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Classification

4

Requested by

Subtitle

Evaluation of core data

Co-workers

Title

Statoil
Evaluation of core data

STATOIL 15/8-1
EXPLORATION & PRODUCTION
LABORATORY

Prepared		Approved	
8/7-82	K. Sørheim	8/7-82	Per Thomassen

Comments to Geco report from well 15/8-1

Routine and set I

The routine core measurements, (Klinkenberg corrected permeability, porosity and calculation of grain density for all plug samples and the measurements for set I seem reasonable. For a few samples low porosity gives high permeability and vice versa (15.1, 39.1, 51.1). This is due to grain size and cementation.

Set II

We asked for porosity by saturation technique for 3 samples (31.1, 51.1, 90.1). The report don't tell us that this is done. We can see from table (porosity recuction measured by brine with net overburden page 36) that reference porosity (10 bar) is the same as measured by Helium.

Set III

We asked for gas-perm. and porosity reduction as a function of overburden pressure. It is to be noted that the reference porosity (15 bar) is higher than the porosity measured for routine core measurements. These two have been measured with different techniques (page 40). The porosities obtained from conventional matrix cup measurements (grain volume measurement) are lower than what measured in the hydrostatic cell (pore volume Vp is directly measured). Page 40, 41 in the report show this difference, and the corrected table is on page 41.

All data in this report are presented as specified by Statoil Lab. in a letter to Geco 24/2-82.

10. Saturations Sw and Sxo.

Saturation was calculated from the North Sea equation with values of M = 1.7, N = 1.9 and A = 1 which were taken from special core analysis.

Method: The North Sea method is used for the calculation:

Sw: $1.0/(RT)^{1/2} = \left[VSH^{C}/\ RSH^{1/2} + PHIF^{M/2.0}/(A * RW)^{1/2}\right] * SW^{N/2.0}$

Sxo: $1.0/(Rxo)^{1/2} = \left[VSH^{C}/\ RSH^{1/2} + PHIF^{M/2.0}/(A * RMF)^{1/2}\right] * Sxo^{N/2.0}$

Input: The curves required for the calculation (RT, VSH, PHIF) are put in by the system as well as the constants 1.0, 2.0 and the square root function. The paramters RSH, M, N, A, RW and C are put in by the analyst.

11. Core data.

Standard core data, helium porosity, horizontal and vertical air permeability (Klinkenberg corrected) and grain density were available for all wells except 15/9-3.

Core porosity was depth correlated to log porosity and the other core data shifted by the same amount.

The log porosity was matched to this core porosity. Figure 5 in each interval of the results section shows this match. Figures 9, 10, 11, 12 of the results general show a histogram match of log and core porosity and log and core density.

APPENDIX III

TECHNIQUE FOR PREDICTION OF CAPILLARY PRESSURE FROM LOG DATA

The J function equation is

$$J = \frac{0.218 \cdot Pc}{\gamma \cos\theta}\left(\frac{k}{\phi}\right)^{1/2}$$

Units used were

- Pc - capillary pressure (psi)
- γ - interfacial tension (dynes/cm)
- k - permeability (md)
- ϕ - porosity (fraction)
- θ - contact angle, degrees

The two J functions refered in the report Petrophysial Evaluation for 15/9-15/6 Volum 1. Febr. 1981 are now changed from

$J = 0.17\ Sw^{-2.788}$ to $J = 0.037\ Sw^{-2.788}$ k>75 md

$J = 0.78\ Sw^{-2.2}$ to $J = 0.017\ Sw^{-2.2}$ k<75 md

by the constant 0.218

No changes were made in the water saturation calculations Swpc.

$Swpc = \left(0.118\left(\frac{k}{\phi}\right)^{1/2} Pc\right)^{-0.359}$ k< 75 md

$Swpc = \left(0.0256\left(\frac{k}{\phi}\right)^{1/2} Pc\right)^{-0.455}$ k> 75 md

units used were:

- Pc - capillary pressure (psi)
- k - core measured permeability (md)
- ϕ - core measured porosity (fraction)
- ρw - water density (gm/cm^3)
- ρg - gas density (gm/cm^3)
- H - height above WOC (m)

$Pc = (\rho w - \rho g) \cdot g \cdot H$

The correlation to fit water saturations from core data to log saturations was now found to be:

$$Sw\ (corr\ Pc) = 1.60\ Swpc - 0.12$$

The results are shown in a log cross plot of Sw vs Swpc.

STATOIL

EVALUATION OF CORE DATA

WELL: 15/8-1

DATE: MAY 1982.

TABLE OF CONTENTS

GECO

COMMENTS.

PREPARATION.

The core sample analyses were performed on 2 3/4" by 1½" cylindrical plugs. The samples were extracted using methanol, followed by toluene and repeated with methanol.

The samples were dried in a humidity controlled cabinet at 60°C and 40% relative humidity.

Helium porosity and air permeability by multi-point technique corrected for Klinkenberg effects were measured.

SIMULATED FORMATION BRINE:

Na :	41 300	ppm
K :	1 470	ppm
Mg :	1 380	ppm
Ca :	4 750	ppm

These cation contents are achieved by mixing the chloride salts of the cations in the table above.

Physical properties of the solution at 23°C :

Density : 1.086 gr/cc

Viscosity: 1.17 cp

Resisitivity: 0.072 ohm-m

RESISTIVITY INDEX - CAPILLARY PRESSURE MEASUREMENTS.

Set 1 was 100% saturated with simulated formation brine.
The samples were desaturated in a porous plate cell by saturated air at 7 different pressure levels,up to 12 bar.
Stability time at each pressure level varied from 3 to 4 days.

The different water saturations were determined by the weight of the sample.

At the same time the resistivity index was measured using a frequency of $1KH_z$.
The Resistivity Index (Ri) equation.

$$Ri = b \cdot Sw^{-n}$$

has been evaluated both by weighted least square method (yielding b=1.00) and free least square method.
The forced fit is presented graphically.

INCREASING HYDROSTATIC PRESSURE MEASUREMENTS:

Set 2 was 100% saturated with simulated formation brine.
Applying increasing hydrostatic sleeve pressure, the formation resistivity factor, porosity and liquid permeability were measured simultaneously in a triaxial holder. To avoid effects of surface water on the plugs, the "atmospheric" pressure was set at 10 bar. A graduated pipette (Vol. 1,0 ml grad. 0.01 ml) was used to see when stability occured and to measure the pore volume reduction.

The formation resistivity factor was measured using a frequency of IK Hz.

The formation resistivity factor equation:

$$FF = a \cdot \phi^{-m}$$

has been evaluated both by weighted least squares method for each sleeve pressure. Also reported are a composite table and an evaluation of the equation using all the formation resistivity factors measured at atmospheric and "atmospheric" pressure. The forced fit curves are presented graphically.

Set 3 While applying increasing hydrostatic sleeve pressure, helium porosity and Klinkenberg corrected air permeability by multipoint technique were measured simultaneously in a triaxal holder.

Measurement procedure:

The sample was installed in a rubber sleeve, then placed tightly in a triaxial holder with confining liquid.

The hydrostatic pressure was increased to 15 bar ("atmospheric pressure") to avoid gas flow and volume between the sleeve wall and the sample.
A helium porosimeter and a permeameter were connected to the holder to measure pore volume by helium injection and the Klinkenberg corrected air permeability.
These measurements were repeated at hydrostatic pressures of 50,100,200 and 300 bar.

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Conclusion:

The results show that the porosities obtained at "atmospheric" pressure in the hydrostatic cell were higher than the porosities obtained from conventional matrix cup measurements. This is due to the fact that the hydrostatic cell measurement is dependent on the shape of the sample, while the matrix cup measurement is not dependent on sample shape.
We assumed the difference between the "atmospheric" pressure measurement and the matrix cup measurement to be constant at all pressure levels.
The hydrostatic cell porosities are reported both uncorrected and corrected to conventional matrix cup measurements.

For all hydrostatic pressure measurements the geometric factor (area/length) was corrected at confining pressure assuming the compression was the same in all direction.

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SAMPLE LIST

Well: 15/8-1

Sample no	Depth(m)	Set
15.1	3662.90	3
20.1	64.70	1
31.1	70.70	2
37.1	72.60	3
39.1	73.70	1
43.1	84.40	1
51.1	89.70	2
55.1	91.00	3
61.1	93.13	1
63.1	93.90	3
66.1	95.40	3
72.1	97.25	1
79.1	99.60	3
90.1	3704.00	2
93.1	05.10	1

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POROSITY AND GRAIN DENSITY

Sample no.	Helium Porosity %	Brine Sat. Porosity %	Grain Density
15.1	13.6		2.65
20.1	17.3		2.65
31.1	16.8	16.9	2.65
37.1	17.2		2.65
39.1	19.9		2.66
43.1	20.2		2.65
51.1	20.0	20.0	2.64
55.1	19.3		2.65
61.1	20.2		2.66
63.1	21.2		2.64
66.1	14.1		2.65
72.1	16.6		2.65
79.1	13.0		2.65
90.1	14.8	14.5	2.64
93.1	16.9		2.67

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KLINKENBERG CORRECTED AIR PERMEABILITY

Sample no.	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15.1	0.944	707	
	0.644	695	
	0.489	679	653
20.1	0.927	547	
	0.636	533	
	0.483	526	503
31.1	0.926	566	
	0.636	557	
	0.484	551	535
37.1	0.948	814	
	0.646	794	
	0.490	785	753
39.1	0.836	174	
	0.592	171	
	0.458	169	163
43.1	0.961	931	
	0.652	917	
	0.493	907	883
51.1	0.794	140	
	0.571	137	
	0.445	136	131
55.1	0.888	311	
	0.617	307	
	0.473	304	296

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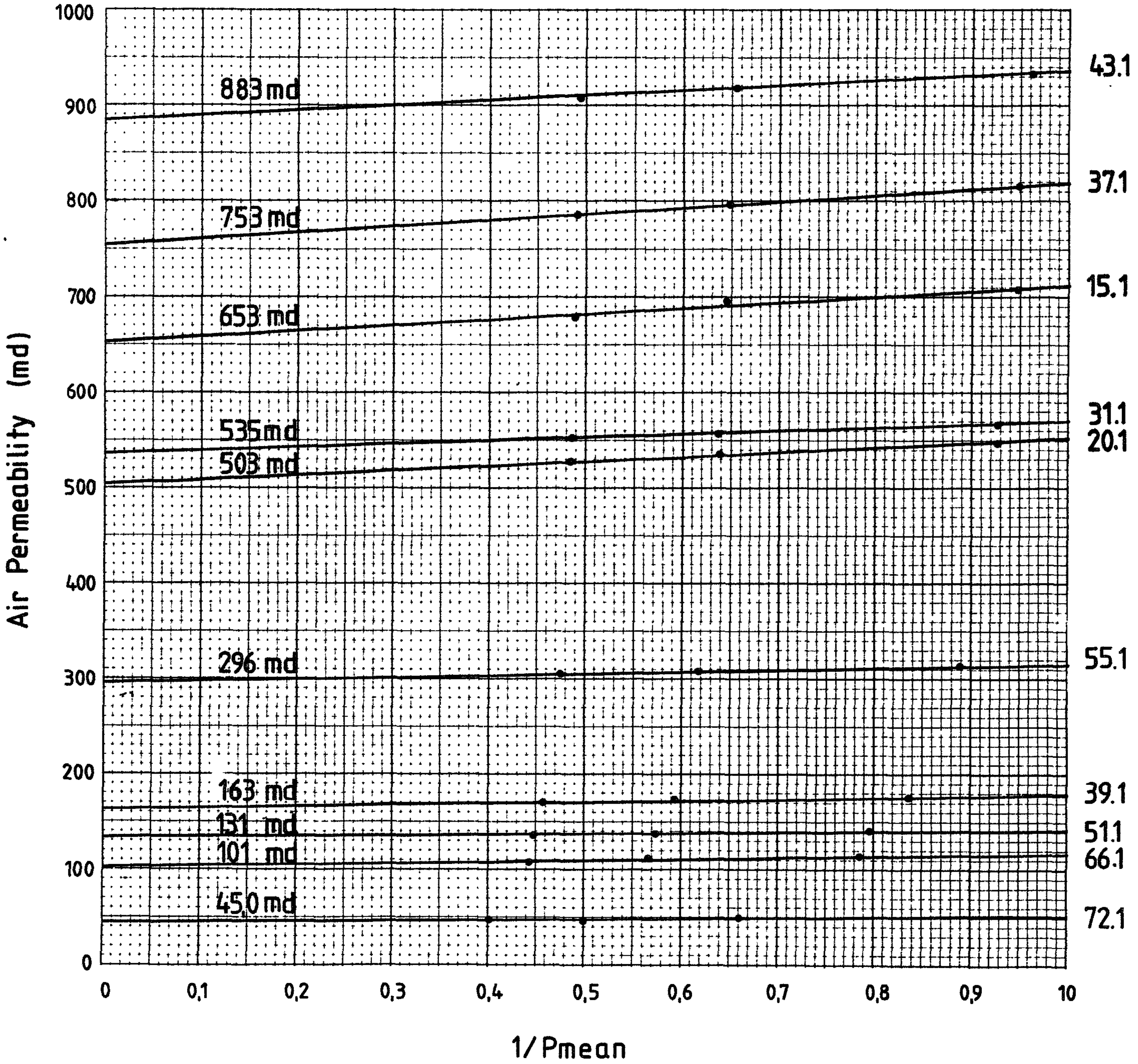
KLINKENBERG CORRECTED AIR PERMEABILITY

Sample no.	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
61.1	0.979	1771	
	0.660	1735	
	0.498	1705	1642
63.1	0.993	6423	
	0.667	6337	
	0.502	6247	6087
66.1	0.784	114	
	0.565	111	
	0.442	108	101
72.1	0.658	49.3	
	0.497	48.3	
	0.399	47.6	45.0
79.1	0.509	4.53	
	0.407	4.35	
	0.339	4.20	3.55
90.1	0.612	11.1	
	0.470	10.6	
	0.381	10.4	9.20
93.1	0.609	17.1	
	0.468	16.5	
	0.380	16.3	14.9

