SPECIAL CORE ANALYSIS STUDY

FOR

B.P. PETROLEUM DEVELOPMENT LTD.

Well: 7/12-6

CORE LAB

SPECIAL CORE ANALYSIS STUDY

FOR

B.P. PETROLEUM DEVELOPMENT LTD.

Well: 7/12-6

CORE LABORATORIES UK LTD.

75 GREENFIELD ROAD,
LONDON E1 1EJ

Directors: J. S. Green (Managing)
W. B. P. O'Driscoll (Financial)
J. D. Wisenbaker (USA)
W. A. Robbins (USA)
M. Blackburn

Telephone: 01-377 9777
Telex: 8811086
Cable: CORELABOR

B.P. Petroleum Development Limited
P.O. Box 30
Mariero
4001-Stavanger
Norway

4th October 1982

Attention: Mr P.S. Buckley

Subject: Special Core Analysis Study
Well: 7/12-6
Formation: Ula
Area: North Sea, Norway
File: UKSCAL 311-81189

Gentlemen,

In a service order dated 10th September 1981, ref: EYN-040-18-337, Core Laboratories UK Limited was requested to perform a series of special core analysis measurements, as listed below, on samples from the subject well.

Group 1
a). Formation Factor and Resistivity Index
b). Formation Factor as a Function of Overburden Pressure.
c). Air-Brine Capillary Pressure with Height Correlations and Calculations
d). Mercury Injection and Pore Size Distribution
e). Amott Wettability
f). Cation Exchange Capacity
g). Clay Analysis

Group 2
h). Liquid Permeability as a Function of Throughput
i). Porosity and Permeability as a Function of Overburden Pressure

Group 3
j). Waterflood Susceptibility
k). Steady-State Water-Oil Relative Permeability
l). Waterflood Susceptibility at Reservoir Conditions.

Cont'd.....

Table of Contents

Results for the Group 1 analyses were submitted as a final report in May 1982, results for the Group 2 analyses are presented herein as a final report and serve to confirm previous preliminary data. Results for Group 3 analyses will be submitted as a final report at a later date. A table of contents immediately follows this letter.

It has been a pleasure working with B.P. Petroleum Development Limited on this study. Should you have any questions please do not hesitate to contact us.

Yours faithfully,
CORE LABORATORIES UK LIMITED

Jon Roberts
Laboratory Manager - Special Core Analysis

JCR/MTD/hsb

10cc - Addressee

1cc - G. Langley
B.P. Research Centre
Chertsey Road
Sunbury-on-Thames
Middlesex TW16 1LN

Special Core Analysis Procedures

Sample Preparation

A total of thirty-four preserved, full diameter core pieces were received for use in this study. From this core, forty-two one and a half inch diameter core plug samples were drilled using synthetic formation brine as the bit lubricant. Upon completion of the drilling programme the core was resealed in saran wrap, aluminium foil and wax.

The samples were cleaned in hot refluxing solvents at a temperature of approximately 60°C until the effluent was clear, they were then leached in methanol. In a letter dated 8th September 1981 from B.P. Petroleum Development Limited, outlining testing procedures, it was requested that if the samples were well consolidated, they should not undergo humidity controlled drying and permeability and porosity measurements until completion of the test scheduled for the samples. As the samples were well consolidated these instructions were carried out where testing procedures permitted. All samples used are described with respect to depth and lithology on page 1.

Liquid Permeability as a Function of Throughput Date (Page 6)

Six samples were scheduled to undergo this anlaysis.

The samples were pressure saturated with treated, degassed kerosene, they were each then mounted in a hydraulic core holder and were flushed with this kerosene. Permeability was monitored at regular intervals and after a throughput of approximately 200 pore volumes permeability was monitored in the reverse flow direction. In all cases permeability to the kerosene measured in the reverse direction of flow, did not change by a significant amount.

Throughout the flushes permeabilities remained stable except for sample 25A where there was an increase of approximately 14% in permeability.

The samples were then recleaned in hot xylene followed by methanol, they were then pressure saturated with synthetic formation brine. This brine consisted of approximately 247,000 mg/l total dissolved solids and was synthesised according to information furnished for use in this study. A copy of this analysis is presented on page 4. The samples were each then mounted in a hydraulic core holder and were flushed with the brine. Permeability was monitored at regular intervals for a throughput of approximately 200 pore volumes. Permeability was again measured in the reverse direction of flow, and again the permeability did not change by a significant amount. For sample 3A, although permeability remained stable throughout the flush, the meaured permeability was approximately 21% higher than that measured for the kerosene flush.

Cont'd.....

For sample number 7A the initial permeability to the brine was the same as for the kerosene flush, however, permeability during the brine flush increased sharply by 42% and then stabilised at this higher figure. For samples 11A and 18A permeability throughout the brine flush remained fairly stable and the permeability to the brine is comparable to the permeability to kerosene. For sample 25A the permeability to the brine is comparable to the final permeability to the kerosene. For sample 30A again the permeability to the brine remained fairly stable and the initial permeablity to the brine is comparable to the final permeability to the kerosene. However, there is a gradual decline in permeability, the final brine permeability being approximately 14% lower than the final kerosene permeability.

Following the synthetic formation brine flush the samples were flushed with North Sea Water. This brine consisted of approximately 36,000 mg/l total dissolved solids and a copy of this analysis is presented on page 5. Permeability was monitored for approximately 200 pore volumes throughput and the permeability was then measured in the reverse direction of flow, and again the reverse permeabilities were very similar to the final forward permeabilities.

For samples numbered 3A, 11A, 18A and 30A, permeability remained fairly stable throughout the flush and permeabilities measured were similar to those measured during the synthetic formation brine flush. For sample 7A the initial permeability to the seawater was very similar to the initial permeability to the synthetic formation brine, however as in the previous flush, the permeability increased, but by only 15% as compared to an increase of 42% measured previously. For sample 25A, the initial permeability to seawater was 15% lower than the final permeability to the synthetic formation brine. During this flush permeability declined and the final permeability was 10% lower than the initial and 24% lower than the final permeability to the synthetic formation brine.

The samples were then cleaned in hot methanol followed by xylene, and were then pressure saturated with treated degassed kerosene. The samples were then each mounted in a hydraulic core holder and were flushed with the kerosene for a throughput of approximately 200 pore volumes. Permeability was monitored throughout and when permeability was measured in the reverse direction of flow, permeability was found to be very similar to the final forward permeability.

For samples numbered 3A, 7A, 11A, 18A and 30A permeability remained stable throughout the flush and permeabilities to the kerosene were very similar to those measured during the brine flushes. For sample 25A, the initial permeability to the kerosene was similar to the final permeability to the seawater, however during the flush, permeability

Cont'd.....

increased sharply and the final permeability was 44% higher than the initial. The final permeability is comparable to the final permeability obtained during the previous kerosene and synthetic formation brine flush.

Following these measurements the samples were recleaned in hot refluxing solvents and dried in a humidity controlled oven. Air permeability and helium injection porosity were then measured.

Samples numbered 7A and 30A were evacuated and pressure saturated with treated degassed kerosene, they were each then mounted in a hydraulic core holder and were flushed with this kerosene for a throughput of approximately 200 pore volumes. Permeability was monitored throughout, and was then measured in the reverse flow direction where for both samples it was stable, as compared to the final forward permeability.

For sample 7A, permeability remained stable and was similar to the permeabilities measured previously. For samples 30A however, the initial permeability was 12% lower then the final permeability measured previously. Permeability declined further and the final permmeability was 16% lower than the final permeability measured in the previous flush.

The samples were then cleaned in xylene followed by methanol, they were then saturated with synthetic formation brine, and were each then mounted in a hydraulic core holder and were flushed with the brine for approximately 200 pore volumes throughput. Again permeability was measured in the reverse direction of flow and again it was found to be stable as compared to the final forward permeability

For sample 7A the initial permeability increased by 20% as compared to the previous flush. This permeability remained constant throughout and this permeability is comparable to the final permeability measured in the previous synthetic formation brine flush.

For sample 30A, the initial permeability was 10% lower than the final kerosene permeability, however permeability increased with throughput and the final permeability was 16% higher than the final kerosene permeability.

Air Permeability and Helium Injection Porosity as a Function of Overburden Pressure Data (Page 40)

The samples which had previously undergone liquid permeability measurements were also scheduled to undergo this analysis.

Cont'd.....

Samples numbered 7A and 30A were recleaned in hot refluxing solvents and dried in a humidity controlled oven. Air permeability and helium injection porosity were then measured. Sample number 30A fractured and was unsuitable for further analysis.

