

~~SLIP~~
WELL File

Newbury Spearfish Charles

0-112

Newbury Field

Bottineau County

N. Dakota

16/N-79W-16

Special Core Analysis Study

for

AMERADA HESS CORPORATION

Spearfish and Charles Formation
Bottineau County, N. Dakota

Special Core Analysis



CORE LABORATORIES, INC.

Special Core Analysis



October 20, 1981

Amerada Hess Corporation
P. O. Box 2040
Tulsa, Oklahoma 74102

Attention: Mr. Sol O. Asekun

Subject: Special Core Analysis Study
Newburg Spearfish-Charles O-712 and P-713 Well
Spearfish and Charles Formation
Newburg Field
Bottineau County, N. Dakota
File Number: SCAL-309-81128

Gentlemen:

By letter dated March 5, 1981, Mr. Sol O. Asekun, a representative of Amerada Hess Corporation, requested Core Laboratories, Inc., to perform Steady-State Water-Oil Relative Permeability Tests on Native-State Samples.

Core material recovered from the subject wells was transferred from Core Laboratories' Oklahoma City, Oklahoma facility, on April 3, 1981, to Dallas, Texas. Upon inspection of the core samples it was discovered that only the intervals of 3358-3359 and 3385-3386 feet from the NSCU P-713 well were in a preserved condition. Mr. John Evanoff of Core Laboratories, Inc., advised Mr. Asekun of the situation on April 8, 1981. It was decided at that time that steady-state water-oil relative permeability tests would be conducted only on the native-state, preserved samples. Unsteady-state water-oil relative permeability tests would be performed on samples from the remaining (unpreserved) depth intervals.

Final results of the steady-state and unsteady-state relative permeability tests are presented herein. The samples tested are lithologically described and identified, as to sample number and depth interval on Page 1.

Sample Preparation

Unpreserved core segments, representing various depth intervals ranging from 3354 to 3395 from the O-712 well, and 3354 to 3390 from the P-713

well and preserved native-state core segments from the depth of 3358-59 and 3385-86 from the P-713 well were submitted for use in this study.

Two plug-sized samples, 1 1/4 inches in diameter, were obtained from the two preserved core segments representing the P-713 well, using a diamond core bit with oil as the bit coolant and lubricant. These samples were maintained in a fresh condition until the time of testing, by submerging them under a refined mineral oil.

Three plug-sized samples, 1 1/2 inches in diameter, were obtained from the unpreserved intervals of the P-713 well, and five plug-sized samples, 1 1/2 inches in diameter, were obtained from the full-diameter core segments representing the O-712 well, using a diamond core bit with water as the bit coolant and lubricant. Following drilling, these samples were extracted of hydrocarbons with toluene, leached of salt with methyl alcohol and oven-dried. Permeability to air, and helium (Boyle's Law) porosity were determined for each of the cleaned and dried samples.

Steady-State Water-Oil Relative Permeability

The two samples selected for steady-state water-oil relative permeability tests were evacuated and dynamically saturated with a refined laboratory oil having a viscosity of approximately 1.5 centipoise. The effective permeabilities to oil were determined in the presence of the unknown initial water saturations. At this time it was observed that Sample 9A experienced severe grain loss, therefore this sample was eliminated from further testing. The effective permeability to oil for Sample 9A is presented on Page 2.

An imbibition (water saturation increasing) steady-state water-oil relative permeability test was performed on the remaining core plug, using as the displacing phase a brine normally utilized for the steady-state method. At the conclusion of the steady-state relative permeability test, the effective permeability to water was determined in the presence of the residual oil saturation. The residual fluids present in the core plug at terminal conditions of testing were determined by toluene distillation, (Dean Stark technique). The fluid saturations present in the sample prior to testing were calculated by material balance. Following toluene distillation and drying, the permeability to air and porosity were determined for the samples. The results of the steady-state water-oil relative permeability test are summarized on Page 3, presented in tabular form on Page 4 and in graphical form on Pages 5 and 6.

Amerada Hess Corporation
Newburg Field
Page Three

Unsteady-State Water-Oil Relative Permeability

Three plug-sized samples representing the P-713 well and five plug-sized samples representing the O-712 well were selected to undergo unsteady-state water-oil relative permeability. In preparation for the relative permeability tests, the eight samples were evacuated and pressure-saturated with a simulated formation water. The simulated formation water, having a density of approximately 1.081, was synthesized to be compatible with water analysis and density information supplied for the two subject wells. Initial (pseudo-connate) water saturations for the samples were established using a high-pressure porous plate desaturation cell and an air-brine system. The pore space voided in this manner was resaturated with a refined mineral oil having a viscosity of approximately 20 centipoise. Effective permeabilities to oil were determined for each sample in the presence of the initial water saturations.

The simulated formation water, having a viscosity of approximately 1.16 centipoise, was used as the displacing phase in the water-oil relative permeability test. At terminal conditions of water floodout, (99.99 percent water cut) effective permeabilities to water were determined in the presence of the residual oil saturations. The residual oil saturations averaged 38.3 and 34.3 percent pore space for samples tested from the O-712 well and the P-713 well respectively.

Results of the unsteady-state water-oil relative permeability analyses for samples representing the Spearfish Formation are summarized on Page 7, presented in tabular form on Pages 8 through 12, and in graphical form on Pages 13 through 22. Test results for the Charles Formation are summarized on Page 23, presented in tabular form on Pages 24 through 26, and in graphical form on Pages 27 through 32.

It has been a pleasure to provide Amerada Hess with this study. Thank you for giving our staff this opportunity to serve you. Should you have any questions, or require further assistance, please do not hesitate to contact us.

Very truly yours,

Core Laboratories, Inc.



John C. Evanoff, Laboratory Supervisor
Special Core Analysis

JCE:JLK:sd
Distribution List

Special Core Analysis



Distribution List

- 4 cc. - Amerada Hess Corporation
Attn: Mr. S. O. Asekun
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Tulsa, Oklahoma 74102
- 2 cc. - Amerada Hess Corporation
Attn: Mr. Howard Thomas
P. O. Box 1486
Williston, North Dakota 58801
- 1 cc. - Amerada Hess Corporation
Attn Mr. R. Forbes
RFD No. 1
Newburg, North Dakota 58762

IDENTIFICATION AND LITHOLOGICAL DESCRIPTION OF SAMPLES

Amerada Hess Corporation
Formations as Listed
Bottineau County, North Dakota

Wells as Listed
Newburg Field

<u>Sample Identification</u>	<u>Depth, feet</u>	<u>Lithological Description</u>
<u>NSCU 0-712 Well: Spearfish Formation</u>		
1A	3355-56	Ss, mott brn-pnk-tn-olv-wh, mod indr, vfn-crs gr, sil cmt, fe stain, cly
6A	3360-61	Ss, mott gry-olv-brn-or-wh, mod indr, vfn-med gr, cly cmt, fe stain, frac
12A	3366-67	Ss, or-brn w/dk brn lams, mod indr, vfn-med gr, cly cmt, fe stain, frac
<u>NSCU 0-712 Well: Charles Formation</u>		
32A	3392-93	Ls, bf, sec med xln dolo, vugs, v/sl/pyr
34A	3394-95	Ls, bf, sec med-crs xln dolo, sl/vugs
<u>NSCU P-713 Well: Spearfish Formation</u>		
5A	3354-55	Ss, brn-or-brn-gry lams, mod indr, vfn-crs gr, cly cmt, fe stains, sl/calc gr
7A	3356-57	Ss, mott lt brn-tan-or-wh, mod indr, vfn-crs gr, cly cmt, fe stains
9A	3358-59	Ss, mott tan-grn-gry, mod indr, vfn-crs gr, sil cmt, lam fn-med ss w/fe cmt
<u>NSCU P-713 Well: Charles Formation</u>		
33A	3385-86	Ls, bf, sec med xln dolo, pp vugs
37A	3389-90	Dolo ls, bf-lt brn, sec med xln dolo, sl/cly

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Petroleum Reservoir Engineering
DALLAS, TEXAS 75247

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EFFECTIVE PERMEABILITY TO OIL

Amerada Hess Corporation
Spearfish Formation
Bottineau County, North Dakota

NSCU P-713 Well
Newburg Field

<u>Sample I.D.</u>	<u>Depth, feet</u>	<u>Effective Permeability to Oil, millidarcys</u>
9A	3358-59	0.85

SUMMARY OF STEADY-STATE WATER-OIL RELATIVE PERMEABILITY TEST RESULTS

Amerada Hess Corporation
 Newburg Field

NSCU P-713 Well
 Bottineau County, North Dakota

Charles Formation

Water Saturation Increasing

Sample I.D.	Depth, feet	Permeability to Air, millidarcys	Porosity, percent	Initial Conditions		Terminal Conditions		Oil Recovered	
				Water Saturation, percent pore space	Effective Permeability to Oil, millidarcys	Oil Saturation, percent pore space	Effective Permeability to Water, millidarcys	percent pore space	percent oil in place
33A	3385-86	1.1	9.2	27.7	0.79	31.7	0.26	40.6	56.2

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STEADY-STATE WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU P-713 Well
Charles Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 33A
Sample Depth: 3385-86 feet
Permeability to Air: 1.1 md
Porosity: 9.2 percent
Initial Water Saturation: 27.7 percent
Effective Permeability to
Oil at S_{wi} : 0.79 md

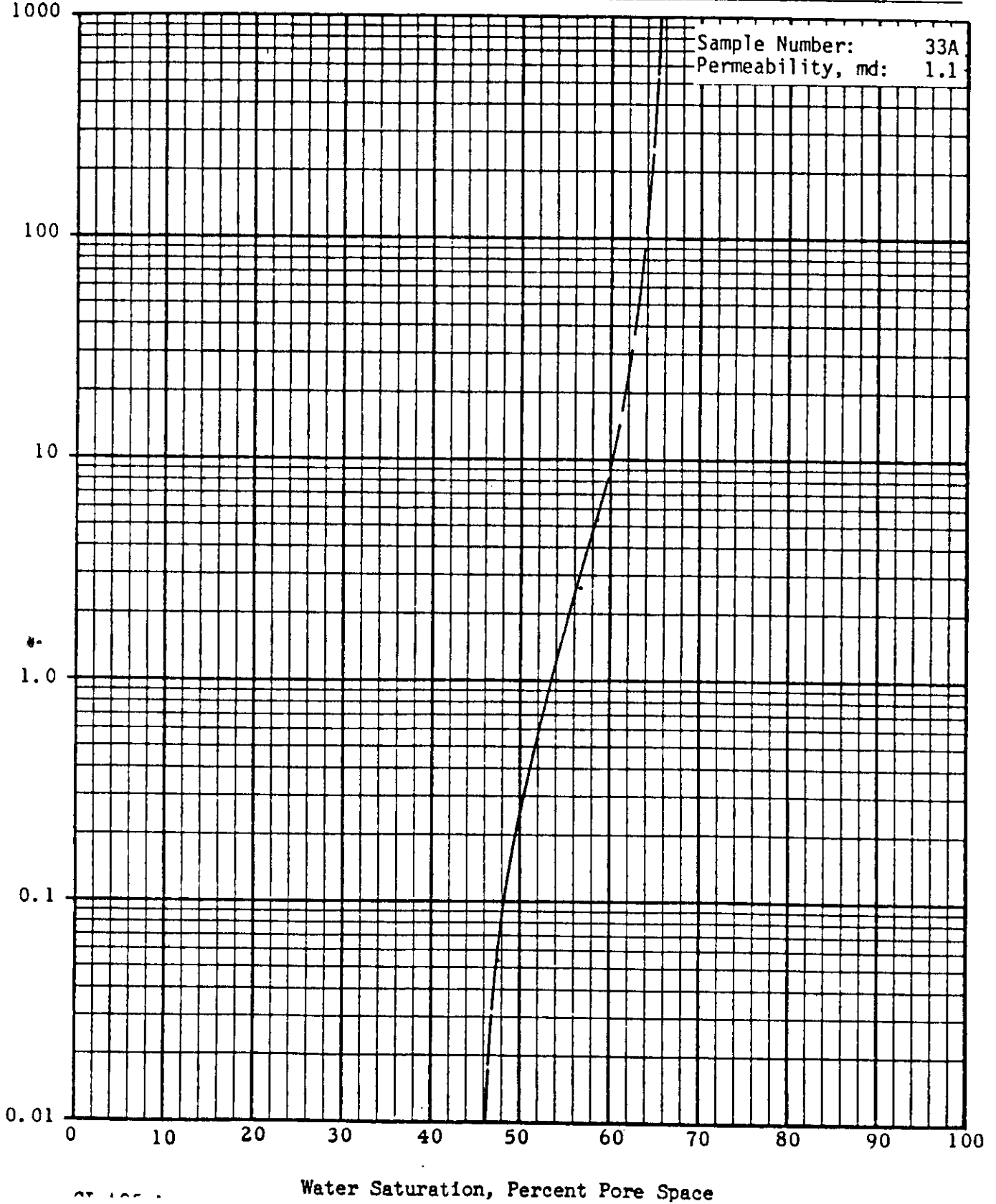
<u>Water Saturation,</u> <u>percent pore space</u>	<u>Water-Oil Relative</u> <u>Permeability Ratio</u>	<u>Relative Permeability</u> <u>to Water,* fraction</u>	<u>Relative Permeability</u> <u>to Oil,* fraction</u>
27.7	0.000	0.000	1.000
47.7	0.054	0.017	0.321
48.2	0.107	0.029	0.268
52.1	0.539	0.069	0.129
56.8	2.69	0.125	0.047
58.6	5.41	0.138	0.026
68.3		0.329	

*Relative to the effective permeability to oil at initial water saturation.

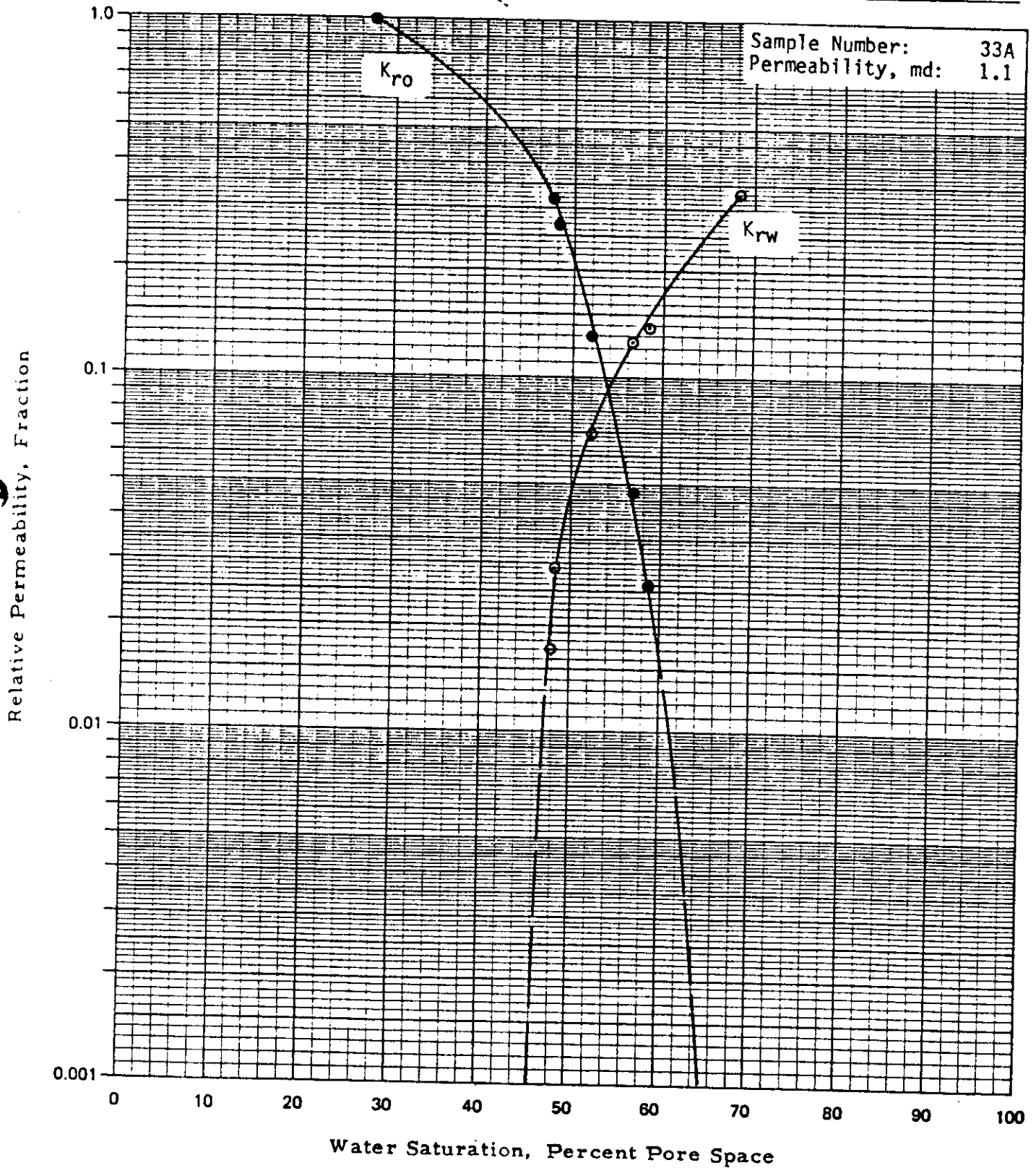
Company Amerada Hess Corporation Formation Charles Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 33A
Permeability, md: 1.1

Water-Oil Relative Permeability Ratio



Company Amerada Hess Corporation Formation Charles Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota



SUMMARY OF WATER-OIL RELATIVE PERMEABILITY TEST RESULTS

Amerada Hess Corporation Newburg Field			Wells as Listed Bottineau County, North Dakota			Spearfish Formation			
Sample I.D.	Depth, feet	Permeability to Air, millidarcys	Porosity, percent	Initial Conditions		Terminal Conditions		Oil Recovered percent pore space	Oil Recovered percent oil in place
				Water Saturation, percent pore space	Effective Permeability to Oil, millidarcys	Oil Saturation, percent pore space	Effective Permeability to Water, millidarcys		
NSCU 0-712 Well									
1A	3355-56	19	10.0	43.4	2.2	36.4	0.24	20.2	35.7
6A	3360-61	30	17.3	31.8	2.9	50.8	1.2	17.4	25.5
12A	3366-67	5.8	17.9	38.0	1.3	43.3	0.86	18.7	30.2
NSCU P-713 Well									
5A	3354-55	0.65	15.2	66.2	0.51	22.9	0.36	10.9	32.2
7A	3356-57	4.7	11.5	29.6	2.0	38.7	1.4	31.7	45.0

WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
 NSCU 0-712 Well
 Spearfish Formation
 Newburg Field
 Bottineau County
 North Dakota

Sample Identification: 1A
 Sample Depth: 3355-56 feet
 Permeability to Air: 19 md
 Porosity: 10.0 percent
 Initial Water Saturation: 43.4 percent
 Effective Permeability to Oil at S_{wi} : 2.2 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
43.4	0.000	0.000	1.000
54.6	0.616	0.054	0.088
55.3	0.738	0.058	0.079
56.9	1.23	0.063	0.051
57.8	1.79	0.066	0.037
59.0	3.18	0.070	0.022
59.6	4.60	0.072	0.016
60.0	5.99	0.074	0.012
61.1	14.1	0.079	0.0056
61.8	29.8	0.081	0.0027
62.3	58.4	0.085	0.0015
62.8	154	0.088	0.00058
63.1	411	0.092	0.00022
63.4	1260	0.095	0.000076
63.6		0.109	

*Relative to the effective permeability to oil at initial water saturation.

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Petroleum Reservoir Engineering

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WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU 0-712 Well
Spearfish Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 6A
Sample Depth: 3360-61 feet
Permeability to Air: 30 md
Porosity: 17.3 percent
Initial Water Saturation: 31.8 percent
Effective Permeability to Oil at S_{wi} : 2.9 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
31.8	0.000	0.000	1.000
33.9	1.60	0.346	0.217
34.7	2.05	0.348	0.170
35.4	2.45	0.351	0.143
36.4	3.25	0.356	0.109
36.9	3.76	0.358	0.095
38.3	5.62	0.368	0.065
39.5	7.80	0.376	0.048
40.4	10.5	0.382	0.037
41.2	13.5	0.387	0.029
41.9	17.1	0.398	0.023
42.5	21.4	0.405	0.019
43.2	27.7	0.413	0.015
44.2	40.8	0.426	0.010
45.4	68.2	0.443	0.0065
47.4	220	0.463	0.0021
48.2	475	0.475	0.00100
48.6	916	0.481	0.00053
49.2		0.414	

*Relative to the effective permeability to oil at initial water saturation.

WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU 0-712 Well
Spearfish Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 12A
Sample Depth: 3366-67 feet
Permeability to Air: 5.8 md
Porosity: 17.9 percent
Initial Water Saturation: 38.0 percent
Effective Permeability to Oil at S_{wi} : 1.3 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
38.0	0.000	0.000	1.000
39.3	1.12	0.310	0.277
39.7	1.28	0.328	0.255
40.3	1.59	0.344	0.217
40.9	1.95	0.358	0.184
41.5	2.37	0.370	0.156
42.0	2.82	0.380	0.135
42.5	3.23	0.390	0.121
43.1	3.91	0.406	0.104
43.9	4.94	0.426	0.086
44.6	6.01	0.442	0.074
45.4	7.46	0.457	0.061
46.4	9.72	0.480	0.049
47.5	13.1	0.496	0.038
48.8	18.9	0.529	0.028
50.4	31.1	0.549	0.018
51.5	44.1	0.579	0.013
53.2	86.0	0.600	0.0070
54.6	206	0.627	0.0030
55.1	318	0.647	0.0020
55.2	347	0.661	0.0019
55.3	371	0.672	0.0018
56.7		0.662	

*Relative to the effective permeability to oil at initial water saturation.

WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU 0-712 Well
Spearfish Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 5A
Sample Depth: 3354-55 feet
Permeability to Air: 0.65 md
Porosity: 15.2 percent
Initial Water Saturation: 66.2 percent
Effective Permeability to
Oil at S_{wi} : 0.51 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
66.2	0.000	0.000	1.000
68.6	1.06	0.298	0.280
68.9	1.27	0.332	0.262
69.5	1.86	0.362	0.195
69.8	2.42	0.386	0.159
70.1	2.94	0.405	0.138
70.5	3.79	0.435	0.115
71.0	5.19	0.483	0.093
71.7	7.59	0.515	0.068
72.8	13.7	0.552	0.040
74.0	29.1	0.597	0.021
74.8	55.7	0.621	0.011
75.6	114	0.644	0.0057
76.3	311	0.665	0.0021
77.0	6610	0.675	0.00010
77.1		0.706	

*Relative to the effective permeability to oil at initial water saturation.

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Petroleum Reservoir Engineering

DALLAS, TEXAS 75247

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WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU 0-712 Well
Spearfish Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 7A
Sample Depth: 3356-57 feet
Permeability to Air: 4.7 md
Porosity: 11.5 percent
Initial Water Saturation: 29.6 percent
Effective Permeability to
Oil at S_{wi} : 2.0 md

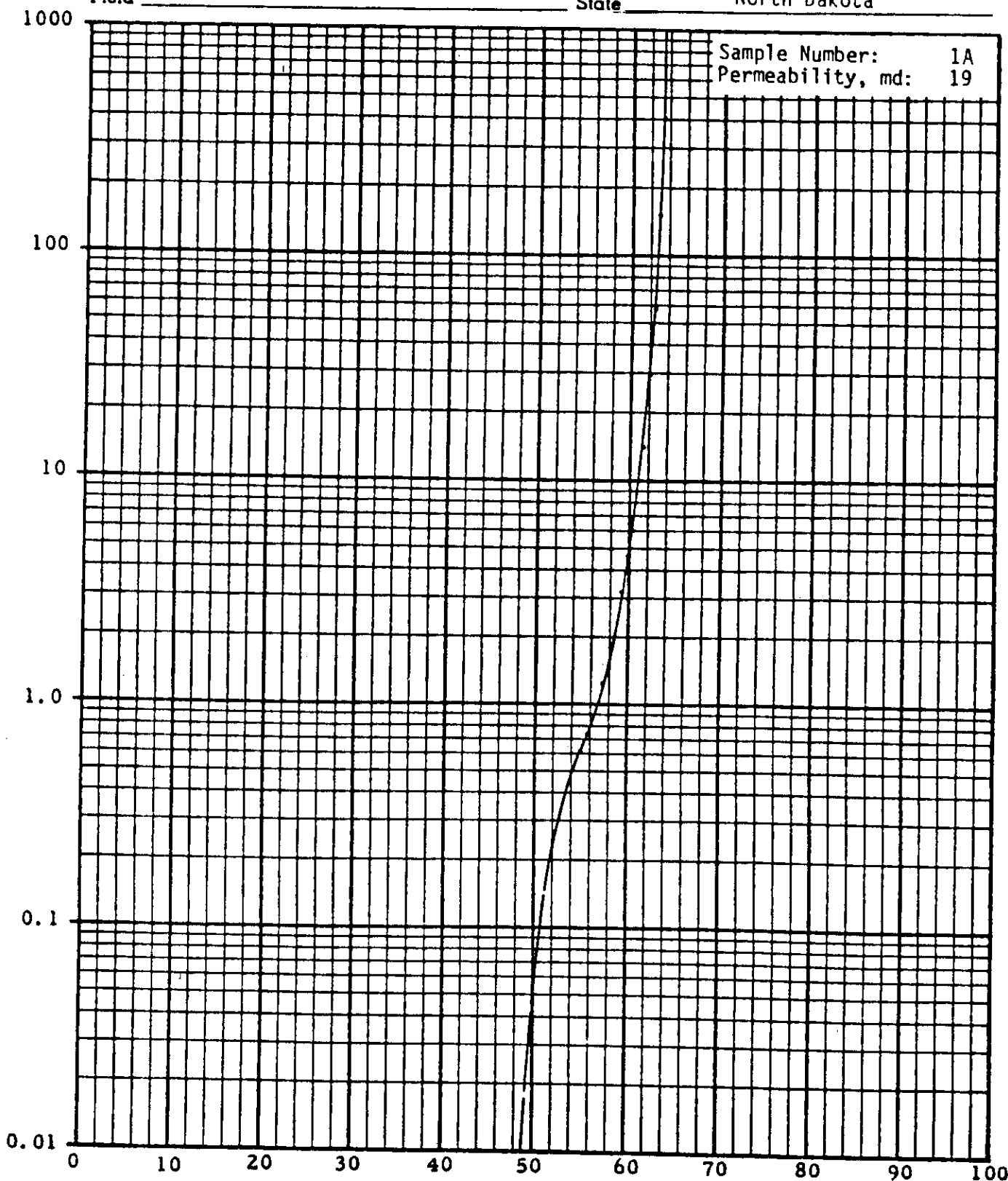
<u>Water Saturation,</u> <u>percent pore space</u>	<u>Water-Oil Relative</u> <u>Permeability Ratio</u>	<u>Relative Permeability</u> <u>to Water,* fraction</u>	<u>Relative Permeability</u> <u>to Oil,* fraction</u>
29.6	0.000	0.000	1.000
35.0	0.522	0.158	0.303
36.1	0.673	0.180	0.267
37.5	0.955	0.200	0.209
38.6	1.24	0.216	0.175
40.1	1.72	0.242	0.140
43.6	3.41	0.294	0.086
46.4	6.26	0.333	0.053
47.2	7.38	0.353	0.048
49.1	11.1	0.382	0.034
51.6	21.1	0.433	0.021
55.3	56.9	0.493	0.0087
58.1	171	0.553	0.0032
59.2	301	0.589	0.0020
60.2	613	0.612	0.00100
61.3		0.700	

*Relative to the effective permeability to oil at initial water saturation.