GECO Petroleum Laboratory

KLINKENBERG CORRECTION



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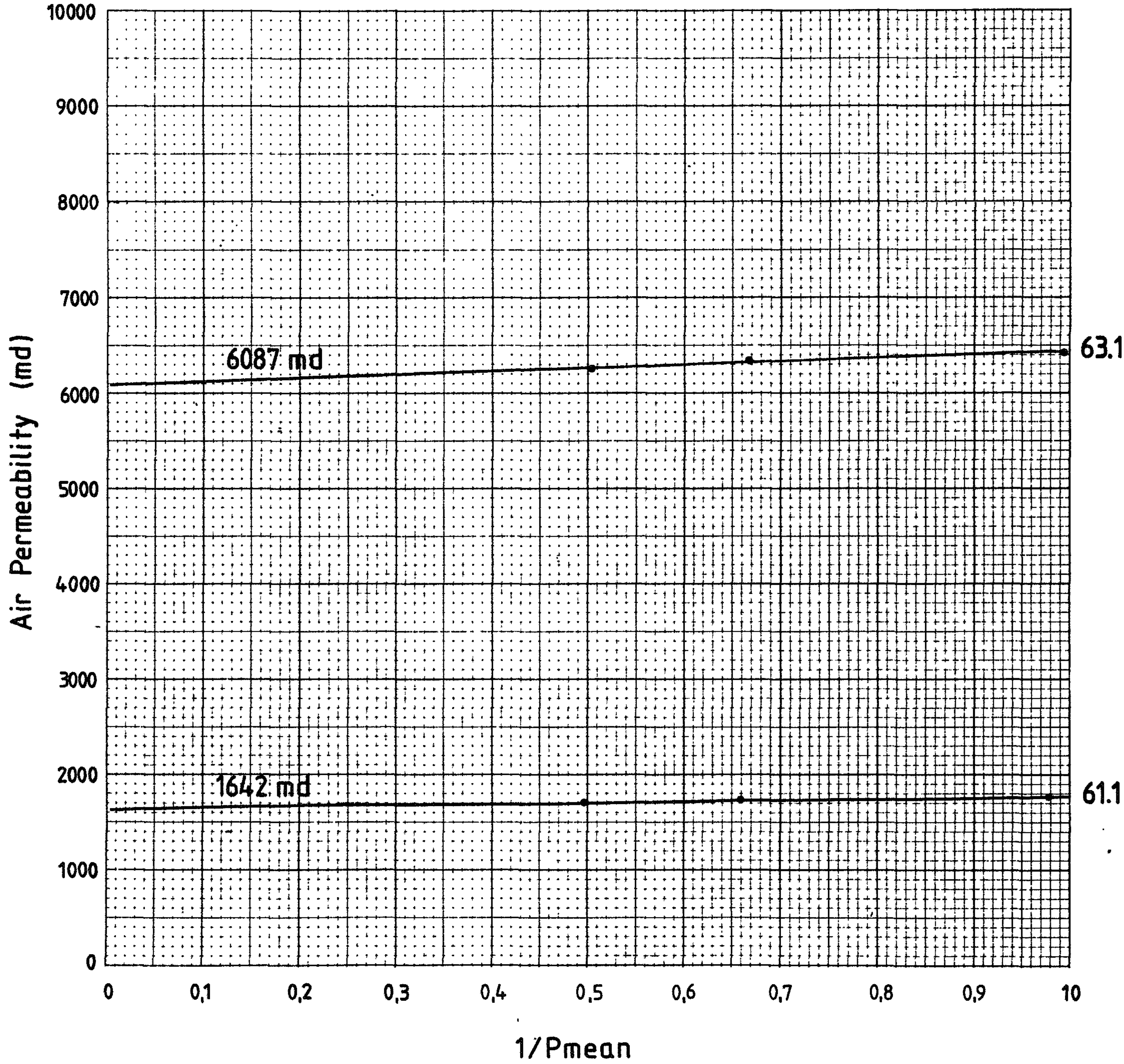
KLINKENBERG CORRECTION



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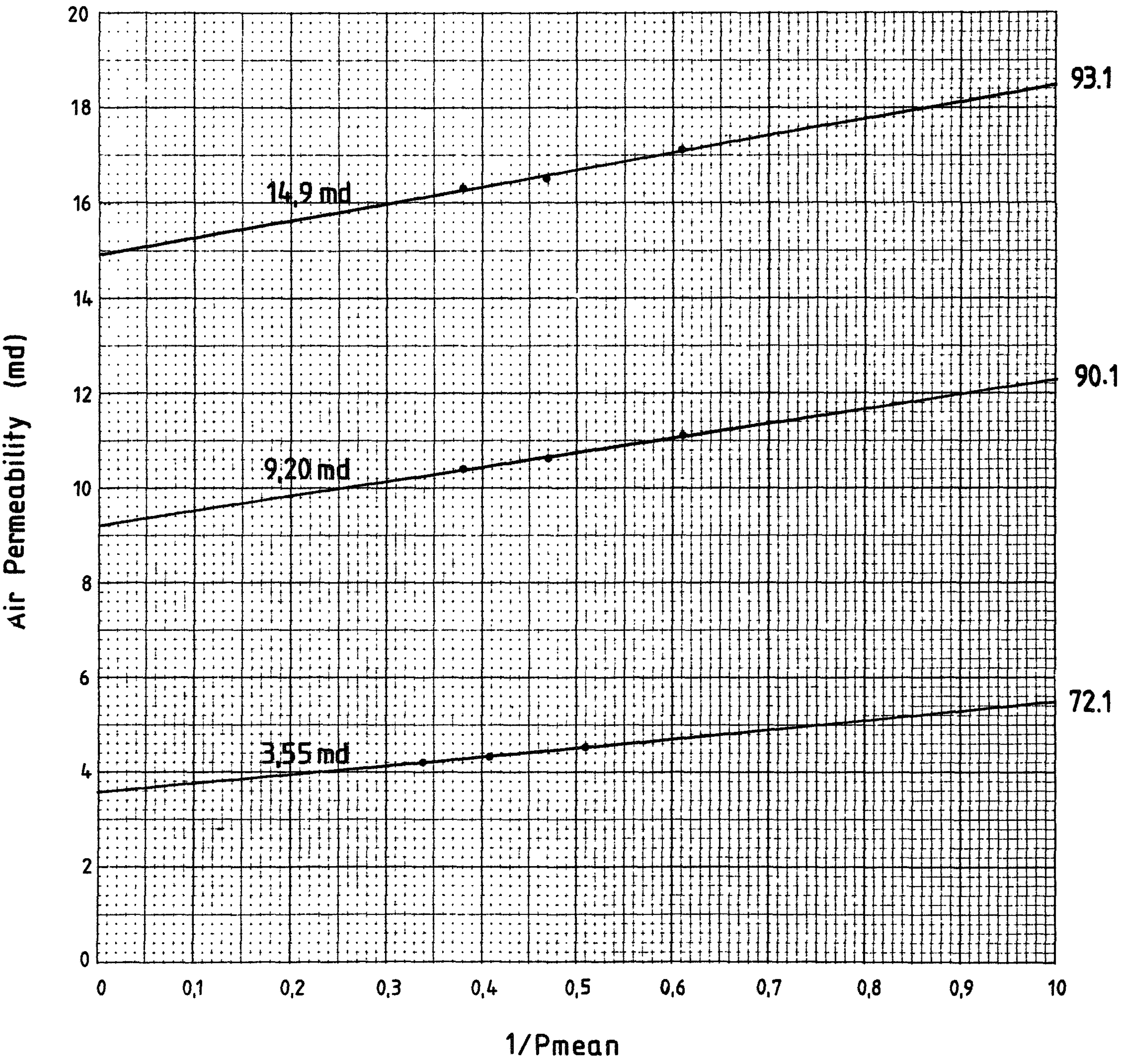
Petroleum
Laboratory

KLINKENBERG CORRECTION



CAPILLARY PRESSURE BY RESTORED STATE METHOD

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GEOPHYSICAL COMPANY OF NORWAY A/S

COMPANY: STATOIL

WELL: 15/8-1

DEPTH m	NO	PERMEABILITY K, e.l	POROSITY Ø	BRINE SATURATION VERSUS PRESSURE (Bar) 0	0.05	0.1	0.3	0.5	1.0	3.0	12.0	
3664.70	20.1	503	17.3	100	82.5	48.6	31.5	26.3	22.0	20.8	20.6	
73.70	39.1	163	19.9	100	96.6	87.3	42.6	33.9	28.9	27.1	26.9	
84.40	43.1	883	20.2	100	78.1	46.4	26.9	22.6	19.0	18.2	18.0	
93.13	61.1	1642	20.2	100	57.3	41.0	26.5	22.7	19.5	19.0	18.5	
97.25	72.1	45.0	16.6	100	100	100	70.2	55.1	46.6	45.6	44.9	
3705.10	93.1	14.9	16.9	100	100	100	97.6	77.0	58.2	54.9	53.6	

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Capillary Pressure Curve

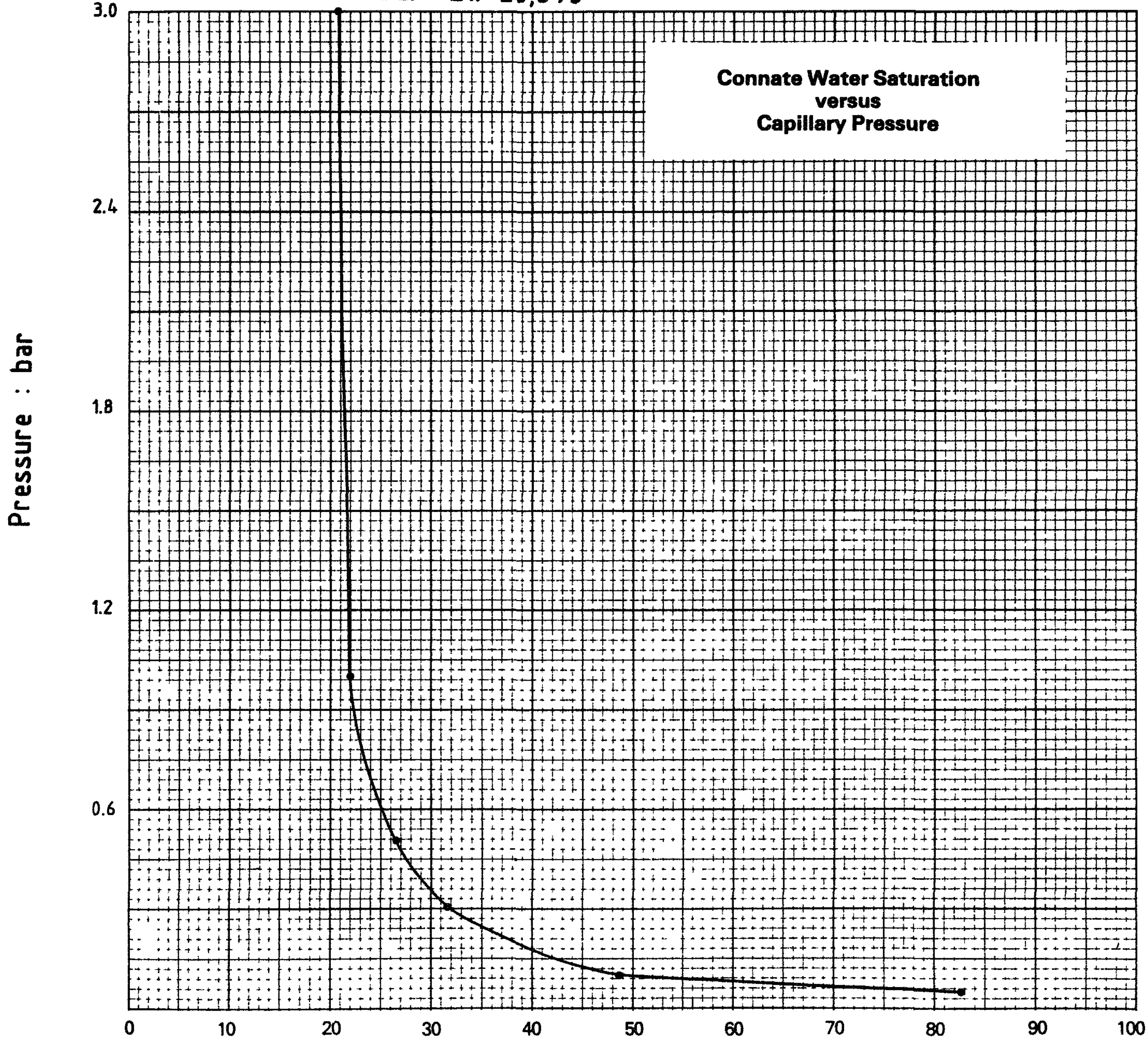
GECO
GEOPHYSICAL COMPANY OF NORWAY A-S

Well 15/8-1

Sample No. 201 Kair 503

Depth 3664.70 Ø 17.3%

At 12 bar: Sw=20,6%



Brine Saturation, Per Cent Pore Space.

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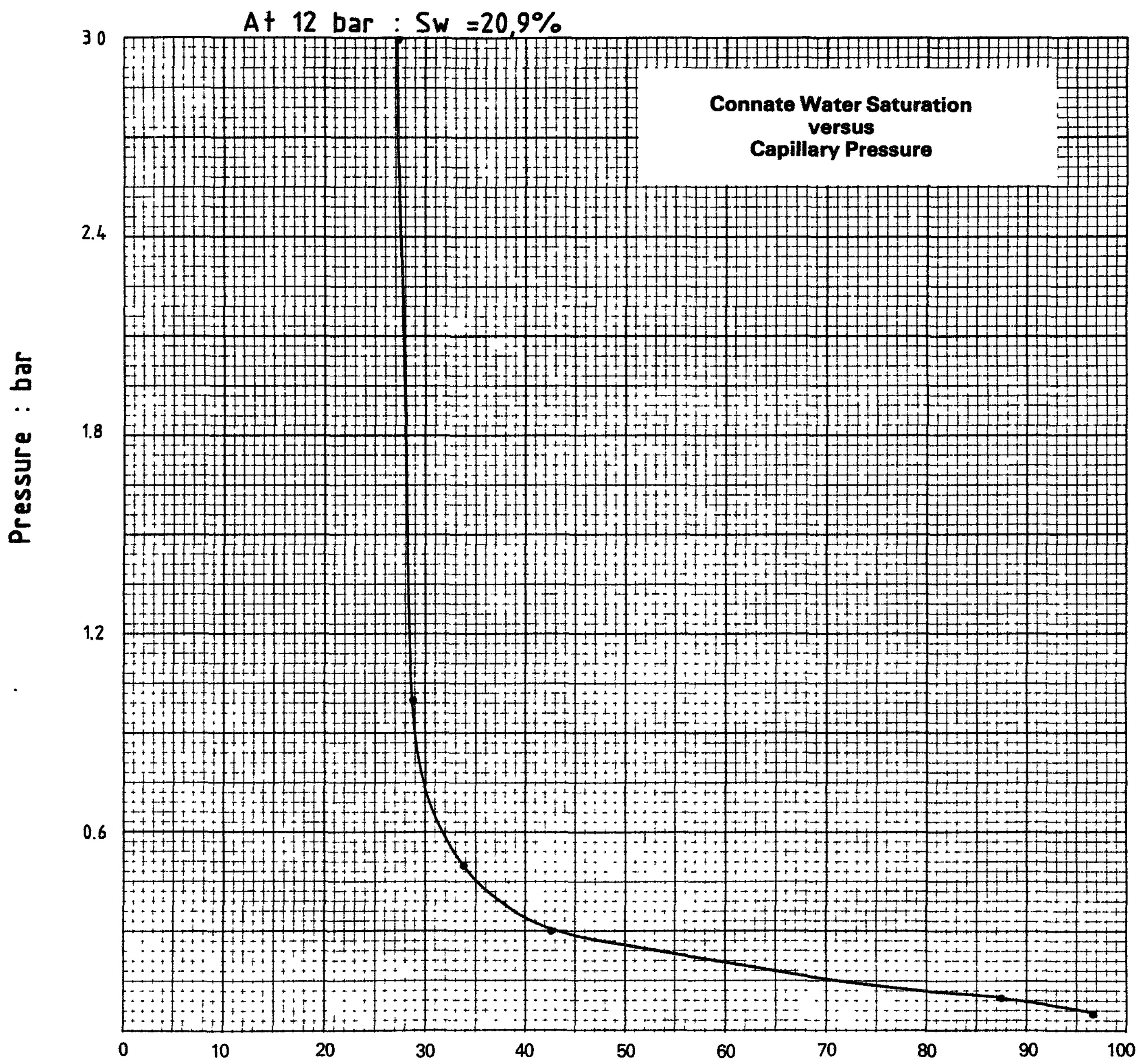
Capillary Pressure Curve

GECO
GEOPHYSICAL COMPANY OF NORWAY A-S

Well 15/8-1

Sample No. 391 Kair 163 md

Depth 3673,70m Ø 19,9%



Brine Saturation, Per Cent Pore Space.