The remaining five samples were each placed in a hydraulic core holder and air permeability and helium injection porosity were measured at increasing sleeve pressure of approximately 2650 psi, 3350 psi, 3950 psi and 4750 psi. These overburden pressures were maintained between measurements.

Once the measurements had been completed, the overburden pressure was removed, and two samples numbered 7A and 25A were selected for hysteresis checks. The samples underwent the measurements as before and for both samples the results obtained compare closely with the first set of overburden results, and fall within the acceptable range of accuracy for the measurements. Results are presented in tabular form on page 40.

COMPANY: B.P. PET. DEV. LTD. NORWAY
FORMATION: ULA

WELL: 7/12-6
COUNTRY: NORTH SEA

FIELD:
STATE: UK

IDENTIFICATION AND DESCRIPTION OF PLUG SAMPLES

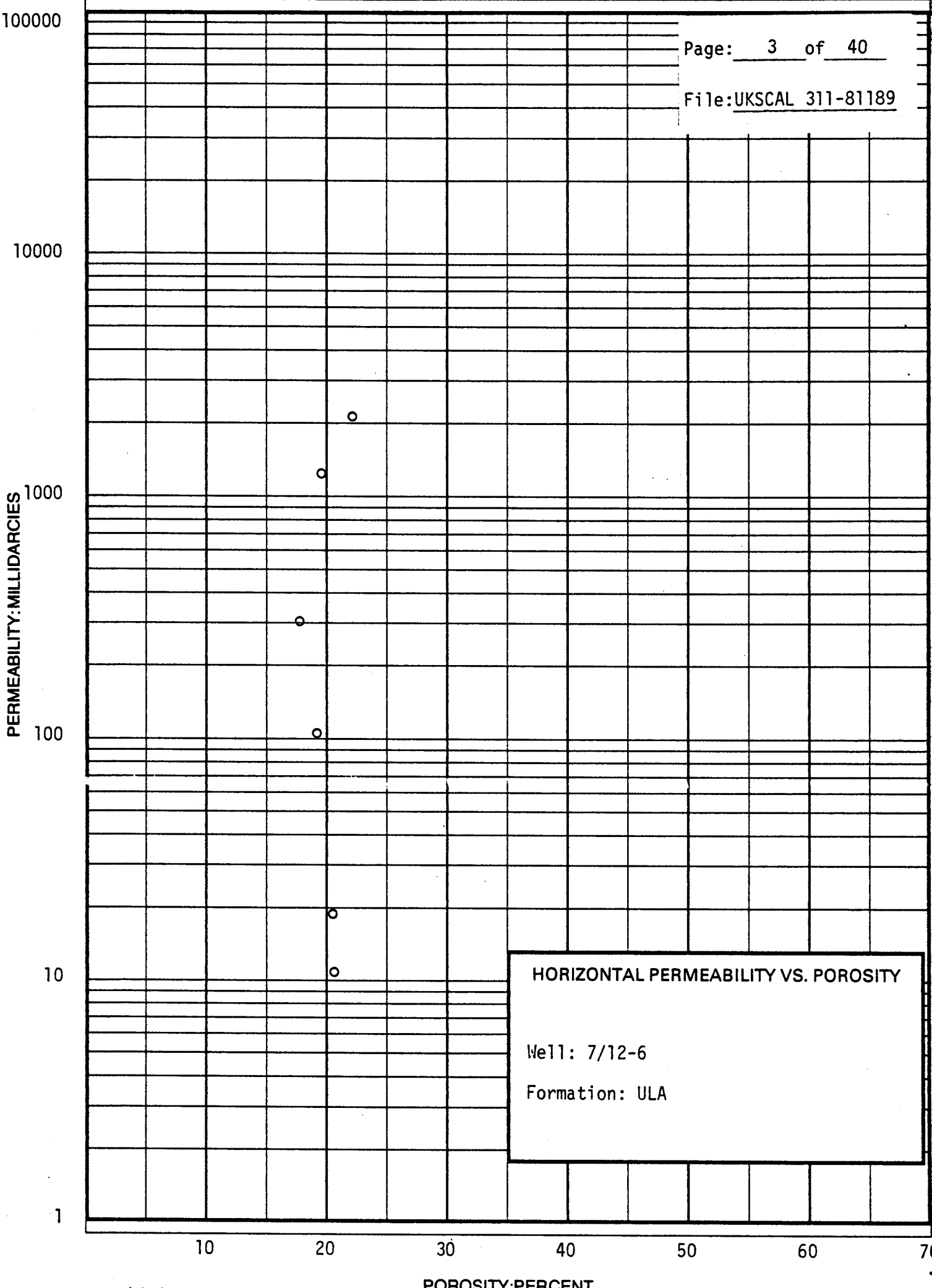
Sample Number	Depth Metres	Lithological Description
3A	3412.61	Sst, gry, f-vfgr, sbang-sbrndd, m-wsrt, wlcmt, carb, mic, tr pyr, tr calc.
7A	3423.89	Sst, gry, f-vfgr, sbang-sbrndd, m-wsrt, m-wlcmt, carb, mic, sl tr calc.
11A	3440.86	Sst, gry, m-fgr, sbang, m-wsrt, m-wlcmt, carb/arg lyrs & strks, calc in pts, tr mic.
18A	3463.61	As above.
25A	3480.09	Sst, gry, m-fgr, ang-sbang, m-wsrt, m-wlcmt, carb, tr mic, tr calc in pts.
30A	3494.13	Sst, gry, m-fgr, sbang-sbrndd, m-wsrt, mcmt, tr carb, tr mic, tr calc, w/calc cmt in pt of plug, w/sb vert frac.

Air Permeability, Helium Porosity and Grain Density Data

Sample Number	Air Permeability, Md	Helium Porosity (Per Cent)	Grain Density
3A	11 (8.6)*	20.8	2.66
7A	19 (15)*	20.7	2.65
11A	307 (294)*	17.6	2.64
18A	105 (94)*	19.1	2.65
25A	2060 (1980)*	22.3	2.63
30A	1270 (1215)*	19.4	2.64

* Klinkenberg Corrected

File:UKSCAL 311-81189



HORIZONTAL PERMEABILITY VS. POROSITY

Well: 7/12-6

Formation: ULA

FORMATION WATER ANALYSIS DATA

CONSTITUENTS

CATIONS

	Mg/L	Meq/L
Sodium	52225	2271.8
Potassium	3507	89.7
Calcium	34675	1730.3
Magnesium	2249	185.0
Barium	91	1.3
Iron	107	3.8
Strontium	1157	26.4
Lithium	29.2	4.2

ANIONS

Chloride	153025	4316.8
Sulphate	44	0.92
Bicarbonate	134	2.2
Carbonate	NIL	-
Sulphide	NIL	-
Hydroxide	NIL	-
Bromide	160	2.0

Total Dissolved Solids: 247.400 mg/L
Density: 1.174 gm/cc at 68°F
Ph at 25°C: 5.4
Resistivity at 25°C/77°F = 0.0520 ohm-m

NORTH SEA WATER ANALYSIS DATA

CONSTITUENTS:	Mg/L:	Meq/L:
CATIONS:		
Sodium	11,100	482.9
Calcium	430	21.5
Magnesium	1,340	110.2
Iron	< 0.01	< 0.01
ANIONS:		
Chloride	19,900	561.4
Bicarbonate	153	2.5
Sulphate	2,770	57.7

Total Dissolved Solids, Mg/l: 35,693
Specific Gravity at 60°F: 1.022

LIQUID PERMEABILITY DATA

Sample Number: 3A Porosity, Per Cent: 20.8

Air Permeability, MD: 11 (8.6)* Liquid: Kerosene (Phase 1)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
6.8	0.401	0.618	*0.791
6.7	0.801	0.609	*0.779
6.6	2.00	0.600	*0.767
6.3	4.01	0.573	*0.733
6.4	8.01	0.582	*0.744
6.5	12.0	0.591	*0.756
6.4	16.0	0.582	*0.744
6.4	24.0	0.582	*0.744
6.4	32.1	0.582	*0.744
6.4	40.1	0.582	*0.744
6.4	56.1	0.582	*0.744
6.4	64.1	0.582	*0.744
6.5	72.1	0.591	*0.756
6.5	80.1	0.591	*0.756
6.5	96.2	0.591	*0.756
6.5	128	0.591	*0.756
6.4	160	0.582	*0.744
6.4	192	0.582	*0.744
6.4**	-	0.582	*0.744

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 3A Porosity, Per Cent: 20.8