Company Amerada Hess Corporation Formation Spearfish Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota

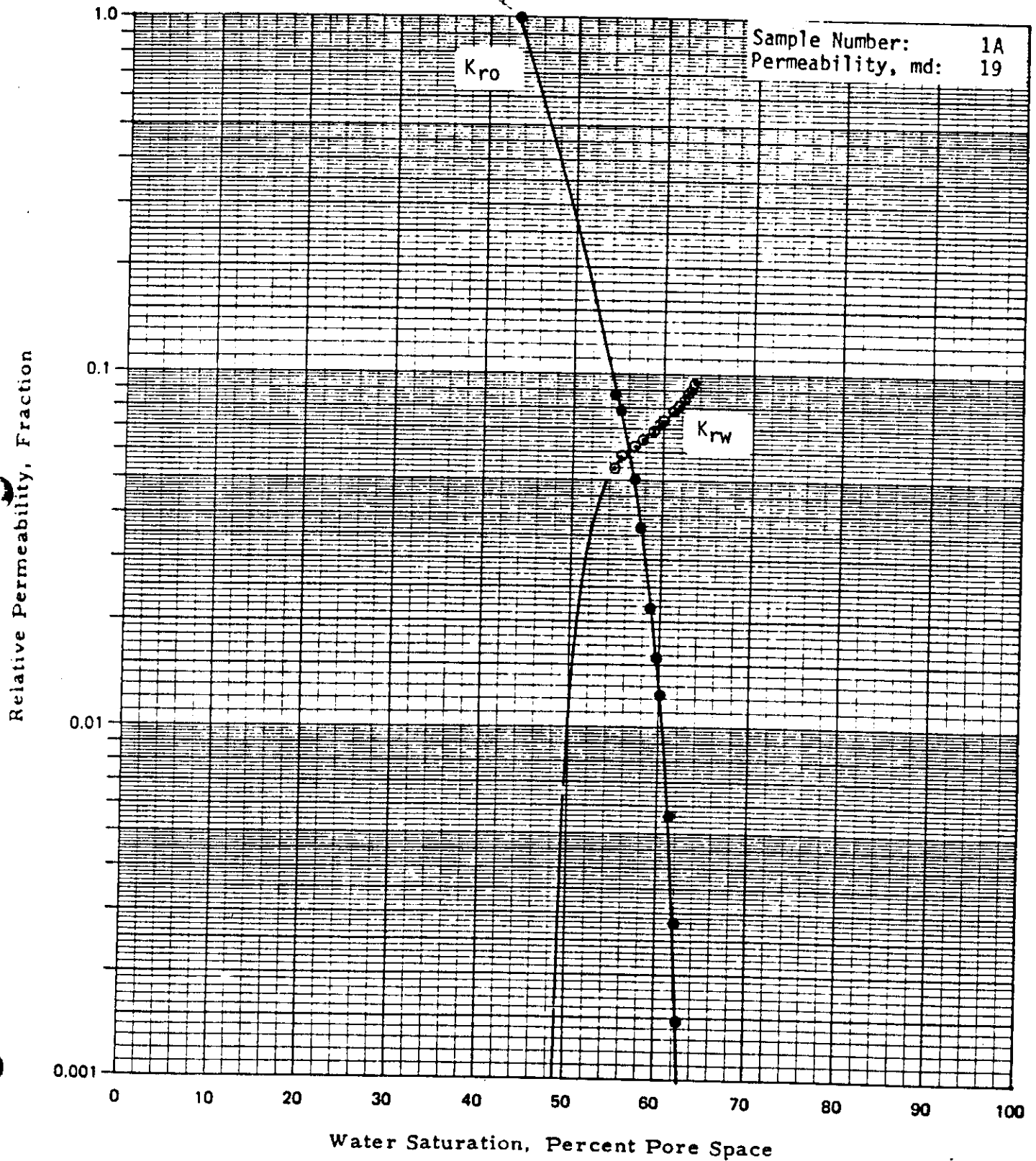
Sample Number: 1A
Permeability, md: 19

Water-Oil Relative Permeability Ratio

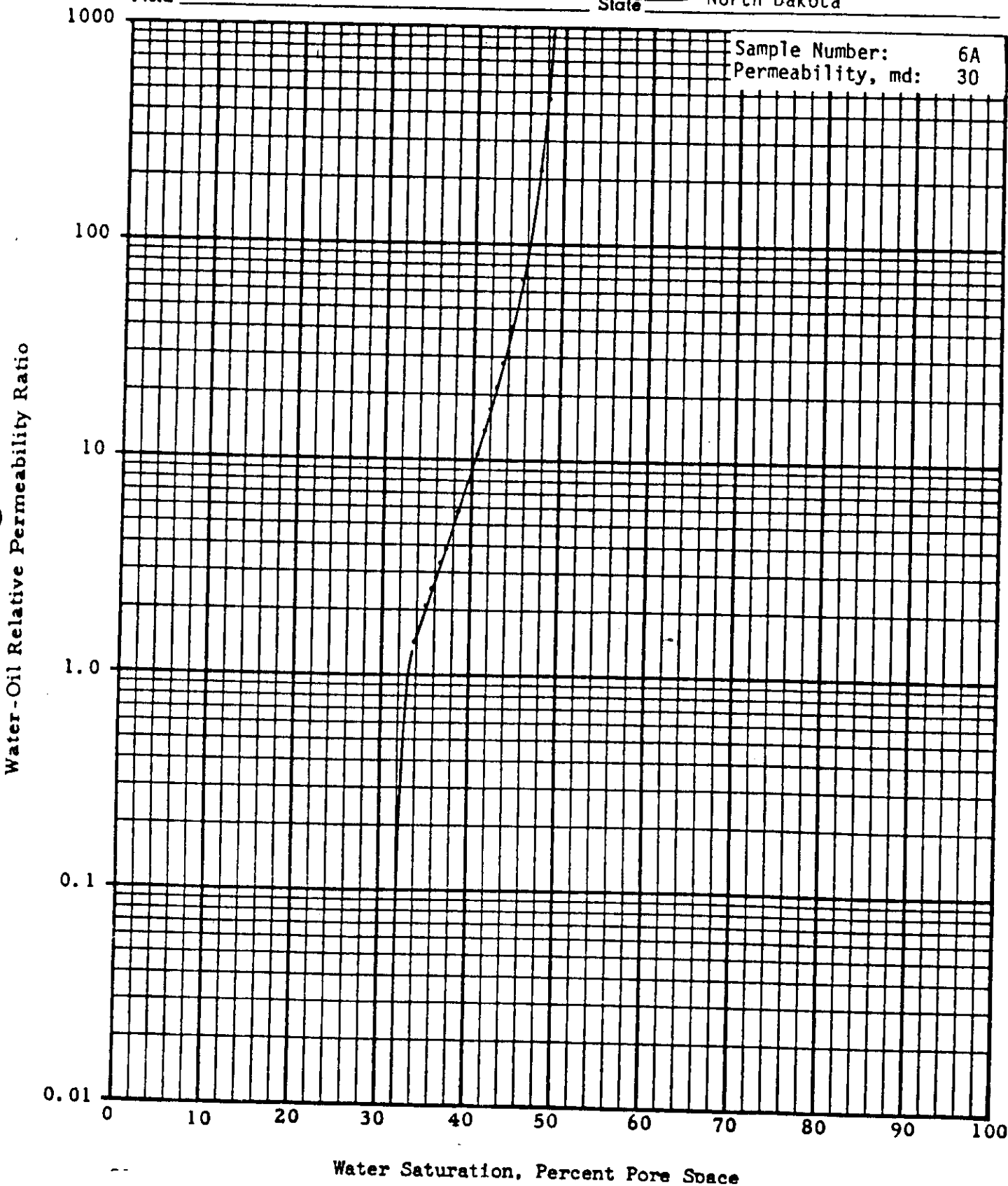


Company Amerada Hess Corporation Formation Spearfish Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 1A
Permeability, md: 19

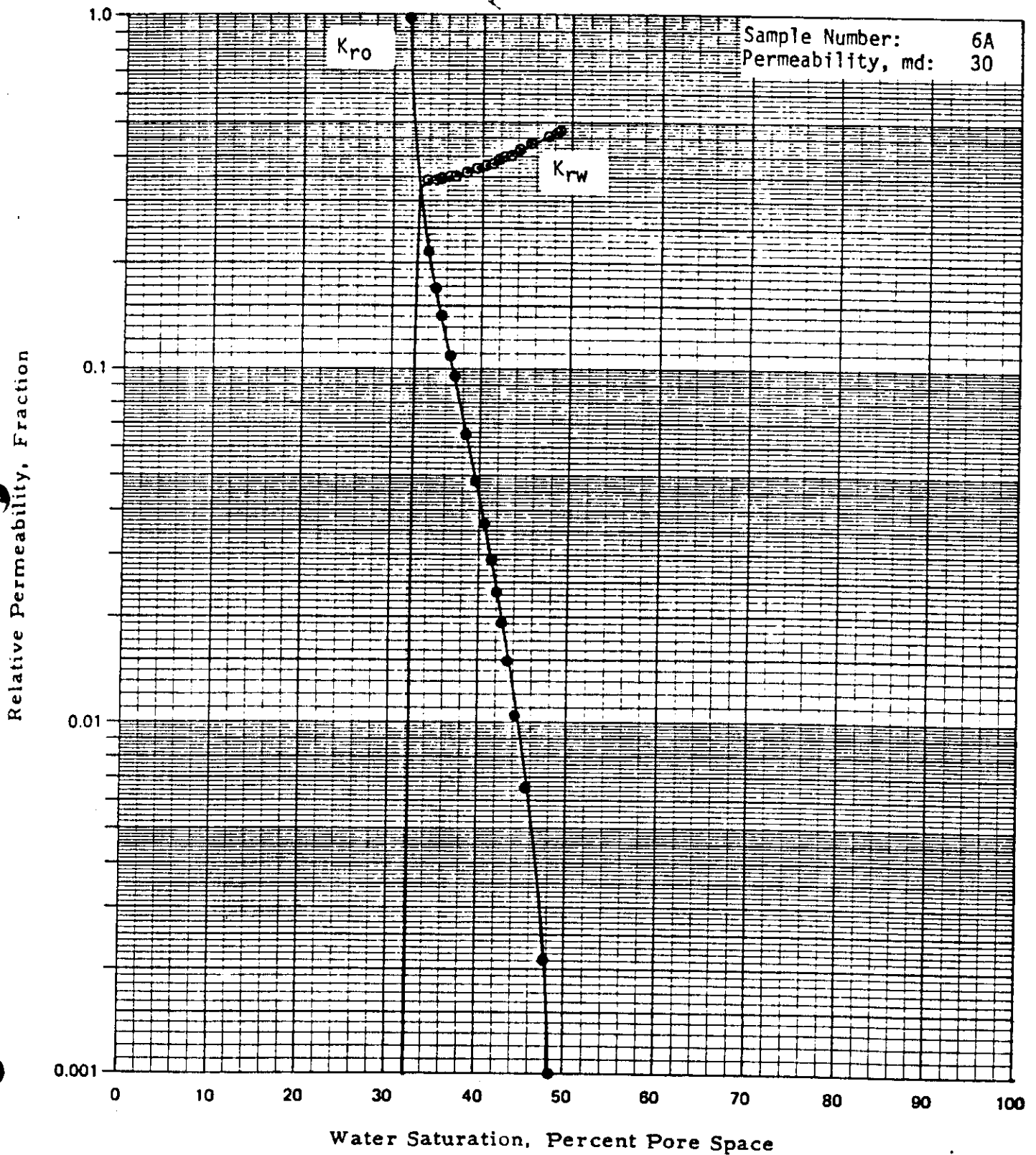


Company Amerada Hess Corporation Formation Spearfish Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota



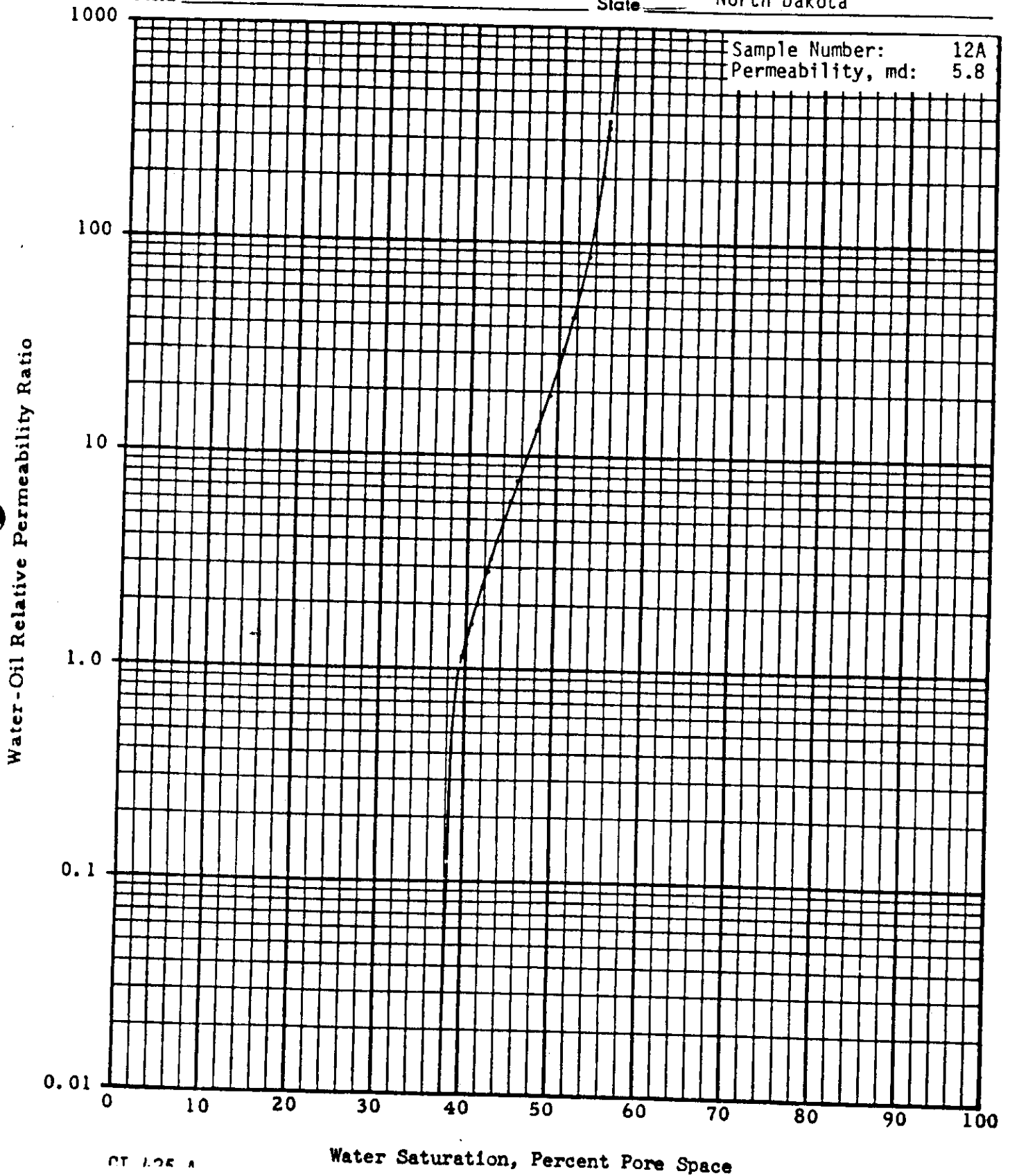
Company Amerada Hess Corporation Formation Spearfish Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 6A
Permeability, md: 30

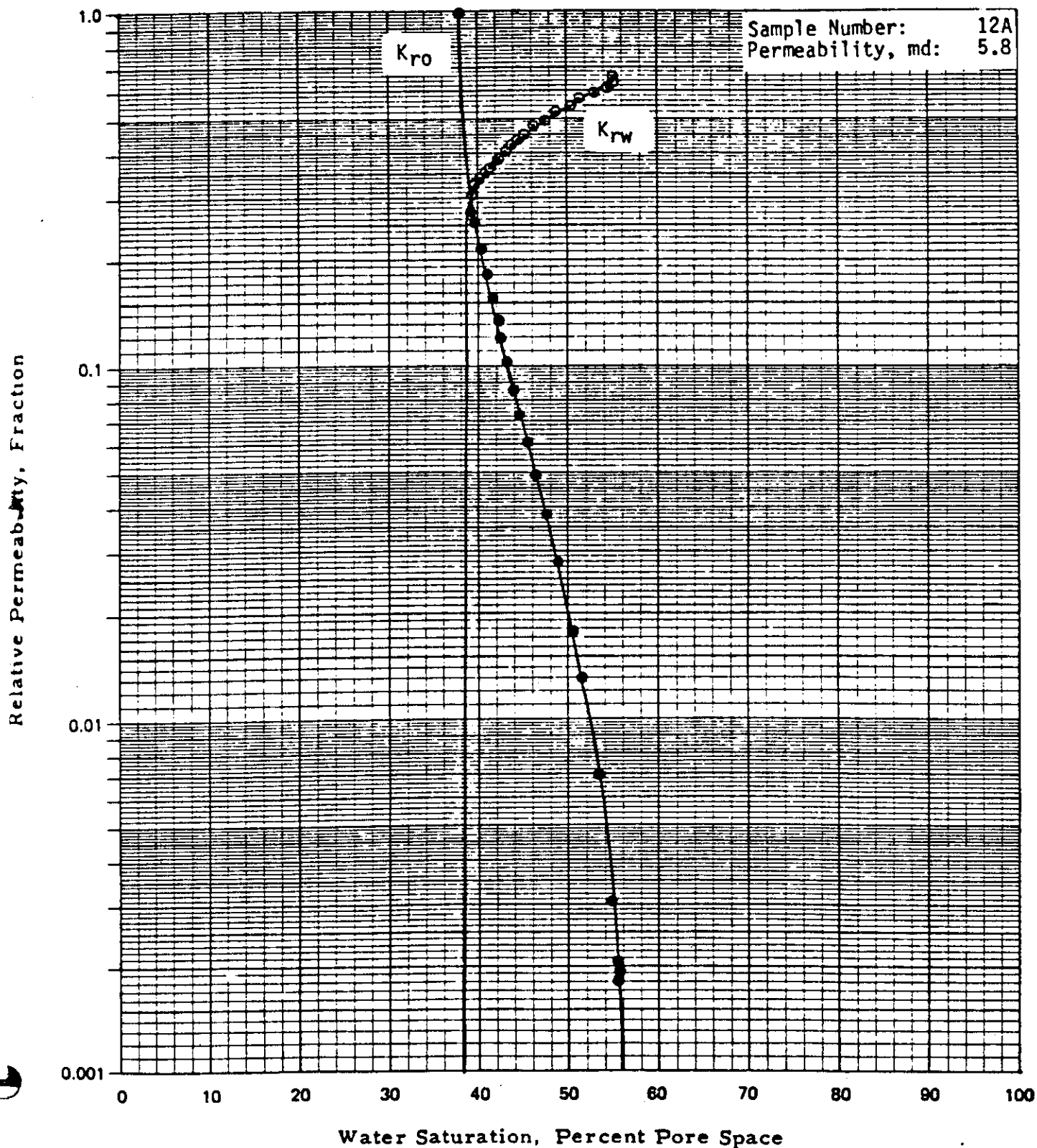


Company Amerada Hess Corporation Formation Spearfish Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 12A
Permeability, md: 5.8



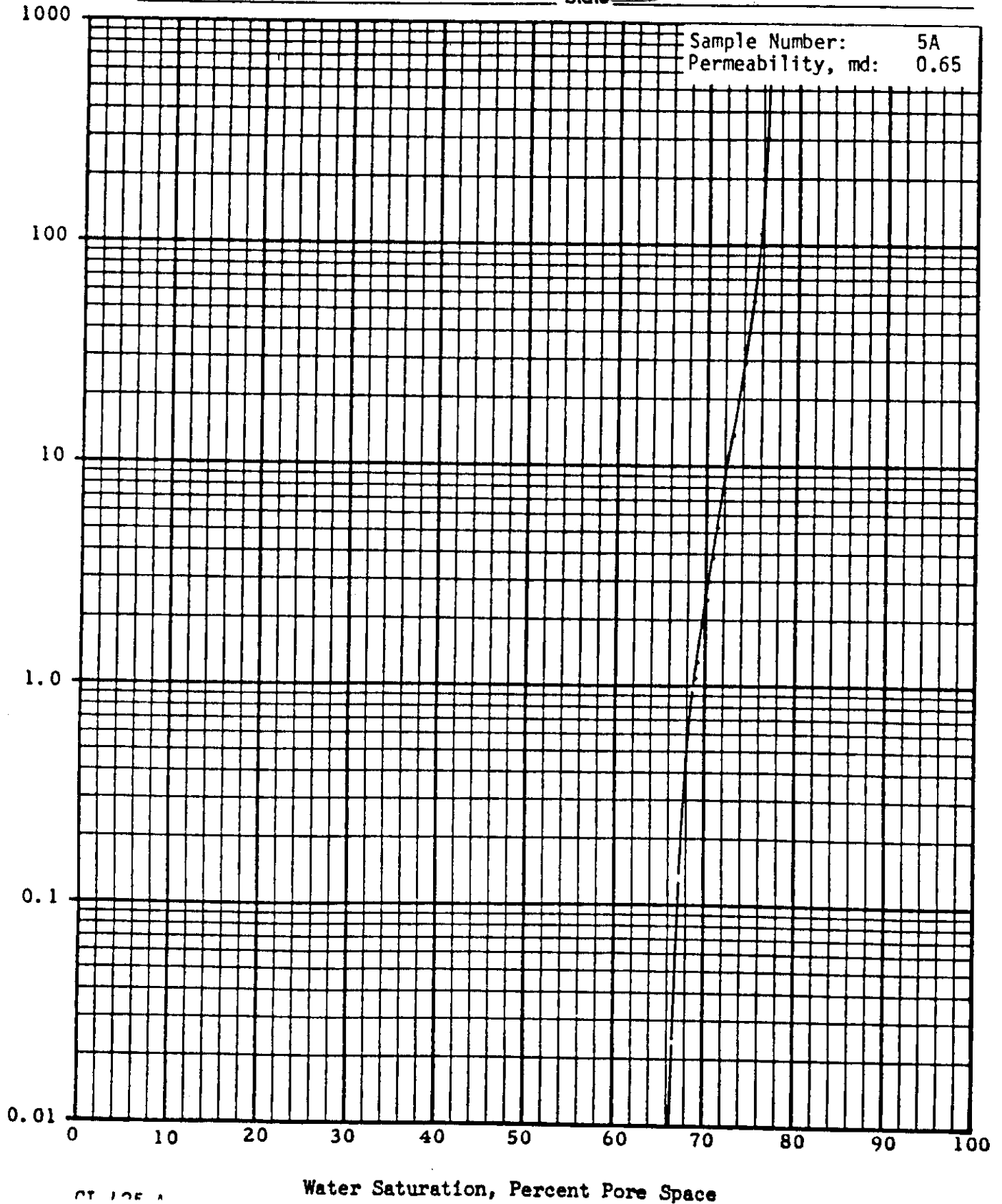
Company Amerada Hess Corporation Formation Spearfish Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota



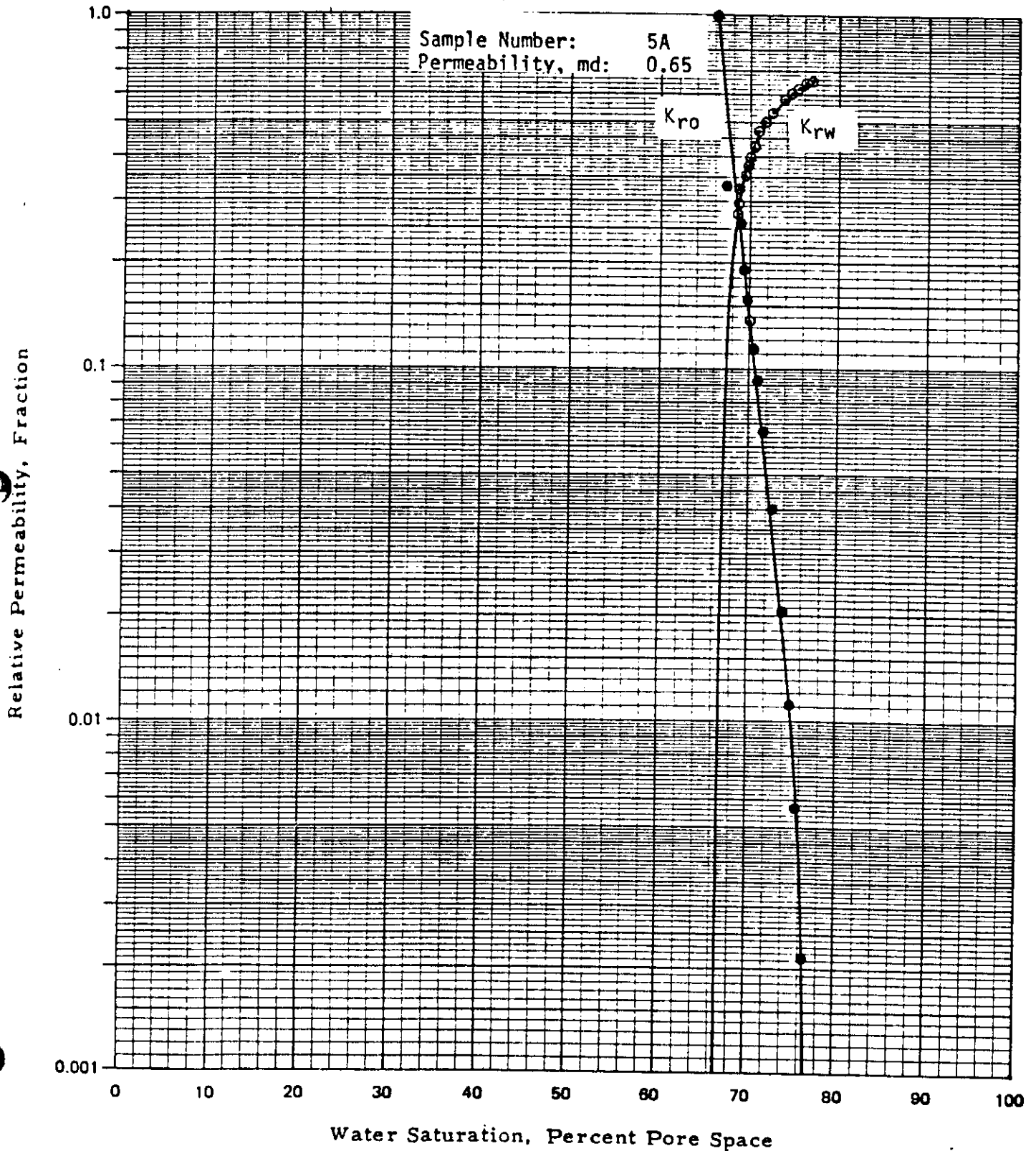
Company Amerada Hess Corporation Formation Spearfish Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 5A
Permeability, md: 0.65

Water-Oil Relative Permeability Ratio

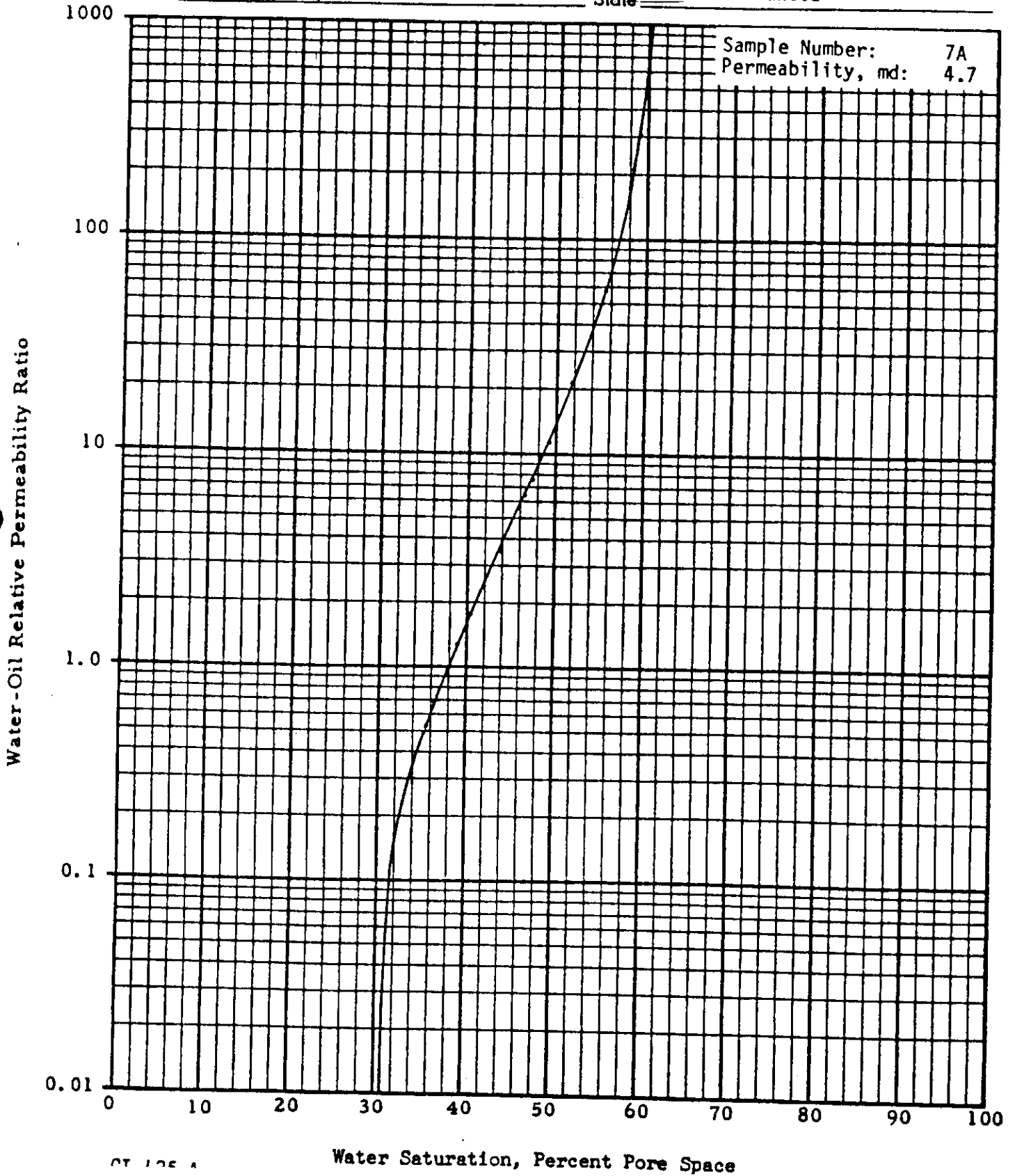


Company Amerada Hess Corporation Formation Spearfish Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota



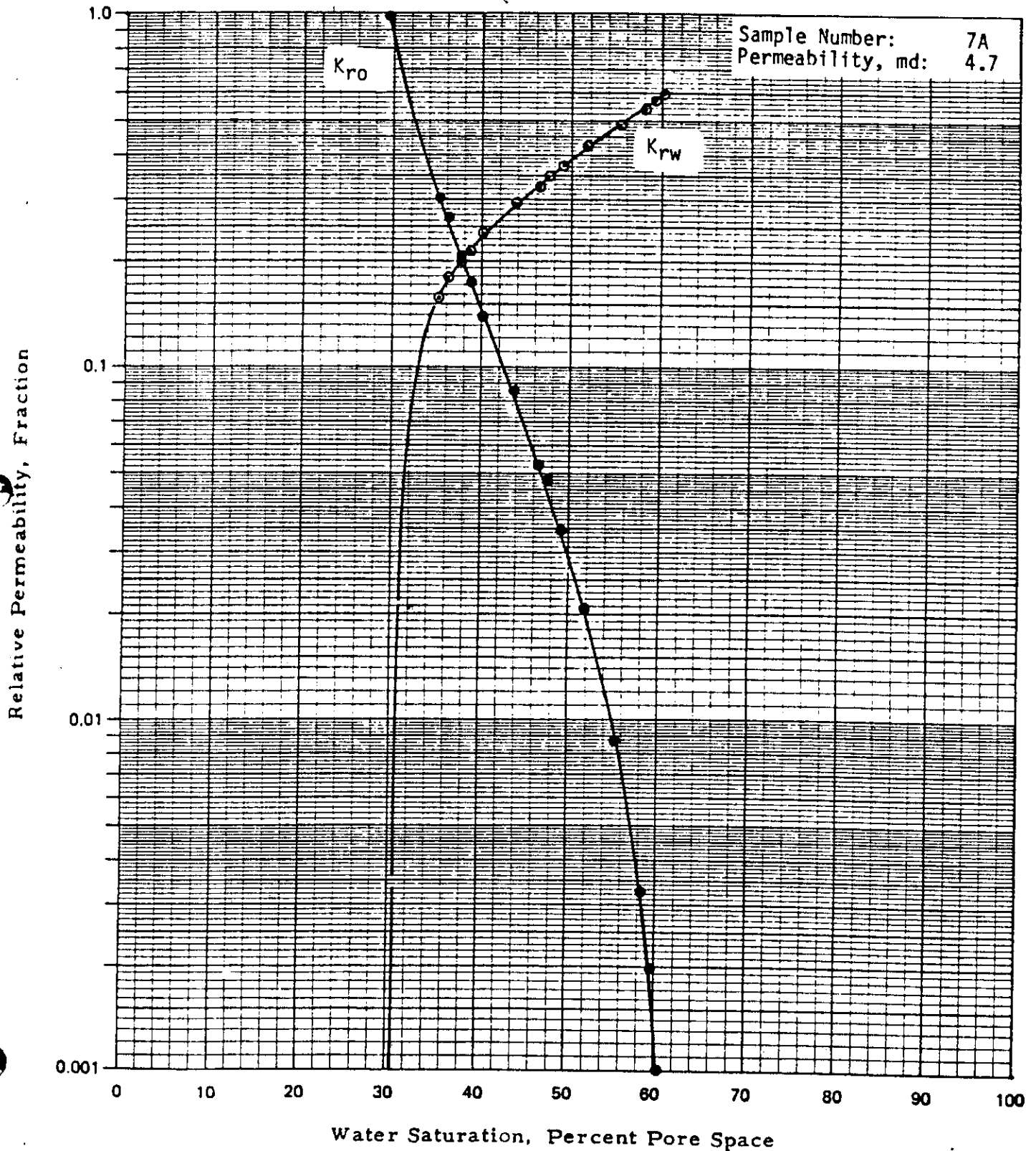
Company Amerada Hess Corporation Formation Spearfish Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 7A
Permeability, md: 4.7



Company Amerada Hess Corporation Formation Spearfish Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 7A
Permeability, md: 4.7



SUMMARY OF WATER-OIL RELATIVE PERMEABILITY TEST RESULTS

Amerada Hess Corporation Newburg Field			Wells as Listed Bottineau, North Dakota		Charles Formation		
Sample I.D.	Depth, feet	Permeability to Air, millidarcys	Porosity, percent	Initial Conditions		Terminal Conditions	
				Water Saturation, percent pore space	Effective Permeability to Oil, millidarcys	Oil Saturation, percent pore space	Effective Permeability to Water, millidarcys
NSCU 0-712 Well							
32A	3392-93	31	17.2	18.8	21	30.0	9.8
34A	3394-95	0.97	12.7	18.1	0.31	30.8	0.05
NSCU P-713 Well							
37A	3389-90	2.5	14.7	11.5	1.4	41.4	0.32

WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU 0-712
Charles Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 32A
Sample Depth: 3392-93 feet
Permeability to Air: 31 md
Porosity: 17.2 percent
Initial Water Saturation: 18.8 percent
Effective Permeability to
Oil at S_{wi} : 21 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
18.8	0.000	0.000	1.000
26.6	0.233	0.093	0.401
28.7	0.289	0.110	0.380
32.3	0.449	0.129	0.286
34.6	0.591	0.143	0.241
36.3	0.720	0.154	0.215
37.8	0.851	0.165	0.194
42.6	1.48	0.192	0.130
47.2	2.62	0.220	0.084
48.3	3.08	0.231	0.075
49.4	3.52	0.244	0.069
51.1	4.39	0.252	0.057
52.3	5.20	0.260	0.050
53.3	5.94	0.270	0.046
54.9	7.54	0.283	0.038
56.9	10.2	0.305	0.030
62.1	26.5	0.334	0.013
64.9	58.4	0.369	0.0063
68.5	362	0.429	0.0012

*Relative to oil permeability

WATER-OIL RELATIVE PERMEABILITY

Amerada Hess Corporation
NSCU 0-712
Charles Formation
Newburg Field
Bottineau County
North Dakota

