Reservoir evaluation of

30/7-2 EOCENE DISCOVERY

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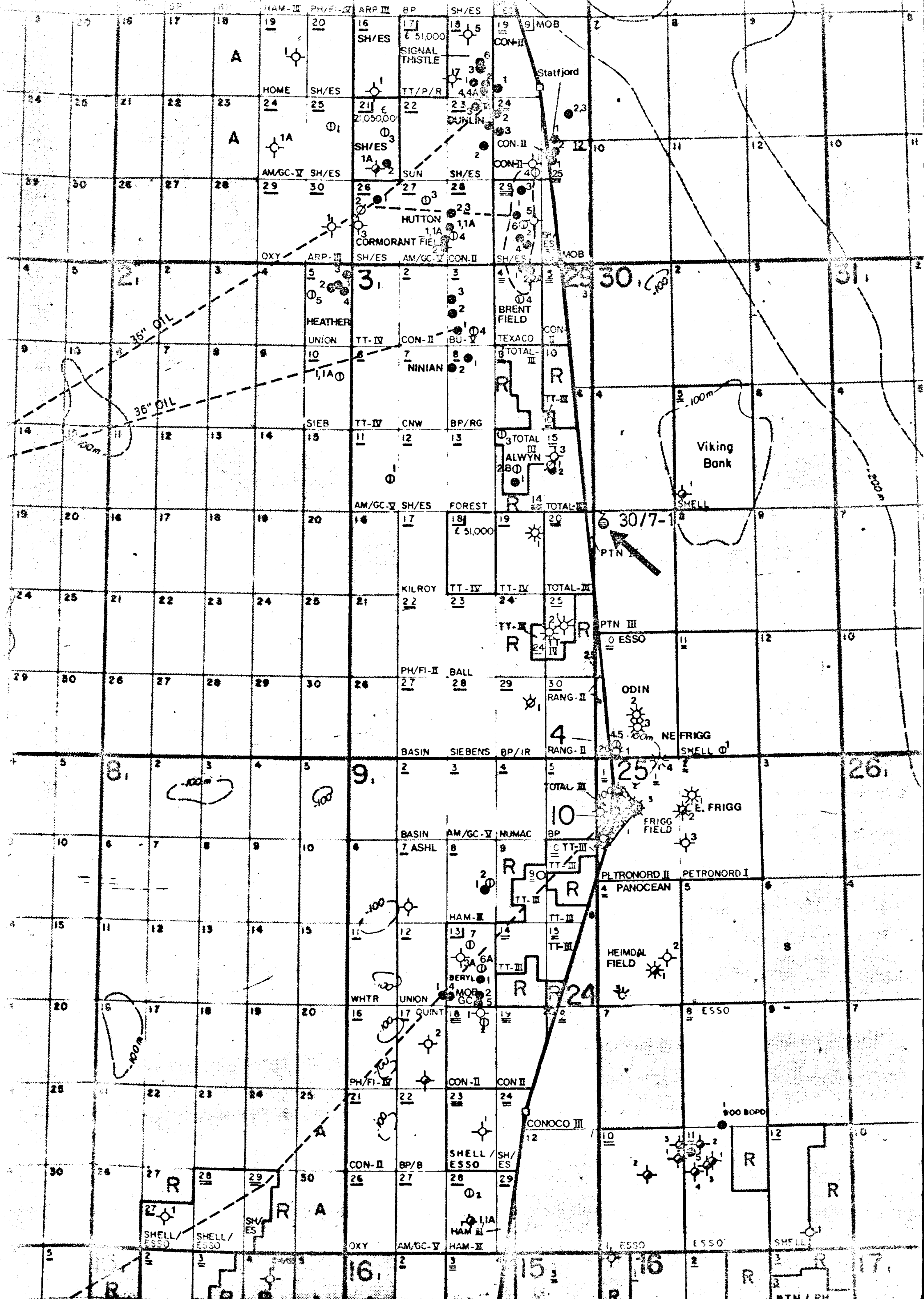
SIGNAL THISTLE
Statfjord
DUNLIN
HUTTON
CORMORANT FIELD
HEATHER
BRENT FIELD
NINIAN
ALWYN
36" OIL
36" OIL
Viking Bank
30/7-1
KILROY
ODIN
NE FRIGG
FRIGG FIELD
E. FRIGG
PANOCEAN
HEIMDAL FIELD
BERYL
CONOCO III
3
30
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2
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25
26
4
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17

CONCLUSIONS

1. A discovery of hydrocarbon accumulation was done at 1747 m RKB.

2. The net oil coloumn is limited to 3.15m. Due also to the reduced magnitude of the bulk volume, the oil in place is in the range of $18 \cdot 10^6$ Nm^3 ($113 \cdot 10^6$ bbl).

3. Due to a small oil gross pay (21m), the presence of gas-cap and water table will limit the well rate to a low value, 10 bbl/day, (despite a high productivity index), in order to avoid gas-coning or water-coning effects.

4. The solution gas drive is showing a good recovery in spite of high oil viscosity(u = 5.19cp)

5. As microscopical displacement efficiency shows better displacement behaviour for water drive (MDE = 28,6%) than for gas drive (MDE = 7,5%)

6. All evaluation developed in this study are showing that the 30/7-2 well discovery does not represent a reserve to be developed. In addition to the small rates requested to prevent coning effects will reduce all chances for this discovery to be considerd as an additional reserve.

ABSTRACT.

A resumé of all results obtained in the present study is given hereunder:

Discovery

The well 30/7-2 discovered a relative small accumulation of oil and gas in a Middle - lower Eocene sand reservoir. A final contour map of the Cla seismic marker was drawn in the vicinity of well 30/7-2 (Fig.1)

Reservoir parameters

Seismic marker	RKB	1747.0 m
Top of sand	"	1749.8 m
Gas oil contact	"	1762.8 m
Oil water contact	"	1783.0 m
Gross pay		33.2 m
Net pay		25.6 m
Net pay fraction gas zone	α_g	0.73
Net pay fraction oil zone	α_o	0.81
Porosity gas zone	Ø	22.2 %
Porosity oil zone	Ø	29.4 %
Water saturation gas zone	Sw	18.2 %
Water saturation oil zone	Sw	19.4 %
Net gas column		1.22m
Net oil column		3.15m

Testing results

Average productivity index	$22m^3$/day/atm.
Reservoir pressure at 1770m	2585 psi
Reservoir temperature	53^oC

Due to very fast pressure rise it has not been possible to perform a pressure build up analysis on the test results. However, a permeability above 1D is indicated from the productivity index calculated.

During both DST'S serious sandproblems occured and the testing equipment was badly eroded by the sand.

Core analysis

The grain size distribution analysis of the sand indicates a bimodal sand. The two classes have a d_{50} of 0.508mm and 0.2253mm respectively. The average d_{50} measured on all the samples is 0.14mm.

Hydrocarbons in place

Gas cap (free gas)	$1.1 \cdot 10^9 Nm^3$
Gas in solution	$0.8 \cdot 10^9 Nm^3$
Oil in place	$18 \cdot 10^6 Nm^3$

Well productivity

In order to prevent the water coning and in the absence of any impermeable layer the daily rate is very low (10 Bbl/day). But if the water-coning and gas coning could be prevented it might reach values between 2500-5000 Bbl/day due to the high permeability.

Recovery factor

If the main drive mechanism will be the solution gas drive,at the end of total energy depletion - a final recovery estimated by various procedure is giving:

36% - for K = 500 MD, by statistical method
38.5% " K = 1000 MD " " "
24.5% - calculated by Tracy's method

The microscopical displacement efficiency have been calculated by using Buckley-Leverett's procedure. The result for gas expansion or water encroachment, indicate:

M.D.E. (gas cap drive): 7,75%
M.D.E. (water drive) : 28,6%

This means that gas advancement recovery will be very small.

The relationship p vs $^{Np}/_{N}$ and GOR vs $^{Np}/_{N}$ have been calculated. The results are presented in Fig. 15. The results are showing a maximum fianl recovery of 24.5%.

2. Water and gas displacement (Buckley Leverett)

The sweep efficiency by water and gas displacement is calculated by the Buckley Leverett method. (Fig. 16 and 17). The relative permeabilities are shown in tables 6 and 7.

The microscopical displacement efficiency is:

MDE for waterdrive 28.6%
MDE for gas cap drive 7.75%

DISCUSSION

A. FIELD HISTORY

1. Introduction

The Block 30/7 was opened July 12th 1973. Seismic was shot during 1971 by Delta-Seiscon, Prakla-Seismos (for Mobil) SSL and Western. (In 1973 further seismic was done by GECO). The Isochron interpretation of these data are shown in fig. 2 and 3.

On 14th of September 1973 the Petronord group applied for concession of blocks 30/7 and 29/9. By a Royal Decree of November 15th 1974 the companies in the Petronord/Statoil group were awarded production licence no 040 covering blocks 29/9 and 29/7 on the Norwegian shelf.

The participants and their % interest are following:

Den norske stats oljeselskap a/s-Statoil	50.0%
Norsk Hydro production a/s	6.8%
Elf Norge a.s.	19.2%
Total Marine Norsk a/s	14.4%
Aquitaine Norge a/s	9.6%

The production licence and the participation agreement was accepted by the partners on March 17th. 1975.

2. Drilling

A first well has been drilled through the Eocene sand in block 30/7. The objective of the drilling was to reach the Maastrichian, having as main aim to investigate: structural closure of Eocene and Paleocene and sand development.

The planned location of the first well 30/7-1 is shown in both maps of Figs. 2 and 3.

Due to technical problems the well had to be abandoned after drilling 358m, and relocated at 150 feet east of the first location. This well was denominated 30/7-2 and its final location is N 60° 29' 06" E 02° 01' 40.85". On November 9th 1975 T.D. was reached at the depth of 2591m*

3. Hydrocarbon shows

Two minor Hydrocarbon shows were encountered in the upper Eocene and in addition slight oil stain on cuttings was observed at 1700m. More encouraging oil shows occured in sandstone cuttings from 1750m-1821.7m, and these shows have been confirmed in the six cores which were cut from 1753m to 1821.7m. The logs indicate that a gas and oil bearing sand was located in the interval 1749.8m - 1783m confirming the shows. The shows have been confirmed through bottom hole samples obtained from FIT's and DST's.

* All depths are measured from RKB

B. GEOLOGICAL EVALUATION

1. Geophysics.

The final isochrone map and the isobath of the Cla horizon are shown in Fig. 1 and 4 respectively. For depth conversion the seismic time in 30/7-2 has been set equal to the interpolated check shot-time recorded in the well, i.e. 866 ms o.w.t. and the depth equal to 1724 m MSL, and hence the average velocity,

$$v = 1724/0.866 \text{ m/s} = 2014 \text{ m/s}$$

has been used over the area.

The depth map has been planimetered, and in Fig. 5 the depth was plotted v.s. the area. The reservoir is divided in two zones: a gas cap zone and an oil zone. The diagram gross pay v.s. area indicates the gas oil contact at 1762.8m dividing the total height in a gross pay of 36m for gas cap zone and 20m for the oil zone. The estimation of the gas-oil contact was based on logs interpretation.

2. Geological delineation.

The reservoir, dated middle-lower Eocene, consists of an unconsolidated, medium grained sand compsed of moderately sorted subrounded quartz grains with some free mica. Interbedded with large flakes of mica.

Deposition appears to have taken place in a deltaic environment, which persisted from Paleocene to Middle Eocene.

C. RESERVOIR ROCK AND FLUID PROPERTIES

1. Log analysis

The well was logged from 110 m to 2590 m RKB. Two CPI'S based on BHC-GR, DLL with micro spherical, CNL-FDC-GR and IES were made. The first CPI was computed as a preliminary CPI using the coriband program whereas the second CPI was run with a dual mineral presentation (mica option) with the two minerals being mica and quartz. A further evaluation of the logs was done by Norsk Hydro and the results have confirmed the CPI's estimation. In table 1 the basic log parameters are listed.

A copy of the logs run over the pay interval and the CPI computed with the mica option are presented in fig. 6. The average value of the reservoir parameters and the depth data have been calculated from the mica option CPI and reported among data of Table 2.

The main hydrocarbon zone occurs in the interval 1749-1782.2 m RKB. Below 1782.2 m some sandstone stringers with oil are present with the thickest zone at 1807.5 - 1810.5 m RKB.

The cut-off factors used for calculating net pay have been chosen so that only pay with movable hydrocarbons (CPI) was included in the net pay. The following cut offs have been used.

Gas zone $S_w < 50$

$V_{cl} < 50$

Oil zone $S_w < 50$

$V_{cl} < 30$

2. Core analysis

Six full size cores were cut in the interval 1753.0 - 1821.7 m. All the cores have shown the presence of hydrocarbons. The core report is enclosed as appendix. 2.

The lithology of the formation is mainly an unconsolidated sand with shale interbeds. On the six cores a series of petrophysical measurements such as grain density and grain size distributions were measured on 36 selected samples.

The average grain density of the clean sand in the hydrocarbons zone (1762-1770 m RKB) and of the clean sand in the water zone (1777-1798 m RKB) were measured in the laboratory and found to be 2.67 g/cc and 2.66g/cc respectively. The results are comparable to the grainsize computed by the CPI.

The grain size distributions from the selected samples are plotted in Fig. 7. The cumulative distribution curves have two slopes which indicates a bimodal sand.

An average distribution curve considered as the most representative sample was reexamined as two cumulative curves of two different "population". The results are presented in Fig. 8 where it might be observed that the slopes are differentiating and the geometric average diameter are:
d_{50}= 0.0508 mm and d_{50} = 0.2253 mm respectively instead of d_{50} = 0.14 as it is when the two sand populations were mixed in the cumulative frequency curve.

An experimental correlation between d_{50} and intrinsic permeability suggests a permeability of 160 md for the finest sand and 30 d for the other one. In fig. 9 is presented a diagram from literature which correlates grain size, permeability and frequency distribution with the type of depositional environment. The two classes of sand from the sample are shown as dotted curves, indicating a deposit between coarse colluvium and coarse alluvial sand.