Air Permeability, MD: 11 (8.6)* Liquid: Synthetic Formation Brine (Phase 2)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
8.2	0.401	0.745 *0.953
8.3	0.801	0.755 *0.965
8.4	2.00	0.764 *0.977
8.8	4.01	0.800 *1.023
8.7	8.01	0.791 *1.012
8.8	12.0	0.800 *1.023
8.7	16.0	0.791 *1.012
8.8	24.0	0.800 *1.023
8.7	32.1	0.791 *1.012
8.8	40.1	0.800 *1.023
8.8	56.1	0.800 *1.023
8.9	64.1	0.809 *1.035
8.8	72.1	0.800 *1.023
8.8	80.1	0.800 *1.023
8.8	96.2	0.800 *1.023
8.7	128	0.791 *1.012
8.7	160	0.791 *1.012
8.8	192	0.800 *1.023
8.7**	-	0.791 *1.012

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
LONDON—ABERDEEN

File: UKSCAL 311-81189

LIQUID PERMEABILITY DATA

Sample Number: 3A Porosity, Per Cent: 20.8

Air Permeability, MD: 11 (8.6)* Liquid: North Sea Water (Phase 3)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
8.2	0.401	0.745 *0.953
8.2	0.801	0.745 *0.953
8.3	2.00	0.755 *0.965
8.2	4.01	0.745 *0.953
8.1	8.01	0.736 *0.942
8.2	12.0	0.745 *0.953
8.2	16.0	0.745 *0.953
8.3	24.0	0.755 *0.965
8.3	32.1	0.755 *0.965
8.3	40.1	0.755 *0.965
8.2	56.1	0.745 *0.953
8.3	64.1	0.755 *0.965
8.3	72.1	0.755 *0.965
8.3	80.1	0.755 *0.965
8.3	96.2	0.755 *0.965
8.3	128	0.755 *0.965
8.2	160	0.745 *0.953
8.2	192	0.745 *0.953
8.2**	-	0.745 *0.953

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 3A Porosity, Per Cent: 20.8

Air Permeability, MD: 11 (8.6)* Liquid: Kerosene (Phase 4)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
8.1	0.401	0.736	*0.942
8.1	0.801	0.736	*0.942
7.8	2.00	0.709	*0.907
7.9	4.01	0.718	*0.919
7.8	8.01	0.709	*0.907
8.2	12.0	0.745	*0.953
8.0	16.0	0.727	*0.930
8.0	24.0	0.727	*0.930
8.1	32.1	0.736	*0.942
8.0	40.1	0.727	*0.930
8.1	56.1	0.736	*0.942
8.1	64.1	0.736	*0.942
8.1	72.1	0.736	*0.942
8.0	80.1	0.727	*0.930
8.1	96.2	0.736	*0.942
8.1	128	0.736	*0.942
8.0	160	0.727	*0.930
8.1	192	0.736	*0.942
8.0**	-	0.727	*0.930

* Klinkenberg Corrected

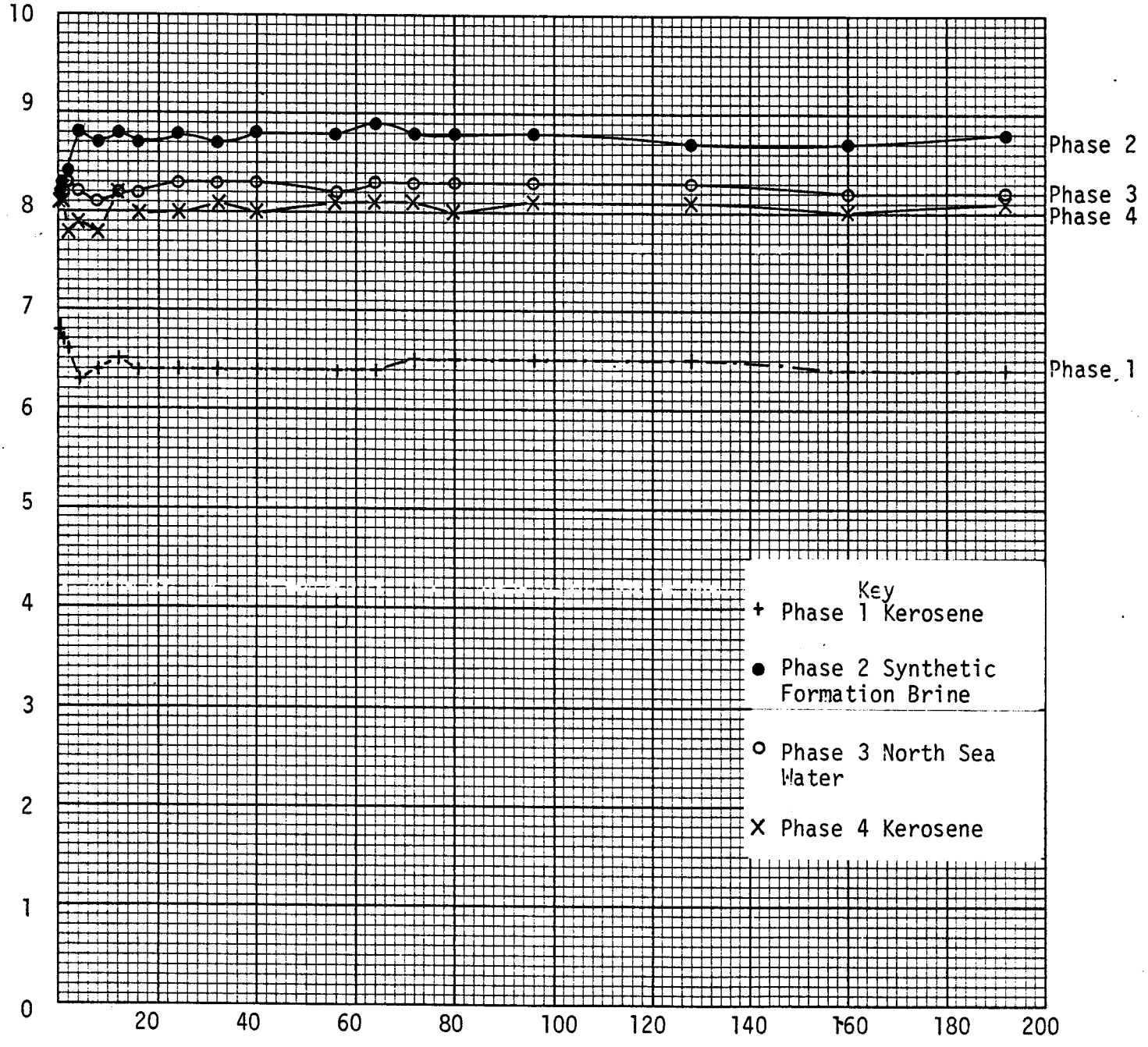
** Measured in Reverse Flow Direction

Company B.P. PET. DEV. LTD. NORWAY
Well 7/12-6
Field

Formation ULA
Country NORTH SEA
NORWAY

SAMPLE NUMBER: 3A

DEPTH, METRES: 3412.61



LIQUID PERMEABILITY DATA

Sample Number: 7A Porosity, Per Cent: 20.7

Air Permeability, MD: 19 (15)* Liquid: Kerosene (Phase 1)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
12	0.457	0.632	*0.800
12	0.914	0.632	*0.800
12	2.29	0.632	*0.800
12	4.57	0.632	*0.800
13	9.14	0.684	*0.867
12	18.3	0.632	*0.800
12	27.4	0.632	*0.800
13	36.6	0.684	*0.867
13	45.7	0.684	*0.867
13	54.8	0.684	*0.867
13	64.0	0.684	*0.867
12	73.1	0.632	*0.800
12	82.3	0.632	*0.800
12	91.4	0.632	*0.800
12	110	0.632	*0.800
12	146	0.632	*0.800
12	165	0.632	*0.800
12	192	0.632	*0.800
12**	-	0.632	*0.800

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 7A Porosity, Per Cent: 20.7

Air Permeability, MD: 19 (15)* Liquid: Synthetic Formation Brine (Phase 2)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
12	0.457	0.632	*0.800
12	0.914	0.632	*0.800
11	2.29	0.579	*0.733
17	4.57	0.895	*1.133
17	9.14	0.895	*1.133
17	18.3	0.895	*1.133
17	27.4	0.895	*1.133
17	36.6	0.895	*1.133
17	45.7	0.895	*1.133
17	54.8	0.895	*1.133
17	64.0	0.895	*1.133
17	73.1	0.895	*1.133
17	82.3	0.895	*1.133
17	91.4	0.895	*1.133
17	110	0.895	*1.133
17	146	0.895	*1.133
17	165	0.895	*1.133
17	192	0.895	*1.133
17**	-	0.895	*1.133*

