SPECIAL CORE ANALYSIS STUDY

FOR

NORSK SHELL EXPLORATION AND PRODUCTION

WELL: 31/2-13

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WELL: 31/2-13

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CORE LABORATORIES UK LTD.
Special Core Analysis

Norsk Shell Exploration and Production
Damlse Ferusuei 43,
P.O. Box 10,
N-4033, Forus,
Norway.

5th December 1984

Attention: G.J. Van Dijk

Subject: Special Core Analysis Study
Well: 31/2-13
File: UKSCAL 311-84140

Gentlemen,

In a purchase order dated 25th June 1984 from Norsk Shell Exploration and Production, Core Laboratories UK Limited was requested to perform formation factors as a function of overburden pressure and cation exchange capacity measurements on eleven, unconsolidated samples from the subject well.

The results of these measurements are presented herein, as a final report, and serve to confirm all previous preliminary data.

Eleven uncleaned samples were received for use in this study. The samples were all mounted in thin metal sleeves to prevent them disintegrating during cleaning and testing. They were cleaned in cool refluxing solvents and dried in a controlled humidity oven. Permeability to air, helium injection porosity and grain density were then measured.

The clean, dry samples were evacuated and pressure saturated with a simulated brine consisting of approximately 52,500 mg/L sodium chloride which was synthesised according to information furnished for use in this study. A copy of the analysis is presented on page 3.

The samples were then frozen and the protective sleeves removed. The unmounted frozen samples were each mounted in a hydraulic core holder and allowed to thaw, under 200 psi confining pressure. The samples were then flushed slowly with the simulated brine to ensure the removal of all trapped gas.

Electrical resistivities of the brine saturated samples and saturant brine were then measured on consecutive days until results stabilised indicating ionic equilibrium within the core samples. Formation resistivity factors were calculated and results are presented in tabular form on page 4 and in graphical form on page 5. The cementation exponent 'm' value is 1.85, with an intercept 'a' value of unity.

Cont'd.....

The measurements were then repeated at effective overburden pressures of 200 psi, 1500 psi and 3000 psi. A constant internal pore pressure of 200 psi was maintained throughout the resistivity measurements. Reductions in pore volumes with each increase in sleeve pressure were monitored by measurement of brine displaced from the samples.

Results are presented in tabular form on page 4 and in graphical form on pages 6 through 8. The cementation exponent value varied from 1.88 at 200 psi effective overburden pressure to 1.94 at 3000 psi effective overburden pressure.

The samples were then scheduled to undergo cation exchange capacity measurements. An ammonium acetate titration technique was used in determining the cation exchange capacity of each sample. Results are presented in tabular form on page 9.

It has been a pleasure working for Norsk Shell Exploration and Production on this study. Should you have any questions, please do not hesitate to contact us.

Yours faithfully,
CORE LABORATORIES UK LIMITED.

M. Boulby

Mr. M. Boulby
Laboratory Manager

MB/CPE/HW/DEC10

Identification And Description Of Samples

Company: NORSK SHELL EXPLORATION AND PROD. Well: 31/2-13

Formation: Field:

Country:

Sample Number	Depth, Metres	Lithological Description
1	1774.2	Sst, dk gry, f-mgr, vpcmt, msrt, mic, fe mins.
2	1809.6	As Above
3	1820.5	Sst, dk gry, f-mgr, pcmt, msrt, mic, fe mins.
4	1821.5	As Above
5	1822.1	As Above
6	1822.2	As Above
7	1823.1	As Above
8	1825.8	As Above
9	1833.8	Sst, dk gry, f-mgr, pcmt, m-psrt, mic, foss frags.
10	1836.6	As Above
11	1857.5	Sst, dk gry, f-mgr, vpcmt, msrt, tr mic, tr blk mins.