Geco nr 061 — Rogaland Industritrykk A s

Capillary Pressure Curve

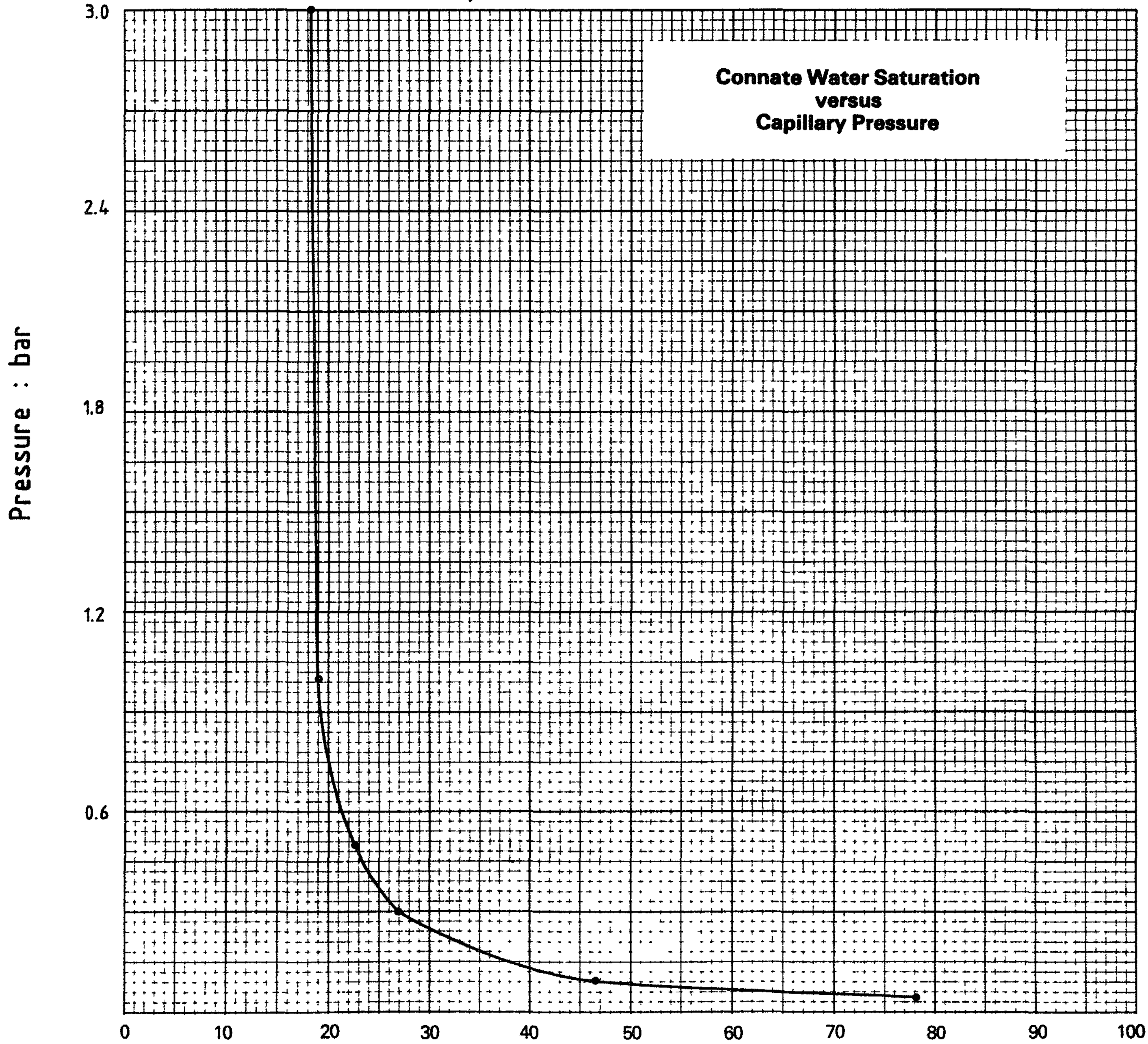
GECO
GEOPHYSICAL COMPANY OF NORWAY A/S

Well 15/8-1

Sample No. 43,1 Kair 883 md

Depth 3684,40m Ø 20,2%p.

At 12 bar : 18,0%



Brine Saturation, Per Cent Pore Space.

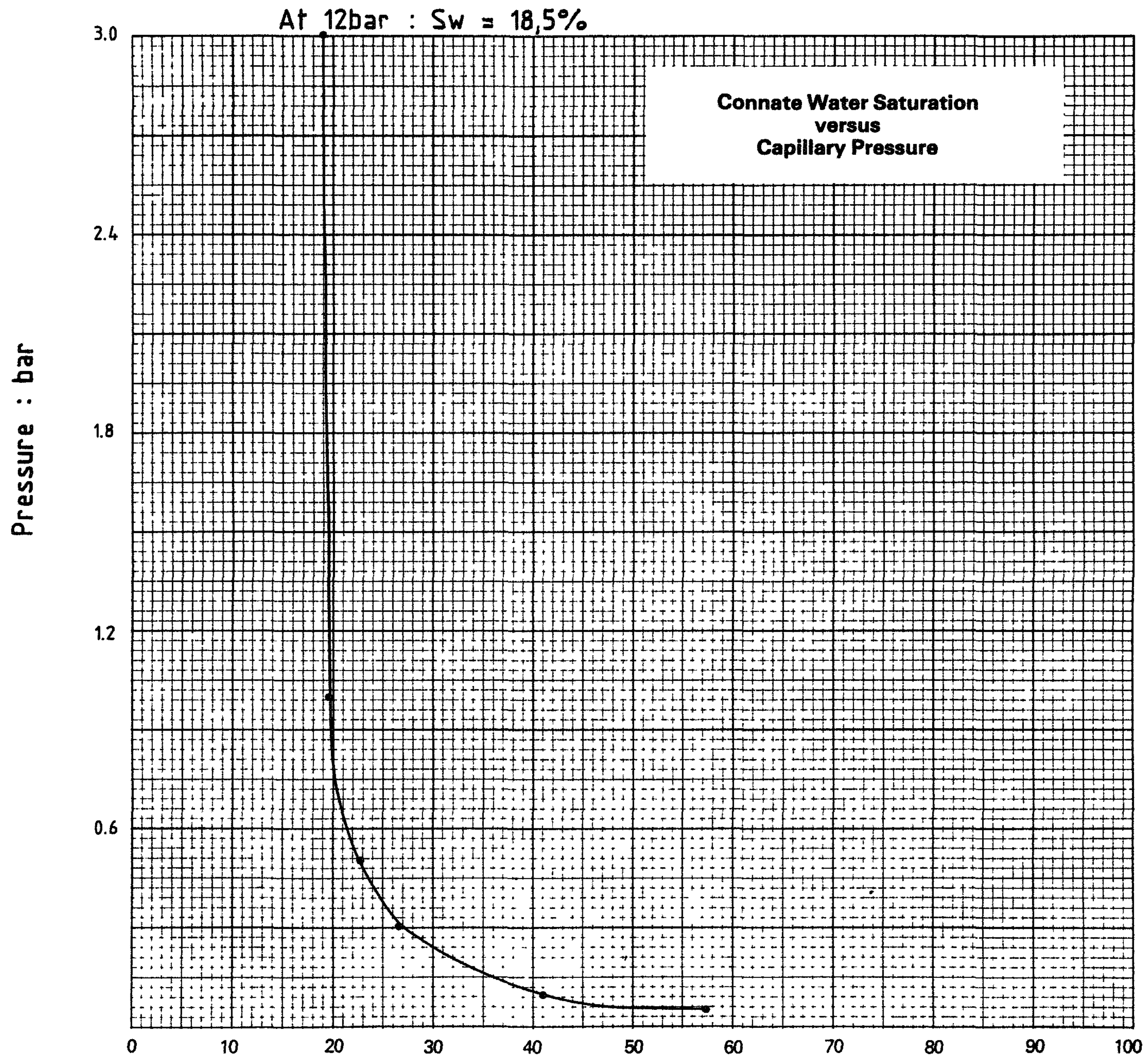
Capillary Pressure Curve

GECO
GEOPHYSICAL COMPANY OF NORWAY A/S

Well ....15/8-1..........

Sample No. .61,1..............Kair ...1642md.........

Depth ......3693,13m.........ø ....20,2%.........



Brine Saturation, Per Cent Pore Space.

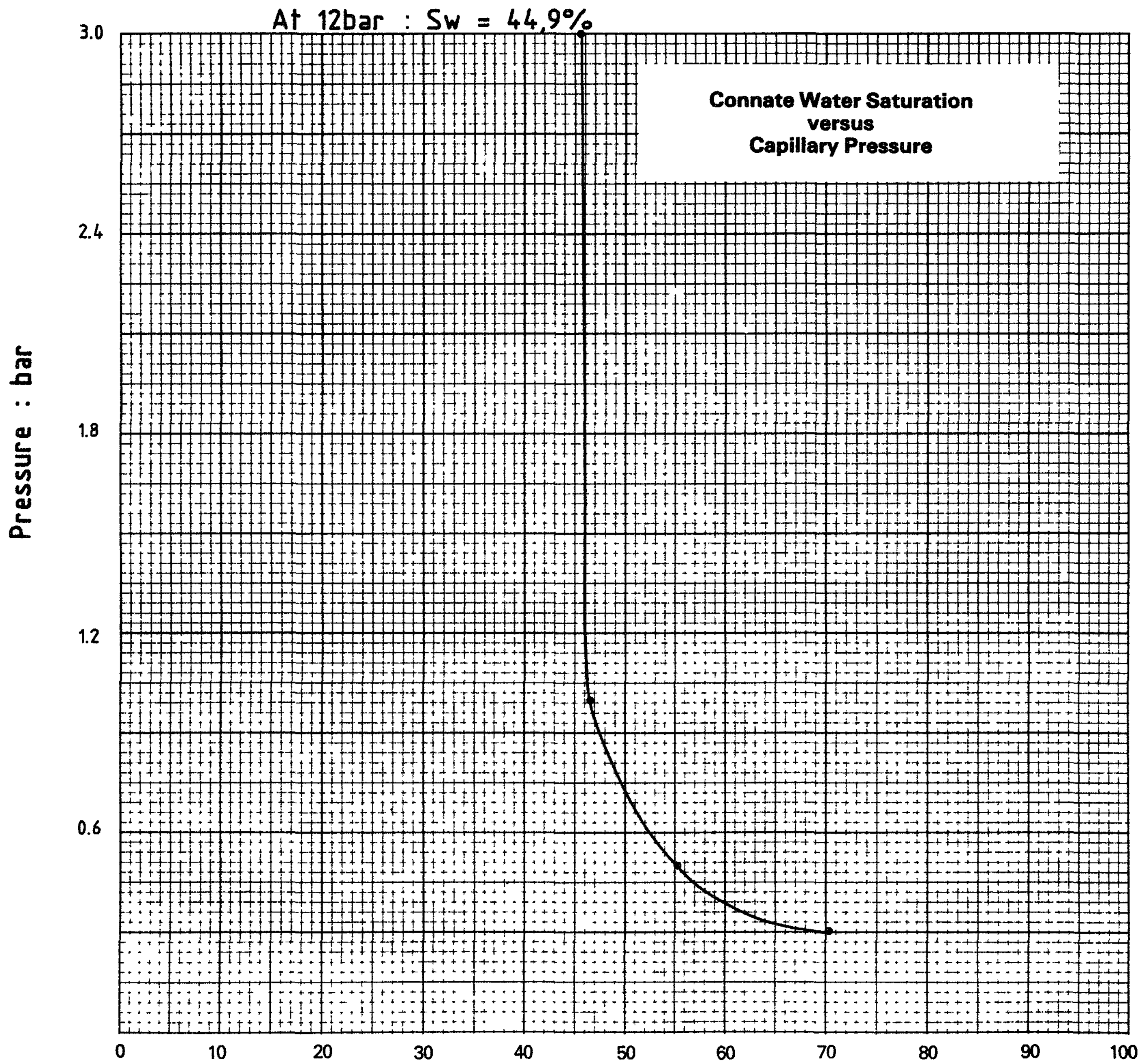
Geco nr. 061 — Rogaland Industritrykk A.s

Capillary Pressure Curve

Well ....15/8-1..........

Sample No. ..721..............Kair ...45,0md.................

Depth ......3697,25m.........Ø .....16,6%..........



Brine Saturation, Per Cent Pore Space.

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Capillary Pressure Curve

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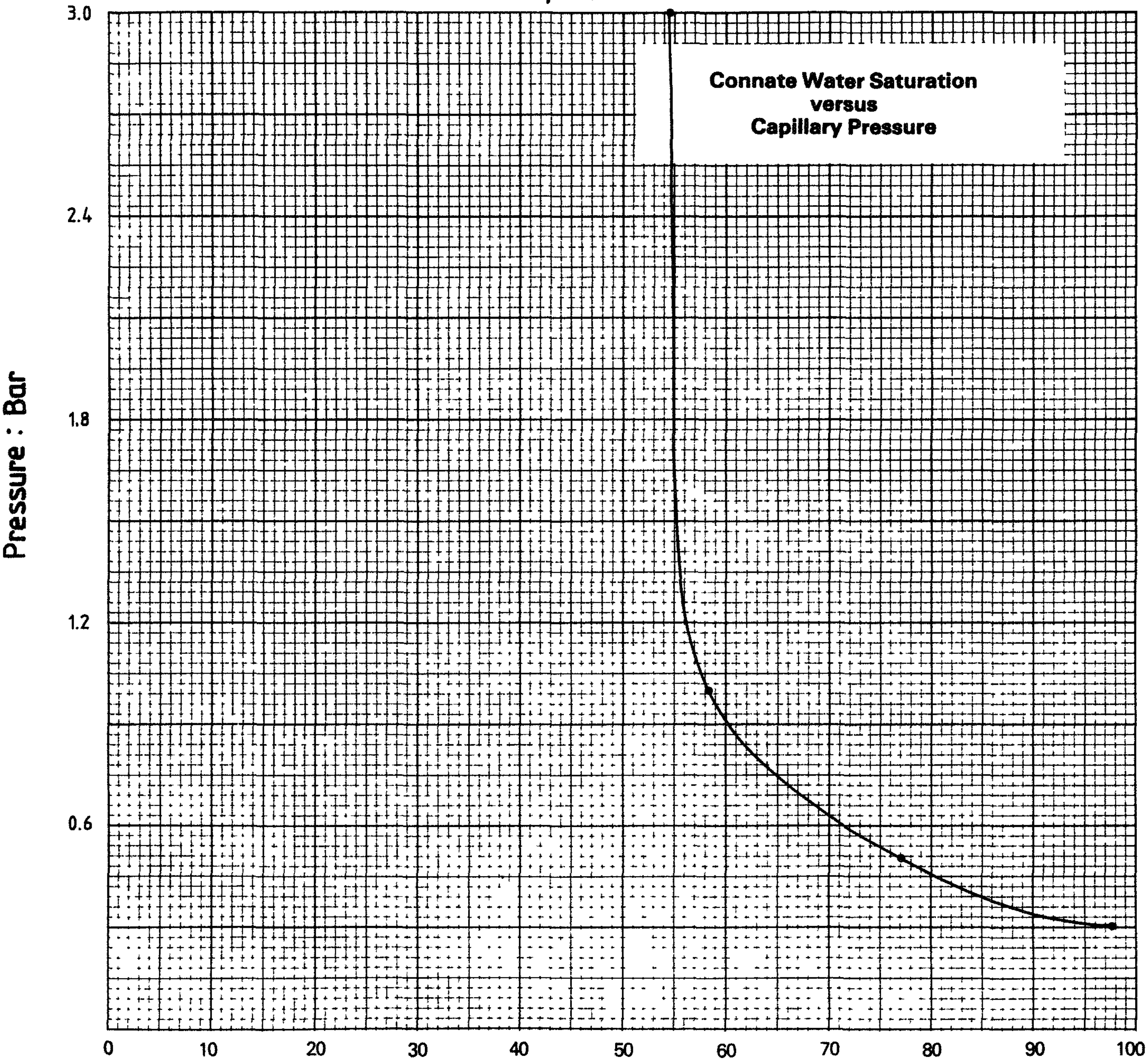
Well 15/8-1

Sample No. 93,1 Kair 14,9md

Depth 3705,10m Ø 16,9%

At 12 bar : Sw = 53,6%



Brine Saturation, Per Cent Pore Space.

