

34-31-40W
15-129-205-11

CORE LABORATORIES, INC.



Reply To
10703 E. BETHANY DRIVE
AURORA, COLORADO 80014

November 24, 1982

Amoco Production Company
7200 South Alton Way
Englewood, Colorado 80112

Attention: Ms. Lilian Fandriana

Subject:

Special Core Analysis Study
Breeding Gas Unit F No. 1 Well
Kinsler Field
SW/4 Section 34-T31S-R40W
Chase Formation
Morton County, Kansas
File Number: SCAL 203-820062

Gentlemen:

On August 6, Ms. Lilian Fandriana requested Core Laboratories to perform Special Core Analysis testing on core material from the subject well. Core material was obtained from the Amoco Core Warehouse. Reported are the final data results from the following tests:

- 1) Formation Resistivity Factor and Resistivity Index Measurements.
- 2) Formation Resistivity Factor Measurements at Overburden Pressure.

A set of one inch diameter core plugs were drilled using a diamond core bit with tap water as a bit lubricant and coolant. The core plugs were subsequently extracted of hydrocarbons using hot toluene and leached of salt using hot methyl alcohol in a centrifuge solvent reflux apparatus. Upon completion of cleaning, the core plugs were dried in a conventional vacuum oven at 180°F for 24 hours. Permeability to air and Boyle's Law porosity values were obtained on the dried core plugs and this data is presented on Page 2 of this report. Each core plug sample is identified as to sample number, sample depth and lithologically described on Page 1.

1) Formation Resistivity Factor and Resistivity Index Measurements:

The set of 1" diameter samples were evacuated and pressure saturated with a simulated formation brine. The brine composition analysis is provided on Page 4. The electrical resistivities of the brine and saturated samples were measured at regular intervals of two to three days until results stabilized, indicating ionic equilibrium had occurred. The measured resistivity of the saturant was 0.0462 ohm-meters at 72°F. The core plugs were then partially desaturated by dynamic displacement in a high speed centrifuge at two desaturation points. The initial desaturation point was at 120 psi for a duration of one hour, while the second point was performed at 468 psi for 4 hours. The volumetric readings obtained at each point for each core sample were used and checked against gravimetric calculations for saturation determination. Concurrently each sample had resistivity measurements at each desaturation point. The resistivity index results are presented in tabular form on Page 5, 6 and 7 and in composite graph form on Pages 8, 9, 10, 11 and 12. The saturation exponents "n" and cementation exponents "m" at room conditions are arranged according to 4 zones within the Chase Formation. A composite plot of all zones is given on Page 12.

<u>CHASE FORMATION</u>	<u>"n"</u>	<u>"m"</u>	<u>"a"</u>	
Krider Zone	2.11	1.85	1.00	
Winfield Zone	2.00	1.82	1.00	* Calculations
Towanda Zone	1.77	1.75	1.00	derived using
Lower Fort Riley Zone	2.00	1.91	1.00	Archie equation
Composite Zone Data	1.87	—	1.00	

In comparing the exponent values for each zone, it becomes apparent that the Towanda zone is different. Examination of the core plug samples offer a good explanation, in that the sample lithology is different. The sand stone samples are reddish in color and have various minerals such as anhydrite and scattered pyrite.

2) Formation Resistivity Factor Measurements at Overburden Pressure:

The core plug samples were saturated as above and electrical resistivities were measured at an effective overburden pressure of 0.0, 200, 1850, 1900 and 2050 psi. The samples exhibited normal trends of increasing formation resistivity factors and cementation exponents with increasing effective overburden pressures. Using the Archie equation, the following cementation exponent "m" can be calculated from the data:

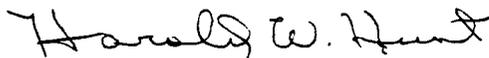
<u>Chase Formation</u>	<u>"m" (0.0 psi)</u>	<u>"m" (200 psi)</u>	<u>"m" (1850 psi)</u>	<u>"m" (1900 psi)</u>	<u>"m" (2050 psi)</u>
Krider Zone	1.85	1.89	2.08	—	—
Winfield Zone	1.82	1.92	2.04	—	—
Towanda Zone	1.75	1.90	—	2.02	—
Lower Ft. Riley Zone	1.91	2.00	—	—	2.12

Tabular data is presented on Page 13 and graph plots are presented on Pages 14 through 25.

It has been a pleasure working with Amoco Production Company on this study. Should you have any questions pertaining to these test results or if we can be of further assistance, please contact Mercer L. Brugler at 303-751-9334.

Very truly yours,

CORE LABORATORIES, Inc.



Harold W. Hunt
District Manager

HWH:MLB:ss
cc 10 addressee

Company AMOCO PRODUCTION COMPANY Formation CHASE
 Well BREEDING GAS UNIT F NO. 1 County MORTON
 Field KINSLER State KANSAS

IDENTIFICATION AND LITHOLOGICAL DESCRIPTION OF SAMPLES

<u>Sample Identification</u>	<u>Depth, feet</u>	<u>Lithological Description</u>
Krider Zone		
1	2182	Sst,sil,lt gry,vf gr,wl srted,wl consol, scat pyr,tr mic
2	2186	Sst,sil,lt gry,vf gr,wl srted,wl consol, scat pyr,tr mic,slily lmy
3	2187	Sst,calc,lt gry,vf gr,wl srted,wl consol, slily slty,scat pyr
Winfield Zone		
4	2212	Ls, lt gry,vf xln,wl ind,pso,ool,tr pyr
5	2214	Ls, lt gry,vf xln,wl ind,pso,ool,tr pyr
6	2216	Ls, lt gry,vf xln,wl ind,v sdy,lam,sd peb
Towanda Zone		
7	2240	Sst,calc,rdsh,vf gr,wl srted,wl consol,sid abd anhy,slily slty
8	2243	Sst,sil,rdsh,vf gr,wl srted,wl consol,slily slty,slily lmy
9	2248	Sst,sil,pk-bu,vf gr,wl srted,wl consol,lmy, slily slty,tr pyr
10	2251	Sst,sil,lt gry,vf gr,wl srted,wl consol,slty, slily lmy,scat pyr
11	2254	Sst,sil,gry,vf-f gr,prly srted,wl consol, slty,slily lmy,anhy,scat pyr,frac
Lower Fort Riley Zone		
12	2377	Ls,lt gry,vfxln,wl ind,psool,sdy
13	2387	Ls,gry,vf xln,wl ind,psool,sdy
14	2391	Ls,gry,vf xln,wl ind,psool,sdy,scat pyr

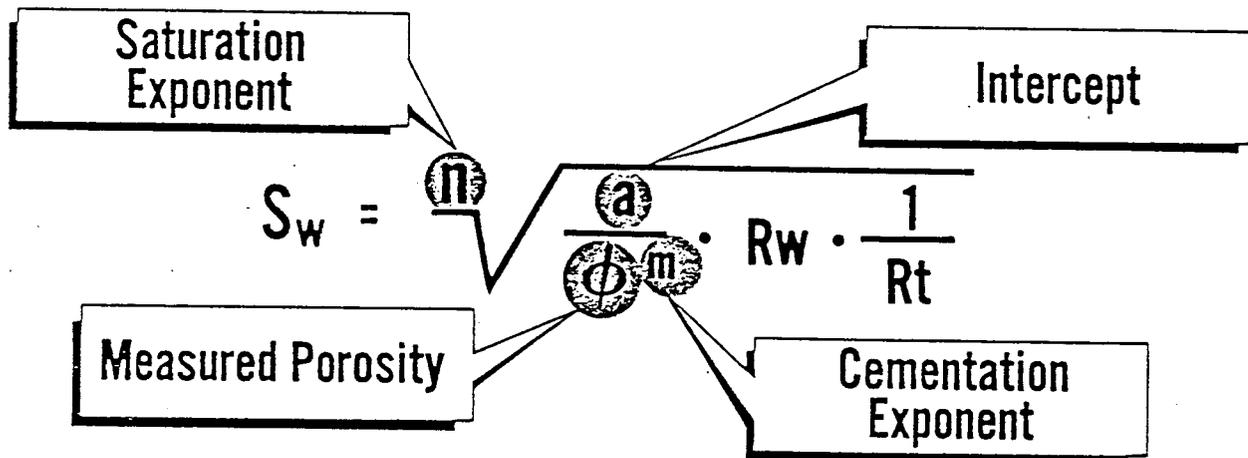
PERMEABILITY TO AIR AND POROSITY

Company: AMOCO PRODUCTION COMPANY Well: BREEDING GAS UNIT F NO. 1
 Formation: CHASE Field: KINSLER
 County (Parish), State: MORTON, KANSAS

Sample Identification	Depth, feet	Permeability to Air, millidarcys	Porosity, percent
Krider Zone			
1	2182	11	16.4
2	2186	3.8	12.6
3	2187	0.62	13.4
Winfield Zone			
4	2212	0.30	11.4
5	2214	1.5	12.6
6	2216	0.22	10.2
Towanda Zone			
7	2240	0.56	13.3
8	2243	14	19.3
9	2248	119	23.2
10	2251	102	27.7
11	2254	0.20	9.7
Lower Ft. Riley Zone			
12	2377	2.3	14.0
13	2387	0.26	12.0
14	2391	0.16	10.4

This report, based on observations and materials supplied by the client, is prepared for the exclusive and confidential use by the client. The analyses, opinions, or interpretations contained herein represent the judgement of Core Laboratories, Inc.; however, Core Laboratories, Inc., and its employees assume no responsibility and make no warranties or representations as to the utility of this report to the client or as to the productivity, proper operation, or profitability of any oil, gas, or other mineral formation or well in connection with which such report may be used or relied upon.

$$S_w = \sqrt[n]{\frac{F \cdot R_w}{R_t}} = \sqrt[n]{\frac{R_o}{R_t}}$$



Rock Properties Influencing Calculated Water Saturations

SIMULATED BRINE COMPOSITION

<u>Constituents</u>	<u>Concentration, gm/L</u>
Sodium Chloride (NaCl)	270.6
Calcium Chloride (CaCl ₂)	13.0
Magnesium Chloride (MgCl ₂ ·6H ₂ O)	12.5
Barium Chloride (BaCl ₂ ·2H ₂ O)	—
Sodium Bicarbonate (NaHCO ₃)	—
Sodium Carbonate (Na ₂ CO ₃)	—
Sodium Sulfate (Na ₂ SO ₄)	2.0
Potassium Chloride (KCL)	0.6

The brine composition was prepared from the following analysis:

Company: AMOCO PRODUCTION COMPANY Well: WRATIL GAS UNIT NO. 1
 Formation: CHASE Field: G.L. HAYWARD GAS UNIT NO. 1
 County (Parish), State: MORTON, KANSAS Field: KINSLER