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 7A Porosity, Per Cent: 20.7

Air Permeability, MD: 19 (15)* Liquid: North Sea Water (Phase 3)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
13	0.457	0.684	*0.867
15	0.914	0.790	*1.000
15	2.29	0.790	*1.000
15	4.57	0.790	*1.000
15	9.14	0.790	*1.000
15	18.3	0.790	*1.000
15	27.4	0.790	*1.000
15	36.6	0.790	*1.000
15	45.7	0.790	*1.000
15	54.8	0.790	*1.000
15	64.0	0.790	*1.000
15	73.1	0.790	*1.000
15	82.3	0.790	*1.000
15	91.4	0.790	*1.000
15	110	0.790	*1.000
15	146	0.790	*1.000
15	165	0.790	*1.000
15	192	0.790	*1.000
15**	-	0.790	*1.000

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 7A Porosity, Per Cent: 20.7

Air Permeability, MD: 19 (15)* Liquid: Kerosene (Phase 4)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
17	0.457	0.895	*1.133
17	0.914	0.895	*1.133
17	2.29	0.895	*1.133
17	4.57	0.895	*1.133
17	9.14	0.895	*1.133
17	18.3	0.895	*1.133
17	27.4	0.895	*1.133
17	36.6	0.895	*1.133
16	45.7	0.842	*1.067
17	54.8	0.895	*1.133
17	64.0	0.895	*1.133
16	73.1	0.842	*1.067
16	82.3	0.842	*1.067
17	91.4	0.895	*1.133
17	110	0.895	*1.133
16	146	0.842	*1.067
16	165	0.842	*1.067
16	192	0.842	*1.067
16**	-	0.842	*1.067

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 7A Porosity, Per Cent: 20.8

Air Permeability, MD: 19 (15)* Liquid: Kerosene (Phase 5)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
16	0.454	0.842	*1.067
15	0.907	0.789	*1.000
15	2.27	0.789	*1.000
15	4.54	0.789	*1.000
15	9.07	0.789	*1.000
15	13.6	0.789	*1.000
15	18.1	0.789	*1.000
15	27.2	0.789	*1.000
15	36.3	0.789	*1.000
15	45.4	0.789	*1.000
15	54.4	0.789	*1.000
15	63.5	0.789	*1.000
15	72.6	0.789	*1.000
15	81.7	0.789	*1.000
15	90.7	0.789	*1.000
15	109	0.789	*1.000
15	127	0.789	*1.000
15	163	0.789	*1.000
15	218	0.789	*1.000
15**	-	0.789	*1.000

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 7A Porosity, Per Cent: 20.8

Air Permeability, MD: 19 (15)* Liquid: Synthetic Formation Brine (Phase 6)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
18	0.454	0.947	*1.200
18	0.907	0.947	*1.200
18	2.27	0.947	*1.200
18	4.54	0.947	*1.200
18	9.07	0.947	*1.200
18	13.6	0.947	*1.200
18	18.1	0.947	*1.200
18	27.2	0.947	*1.200
18	36.3	0.947	*1.200
18	45.4	0.947	*1.200
18	54.4	0.947	*1.200
18	63.5	0.947	*1.200
18	72.6	0.947	*1.200
18	81.7	0.947	*1.200
18	90.7	0.947	*1.200
18	109	0.947	*1.200
18	127	0.947	*1.200
18	163	0.947	*1.200
18	218	0.947	*1.200
18**	-	0.947	*1.200

* Klinkenberg Corrected

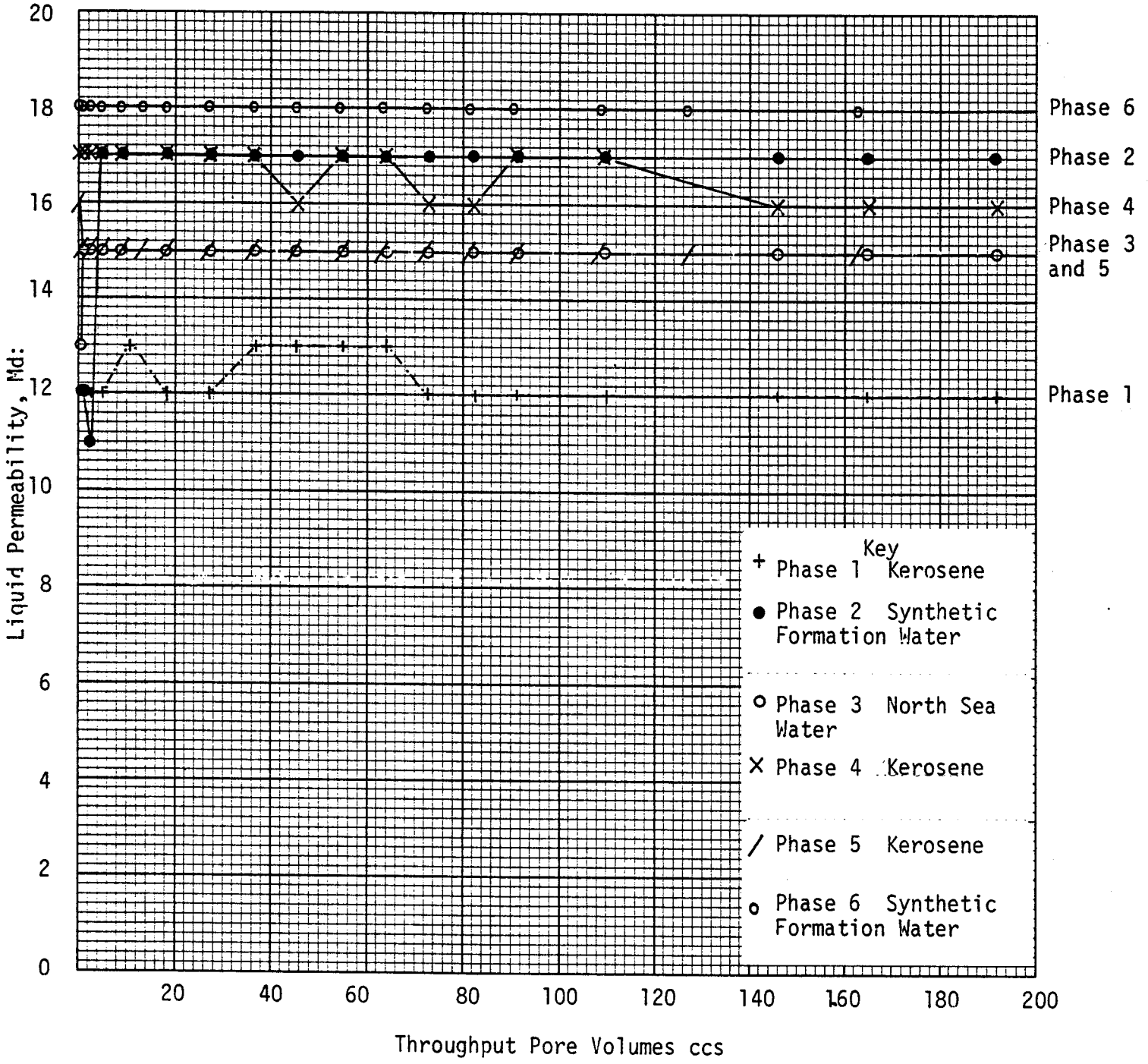
* Measured in Reverse Flow Direction

Company B.P. PET. DEV. LTD. NORWAY
Well 7/12-6
Field

Formation ULA
Country NORTH SEA
NORWAY

SAMPLE NUMBER 7A

DEPTH, METRES: 3423.89



LIQUID PERMEABILITY DATA

Sample Number: 11A Porosity, Per Cent: 17.6

Air Permeability, MD: 307 (294)* Liquid: Kerosene (Phase 1)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
263	0.556	0.857	*0.895
268	1.11	0.873	*0.912
258	2.78	0.840	*0.878
258	5.56	0.840	*0.878
259	11.1	0.844	*0.881
259	16.7	0.844	*0.881
255	22.2	0.831	*0.867
257	33.4	0.837	*0.874
261	44.5	0.850	*0.888
260	55.6	0.847	*0.884
256	66.7	0.834	*0.871
260	77.9	0.847	*0.884
267	89.0	0.870	*0.908
264	100	0.860	*0.898
264	122	0.860	*0.898
267	145	0.870	*0.908
265	167	0.863	*0.901
264	211	0.860	*0.898
260**	-	0.860	*0.898