A correlation between grain size geometric average d_{50} and the ratio $d80/d50$ were examined agains depth. In fact the grain size d50 is indicating a value proporional to permeability and therefore d50 vs. depth is showing the variation of permeability.

In fig. 10 the d_{50} and ration d_{80}/d_{50} are plotted versus depth. The average d_{50} is 0.14 mm. The curve of the ratio d_{80}/d_{50} divides the interval into three units. Between 1777 m and 1797 m the sand is quite uniform and well sorted. In the lower unit the sand is less well sorted and contains some very fine beds. In the upper unit the sand is poorly sorted, variable shaly, and fine to coarse. The granulometric curves compare favorably with the Gamma ray log (fig. 6) and with the core report.

Porosity and permeability have not been measured on the cores taken in the hydrocarbon zone due to the unconsolidated nature of the sand. However, an experimental (5) correlation between the average grain size and permeability of an unconsolidated sand indicates the clean Eocene sand to have a permeability larger than 1 darcy. In the Paleocene horizontal permeabilities varying between 20 and 2000 md have been measured on consolidated samples from depth 1971 m to 1988 m RKB.

3. Well testing

4 FITs and 2 DSTs were run. A summary of the test results is given in fig. 11. DST no 1 was run in the interval 1796.5 m to 1801 m RKB. There was no flow of formation fluid to the surface during the test but a sample of formation water was collected from the drill string between the ARP tester and the Hydrospring.

DST no 2 was run in the interval 1766-1776.5 m RKB. The well flowed oil and gas to the surface but the separator did not stabilize for long enough to enable good measurement of the flow rate. The flow rate is estimated to have been in the range 80 - 140 m^3 stock tank oil per day (500-900 STB/d).

The type of formation fluid recovered from the DST's and the FIT's confirms the interpretation of the CPI as to the nature of the fluids being present in the Eocene sand. In DST no 2 gauge no 2651 seems to be recording 3.5-4.8 atm (50-70 psi) too high. Analysis of the final hydrostatic pressure recorded by the 4 gauges (shown in table 3 and fig. 12) confirms this.

Therefore the readings of gauge no 2651 has been neglected in the calculations of the static pressure.

The average formation pressure at 1710 m RKB is 2585 psig.(175.9atm) (table 4 and fig. 13)

Due to the very fast pressure rise no pressure build-up analysis can be performed on the test results. However, with the flowrate ranging between 80-140 m^3 of stock tank oil per day the productivity index lies in the range 16-28 m^3 stock tank oil/day/atm (6.7-12 bbl/day/psi). This indicates a permeability in the range of 1-2 darcy.

In both DST's production of sand from the unconsolidated formation created serious difficulties in the execution of the testing.

At the recovery of the tool string in DST no 1 a large fraction of it was found to be filled with sand (no oil stains).
In DST no. 2 the content of sand in the produced oil exceeded 14% at the start of the flow decreasing to less than 1% after 4 hours.

4. Sampling

FIT no 2 and 3 at 2010 m and 1978.5 m RKB respectively were found to contain only mud and mudfiltrate. From FIT no 4 at 1808.5 m were recovered oil and from FIT no 5 at 1753 m RKB gas were recovered.

DST no 1 recovered formation water only. A sample of water was collected from the drill string between the APR tester and the hydrospring.

DST no 2 recovered oil and gas.

A PVT sample of gas from FIT no 5 and separator samples of oil and gas from DST no 2 have been analysed by the laboratory of SINTEF in Trondheim [1].

The water sample was analysed at the laboratories of NTNFK together with a sample of the spotting fluid[2].

5. Analysis of the formation fluid

Recombination of the separator samples of gas and oil at 53.3° C (128°F) gave a bubble point pressure of 174.69 atm (2568 psig). Flash liberation of gas resulted in a GOR of 46.7 Nm^3/m^3 st.t. oil (260 scf/STB) and a formation volume factor of 1.116. The gravity of the residual oil and separator gas was respectively 20.0° API and 0.569 (air=1). The oil has a viscosity of 5.2 cp at the saturation pressure. A NMR-spectrum indicates the oil to be paraffinic with an average molecular weight of approximate 278.

A summary of the results from the fluid analysis is given in table 5.

D. VOLUMETRIC ESTIMATE OF HYDROCARBONS IN PLACE.

The contour map of the seismic marker C la in the vicinity of well 30/7-2 shown in Fig. 1. is the basic data for bulk volume evaluation. A volumetric estimate of hydrocarbons in place in the Eocene structure has been determined by using the contour map and the reservoir parameters listed in table 2.

The bulk volume of sand saturated with hydrocarbon between the isobathes 1749.8 and 1783 m RKB as shown in Fig. 5, was estimated:

$$V_B = 153 \cdot 10^6$$

where the bulk of gas sand is:

$$V_{BG} = 49.6 \cdot 10^6 m^3$$

and the bulk of oil is:

$$V_{BO} = 103.4 \cdot 10^6 m^3$$

The gas volum factor B_g is

$$Bg = \frac{pT_o}{Tzp_o}$$

where z is 0.87. P and T is given in table 2

$$\underline{Bg = 169.6 \ ^{Nm3}/m^3}$$

The gas in place is then:

V_{BG} $\emptyset_{gas}$ $(1-S_{wgas})$ x B_g x gas:	$1.1 \cdot 10^9 Nm^3$
V_{BO} $\emptyset_{oil}$ $(1-S_{woil})$ x $oil/^{B}o)RS$	$0.8 \cdot 10^9 Nm^3$
	$1.9 \cdot 10^9 Nm^3$

B_o if from PVT data 1.108 m^3/ STM^3
The oil in place is then V_{BO} $\emptyset_{oil}$ $(1-S_{woil})$ x $oil/^{B}o$ $18 \cdot 10^6 Nm^3$

E. WELL PRODUCTIVITY

The well 30/7-2 discovered a relatively thin (20m gross pay) oil column in an Eocene sand formation. Since other oil accumulation might be found in older sediments below the 30/7-2 discovery, a calculation of 30/7-2 oil rate was performed to establish whether the discovery has to be considered as an additional reserve or not.

1. Absence of water and gas coning

If an impermeable layer could be established by well completion so that water and gas coning are avoided, the rate might reach the following order of magnitude based on PI evaluated from testing data.

$$PI_{average} = 22 m^3/day/atm = 9.67 \text{ Bbl/day/psi}$$

Considering a pressuredrop in the range of 0.1 Pi to 0.2 Pi, equivalent to

$$\Delta p = (0.1 - 0.2) P_i = 250 - 500 \text{ psi}$$

$$\Delta p = 250\text{-}500 \text{ psi}.$$

the rate is

$$2500^{bbl}/day \text{ to } 5000^{bbl}/day$$

The additional production in this case might reach 10^6 Bbl/year/well.

It is emphasized that the friable sand of 30/7-2 will not be very favourable to any kind of workover designed to minimise coning effects by attempting to isolate water, oil and gas zones (e.g. by using squeezed cement).

2. Case of water coning.

According to log evaluation and core data there is no impermeable layer of large extention in the oil zone. The risk of a water coning development therefore has to be considered when calculating well rate. The maximum ΔP admissible for a water free production rate is, ΔP-cone, given by the following equation.

$$P_c, \max = \frac{\rho_{water} - \rho_{oil}}{1.0332} \quad z$$

Where ρ_{water} and ρ_{oil} is the spesific weight of water and oil respectively, and z is total height minus perforated height.

$$\rho_{water} = 1.0318 \times 10^{-3} kg/cm^3 \quad (2)$$

$$\rho_{oil} = 0.866 \times 10^{-3} kg/cm^3 \quad (1)$$

$$\underline{\Delta P_{coning} = 0.163 \text{ atm}}$$

When introducing the maximum pressure drop in the flowing eqation it results.

$$q = \frac{2\pi h_p k\Delta p}{\mu B_o \ln r_e/r_w} \times \{1+7 \frac{r_w}{2h_p} \cos(f x 90^o)\}$$

where

h:	total height	20m
h_p:	perforated height	10m
f:	h/h_p	0.5
k:	permeability	1D
r_w:		0.1m
$\ln r_e/r_w$		9.8
μ		5.2cp
B_o		$1.11m^3/STM^3$

$q = 1.82\ STM^3/day = 11.46STB/day$

If water coning can not be avoided by the presence of an impermeable layer the rate is so limited that the Eocene discovery has to be disregarded as additional reserves.

In this calculations the gas coning was not considered since the water coning already is limiting the production to extremely low figures.

F CONSIDERATIONS ON RECOVERY FACTOR

Neglecting the fact that the oil in place is very small and well ratio is limited by coning effects, a recovery factor might be evaluated as an index of various drive mechanisms.

The recovery of oil through solution gas drive mechanism will be evaluated refered to unit volume of oil and is therefore independent of time or field development.

The water drive or gas cap recovery evaluation will be limited only to the evaluation of microscopical displacement efficiency without any attempt of estimating the sweep efficiency and conformance factor. In other words the evaluation is independent of field development.

1. Solution gas drive mechanism.

1.1. Statistical method based on fluid properties and statistic data. The equation to be used is:

$$RE = 41.815 \times \left[\frac{\phi(1-S_w)}{B_{ob}}\right]^{0.1611} \times \left[\frac{k}{\mu_{ob}}\right]^{0.0979} \times \left[S_w\right]^{0.3722} \times \left[\frac{P_b}{P_a}\right]^{0.1741}$$

Where RE the recovery efficiency in percent

ϕ	porosity (fraction)	0.294
Sw	watersaturatin (fraction)	0.194
B_{ob}	Formation volum factor for oil bbl/bbl	1.116
μob	oil viscosity (cp)	5.19
k	permeability in md	
Pb	bubble point pressure (psi)	2568
Pa	abandonment pressure	

In fig. 14 $^{Pb}/Pa$ is plotted v.s. RE. The recovery is calculated for permeabilities of 1000 md and 500 md.

RE = 36% for k = 500

RE = 38,5% for k = 1000

at an abandonment pressure of 600 psi. This method of calculating the recovery factor gives very optimistic results.

1.2. Solution of material balance Equation (Tracy's method)

For a fixed pressure, N_p is assumed, and the assumption is checked by solution of the following equations.

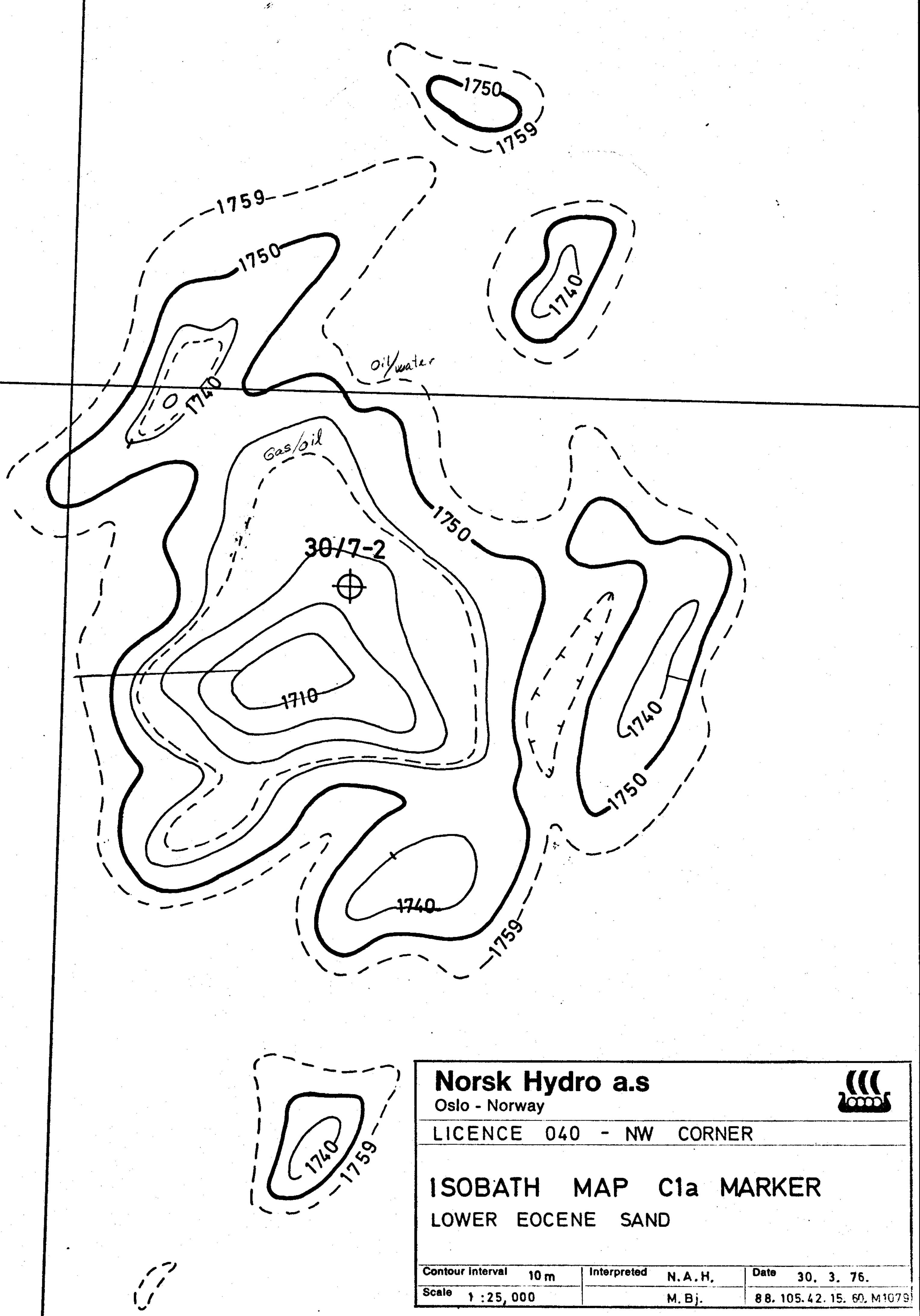
1. $$S_o = (1-S_w) \times (1-\frac{N_p}{N}) \times \frac{B_o}{B_{oi}}$$