Sample Identification: 34A
Sample Depth: 3394-95 feet
Permeability to Air: 0.97 md
Porosity: 12.7 percent
Initial Water Saturation: 18.1 percent
Effective Permeability to
Oil at S_{wi} : 0.31 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
18.1	0.000	0.000	1.000
32.7	0.103	0.058	0.563
35.7	0.131	0.065	0.490
41.6	0.223	0.078	0.348
51.4	0.640	0.100	0.155
55.0	1.11	0.110	0.098
58.2	2.00	0.120	0.060
61.6	4.61	0.130	0.028
63.9	9.83	0.143	0.015
65.6	20.6	0.150	0.0073
66.7	43.2	0.160	0.0038
68.1	170	0.168	0.00098
68.8	518	0.175	0.00035
69.2		0.161	

*Relative to oil permeability

WATER-OIL RELATIVE PERMEABILITY

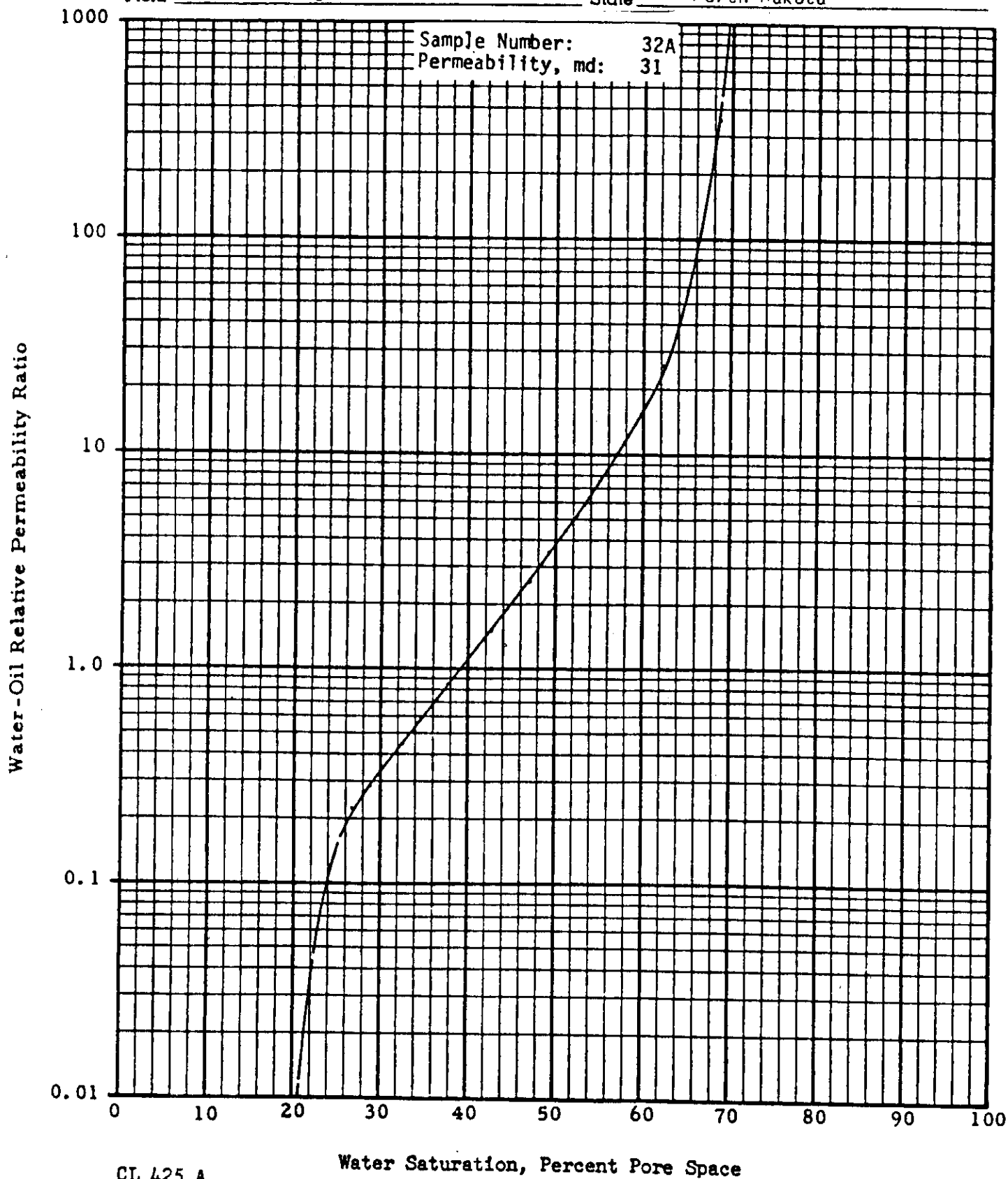
Amerada Hess Corporation
NSCU P-713
Charles Formation
Newburg Field
Rottineau County
North Dakota

Sample Identification: 37A
Sample Depth: 3389-90 feet
Permeability to Air: 2.5 md
Porosity: 14.7 percent
Initial Water Saturation: 11.5 percent
Effective Permeability to
Oil at S_{wi} : 1.4 md

<u>Water Saturation, percent pore space</u>	<u>Water-Oil Relative Permeability Ratio</u>	<u>Relative Permeability to Water,* fraction</u>	<u>Relative Permeability to Oil,* fraction</u>
11.5	0.000	0.000	1.000
22.9	0.101	0.050	0.498
26.0	0.146	0.061	0.416
35.7	0.446	0.097	0.218
39.5	0.726	0.113	0.155
42.6	1.16	0.125	0.108
44.9	1.72	0.135	0.078
46.9	2.57	0.149	0.058
49.3	4.29	0.163	0.038
50.8	6.13	0.172	0.028
52.7	11.0	0.184	0.017
54.9	26.9	0.199	0.0074
56.9	99.1	0.211	0.0021
57.8	286	0.220	0.00077
58.6		0.229	

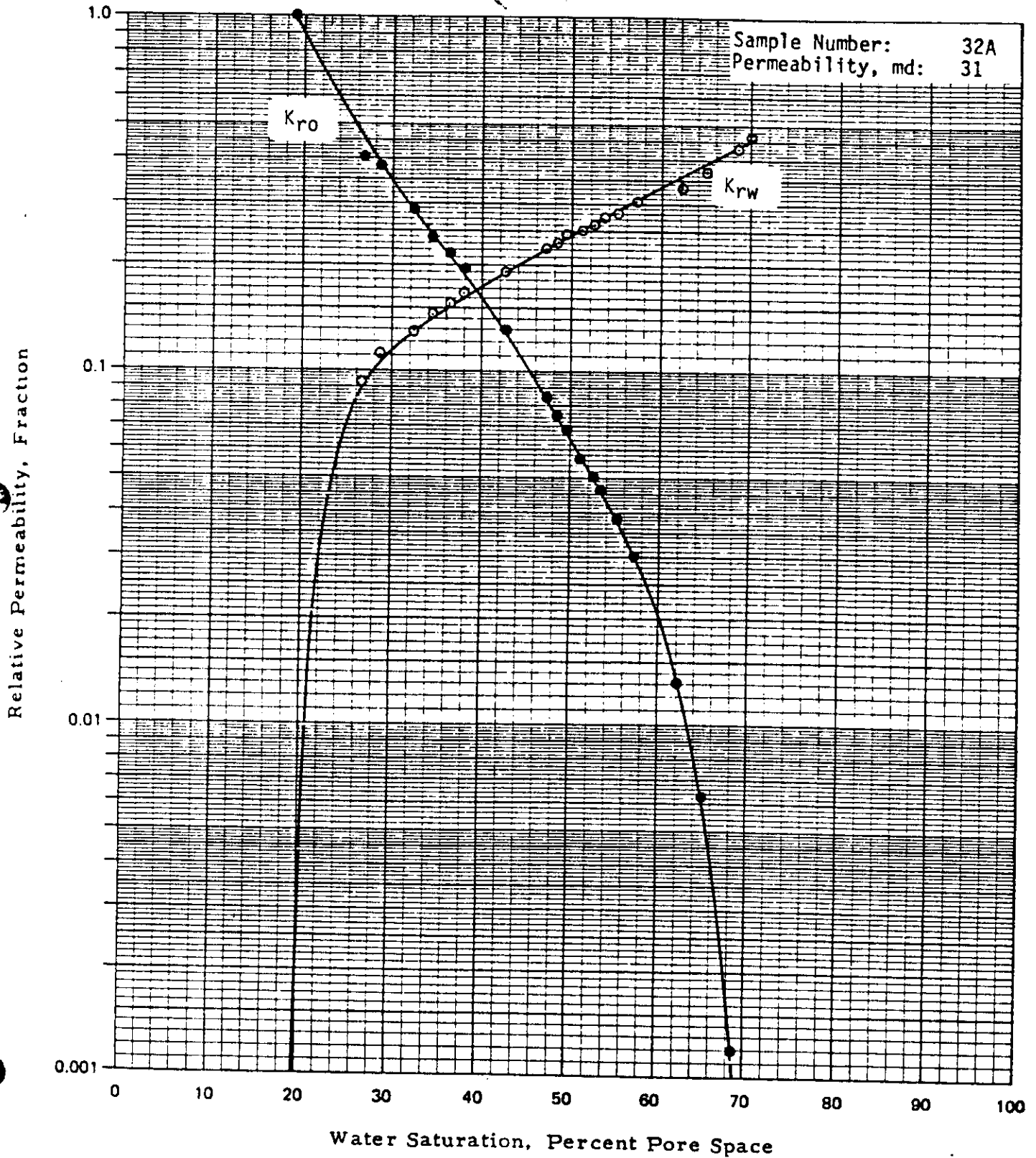
*Relative to oil permeability

Company	Amerada Hess Corporation	Formation	Charles Formation
Well	0-712 Well	County	Bottineau County
Field	Newburg Field	State	North Dakota



Company Amerada Hess Corporation Formation Charles Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota

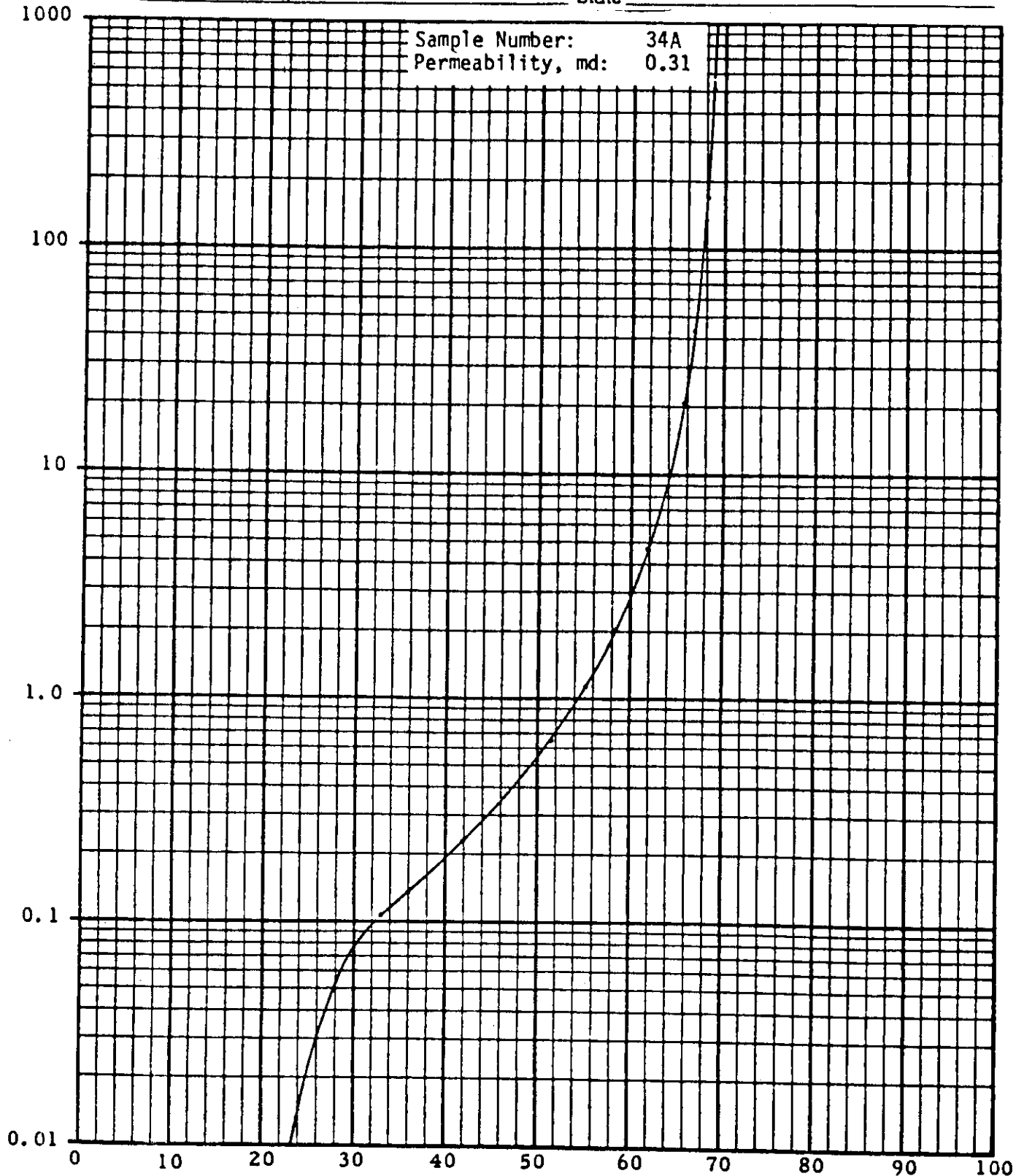
Sample Number: 32A
Permeability, md: 31



Company Amerada Hell Corporation Formation Charles Formation
Well 0-712 Well County Rottineau County
Field Newburg Field State North Dakota

Sample Number: 34A
Permeability, md: 0.31

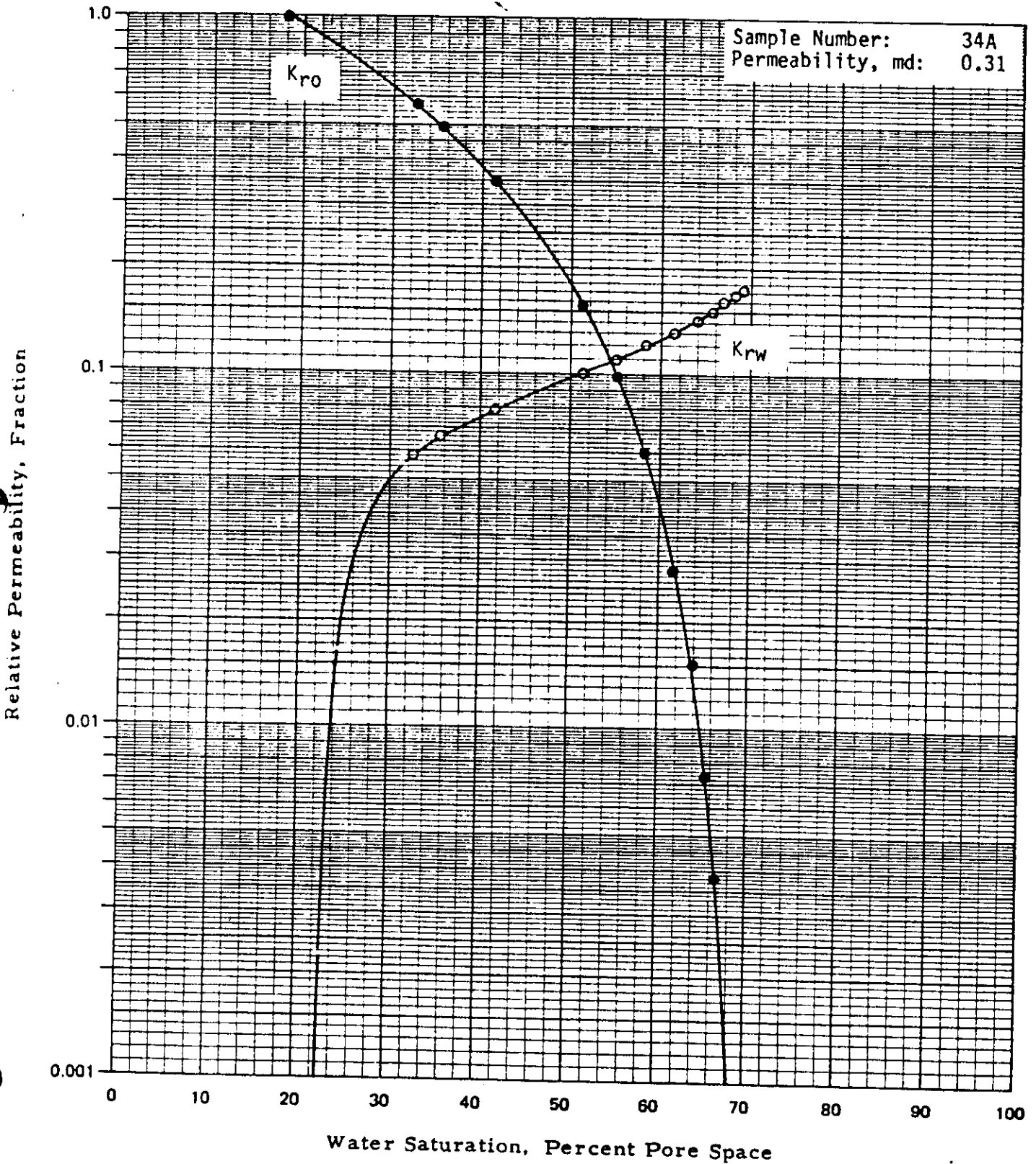
Water-Oil Relative Permeability Ratio



CL 425 A

Water Saturation, Percent Pore Space

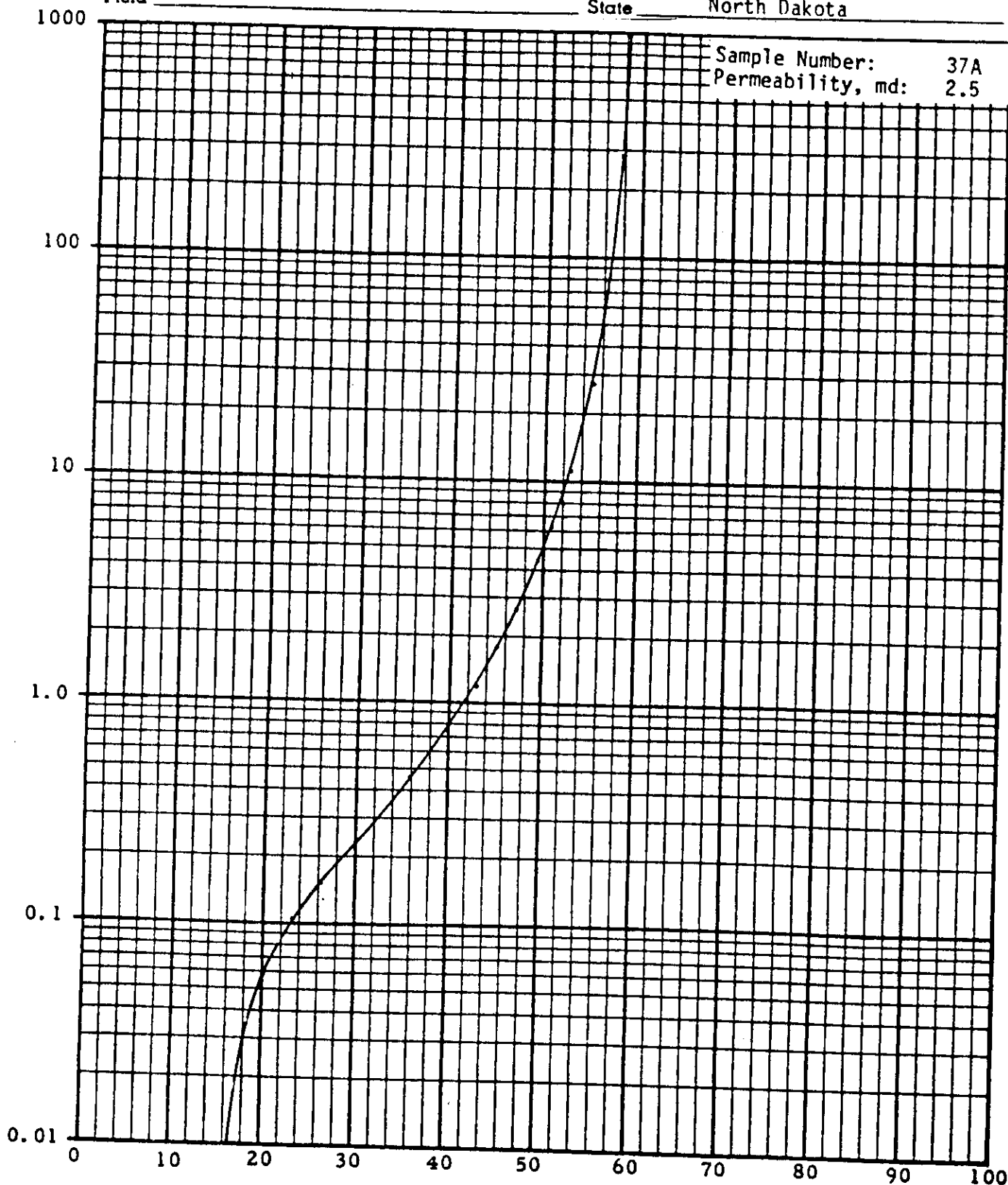
Company Amerada Hess Corporation Formation Charles Formation
Well 0-712 Well County Bottineau County
Field Newburg Field State North Dakota



Company Amerada Hess Corporation Formation Charles Formation
Well P-713 Well County Bottineau County
Field Newburg Field State North Dakota

Sample Number: 37A
Permeability, md: 2.5

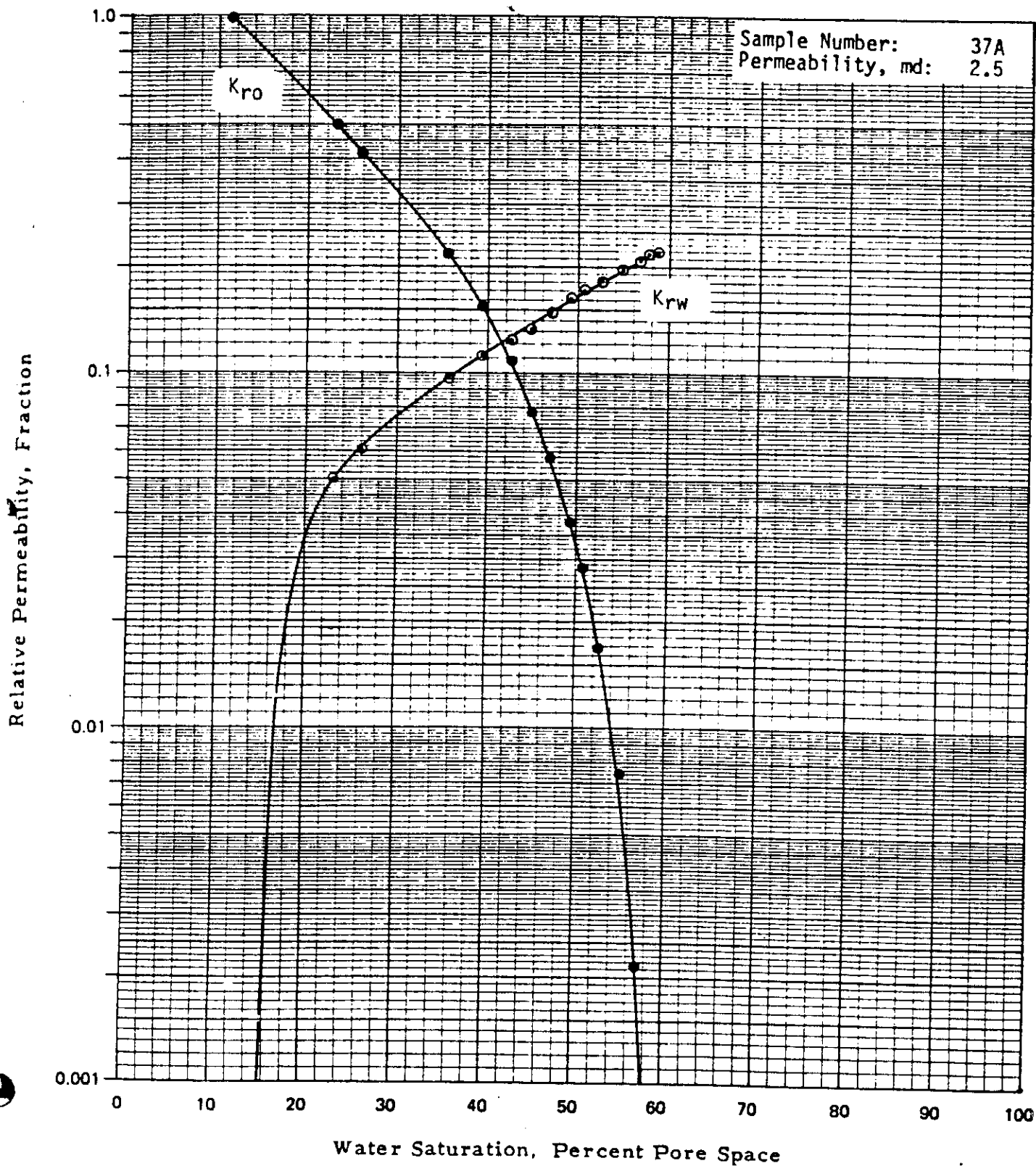
Water-Oil Relative Permeability Ratio



CL 425 A

Water Saturation, Percent Pore Space

Company	Amerada Hess Corporation	Formation	Charles Formation
Well	P-713 Well	County	Bottineau County
Field	Newburg Field	State	North Dakota



CORE LABORATORIES - CANADA, LTD.



82 12 01

Omega Hydrocarbons Ltd.
630, 330 - 5 Avenue, S.W.
Calgary, Alberta
T2P 0L4

Attention: Mr. Ed Wyse

Gentlemen:

SUBJECT: Special Core Analysis Study
Omega Waskada Prov 16-22-1-26 W1M
Omega Waskada 3-25MC3A-1-26 W1M
Our File Number: 7009-312-82-040

As requested by Mr. Ed Wyse in a telephone conversation with Mr. Bruce Barnaby on October 6, 1982, Special Core Analysis Tests were performed on core plugs from the Spearfish Formation of the subject wells. Tests include:

1. Overburden Permeability and Porosity Measurements
2. Air-Brine Capillary Pressure Tests
3. Formation Resistivity Index Measurements
4. Formation Resistivity Factor Measurements at atmospheric pressure and at one overburden pressure
5. Liquid Permeability Measurements
6. Unsteady-State Gas-Oil Relative Permeability Measurements at room conditions
7. Unsteady-State Water-Oil Relative Permeability Measurements at room conditions

Samples used in this study are lithologically described and identified as to sample number and depth interval on page 1.

Cylindrical core plugs, 38 mm in diameter, were drilled from full diameter core pieces for use in this study. Samples from the Omega Waskada 3-25MC3A-1-26 W1M well were drilled from preserved core pieces using oil as the bit

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lubricant and coolant. The core plugs selected for Liquid Permeability Measurements and Relative Permeability Tests were immersed in oil to preserve their native-state condition until testing could commence. The remaining samples were extracted with toluene to remove all hydrocarbons, leached of salt with methanol and oven dried at 85° C. Samples from the Omega Waskada Prov 16-22-1-26 W1M well were drilled from full diameter core pieces using water as the bit lubricant and coolant. These samples were cleaned and dried as previously discussed. Air permeability, porosity and grain density values of samples used in this study are reported in the tabular data and with the graphical illustrations.

Overburden Permeability and Porosity Measurements were performed on 4 core samples at 4 simulated overburden pressures ranging from 1 400 kPa to 11 900 kPa. Each sample was placed in a hydrostatic core holder and permeability and porosity values were determined as the overburden pressure was incrementally increased. Test results are tabulated on page 2 and graphically illustrated on pages 3 through 6.

In preparation for Air-Brine Capillary Pressure Tests and Electrical Property Measurements, 5 core plugs were evacuated and pressure-saturated with 92 400 ppm T.D.S. simulated formation brine with a resistivity of 0.106 Ohm-metres at 25° C. The brine was synthesized from a Produced Water analysis of the 7-25-1-25 W1M well. Electrical resistivities of both the brine and the brine saturated core plugs were measured. These measurements were repeated over a period of several days until the resistivities stabilized, indicating ionic equilibrium had been attained within the core plugs. The brine saturated core plugs were then placed on a semi-permeable diaphragm and the brine was displaced with humidified air. Fluid saturations were computed after equilibrium saturations had been attained at 6 successively higher pressure levels. Results of these tests are presented in tabular form on page 6 and in graphical form on pages 8 through 12. In conjunction with these measurements, electrical resistivities were determined at the 6 equilibrium saturations. The formation resistivity index - saturation relationships are presented in tabular form on page 13 and in graphical form on pages 14 through 19. The computer determined regression lines on the graphical illustrations were calculated using the least squares method.

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After the capillary pressure tests, the samples were releached, oven dried and resaturated with brine. Electrical resistivity measurements were repeated until ionic equilibrium was again attained. Electrical resistivities of the core plugs were then determined under 1 simulated formation overburden pressure. Results of the overburden formation resistivity factor tests are tabulated on page 20 and graphically illustrated on pages 21 through 23.

Two, native-state core plugs were selected for Liquid Permeability Measurements. Each sample was injected with 92 400 ppm T.D.S. simulated formation brine and permeabilities were measured as a function of pore volume throughput to the brine as indicated in the tabular data on pages 24 and 25. During testing, oil was often noted in the effluent. For sample number P-5B/3-25, the brine may have caused sample plugging due to mobile fines as evidenced by the immediate increase in permeability when the flow direction was reversed. Upon completion of the liquid permeability tests, the samples were extracted with toluene to remove all hydrocarbons, leached of salt with methanol and oven dried at 85° C. Air permeability, porosity and grain density values were then determined and results are reported with the tabular data.

In preparation for Gas-Oil Relative Permeability Tests, 2 native-state core plugs were flushed to immobile water saturation using a refined mineral oil with a viscosity of approximately 20 mPa·s. Effective permeability to oil in the presence of irreducible water saturation was determined on each core plug. The oil present in each core plug was then dynamically displaced with humidified nitrogen gas and incremental volumes of oil and gas production were measured as a function of time. Production data was used to calculate the gas-oil relative permeability characteristics which are presented in tabular form on pages 26 and 27 and in graphical form on pages 28 through 31.

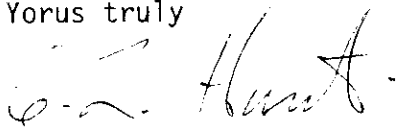
-iv-

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At the conclusion of the gas-oil relative permeability tests, the 2 core plugs were submerged under the refined mineral oil and evacuated for a short period of time to remove any gas saturation present. The core plugs were also flushed with oil to ensure total liquid saturation. The 3 additional native-state samples selected for water-oil relative permeability measurements were flushed to immobile water saturation using a refined mineral oil with a viscosity of approximately 20 mPa·s. Effective permeability to oil in the presence of irreducible brine saturation was then determined on all 5 core plugs. The oil was displaced with 92 400 ppm T.D.S. simulated formation brine and volumes of each effluent fluid were determined at measured time intervals. From this data, the water-oil relative permeability characteristics were calculated. Results are presented in tabular form on pages 32 through 37 and in graphical form on pages 38 through 47. At terminal conditions of water floodout, the liquid flow was reversed and the effective permeability to water was determined in the opposite direction in which the flood had been performed. Sample numbers P-8/3-25, P-12/3-25 and P-13/3-25 exhibited initial increases in permeability which is an indication of the presence of mobile fines. These higher liquid permeability values were converted to relative permeability values and plotted on the graphs as a black dot. By extrapolating the relative permeability-to-water curve to the black dot, an indication of probable performance, had plugging not occurred, may be obtained. Upon test completion each sample was extracted with toluene in a Dean Stark apparatus and fluid saturations were determined as indicated in the tabular data. The core plugs were leached of salt with methanol and oven dried at 85° C. Air permeability and porosity values were then determined and results are reported with the relative permeability test data.

We appreciate the opportunity to be of service to Omega Hydrocarbons Ltd. Should you have any questions pertaining to these test results or if we may be of further assistance, please do not hesitate to contact us.