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 11A Porosity, Per Cent: 17.6

Air Permeability, MD: 307 (294)* Liquid: Synthetic Formation Brine (Phase 2)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
233	0.556	0.759	*0.793
233	1.11	0.759	*0.793
237	2.78	0.772	*0.806
237	5.56	0.772	*0.806
237	11.1	0.772	*0.806
233	16.7	0.759	*0.793
238	22.2	0.775	*0.810
233	33.4	0.759	*0.793
246	44.5	0.801	*0.837
241	55.6	0.785	*0.820
249	66.7	0.811	*0.847
251	77.9	0.818	*0.854
248	89.0	0.808	*0.844
253	100	0.824	*0.861
252	122	0.821	*0.857
257	145	0.837	*0.874
259	167	0.844	*0.881
257	211	0.837	*0.874
255**	-	0.831	*0.867

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 11A Porosity, Per Cent: 17.6

Air Permeability, MD: 307 (294)* Liquid: North Sea Water (Phase 3)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
244	0.556	0.795	*0.830
244	1.11	0.795	*0.830
247	2.78	0.805	*0.840
252	5.56	0.821	*0.857
262	11.1	0.853	*0.891
262	16.7	0.853	*0.891
264	22.2	0.860	*0.898
273	33.4	0.889	*0.929
272	44.5	0.886	*0.925
272	55.6	0.886	*0.925
287	66.7	0.935	*0.976
275	77.9	0.896	*0.935
278	89.0	0.906	*0.946
273	100	0.889	*0.929
279	122	0.909	*0.949
274	145	0.893	*0.932
280	167	0.912	*0.952
279	211	0.909	*0.949
276	-	0.899	*0.939

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 11A Porosity, Per Cent: 17.6

Air Permeability, MD: 307 (294)* Liquid: Kerosene (Phase 4)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
238	0.566	0.775	*0.810
244	1.11	0.795	*0.830
246	2.78	0.801	*0.837
243	5.56	0.792	*0.827
240	11.1	0.782	*0.816
249	16.7	0.811	*0.847
246	22.2	0.801	*0.837
249	33.4	0.811	*0.847
245	44.5	0.798	*0.833
244	55.6	0.795	*0.830
235	66.7	0.765	*0.799
235	77.9	0.765	*0.799
243	89.0	0.792	*0.827
243	100	0.792	*0.827
241	122	0.785	*0.820
248	145	0.808	*0.844
246	167	0.801	*0.837
244	211	0.795	*0.830
241**	-	0.785	*0.820

* Klinkenberg Corrected

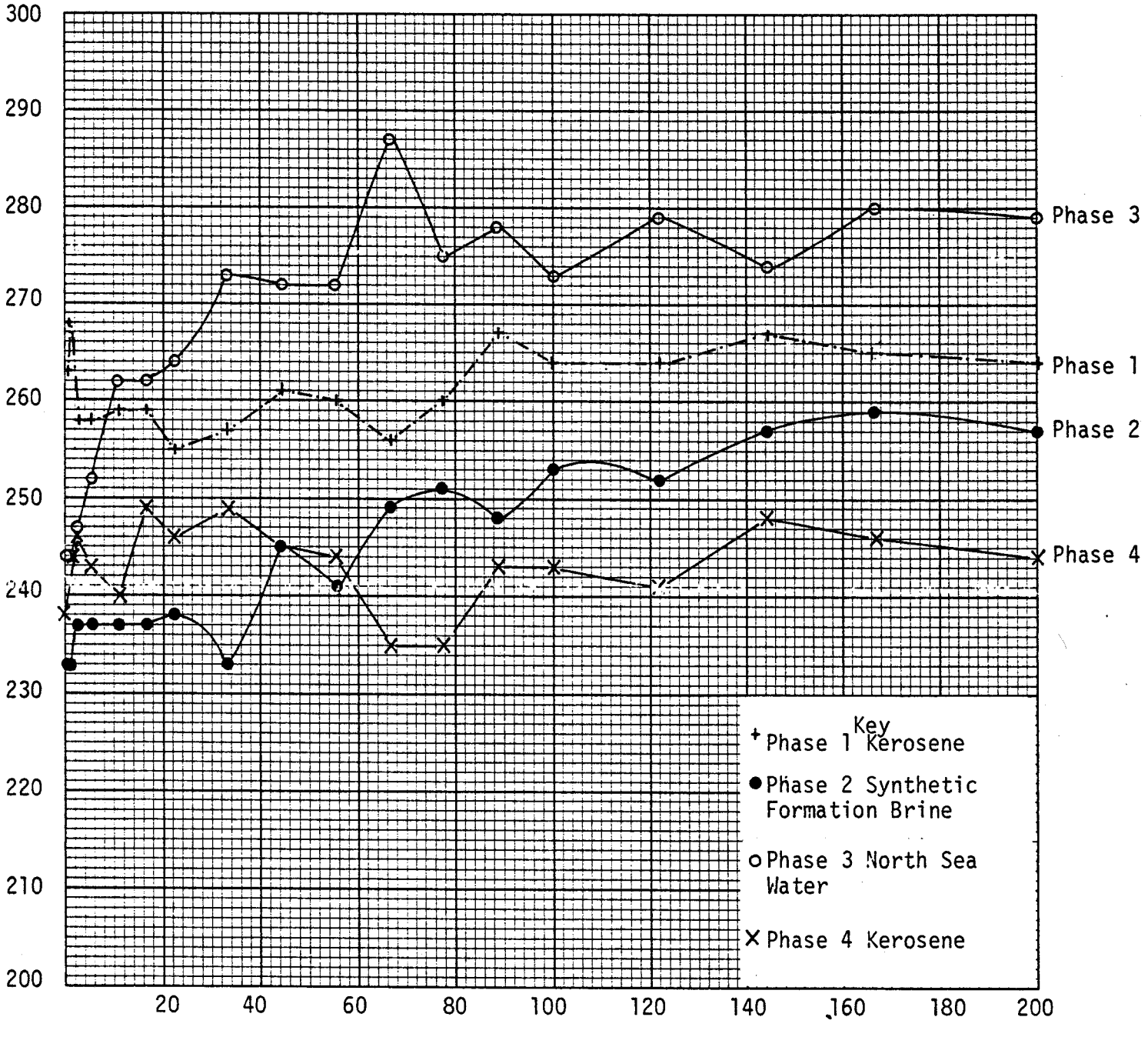
** Measured in Reverse Flow Direction

Company B.P. PET. DEV. LTD. NORWAY
Well 7/12-6
Field

Formation
Country NORTH SEA UK

SAMPLE NUMBER: 11A

DEPTH, METRES: 3440.86



LIQUID PERMEABILITY DATA

Sample Number: 18A Porosity, Per Cent: 19.1

Air Permeability, MD: 105 (94)* Liquid: Kerosene (Phase 1)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
82	0.611	0.781	*0.872
83	1.22	0.790	*0.883
82	3.05	0.781	*0.872
80	6.11	0.762	*0.851
79	12.2	0.752	*0.840
80	18.3	0.762	*0.851
80	24.4	0.762	*0.851
77	36.6	0.733	*0.819
79	48.8	0.752	*0.840
80	61.1	0.762	*0.851
79	73.3	0.752	*0.840
79	85.5	0.752	*0.840
79	97.7	0.752	*0.840
79	122	0.752	*0.840
79	147	0.752	*0.840
79	171	0.752	*0.840
79	220	0.752	*0.840
78**	-	0.743	*0.830

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
LONDON—ABERDEEN

File: UKSCAL 311-81189

LIQUID PERMEABILITY DATA

Sample Number: 18A Porosity, Per Cent: 19.1

Air Permeability, MD: 105 (94)* Liquid: Synthetic Formation Brine (Phase 2)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
85	0.611	0.810	*0.904
87	1.22	0.829	*0.926
87	3.05	0.829	*0.926
87	6.11	0.829	*0.926
87	12.2	0.829	*0.926
85	18.3	0.810	*0.904
86	24.4	0.819	*0.915
86	36.6	0.819	*0.915
86	48.8	0.819	*0.915
87	61.1	0.829	*0.926
85	73.3	0.810	*0.904
85	85.5	0.810	*0.904
84	97.7	0.800	*0.894
84	122	0.800	*0.894
84	147	0.800	*0.894
82	171	0.781	*0.872
82	220	0.781	*0.872
83**	-	0.791	*0.883

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 18A Porosity, Per Cent: 19.1