Permeability, Porosity And Grain Density

Company: NORSK SHELL EXPLORATION AND PROD. Well: 31/2-13

Formation: Field:

Country:

Sample Number	Depth, Metres	Permeability to Air, Millidarcys	Porosity, percent	Grain Density, gm/cm^3
1	1774.2	370	32.9	2.71
2	1809.6	172	29.2	2.67
3	1820.5	41	20.1	2.66
4	1821.5	65	28.4	2.68
5	1822.1	106	31.1	2.68
6	1822.2	58	30.2	2.69
7	1823.1	48	31.1	2.73
8	1825.8	39	28.5	2.62
9	1833.8	16	34.3	2.57
10	1836.6	26	31.2	2.58
11	1857.5	62	27.7	2.64

Water Analysis

Total Dissolved Solids, mg/L: 52,500

CONSTITUENTS	mg/L
Sodium Chloride	42,000
Calcium Chloride	10,500

Formation Resistivity Factor As A Function Of Overburden Pressure

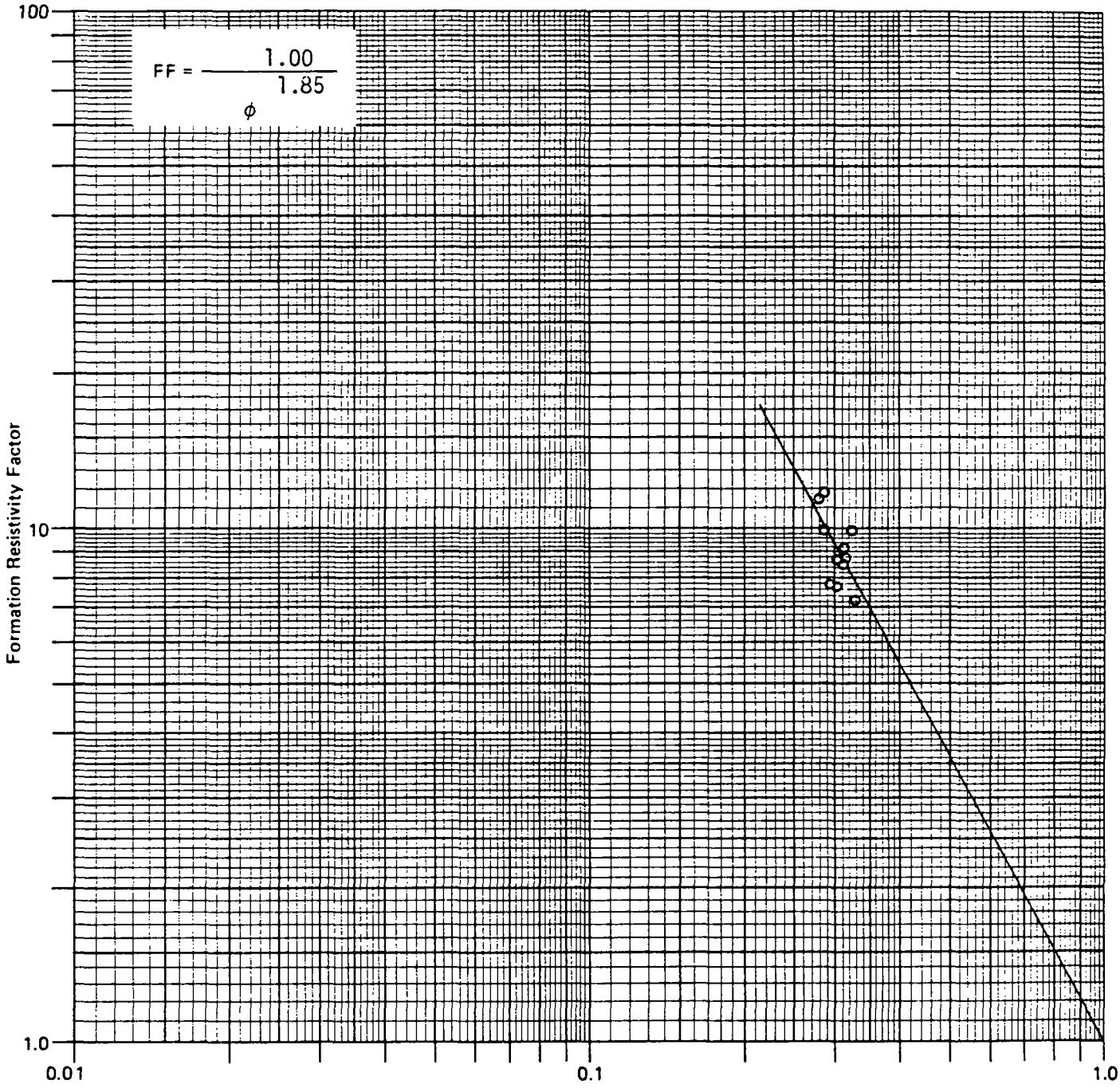
Company: NORSK SHELL EXPLORATION AND PROD. Well: 31/2-13
Formation: Field:
Country:
Saturant: SIMULATED BRINE
Resistivity of Saturant: 0.17 ohm-meters at 60 °F