<u>Constituent</u>	<u>Concentration, mg/L</u>	<u>Constituent</u>	<u>Concentration, mg/L</u>
Sodium	106800	Chloride	177123
Calcium	4700	Bicarbonate	—
Magnesium	1500	Sulfate	1355
Barium	—	Carbonate	—
Iron	245	Hydroxide	—
		Potassium	320

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FORMATION RESISTIVITY FACTOR AND RESISTIVITY INDEX

Company: AMOCO PRODUCTION COMPANY Well: BREEDING GAS UNIT F NO. 1
 Formation: CHASE Field: KINSLER
 County (Parish), State: MORTON, KANSAS
 Saturant: Simulated Formation Brine
 Resistivity of Saturant: .0462 ohm-meters at 72 °F (C)

Sample I.D.	Depth, feet	Permeability to Air, millidarcys	Porosity, percent	Formation Resistivity Factor	Brine Saturation, percent pore space	Resistivity Index	
Krider Zone	1	2182	11	16.4	24.5	100	1.00
						65.8	2.33
						35.3	7.75
	2	2186	3.8	12.6	44.4	100	1.00
						58.8	3.08
						40.6	7.42
	3	2187	0.62	13.4	42.6	100	1.00
						73.1	2.18
						46.8	4.33
Winfield Zone	4	2212	0.30	11.4	53.6	100	1.00
						76.1	2.10
						48.0	4.38
	5	2214	1.5	12.6	45.5	100	1.00
						52.0	3.96
						30.6	9.76
	6	2216	0.22	10.2	52.8	100	1.00
						87.4	1.67
						67.0	3.16

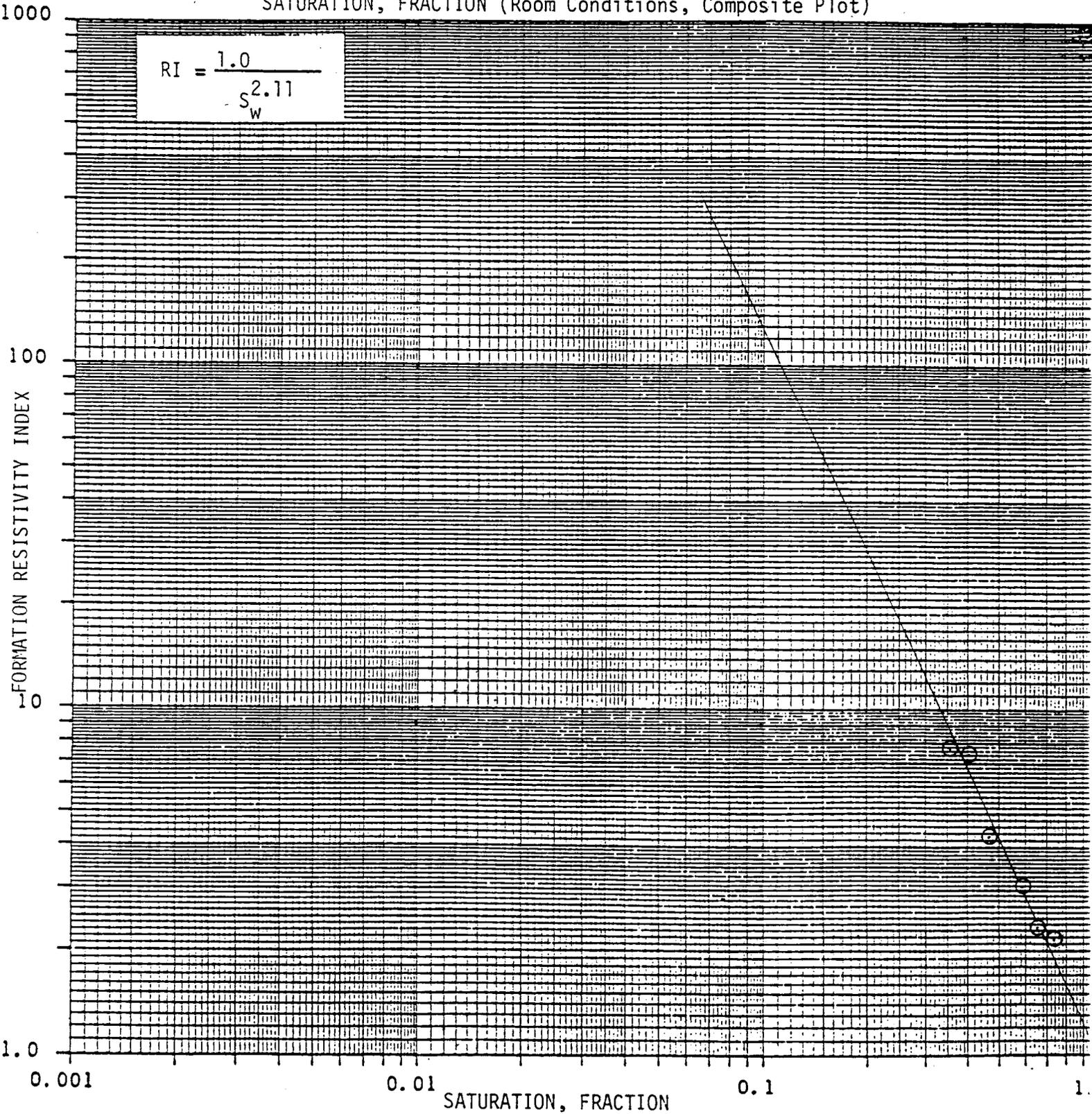
FORMATION RESISTIVITY FACTOR AND RESISTIVITY INDEXCompany: AMOCO PRODUCTION COMPANY Well: BREEDING GAS UNIT F NO. 1Formation: CHASE Field: KINSLERCounty (Parish), State: MORTON, KANSASSaturant: Simulated Formation BrineResistivity of Saturant: .0462 ohm-meters at 72 °F (C)

Sample I.D.	Depth, feet	Permeability to Air, millidarcys	Porosity, percent	Formation Resistivity Factor	Brine Saturation, percent pore space	Resistivity Index
7	2240	0.56	13.3	31.6	100	1.00
					97.5	1.28
					73.9	2.77
8	2243	14	19.3	18.6	100	1.00
					51.8	2.90
9	2248	119	23.2	11.8	100	1.00
					38.7	5.06
					17.9	23.2
10	2251	102	27.7	14.3	100	1.00
					43.5	3.33
					30.2	6.41
11	2254	0.20	9.7	60.4	100	1.00
					93.9	1.53
					56.4	3.29

Towanda
Zone

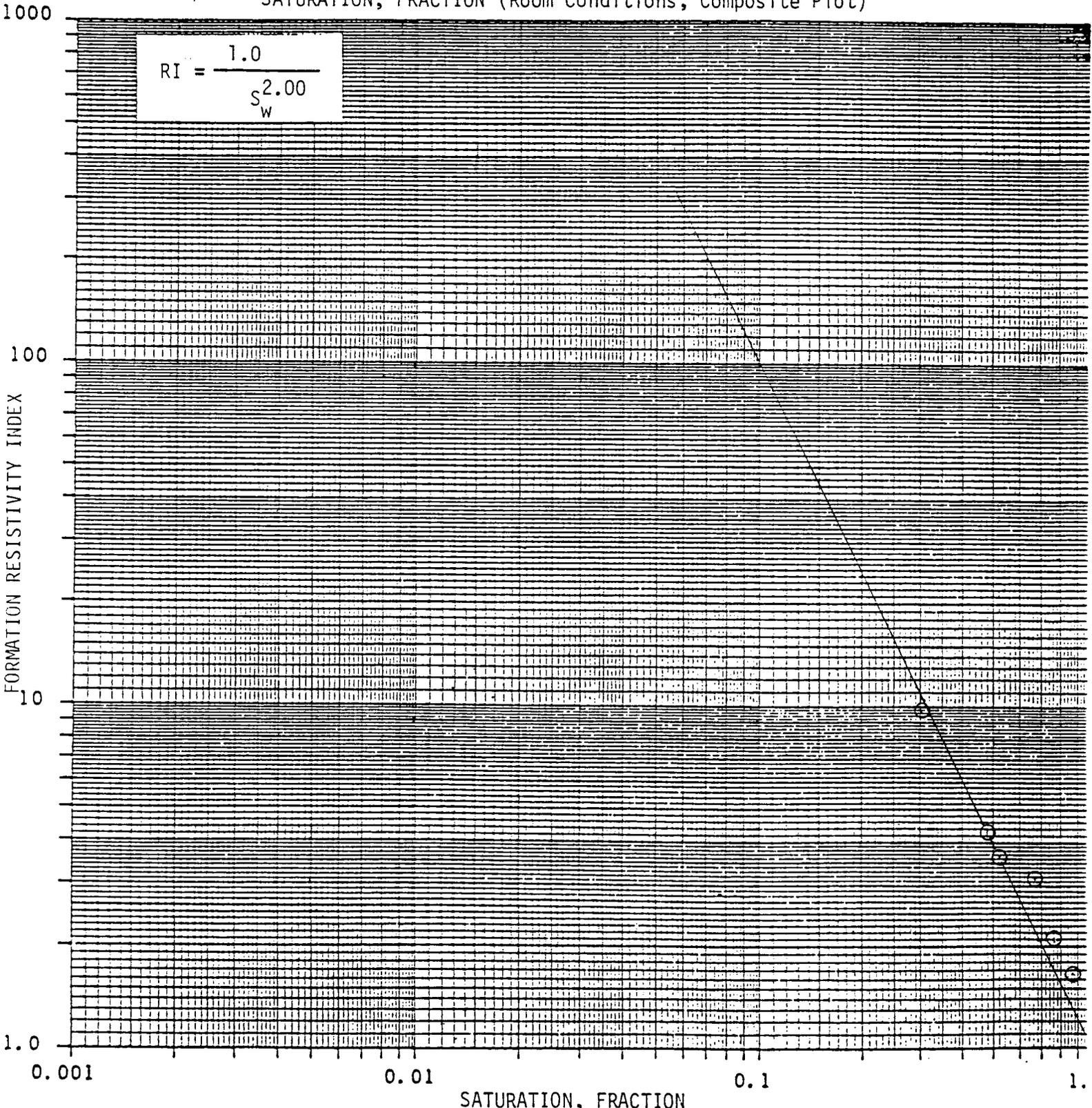
Company AMOCO PRODUCTION COMPANY Formation CHASE-KRIDER ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY INDEX
versus
SATURATION, FRACTION (Room Conditions, Composite Plot)