Air Permeability, MD: 105 (94)* Liquid: North Sea Water (Phase 3)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
80	0.611	0.762	*0.851
87	1.22	0.829	*0.926
88	3.05	0.838	*0.936
87	6.11	0.829	*0.926
86	12.2	0.819	*0.915
85	18.3	0.810	*0.904
86	24.4	0.819	*0.915
86	36.6	0.819	*0.915
85	48.8	0.810	*0.904
85	61.1	0.810	*0.904
84	73.3	0.800	*0.894
85	85.5	0.810	*0.904
84	97.7	0.800	*0.894
82	122	0.781	*0.872
84	147	0.800	*0.894
82	171	0.781	*0.872
82	220	0.781	*0.872
81**	-	0.771	*0.862

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 18A Porosity, Per Cent: 19.1

Air Permeability, MD: 105 (94)* Liquid: Kerosene (Phase 4)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
79	0.611	0.752	*0.840
79	1.22	0.752	*0.840
78	3.05	0.743	*0.830
78	6.11	0.743	*0.830
79	12.2	0.752	*0.840
78	18.3	0.743	*0.830
78	24.4	0.743	*0.830
78	36.6	0.743	*0.830
78	48.8	0.743	*0.830
78	61.1	0.743	*0.830
78	73.3	0.743	*0.830
78	85.5	0.743	*0.830
79	97.7	0.752	*0.840
78	122	0.743	*0.830
78	134	0.743	*0.830
78	159	0.743	*0.830
78	208	0.743	*0.830
77**	-	0.733	*0.819

* Klinkenberg Corrected

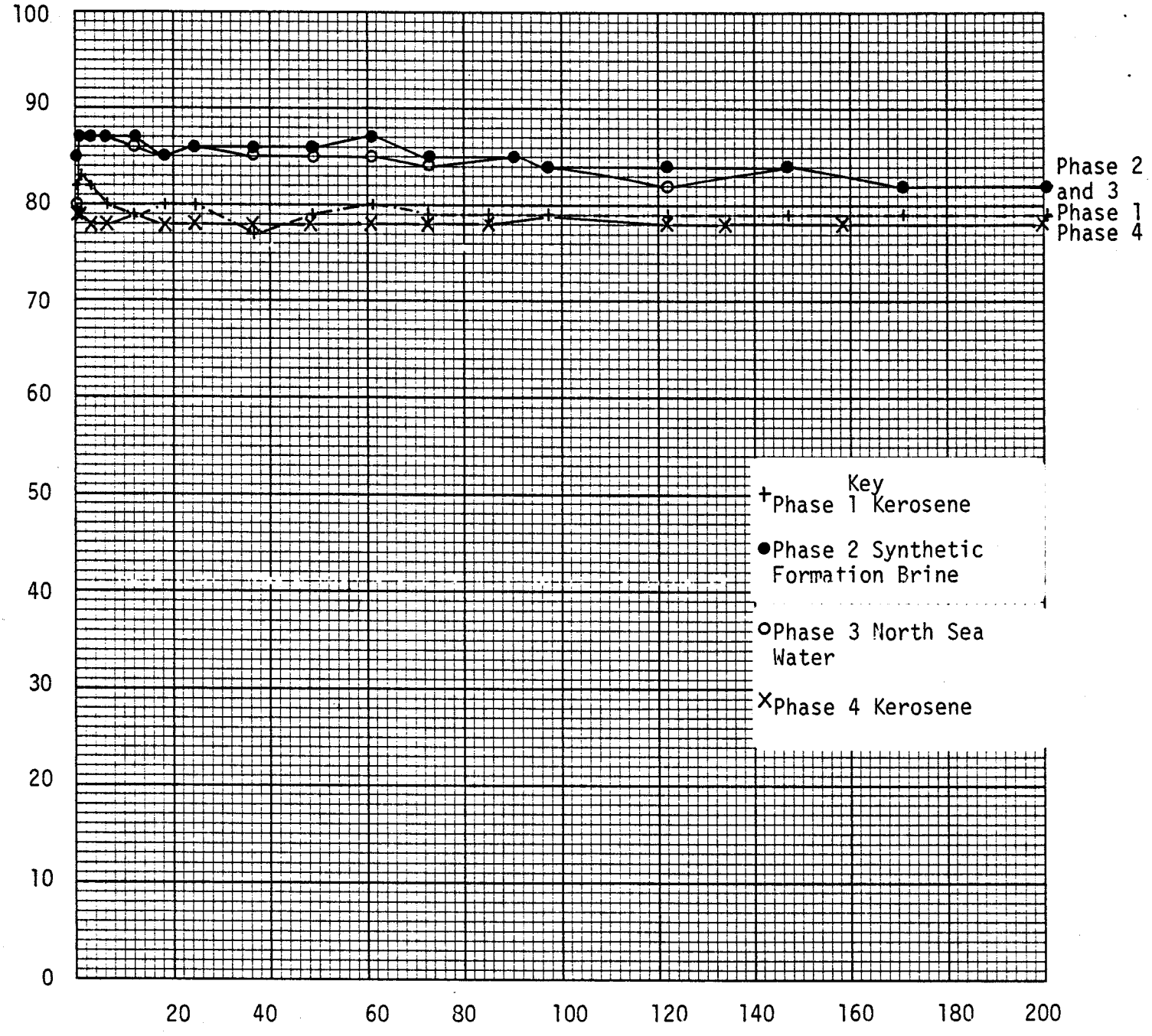
** Measured in Reverse Flow Direction

Company B.P. PET. DEV. LTD. NORWAY
Well 7/12-6
Field

Formation ULA
Country NORTH SEA
NORWAY

SAMPLE NUMBER: 18A

DEPTH, METRES: 3463.61



LIQUID PERMEABILITY DATA

Sample Number: 25A Porosity, Per Cent: 22.3

Air Permeability, MD: 2060 (1980)* Liquid: Kerosene (Phase 1)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
1340	0.374	0.651 *0.677
1320	0.749	0.641 *0.667
1360	1.87	0.660 *0.687
1400	3.74	0.680 *0.707
1500	7.49	0.728 *0.758
1520	15.0	0.738 *0.768
1510	29.9	0.733 *0.763
1510	37.4	0.733 *0.763
1510	44.9	0.733 *0.763
1510	52.4	0.733 *0.763
1500	67.4	0.728 *0.758
1530	74.9	0.743 *0.773
1510	82.3	0.733 *0.763
1530	97.3	0.743 *0.773
1500	112	0.728 *0.758
1550	142	0.752 *0.783
1520	172	0.738 *0.768
1530	202	0.743 *0.773
1500**	-	0.728 *0.758

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 25A Porosity, Per Cent: 22.3

Air Permeability, MD: 2060 (1980)* Liquid: Synthetic Formation Brine (Phase 2)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
1490	0.374	0.723 *0.753
1420	0.749	0.689 *0.717
1420	1.87	0.689 *0.717
1410	3.74	0.685 *0.712
1440	7.49	0.699 *0.727
1490	15.0	0.723 *0.753
1500	29.9	0.728 *0.758
1520	37.4	0.738 *0.768
1530	44.9	0.743 *0.773
1500	52.4	0.728 *0.758
1540	67.4	0.748 *0.778
1510	74.9	0.733 *0.763
1570	82.3	0.762 *0.793
1570	97.3	0.762 *0.793
1610	112	0.782 *0.813
1640	142	0.796 *0.828
1630	172	0.791 *0.823
1640	202	0.796 *0.828
1630**	-	0.791 *0.823

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 25A Porosity, Per Cent: 22.3

Air Permeability, MD: 2060 (1980)* Liquid: North Sea Water (Phase 3)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
1390	0.374	0.675 *0.702
1370	0.749	0.665 *0.692
1310	1.87	0.636 *0.662
1340	3.74	0.651 *0.677
1310	7.49	0.636 *0.662
1310	15.0	0.636 *0.662
1310	29.9	0.636 *0.662
1310	37.4	0.636 *0.662
1330	44.9	0.646 *0.672
1310	52.4	0.636 *0.662
1290	67.4	0.626 *0.652
1300	74.9	0.631 *0.657
1250	82.3	0.607 *0.631
1310	97.3	0.636 *0.662
1310	112	0.636 *0.662
1280	142	0.621 *0.646
1250	172	0.607 *0.631
1250	202	0.607 *0.631
1250	217	0.607 *0.631
1265**	-	0.614 *0.639