Yours truly



C.L. (Clay) Hunt



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CALGARY, ALBERTA



PAGE 1 of 47
FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

IDENTIFICATION OF SAMPLES

<u>SAMPLE NUMBER</u>	<u>DEPTH METRES</u>	<u>LITHOLOGICAL DESCRIPTION</u>
<u>Omega Waskada Prov 16-22-1-26 W1M</u>		
48/16-22	917.05	SST: lt-brn, mod ind, vf gr, wl srt, sh lam
52/16-22	917.66	SST: brn, mod ind, vf gr, wl srt, mic, lam
62/16-22	919.45	SST: brn, mod ind, vf gr, wl srt, mic, lam
71/16-22	921.57	SST: brn, mod ind, f gr, wl srt, mic
73/16-22	921.98	SST: gn-gry, mod ind, vf gr, wl srt, mic
74/16-22	922.24	SST: lt-gry, mod ind, vf-f gr, mod srt, dol
<u>Omega Waskada 3-25MC3A-1-26 W1M</u>		
13/3-25	905.85	SST: gn-gry, mod ind, vf gr, wl srt, dol, anhy
P-5A/3-25	906.40	SST: gry, mod ind, vf gr, wl srt, pyr
P-5B/3-25	906.40	SST: gry, mod ind, vf gr, wl srt, Fe-st
20/3-25	906.72	SST: brn, mod ind, vf gr, wl srt, mic
P-8/3-25	907.33	SST: brn, wl ind, vf-f gr, p srt, dol
P-10/3-25	908.35	SST: gry, mod ind, vf gr, wl srt, Fe-st
P-12/3-25	918.99	SST: gry, mod ind, vf gr, wl srt, dol
P-13/3-25	919.22	SST: brn, mod ind, vf gr, wl srt, lmy, lam
64/3-25	919.53	SST: lt-brn, wl ind, vf gr, wl srt, dol
P-14/3-25	919.65	SST: lt-brn, mod ind, vf gr, wl srt, dol



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PAGE 2 of 47
FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

OVERBURDEN PERMEABILITY AND POROSITY MEASUREMENTS

<u>SAMPLE NUMBER</u>	<u>GRAIN DENSITY kg/m³</u>	<u>NET OVERBURDEN PRESSURE, kPa</u>	<u>AIR PERMEABILITY MILLIDARCYS</u>	<u>POROSITY FRACTION</u>
<u>Omega Waskada Prov 16-22-1-26 W1M</u>				
48/16-22	2700	1 400	2.73	0.177
		3 400	1.26	0.174
		6 900	1.05	0.172
		11 900	0.97	0.170
52/16-22	2670	1 400	50.8	0.251
		3 400	48.1	0.247
		6 900	46.7	0.245
		11 900	45.4	0.244
74/16-22	2720	1 400	0.10	0.106
		3 400	0.094	0.104
		6 900	0.085	0.103
		11 900	0.073	0.102
<u>Omega Waskada 3-25MC3A-1-26 W1M</u>				
20/3-25	2690	1 400	9.30	0.216
		3 400	9.02	0.212
		6 900	8.84	0.210
		11 900	8.68	0.208

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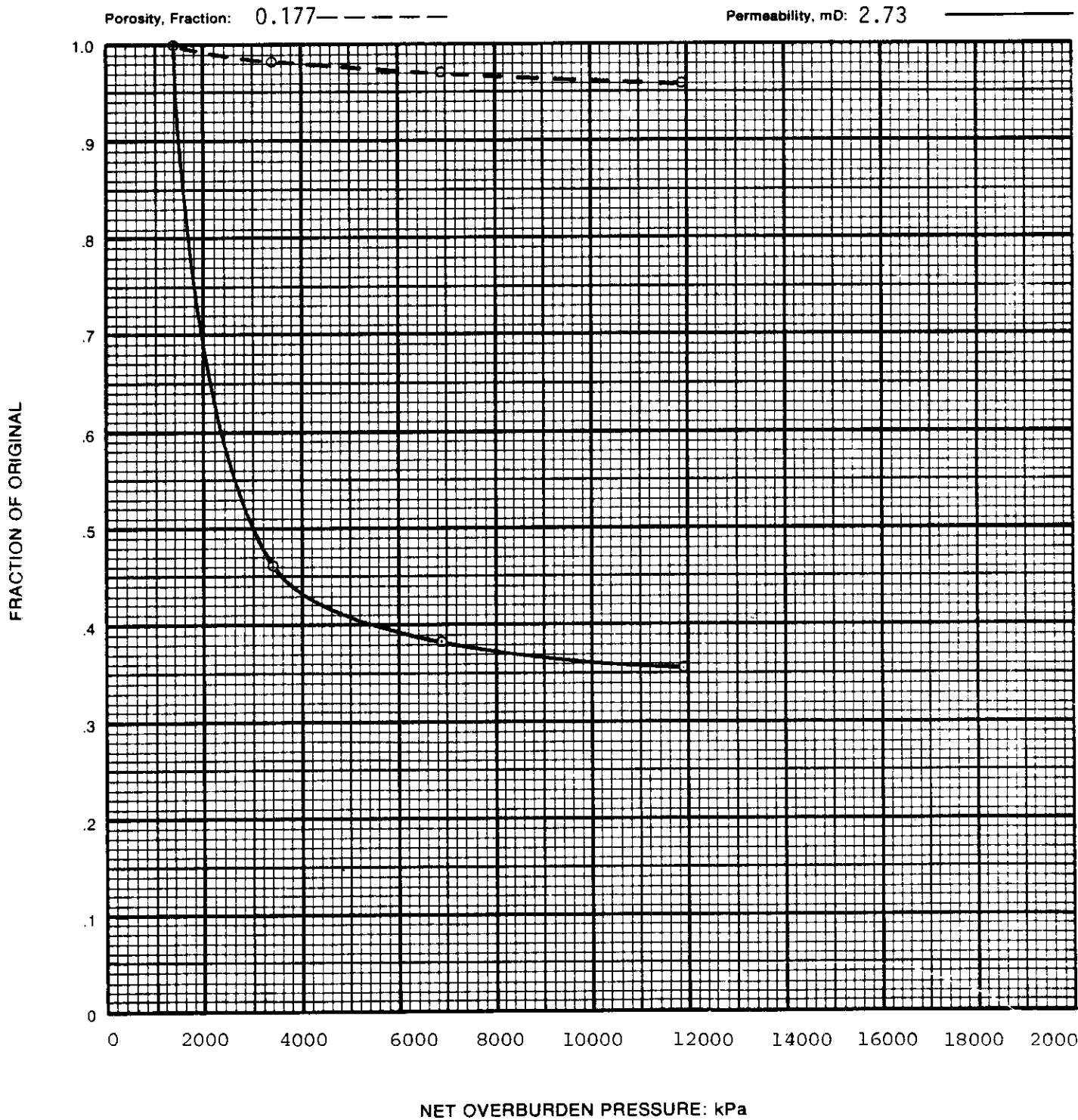
EFFECT OF NET OVERBURDEN PRESSURE ON POROSITY AND PERMEABILITY

PAGE 3 of 47
FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 48/16-22



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EFFECT OF NET OVERBURDEN PRESSURE ON POROSITY AND PERMEABILITY

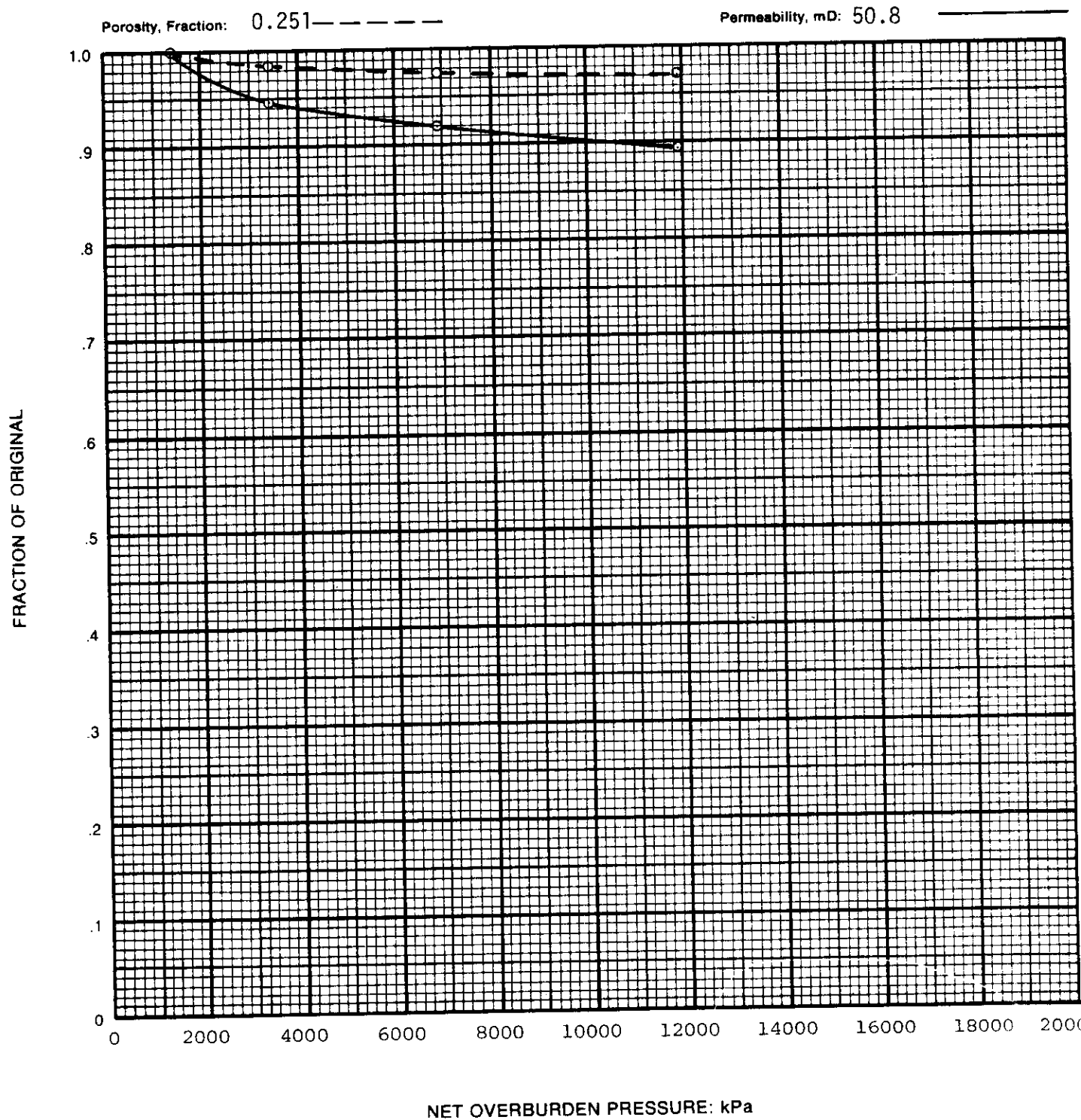
PAGE 4 of 47

FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 52/16-22



EFFECT OF NET OVERBURDEN PRESSURE ON POROSITY AND PERMEABILITY

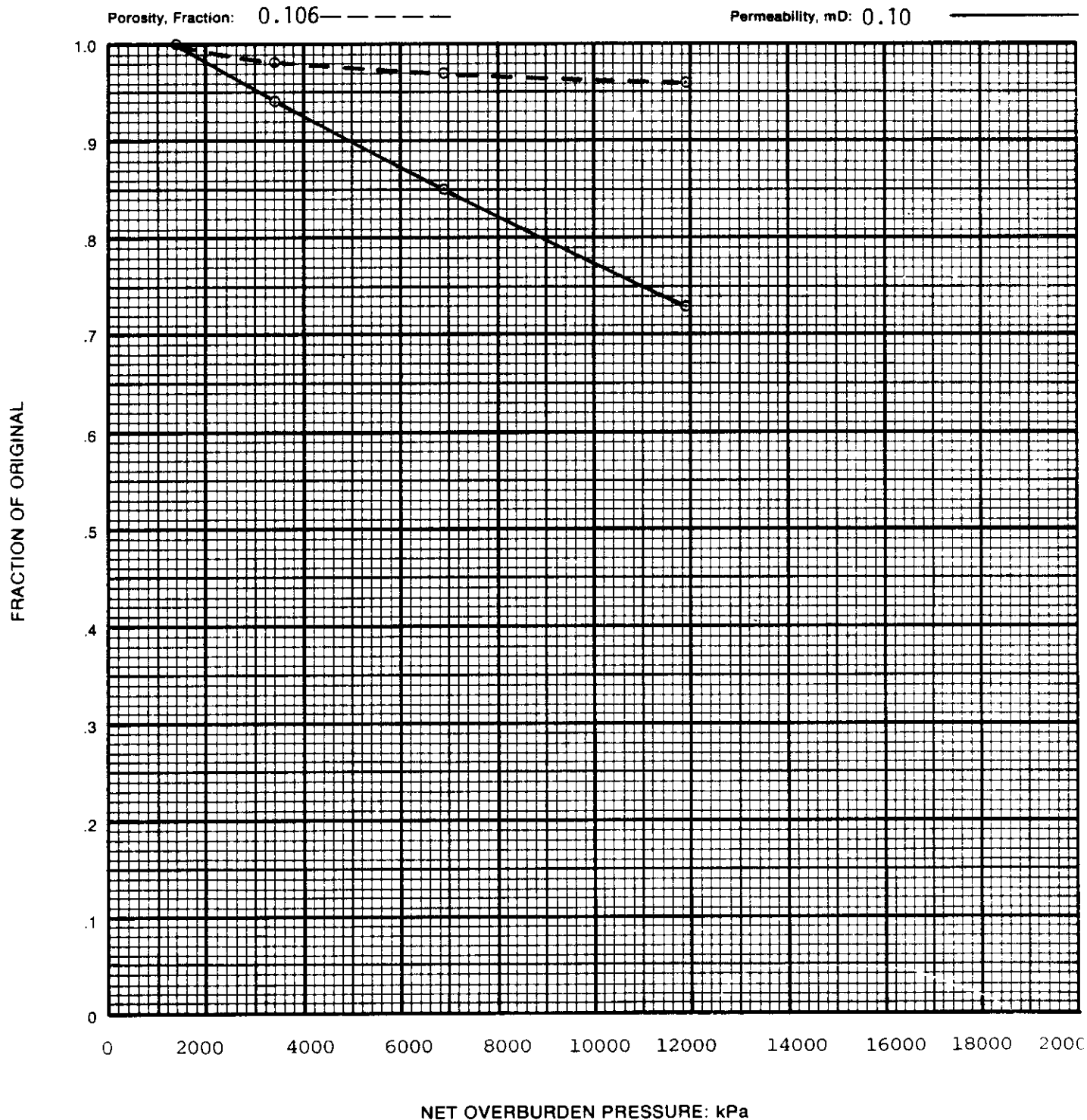
PAGE 5 of 47

FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 74/16-22



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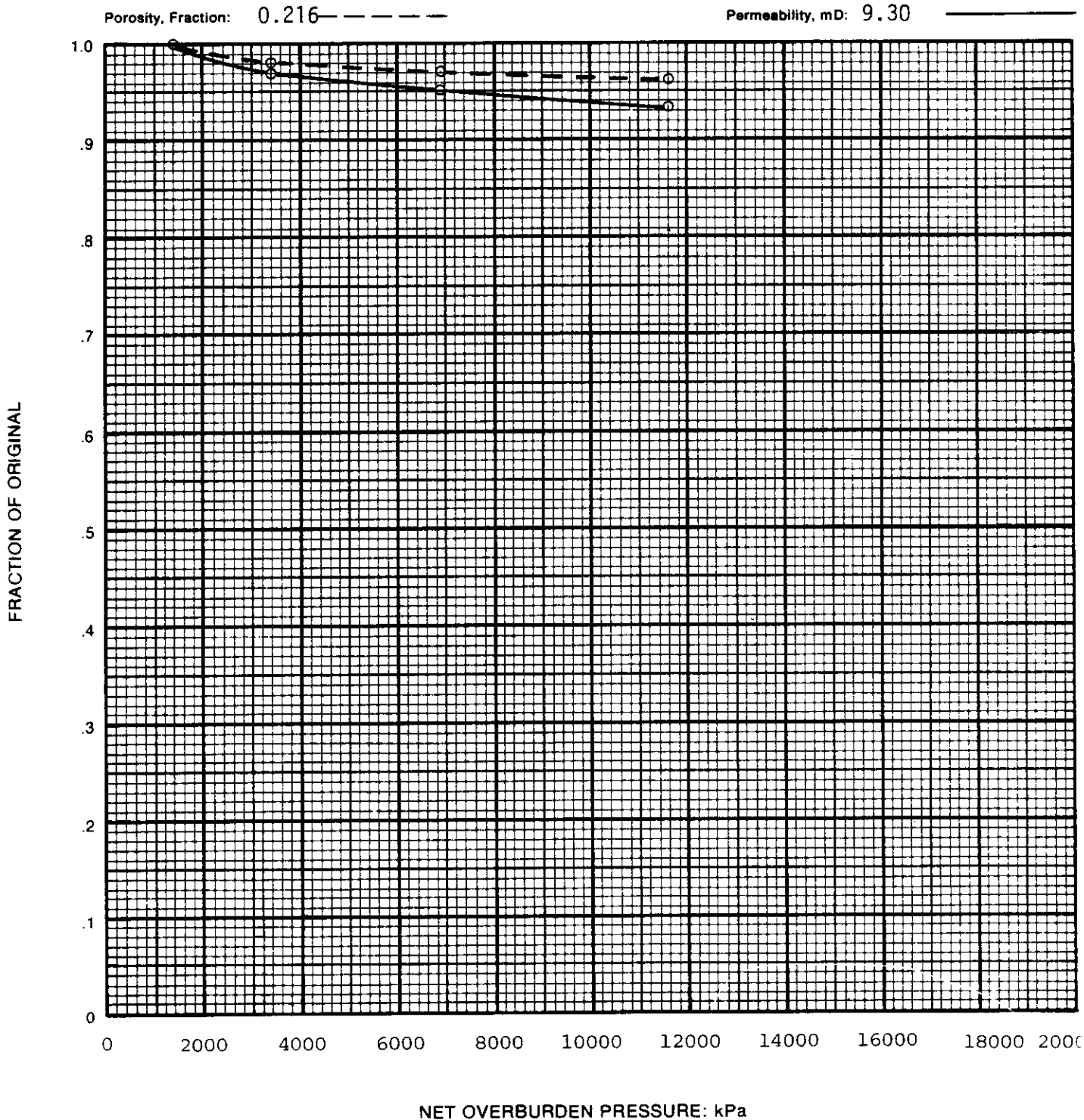
EFFECT OF NET OVERBURDEN PRESSURE ON POROSITY AND PERMEABILITY

PAGE 6 of 47
FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 20/3-25



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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

AIR-BRINE CAPILLARY PRESSURE DATA

PRESSURE, kPa (gauge):

5 15 30 60 120 240

<u>SAMPLE NUMBER</u>	<u>PERMEABILITY MILLIDARCYS</u>	<u>POROSITY FRACTION</u>	<u>GRAIN DENSITY kg/m³</u>	<u>WETTING PHASE SATURATION, PORE VOLUME FRACTION</u>					
<u>Omega Waskada Prov 16-22-1-26 W1M</u>									
62/16-22	6.41	0.193	2680	1.000	1.000	1.000	0.722	0.627	0.466
71/16-22	92.7	0.221	2680	1.000	1.000	0.668	0.389	0.305	0.256
73/16-22	16.5	0.207	2680	1.000	1.000	1.000	0.734	0.475	0.355
<u>Omega Waskada 3-25MC3A-1-26 W1M</u>									
13/3-25	0.70	0.138	2720	1.000	1.000	1.000	0.950	0.872	0.804
64/3-25	3.66	0.149	2710	1.000	1.000	1.000	0.767	0.568	0.496

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AIR BRINE CAPILLARY PRESSURE TEST

PAGE 8 of 47

FILE 7009-312-82-040

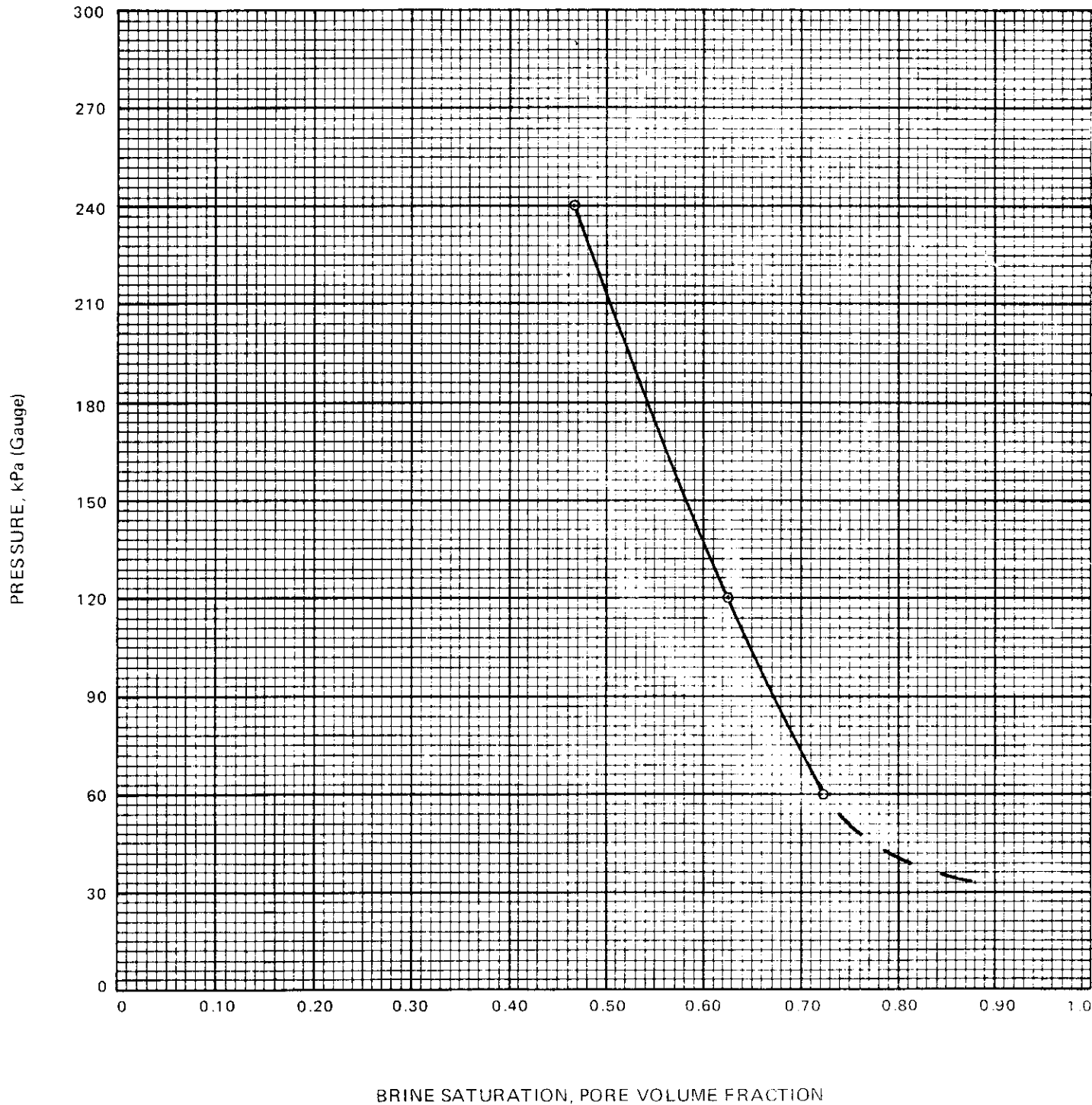
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 62/16-22

Porosity, Fraction: 0.193

Permeability, Millidarcys: 6.41



AIR BRINE CAPILLARY PRESSURE TEST

PAGE 9 of 47
FILE 7009-312-82-040

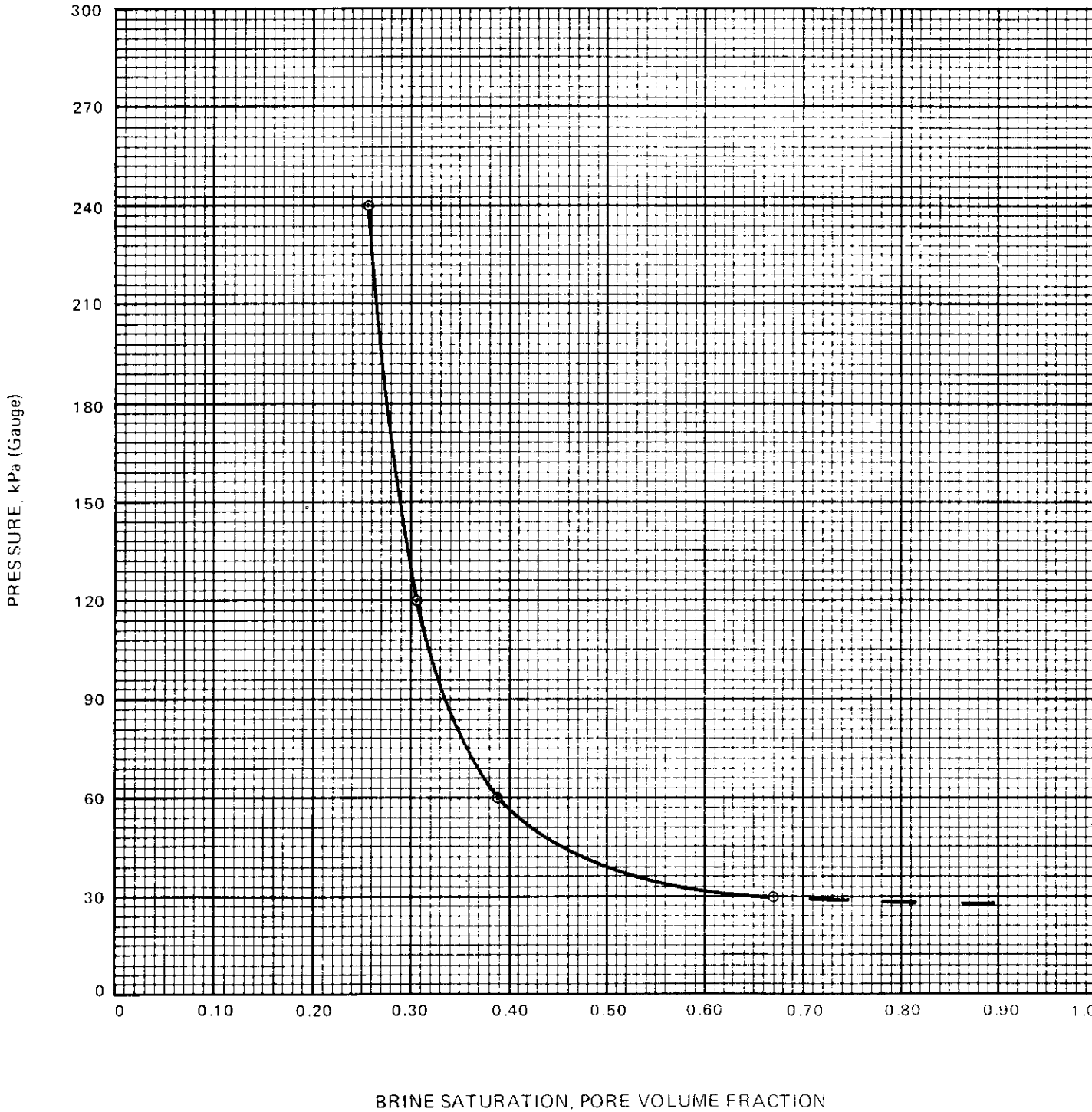
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 71/16-22

Porosity, Fraction: 0.221

Permeability, Millidarcys: 92.7



AIR BRINE CAPILLARY PRESSURE TEST

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FILE 7009-312-82-040

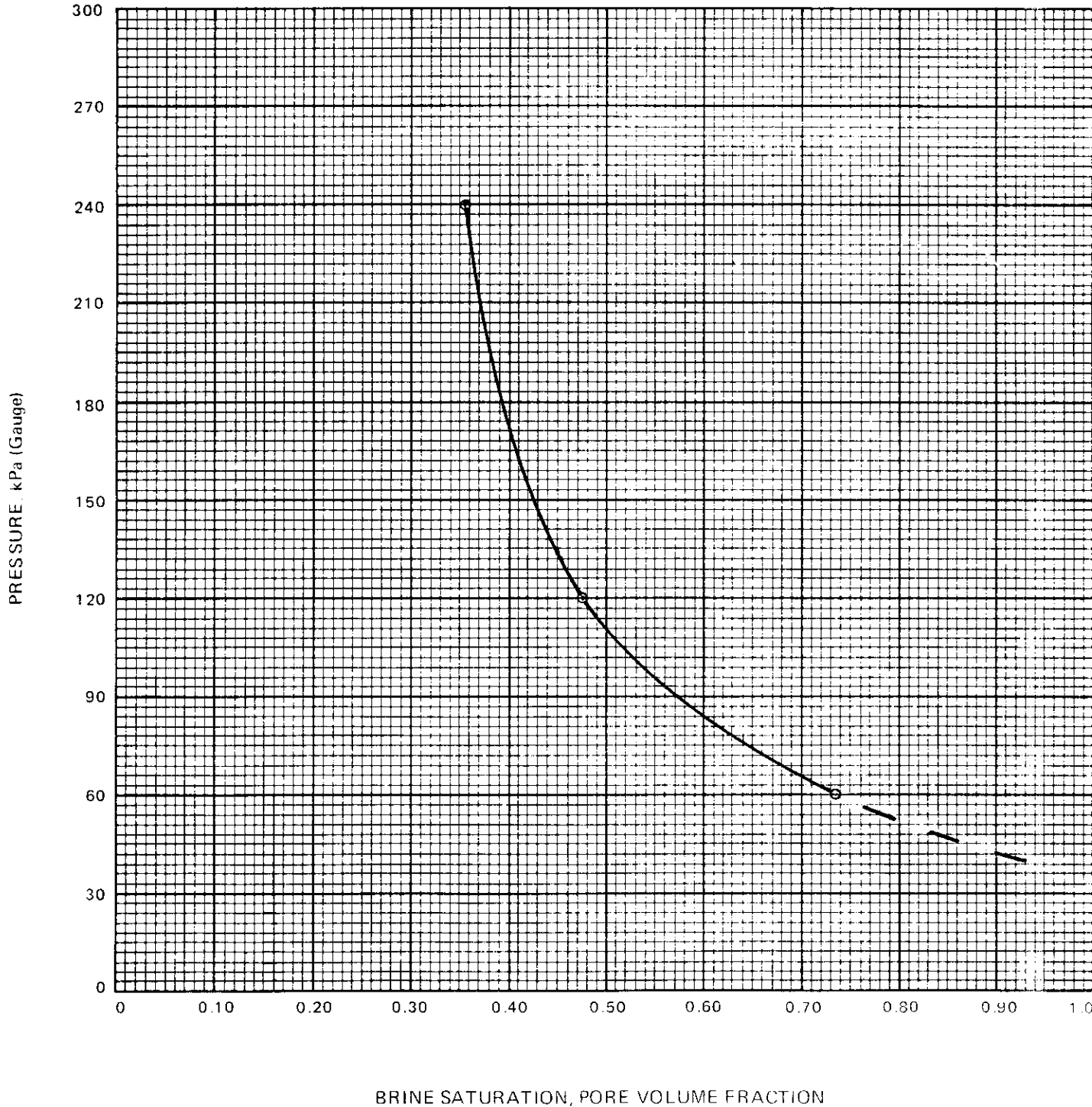
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 73/16-22