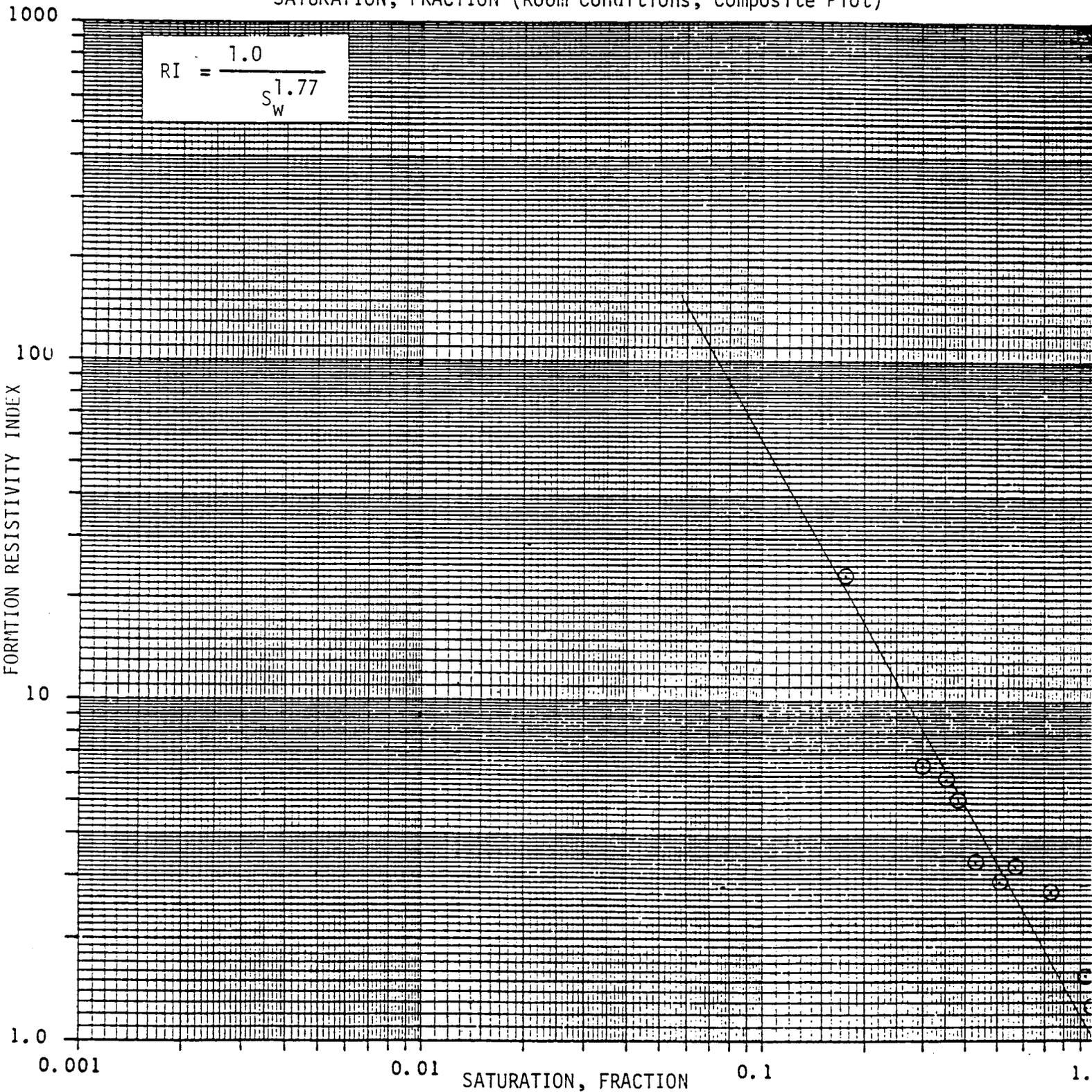
Company AMOCO PRODUCTION COMPANY Formation CHASE-WINFIELD ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY INDEX
versus
SATURATION, FRACTION (Room Conditions, Composite Plot)



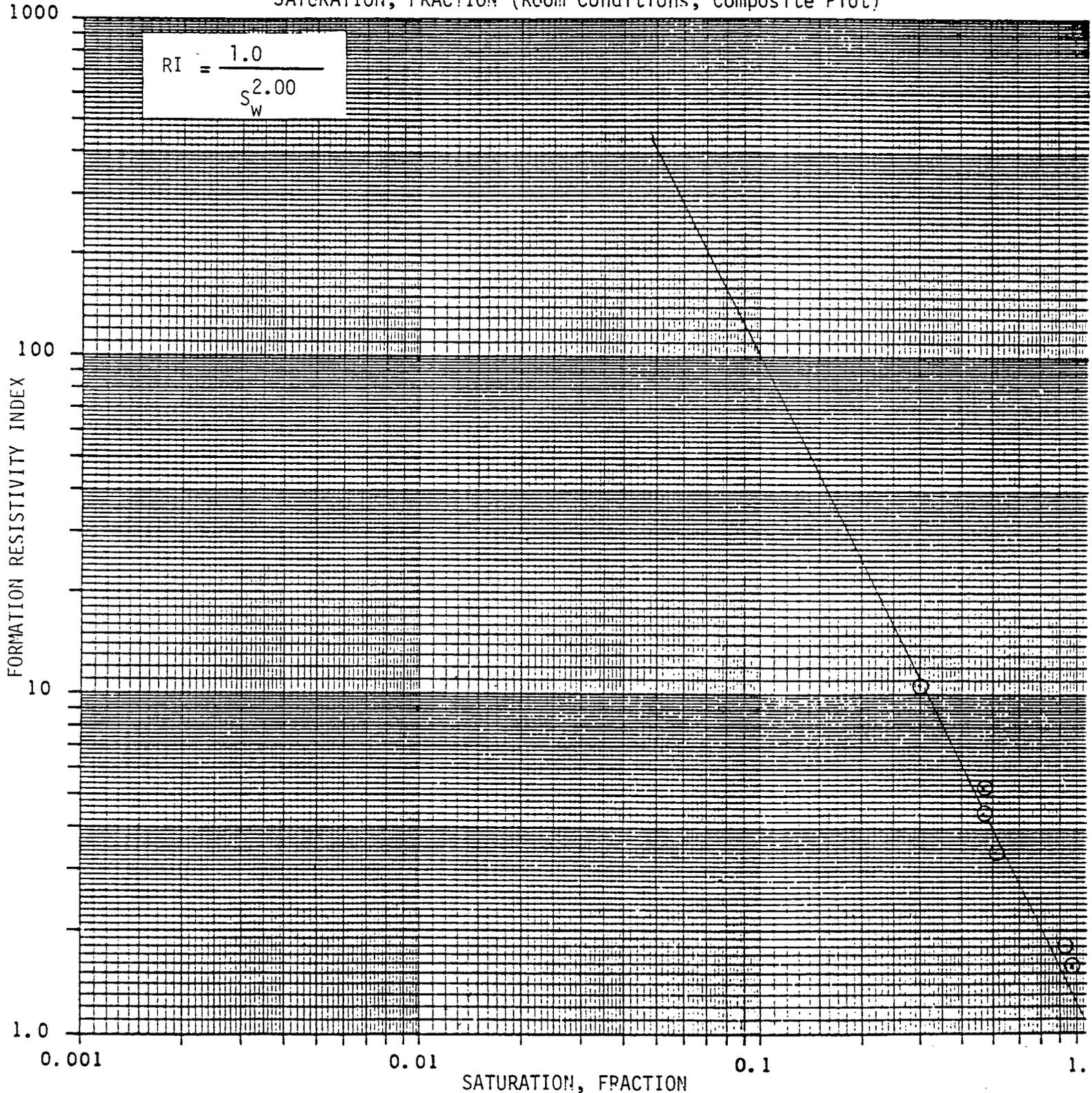
Company AMOCO PRODUCTION COMPANY Formation CHASE-TOWANDA ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY INDEX
versus
SATURATION, FRACTION (Room Conditions, Composite Plot)



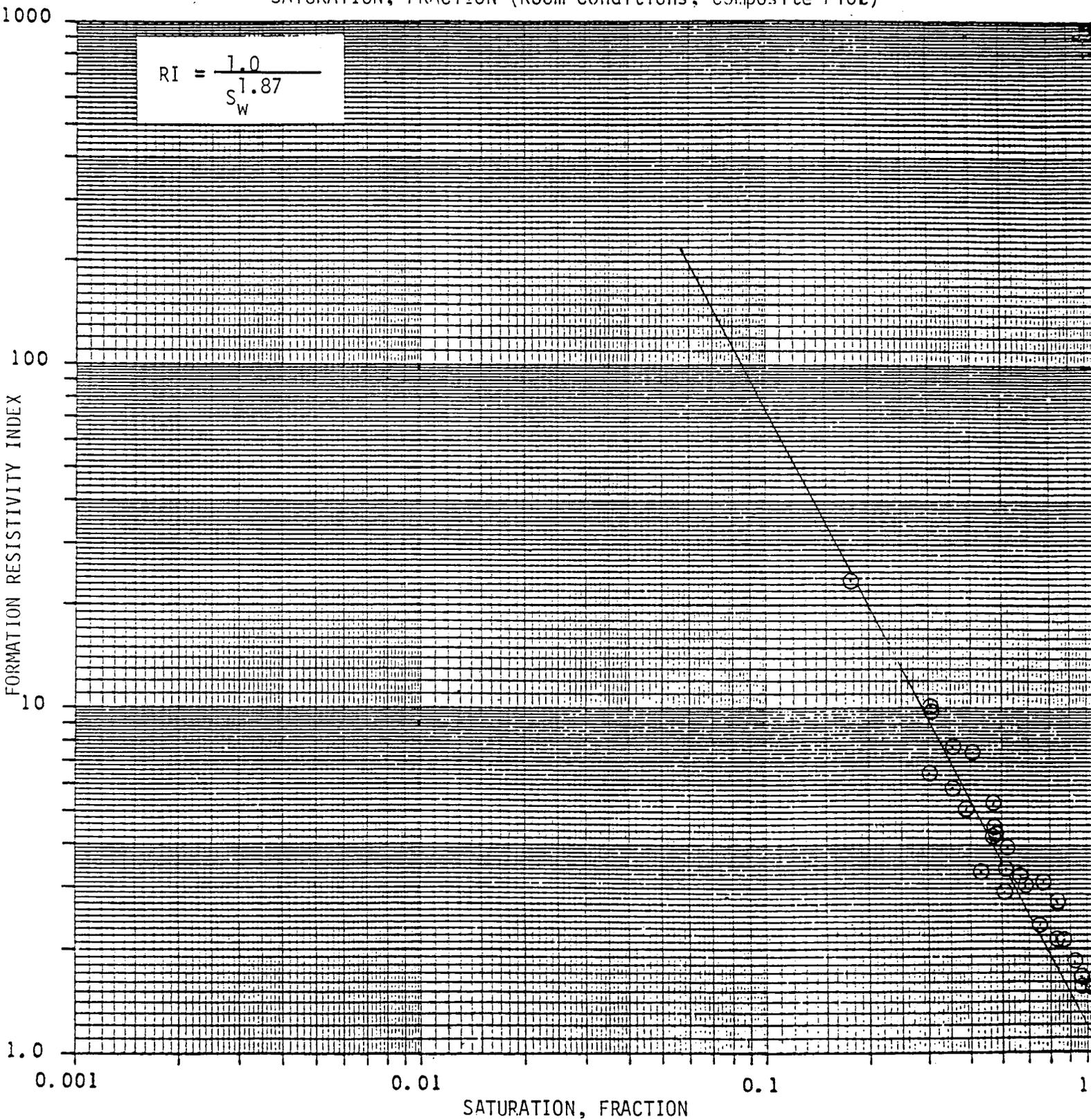
Company AMOCO PRODUCTION COMPANY Formation CHASE-LOWER FORT RILEY ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY INDEX
versus
SATURATION, FRACTION (Room Conditions, Composite Plot)



