY (cp): 0.0280

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.542

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.4881

RADIUS OF DRAINAGE (Ft): 500.6

CALCULATED K (md): 0.4881

STEADY TIME (HRS.): 535.43

STABILIZED FLOW (MCF/D): 1887.05

AO F PRESSURE (psia): 294

STABILIZED AOF (MCF/D): 2,028

# TIGHT GAS SANDS PERMEABILITY AND STABILIZED FLOW RATE VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/25/91

WELL NAME: RED HILLS UNIT 1

INTERVAL: 14840-64'

STIMULATED ? (Y/N): NO;48 BBL ACID

FLOW RATE (MCF/D): 1,360

FLOW TIME (HRS.): 5

FLOWING BHP (psia): 590

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 210

RESERVOIR PRESSURE (Pi): 7,419

GAS POROSITY: 0.030

WELLBORE RADIUS (Ft): 0.333

SKIN FACTOR: 0.0

PAY HEIGHT: 10

Z-FACTOR: 1.190

GAS COMPRESSIBILITY: 0.000074

GAS VISCOSITY (cp): 0.0280

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.542

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.247

RADIUS OF DRAINAGE (Ft): 229.9

CALCULATED K (md): 0.2470

STEADY TIME (HRS.): 1,058.28

STABILIZED FLOW (MCF/D): 983.55

AOF PRESSURE (psia): 284

STABILIZED AOF (MCF/D): 1,028

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/22/91

WELL NAME: VACA DRAW UNIT 1

INTERVAL: 14954-15716'

STIMULATED ? (Y/N): NO; NOT REPORTED

FLOW RATE (MCF/D): 400

FLOW TIME (HRS.): 48

FLOWING BHP (psia): 214

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 8,500

GAS POROSITY: 0.060

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 62

Z-FACTOR: 1.275

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0300

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.518

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0092

RADIUS OF DRAINAGE (Ft): 114.3

CALCULATED K (md): 0.0092

STEADY TIME (HRS.): 41,208.73

STABILIZED FLOW (MCF/D): 259.38

AO F PRESSURE (psia): 164

STABILIZED AO F (MCF/D): 261

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/22/91

WELL NAME: VACA DRAW UNIT 1

INTERVAL: 14954-15716'

STIMULATED ? (Y/N): YES; 6000 GAL ACID

FLOW RATE (MCF/D): 90

FLOW TIME (HRS.): 144

FLOWING BHP (psia): 357

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 8,500

GAS POROSITY: 0.060

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 62

Z-FACTOR: 1.275

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0300

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.518

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.002

RADIUS OF DRAINAGE (Ft): 92.3

CALCULATED K (md): 0.0020

STEADY TIME (HRS.): 187,442.40

STABILIZED FLOW (MCF/D): 56.04

AOF PRESSURE (psia): 164

STABILIZED AOF (MCF/D): 57

# TIGHT GAS SANDS

## PERMEABILITY AND STABILIZED FLOW RATE

### VACA DRAW / PITCHFORK RANCH AREA

DATE: 11/22/91

WELL NAME: VACA DRAW UNIT 1

INTERVAL: 15291-322'

STIMULATED ? (Y/N): NO; 240 BBL H2O

FLOW RATE (MCF/D): 30

FLOW TIME (HRS.): 24

FLOWING BHP (psia): 200

GAS GRAVITY (Yg): 0.580

TEMP. DEGREE F (T): 221

RESERVOIR PRESSURE (Pi): 8,500

GAS POROSITY: 0.040

WELLBORE RADIUS (Ft): 0.250

SKIN FACTOR: 0.0

PAY HEIGHT: 36

Z-FACTOR: 1.275

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0300

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.518

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0009

RADIUS OF DRAINAGE (Ft): 31.0

CALCULATED K (md): 0.0009

STEADY TIME (HRS.): 281,441.13

STABILIZED FLOW (MCF/D): 14.73

AOE PRESSURE (psia): 64

STABILIZED AOE (MCF/D): 15

**TIGHT GAS SANDS**  
**PERMEABILITY AND STABILIZED FLOW RATE**  
**VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/25/91

WELL NAME: VACA DRAW 13 FED NO. 1

INTERVAL: 15014-53'

STIMULATED ? (Y/N): YES; 4000 GAL ACID + N2

FLOW RATE (MCF/D): 850

FLOW TIME (HRS.): 7

FLOWING BHP (psia): 5,018

GAS GRAVITY ( $\gamma_g$ ): 0.576

TEMP. DEGREE F (T): 227

RESERVOIR PRESSURE (Pi): 10,814

GAS POROSITY: 0.058

WELLBORE RADIUS (Ft): 0.160

SKIN FACTOR: 0.0

PAY HEIGHT: 22

Z-FACTOR: 1.459

GAS COMPRESSIBILITY: 0.000041

GAS VISCOSITY (cp): 0.0323

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.467

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.086

RADIUS OF DRAINAGE (Ft): 144.4

CALCULATED K (md): 0.0860

STEADY TIME (HRS.): 3,756.67

STABILIZED FLOW (MCF/D): 589.20

AO F PRESSURE (psia): 254

STABILIZED AO F (MCF/D): 1,073

**TIGHT GAS SANDS  
PERMEABILITY AND STABILIZED FLOW RATE  
VACA DRAW / PITCHFORK RANCH AREA**

DATE: 11/25/91

WELL NAME: VACA DRAW 13 FED NO.1

INTERVAL: 15264-88'

STIMULATED ? (Y/N): YES; 4000 GAL ACID + N2

FLOW RATE (MCF/D): 350

FLOW TIME (HRS.): 38

FLOWING BHP (psia): 560

GAS GRAVITY (Yg): 0.576

TEMP. DEGREE F (T): 227

RESERVOIR PRESSURE (Pi): 9,063

GAS POROSITY: 0.064

WELLBORE RADIUS (Ft): 0.160

SKIN FACTOR: 0.0

PAY HEIGHT: 13

Z-FACTOR: 1.350

GAS COMPRESSIBILITY: 0.00005

GAS VISCOSITY (cp): 0.0318

SPACING ACRES: 320

FORMATION VOLUME FACTOR (Bg): 0.493

SPACING RADIUS (Ft): 2,106

ASSUMED K (md): 0.0451

RADIUS OF DRAINAGE (Ft): 211.6

CALCULATED K (md): 0.0451

STEADY TIME (HRS.): 9,482.57

STABILIZED FLOW (MCF/D): 257.94

AOE PRESSURE (psia): 114

STABILIZED AOE (MCF/D): 271