Porosity, Fraction: 0.207

Permeability, Millidarcys: 16.5



AIR BRINE CAPILLARY PRESSURE TEST

PAGE 11 of 47
FILE 7009-312-82-040

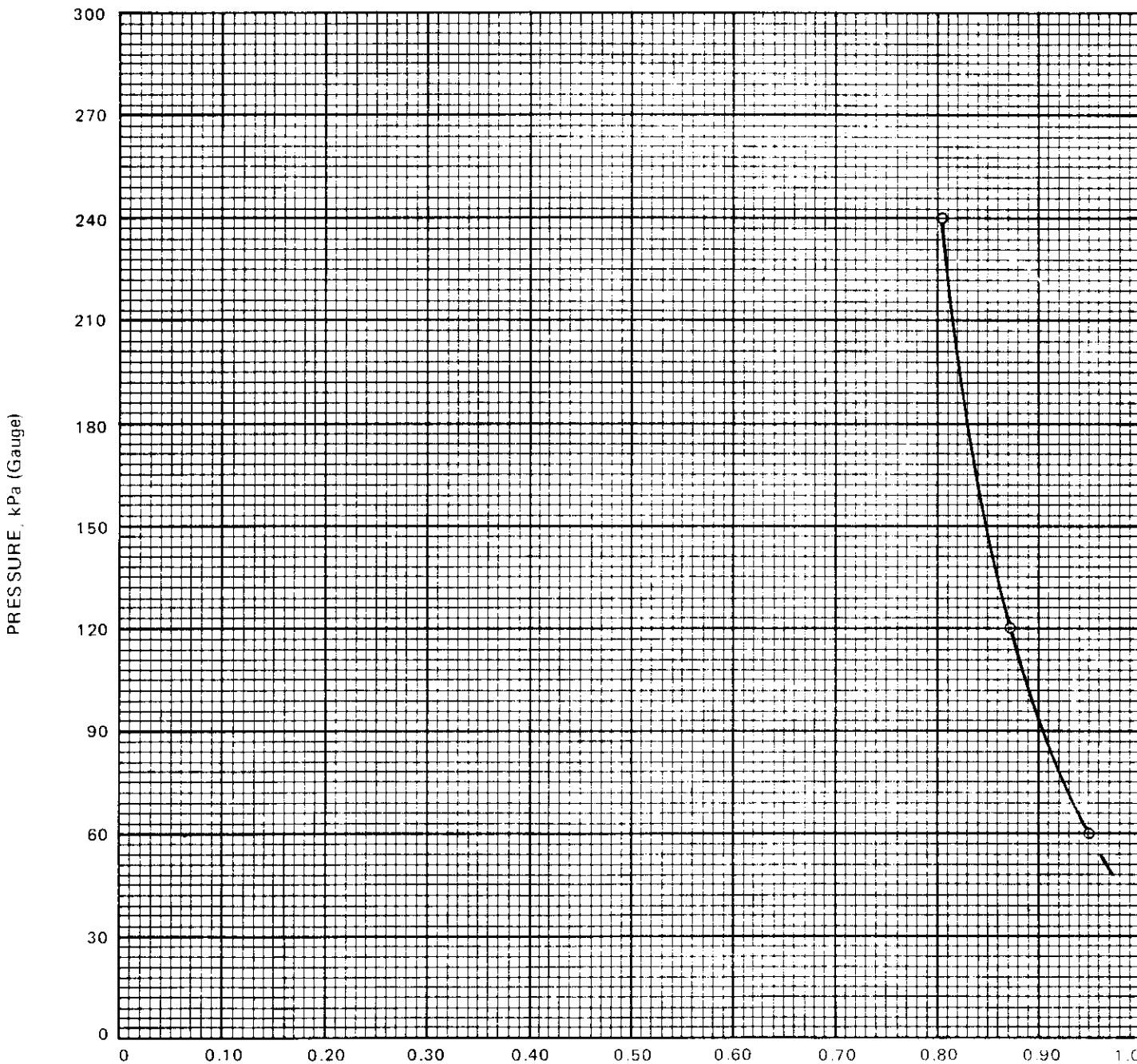
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 13/3-25

Porosity, Fraction: 0.138

Permeability, Millidarcys: 0.70



BRINE SATURATION, PORE VOLUME FRACTION

AIR BRINE CAPILLARY PRESSURE TEST

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FILE 7009-312-82-040

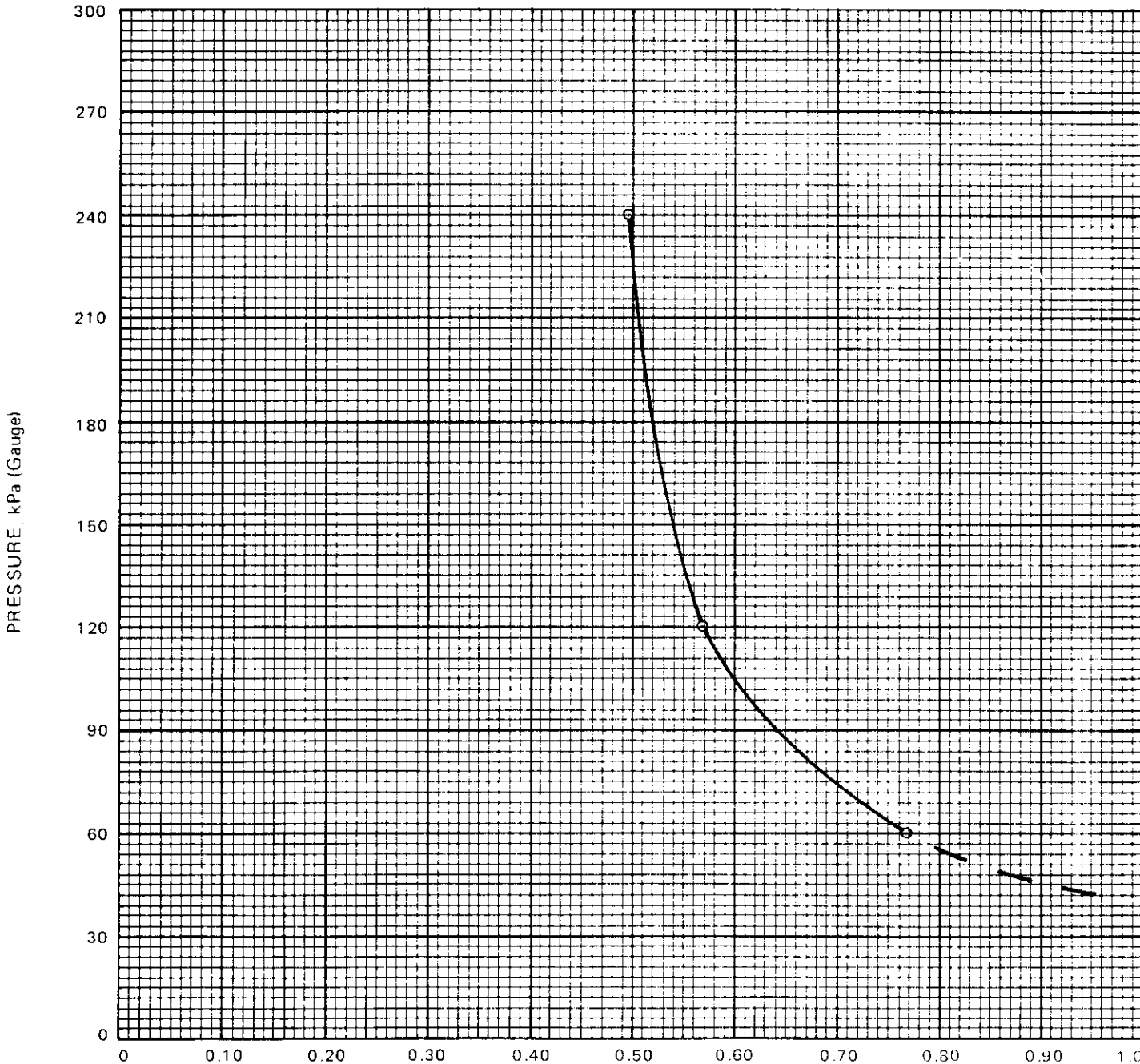
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25-MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 64/3-25

Porosity, Fraction: 0.149

Permeability, Millidarcys: 3.66



BRINE SATURATION, PORE VOLUME FRACTION

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PAGE 13 of 47
FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

FORMATION RESISTIVITY FACTOR AND RESISTIVITY INDEX DATA

SATURANT: 92 400 ppm T.D.S. Simulated Formation brine
RESISTIVITY OF SATURANT: 0.106 Ohm-metres at 25° C

SAMPLE NUMBER	PERMEABILITY MILLIDARCYS	POROSITY FRACTION	FORMATION RESISTIVITY FACTOR	BRINE SATURATION PORE VOLUME FRACTION	RESISTIVITY INDEX
Omega Waskada Prov 16-22-1-26 W1M					
62/16-22	6.41	0.193	17.1	1.000	1.00
				0.722	2.30
				0.627	2.95
				0.466	5.30
71/16-22	92.7	0.221	10.9	1.000	1.00
				0.668	2.50
				0.389	7.04
				0.305	11.0
				0.256	14.3
73/16-22	16.5	0.207	13.2	1.000	1.00
				0.734	2.25
				0.475	5.01
				0.355	8.34
Omega Waskada 3-25MC3A-1-26 W1M					
13/3-25	0.70	0.138	30.6	1.000	1.00
				0.950	1.18
				0.872	1.38
				0.804	1.56
64/3-25	3.66	0.149	23.9	1.000	1.00
				0.767	1.70
				0.568	2.78
				0.496	3.13

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FORMATION RESISTIVITY INDEX

FILE: 7009-312-82-04

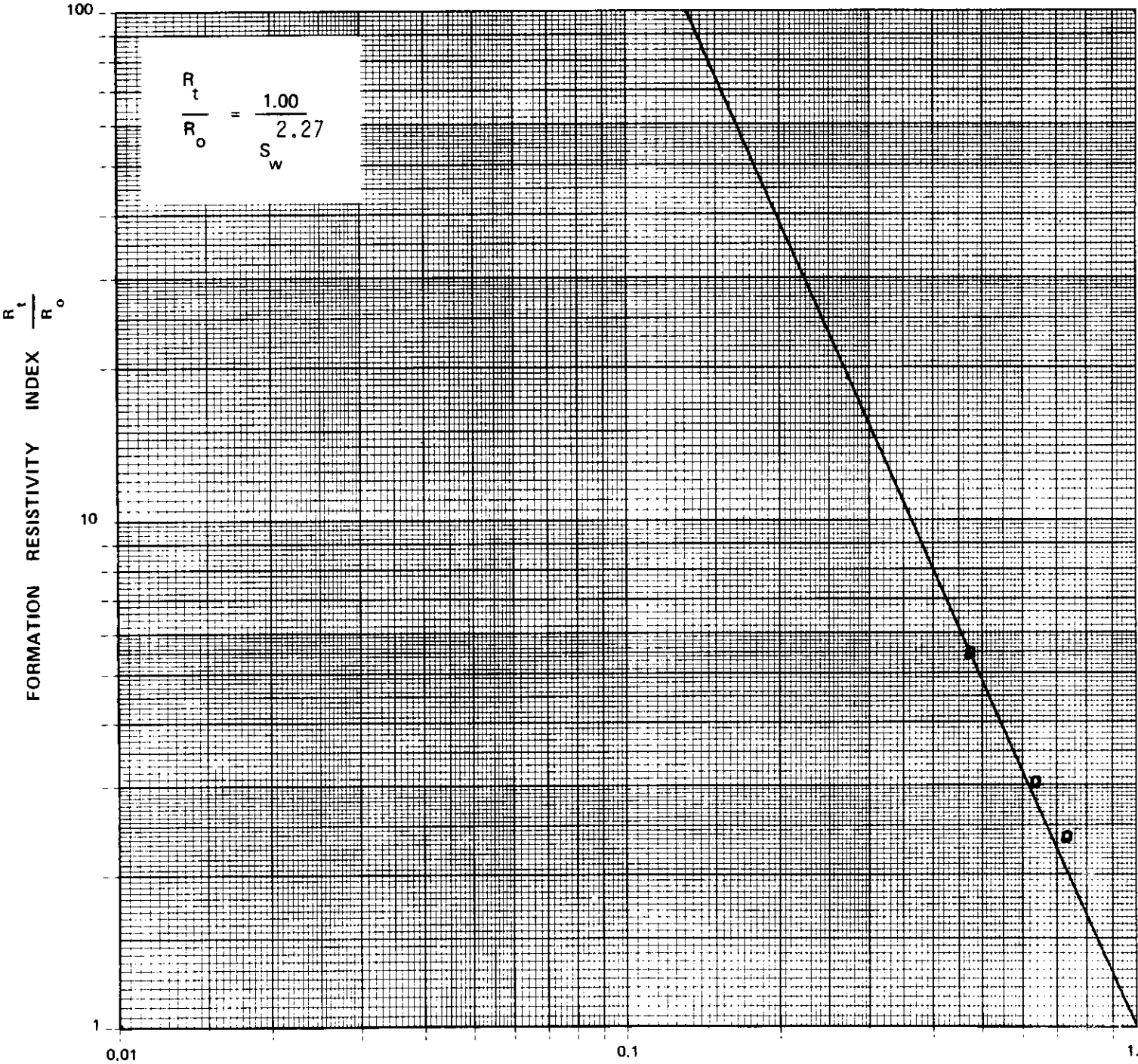
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 62/16-22

Porosity, Fraction 0.193

Permeability, Millidarcys: 6.41



FORMATION RESISTIVITY INDEX

FILE: 7009-312-82-04

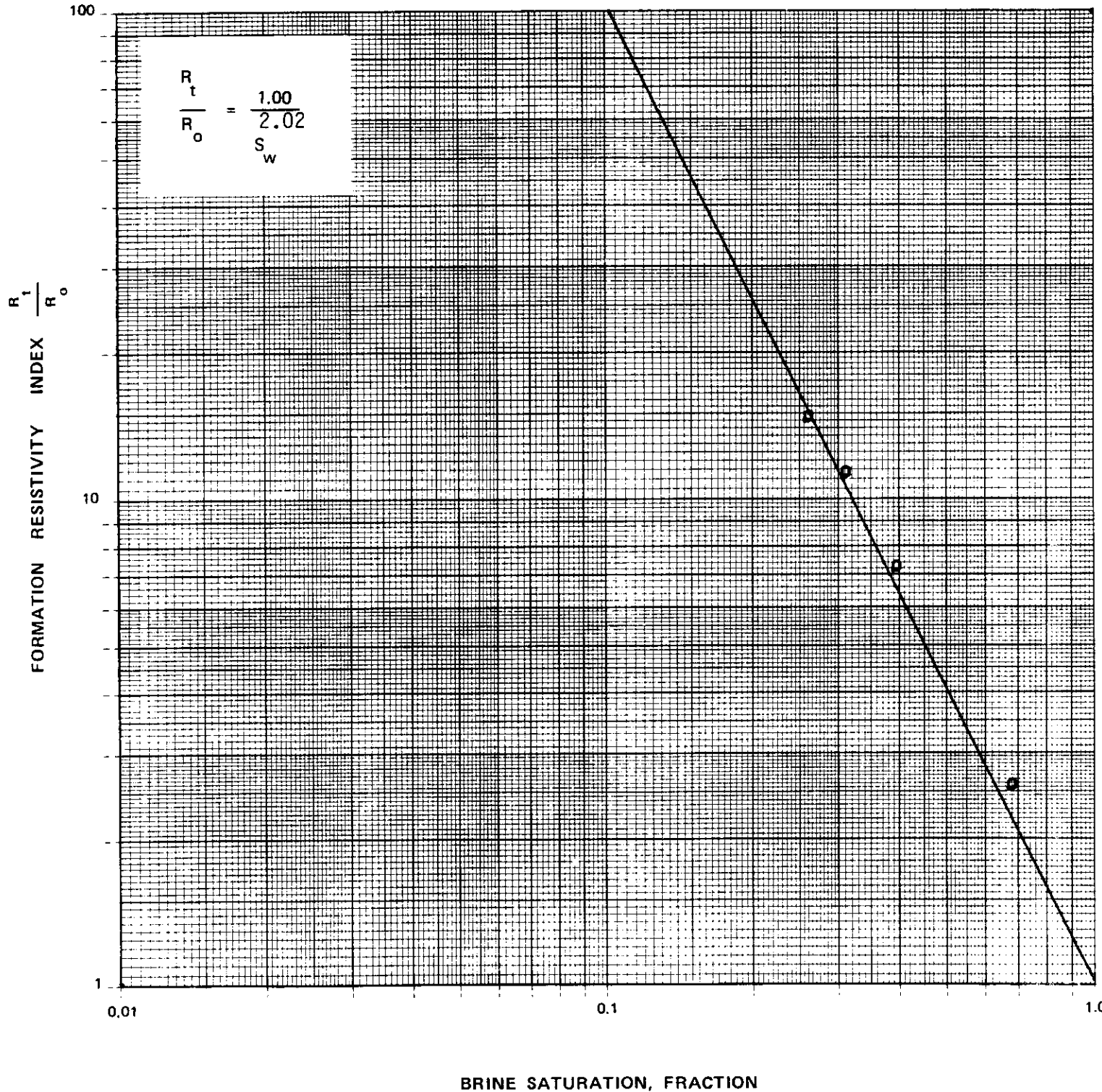
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 71/16-22

Porosity, Fraction 0.221

Permeability, Millidarcys: 92.7



FORMATION RESISTIVITY INDEX

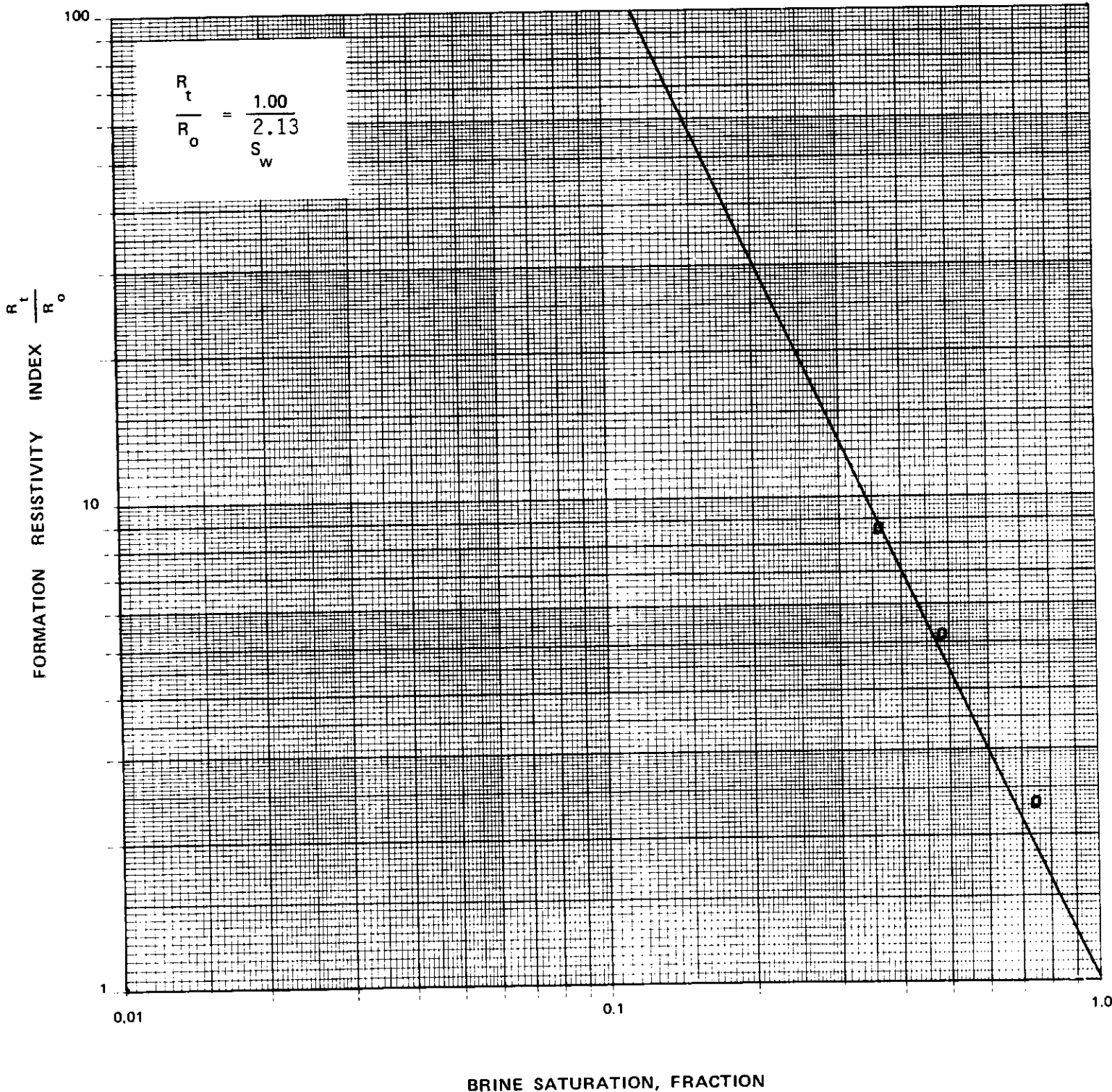
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada Prov 16-22-1-26
LOCATION LSD 16-22-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 73/16-22

Porosity, Fraction 0.207

Permeability, Millidarcys: 16.5



FORMATION RESISTIVITY INDEX

FILE: 7009-312-82-04

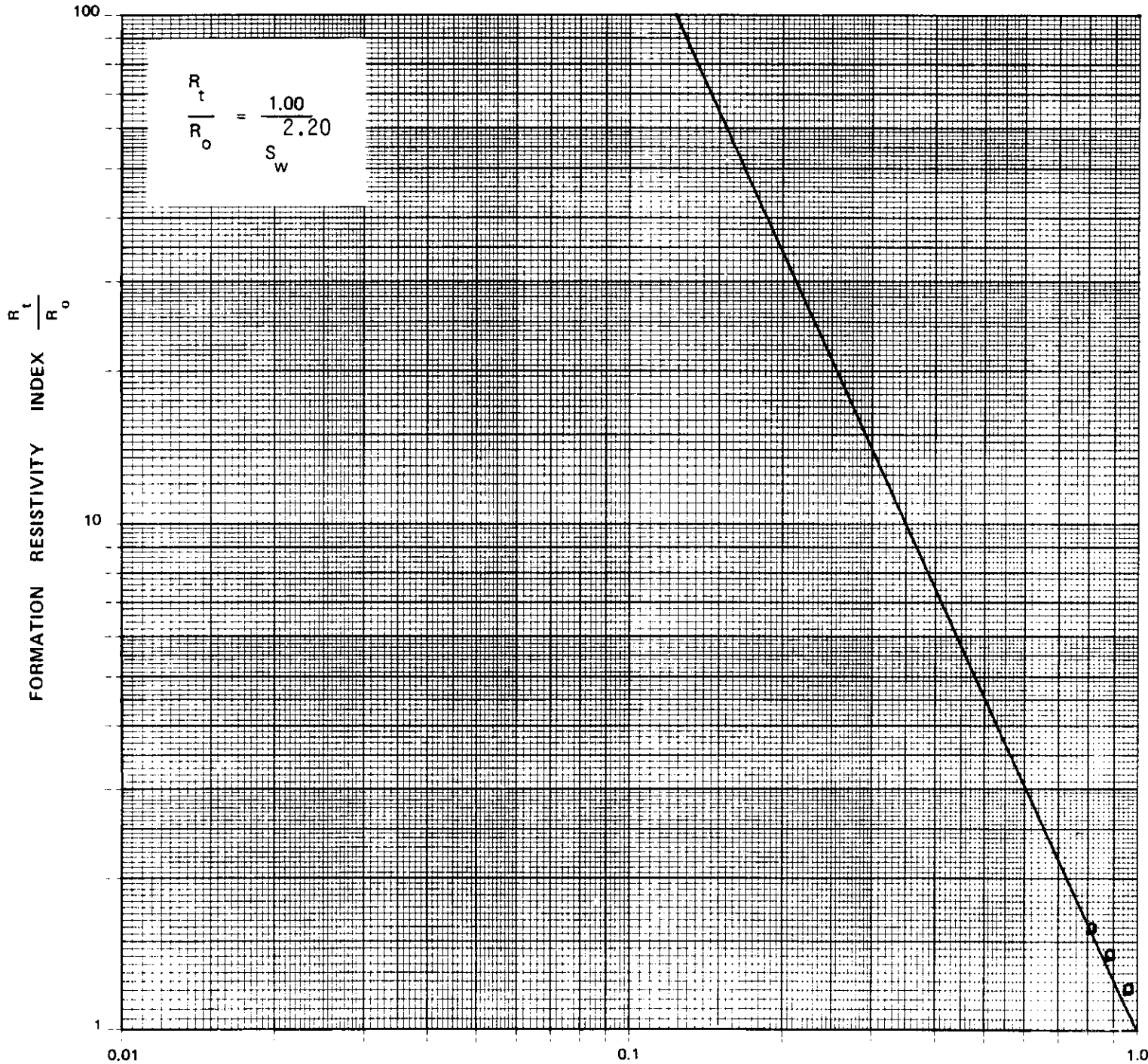
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 13/3-25

Porosity, Fraction 0.138

Permeability, Millidarcys: 0.70



BRINE SATURATION, FRACTION

FORMATION RESISTIVITY INDEX

FILE: 7009-312-82-04

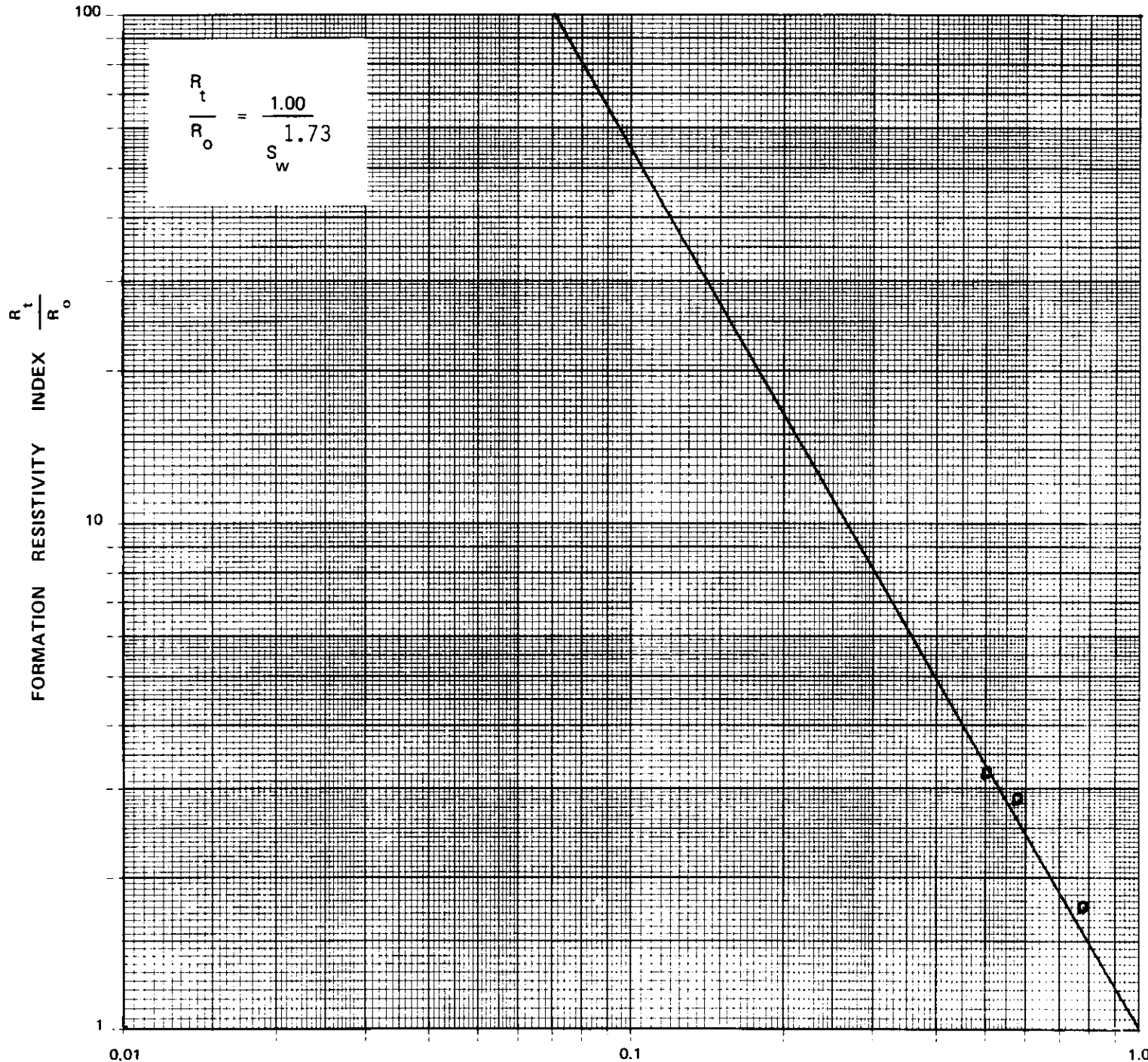
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SAMPLE 64/3-25

Porosity, Fraction 0.149

Permeability, Millidarcys: 3.66



BRINE SATURATION, FRACTION

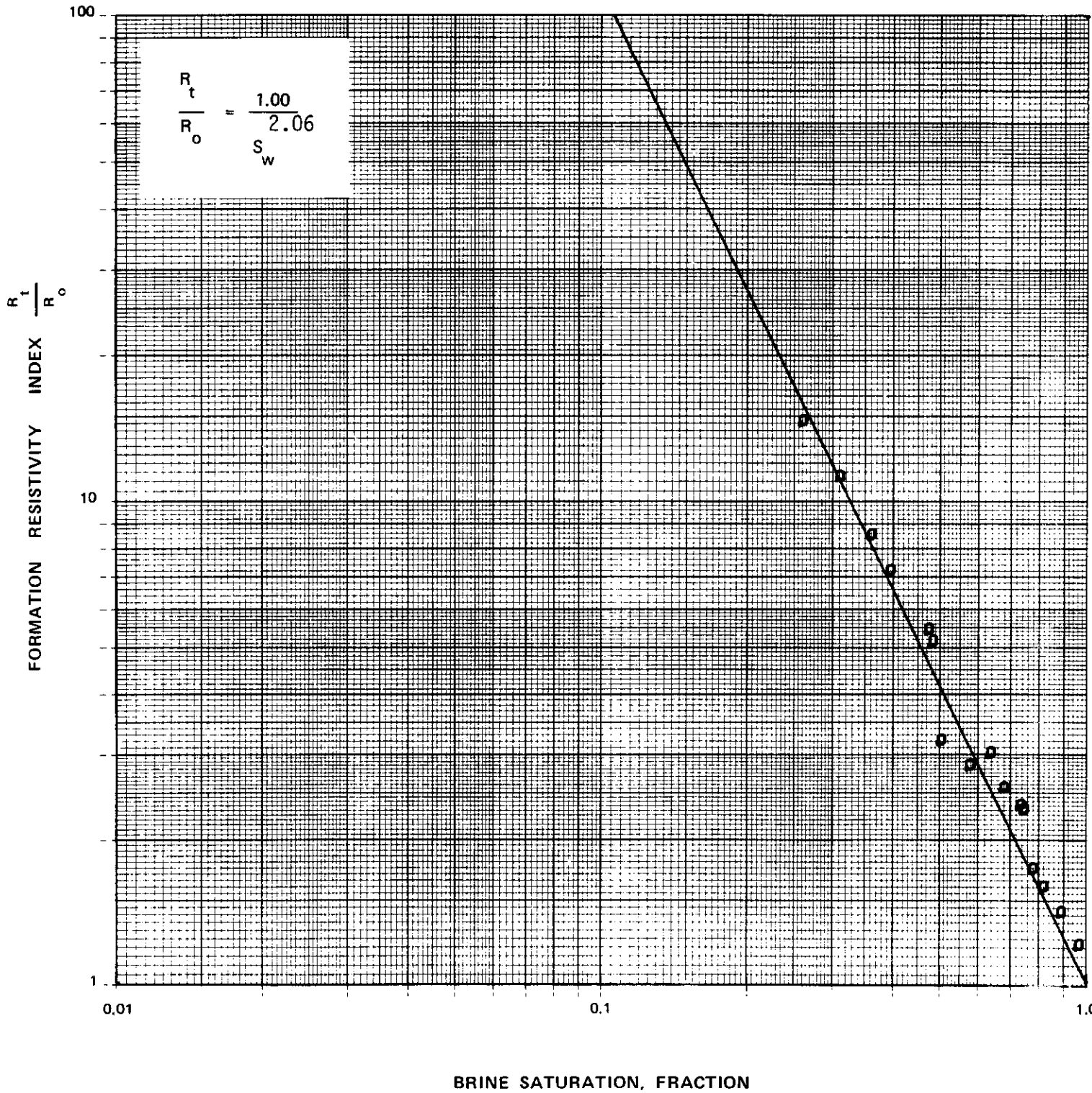
FORMATION RESISTIVITY INDEX

FILE: 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

COMPOSITE PLOT





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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