Company AMOCO PRODUCTION COMPANY Formation CHASE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY INDEX
versus
SATURATION, FRACTION (Room Conditions, Composite Plot)



FORMATION RESISTIVITY FACTOR AS A FUNCTION OF OVERBURDEN PRESSURE

Company: AMOCO PRODUCTION COMPANY Well: BREEDING GAS UNIT F NO. 1

Formation: CHASE Field: KINSLER

County (Parish), State: MORTON, KANSAS

Saturant: Simulated Formation Brine

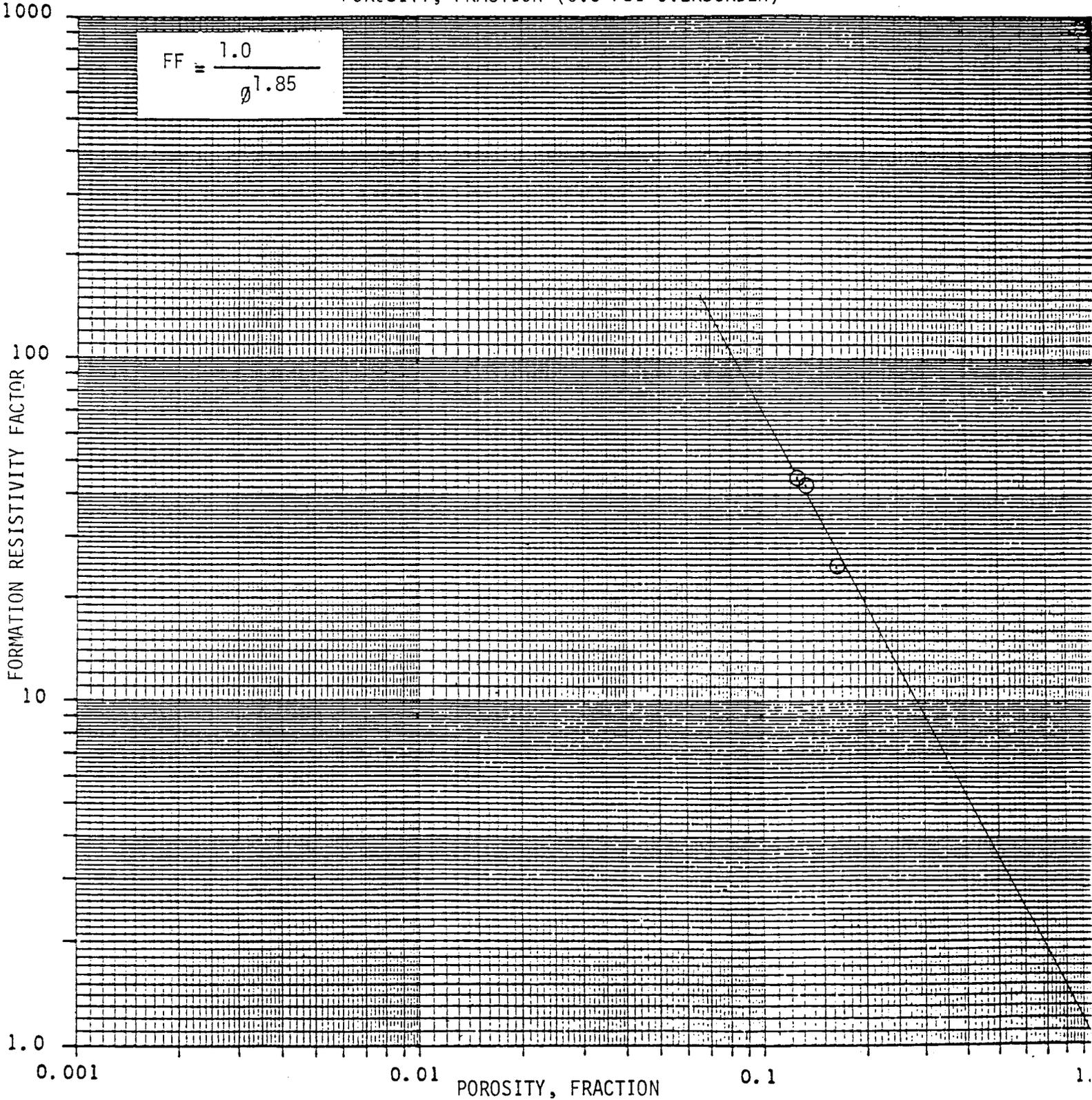
Resistivity of Saturant: .0462 ohm-meters at 72 °F (C)

	Sample I.D.	Depth, feet	Permeability to Air, millidarcys	Porosity, percent	Effective Overburden Pressure, psi					
					0.0	200	1850	1900	2050	
					Formation Resistivity Factor					
KRIDER	1	2182	11	16.4	24.5	30.1	42.6			
	2	2186	3.8	12.6	44.4	47.2	66.2			
	3	2187	0.62	13.4	42.6	48.7	66.6			
WINFIELD	4	2212	0.30	11.4	53.6	66.0	83.2			
	5	2214	1.5	12.6	45.5	57.8	73.6			
	6	2216	0.22	10.2	52.8	65.0	84.3			
TOWANDA	7	2240	0.56	13.3	31.6	37.4		52.9		
	8	2243	14	19.3	18.6	21.8		33.8		
	9	2248	119	23.2	11.8	14.6		18.2		
	10	2251	102	27.7	14.3	17.4		23.5		
	11	2254	0.20	9.7	60.4	81.0		103		
L.FT.RILEY	12	2377	2.3	14.0	46.0	61.2			72.7	
	13	2387	0.26	12.0	58.5	70.5			84.5	
	14	2391	0.16	10.4	53.8	72.5			87.6	

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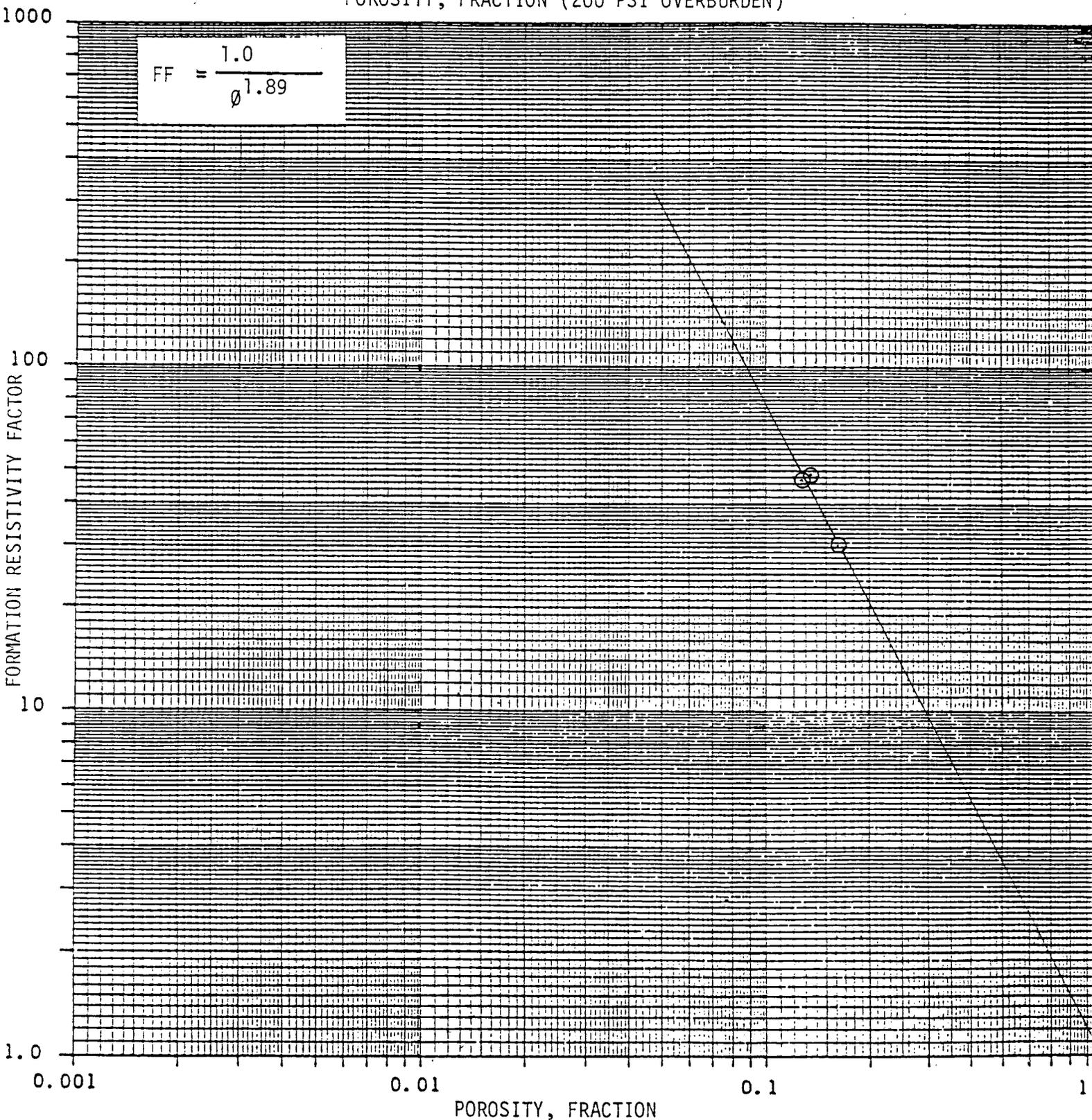
Company AMOCO PRODUCTION COMPANY Formation CHASE-KRIDER ZONE
Well BREEDNING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (0.0 PSI OVERBURDEN)