2. $$R = \frac{k_{rg}}{k_{ro}} \frac{\mu_o \mu_g}{BoBg} + R_s$$

3. $$N_pR_p = (N_pR_p)_{n-1} + \frac{R_{n-1}+R_n}{2} (N_{pn}-(N_p)_{n-1})$$

4. $$N_pR_p = \frac{N(B_t-B_{ti})-N_p(B_t-R_{si}B_g)}{B_g}$$

FIG. 1



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LICENCE 040 - NW CORNER

ISOBATH MAP C1a MARKER

LOWER EOCENE SAND

Contour interval	10 m	Interpreted	N.A.H.	Date	30. 3. 76.
Scale	1 :25, 000		M.Bj.		88. 105. 42. 15. 60. M1079

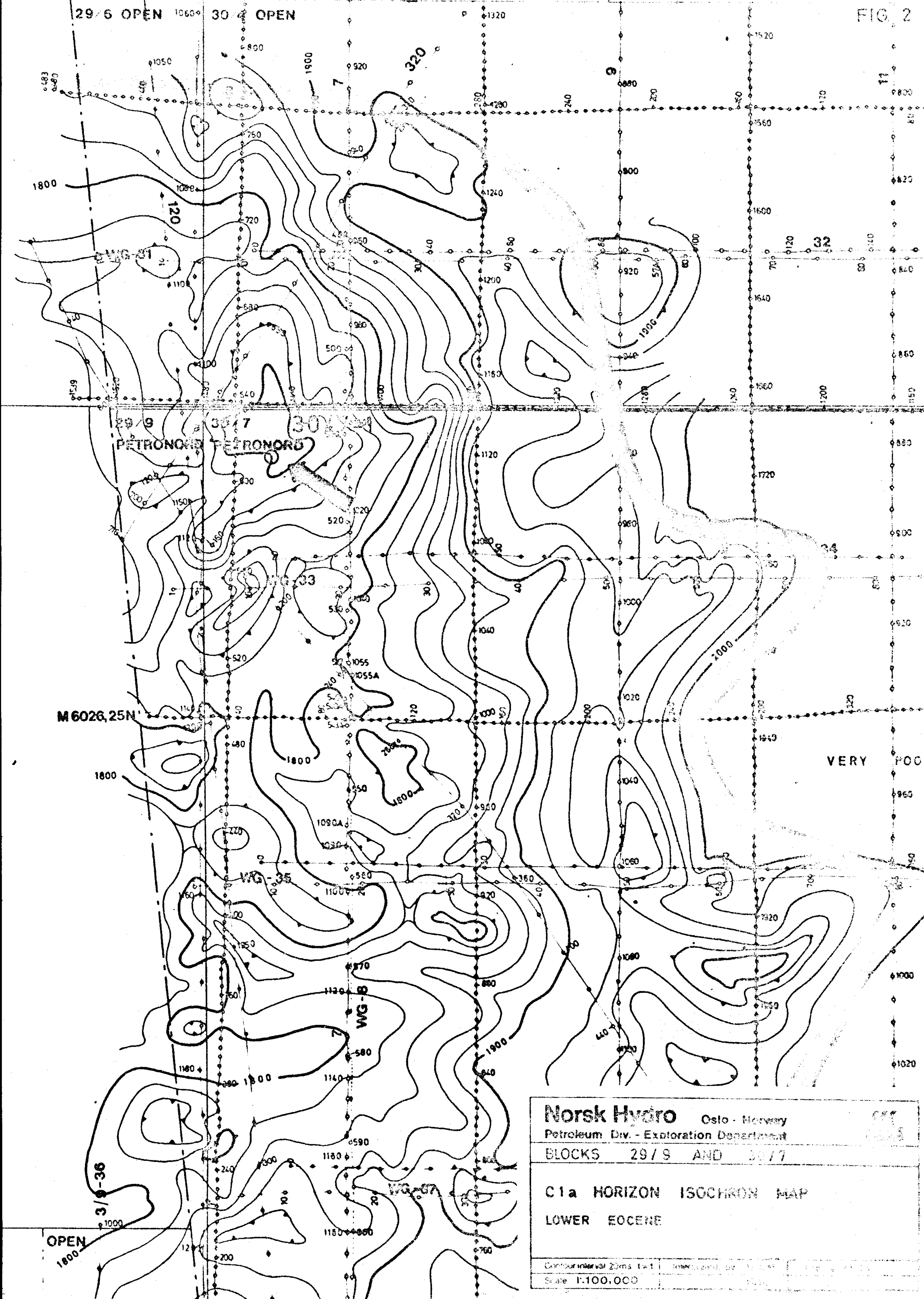
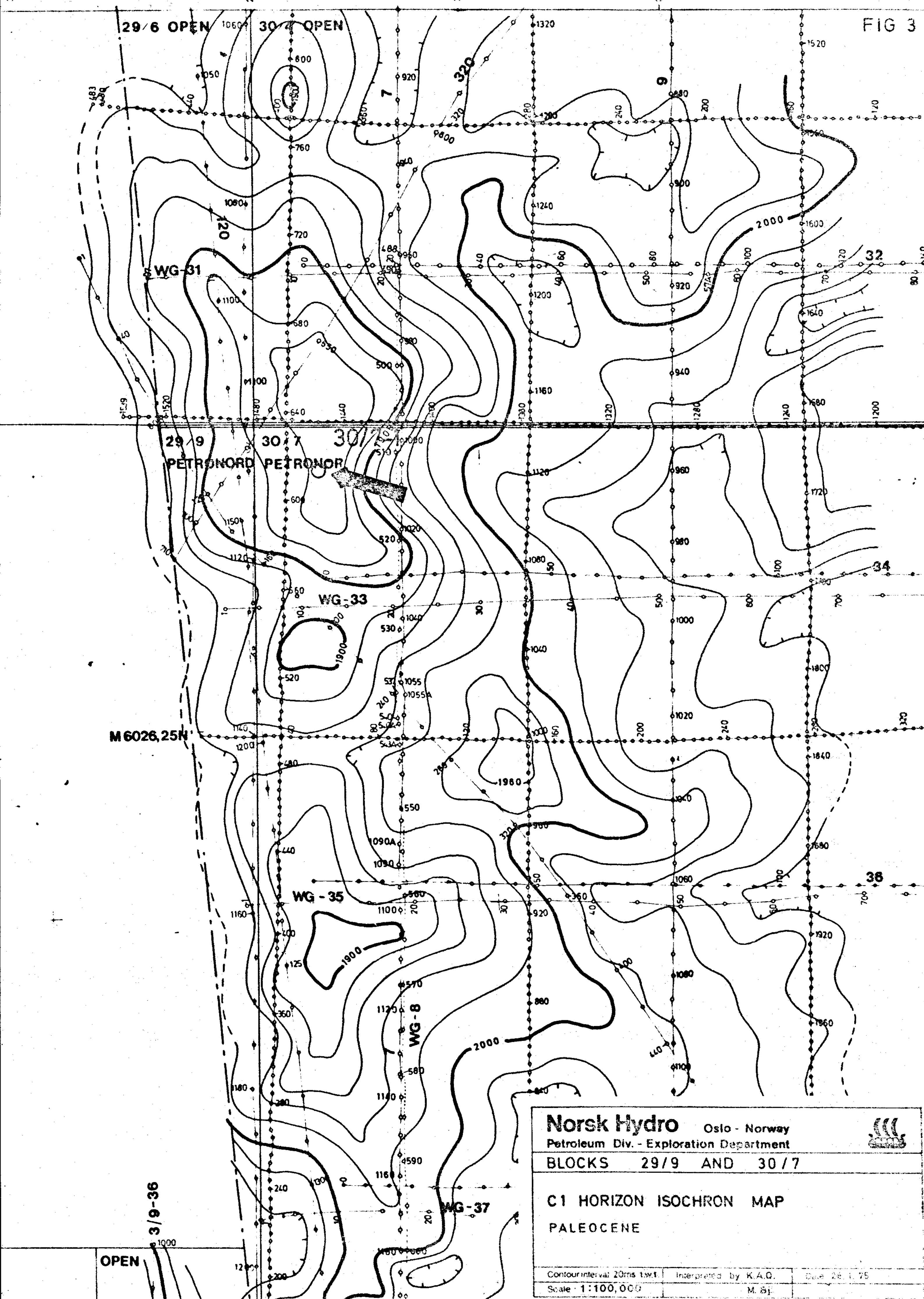

29/6 OPEN
30/4 OPEN
29/9
PETRONORD
30/7
PETRONORD
M 6026,25N
VERY POO
OPEN
WG-31
WG-33
WG-35
WG-8
WG-37
3/9-36
1800
1900
Norsk Hydro Oslo - Norway
Petroleum Div. - Exploration Department
BLOCKS 29/9 AND 30/7
C1a HORIZON ISOCHRON MAP
LOWER EOCENE
Contour interval 20ms
Scale 1:100,000

FIG. 2

FIG 3



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Petroleum Div. - Exploration Department

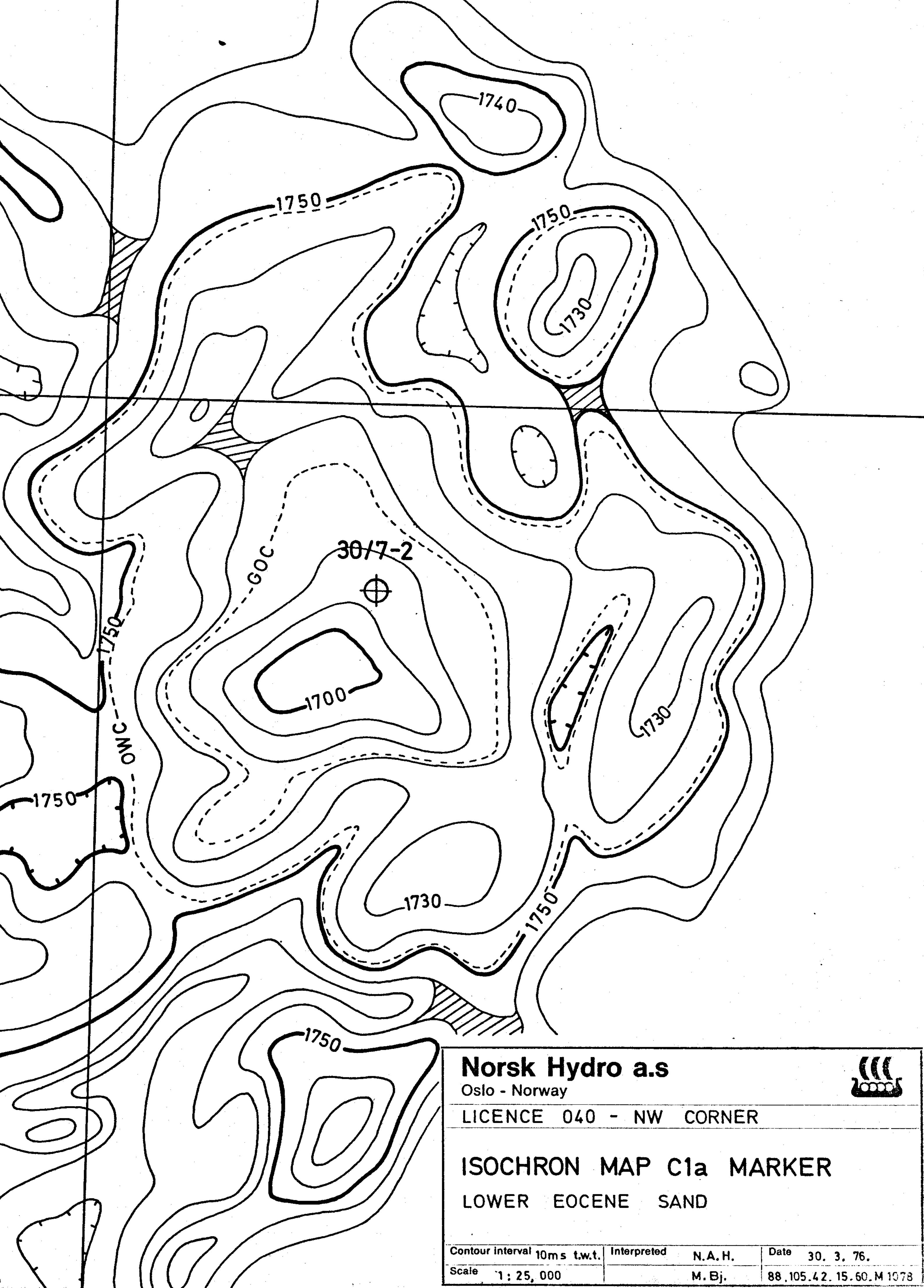
BLOCKS 29/9 AND 30/7

C1 HORIZON ISOCHRON MAP

PALEOCENE

Contour interval 20ms t.w.t.	Interpreted by K.A.Q.	Date 26.1.75
Scale 1:100,000	M. Bj.	