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LOG K.e.1 VERSUS Sw AT 12 BAR

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Sample no	Sw (fraction)	K.e.1(md)	Log K.e.1.
20.1	20.6	503	2.70
39.1	26.9	163	2.21
43.1	18.0	883	2.95
61.1	18.5	1642	3.22
72.1	44.9	45.0	1.65
93.1	53.6	14.9	1.17

By Least Square method following equation was :

evaluated: $Sw = -18.66 \text{ Log K.e.l.} + 73.66$

K.e.l: equivalent liquid permeability (Klinkenberg corrected air permeability).

PERMEABILITY VERSUS WATER SATURATION AT 12 BAR

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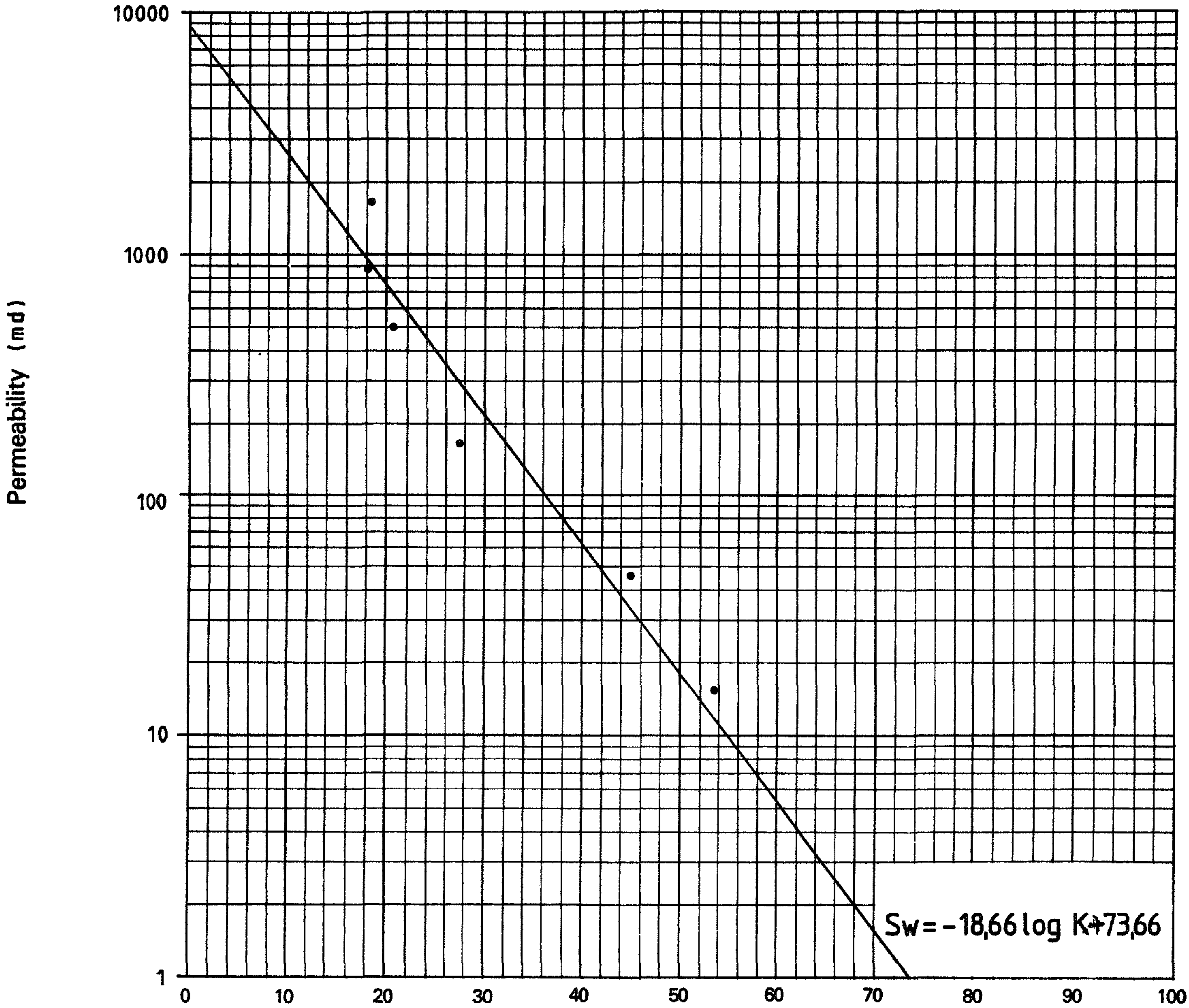
Company ......Statoil......

Well ......15/8 - 1......



Water Saturation, Per Cent Pore Space.

RESISTIVITY INDEX

COMPANY: STATOIL

WELL: 15/8 - 1

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GEOPHYSICAL COMPANY OF NORWAY A·S

DEPTH	NO	PERMEABILITY	POROSITY	Resistivity ratio versus brine saturation								
				FF	RR	RR	RR	RR	RR	RR	RR	RR
m		K.e.l	Ø	0	0.05	0.1	0.3	0.5	1.0	3.0	12.0	
3664.70	20.1	503	17.3	20.8	1.48	3.44	6.80	9.58	13.3	14.4	14.6	
3673.70	39.1	163	19.9	21.0	1.07	1.30	4.81	8.69	10.2	11.0	11.8	
3684.40	43.1	883	20.2	15.7	1.63	3.72	10.0	14.3	20.8	22.5	22.5	
3693.13	61.1	1642	20.2	19.5	2.57	4.59	12.6	13.2	18.9	18.9	20.1	
3697.25	72.1	45.0	16.6	26.3	1.0	1.0	2.40	3.67	5.42	5.96	6.22	
3705.10	93.1	14.9	16.9	24.3	1.0	1.0	1.09	1.85	3.45	3.71	4.22	

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RESISTIVITY INDEX

By Weighted Least Squares method

Sample no	$Ri = b\ Sw^{-n}$
20.1	$Ri = 1.00\ Sw^{-1.70}$
39.1	$Ri = 1.00\ Sw^{-1.88}$
43.1	$Ri = 1.00\ Sw^{-1.80}$
61.1	$Ri = 1.00\ Sw^{-1.78}$
72.1	$Ri = 1.00\ Sw^{-2.25}$
93.1	$Ri = 1.00\ Sw^{-2.26}$

By Least Squares method

20.1	$Ri = 1.05\ Sw^{-1.66}$
39.1	$Ri = 1.01\ Sw_{-1.87}$
43.1	$Ri = 0.97\ Sw^{-1.82}$
61.1	$Ri = 0.93\ Sw^{-1.83}$
72.1	$Ri = 1.10\ Sw^{-2.12}$
93.1	$Ri = 1.04\ Sw^{-2.20}$

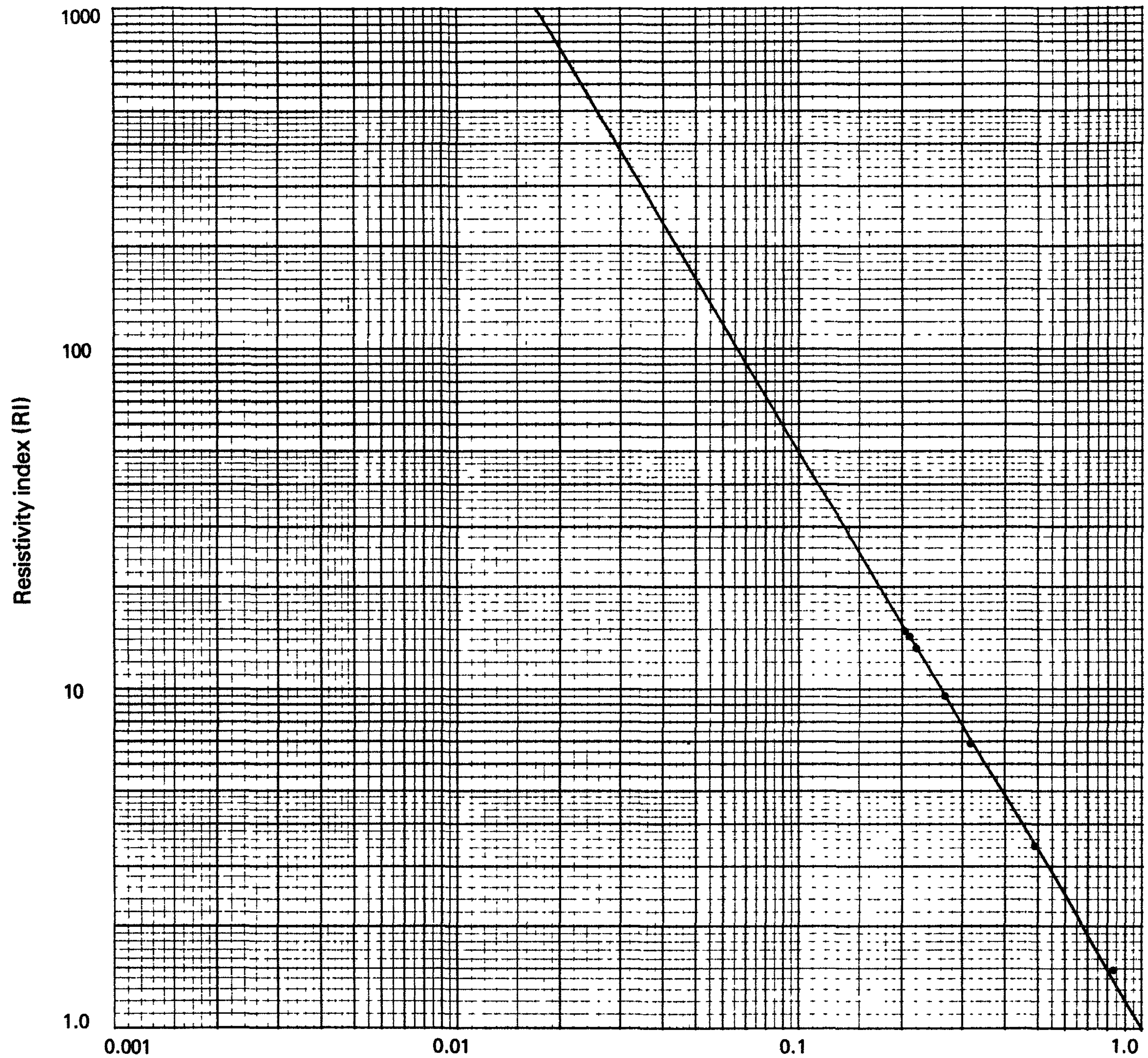
Resitivity index versus water Saturation

GECO
GEOPHYSICAL COMPANY OF NORWAY A·S

Company Statoil

Well 15/8-1 Sample no 20,1

$Ri = 1{,}00\, Sw^{-1{,}70}$



Water Saturation, Fraction of Pore Space.

Geco nr. 064 – Rogaland Industritrykk A s

Resitivity index versus water Saturation

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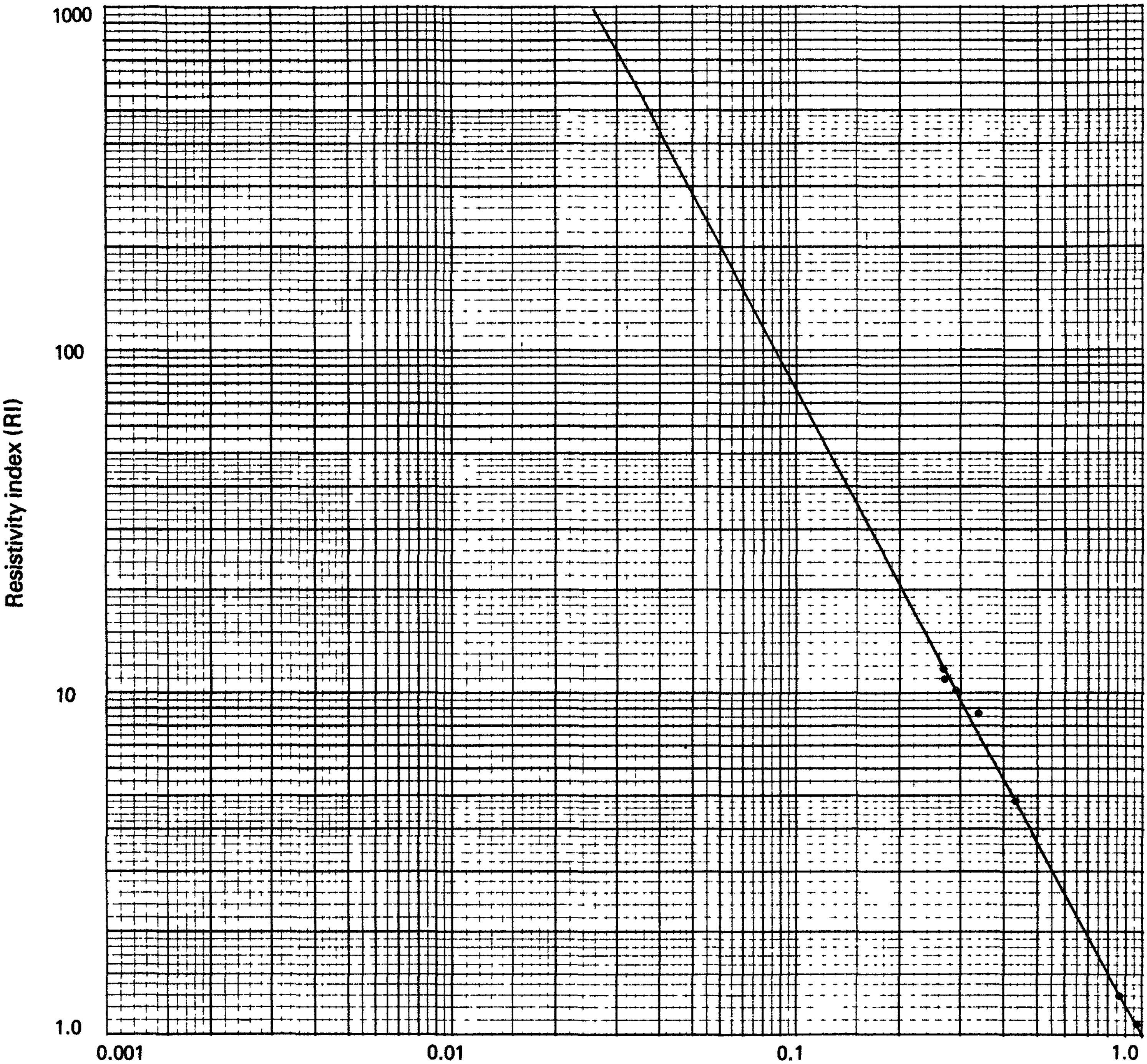
GEOPHYSICAL COMPANY OF NORWAY A·S

Company Statoil

Well 15/8-1 Sample no 39,1

$Ri = 1{,}00\ Sw^{-1{,}88}$



Water Saturation, Fraction of Pore Space.