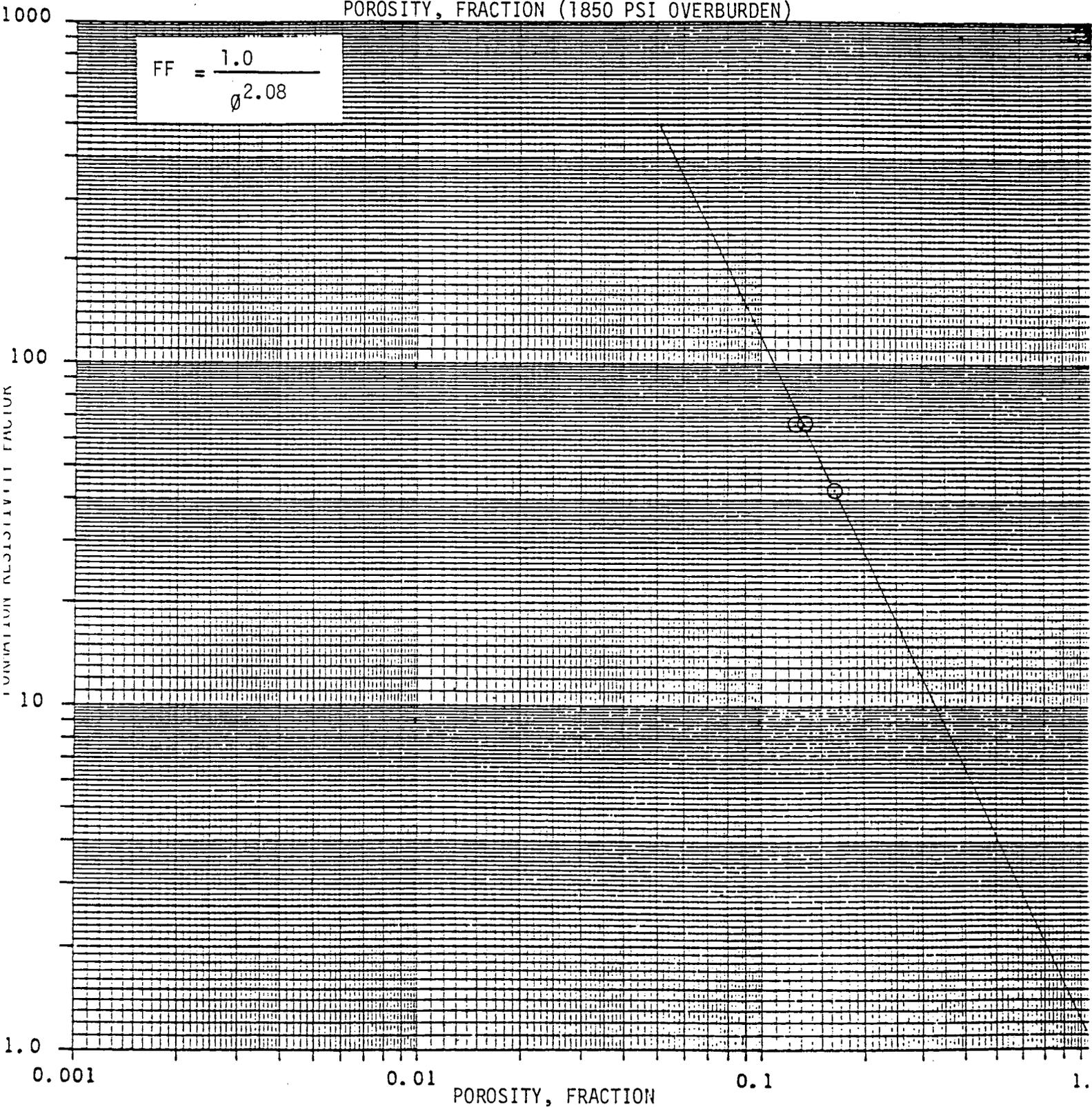
Company AMOCO PRODUCTION COMPANY Formation CHASE-KRIDER ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (200 PSI OVERBURDEN)



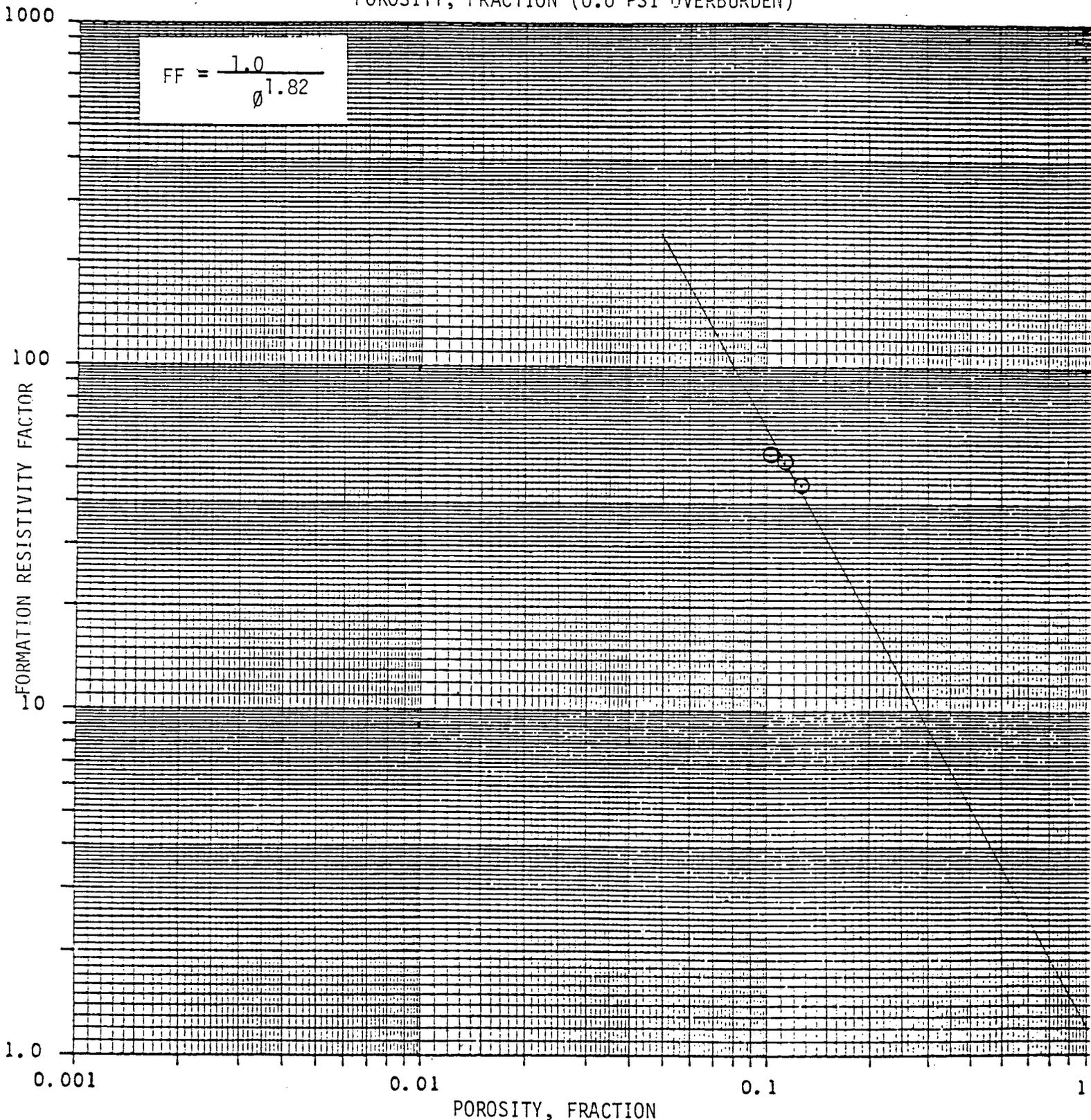
Company AMOCO PRODUCTION COMPANY Formation CHASE-KRIDER ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (1850 PSI OVERBURDEN)



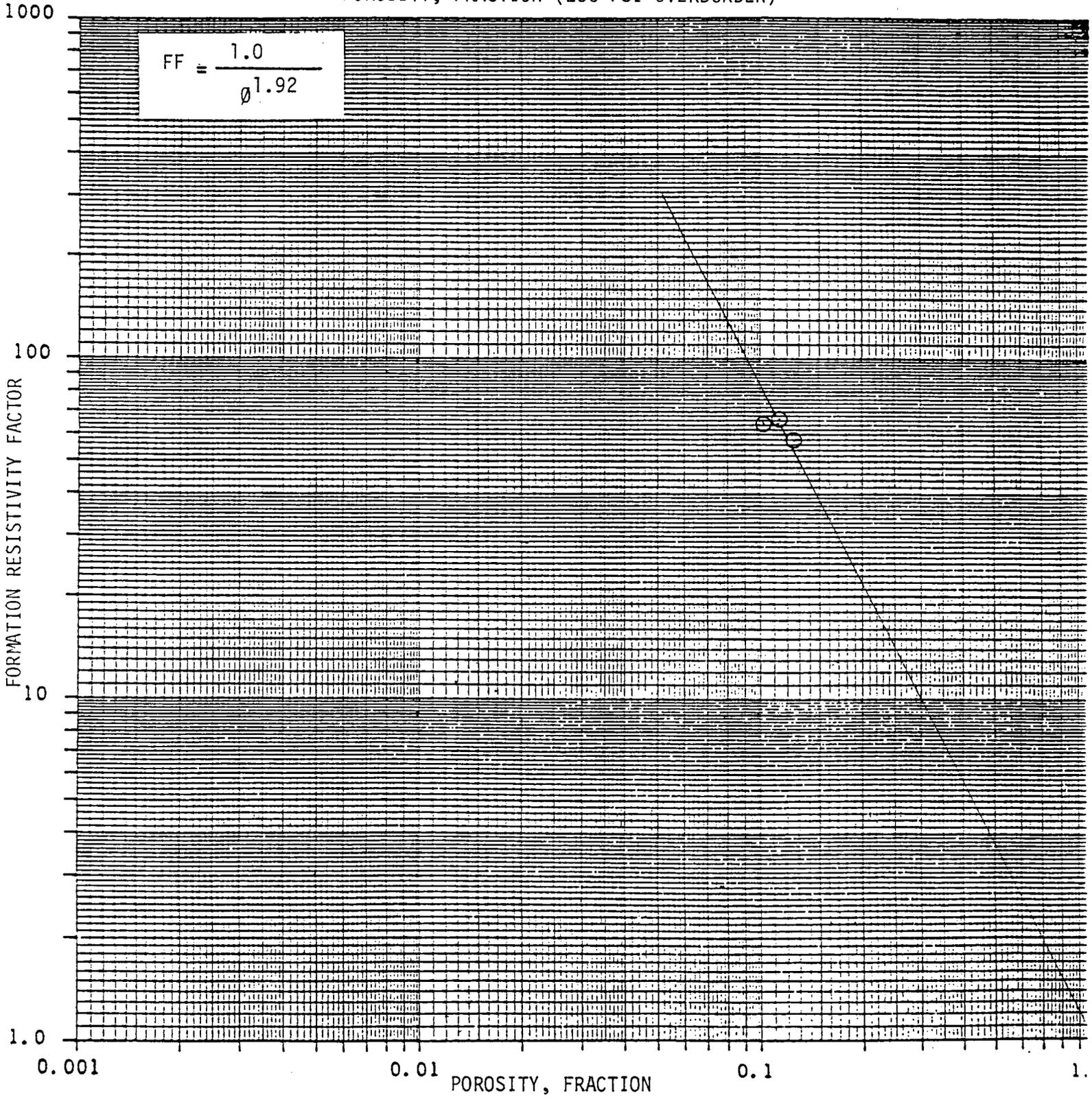
Company AMOCO PRODUCTION COMPANY Formation CHASE-WINFIELD ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (0.0 PSI OVERBURDEN)