Effective Overburden Pressure Psi:

Sample Number	ROOM CONDITIONS Porosity percent	ROOM CONDITIONS Formation factor	200 Porosity percent	200 Formation factor	1,500 Porosity percent	1,500 Formation factor	3,000 Porosity percent	3,000 Formation factor
1	32.9	7.26	32.6	7.35	30.9	8.14	29.9	8.66
2	29.2	7.80	28.6	7.97	25.9	9.60	23.9	11.0
3	30.1	8.75	29.5	8.98	25.8	11.7	23.8	13.4
4	28.4	9.86	27.7	10.5	24.9	14.3	23.5	16.1
5	31.1	8.56	30.8	9.14	29.1	10.6	27.7	11.0
6	30.2	7.71	29.7	8.16	28.2	10.5	23.9	12.6
7	31.1	9.16	30.6	10.2	27.9	12.2	26.3	13.6
8	28.5	11.8	28.0	13.3	25.6	18.3	24.3	21.8
9	34.3	9.97	33.7	10.9	30.0	15.9	27.0	21.7
10	31.2	8.74	30.5	9.59	27.0	13.0	24.3	17.1
11	27.7	11.4	27.3	12.6	25.3	15.6	24.1	17.4

Company NORSK SHELL EXPLORATION AND PROD. Formation
Well 31/2-13 Country
Field

ROOM CONDITIONS

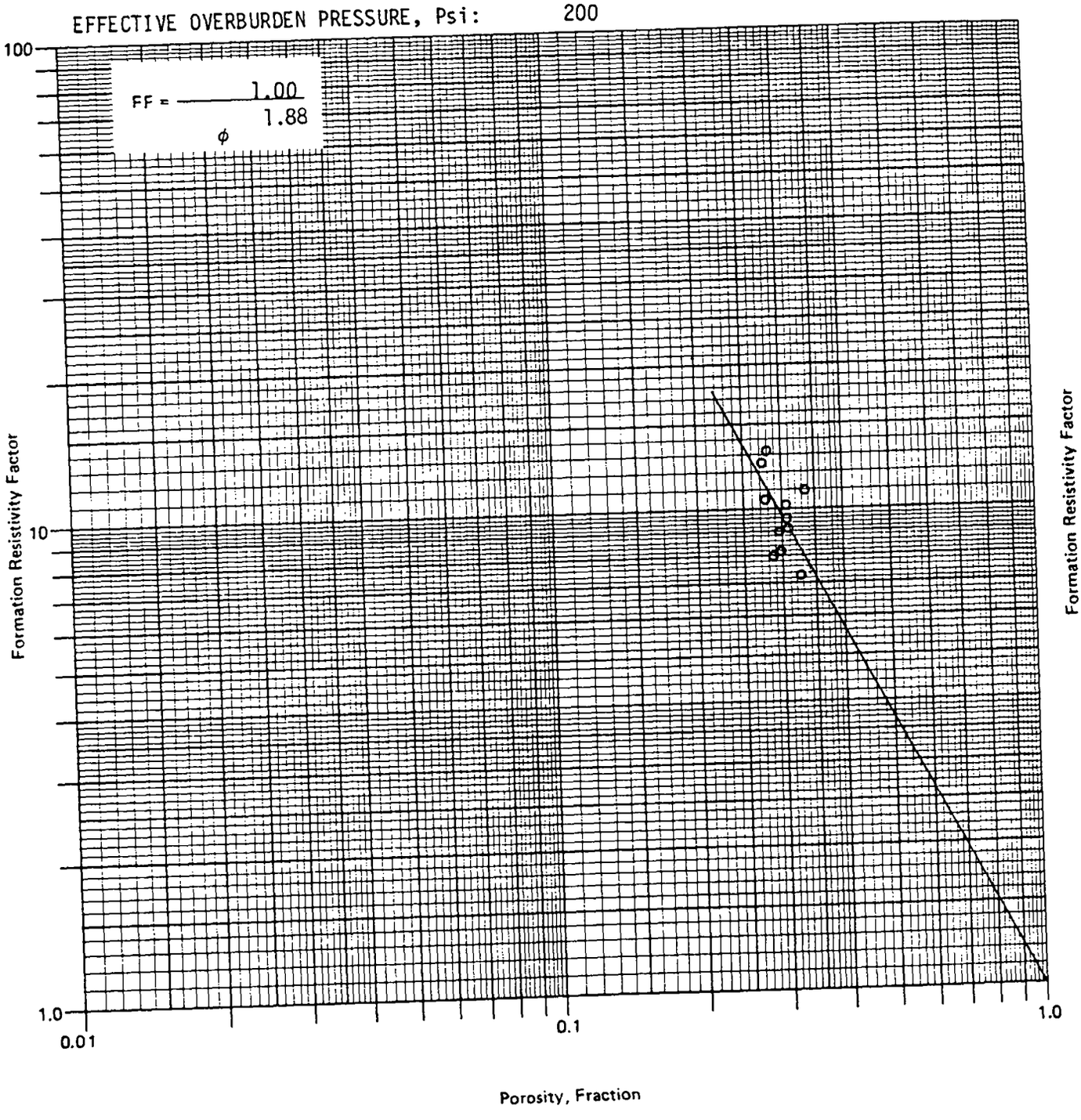


CORE LABORATORIES, UK LTD.
Petroleum Reservoir Engineering
LONDON·ABERDEEN

File UKSCAL 311-84140

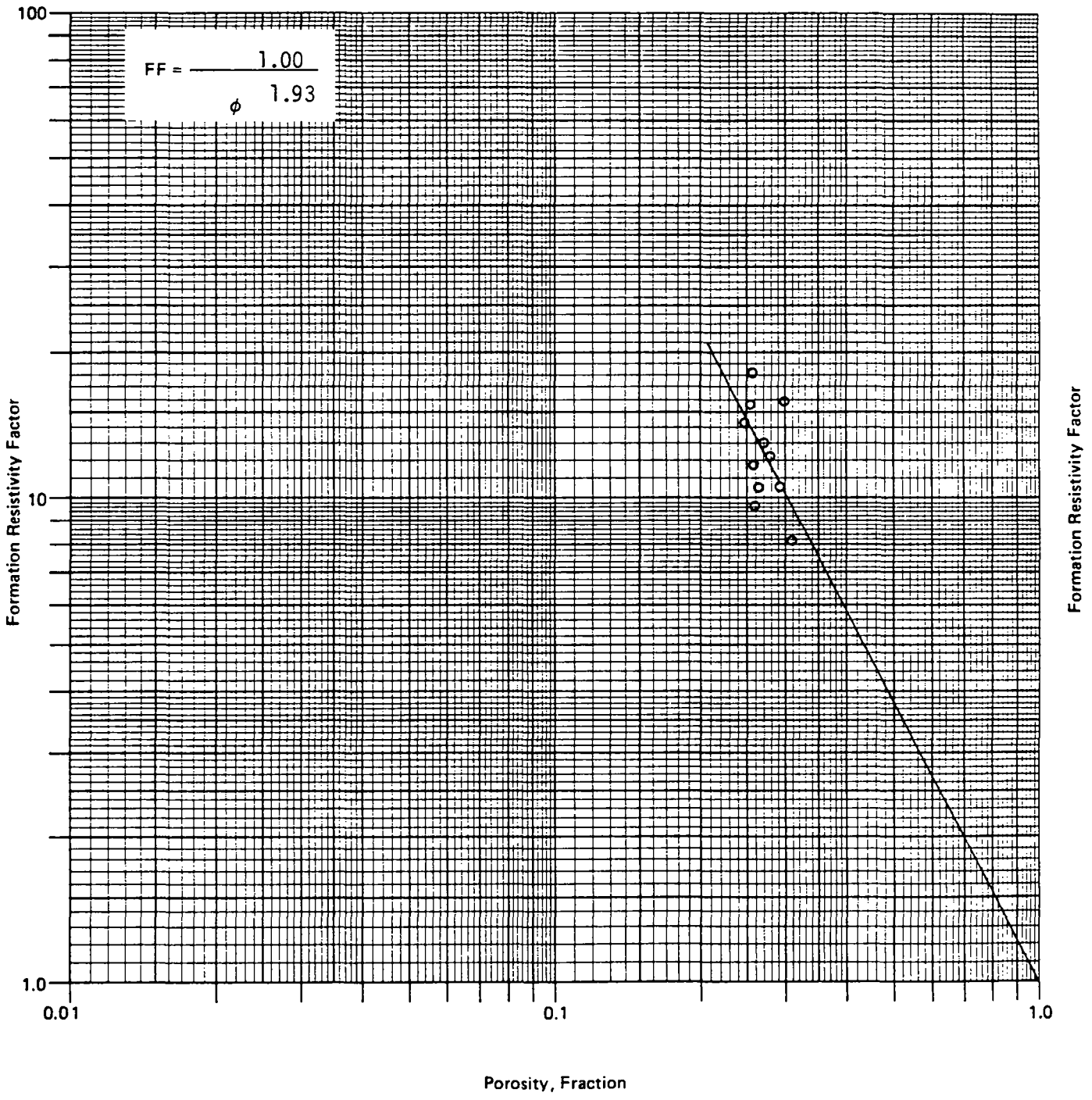
Company NORSK SHELL EXPLORATION AND PROD Formation
Well 31/2-13 Country
Field