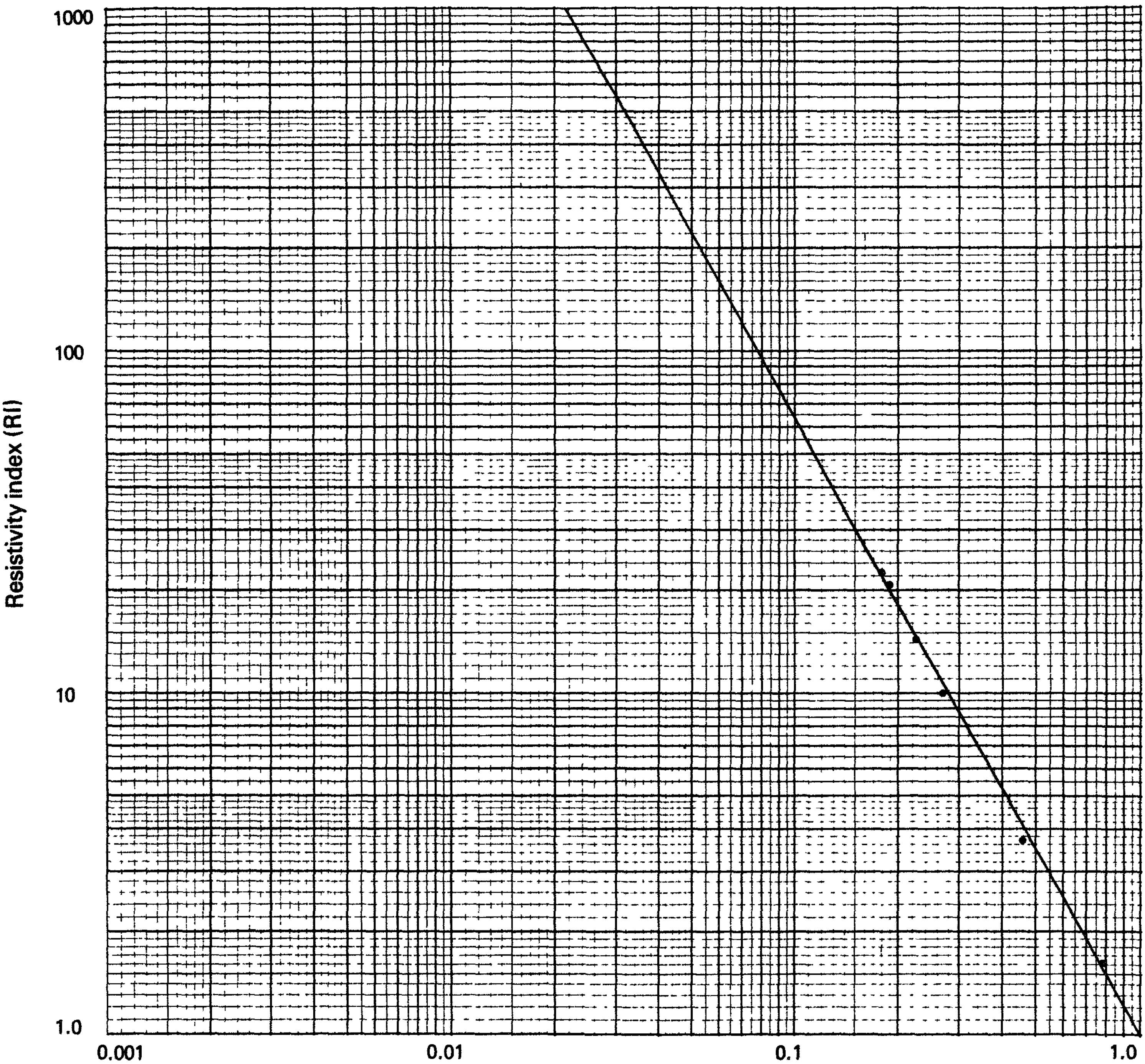
Resitivity index versus water Saturation

GECO
GEOPHYSICAL COMPANY OF NORWAY A·S

Company Statoil

Well 15/8-1 Sample no 43,1

$Ri = 1{,}00\ Sw^{-1{,}80}$



Water Saturation, Fraction of Pore Space.

Resitivity index versus water Saturation

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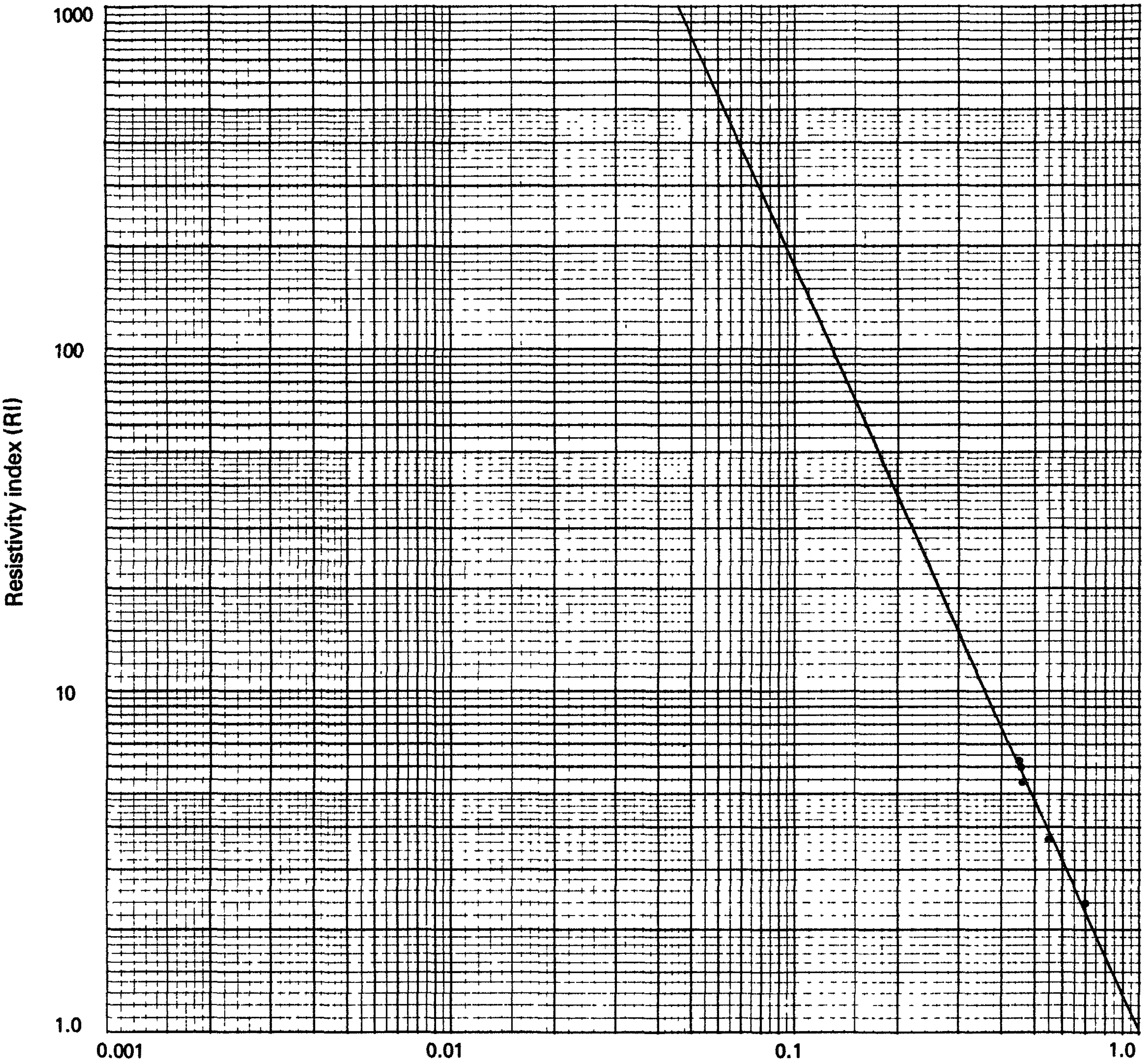
Well 15/8-1 Sample no 72,1

$Ri = 1{,}00\ Sw^{-2{,}25}$



Water Saturation, Fraction of Pore Space.

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Resitivity index versus water Saturation

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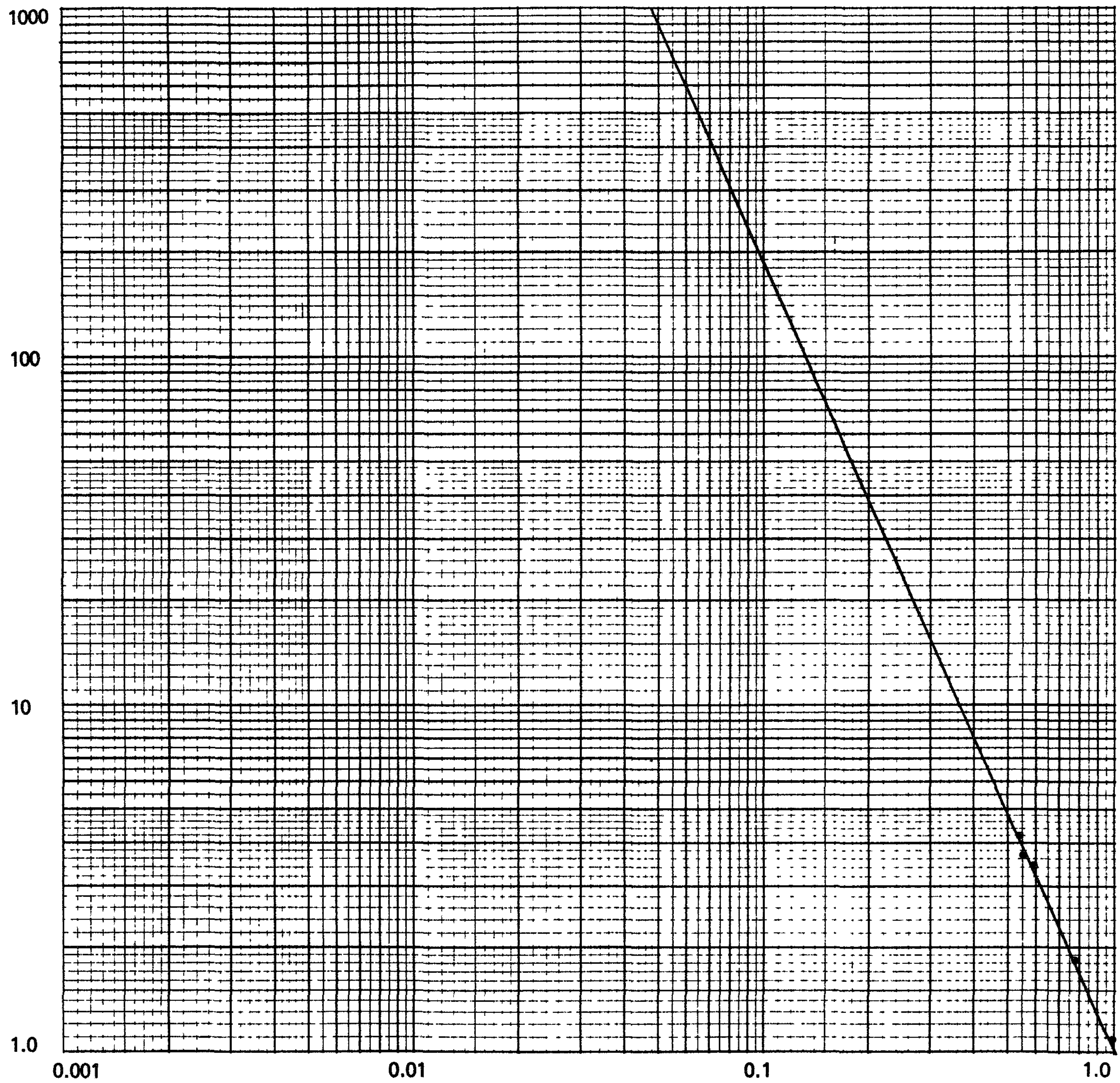
Well 15/8-1 Sample no 93,1

$Ri = 1{,}00\ Sw^{-2{,}25}$



Water Saturation, Fraction of Pore Space.

GECO

FORMATION RESISITIVITY FACTOR MEASURED AT ATMOSPHERIC OR EQUIVALENT ATMOSPHERIC CONDITIONS

$$FF = a \cdot \emptyset^{-m}$$

Simulated formation brine:

Na :	41 300	ppm
K :	1 470	ppm
Mg :	1 380	ppm
Ca :	4 750	ppm

Brine resistivity at 23°C : : 0.072 ohm-m
Frequency : 1 KHz

Sample no.	Porosity	Formation resistivity factor
20.1	17.3	20.8
31.1x)	16.8	22.1
39.1	19.9	21.0
43.1	20.2	15.7
51.1x)	20.0	18.5
61.1	20.2	19.5
72.1	16.6	26.3
90.1x)	14.8	29.8
93.1	16.9	24.3

By weighted Least squares method: a = 1.00 m = 1.78

By Least squares method : a = 1.51 m = 1.55

x): These samples have been measured at a Net Confining Pressure of 10 bar (equivalent atmospheric conditions).

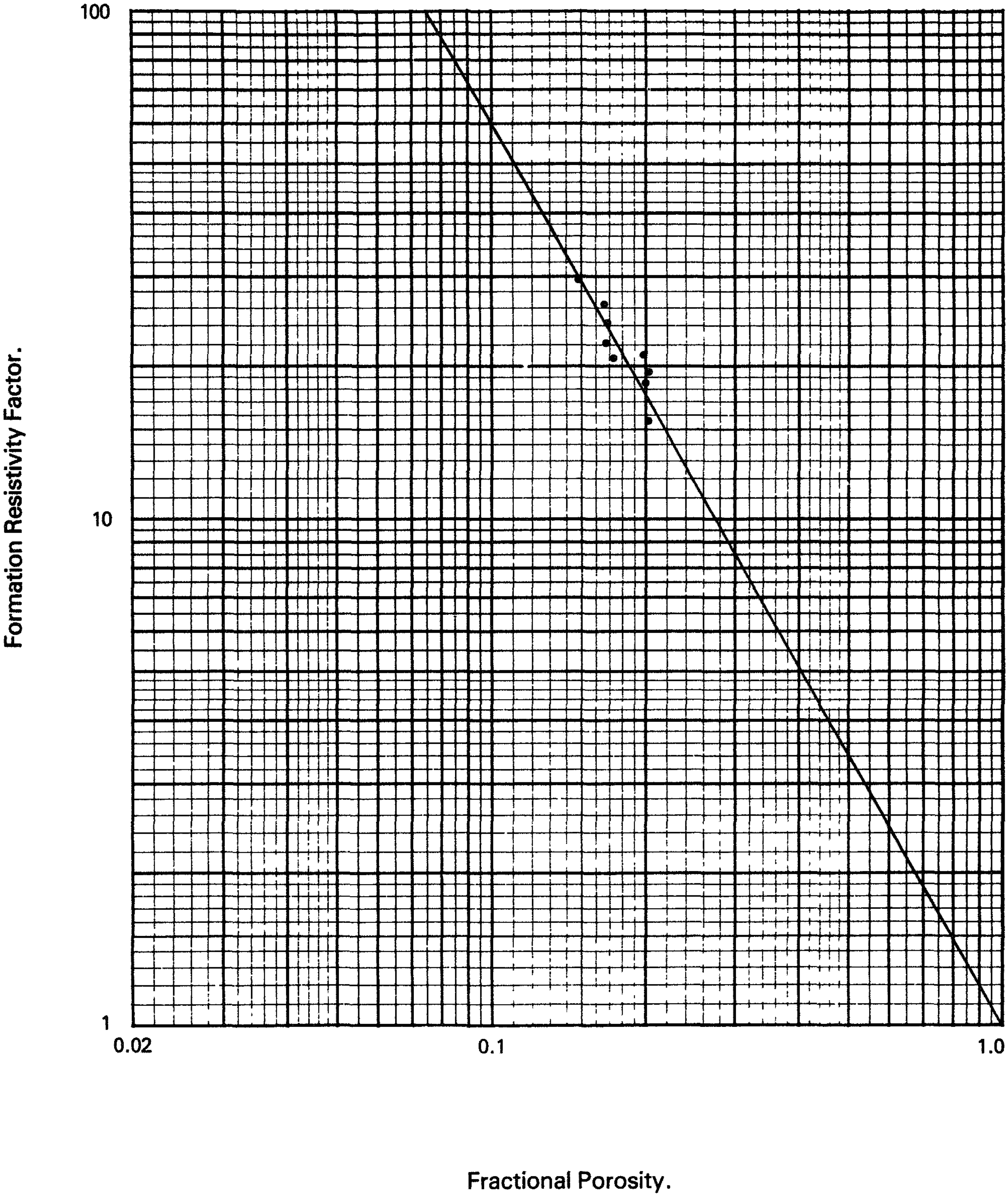
Formation Factor versus Porosity

Company Statoil

Well 15/8-1

"Atmospherical" Conditions Composite

$FF = 1,00 \quad Ø^{-1,78}$



Geco nr. 062 — Rogaland Industritrykk A.s

FORMATION RESISTIVITY FACTOR MEASURED AT DIFFERENT NET CONFINING PRESSURES.