FIG. 4



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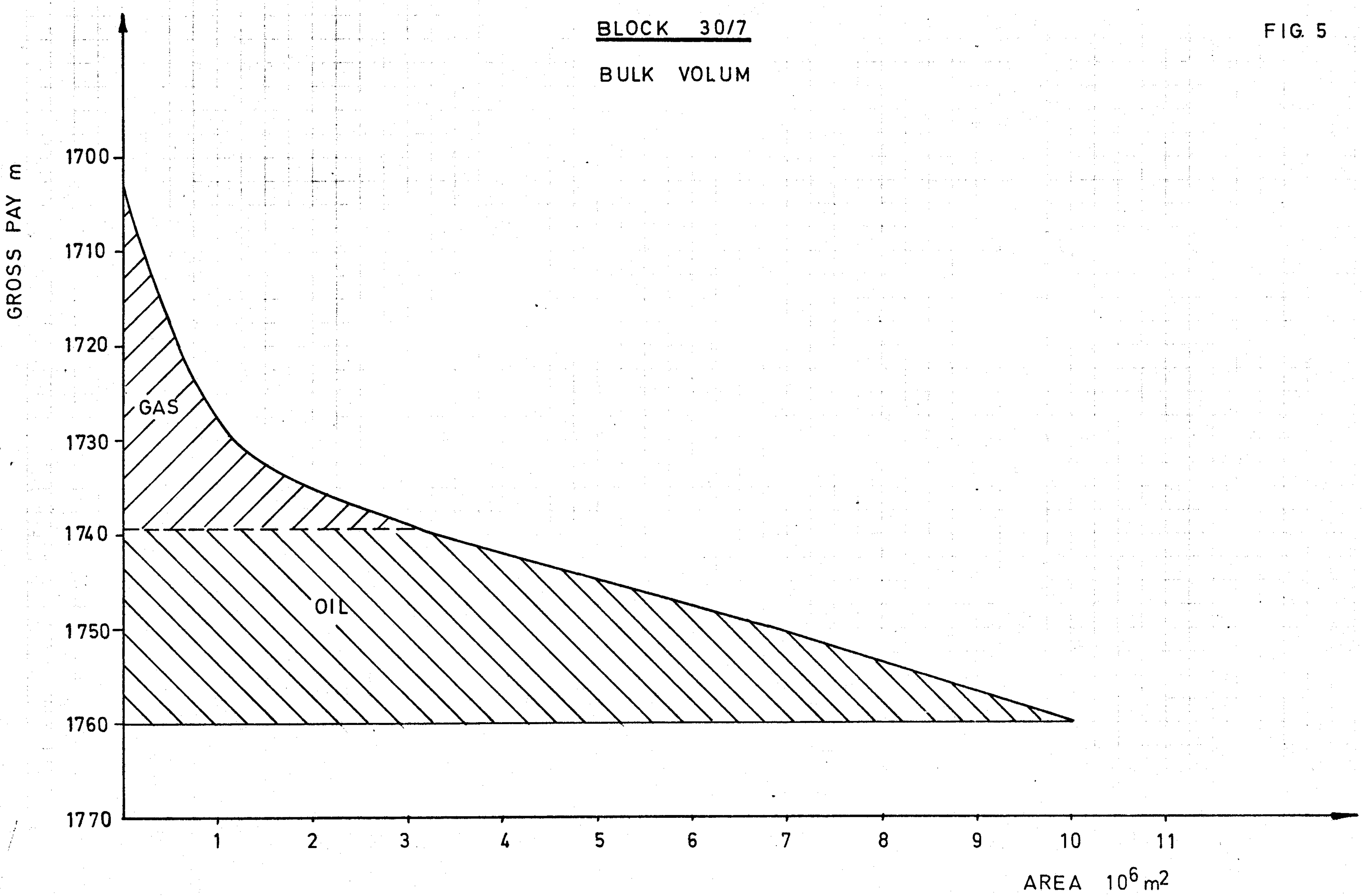
ISOCHRON MAP C1a MARKER

LOWER EOCENE SAND

Contour interval	10ms t.w.t.	Interpreted	N.A.H.	Date	30. 3. 76.
Scale	1: 25, 000		M. Bj.		88.105.42.15.60.M 1078

FIG. 5


BLOCK 30/7
BULK VOLUM
GROSS PAY m
1700
1710
1720
1730
1740
1750
1760
1770
GAS
OIL
1
2
3
4
5
6
7
8
9
10
11
AREA 10⁶ m²

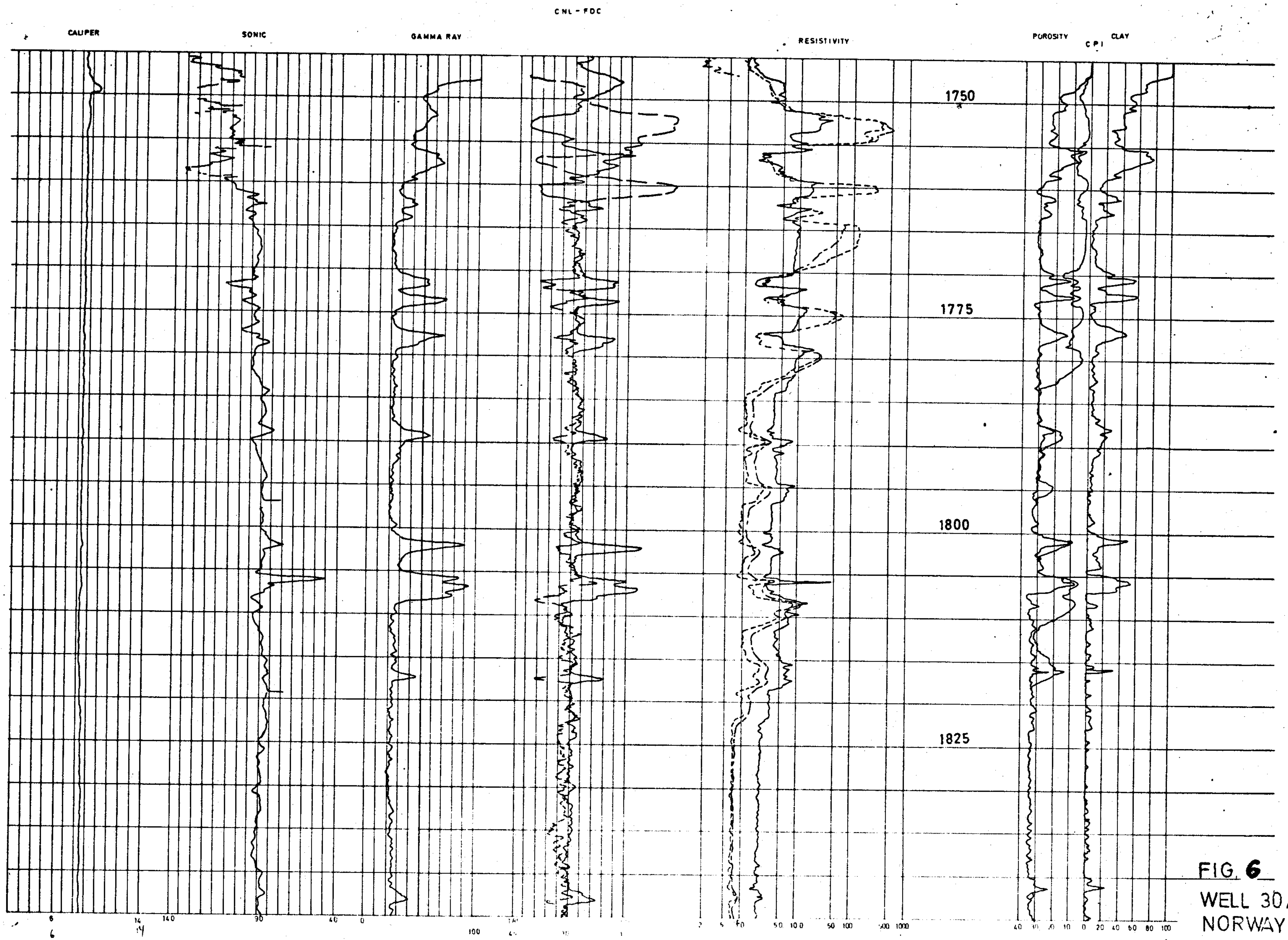


FIG. 6
WELL 30/7-2
NORWAY

FIG. 7

WELL 30 / 7 - 2

GRAIN SIZE DISTRIBUTION
IN SAMPLES TAKEN IN THE
INTERVAL 1753,0 – 1821,7 m

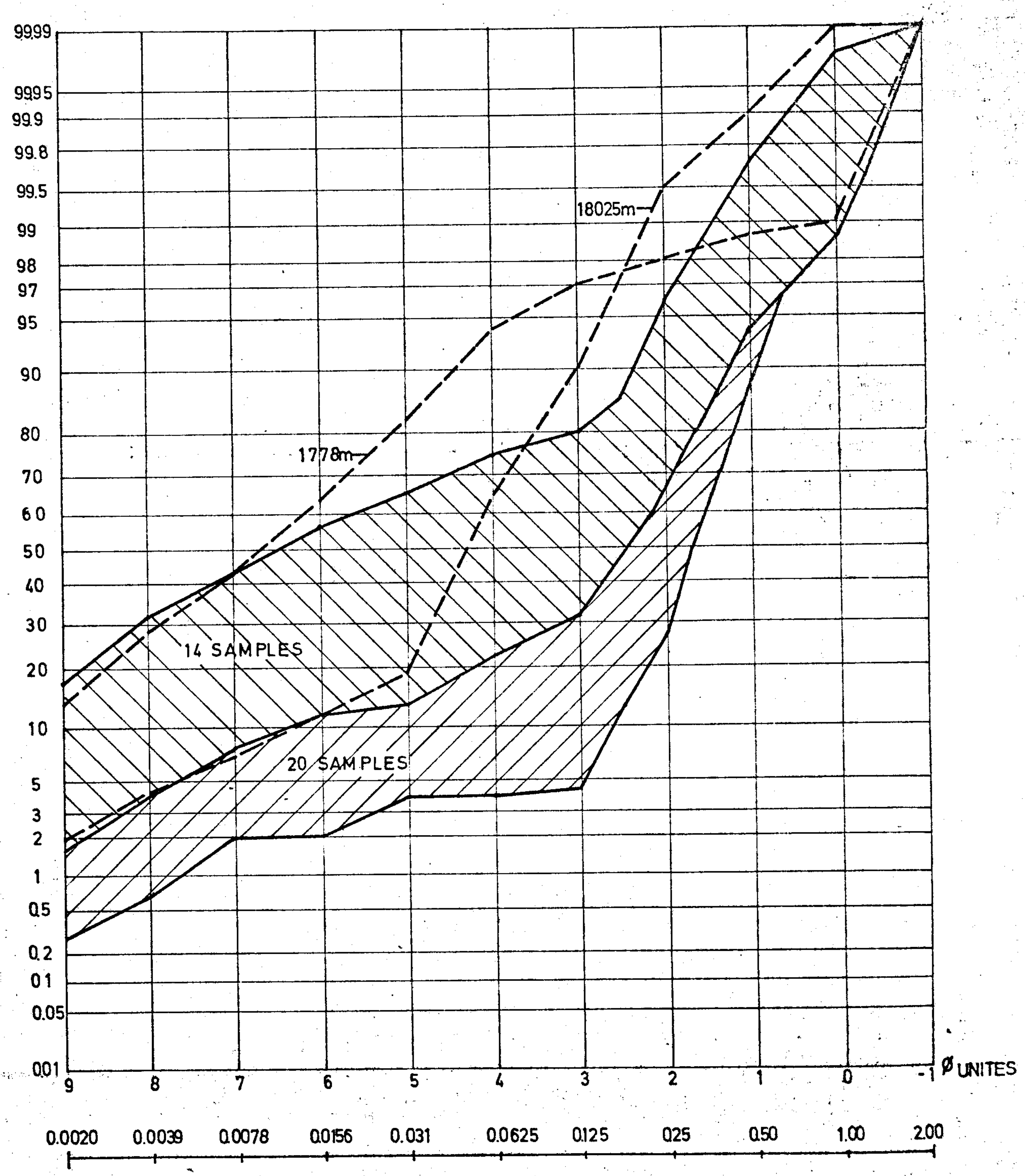
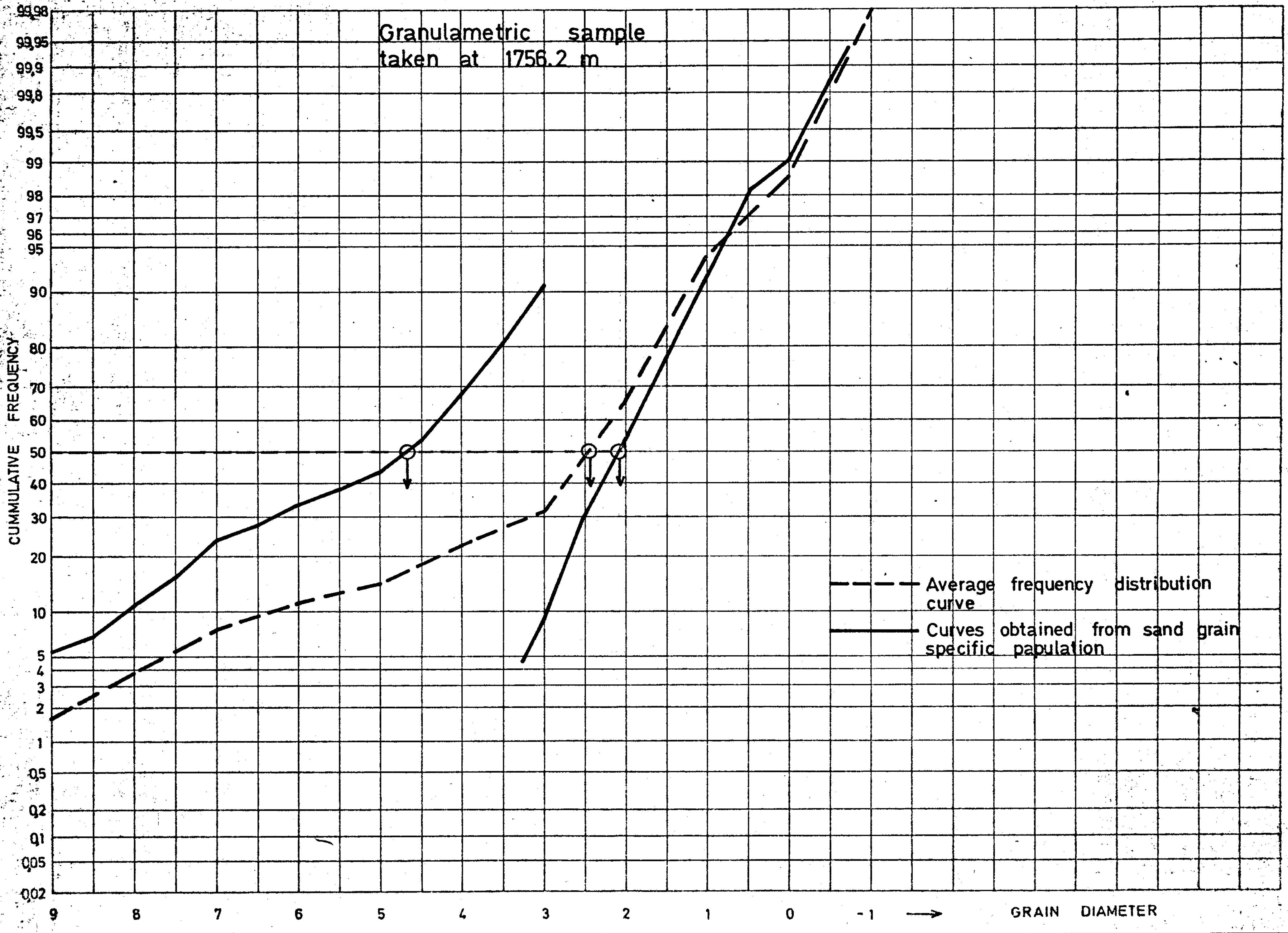
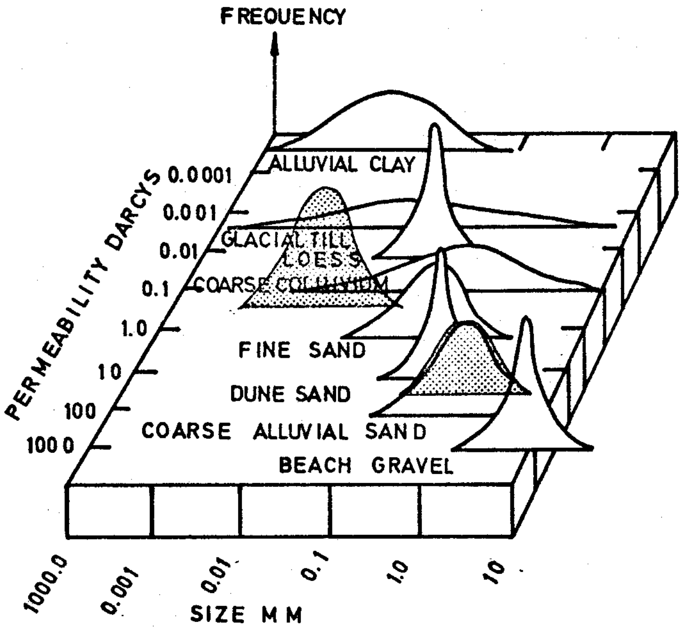


