

statoil

WIRELINE FORMATION TESTING (RFT)

REPORT

WELL 6407/1-3

PL 073 TYRIHANS FIELD

LET-BERGEN

APRIL 1984

COMPLETED

APPROVED

Den norske stats oljeselskap a.s



CLASSIFICATION

LICENCE DOCUMENT

MADE BY

STEINAR LYNGROTH

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J. H. H. H.

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1. SUMMARY

1.1 Introduction

The well 6407/1-3 was the second well drilled in the Tyrihans field and the first well on the A structure. A structure map of the Tyrihans area is shown in fig. 1.1. Fig. 1.2 shows the 6407/1-3 stratigraphy.

This report describes the results and the conclusions from the wireline formation testing (RFT) carried out in this well.

1.2 Objectives

The RFT was run in several sections of the well, and the main objectives for this testing were to obtain:

- 1) Reservoir pressure gradients in the hydrocarbon bearing section and in the underlying water zones.
- 2) Fluid contacts
- 3) Formation fluid samples
- 4) Pore pressure information

1.3 Results

A total of 34 pressure tests were performed and 24 of these gave reliable results. In addition, segregated samples were collected at 3 different depths. One sample run was unsuccessful due to low formation permeability.

The reservoir pressure obtained from the RFT is shown in figure 1.3.

Pressure gradients were obtained in the gas, oil and water zones of the H1-4 formation, and in a water zone in the H1-2 formation:

Gas gradient (H1-4): 0.021 bar/m (0.216 g/cm³)
Oil gradient (H1-4): 0.068 bar/m (0.693 g/cm³)
Water gradient (H1-4): 0.101 bar/m (1.026 g/cm³)
Water gradient (H1-2): 0.103 bar/m (1.05 g/cm³)

A gas oil contact in the H1-4 formation has been defined at 3687 mRKB (-3658 m MSL). An oil water contact can not be defined because no water was encountered directly below the oil zone and because the deeper water zones are in pressure regimes slightly different from the hydrocarbon zone.

The maximum pore pressure in the H1-4 formation is calculated to be 1.06 g/cm³ EMW at 3600 m RKB (-3571 m MSL) by extrapolating the gas gradient to the top of the reservoir sand.

1.4 Conclusions

The reservoir pressure in well 6407/1-3 is very close to the pressure seen in well 6407/1-2 on a separate structure about 8.5 km to the south. The hydrocarbon pressure gradients are, however, different, showing that the hydrocarbon characteristics for the two structures are different. For this well the pressure gradients show a gas zone overlying an oil zone.

No oil water contact can be defined, but the available data do not exclude the possibility of a contact at the same depth as the hydrocarbon water contact of well 6407/1-2 (-3687 m MSL).

The permeable water zone at about 50 m below the oil zone is in a pressure regime with pore pressure slightly lower than for the hydrocarbon zone, indicating an impermeable barrier between the two zones. The same phenomena was observed in well 6407/1-2.

NOTE: The reported pressure figures are corrected to absolute pressure.