OVERBURDEN FORMATION RESISTIVITY FACTOR DATA

SATURANT: 92 400 ppm T.D.S. Simulated Formation brine

RESISTIVITY OF SATURANT: 0.106 Ohm-metres at 25° C

PORE PRESSURE, kPa (gauge): 1 400

EFFECTIVE OVERBURDEN PRESSURE, kPa (guage)
0 1 400 11 930
FORMATION RESISTIVITY FACTOR

<u>SAMPLE NUMBER</u>	<u>PERMEABILITY MILLIDARCYS</u>	<u>POROSITY FRACTION</u>
--------------------------	-------------------------------------	------------------------------

Omega Waskada Prov 16-22-1-26 W1M

62/16-22	6.41	0.193	17.1	32.0	35.8
71/16-22	92.7	0.221	10.9	17.6	18.5
73/16-22	16.5	0.207	13.2	21.8	24.1

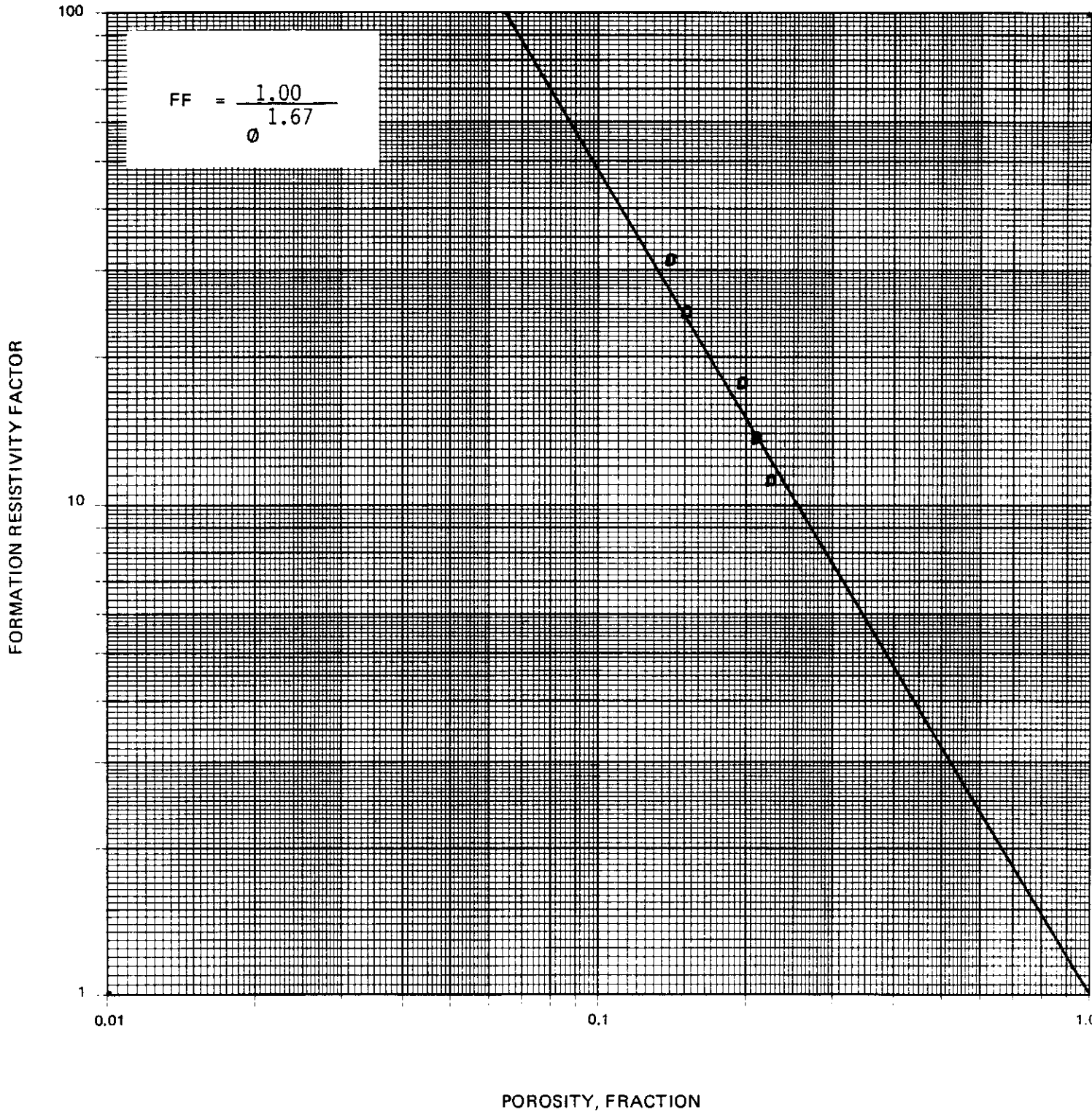
Omega Waskada 3-25MC3A-1-26 W1M

13/3-25	0.70	0.138	30.6	46.8	47.9
64/3-25	3.66	0.149	23.9	37.2	40.7

COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

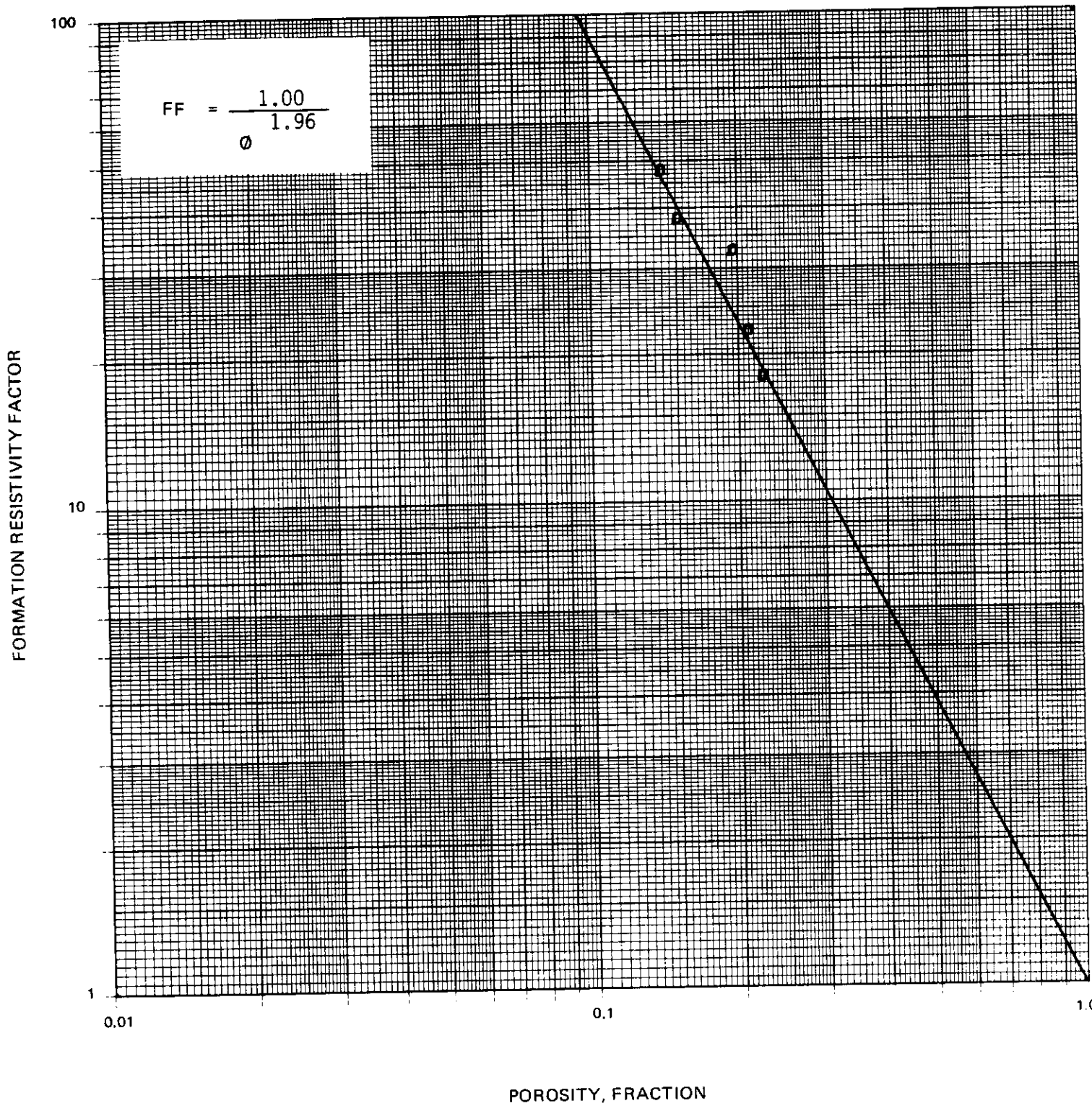
Effective Overburden Pressure, kPa (gauge):0



COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

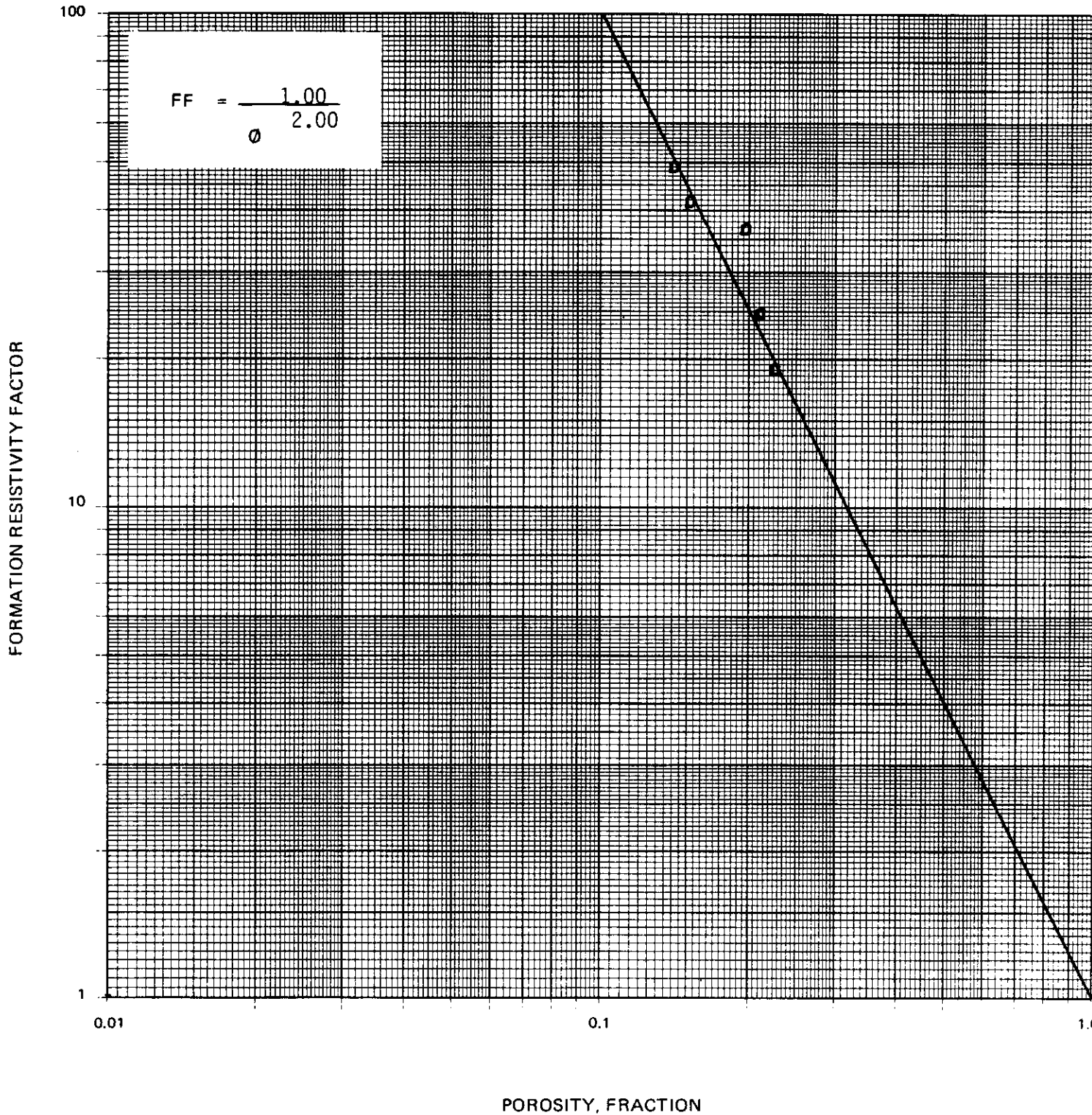
Effective Overburden Pressure, kPa (gauge): 1 400



COMPANY Omega Hydrocarbons Ltd.
WELL
LOCATION

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Effective Overburden Pressure, kPa (gauge): 11 930





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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Alberta

LIQUID PERMEABILITY DATA

Sample Number: P-5B/3-25

POROSITY, FRACTION: 0.239
AIR PERMEABILITY, mD: 40.2
GRAIN DENSITY, kg/m³: 2690

LIQUID PERMEABILITY MILLIDARCYS

THROUGHPUT PORE VOLUME

LIQUID/AIR PERMEABILITY RATIO

92 400 ppm I.D.S. Simulated Formation brine

1.35	0	0.034
2.10	1.1	0.052
3.25	2.2	0.081
3.89	3.3	0.097
4.25	5.5	0.106
4.64	10.9	0.115
5.48	16.4	0.136
5.72	21.9	0.142
6.61	32.8	0.164
5.57	38.2	0.139
5.13	43.7	0.128
4.26	49.2	0.106
3.61	54.6	0.090
2.90	60.1	0.072
2.32	65.6	0.058
1.50	71.0	0.037
1.06	80.9	0.026
1.00	90.7	0.025
13.2	Reverse	0.328

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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

LIQUID PERMEABILITY DATA

Sample Number: P-10/3-25

POROSITY, FRACTION: 0.124
AIR PERMEABILITY, mD: 0.52
GRAIN DENSITY, kg/m³: 2720

<u>LIQUID PERMEABILITY MILLIDARCYS</u>	<u>THROUGHPUT PORE VOLUME</u>	<u>LIQUID/AIR PERMEABILITY RATIO</u>
92 400 ppm T.D.S. Simulated Formation brine		
0.005	0	0.010
0.007	0.5	0.013
0.008	1.0	0.015
0.011	6.1	0.021
0.012	7.3	0.023
0.012	9.8	0.023
0.012	11.0	0.023
0.012	13.4	0.023
0.015	Reverse	0.029



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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

GAS-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-8/3-25

INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.224

AIR PERMEABILITY, mD: 18.9

POROSITY, FRACTION: 0.118

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 10.7

<u>GAS SATURATION, FRACTION PORE SPACE</u>	<u>GAS-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO GAS*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.000	0.000	0.000	1.000
0.060	0.038	0.022	0.589
0.074	0.057	0.028	0.490
0.085	0.080	0.034	0.424
0.096	0.107	0.040	0.373
0.125	0.224	0.064	0.287
0.151	0.385	0.091	0.236
0.181	0.643	0.122	0.190
0.212	1.08	0.148	0.137
0.244	1.91	0.185	0.097
0.281	4.00	0.224	0.056
0.303	6.68	0.262	0.039
0.328	12.1	0.306	0.025
0.352	22.0	0.356	0.016
0.378	43.4	0.395	0.0091

*Relative to Oil Permeability.

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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

GAS-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-13/3-25 INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.205

AIR PERMEABILITY, mD: 6.06
POROSITY, FRACTION: 0.136

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 1.94

<u>GAS SATURATION, FRACTION PORE SPACE</u>	<u>GAS-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO GAS*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.000	0.000	0.000	1.000
0.074	0.017	0.012	0.693
0.102	0.037	0.021	0.557
0.115	0.055	0.026	0.467
0.135	0.102	0.036	0.347
0.157	0.195	0.054	0.277
0.177	0.322	0.069	0.214
0.203	0.617	0.095	0.154
0.225	1.03	0.115	0.111
0.242	1.54	0.143	0.093
0.268	2.77	0.175	0.063
0.297	5.53	0.225	0.041
0.323	10.1	0.274	0.027
0.340	15.3	0.322	0.021
0.360	24.3	0.374	0.015
0.370	36.7	0.425	0.012

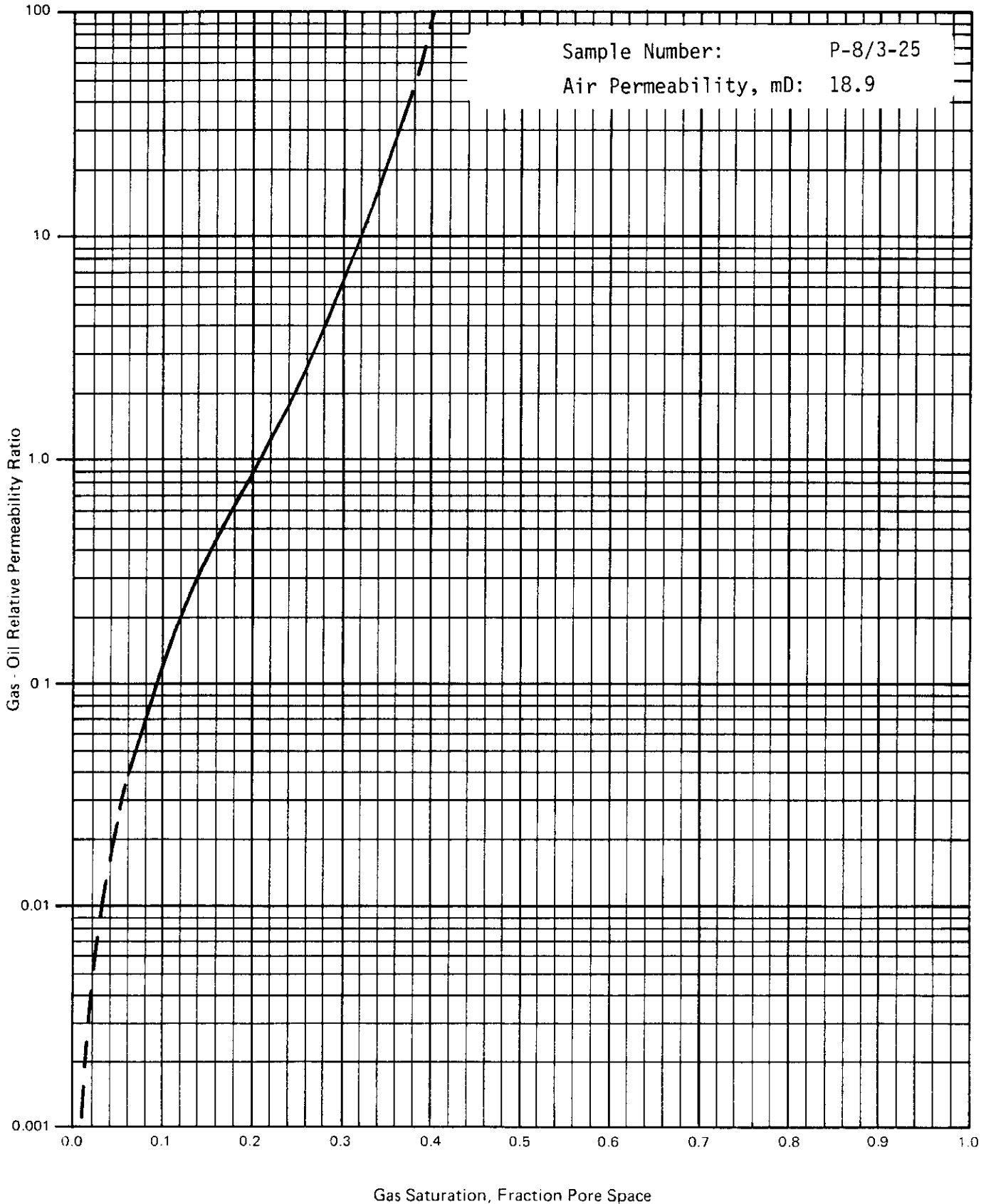
*Relative to Oil Permeability.

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories - Canada Ltd. (all errors and omissions excepted); but Core Laboratories - Canada Ltd. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitability of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

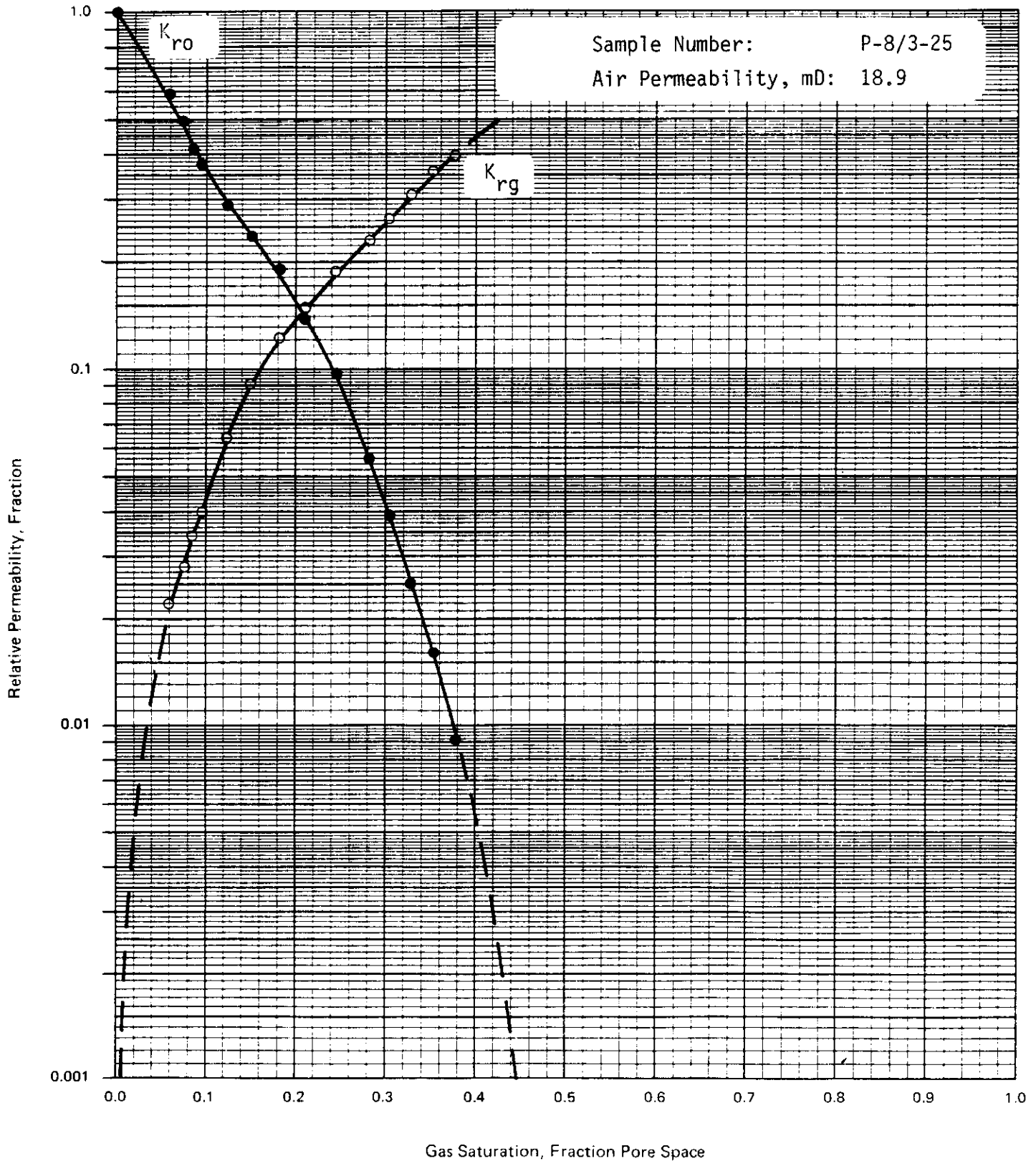
Sample Number: P-8/3-25
Air Permeability, mD: 18.9



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

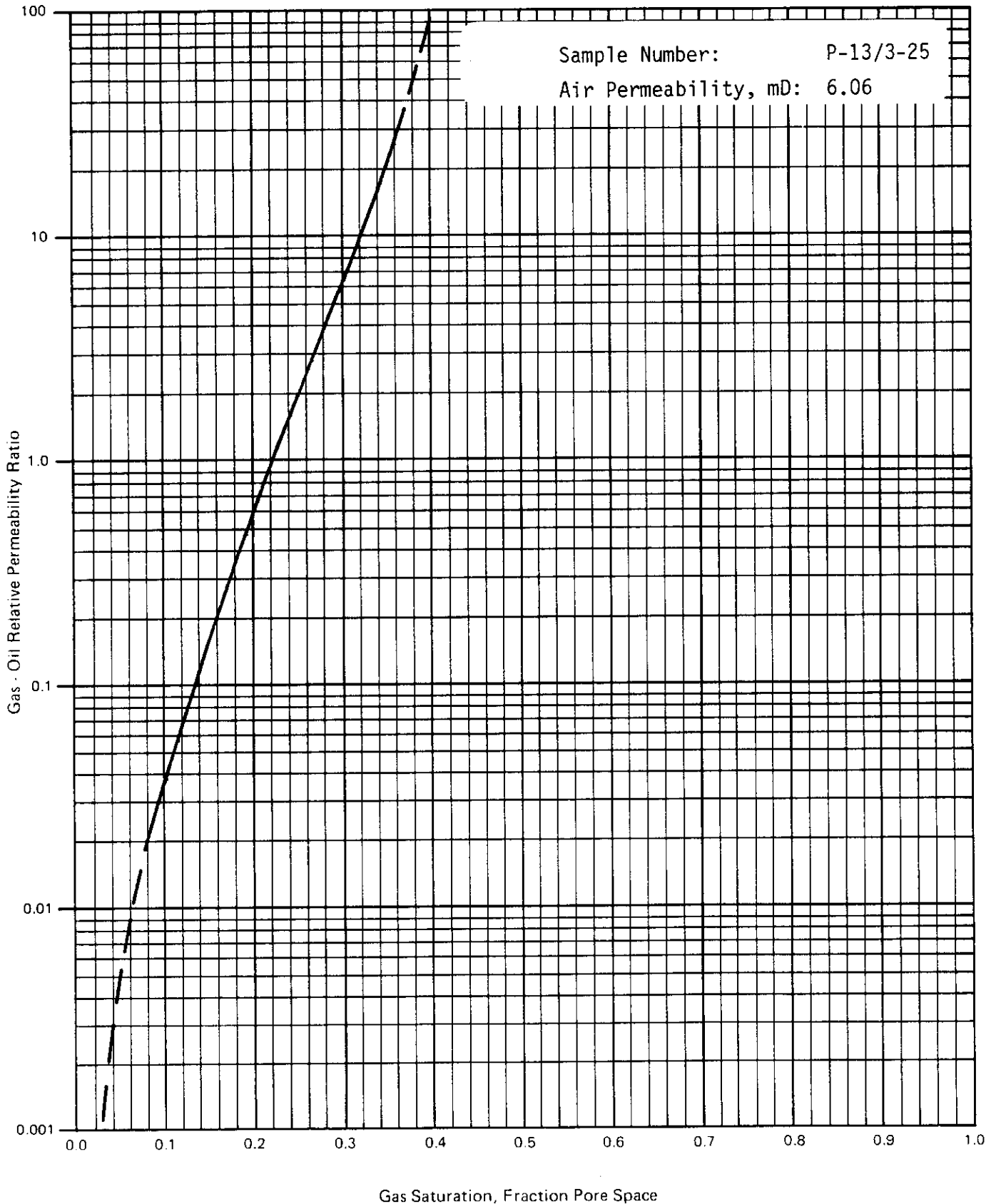
Sample Number: P-8/3-25
Air Permeability, mD: 18.9



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION
FIELD Waskada
PROVINCE Manitoba

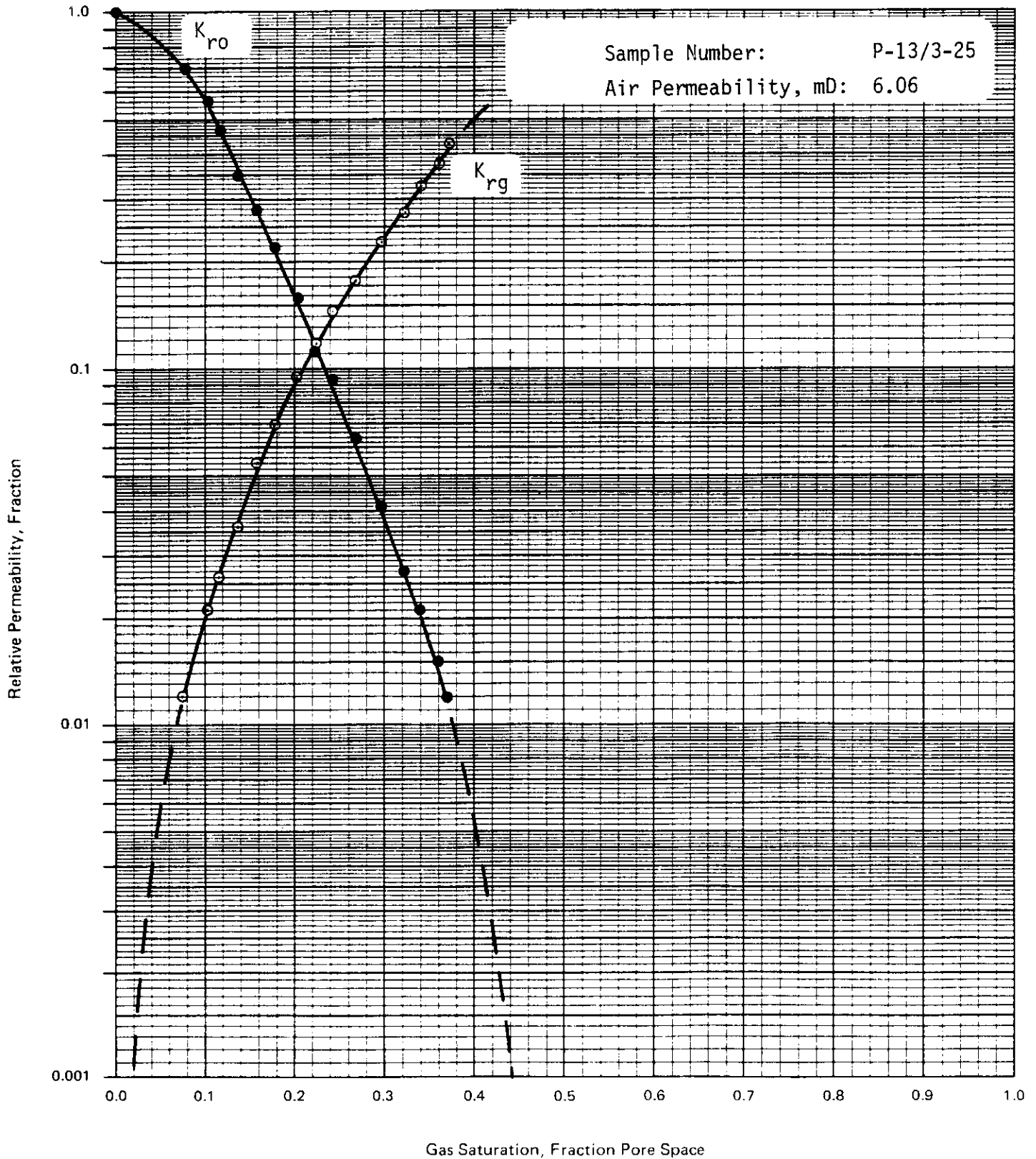
Sample Number: P-13/3-25
Air Permeability, mD: 6.06



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Sample Number: P-13/3-25
Air Permeability, mD: 6.06





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FILE 7009-312-82-040
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M
FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

SUMMARY OF ROOM CONDITION WATER-OIL RELATIVE PERMEABILITY TEST RESULTS

SAMPLE NUMBER	DEPTH METRES	AIR PERMEABILITY MILLIDARCYS	POROSITY FRACTION	INITIAL CONDITIONS			TERMINAL CONDITIONS			OIL RECOVERED	
				WATER SATURATION FRACTION PORE SPACE	OIL PERMEABILITY MILLIDARCYS		SATURATION FRACTION PORE SPACE	WATER PERMEABILITY MILLIDARCYS		FRACTION PORE SPACE	FRACTION OIL IN PLACE
P-5A/3-25	906.40	74.7	0.241	0.201	49.5		0.247	16.5		0.552	0.691
P-8/3-25	907.33	18.9	0.118	0.224	11.0		0.138	3.19(3.55)**		0.638	0.822
P-12/3-25	918.99	11.0	0.172	0.375	4.20		0.225	0.28(0.59)**		0.400	0.779
P-13/3-25	919.22	6.06	0.136	0.205	2.39		0.225	0.53(0.64)**		0.570	0.717
P-14/3-25	919.65	1.30	0.111	0.373	0.21		0.172	0.057		0.455	0.746

** Flow measured in reverse direction

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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

WATER-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-5A/3-25

INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.201

AIR PERMEABILITY, mD: 74.7

POROSITY, FRACTION: 0.241

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 49.5

<u>WATER SATURATION FRACTION PORE SPACE</u>	<u>WATER-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO WATER*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.201	0.000	0.000	1.000
0.399	0.148	0.058	0.390
0.415	0.179	0.059	0.330
0.444	0.259	0.063	0.242
0.467	0.356	0.065	0.183
0.485	0.462	0.067	0.144
0.496	0.557	0.068	0.122
0.522	0.840	0.070	0.084
0.555	1.49	0.075	0.050
0.576	2.25	0.080	0.036
0.588	2.84	0.084	0.030
0.603	3.83	0.091	0.024
0.631	7.00	0.107	0.015
0.663	14.9	0.132	0.0088
0.685	26.6	0.153	0.0057
0.702	43.5	0.185	0.0042
0.718	71.6	0.211	0.0029
0.731	122	0.232	0.0019
0.753	-----	0.333	-----

*Relative to Oil Permeability.