FIG. 8


Granulametric sample
taken at 1756.2 m
%
99,98
99,95
99,9
99,8
99,5
99
98
97
96
95
90
80
70
60
50
40
30
20
10
5
4
3
2
1
0,5
0,2
0,1
0,05
0,02
CUMMULATIVE FREQUENCY
9
8
7
6
5
4
3
2
1
0
-1
GRAIN DIAMETER
Average frequency distribution curve
Curves obtained from sand grain specific papulation

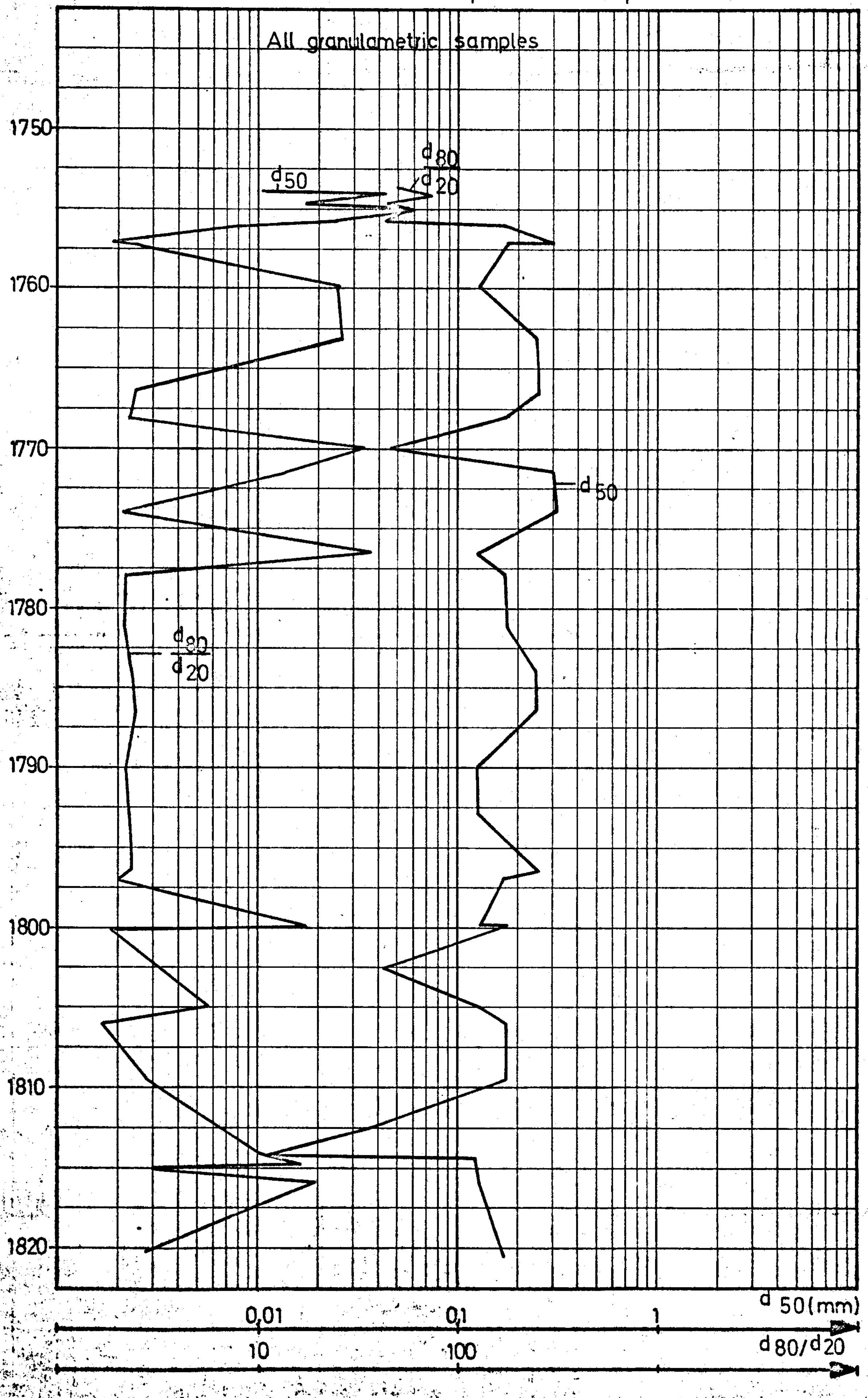
PERMEABILITY OF NATURAL MATERIALS



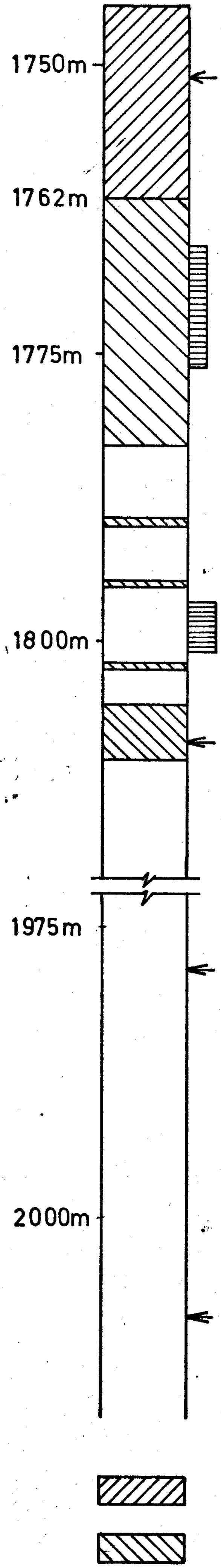
Well 30/7-2

d_{50} and d_{80}/d_{20} plotted v. s. depth

Fig 10



30/7-2 SUMMARY OF TEST RESULTS FIG. 11



FIT no. 5 at 1753 m Sip 2578 psig.

DST no. 2 1766 - 1776,5 m 2 sh/ft
500 - 900 bbl/d. Sip 2582 psig.
Oil gravity 22,2° API
Gas gravity 0.564.

DST no. 1 1796,5 - 1801 m 4 sh/ft.
Formation water and sand recovered.
No shows of oil.
Sip 2614 psig. 47 000 ppm Cl + 3200 ppm Ca.

FIT no 4 1808,5 m Sip 2614 psig.
2 L oil + 2,3 L mixed sand, oil and water.
Oil gravity 21,4° API.

FIT no 1 & 3 at 1978 m & 1978,5 m.
Mud and mudfiltrate recovered
Sip 2865 psig.

FIT no 2 at 2010 m

Gas

Oil

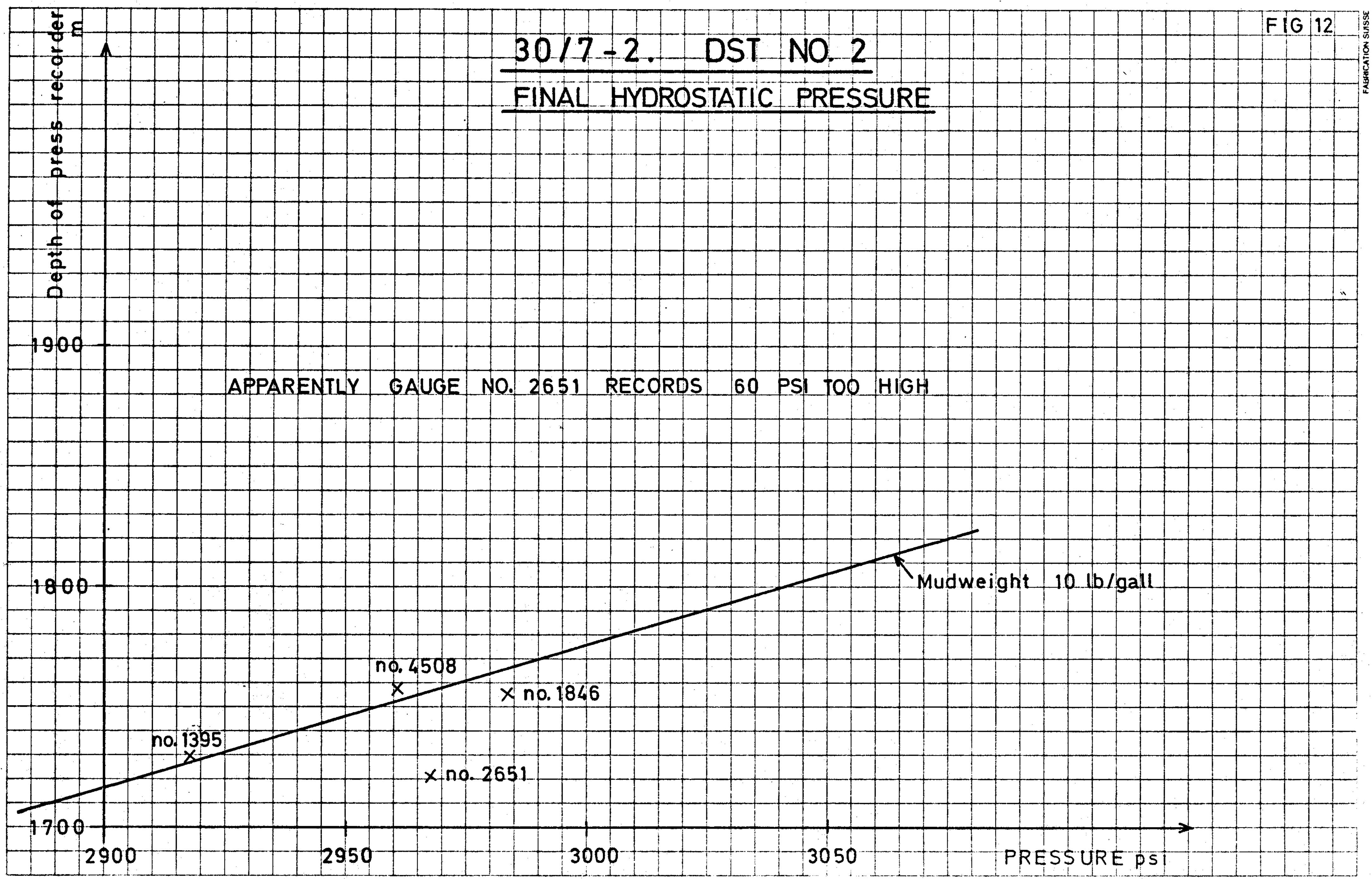
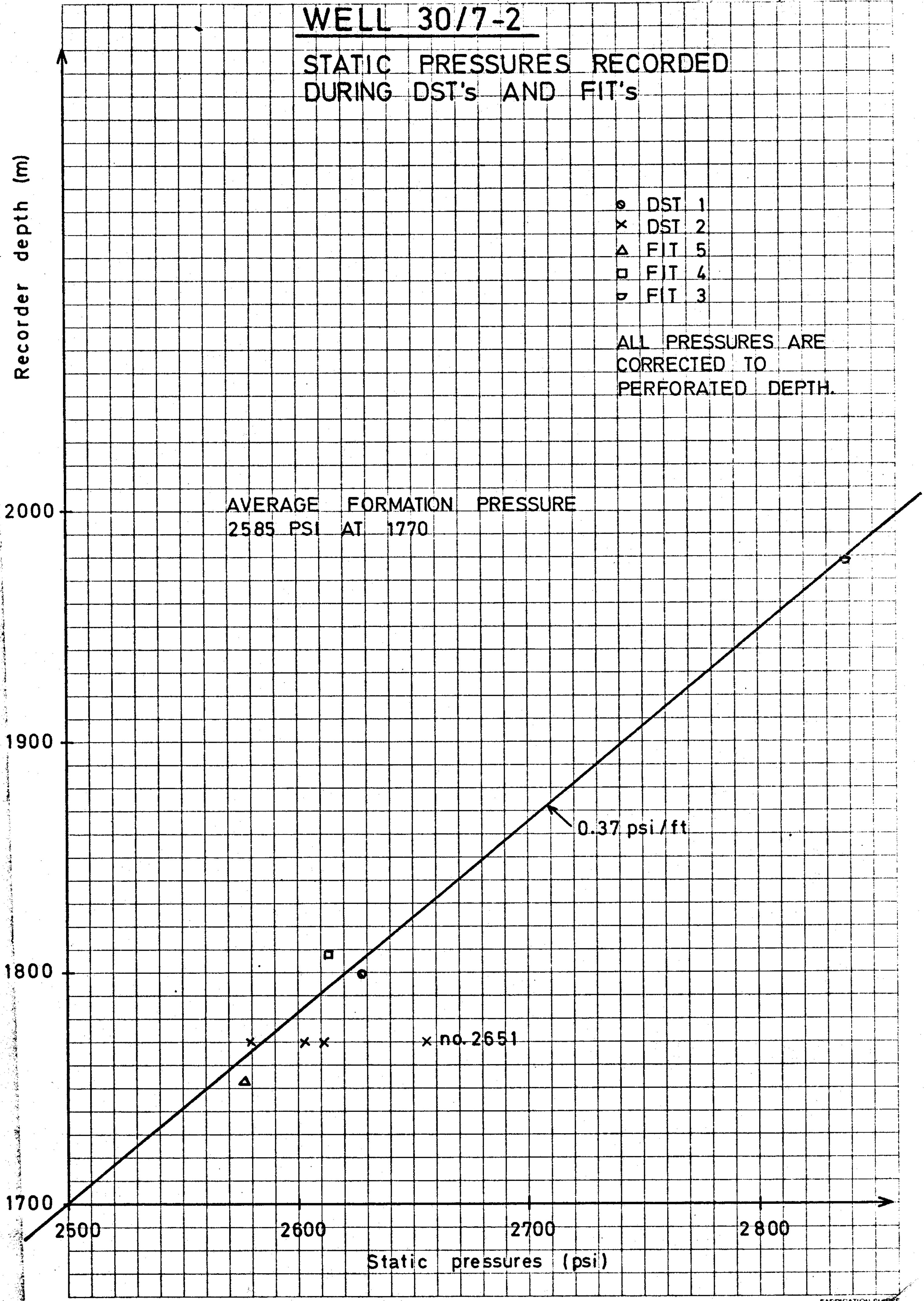