Fig. 1.2

6407/1-3

GENERALIZED STRATIGRAPHY

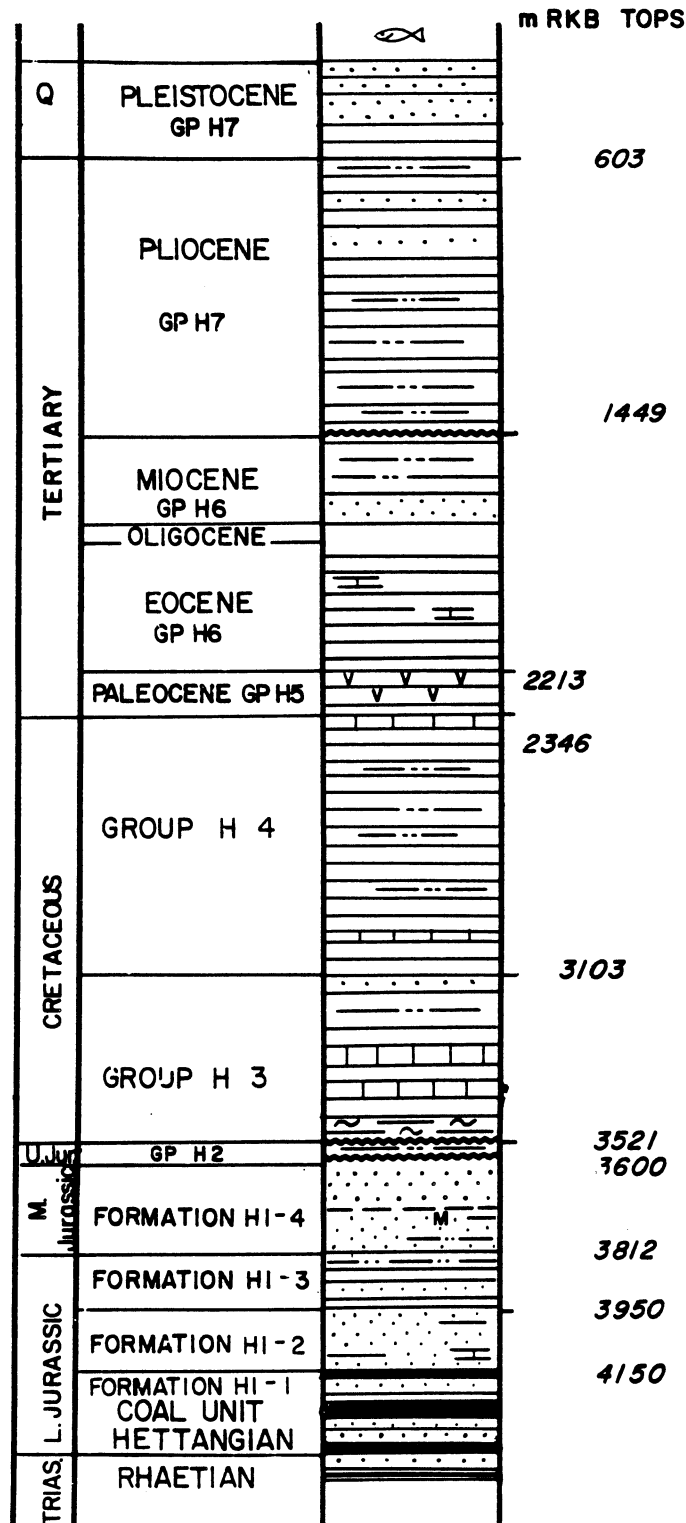
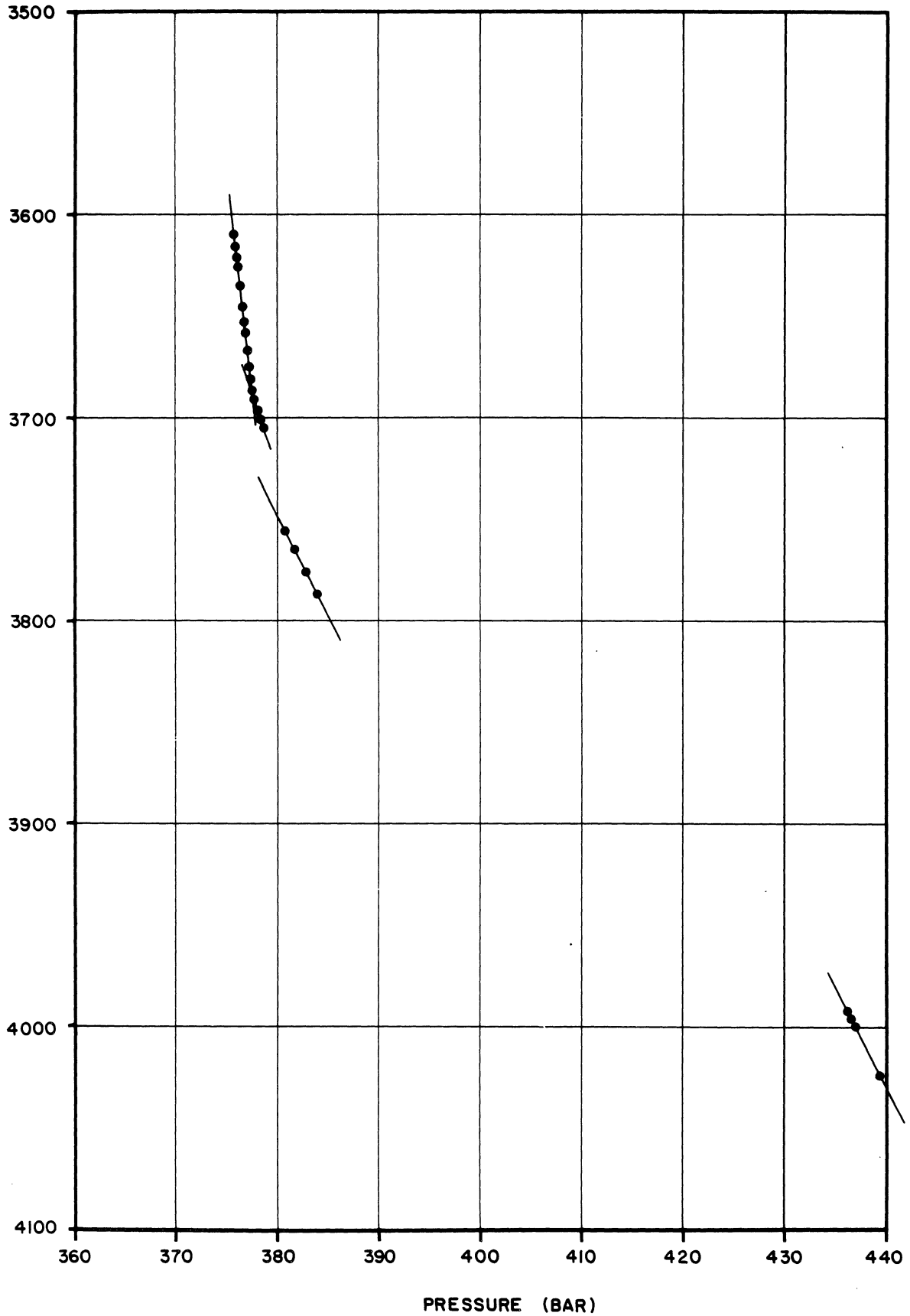