* Klinkenberg Corrected

** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 25A Porosity, Per Cent: 22.3

Air Permeability, MD: 2060 (1980)* Liquid: Kerosene (Phase 4)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
1120	0.374	0.544 *0.566
1070	0.749	0.519 *0.540
1070	1.87	0.519 *0.540
1230	3.74	0.597 *0.621
1610	7.49	0.782 *0.813
1630	15.0	0.791 *0.823
1590	29.9	0.772 *0.803
1590	37.4	0.772 *0.803
1600	44.9	0.777 *0.808
1600	52.4	0.777 *0.808
1610	67.4	0.782 *0.813
1590	74.9	0.772 *0.803
1620	82.3	0.786 *0.818
1620	97.3	0.786 *0.818
1610	112	0.782 *0.813
1590	142	0.772 *0.803
1590	172	0.772 *0.803
1610	202	0.782 *0.813
1590**	-	0.772 *0.803

* Klinkenberg Corrected

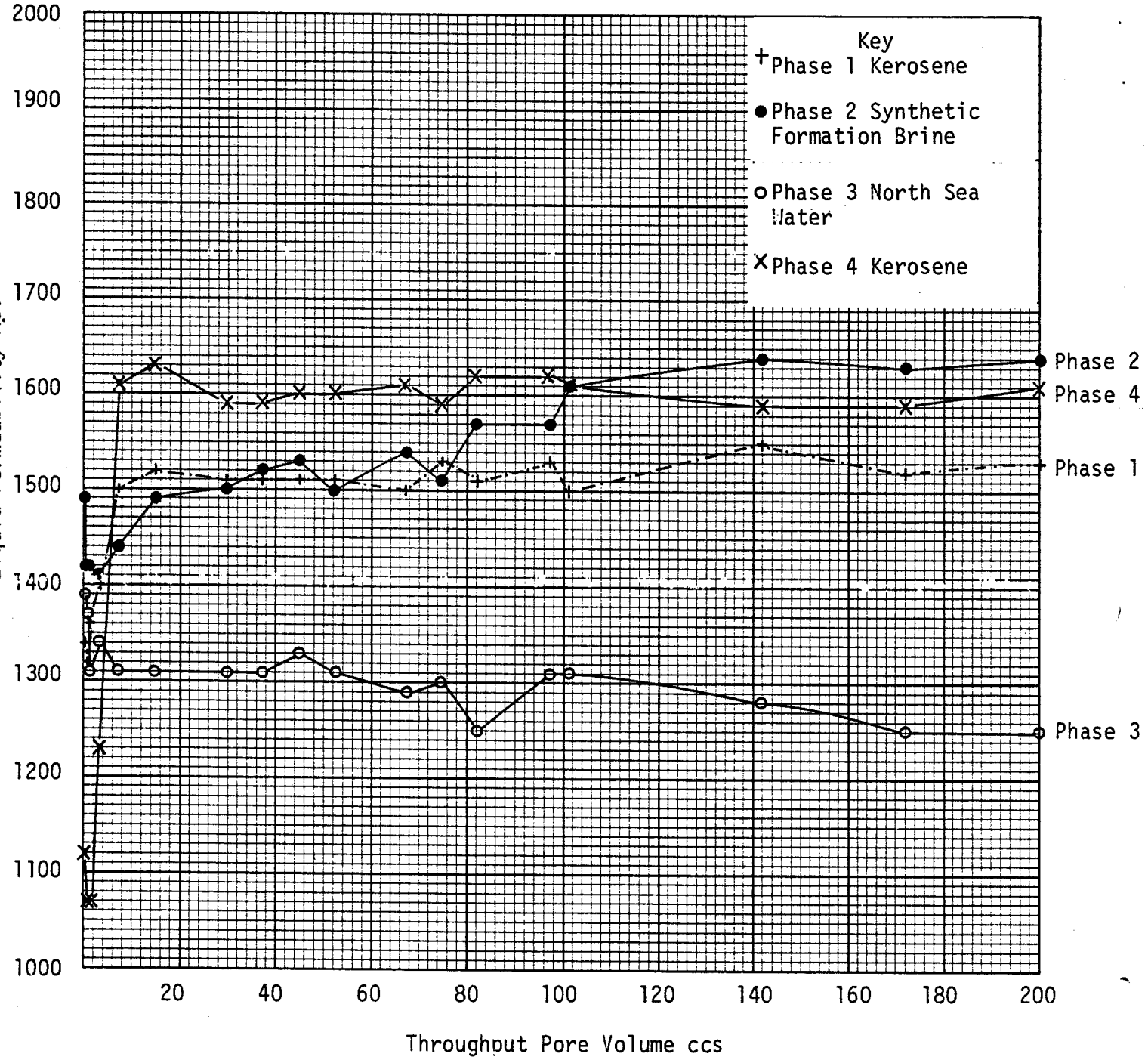
** Measured in Reverse Flow Direction

Company B.P. PET. DEV. LTD. NORWAY
Well 7/12-6
Field

Formation ULA
Country NORTH SEA
NORWAY

SAMPLE NUMBER: 25A

DEPTH, METRES: 3480.09



LIQUID PERMEABILITY DATA

Sample Number: 30A Porosity, Per Cent: 19.4

Air Permeability, MD: 1270 (1215)* Liquid: Kerosene (Phase 1)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
1180	0.556	0.929	*0.971
1120	1.11	0.882	*0.922
1120	2.78	0.882	*0.922
1110	5.56	0.874	*0.914
1120	11.1	0.882	*0.922
1150	16.7	0.906	*0.947
1120	22.2	0.882	*0.922
1120	33.3	0.882	*0.922
1120	44.4	0.882	*0.922
1120	55.6	0.866	*0.922
1100	66.7	0.882	*0.905
1120	77.8	0.866	*0.922
1100	88.9	0.866	*0.905
1110	100	0.866	*0.914
1110	122	0.866	*0.914
1110	144	0.866	*0.914
1110	167	0.866	*0.914
1110	200	0.866	*0.914
1090**	-	0.858	*0.897

* Klinkenberg Corrected ** Measured in Reverse Flow Direction

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
LONDON—ABERDEEN

File: UKSCAL 311-81189

LIQUID PERMEABILITY DATA

Sample Number: 30A Porosity, Per Cent: 19.4

Air Permeability, MD: 1270 (1215) * Liquid: Synthetic Formation Brine (Phase 2)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
1070	0.556	0.843	*0.881
1010	1.11	0.795	*0.831
995	2.78	0.784	*0.819
984	5.56	0.775	*0.810
965	11.1	0.760	*0.794
968	16.7	0.762	*0.797
982	22.2	0.773	*0.808
963	33.3	0.758	*0.793
973	44.4	0.766	*0.801
970	55.6	0.764	*0.798
973	66.7	0.766	*0.801
997	77.8	0.785	*0.821
964	88.9	0.759	*0.793
980	100	0.772	*0.807
969	122	0.763	*0.798
990	144	0.780	*0.815
942	189	0.742	*0.775
949	211	0.747	*0.781
941	233	0.741	*0.774
955	256	0.752	*0.786
960**	-	0.756	*0.786

* Klinkenberg Corrected ** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 30A Porosity, Per Cent: 19.4

Air Permeability, MD: 1270 (1215)* Liquid: North Sea Water (Phase 3)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio	
842	0.556	0.663	*0.693
864	1.11	0.680	*0.711
883	2.78	0.695	*0.727
847	5.56	0.667	*0.697
839	11.1	0.661	*0.691
853	16.7	0.672	*0.702
857	22.2	0.675	*0.705
867	33.3	0.683	*0.714
871	44.4	0.686	*0.717
905	55.6	0.713	*0.745
894	66.7	0.704	*0.736
924	77.8	0.728	*0.760
912	88.9	0.718	*0.751
922	100	0.726	*0.759
926	122	0.729	*0.762
910	144	0.717	*0.749
910	167	0.717	*0.749
909	200	0.716	*0.748
912**	-	0.718	*0.751

* Klinkenberg Corrected ** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 30A Porosity, Per Cent: 19.4

Air Permeability, MD: 1270 (1215)* Liquid: Kerosene (Phase 4)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
993	0.556	0.782 *0.817
923	1.11	0.727 *0.760
964	2.78	0.759 *0.793
951	5.56	0.749 *0.783
938	11.1	0.739 *0.772
941	16.7	0.741 *0.774
943	22.2	0.743 *0.776
944	33.3	0.743 *0.777
946	44.4	0.745 *0.779
927	55.6	0.730 *0.763
947	66.7	0.746 *0.779
939	77.8	0.739 *0.773
949	88.9	0.747 *0.781
939	100	0.739 *0.773
947	122	0.746 *0.779
950	144	0.748 *0.782
949	167	0.747 *0.781
952	200	0.750 *0.784
953**	-	0.750 *0.784