Net confining Pressure bar	Sample No 31.1		51.1		90.1		$FF=a\ Ø^{-m}$	
	Ø	FF	Ø	FF	Ø	FF	By weighted Least Squares method	By Least Squares method
10x)	16.8	22,1	20.0	18.5	14.8	29.8	a=1.00 m=1.77	a=1,50 m=1,54
50	16.3	25.7	19.4	19.0	14.3	32.8	a=1,00 m=1,79	a=1.01 m=1.79
100	16.1	26.5	19.2	19.5	14.1	34.5	a=1,00 m=1,80	a=0.93 m=1,84
200	15.9	27.5	19.0	20.4	13.9	37.0	a=1,00 m=1,82	a=0.87 m=1,89
300	15.8	28.0	18.9	20.6	13.8	38.5	a=1,00 m=1,82	a=0.76 m=1,97

x) : 10 bar is considered as equivalent atmospherical conditions.

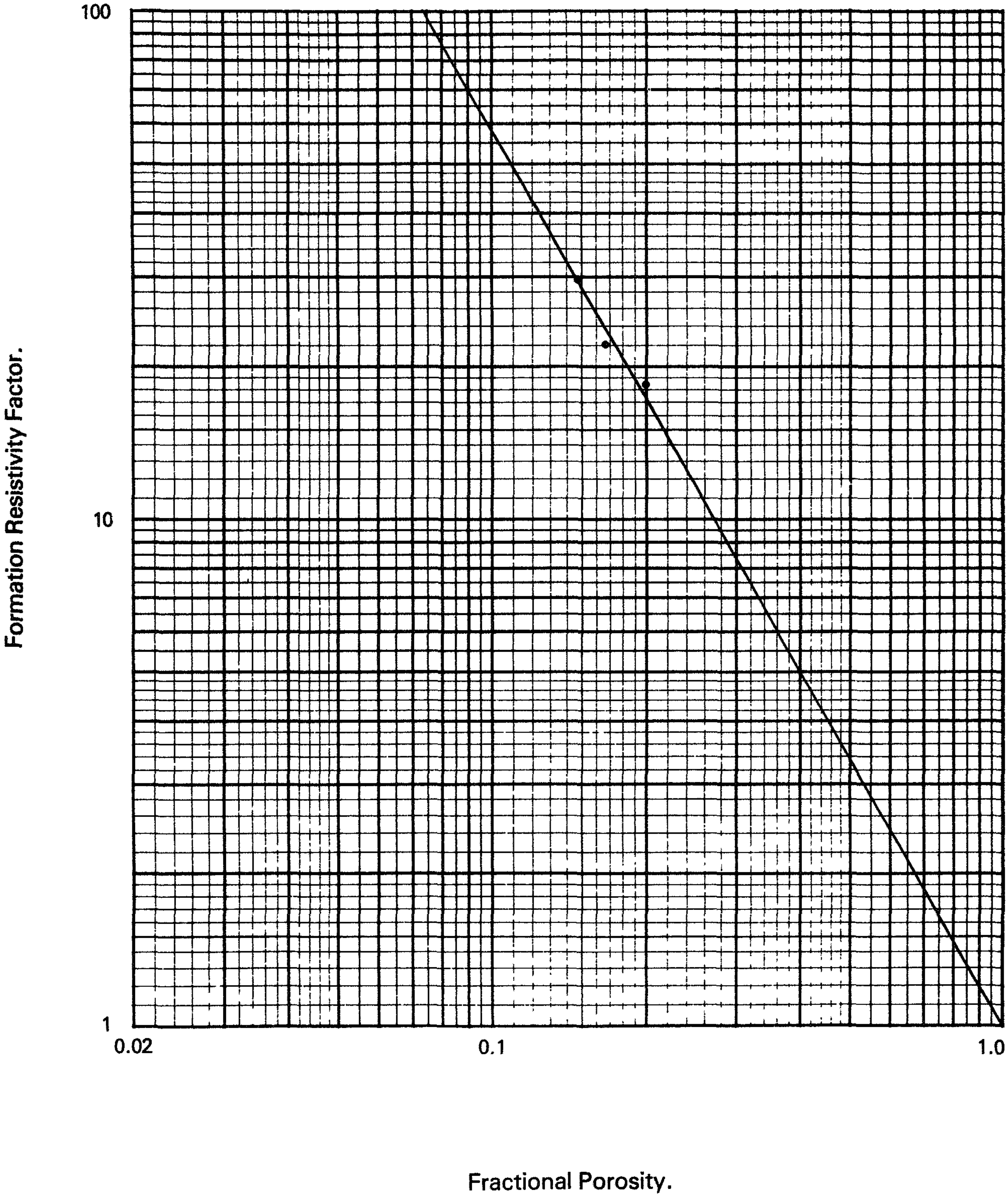
Formation Factor versus Porosity

Company ..Statoil..

Well ..15/8-1..

Net Confining pressure: 10 bar

$FF = 1{,}00 \quad Ø^{-1{,}77}$



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Formation Factor versus Porosity

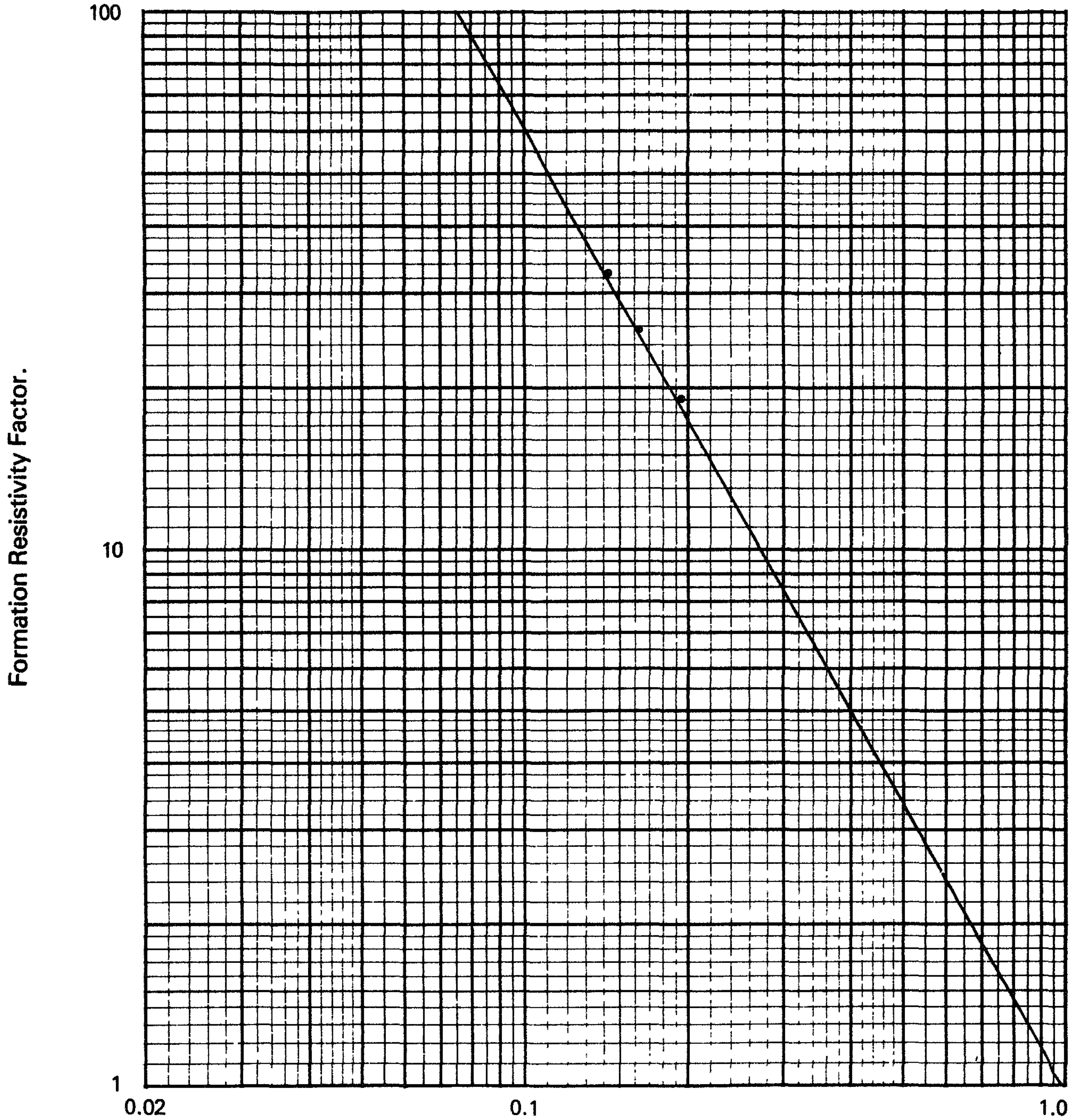
GECO
GEOPHYSICAL COMPANY OF NORWAY A.S

Company ..Statoil..

Well ......15/8-1...

Net Confining pressure: 50bar

$FF = 1{,}00 \ \emptyset^{-1{,}79}$



Fractional Porosity.

Formation Factor versus Porosity

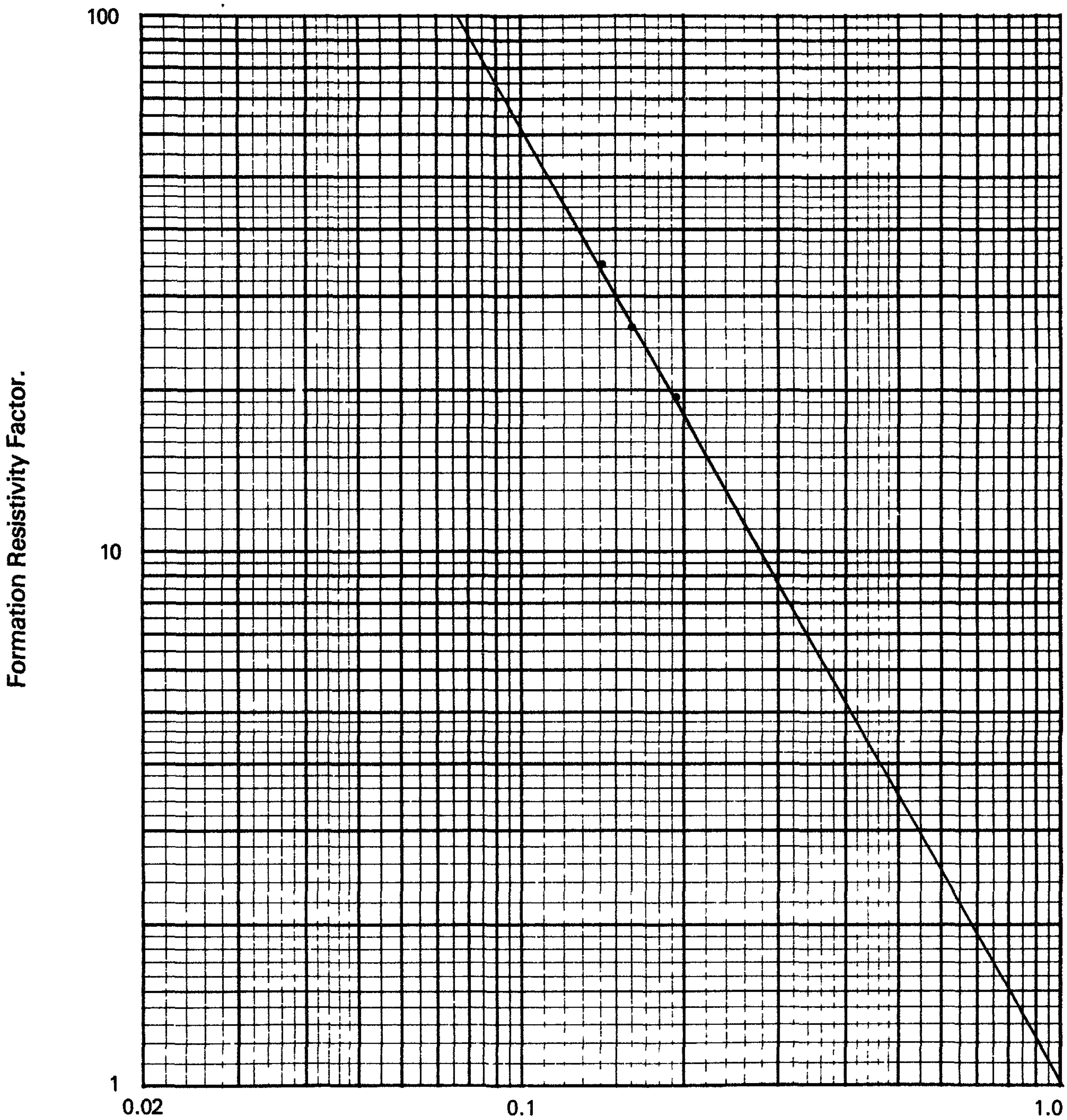
GECO
GEOPHYSICAL COMPANY OF NORWAY A-S

Company Statoil

Well 15/8-1

Net Confining pressure: 100 bar

$FF = 1{,}00 \quad \emptyset^{-1{,}80}$



Fractional Porosity.