EFFECTIVE OVERBURDEN PRESSURE, Psi: 200



Company NORSK SHELL EXPLORATION AND PROD Formation
Well 31/2-13 Country
Field

EFFECTIVE OVERBURDEN PRESSURE, Psi: 1,500

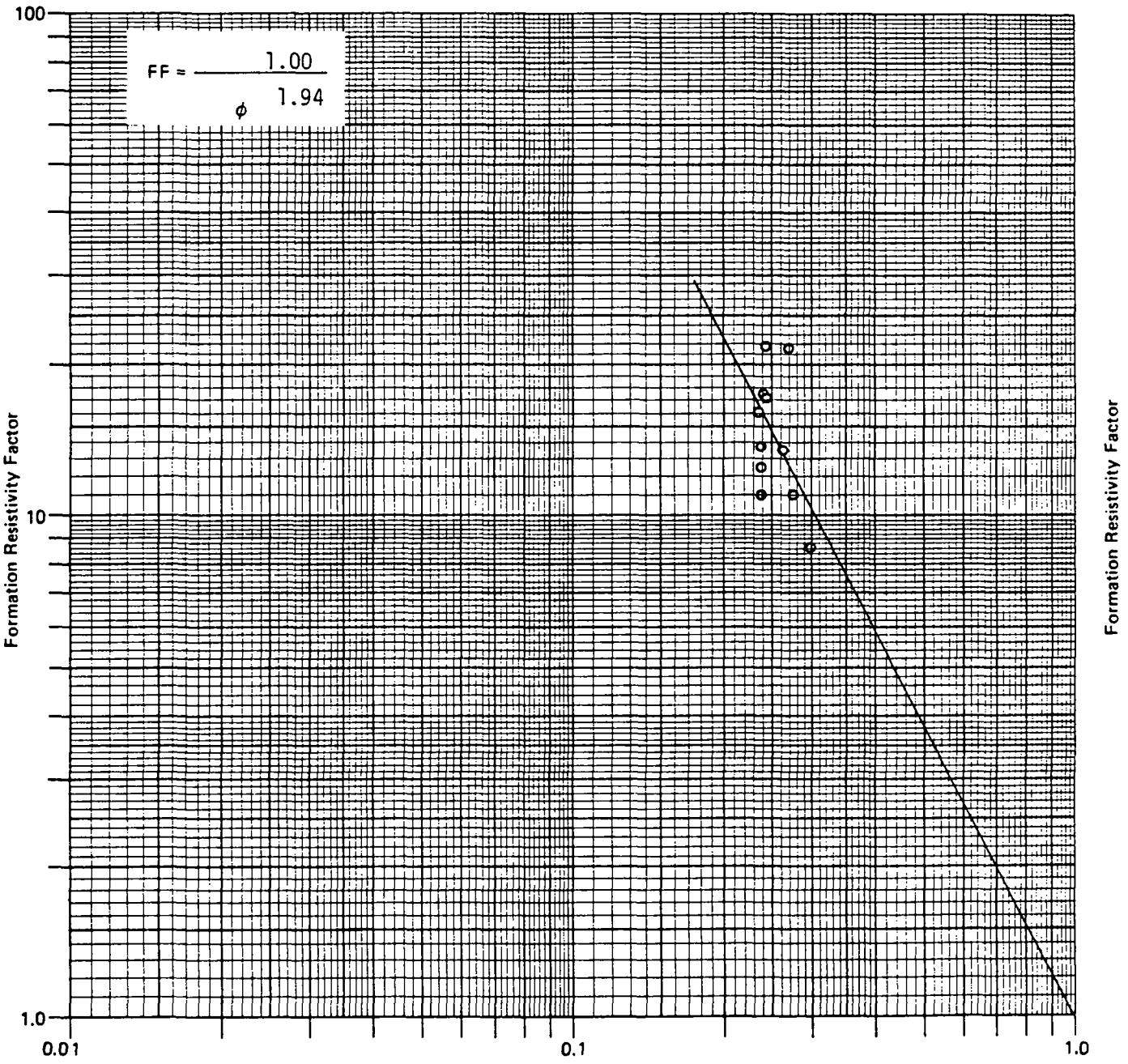


Company NORSK SHELL EXPLORATION AND PROD Formation

Well 31/2-13 Country

Field

EFFECTIVE OVERBURDEN PRESSURE, Psi: 3,000



Cation Exchange Capacity Data

Company: NORSK SHELL EXPLORATION AND PROD. Well: 31/2-13

Formation: Field:

Country:

Sample Number	Depth Metres	Porosity Percent	Cation Exchange Capacity Meq/100g	Pore Volume ccs/100g
1	1774.2	32.9	1.74	18.1
2	1809.6	29.2	1.56	15.5
3	1820.5	30.1	1.10	16.3
4	1821.5	28.4	2.12	14.6
5	1822.1	31.1	1.38	16.7
6	1822.2	30.2	1.35	16.5
7	1823.1	31.1	1.40	16.6
8	1825.8	28.5	2.20	15.2
9	1833.8	34.3	2.70	20.3
10	1836.6	31.2	1.88	17.5
11	1857.5	27.7	0.99	14.5