* Klinkenberg Corrected ** Measured in Reverse Flow Direction

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
LONDON—ABERDEEN

File: UKSCAL 311-81189

LIQUID PERMEABILITY DATA

Sample Number: 30A Porosity, Per Cent: 19.4

Air Permeability, MD: 1270 (1215)* Liquid: Kerosene (Phase 5)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
834	0.556	0.657 *0.686
847	1.11	0.667 *0.697
818	2.78	0.644 *0.673
826	5.56	0.650 *0.686
824	11.1	0.649 *0.678
815	16.7	0.642 *0.671
821	22.2	0.647 *0.676
307	33.3	0.635 *0.664
815	44.4	0.642 *0.671
800	55.6	0.630 *0.658
788	66.7	0.621 *0.649
795	77.8	0.626 *0.654
786	88.9	0.619 *0.647
795	100	0.626 *0.654
824	122	0.649 *0.878
777	144	0.612 *0.640
782	167	0.616 *0.644
799	211	0.629 *0.658
794**	-	0.625 *0.653

* Klinkenberg Corrected ** Measured in Reverse Flow Direction

LIQUID PERMEABILITY DATA

Sample Number: 30A Porosity, Per Cent: 19.4

Air Permeability, MD: 1270 (1215)* Liquid: Synthetic Formation Brine (Phase 6)

Liquid Permeability, MD	Throughput Pore Volumes	Liquid/Air Permeability Ratio
876	0.556	0.690 *0.721
870	1.11	0.685 *0.716
934	2.78	0.735 *0.769
958	5.56	0.754 *0.788
915	11.1	0.720 *0.753
928	16.7	0.731 *0.764
905	22.2	0.713 *0.745
936	33 3	0.737 *0.770
930	44.4	0.732 *0.765
933	55.6	0.735 *0.768
936	66.7	0.737 *0.770
930	77.8	0.732 *0.765
915	88.9	0.720 *0.753
915	100	0.720 *0.753
933	122	0.735 *0.768
907	144	0.714 *0.747
922	167	0.726 *0.759
915	211	0.720 *0.753
923	233	0.727 *0.760
900**	-	0.709 *0.741

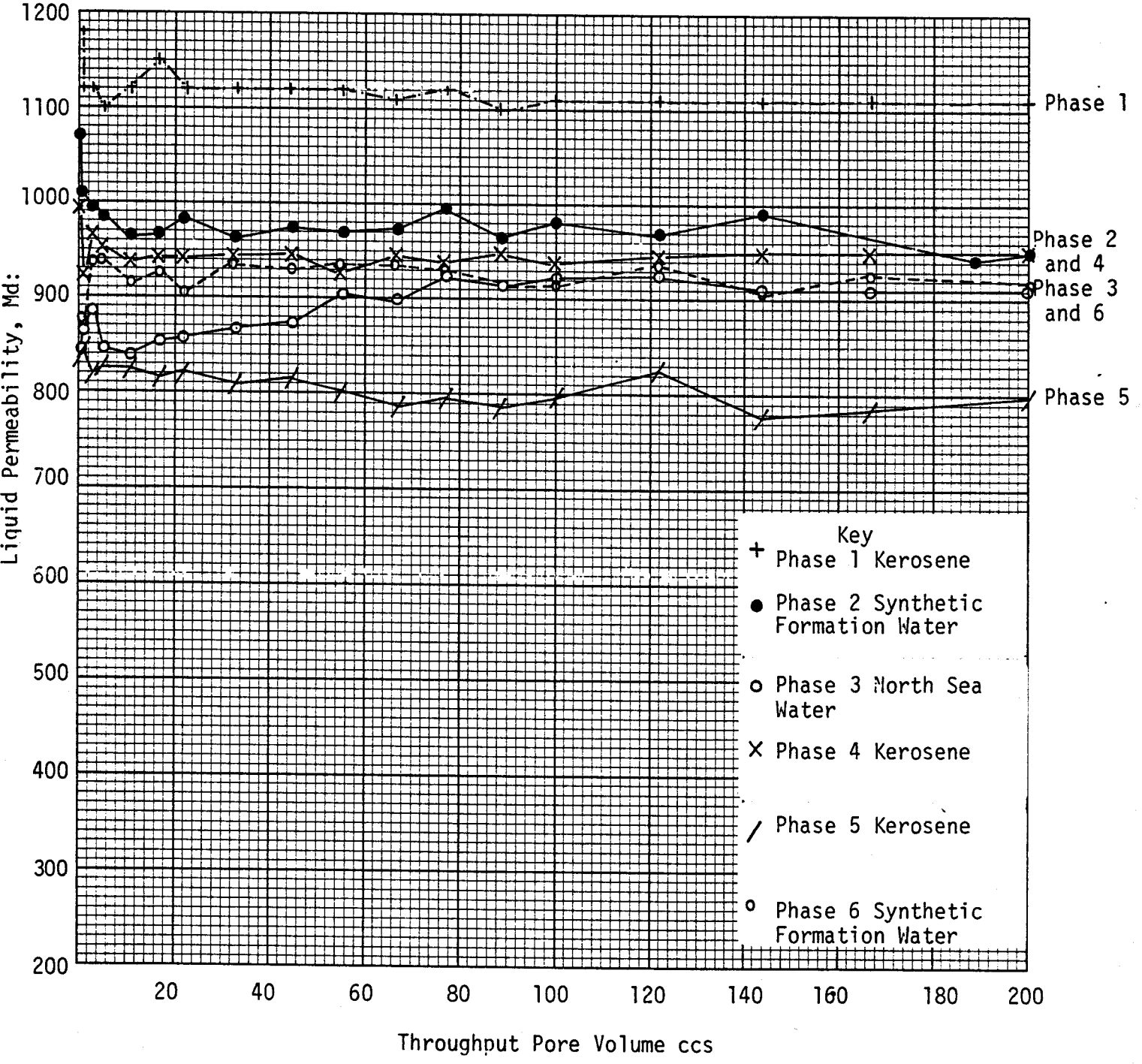
* Klinkenberg Corrected ** Measured in Reverse Flow Direction

Company B.P. PET. DEV. LTD. NORWAY
Well 7/12-6
Field

Formation ULA
Country NORTH SEA
NORWAY

SAMPLE NUMBER: 30A

DEPTH, METRES: 3494.13



Permeability and Porosity as a Function of Overburden Pressure

Effective Overburden Pressure PSI:

Room Conditions				2650			3350			3950			4750		
Sample Number	Air Perm. Md.	KL	Porosity Per Cent	Air Perm. Md.	KL	Porosity Per Cent	Air Perm. Md.	KL	Porosity Per Cent	Air Perm. Md.	KL	Porosity Per Cent	Air Perm. Md.	KL	Porosity Per Cent
3A	11	(8.6)	21.1	9.6	(7.5)	20.6	9.5	(7.4)	20.5	9.4	(7.3)	20.5	9.4	(7.3)	20.4
7A	19	(15)	20.5	16	(13)	19.5	16	(13)	19.4	16	(13)	19.4	16	(13)	19.3
11A	261	(248)	17.7	180	(167)	17.4	178	(165)	17.3	178	(165)	17.3	177	(164)	17.3
18A	105	(94)	19.1	91	(81)	18.9	87	(77)	18.8	85	(75)	18.7	83	(74)	18.5
25A	2020	(1940)	22.1	1490	(1430)	21.7	1440	(1380)	21.7	1400	(1340)	21.6	1340	(1280)	21.6
Hysteresis Check															
7A	19	(15)	20.5	18	(15)	19.7	17	(14)	19.6	17	(14)	19.6	17	(14)	19.5
25A	2060	(1980)	22.1	1350	(1290)	21.4	1300	(1240)	21.2	1270	(1210)	21.2	1230	(1180)	21.2

KL = Klinkenberg Corrected

Appendix I

A. Calculation of Height above free water level from air-brine capillary pressure data.

$$H = \frac{(Pc\ A\text{-}B)\ (1.0 \times 72 - 0.866 \times 30)}{\text{Water gradient psi/ft - oil gradient psi/ft}}$$

where:

Pc A-B	=	Capillary Pressure psi
1.0	=	Cosine Contact Angle (Laboratory)
72	=	Interfacial Tension Angle (Laboratory)
0.866	=	Cosine Contact Angle (Assumed for the Reservoir)
30	=	Interfacial Tension Angle (Assumed for the Reservoir)

B. Calculation of 'J' Factor

(i) Pc Reservoir = Height above Water-Oil Level x w psi/m - O psi/m.

(ii) $$J = \frac{Pc}{T \cos \theta} \quad \frac{Ka}{\emptyset}$$