FIG 12
30/7-2. DST NO. 2
FINAL HYDROSTATIC PRESSURE
Depth of press. recorder m
1900
1800
1700
APPARENTLY GAUGE NO. 2651 RECORDS 60 PSI TOO HIGH
Mudweight 10 lb/gall
no. 4508
no. 1846
no. 1395
no. 2651
2900
2950
3000
3050
PRESSURE psi
FABRICATION SUISSE

FIGURE 13


WELL 30/7-2
STATIC PRESSURES RECORDED DURING DST's AND FIT's
DST 1
DST 2
FIT 5
FIT 4
FIT 3
ALL PRESSURES ARE CORRECTED TO PERFORATED DEPTH.
AVERAGE FORMATION PRESSURE 2585 PSI AT 1770
0.37 psi/ft
no. 2651
Recorder depth (m)
2000
1900
1800
1700
2500
2600
2700
2800
Static pressures (psi)
FABRICATION SUISSE

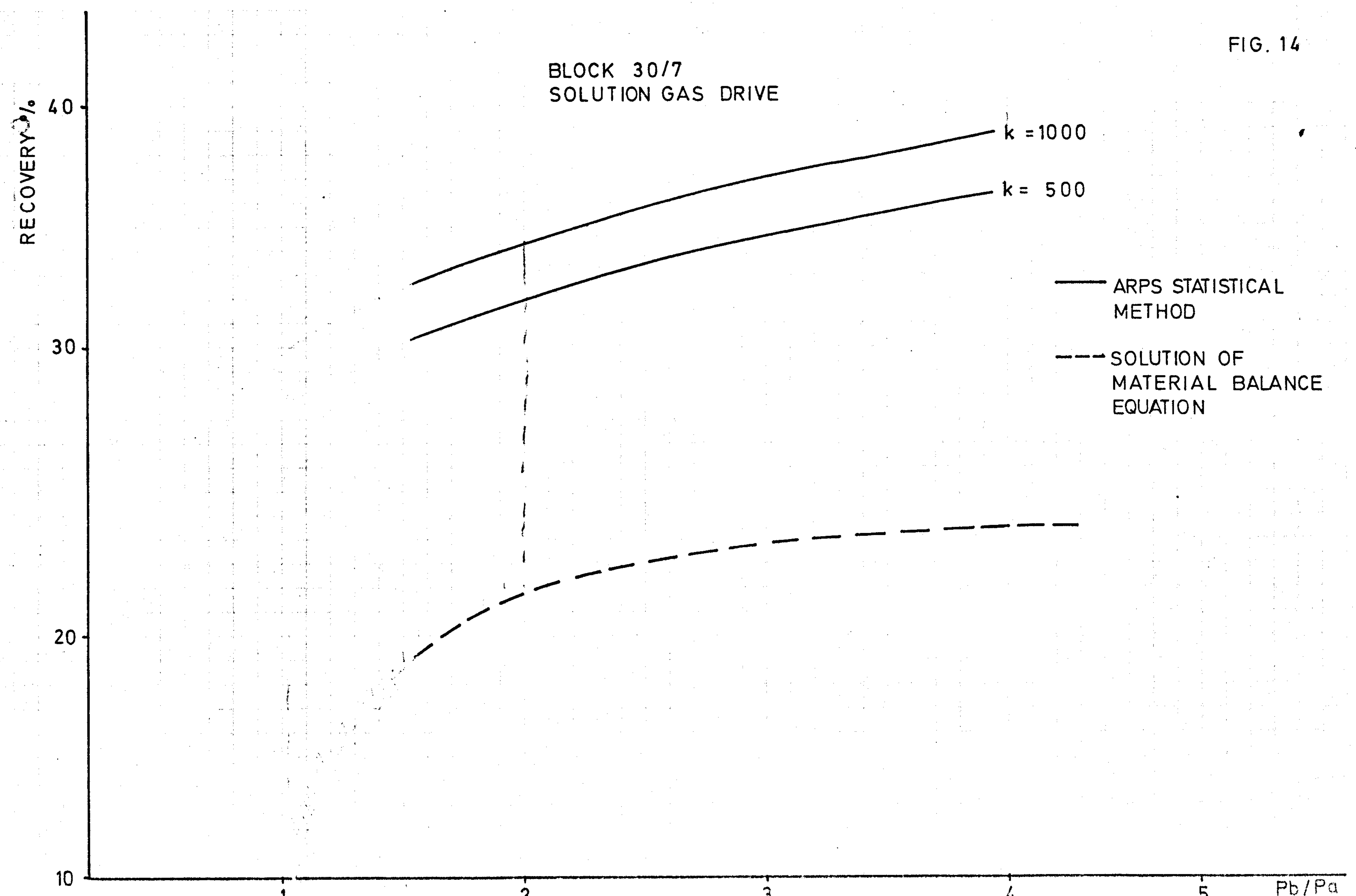
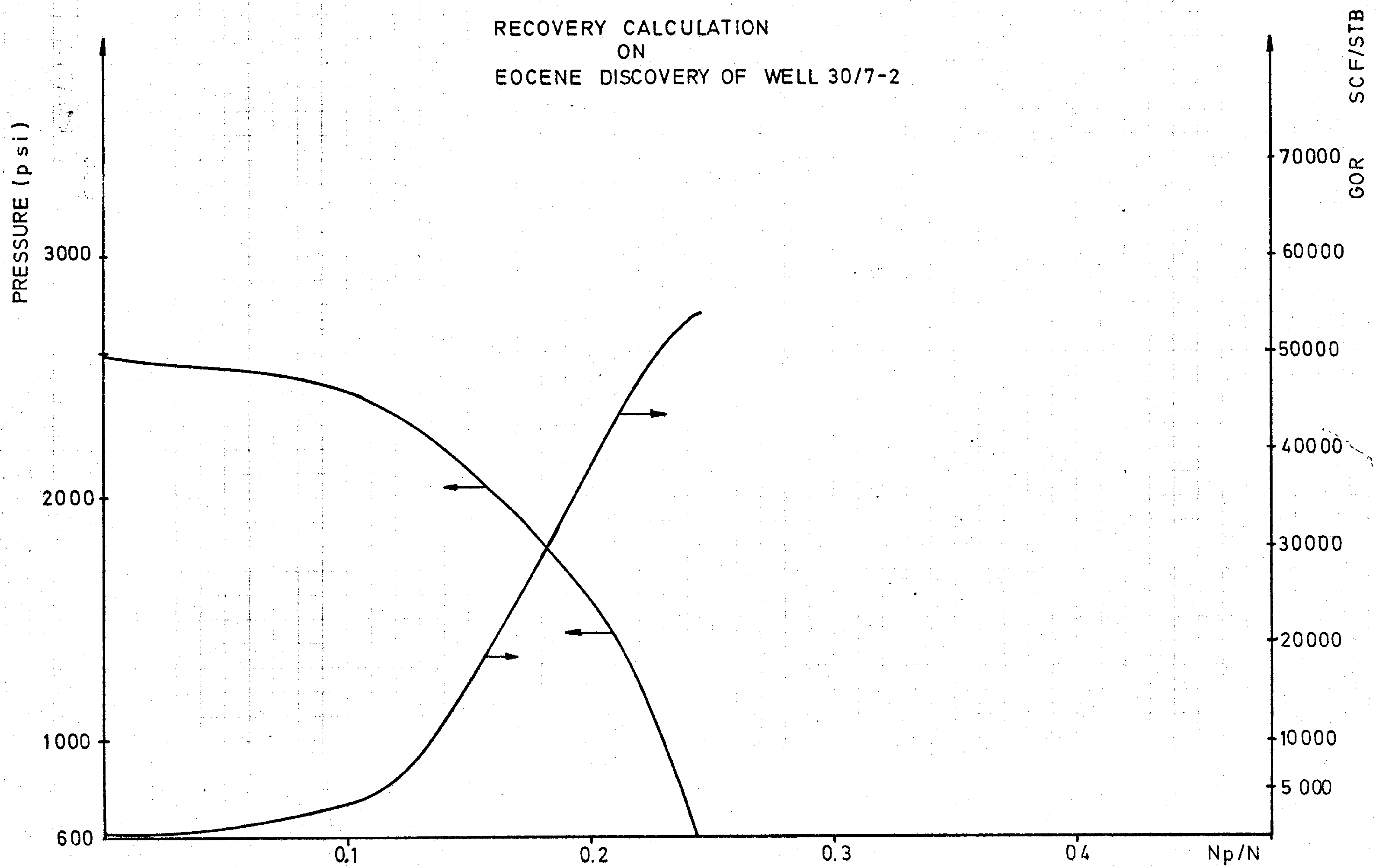


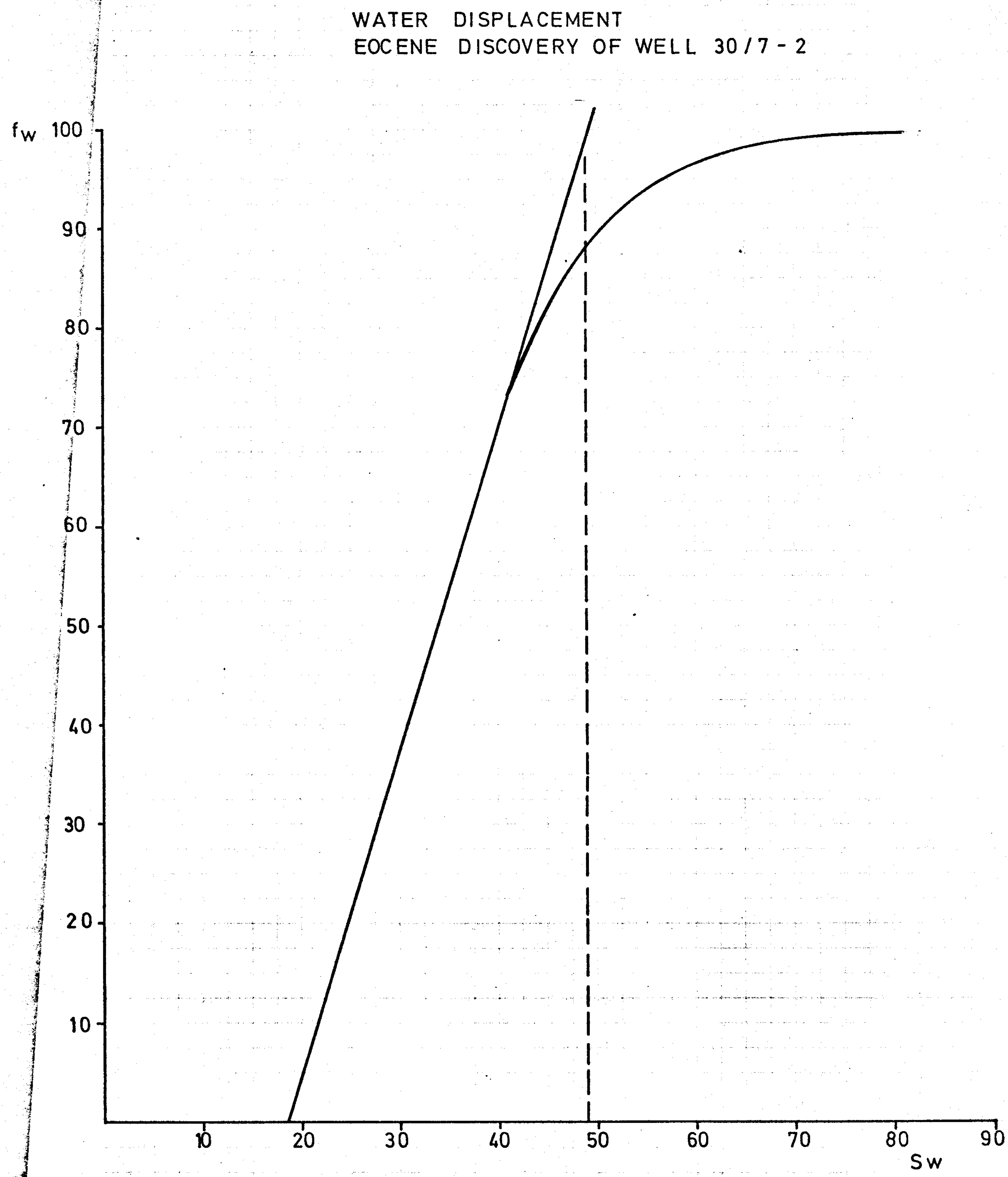
FIG. 14
BLOCK 30/7
SOLUTION GAS DRIVE
RECOVERY %
40
30
20
10
k =1000
k = 500
ARPS STATISTICAL METHOD
SOLUTION OF MATERIAL BALANCE EQUATION
Pb/Pa

