SPECIAL CORE ANALYSIS STUDY

FOR

STATOIL

WELL: 34/10-5

CORE LABORATORIES UK LTD.

75 GREENFIELD ROAD,
LONDON E1 1EJ

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

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

Statoil
Forus
Postboks 300
N-4001
Stavanger
Norway

July 1981

Attention: Mr Peter Read

Subject: Special Core Analysis
Well: 34/10-5
File: UKSCAL 80010

Gentlemen,

In a letter dated 14th March 1980, ref PAR/GEB, from Mr Karl Arland of Statoil, Core Laboratories UK Limited were requested to perform a series of special core analysis measurements on samples from the subject well.

In February 1981 a final report was issued containing the majority of these results. The results of the wettability study are presented herein as an addendum, and serve to confirm those previously submitted in preliminary form.

Two core plug samples, numbered 4A and 4C, were scheduled to undergo wettability analysis. The samples were drilled using synthetic formation brine as the bit lubricant and sample 4A was stored under this brine prior to fresh state analysis. Sample 4C was cleaned in hot methanol and then in xylene and dried in an humidity controlled oven. Air permeability and helium injection porosity were then measured. The samples are described with respect to depth and lithology on page 1 of this report.

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Amott Wettability Data-Fresh State (Page 2)

Sample 4A was mounted in an hydraulic core holder and flushed with synthetic-- formation brine, consisting of approximately 43,000 mg/l total dissolved solids, to ensure the removal of any trapped gas. Effective permeability to this brine was then measured.

The core plug sample was then immersed in treated, degassed kerosene for a period of weeks until static imibibition of the kerosene ceased. The volume of oil imbibed, indicated by the volume of brine displaced was recorded. The plug was then flushed with kerosene and the volume of brine displaced indicated by the volume of kerosene imbibed was recorded. Effective permeability to the kerosene was then measured.

The procedure was then repeated using synthetic formation brine as the imbibing fluid. Wettability indices were calculated using the volumes of fluid statically and dynamically imbibed.

The sample was then cleaned in Dean-Stark type distillation apparatus, leached in methanol and dried in an humidity controlled oven.

Air permeability and helium injection porosity were then measured and fluid saturations calculated using materialbalance equations .

Results are presented in tabular form on page 2, sample 4A shows a tendency to be preferentially wet by water.

Amott Wettability Restored State (Page 3)

Sample 4C was evacuated and pressure saturated with synthetic formation brine and then placed in a high pressure cell and desaturated to immobile water saturation. The samples was then mounted in an hydraulic core holder and flushed with kerosene to ensure the removal of any mobile water and trapped gas.

The sample was then placed in an hydraulic core holder in a reservoir conditions oven. Internal and external pressures were raised simultaneously to approximately 307 bars and 358 bars respectively. The temperature was slowly raised until the reservoir temperature of approximately 162°F was reached, live crude was then flushed through the sample. The plug was allowed to age in this live crude, at reservoir conditions, for two weeks.

Continued.....

Prior to the removal of the sample from the reservoir conditions oven, kerosene was flushed through to prevent blocking of the pore necks when room conditions were reached.

When removed from the reservoir conditions oven the sample was mounted in an hydraulic core holder and flushed with treated, degassed kerosene for a few pore volumes. Effective permeability to this kerosene was then measured.

The sample was then immersed in synthetic formation brine for a period of weeks until static imbibitions of brine had ceased. The volume of brine imbibed, indicated by the volume of kerosene displaced was recorded. The sample was then flushed with brine and the volume of kerosene displaced, indicated by the volume of brine dynamically imbibed, recorded. Effective permeability to the brine was then measured.

The procedure was repeated using kerosene as the imbibing fluid. Wettability indices were calculated using the volumes of fluid statically and dynamically imbibed. Results are presented on page 3 and again this sample shows a tendency to be preferentially wet by water.

It has been a pleasure working with Statoil 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

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CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
LONDON—ABERDEEN

File UKSCAL 80010

COMPANY: STATOIL
WELL: 34/10-5
FIELD:

FORMATION:
COUNTRY: NORTH SEA
STATE: NORWAY

IDENTIFICATION AND DESCRIPTION OF SAMPLES

Sample Number	Depth Metres	Lithological Description
4A	1968.08	ss-f-mgn,mstd, mod cmtd, subang-subrnd, tr mica
4C	1968.16	ss, f-mgn, mstd, m cmtd, subang-subrnd, tr mica, tr arg mat, current bedding

SUMMARY OF FRESH-STATE IMBIBITION AND DYNAMIC DISPLACEMENT

(Amott Method)

Initial Fluid Imbibed is Oil

Sample Number	4A
Air Permeability, Md.	140
Porosity, Per Cent	32.3
Immobile Water Saturation,* Per Cent Pore Space	28.8
Oil Permeability, Md. at Immobile Water Saturation	127
Water Imbibed Statically, Per Cent Pore Space	18.3
Water Imbibed Dynamically, Per Cent Pore Space	37.3
Total Water Imbibed, Per Cent Pore Space	55.6
Immobile Oil Saturation,** Per Cent Pore Space	31.0
Water Permeability, Md. at Immobile Oil Saturation	23
Oil Imbibed Statically, Per Cent Pore Space	7.3
Oil Imbibed Dynamically, Per Cent Pore Space	32.9
Total Oil Imbibed, Per Cent Pore Space	40.
Wettability Index to Water	0.329
Wettability Index to Oil	0.182

* Water Present just prior to water imbibition
** Oil present just prior to oil imbibition
*** Measured in reverse direction of flow

$$\text{Wettability Index} = \frac{\text{Fluid Imbibed}}{\text{Total Fluid Recovered}}$$

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LONDON—ABERDEEN

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SUMMARY OF FRESH-STATE IMBIBITION AND DYNAMIC DISPLACEMENT

(Amott Method)

Initial Fluid Imbibed is Water

Sample Number	4C
Air Permeability, Md.	135
Porosity, Per Cent	27.5
Immobile Water Saturation,* Per Cent Pore Space	31.6
Oil Permeability, Md. at Immobile Water Saturation	46
Water Imbibed Statically, Per Cent Pore Space	6.4
Water Imbibed Dynamically, Per Cent Pore Space	35.8
Total Water Imbibed, Per Cent Pore Space	42.2
Immobile Oil Saturation,** Per Cent Pore Space	26.2
Water Permeability, Md. at Immobile Oil Saturation	5.6
Oil Imbibed Statically, Per Cent Pore Space	2.5
Oil Imbibed Dynamically, Per Cent Pore Space	28.7
Total Oil Imbibed, Per Cent Pore Space	31.2
Wettability Index to Water	0.152
Wettability Index to Oil	0.080

* Water Present just prior to water imbibition
** Oil present just prior to oil imbibition
*** Measured in reverse direction of flow

$$\text{Wettability Index} = \frac{\text{Fluid Imbibed}}{\text{Total Fluid Recovered}}$$