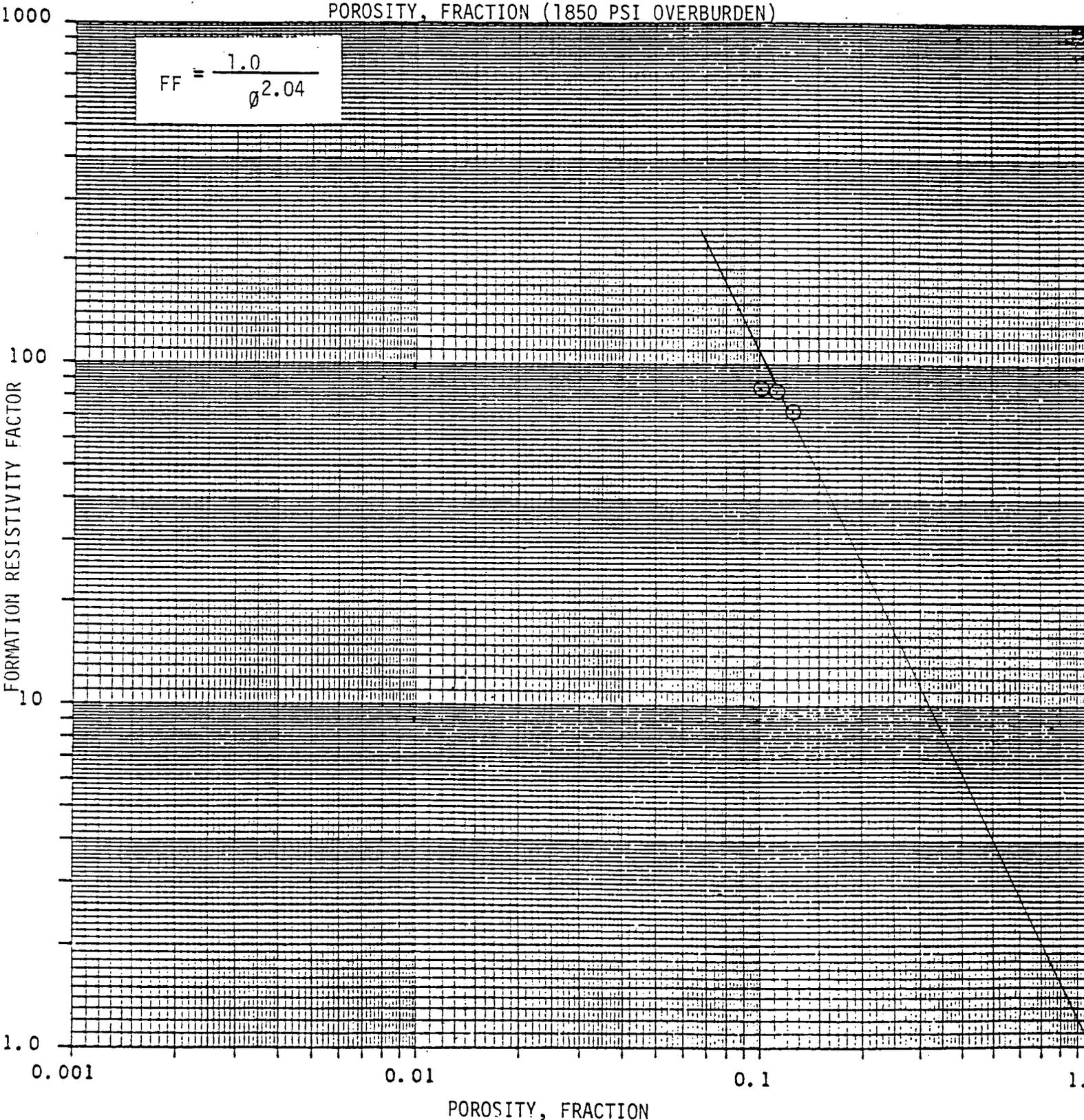
Company AMOCO PRODUCTION COMPANY Formation CHASE-WINFIELD ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (200 PSI OVERBURDEN)



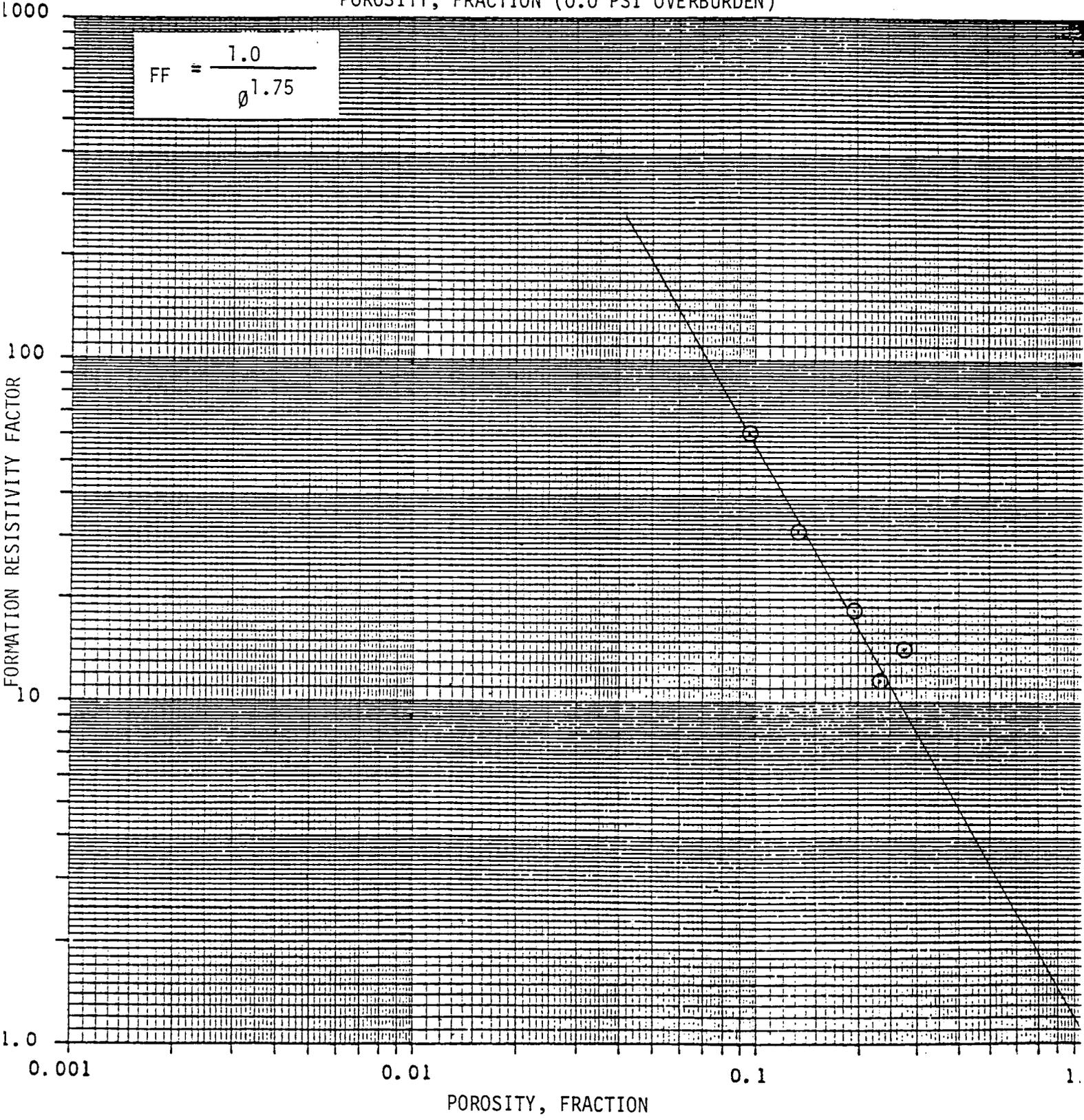
Company AMOCO PRODUCTION COMPANY Formation CHASE-WINFIELD ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (1850 PSI OVERBURDEN)



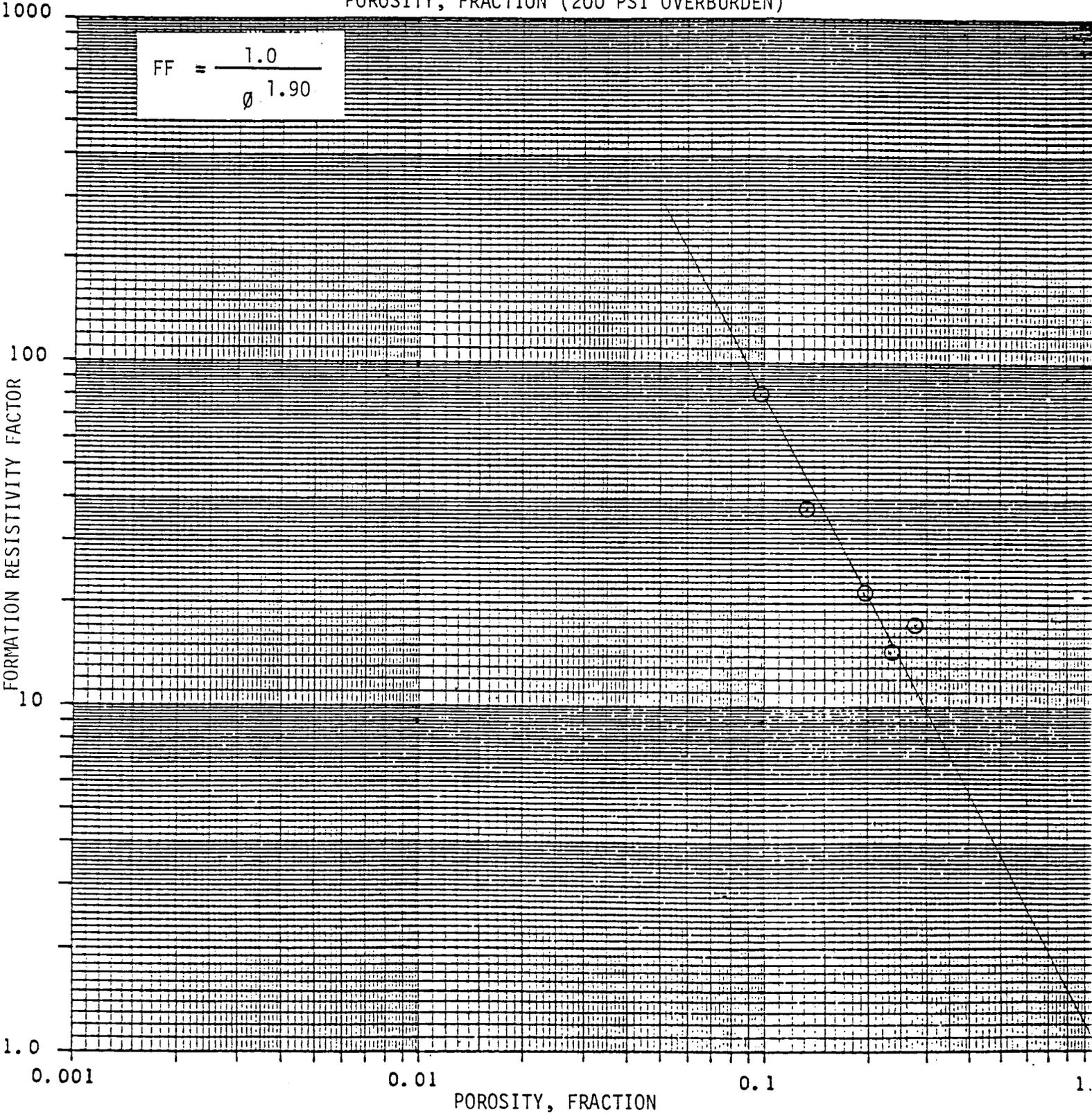
Company AMOCO PRODUCTION COMPANY Formation CHASE-TOWANDA ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (0.0 PSI OVERBURDEN)