FIG. 15



RECOVERY CALCULATION
ON
EOCENE DISCOVERY OF WELL 30/7-2
PRESSURE (psi)
3000
2000
1000
600
0.1
0.2
0.3
0.4
Np/N
SCF/STB
GOR
70000
60000
50000
40000
30000
20000
10000
5 000

FIG. 16



WATER DISPLACEMENT
EOCENE DISCOVERY OF WELL 30/7-2
fw
100
90
80
70
60
50
40
30
20
10
10
20
30
40
50
60
70
80
90
Sw

GAS DISPLACEMENT
EOCENE DISCOVERY OF WELL 30/7-2

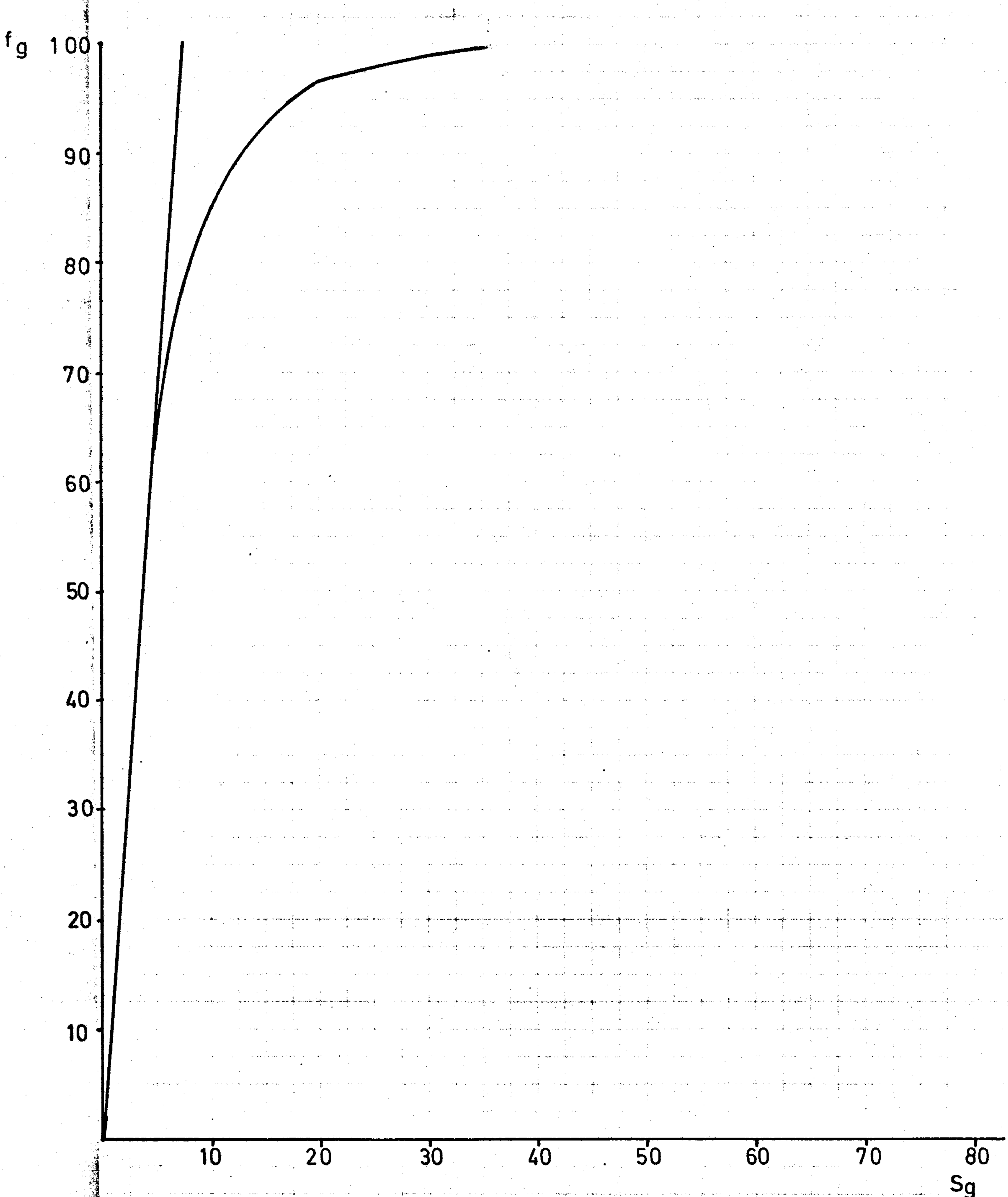


Table 1

WELL 30/7-2

Basic log parameters

	Depth interval	R_w (Ω-m²/m)	R_{mf} (Ω-m²/m)	R_{cl} (Ω-m²/m)	t_{cl} (μ-sec/ft)	ϕ_{Ncl} (%)	ρ_{bcl} (g/cc)	GRmin (API-unites)	GRmax	T°F
CPI	1891.5-1762	0.068	0.298	0.83	130	45	2.31	18	75	117
CPI	1762-1737.5	0.071	0.310	0.83	130	45	2.31	18	75	112
NH	1891.5-1762	0.11	0.298	0.83	140	54	2.10	22	70	117
NH	1762-1737.5	0.11	0.310	0.83	140	54	2.10	22	70	112

Table 2

Well 30/7-2

Results from log interpretation based on CPI.

Seismic marker RKB+	1747.0 m
Top of sand RKB	1749.8 m
Gas oil contact RKB	1762.8 m
Oil water contact RKB	1783.0 m
Gross pay	33.2 m
Net pay gas	9.2 m
Net pay oil	16.4 m
Total net pay	25.6 m
Net/gross gas α_g	0.73
Net/gross oil α_o	0.81
Average porosity gas zone	22.2 %
Average porosity oil zone	29.4 %
Average water saturation gas zone	18.2 %
Average water saturation oil zone	19.4 %
Net gas coloumn	1.22m
Net oil coloumn	3.15m
Reservoir pressure at 1770 m	176.9 ata
Resvoir temperature	53°C

+RKB elevation 22.9 m.

Table 3

Recorded Static Pressures.

Test	Depth of Gauge m	Recorded Pressures psig	Depth of Perforation m	Calculated Pressures psig
FIT 5	1753	2578	1753	2578
DST 2	1723	2595	1770	2657+
DST 2	1725	2553	1770	2612+
DST 2	1756	2586	1770	2604+
DST 2	1758	2565	1770	2581+
DST 1	1792	2619	1799	2692++
FIT 4	1808	2614	1808	2614
FIT 3	1978	2858	1978	2858
FIT 2	2010	No flow	2010	-

Hydrostatic Pressures of DST no 2.

Gauge no.	Depth of Gauge m	Final Hydrostatic Pressure psig
2651	1723	2968
1395	1725	2918
1846	1756	2984
4508	1758	2961

+Recorded gauge pressure has been corrected to the average depth of perforation by assuming an oil column of 0.93 gravity in the test string.

++Recorded gauge pressure has been corrected to the average depth of perforation by assuming a water column of 1.03 gravity in the test string.

Table 4

AVERAGE RESERVOIR PRESSURE

TEST	DEPTH OF RECORD m	PRESS. psi	PRESS. @ DATUM psi (1770 m)
FIT 5	1753	2578	2596
DST 2	1725	2612	2612
DST 2	1756	2604	2604
DST 2	1758	2581	2581
DST 1	1792	2619	2589
FIT 4	1808	2614	2650
FIT 3	1978	2858	2555

Average pressure at datum = 2585 psi

Table 5

Analysis of Hydrocarbon Samples from DST no. 2 and FIT no. 5.

	Recombined Reservoir Fluid	DST 2 Oil	DST 2 Gas	FIT 5 Gas
CH_4	0.37913		.99617	.99550
C_2	0.00146		.00383	.00450
$n-C_3$				
$n-C_4$				
$n-C_5$				
$n-C_6$	0.00188	.0030		
$n-C_7$	0.0619	.00996		
$n-C_8$	0.00015	.00217		
$n-C_9$	0.00019	.00030		
$n-C_{10}$	0.00520	.00840		
$n-C^+_{11}$	0.60580	.97617		

Analysis of Water from DST no. 1

Solids 53.3 g/l (81.6 % NaCl).
Resistivity 0.129 Ohm x m at 20 C

Analysis of Spotting Fluid from DST no. 1

Solids 209.5 g/l (86.5 % $CaCl_2$).

Table 6

Relative permeability of oil to water

Statistical data.[7]

Sw (%)	$\frac{ko}{kw}$
80.6	0
79.6	0.0063
75.4	0.0225
71.2	0.994
67.0	0.11
62.8	0.215
58.6	0.357
50.3	1.000
41.9	3.125
33.5	9.250
25.1	32.000

Table 7

Relative permeability of gas to oil

Statistical data.[7]

Sg %Hydrocarbon Porevolum	kg/ko
0	0
5	0.0063
10	0.0225
15	0.055
20	0.11
25	0.215
30	0.357
40	1.000
50	3.125
60	9.250
70	32.000
80	91.000

Appendix 1

Loganalysis well 30/7-2

Depth	R_t	$\varnothing_{CNL}$	$\rho_{b\ FDC}$	GR	V_{cl}	$\varnothing$
1848.1	0.6	32	2.10	24	0.04	32.3
1846.3	0.6	34	2.09	25	0.06	32.6
1838.1	0.7	32	2.10	25	0.06	31.6
1835.1	0.7	32	2.11	25	0.06	31.2
1831.1	0.7	31	2.10	23	0.02	32.8
1827.1	0.7	31.5	2.10	22	0	33.7
1822.4	0.7	32.5	2.12	22	0	33.0
1812.1	1.0	31.5	2.11	26	0.08	30.3
1808.2	8.0	31.5	2.07	25	0.06	32.9
1803.5	1.0	29.5	2.11	28	0.04	31.4
1789.1	1.0	30	2.10	28	0.09	30.3
1792.0	1.1	29	2.14	24	0.04	29.8
1785.1	1.0	28	2.12	22	0	32.0
1781.6	5.5	30	2.10	22	0	34.3
1767.1	60	28	2.13	24	0.04	31.0
1762.3	20	29	2.11	30	0	33.7

Appendix 2

Core report

WELL NO 30/7-2	

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 1 (SHEET 1)

AREA: NORWEIGIAN NORTH SEA
WELL RKB: 22·9 m.
INTERVAL: 1753m – 1763 m CUT: 1753m – 1765.2m (12·2 m) RECOVERY: 94·4% (11·5m)
SCALE: 1:50 (1cm = 0.5m)
GEOLOGIST: FELLOWES, LEIVESTAD DATE: 27·9·75

DEPTHS (m)	LITHOLOGICAL DESCRIPTIONS	SHOWS
1753·0 – 1753·6	Intbd mica Sst, gy, f, ang, m-crs, subrnd, firm, v poor srtd, abn Mica and Sh, lt gy, firm, subfis, wxy.	No oil stain, scat strong yel flu on crs g, no vis cut, yel-wht flu cut.
1753·6 – 1754·1	Sh a.a. grdg to mica Sst a.a.	No flu from shaly or arg mat
1754·1 – 1755·0	Sst, lt gy, f, ang, m-crs, ang-subrnd, rare rnd, hd, abn Mica, scat basic min: olivin, hornblende? v poorly srtd.	Patchy oil stain in crs g, fair yel flu, no streaming no vis cut, strong yel flu cut.
1755·0 – 1755·3	Sst, dk gy, abn arg mat, abn Mica, scat Lign sl firm, poorly srtd.	A.a.
1755·3 – 1757·5	Sd, unconsol, generally lt gy, clr Qtz, mostly m, subrnd, occ f, subang, occ. sl firm, scat Mica, poor srtd	A.a.
1757·5 – 1758·4	a.a. but bcm more m-crs and rnd	Patchy oil stain, pale wht-yel flu, no streaming vis cut, instant streaming strong pale yel fluo cut.
1758·4 – 1758·9	Sd, patchy brn (oil stained), f-m, subrnd, scat Musc	Patchy oil stain, strong yel flu, instant streaming dk brn vis cut, yel flu cut.
1758·9 – 1760·0	Mica Sltst, dk gy, rare m-crs qtz g, m hd, v fri, abn Musc and arg mat.	No flu from arg mat.
	Sd, brn (heavily oil stained), f-m, subang-subrnd, rare scat Mica	As Sd above.
	Mica Sltst a.a.	As Sltst above
1760·0 – 1760·75	Sd, uncons, brn, f-m, subang-subrnd, abn dk min, scat Mica (Musc), mod srtd.	Patchy heavily oil stain, bright yel-wht flu, inst streaming dk brn vis cut, wht flu cut.
1760·75 – 1761·0	Sst, dk gy, arg, firm, v fri, abn Musc, Biot in arg mat, v poor srtd.	Patchy oil stain in crs g intercalations and show a.a. No flu on arg mat.
1761·0 – 1761·75	Sd, uncons a.a.	Heavily oil stain (saturated) show a.a.
1761·75 – 1763	Sd, v uncons, lt brn (oil stain), m, subrnd, occ f, subang, rare crs-v crs, w rnd, clean, fair srtd.	Heavily oil stain (saturated) v strong lt odour, strong bright yel flu, instant streaming brn vis cut, strong bright yel flu cut.