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Formation Factor versus Porosity

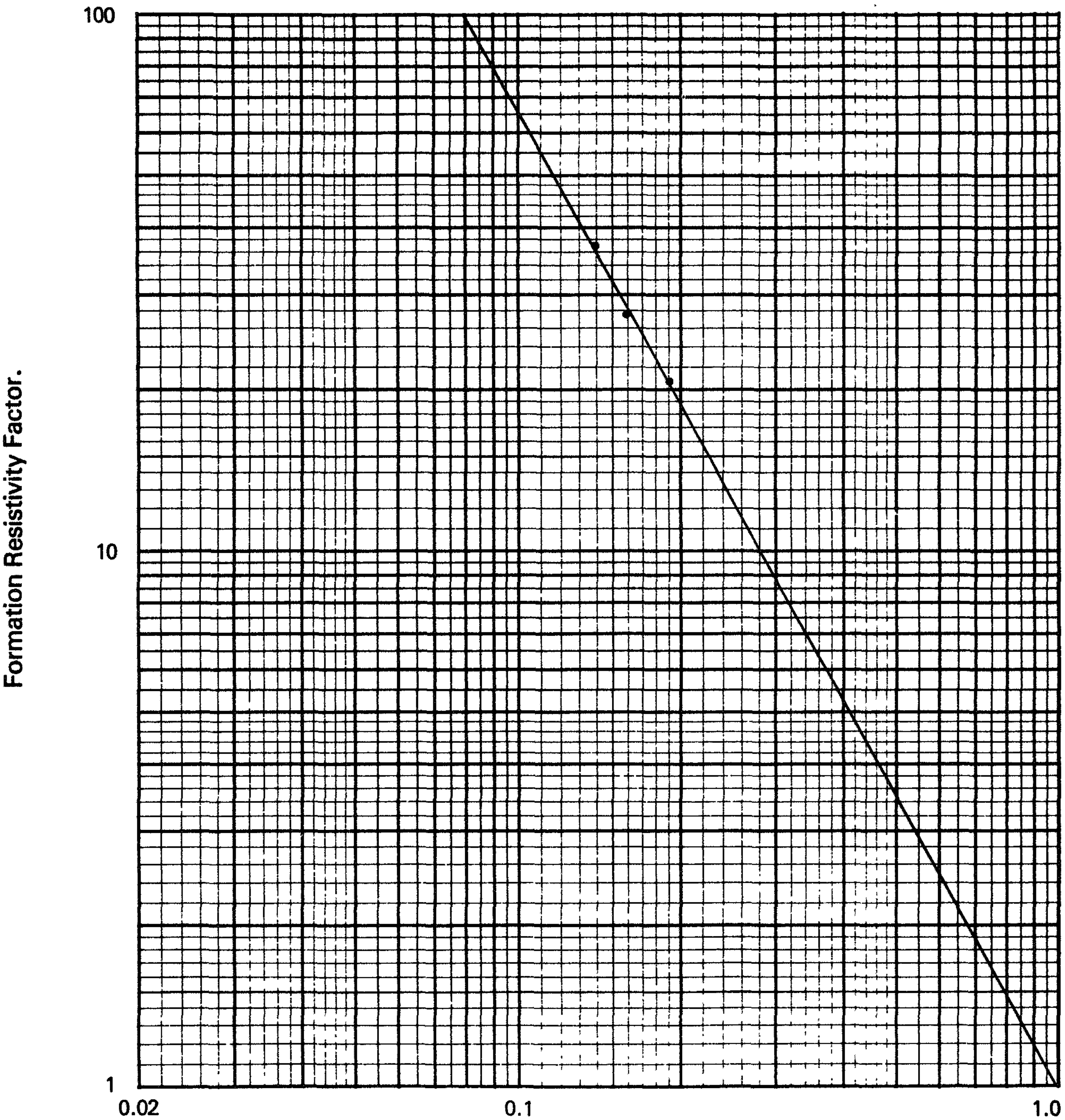
GECO
GEOPHYSICAL COMPANY OF NORWAY A-S

Company Statoil

Well 15/8-1

Net Confining pressure: 200 bar

$FF = 1{,}00 \; \emptyset^{-1{,}82}$



Fractional Porosity.

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Formation Factor versus Porosity

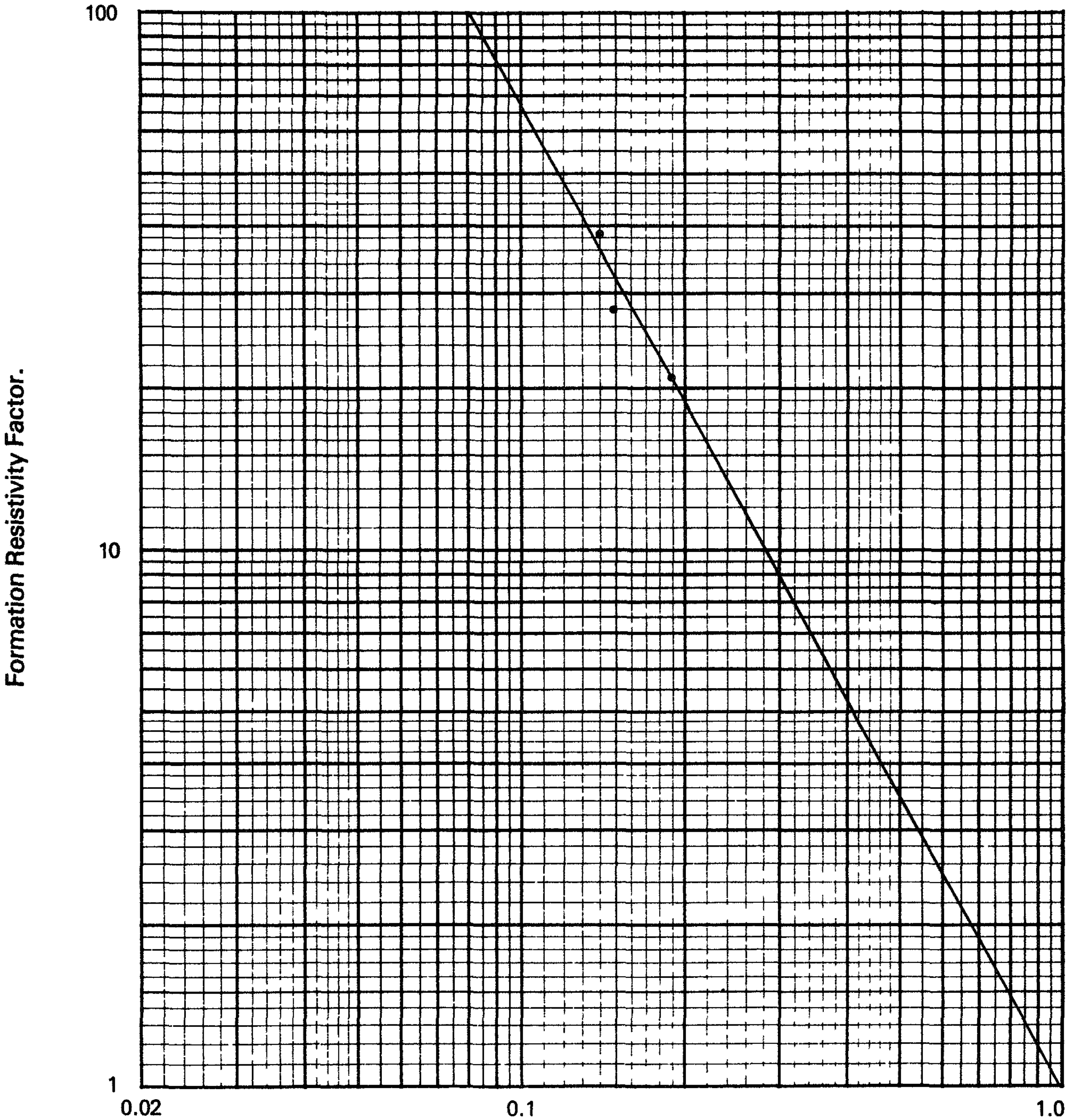
GECO
GEOPHYSICAL COMPANY OF NORWAY A/S

Company Statoil

Well 15/8-1

Net Confining pressure: 300 bar

$FF = 1{,}00 \quad Ø^{-1{,}82}$



Fractional Porosity.

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POROSITY REDUCTION MEASURED BY BRINE WITH NET OVERBURDEN

	10 bar		50 bar			100 bar			200 bar			300 bar		
Sample no.	Pore Volume	Ø orig. %	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø. frac. of orig.
31.1	13.05	16.8	12.60	16.3	0.972	12.42	16.1	0.961	12.24	15.9	0.949	12.14	15.8	0.942
51.1	15.63	20.0	15.07	19.4	0.972	14.85	19.2	0.960	14.67	19.0	0.951	14.54	18.9	0.944
90.1	11.43	14.8	11.04	14.3	0.969	10.85	14.1	0.955	10.65	13.9	0.939	10.53	13.8	0.930

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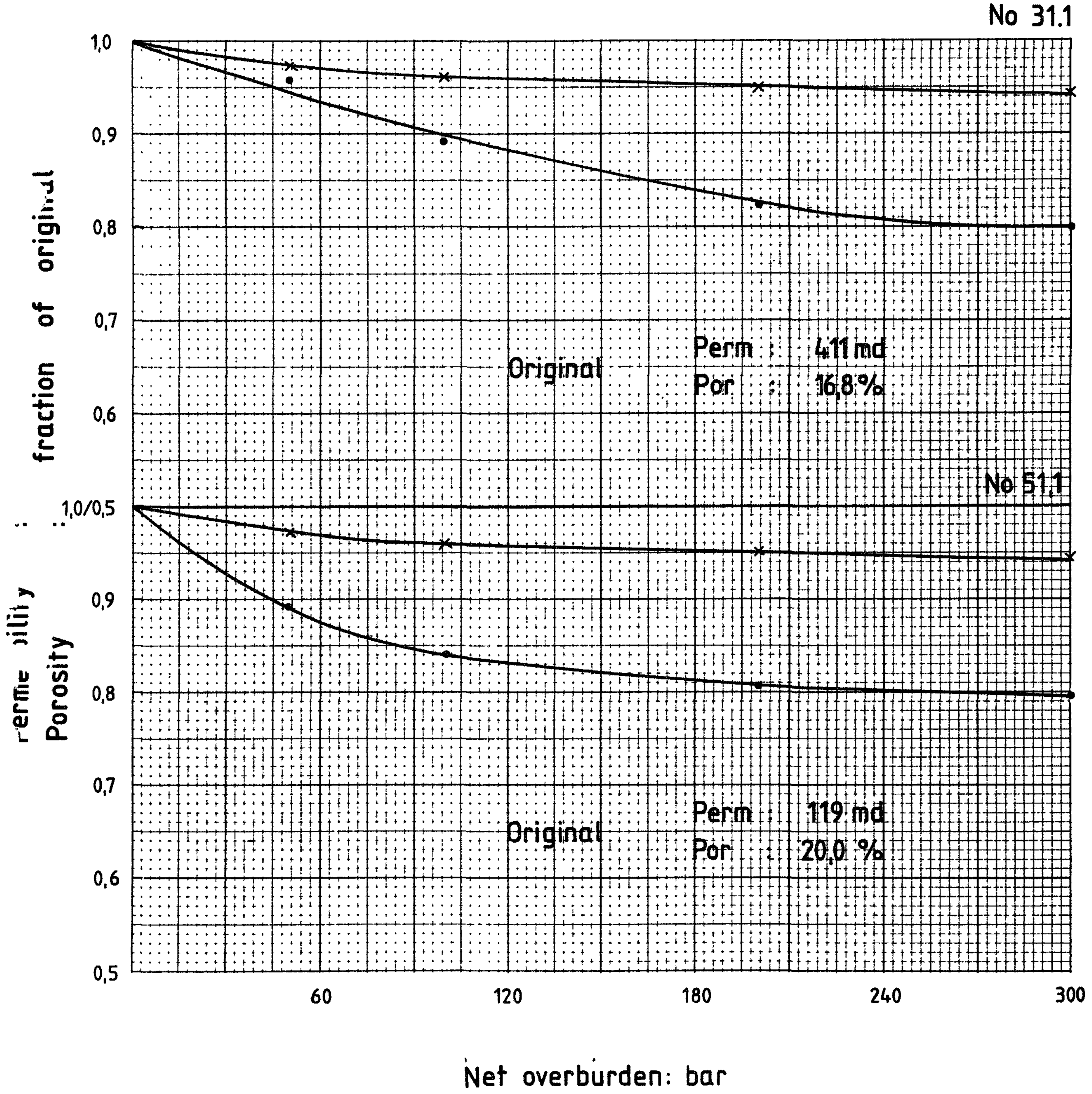
BRINE PERMEABILITY REDUCTION WITH NET OVERBUDEN

viscosity at 23 ^{o}C : 1.17 cp.

Sample no.	10 bar K_{brine} orig.(md)	50 bar K_{brine} (md)	50 bar Fraction of orig.	100 bar K_{brine} (md)	100 bar Fraction of orig.	200 bar K_{brine} (md)	200 bar Fraction of orig.	300 bar K_{brine} (md)	300 bar Fraction of orig.
31.1	411	394	0.959	366	0.891	338	0.822	329	0.800
51.1	119	106	0.891	100	0.840	96.2	0.808	94.5	0.795
90.1	3.18	2.66	0.836	249	0.783	2.30	0.723	2.21	0.695

GECO
Petroleum
Laboratory

Permeability, Porosity Versus Net Overburden



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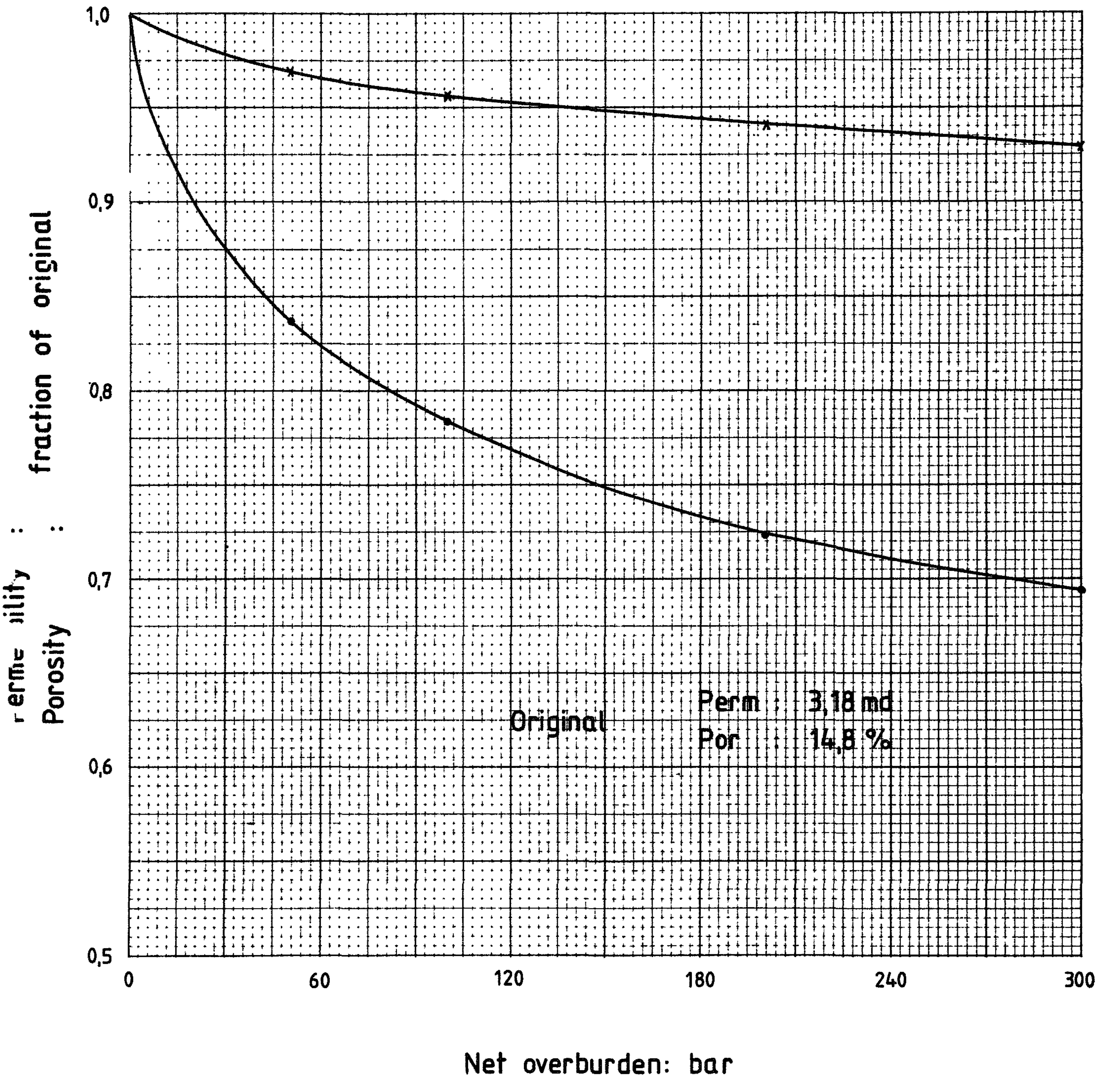
GECO Petroleum Laboratory