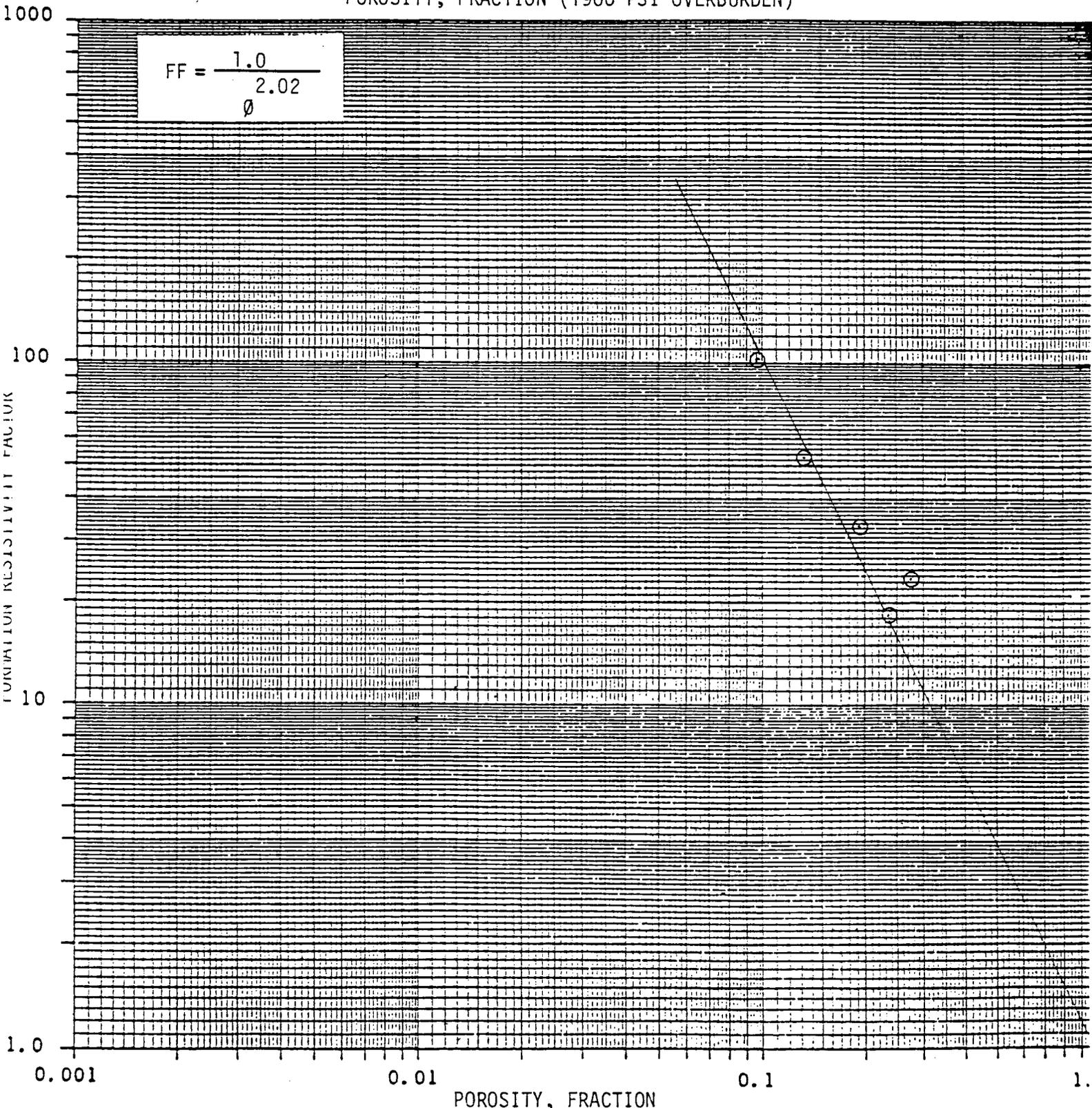
Company AMOCO PRODUCTION COMPANY Formation CHASE-TOWANDA ZONE
Well BREEDING GAS UNIT NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (200 PSI OVERBURDEN)



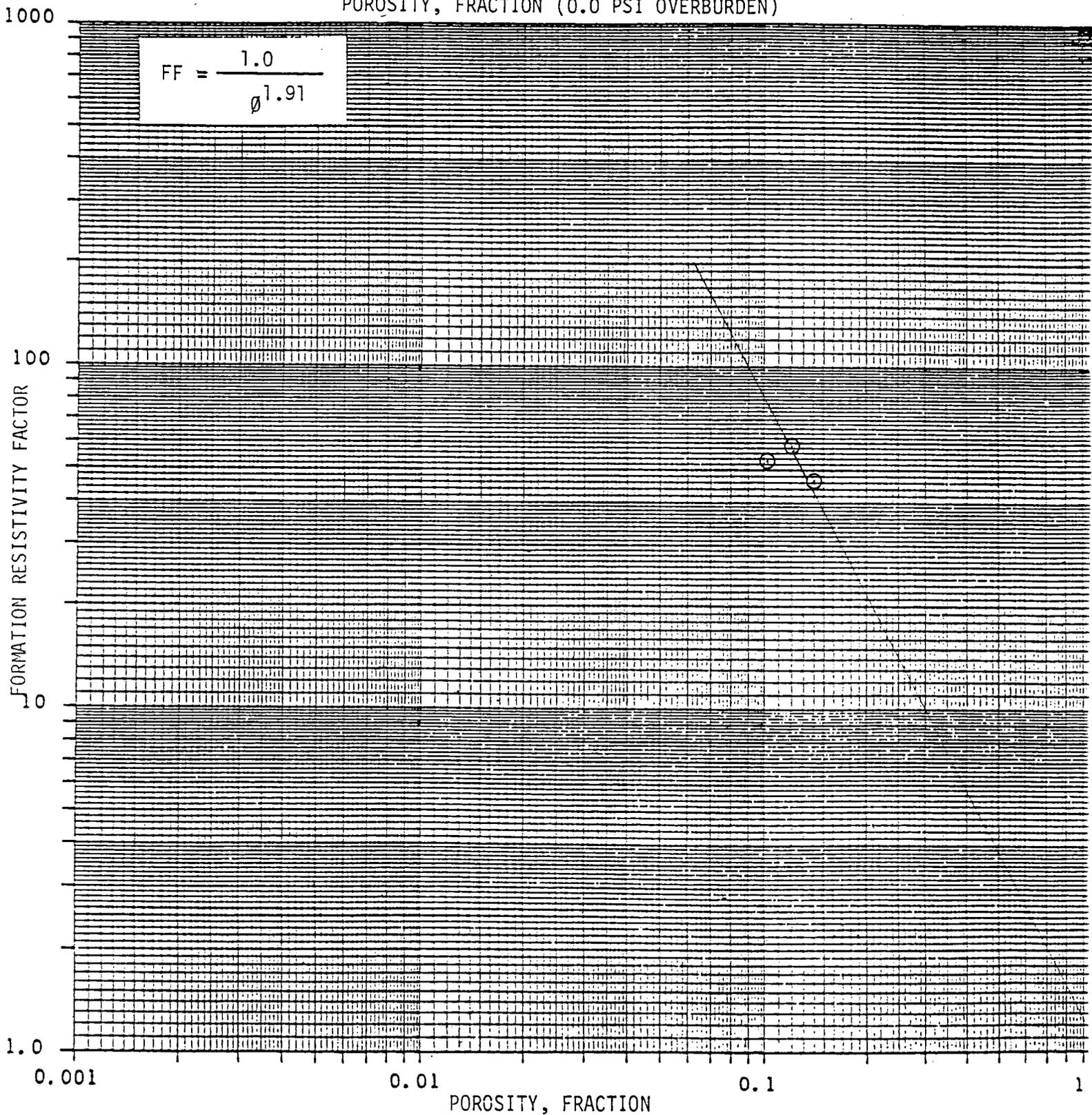
Company AMOCO PRODUCTION COMPANY Formation CHASE-TOWANDA ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (1900 PSI OVERBURDEN)