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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

WATER-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-8/3-25

INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.224

AIR PERMEABILITY, mD: 18.9

POROSITY, FRACTION: 0.118

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 11.0

<u>WATER SATURATION FRACTION PORE SPACE</u>	<u>WATER-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO WATER*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.224	0.000	0.000	1.000
0.385	0.786	0.157	0.199
0.411	1.15	0.186	0.161
0.427	1.45	0.208	0.144
0.440	1.72	0.225	0.131
0.453	2.01	0.239	0.119
0.467	2.37	0.251	0.106
0.480	2.78	0.261	0.094
0.504	3.72	0.282	0.076
0.527	4.73	0.300	0.063
0.570	7.22	0.314	0.044
0.641	14.3	0.321	0.022
0.720	35.7	0.319	0.0089
0.758	65.4	0.314	0.0048
0.774	85.3	0.310	0.0036
0.789	108	0.306	0.0028
0.806	145	0.303	0.0021
0.862	-----	0.290	-----

*Relative to Oil Permeability.

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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

WATER-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-12/3-25

INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.375

AIR PERMEABILITY, mD: 11.0

POROSITY, FRACTION: 0.172

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 4.20

<u>WATER SATURATION FRACTION PORE SPACE</u>	<u>WATER-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO WATER*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.375	0.000	0.000	1.000
0.555	0.317	0.030	0.096
0.576	0.422	0.030	0.071
0.595	0.555	0.030	0.054
0.610	0.706	0.030	0.043
0.621	0.842	0.030	0.036
0.643	1.23	0.031	0.025
0.677	2.39	0.034	0.014
0.701	4.12	0.040	0.0096
0.729	7.29	0.050	0.0069
0.775	25.6	0.067	0.0026

*Relative to Oil Permeability.

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CALGARY, ALBERTA



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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

WATER-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-13/3-25

INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.205

AIR PERMEABILITY, mD: 6.06

POROSITY, FRACTION: 0.136

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 2.39

<u>WATER SATURATION FRACTION PORE SPACE</u>	<u>WATER-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO WATER*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.205	0.000	0.000	1.000
0.373	0.195	0.034	0.174
0.402	0.279	0.039	0.138
0.427	0.383	0.043	0.111
0.477	0.790	0.052	0.066
0.505	1.26	0.060	0.048
0.530	1.93	0.071	0.037
0.559	3.18	0.087	0.027
0.599	6.54	0.106	0.016
0.624	10.5	0.134	0.013
0.652	16.8	0.153	0.0091
0.694	39.3	0.177	0.0045
0.719	73.9	0.205	0.0028
0.739	123	0.221	0.0018
0.775	-----	0.221	-----

*Relative to Oil Permeability

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FILE 7009-312-82-040

COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

WATER-OIL RELATIVE PERMEABILITY DATA

SAMPLE NUMBER: P-14/3-25

INITIAL WATER SATURATION,
FRACTION PORE SPACE: 0.373

AIR PERMEABILITY, mD: 1.30

POROSITY, FRACTION: 0.111

OIL PERMEABILITY AT
INITIAL WATER SATURATION, mD: 0.21

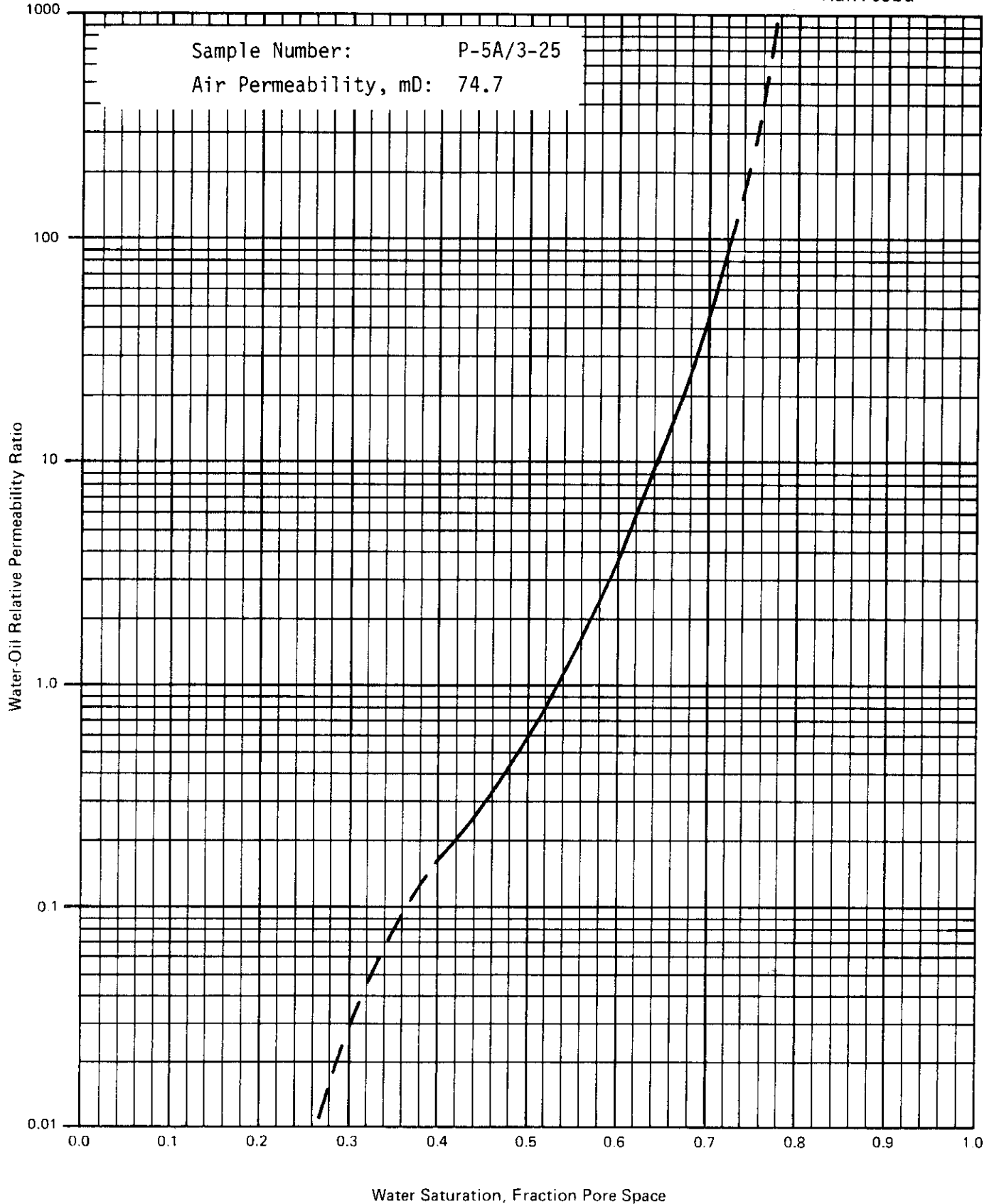
<u>WATER SATURATION FRACTION PORE SPACE</u>	<u>WATER-OIL RELATIVE PERMEABILITY RATIO</u>	<u>RELATIVE PERMEABILITY TO WATER*, FRACTION</u>	<u>RELATIVE PERMEABILITY TO OIL*, FRACTION</u>
0.373	0.000	0.000	1.000
0.481	0.139	0.043	0.308
0.527	0.288	0.056	0.196
0.553	0.465	0.066	0.143
0.588	0.964	0.087	0.090
0.613	1.61	0.106	0.066
0.645	3.11	0.130	0.042
0.673	5.64	0.152	0.027
0.706	10.5	0.181	0.017
0.741	21.1	0.206	0.0097
0.775	43.9	0.225	0.0051
0.802	98.1	0.253	0.0026
0.828	324	0.272	0.00084

*Relative to Oil Permeability

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COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

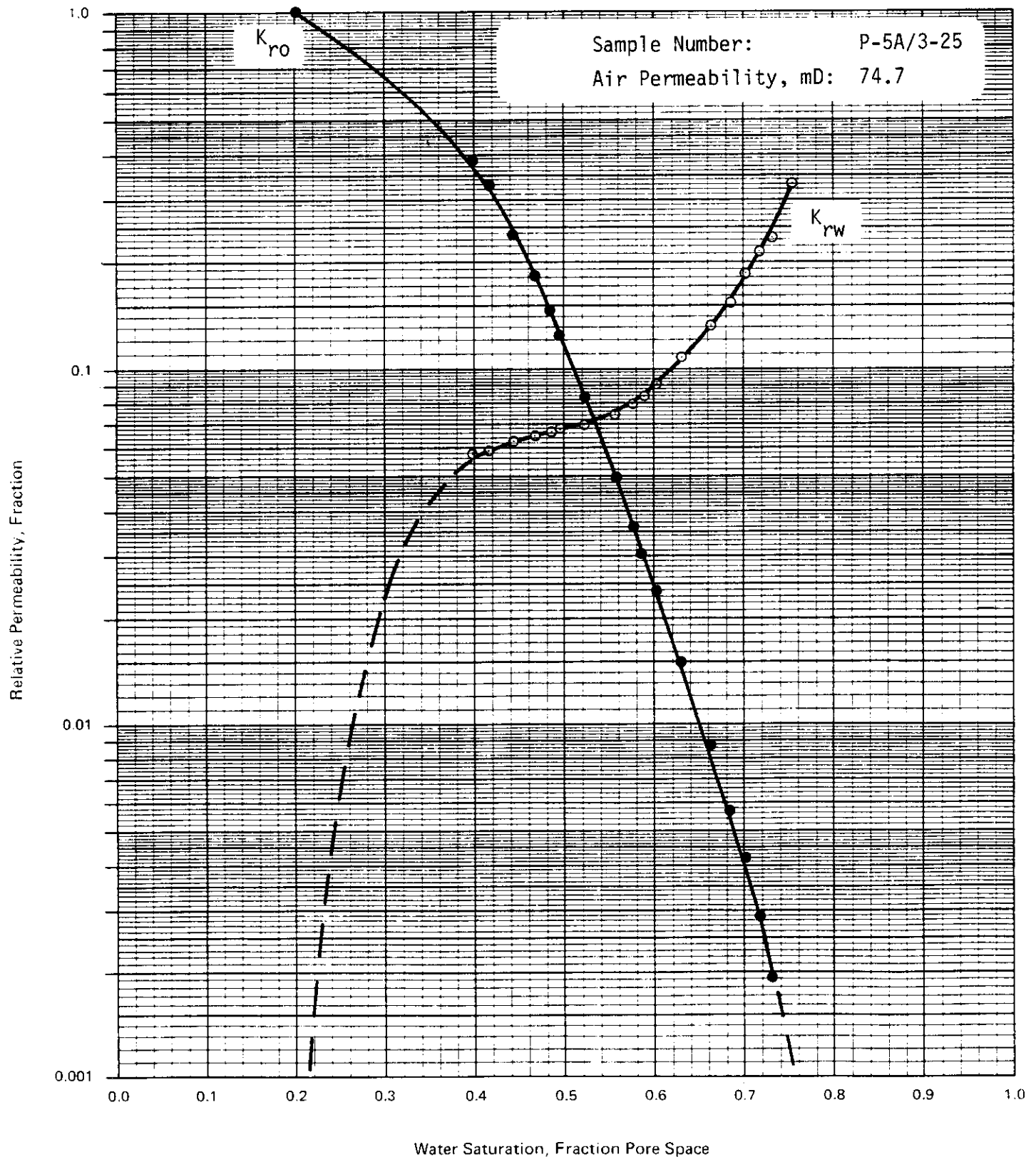
FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

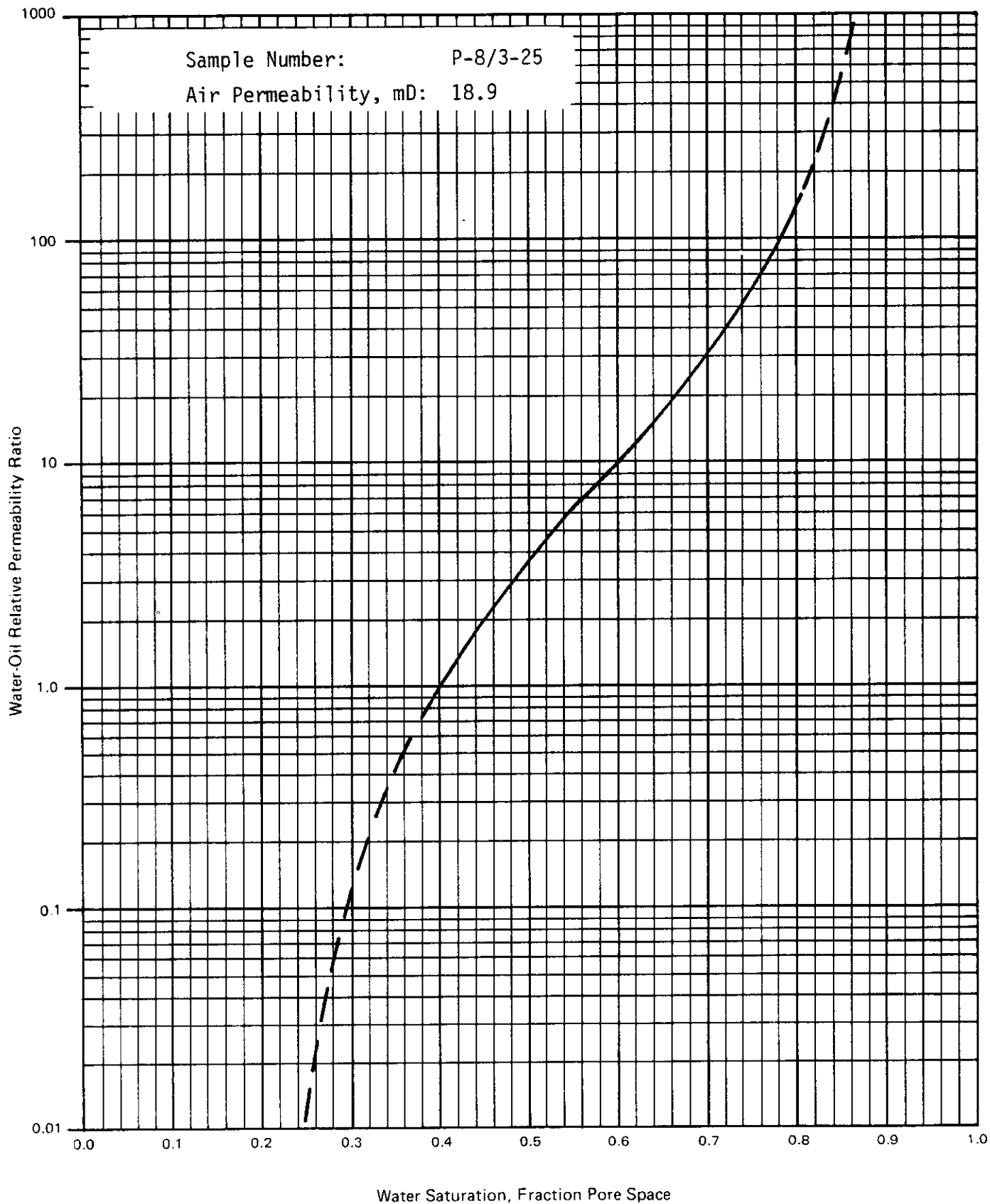
FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Sample Number: P-5A/3-25
Air Permeability, mD: 74.7



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

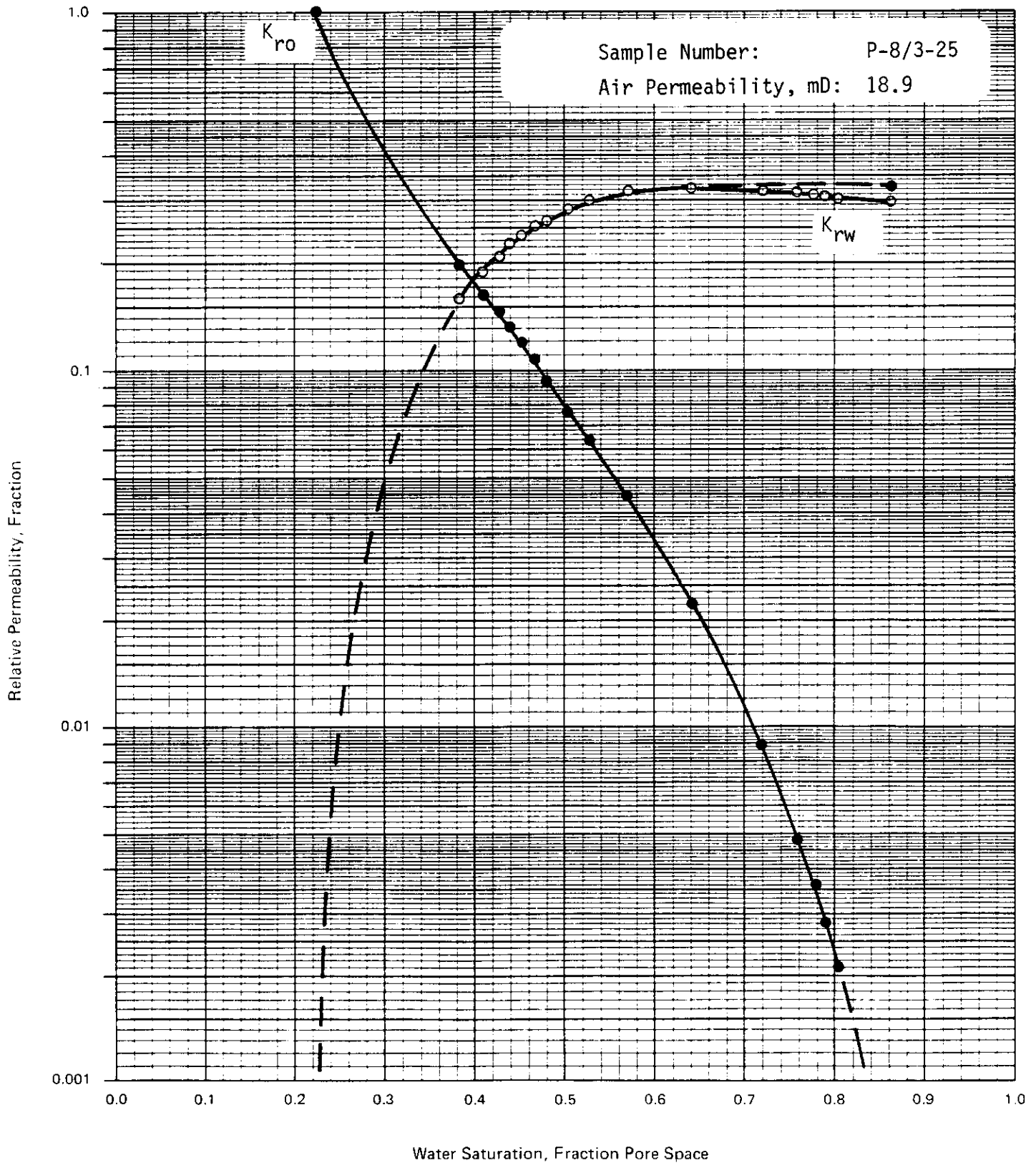
FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

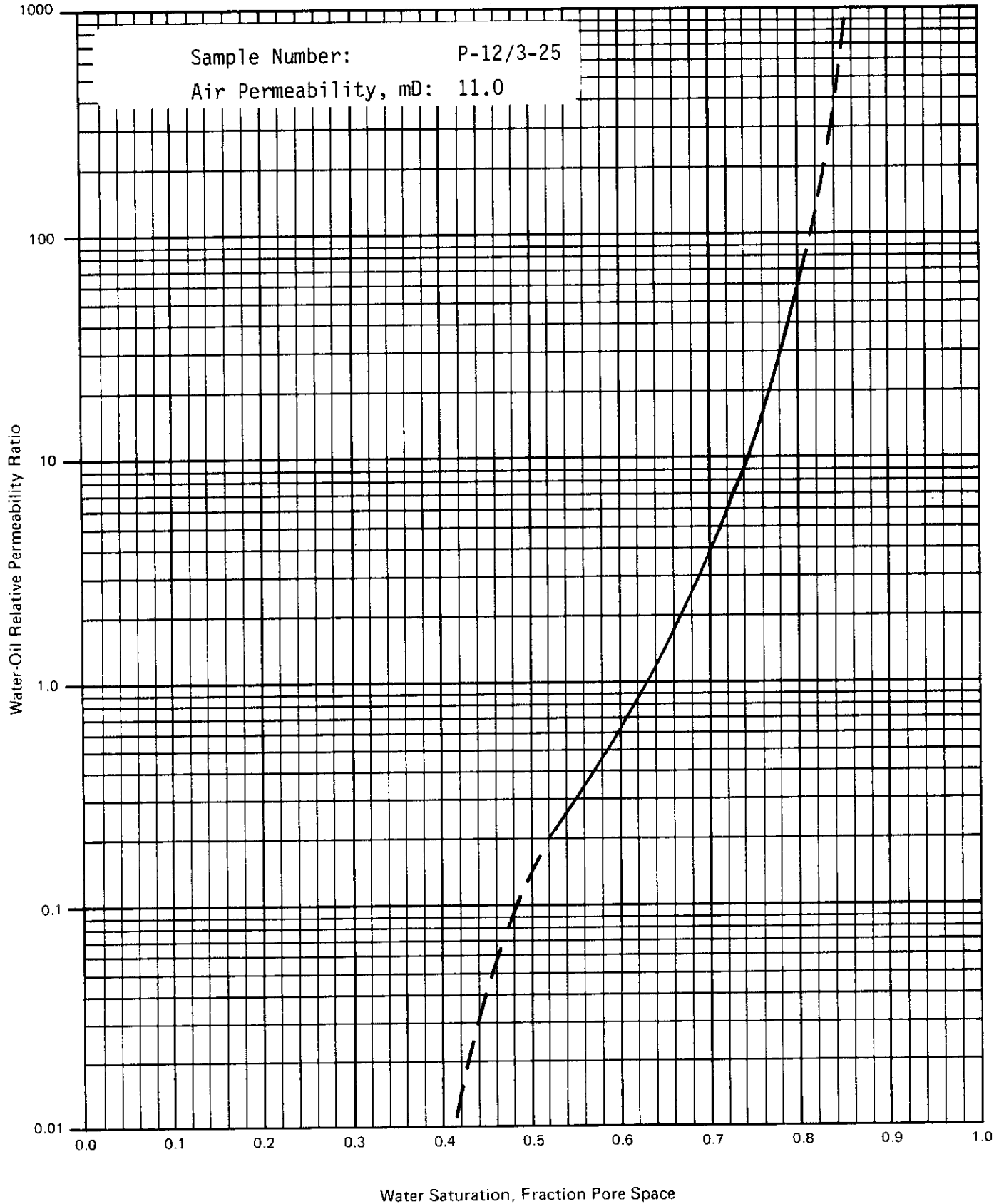
FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Sample Number: P-8/3-25
Air Permeability, mD: 18.9



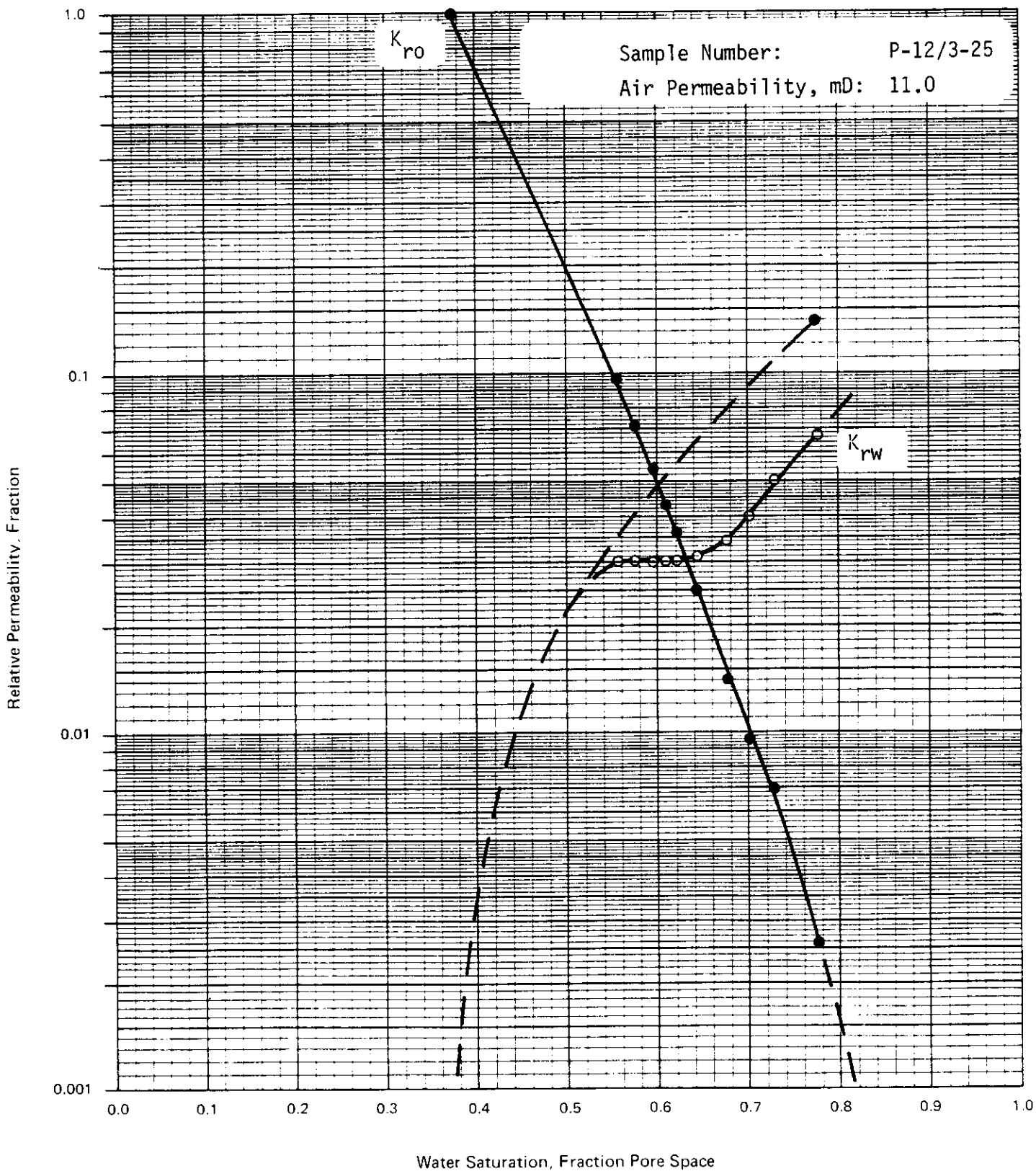
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



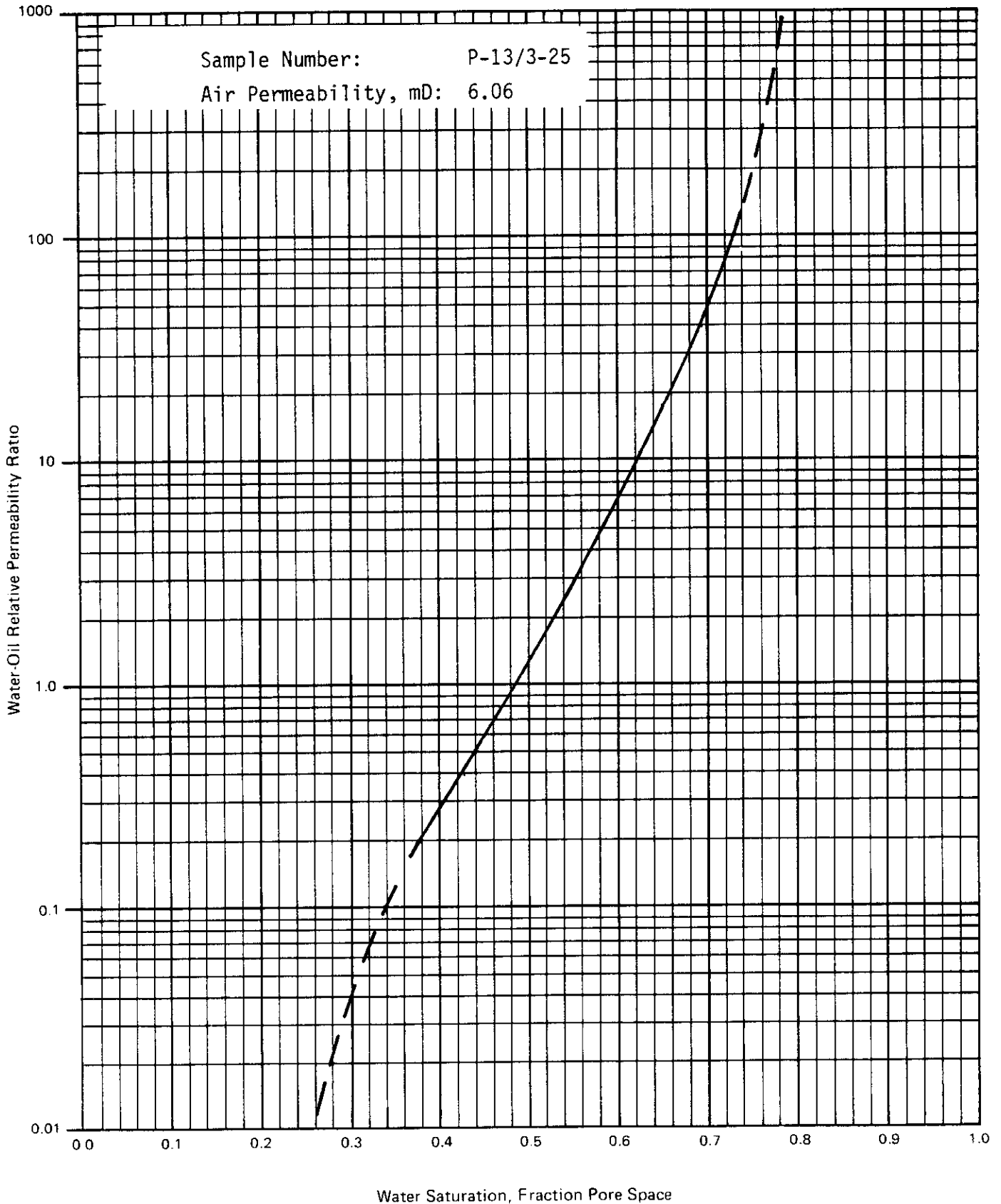
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