Permeability, Porosity Versus Net Overburden

No 90.1



POROSITY REDUCTION MEASURED BY HELIUM WITH NET OVERBURDEN

	15 bar		50 bar			100 bar			200 bar			300 bar		
Sample no	Pore Volume	Ø orig. %	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.
15.1	10.92	14.2	10.55	13.8	0.972	10.33	13.5	0.951	10.09	13.2	0.930	9.95	13.1	0.923
37.1	14.30	18.2	13.89	17.8	0.978	13.63	17.5	0.962	13.35	17.2	0.945	13.18	17.1	0.940
55.1	15.35	20.0	14.90	19.5	0.975	14.65	19.2	0.960	14.42	19.0	0.950	14.30	18.8	0.940
* 63.1	16.80	22.4	16.15	21.7	0.969	15.90	21.5	0.960	15.59	21.2	0.946	15.40	20.9	0.933
66.1	11.55	15.1	11.13	14.6	0.967	10.91	14.4	0.954	10.61	14.1	0.934	10.40	13.8	0.914
79.1	10.51	13.3	10.20	13.0	0.977	10.00	12.8	0.962	9.77	12.5	0.940	9.58	12.3	0.925

*) Plug irregularily shaped.

GECO

POROSITY REDUCTION MEASURED BY HELIUM WITH NET OVERBURDEN

PORE VOLUMES CORRECTED TO MATRIX CUP MEASUREMENTS

	Atm		50 bar			100 bar			200 bar			300 bar		
Sample no.	Pore Volume	Ø orig. %	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.	Pore Volume	Ø%	Ø.frac. of orig.
15.1	10.50	13.6	10.13	13.2	0.971	9.91	13.0	0.953	9.67	12.7	0.932	9.53	12.5	0.921
37.1	13.51	17.2	13.10	16.8	0.977	12.84	16.5	0.961	12.56	16.2	0.943	12.39	16.0	0.932
55.1	14.88	19.3	14.43	18.9	0.977	14.18	18.6	0.964	13.95	18.4	0.951	13.83	18.2	0.944
* 63.1	15.86	21.2	15.21	20.5	0.966	14.96	20.2	0.953	14.65	19.9	0.938	14.46	19.7	0.928
66.1	10.75	14.1	10.33	13.6	0.964	10.11	13.3	0.946	9.81	13.0	0.922	9.60	12.8	0.905
79.1	10.24	13.0	9.93	12.6	0.973	9.73	12.4	0.956	9.50	12.2	0.936	9.31	12.0	0.919

*) Plug irregularily shaped.

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KLINKENBERG CORRECTED AIR PERMEABILITY

at Net Overburden Pressure

Sample no. 15,1 Net Overburden Pressure Bar	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15	0.942	688	
	0.643	675	
	0.488	663	638
50	0.941	642	
	0.643	630	
	0.488	619	596
100	0.941	612	
	0.643	601	
	0.488	591	570
200	0.941	582	
	0.643	570	
	0.488	559	536
300	0.941	566	
	0.643	555	
	0.488	545	524

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KLINKENBERG CORRECTED AIR PERMEABILITY

at Net Overburden Pressure

Sample no. 37.1 Net Overburden Pressure Bar	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15	0.955	826	
	0.649	810	
	0.492	797	768
50	0.955	770	
	0.649	753	
	0.492	746	720
100	0.955	746	
	0.649	731	
	0.492	719	692
200	0.955	713	
	0.649	692	
	0.492	685	654
300	0.955	689	
	0.649	673	
	0.492	663	636

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KLINKENBERG CORRECTED AIR PERMEABILITY

at Net Overburden Pressure

Sample no. 55.1 Net Overburden Pressure Bar	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15	0.888	312	
	0.617	305	
	0.473	301	289
50	0.888	293	
	0.617	286	
	0.473	283	271
100	0.888	282	
	0.617	276	
	0.473	274	264
200	0.888	271	
	0.617	264	
	0.473	261	249
300	0.888	265	
	0.617	257	
	0.473	253	239

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KLINKENBERG CORRECTED AIR PERMEABILITY

at Net Overburden Pressure

Sample no. 63.1 Net Overburden Pressure Bar	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15	0.993	5825	
	0.667	5714	
	0.502	5620	5427
50	0.993	5186	
	0.667	5105	
	0.502	5026	4879
100	0.993	4875	
	0.667	4778	
	0.502	4715	4557
200	0.993	4569	
	0.667	4486	
	0.502	4437	4305
300	0.993	4296	
	0.667	4198	
	0.502	4135	3976

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KLINKENBERG CORRECTED AIR PERMEABILITY

at Net Overburden Pressure

Sample no. 66.1 Net Overburden Pressure Bar	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15	0.784	116	
	0.565	111	
	0.442	108	97.7
50	0.783	105	
	0.565	101	
	0.442	98.3	89.8
100	0.783	102	
	0.565	98.4	
	0.442	95.5	87.4
200	0.783	97.9	
	0.565	94.9	
	0.442	91.8	84.5
300	0.783	95.1	
	0.565	92.0	
	0.442	89.4	82.4

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KLINKENBERG CORRECTED AIR PERMEABILITY

at Net Overburden pressure

Sample no. 79.1 Net Overburden Pressure Bar	(Mean Pressure)$^{-1}$ (atm.abs.)$^{-1}$	Air permeability md	Klinkenberg corrected permeability md
15	0.509	4.38	
	0.407	4.23	
	0.339	4.07	3.48
50	0.509	3.95	
	0.407	3.73	
	0.339	3.59	2.87
100	0.509	3.61	
	0.407	3.42	
	0.339	3.24	2.52
200	0.509	3.18	
	0.407	3.00	
	0.339	2.85	2.20
300	0.509	2.94	
	0.407	2.73	
	0.339	2.60	1.92

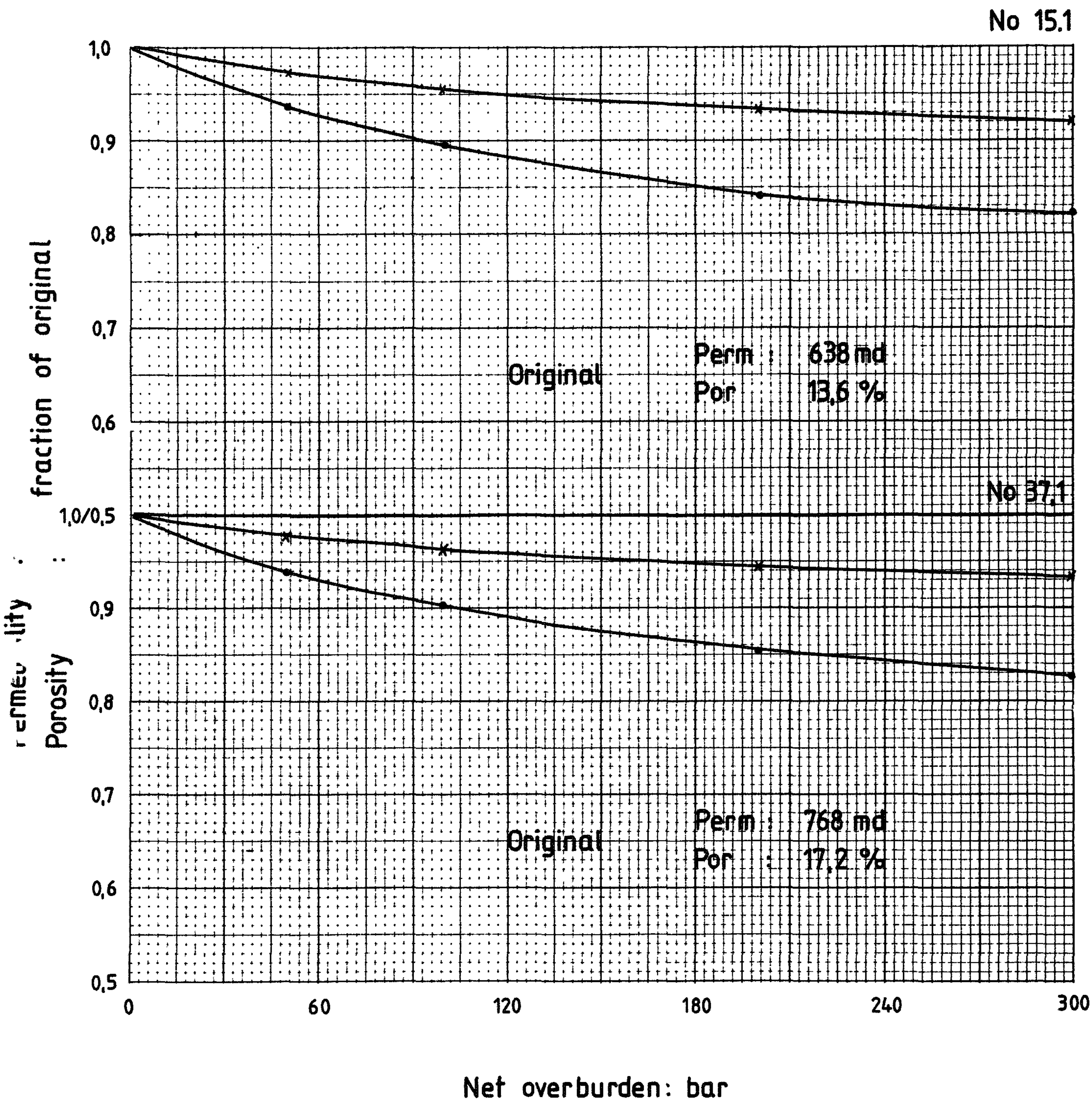
GECO

AIR PERMEABILITY REDUCTION WITH NET OVERBURDEN

Sample no.	15 bar K.e.l. orig.(md)	50 bar K.e.l. (md)	50 bar Fraction of orig.	100 bar K.e.l. (md)	100 bar Fraction of orig.	200 bar K.e.l. (md)	200 bar Fraction of orig.	300 bar K.e.l. (md)	300 bar Fraction of orig.
15.1	638	596	0.934	570	0.893	536	0.840	524	0.821
37.1	768	720	0.938	692	0.901	654	0.852	636	0.828
55.1	289	271	0.938	264	0.913	249	0.862	239	0.827
63.1	5427	4879	0.899	4557	0.840	4305	0.793	3976	0.733
66.1	97.7	89.8	0.919	87.4	0.895	84.5	0.865	82.4	0.843
79.1	3.48	2.87	0.825	2.52	0.724	2.20	0.632	1.92	0.552

GECO
Petroleum
Laboratory

Permeability, Porosity Versus Net Overburden



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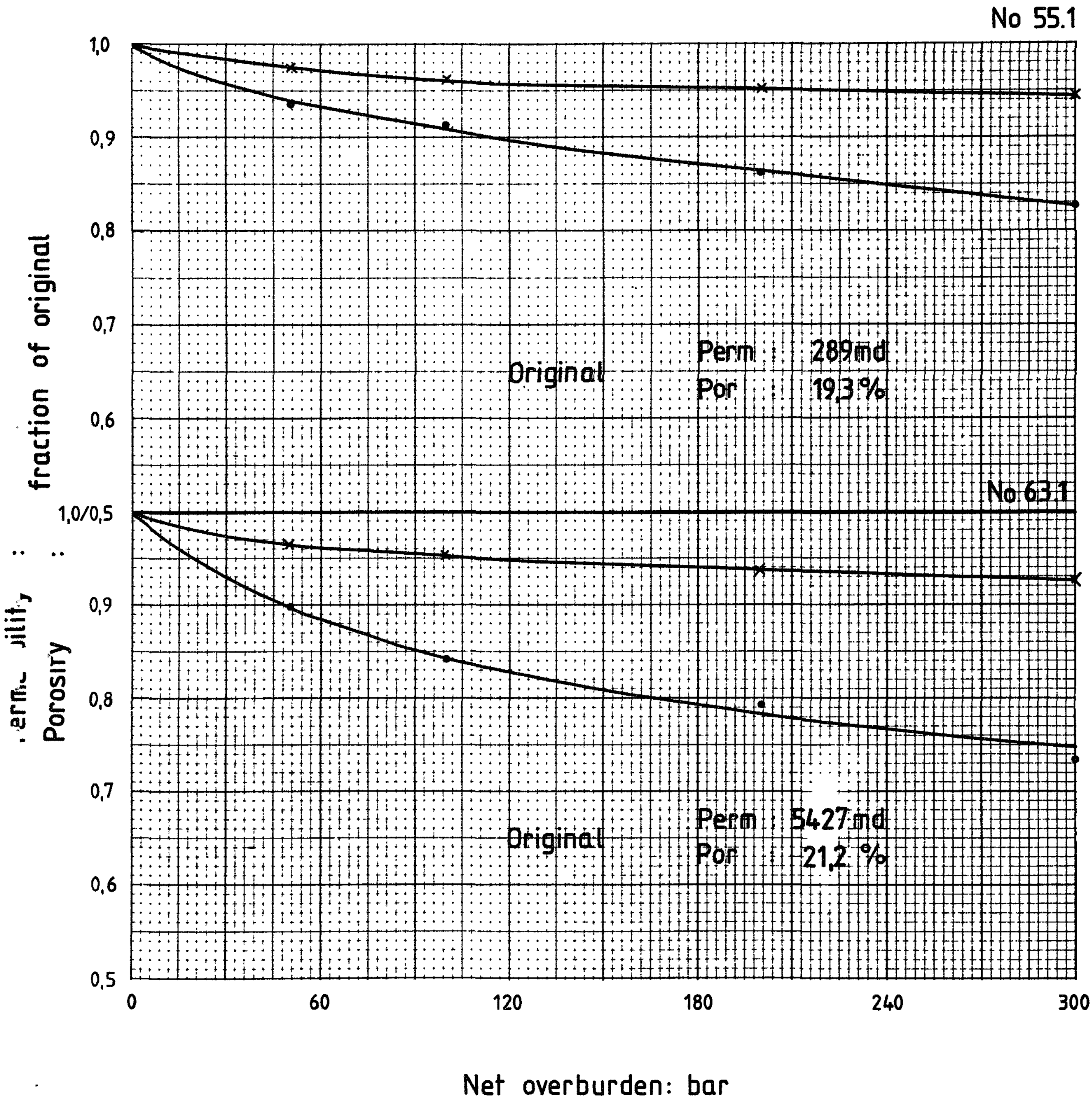
Permeability, Porosity Versus Net Overburden



Permeability, Porosity Versus Net Overburden