Depth scale: 1753 – 1763

WELL 30/7-2	CORE REPORT	CORE NO'S 1

NO. 30/7-2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 1 (SHEET 2)

AREA: CONTINUED FROM SHEE 1
WELL RKB:
INTERVAL CUT: RECOVERY:
SCALE 1·50 (1cm = 0,5m)
GEOLOGIST: DATE

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS (m.)	LITHOLOGICAL DESCRIPTIONS	SHOWS
				Sd, v uncons, a.a.	A.a.
1764			1764		
				NO RECOVERY	
1765			1765·2		

WELL 30/7-2 CORE REPORT CORE NO'S 1

/0
/1-2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 2 (SHEET 1)

AREA: NORWEIGIAN NORTH SEA
WELL RKB 22·9 m
INTERVAL 1765·2 - 1775 m CUT: 1765·2 - 1780 m (15·0 m) RECOVERY: 100%
SCALE 1:50 (1cm = 0,5m)
GEOLOGIST: FELLOWES, LEIVESTAD DATE 28·9·75

DEPTHS (m)	LITHOLOGICAL DESCRIPTIONS	SHOWS
1765·2	Sd, unconsol, lt brn, (oil stain), mostly m, subrnd, tr Musc, mod - poor srtd.	Very strong lt oil odour, heavily oil stain, bright yel-wht flu, instant streaming vis cut, dk brn, yel-wht flu cut.
1769·5	Sh, dk gy, firm - hd, subfis - fis abn Musc, tr Biot, tr Lign, and mica Sltst, dk gy, firm, occ m - crs Qtz, abn Musc, abn arg mat.	No shows
1771·0	Sd, unconsol, lt brn, (oil stain), mostly m, occ crs, subrnd, arg at top and base, w srtd.	As in Sd above.
1772·0	Mica Sltst, dk gy, firm, occ m - crs, abn Musc, tr Biot, occ subfis.	No shows
1772·5	Sd, unconsol, dk brn (oil saturated) rare scat Musc increasing at base, mod - w srtd, poor at base.	As in Sd above.

Depth scale: 1766, 1767, 1768, 1769, 1770, 1771, 1772, 1773, 1774, 1775

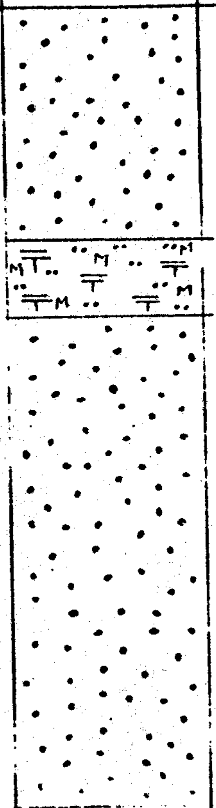
/0
1-2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 2 (SHEET 2)

AREA: CONTINUED FROM SHEET 1
WELL RKB:
INTERVAL: CUT: RECOVERY:
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: DATE:

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
				Sd, a.a.	A.a.
1776					
			1776.5	Mica Sltst a.a.	No shows
1777			1777.0		
				Sd, unconsol, lt brn (oil saturated) mostly m-crs, scat Musc, poor-mod srtd.	As in Sd above.
1778					
1779					
1780			1780.2		



WELL 30/7-2 | CORE REPORT | CORE NO'S 2

NO
30/7-2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 3
SHEET ※1

AREA: Norwegian North Sea
WELL RKB: 22,9 m
INTERVAL: 1780,2m-1792,4m CUT: 12,2m RECOVERY: 100%
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: FELLOWES, LEIVESTAD, RYDBERG
DATE: 29.9.75

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
1781, 1782			1780,2	Sd, uncons, clr qtz, dk yelsh brn (oil-stained), m grnd grdg into f, subrnd, fairly well srtd, tr musc, tr hd blk mineral. V sl increase in grainsize downwards.	Uniform, strong, whsh yel fluo yelding an instant streaming, strong yelsh wh fluo cut. Uniform heavy tan oil staining w/ amber vis cut. Saturated w/ oil. Fluo a/a but patchy.
1783			1782,6	Sd, mainly a/a but loc vf grnd and more mic.	Patchy, fair, whsh yel fluo yelding an instant, streaming, strong yelsh wh fluo cut.
1784, 1785			1783,15	Sd, uncons, clr qtz, olv gry, m grnd grdg into f w/ tr Slt, m-poorly srtd, v muscovitic, tr hd blk min. V sl tr Sh, dk gry.	No fluo - no stain. No fluo - no stain. Patchy, fair, yel fluo yelding an instant, strong/fair yelsh wh fluo cut. No vis stain or vis cut.
1786			1786,0	Sd, a/a w/ tr biotite.	Only v locally sl tr of yel fluo.
1787			1786,8	Sd, uncons, clr qtz, dk yelsh brn (oil-stnd), m-f grnd, ang-subrnd, fairly well srtd, tr musc, tr hd blk min.	Patchy, fair, yel fluo yelding an instant, strong yelsh wh fluo cut. Patchy tan oil stn w/ pale straw vis cut
1788			1787,7	Sd, w/ tr of Slt as in intval 1783,15-1786,0 m.	Only v locally patchy yel fluo yelding an instant fair yelsh wh fluo cut. No vis cut or vis stain.
1789, 1790			1788,7	Sd, uncons, clr qtz, dk yelsh brn (oil-stained), m-f, loc vf grnd, subrnd - sub ang, fairly well srtd, sl tr mica, sl tr dk hd min.	Uniform, strong, yel fluo yelding an instant, strong wh/yelsh wh fluo cut. Uniform tan oil staining w/ dk amber vis cut. Saturated w/ oil.

0
7-2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 3
SHEET ※ 2

AREA: CONTINUED FROM SHEET ※1
WELL RKB:
INTERVAL: CUT: RECOVERY:
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: DATE

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
		M		A/a	A/a
1791		M			
1792		M			
			1792,4		

NO.
/7-2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 4
SHEET * 1

AREA: Norwegian North Sea
WELL RKB 22,9
INTERVAL 1792,4-1802,5 CUT: 1792,4-1800,6 RECOVERY: 81,5 % (8,2 m)
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: FELLOWES, LEIVESTAD, RYDBERG
DATE 30.9.75

DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
1792,4 – 1793,5	Sd, uncons, dk yelsh brn (oil stained), m grnd loc grdg into f grnd, subang-subrnd, micaceous (musc), well srtd, tr hd blk min (hornblend ?).	Uniform/patchy, strong, whsh yel fluo yelding an instant streaming wh/blsh wh cut fluo. Uniform/patchy tan oil staining w/ dk amber vis cut.
1793,5 – 1793,8	Sd, a/a but m gry. Poss v sl increase in grainsize.	No stain - no fluo.
1793,8 – 1795,4	Sd, as 1792,4-1793,5m but locally sl more finegrained.	Show as 1792,4-1793,5m. Patchy, fair yel fluo yelding an instant wh cut fluo. Patchy tan oil stain w/ pale straw cut.
1795,4 – 1796,6	Sd, as 1793,5-1793,8m.	Only v sl tr of yel patchy fluo.
1796,6 – 1796,8	Sd, as 1792,4-1793,5m.	Patchy, fair yel fluo yelding an instant wh cut fluo. Tan stain
1796,8 – 1797,75	Sd, as 1793,5-1793,8m.	No stain - no fluo.
1797,75 – 1798,0	Sd as 1793,5-1793,8m w/ laminae of Sh, dk gry, fiss, well ind, tr pyr.	No stain - no fluo.
1798,0 – 1798,25	Sd, as 1792,4-1793,5m.	Show as 1792,4-1793,5 but straw vis cut.
1798,25 – 1799,25	Sd, as 1793,5-1793,8m interlaminated w/ Sh, dk gry, subfiss, m well ind, v slty, v mic	No stain - No fluo.
1799,25 – 1800,6	Sd, as 1793,5-1793,8m.	No stain - no fluo.
1800,6 – 1802	No Recovery	

NORSK HYDRO a.s

PETROLEÚM DIVISION

CORE REPORT

CORE NO'S 4
SHEET * 2

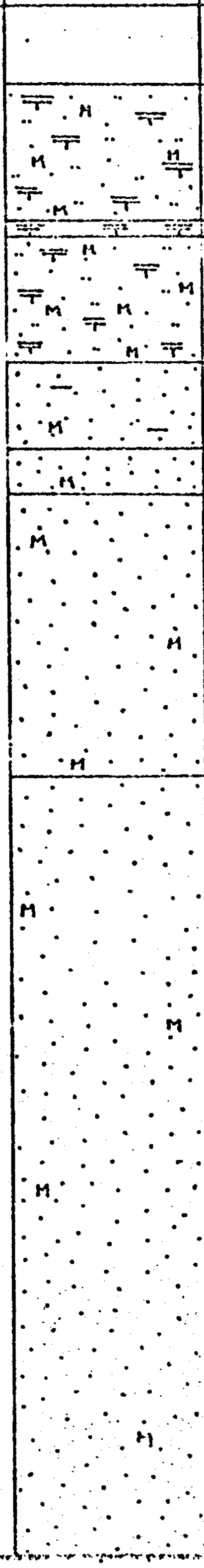
AREA: CONTINUED FROM SHEET 1
WELL RKB:
INTERVAL: CUT: RECOVERY:
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: DATE:

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
1802		No Recovery	1802,5		

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 5
SHEET # 1

AREA: Norwegian North Sea
WELL RKB: 22,? m
INTERVAL: 1802,5 - 1816,2 m. CUT: 1802,5-1814,1 RECOVERY: 84,4 % (11,6 m)
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: FELLOWES, LEIVESTAD, RYDBERG DATE:



DEPTH SCALE	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
	1802,5	Interlaminated Sst, gry, f-vf grdg into Sltst, m hd, ang-subrnd, and Sh, gry-dk gry, smooth, mica, slty.	
1803	1803,4	Sh, clean, dk gry, smooth, mica.	
	1803,5	As 1802,5-1803,4m.	
1804	1804,3	Sst, clr qtz, v fbl, f-vf, m srtd, sl arg, v poorly cons.	Patchy yel strong fluo yelding an instant streaming, blsh wh cut fluo. Patchy staining
1805	1804,9	Sd, clr qtz, dk yelsh brn (oil stained), f-m, rnd-subrnd, w srtd, (mic)	Uniform, yel, fair fluo. Uniform tan stain. Saturated.
	1805,2	Sst, clr qtz, dk yelsh brn (oil stained), f-m, rnd-subrnd, well sorted, sl mic, v poorly consolidated.	Uniform yel, fair fluo yelding an inst. vil, strong streaming blsh wh. cut fluo. Uniform tan oil staining. Amber-dk amber vis cut. Saturated.
1806			
1807	1807,0	Sd, uncons, clr qtz, dk yelsh brn (oil-stain), f-m, rnd-subang, well sorted, (mic).	Show a/a
1808			A/a
1809		A/a	A/a
1810			A/a
1811			A/a
		A/a	A/a
1812			

CORE NO'S 5
SHEET 2

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

AREA: CONTINUED FROM SHEET 1.
WELL RKB:
INTERVAL: CUT: RECOVERY:
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: DATE:

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
		M		A/a	A/a
					A/a
1813				A/a	A/a
					A/a
1814		M M	1814,1	Tr Sh, dk grey, mic.	
1815		No Recovery			
1816			1816,2		

/1 - 2

NORSK HYDRO a.s
PETROLEUM DIVISION
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CORE NO'S 5
SHEET [illegible]

AREA: Norwegian North Sea
WELL RKB: 22.9 m
INTERVAL: 1814.1 - 1816.2 m CUT: 2.1 m RECOVERY: 100 %
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: [illegible]
DATE: 1.10.75

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
			1814.1	Cly, greish gy, sticky.	No fluo
1814.5			1814.6	Sd, uncons, clr, qtz, dk yelsh brn (oil stnd), m-f, w srtd, subang-subrnd, (mica)	Uniform fair/gd fluo, yelding an instant wh streaming cut fluo. Uniform oil stain. Lt [illegible] vis cut.
1815			1815.25		
			1815.4	Cly, A/a	No stain
1816			1816.2	Sd, A/a.	Show A/a.
1817					

Remarks:
When coring co.no. 6 the unrecovered part of co.no 5 was picked up in the core-barrel.
The recovery of the whole core no 5 is thus 100%.

NORSK HYDRO a.s
PETROLEUM DIVISION
CORE REPORT

CORE NO'S 6
SHEET № 1

AREA: Norwegian North Sea.
WELL RKB: 22.9 m
INTERVAL: 1819 - 1821.7 m CUT: 2.7 m RECOVERY: 100 %
SCALE: 1:50 (1cm = 0,5m)
GEOLOGIST: Rydberg, Kihle DATE: 1.10.75

DEPTH SCALE	RE-COVERY	LITHOLOGICAL COLUMN	DEPTHS	LITHOLOGICAL DESCRIPTIONS	SHOWS
			1819.1	Sd, uncons, dk yelsh brn (oil stained), m-f, w srtd, subang - subrnd, (mica).	Uniform, fair ylk fluo, variation in shade with streaming cut fluo. Uniform oil staining w/light amber vis cut.
1820				Sd, uncons, clr. qtz, m gy, m-f, w srtd, subang - subrnd, v sl mica.	No stain - no fluo.
1821					
1822			1821.7		

List of References

1) Reservoirfluid study for Norsk Hydro A/S Oil well no. 30/7-2A SINTEF 16/12-75.

2) Water analysis. NTNF's kontinentalsokkelkontor 7/11-75.

3) Grain size distribution analysis of 36 selected samples from cores 1-6. Norsk Hydro well 30/7-2 NTNF's kontinentalsokkelkontor 7/11-75.

4) Lithologic description, porosity/permeability, residual liquid saturation, grain density, calci/dolomaty and and fluorescence. Well 30/7-2, Inerwall 1970,0-1989,17 (Cores 1-8) Scanwell data 27/10-75.

5) R.S.M. DE WIEST, ed. Flow through porous media, Academic press 1969, between grain size distribution and permeability.

6) Drilling and production practice 1970 Estimating Waterflood Recovery in Sandstone Reservoirs D.A. Wayhan, R.A. Albrecht, D.W. Andrea and W.R. Lancaster.

7) Physical principles of oil production, Muskat.