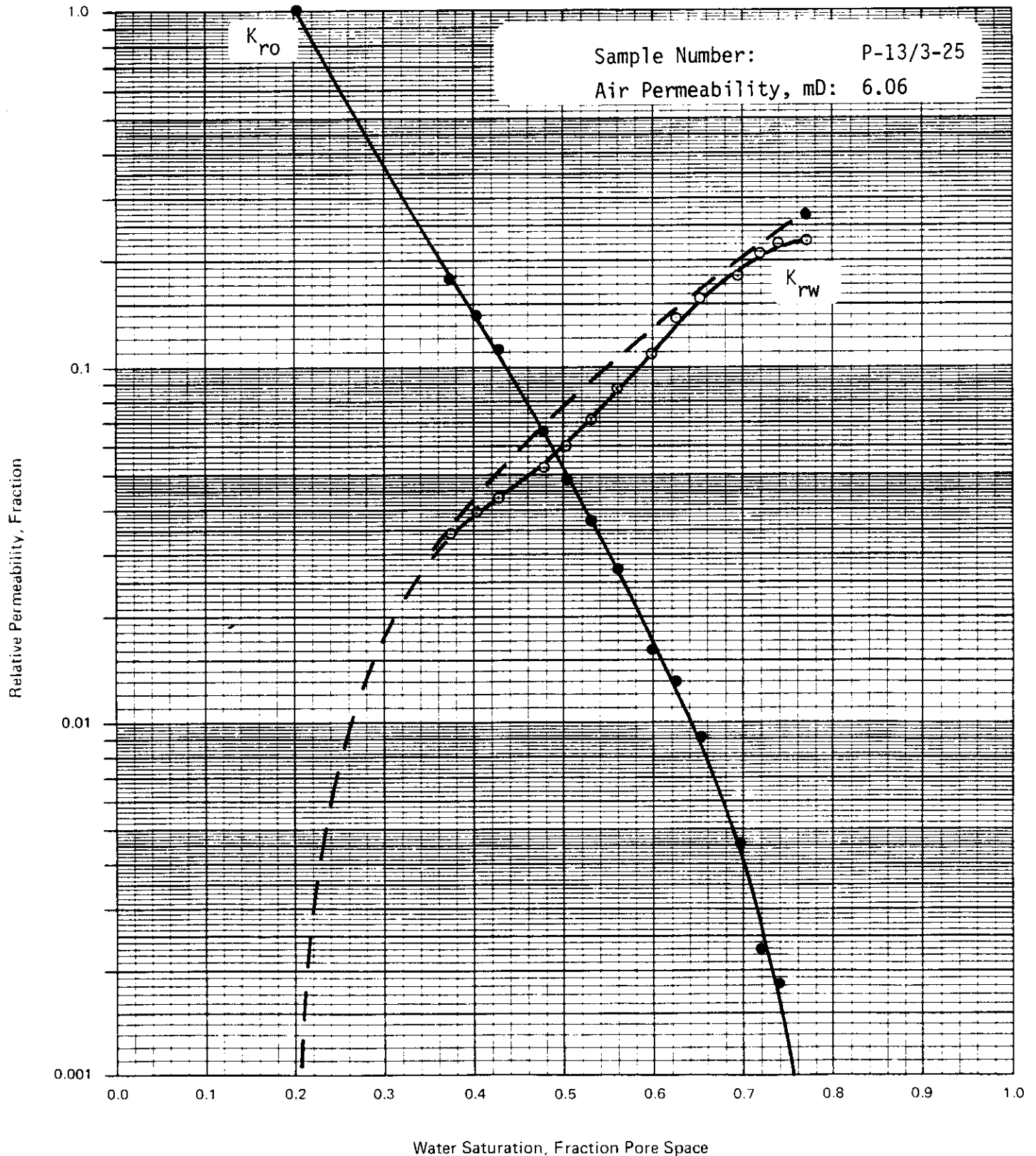
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WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



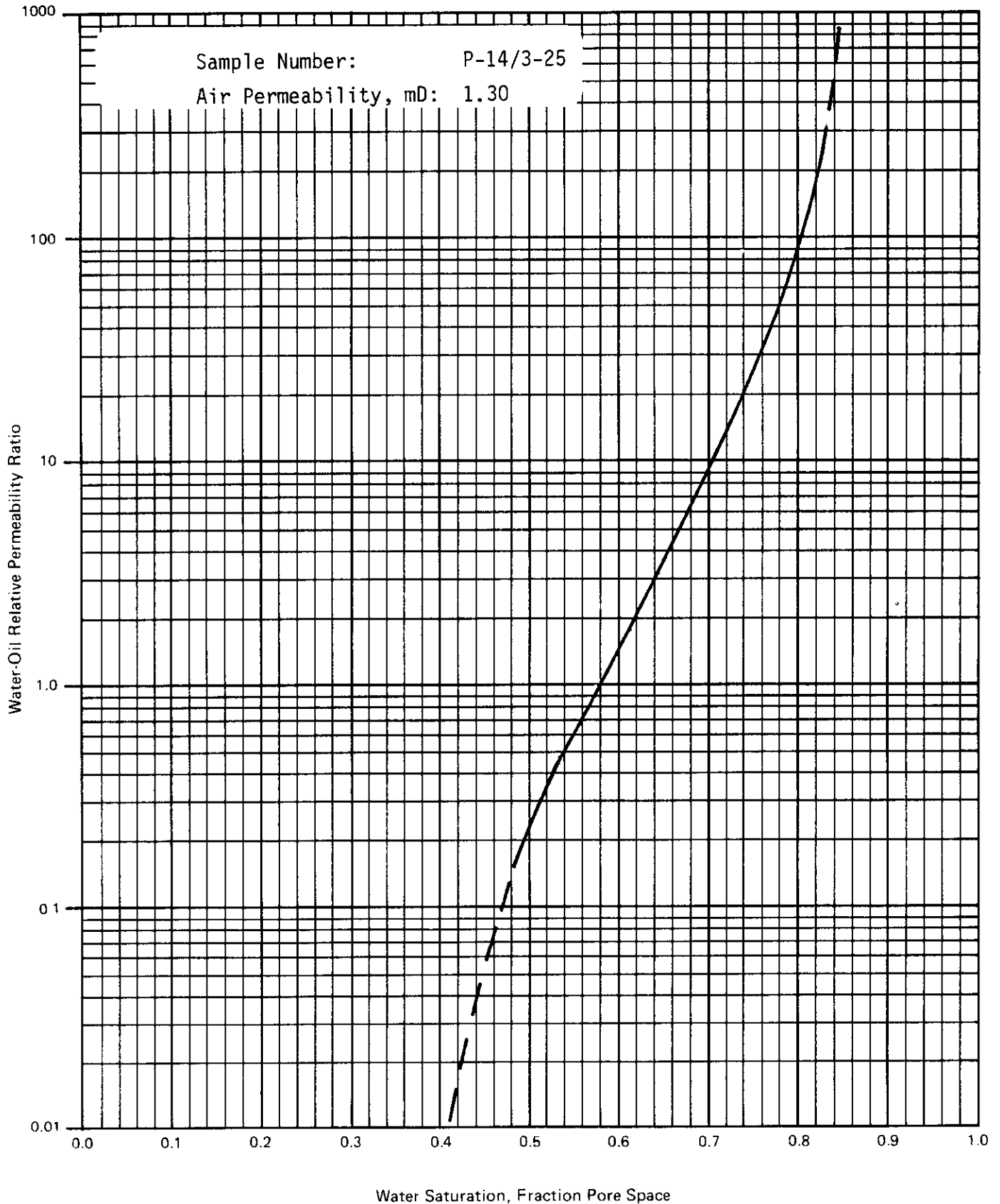
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



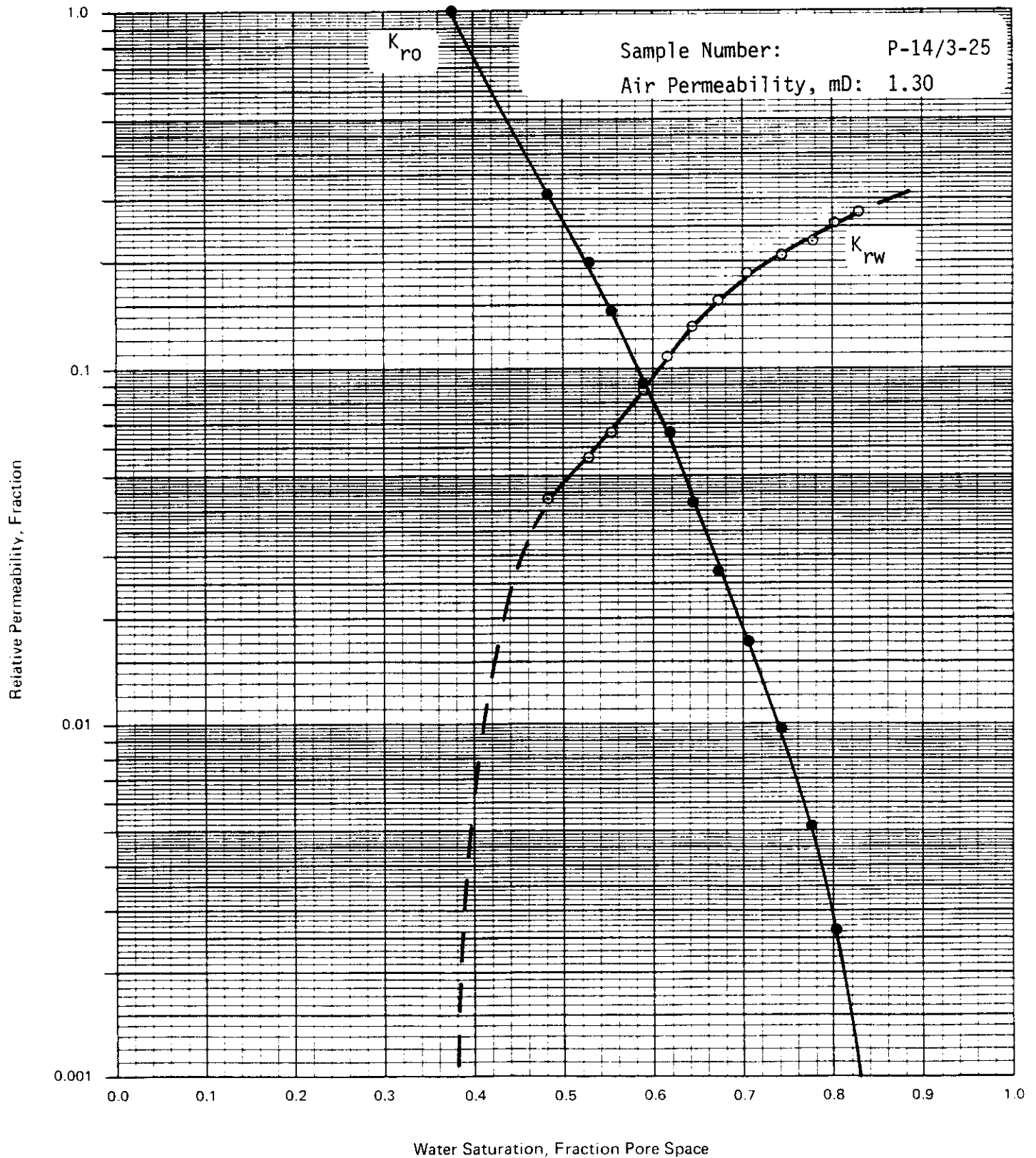
COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



COMPANY Omega Hydrocarbons Ltd.
WELL Omega Waskada 3-25MC3A-1-26
LOCATION LSD 3-25-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba



Special Core Analysis Study
for
CHEVRON CANADA RESOURCES LIMITED
Chevron Waskada 15-1-1-26 W1M
Spearfish Formation
Manitoba

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1984 02 21

Chevron Canada Resources Limited
500 - Fifth Avenue S.W.
Calgary, Alberta
T2P 0L7

Attention: Mr. Gerry Gunning

Gentlemen

SUBJECT: Overburden Formation Resistivity Factor Measurements
Chevron Waskada 15-1-1-26 W1M
Our File Number: 7009-312-83-126

As requested in a conversation between Mr. Gerry Gunning and Mr. Nestor Cebuliak on November 28, 1983, and in subsequent telephone conversations, Overburden Formation Resistivity Factor Tests were performed on 8 core plugs from the Spearfish Formation of the subject well.

Samples used in this study are lithologically described and identified as to sample number, depth interval, permeability to air, Boyle's Law porosity and grain density on pages 1 and 2.

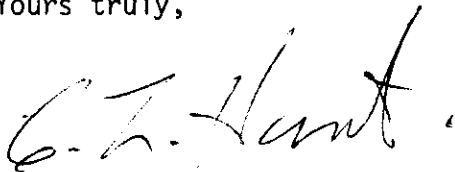
Cylindrical core plugs, 38 mm in diameter, were drilled from weathered, full diameter core pieces using 60 000 ppm T.D.S. brine as the bit lubricant and coolant. The brine was comprised of Sodium Chloride, Calcium Chloride and Calcium Sulfate. The samples were then extracted with toluene in a Soxhlet apparatus to remove all hydrocarbons, leached of inorganic salts with methanol and dried in vacuum oven at 85°C. Permeability to air, Boyle's Law porosity, using helium as the gaseous medium, and grain density values were then determined for each of the cleaned and dried core plugs. Due to the poor quality of the core material, the majority of the samples were fractured and therefore, permeability to air values could not be determined. Test results are tabulated on pages 1 and 2. Sample numbers preceded by an asterisk indicate those not used for subsequent analysis.

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In preparation for Overburden Formation Resistivity Factor Measurements, 8 core plugs were evacuated and pressure-saturated with 104 495 ppm T.D.S. simulated formation brine with a resistivity of 0.073 Ohm-metres at 25°C. The brine was synthesized from a water analysis of the Chevron Waskada 10-1-1-26 W1M well. The chemical constituents of the brine are presented on page 3. Electrical resistivities of both the brine and the brine saturated core plugs were measured. These measurements were repeated over a period of several days until the resistivities stabilized, indicating ionic equilibrium had been attained within the core plugs. Electrical resistivities of the samples were then determined under a simulated formation overburden pressure of 12 400 kPa. The electrical properties determined at overburden pressure conditions were derived from sample resistance measured in a hydrostatic core holder using an improved laboratory technique which incorporates the use of a silver membrane on the end of the sample and silver plated electrodes. The resulting formation resistivity factor values were plotted versus porosity values determined at the same pressure. Results of the overburden formation resistivity factor tests are tabulated on page 4 and graphically illustrated on pages 5 through 7.

We appreciate the opportunity to be of service to Chevron Canada Resources Limited. Should you have any questions pertaining to these test results or if we may be of further assistance, please do not hesitate to contact us.

Yours truly,

A handwritten signature in black ink, appearing to read "C. L. Hunt". The signature is fluid and cursive, with a large initial "C" and "H".

C. L. (Clay) Hunt

CC:jjm



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PAGE 1 of 7

FILE 7009-312-83-126

COMPANY Chevron Canada Resources Limited
WELL Chevron Waskada 15-1-1-26
LOCATION LSD 15-1-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

IDENTIFICATION OF SAMPLES

<u>SAMPLE NUMBER</u>	<u>DEPTH METRES</u>	<u>PERMEABILITY MILLIDARCYS</u>	<u>POROSITY FRACTION</u>	<u>GRAIN DENSITY kg/m³</u>	<u>LITHOLOGICAL DESCRIPTION</u>
*37	910.40	0.39	0.125	2760	SST: brn, wl ind, vf gr, mod srt, sh, dol, anhy
*40	911.28	0.68	0.166	2730	SST: tn, wl ind, vf gr, wl srt, sh, dol
*42	911.80	0.23	0.114	2740	SST: brn, wl ind, vf-f gr, mod srt, sh, dol
*44	912.22	**N/A	0.177	2720	SST: grysh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*47	913.00	**N/A	0.140	2740	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*48	913.26	**N/A	0.153	2760	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*49	913.41	**N/A	0.162	2720	SST: grysh-tn, wl ind, vf gr, wl srt, sh, dol, frac
*51	913.95	**N/A	0.159	2740	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*52	914.28	**N/A	0.187	2730	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*55	915.97	0.94	0.159	2720	SST: gnsh-gry, wl ind, vf gr, wl srt, sh, dol
*56	916.27	**N/A	0.187	2720	SST: gnsh-gry, wl ind, vf gr, wl srt, sh, dol, frac
*58	916.66	**N/A	0.135	2770	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*60	917.37	**N/A	0.122	2790	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, anhy, frac
*61	917.59	**N/A	0.163	2730	SST: grnsh-gry, wl ind, vf gr, mod srt, sh, dol, frac
*67	918.97	**N/A	0.180	2720	SST: grnsh-gry, wl ind, vf gr, wl srt, sh, dol, frac

* Samples not used for subsequent analysis

** Not available due to sample fracture

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CALGARY, ALBERTA



PAGE 2 of 7

FILE 7009-312-83-126

COMPANY Chevron Canada Resources Limited
WELL Chevron Waskada 15-1-1-26
LOCATION LSD 15-1-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

IDENTIFICATION OF SAMPLES (Continued)

<u>SAMPLE NUMBER</u>	<u>DEPTH METRES</u>	<u>PERMEABILITY MILLIDARCYS</u>	<u>POROSITY FRACTION</u>	<u>GRAIN DENSITY kg/m³</u>	<u>LITHOLOGICAL DESCRIPTION</u>
*77	921.80	**N/A	0.178	2710	SST: grnsh-gry, wl ind, vf gr, wl srt, sh, dol, frac
*78	922.16	0.019	0.131	2770	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, anhy
*79	922.79	5.89	0.152	2730	SST: grnsh-gry, wl ind, vf-f gr, mod srt, sh, dol
*80	923.04	**N/A	0.157	2730	SST: grnsh-gry, wl ind, vf gr, mod srt, sh, dol, frac
*82	923.74	**N/A	0.189	2690	SST: grnsh-gry, wl ind, vf gr, mod srt, sh, dol, frac
*83	924.06	**N/A	0.207	2700	SST: grnsh-gry, wl ind, vf gr, mod srt, sh, dol, frac
*84	924.42	**N/A	0.212	2700	SST: grnsh-gry, wl ind, vf gr, mod srt, sh, dol, frac
*86	925.33	**N/A	0.126	2760	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, frac
*87	925.49	**N/A	0.125	2760	SST: grysh-brn, wl ind, vf gr, wl srt, sh, dol, Fe-st, frac
*88	925.79	0.55	0.130	2740	SST: grysh-brn, wl ind, vf gr, mod srt, sh, dol
*90	926.49	0.070	0.088	2780	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, anhy
*91	926.79	**N/A	0.116	2760	SST: brn, wl ind, vf gr, wl srt, sh, dol, anhy, frac
*95	928.36	**N/A	0.134	2780	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, anhy, frac
*96	928.69	0.069	0.084	2790	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, anhy
*97	929.23	**N/A	0.107	2800	SST: rdsh-brn, wl ind, vf gr, wl srt, sh, dol, anhy, frac

* Samples not used for subsequent analysis

** Not available due to sample fracture

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CORE LABORATORIES - CANADA LTD.
Petroleum Reservoir Engineering
CALGARY ALBERTA



Plastic

CONTAINER IDENTITY

WATER ANALYSIS

7009-312-83-126

7021-83-730

LABORATORY NUMBER

3 of 7

PAGE

Chevron Canada Resources Limited

OPERATOR

LSD 10-1-1-26 WPM

LOCATION

Chevron Waskada 10-1-1-26

WELL OR SAMPLE LOCATION NAME

Waskada, Manitoba

FIELD OR AREA

Spearfish

POOL OR ZONE

KB ELEV.

GRO. ELEV.

SAMPLER

TEST TYPE & NO.

TEST RECOVERY

Wellhead

POINT OF SAMPLE

AMT. & TYPE CUSHION

MUD RESISTIVITY @ °C

PUMPING

FLOWING

GAS LIFT

SWAB

WATER

m³/d

OIL

m³/d

GAS

m³/d

TEST INTERVALS OR PERFS.

SEPARATOR RESERVOIR

CONTAINER WHEN SAMPLED @ °C

CONTAINER WHEN RECEIVED @ °C

SEPARATOR

PRESSURES, kPa

TEMPERATURES, °C

83 12 15

83 12 16

LS

DATE SAMPLED (Y/M/D)

DATE RECEIVED (Y/M/D)

DATE ANALYSED (Y/M/D)

ANALYST

REMARKS

ION	mg/L	mg Fraction	MEQ/L
Na	37500.	0.3589	1631.1
K	272.	0.0026	7.0
Ca	2383.	0.0228	118.9
Mg	276.	0.0026	22.7
Ba			
Sr			
Fe	NOT DETECTED		

ION	mg/L	mg Fraction	MEQ/L
Cl	59942.	0.5736	1690.7
Br			
I			
HCO ₃	131.	0.0013	2.1
SO ₄	3992.	0.0382	83.2
CO ₃	0.	0.0000	0.0
OH	0.	0.0000	0.0
H ₂ S	NOT DETECTED		

TOTAL SOLIDS mg/L

BY EVAPORATION @ 110°C

BY EVAPORATION @ 180°C

104495.

AT IGNITION

CALCULATED

1.0755 @ 15.4°C
SPECIFIC GRAVITY

1.3490 @ 20.
REFRACTIVE INDEX

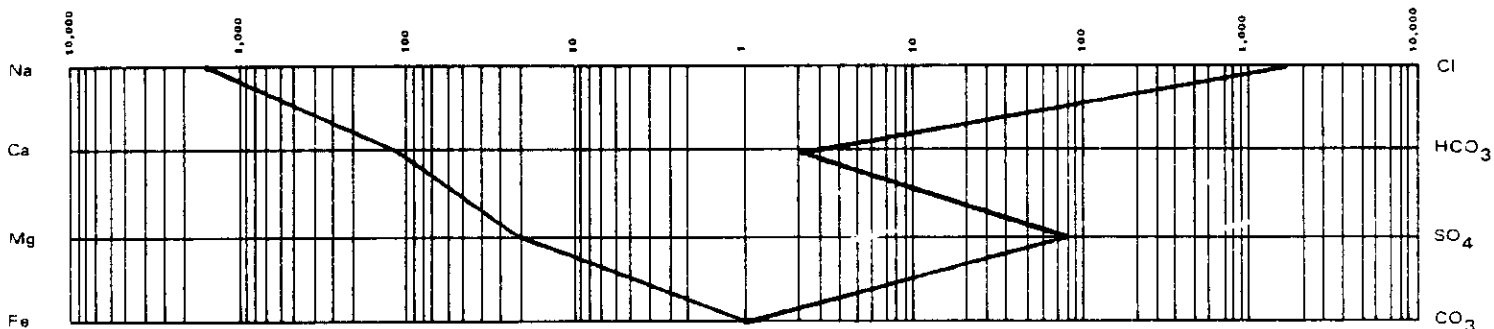
7.3

pH

0.073

@ 25°C
RESISTIVITY (OHM/METERS)

LOGARITHMIC PATTERN MEQ PER LITRE



REMARKS NaCl equiv. .102561.



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CALGARY, ALBERTA



PAGE 4 of 7

FILE 7009-312-83-126

COMPANY Chevron Canada Resources Limited

WELL Chevron Waskada 15-1-1-26

LOCATION LSD 15-1-1-26 W1M

FORMATION Spearfish

FIELD Waskada

PROVINCE Manitoba

OVERBURDEN FORMATION RESISTIVITY FACTOR DATA

SATURANT: 104 495 ppm T.D.S. Simulated Formation brine

RESISTIVITY OF SATURANT: 0.073 Ohm-metres at 25°C

PORE PRESSURE, kPa (gauge): 1 400

SAMPLE NUMBER	PERMEABILITY MILLIDARCYS	POROSITY FRACTION	*POROSITY FRACTION at 12 400 kPa	EFFECTIVE OVERBURDEN PRESSURE, kPa (guage)		
				0	1 400	12 400
FORMATION RESISTIVITY FACTOR						
42	0.23	0.114	0.108	45.8	57.3	69.3
44	**N/A	0.177	0.167	25.2	31.4	39.0
52	**N/A	0.187	0.177	24.8	30.0	37.3
55	0.94	0.159	0.149	31.7	40.2	50.3
79	5.89	0.152	0.143	34.7	37.7	45.9
80	**N/A	0.157	0.148	33.2	35.7	44.6
88	0.55	0.130	0.123	44.1	50.7	64.6
96	0.069	0.084	0.083	81.1	103	131

* Porosity determined at an effective overburden pressure of 12 400 kPa and plotted versus the formation resistivity factor determined at the same pressure

** Not available due to sample fracture

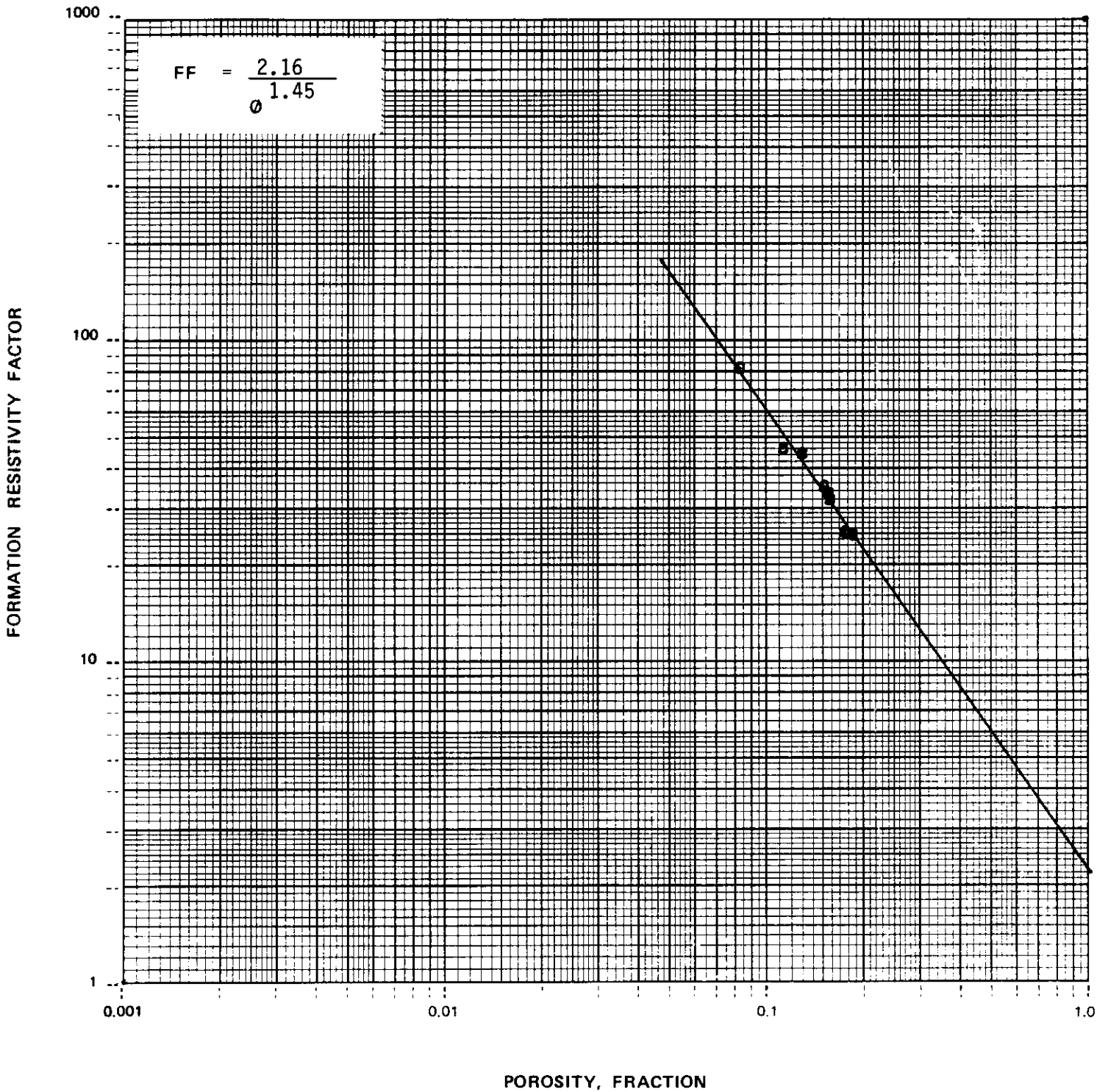
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FORMATION RESISTIVITY FACTOR

COMPANY Chevron Canada Resources Limited
WELL Chevron Waskada 15-1-1-26
LOCATION LSD 15-1-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Effective Overburden Pressure, kPa (gauge): 0

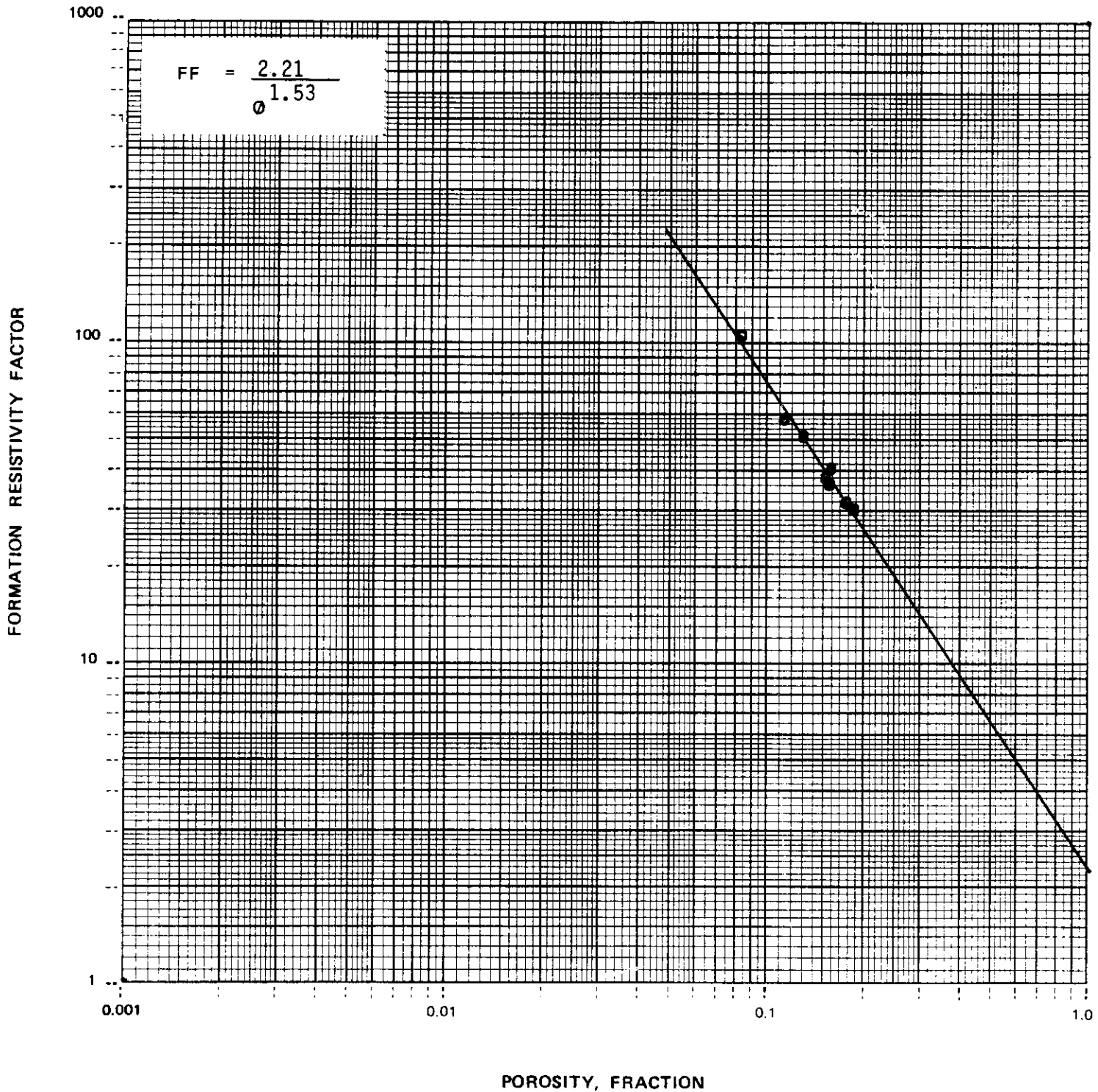


FORMATION RESISTIVITY FACTOR

COMPANY Chevron Canada Resources Limited
WELL Chevron Waskada 15-1-1-26
LOCATION LSD 15-1-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Effective Overburden Pressure, kPa (gauge): 1 400



FORMATION RESISTIVITY FACTOR

COMPANY Chevron Canada Resources Limited
WELL Chevron Waskada 15-1-1-26
LOCATION LSD 15-1-1-26 W1M

FORMATION Spearfish
FIELD Waskada
PROVINCE Manitoba

Effective Overburden Pressure, kPa (gauge): 12 400