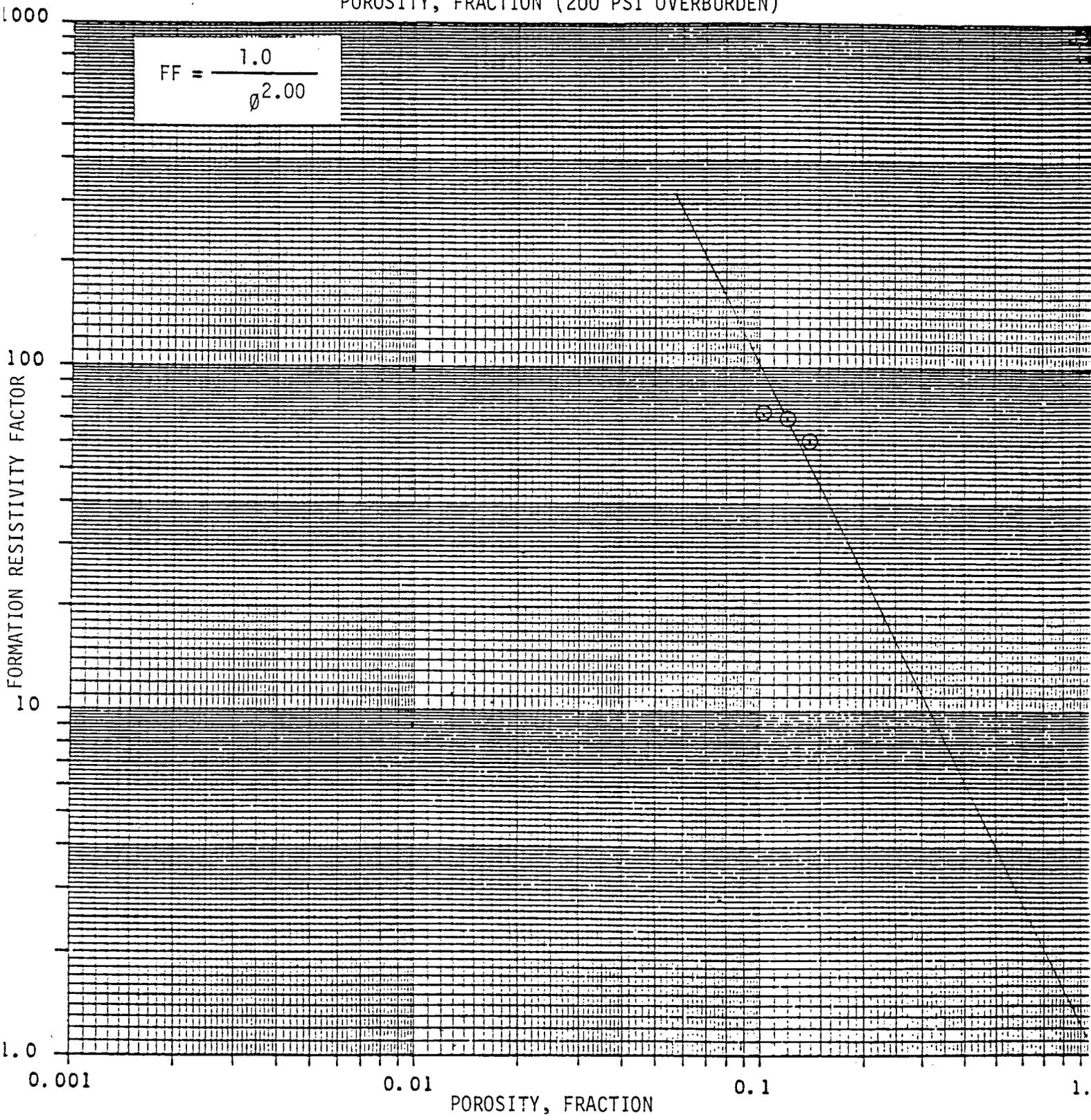
Company AMOCO PRODUCTION COMPANY Formation CHASE-LOWER FT. RILEY ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (0.0 PSI OVERBURDEN)



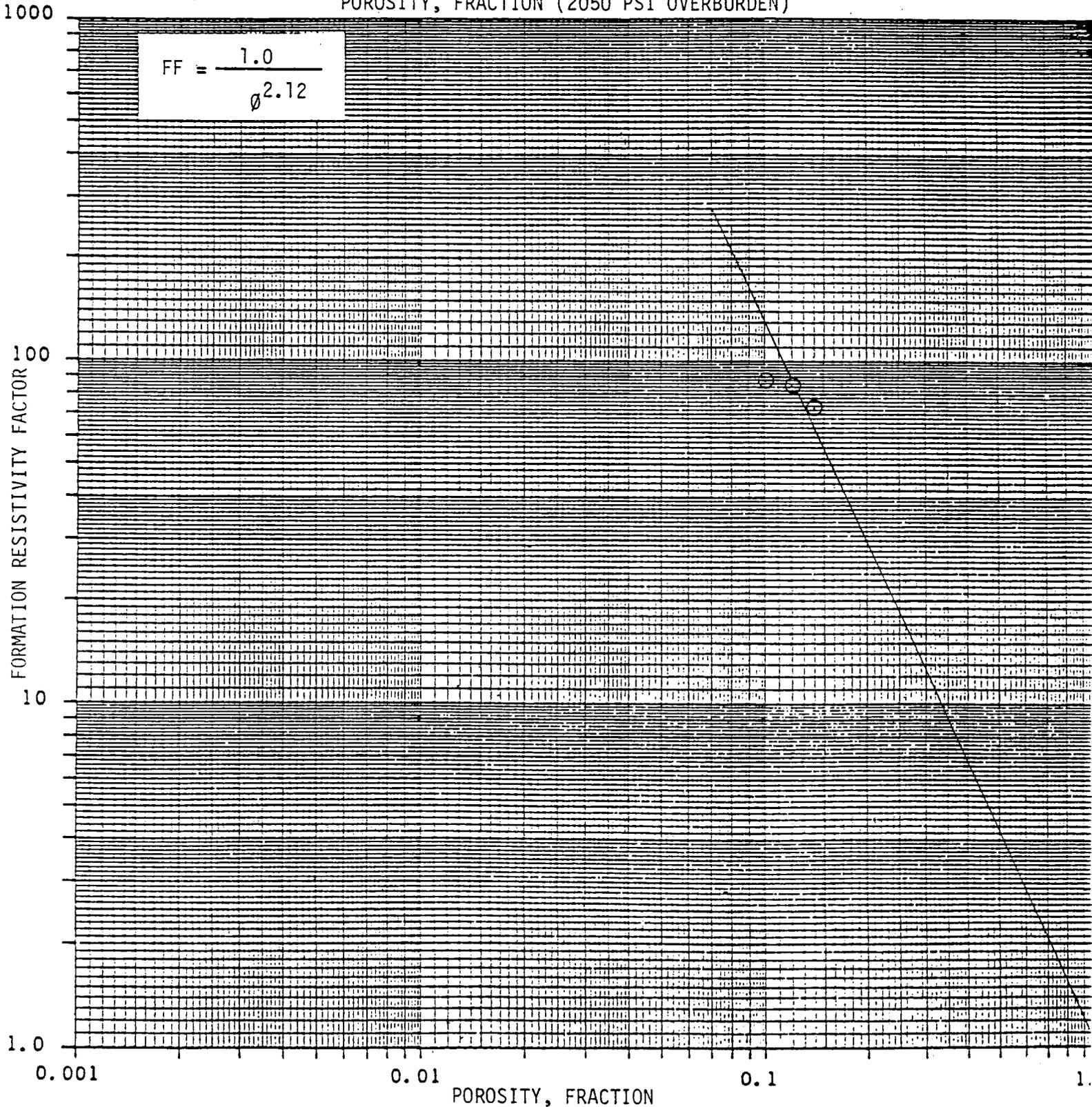
Company AMOCO PRODUCTION COMPANY Formation CHASE-LOWER FT. RILEY ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (200 PSI OVERBURDEN)



Company AMOCO PRODUCTION COMPANY Formation CHASE-LOWER FT. RILEY ZONE
Well BREEDING GAS UNIT F NO. 1 County MORTON
Field KINSLER State KANSAS

FORMATION RESISTIVITY FACTOR
versus
POROSITY, FRACTION (2050 PSI OVERBURDEN)



341

SPECIAL CORE ANALYSIS STUDY

for

AMOCO PRODUCTION COMPANY

AMOCO BREEDING GAS UNIT F NO. 1 WELL

LKINSLER FIELD

MORTON COUNTY, KANSAS

*Morrow Sands
~ 5300'*

CORE LABORATORIES, INC.



Reply To:
10703 E. BETHANY DRIVE
AURORA, COLORADO 80014

December 13, 1982

Amoco Production Company
1670 Broadway
Denver, Colorado 80202

Attention: Mr. Bob Cruz

Subject:

Special Core Analysis Study
Amoco Breeding Gas Unit F No. 1
Kinsler Field
Mission Canyon Formation
Morton County, Kansas
File Number: SCAL 203-820045

Gentlemen:

On June 8, Mr. Bob Cruz requested Core Laboratories to perform Special Core Analysis on core samples from the subject well. Reported in final form are eleven wet chemistry Cation Exchange Capacity values. One sample (depth 5168.7) is not reported as a result of a spill during analyses.

1) Procedure:

Wet chemistry method samples are prepared for Cation Exchange Capacity analysis by crushing to pass through a 10 mesh sieve, extracting and leaching with toluene, acetone and methanol and air drying. They are then pulverized to pass through a 60 mesh sieve and split into two equal portions, one being used for "wet chemistry" analysis utilizing an ammonium acetate method, while the other portion is oven dried to 105°C., to obtain a corrected dry weight. The "wet chemistry" portion is boiled in a 2 Normal ammonium chloride solution to remove carbonates, then filtered. Next, the sample is agitated in 1 Normal ammonium acetate (pH neutral) to exchange the cations naturally present in the clays for the ammonium ion. Following cation exchange, the sample is washed with a 70 percent aqueous solution of methanol to remove the cations not bound to the clays. Ammonia is then distilled from the clays into a 0.1 Normal hydrochloric acid solution and the excess acid is titrated with 0.1 Normal sodium hydroxide. Cation Exchange Capacity values are calculated according to the formula:

Amoco Production Company
Page 2

$$\text{CEC (meg/100 gms)} = \frac{(\text{ml HCl X Norm. HCl}) - (\text{ml NaOH X Norm. NaOH})}{\text{equivalent wt. of } 105^{\circ} \text{ oven dried sample}} \times 100$$

The effective concentration of clay-exchange cations in milliequivalents per milliliter of pore space is represented by Q_v and is obtained by the following equation:

$$Q_v = \frac{\text{CEC}(1-\phi)G_d}{\phi \times 100}$$

The results of the wet chemistry cation exchange capacity measurements are presented on Page 1.

It has been a pleasure working with Amoco Production Company on this study. Should you have any questions pertaining to these test results or if we can be of further assistance, please contact Mercer L. Brugler at 303-751-9334.

Very truly yours,

CORE LABORATORIES, Inc.



Harold W. Hunt
District Manager

HWH:MLB:ss
cc 6 addressee

Company AMOCO PRODUCTION COMPANY Formation MISSION CANYON
Well AMOCO BREEDING GAS UNIT F #1 County MORTON
Field KINSLER State KANSAS

Cation Exchange Capacity Analysis
(Wet Chemistry Method)

<u>Sample Number</u>	<u>Depth Feet</u>	<u>Cation Exchange Capacity Milliequivalents/100 grams</u>
5	5159.4	0.0601
6	5163.9	0.1207
7	5230.0	0.5428
8	5234.4	0.6051
9	5236.6	0.7327
10	5242.6	1.216
11	5254.9	1.511
12	5258.8	1.834
13	5261.6	2.685
14	5265.5	0.9056
15	5268.1	1.215