Fig. 1.3

WIRELINE FORMATION TESTER PRESSURE VS DEPTH (RFT)

DEPTH
(m RKB)

WELL 6407/1-3



2. GENERAL INFORMATION

2.1 Well data

Licence:	PL 073
Well:	6407/1-3
Location:	64° 52' 25.48" N 07° 02' 53.47" E
Classification:	Exploration (wildcat) well
Rig:	Dyvi Delta
Spud date:	17.09.83
Completion date:	17.01.84
RKB elevation:	29 m
Water depth:	286 m
Total depth:	4469 m
Electric logging:	Schlumberger
Status:	Plugged and abandoned

3. TEST PERFORMANCE AND ANALYSIS

3.1 Pressure measurements, operations and results

Run no. 1: Three pressure tests were made in the H-3 (Cretaceous) formation. The logs indicate some hydrocarbon saturation in this zone, but the pressure tests were unsuccessful because of low permeability. All the tests were supercharged, and the rest of the planned tests were therefore cancelled.

See table 3.1 for test details.

Run no. 2: 24 pressure tests were made throughout the gas, oil and water zones in the H1-4 formation. One test has seal failure and 3 were supercharged. The remaining 20 tests had low pressure drawdown and fast build up indicating high permeability. The formation pressure measurements are considered to be of good quality.

Two attempts were made to obtain a pressure test at 3950.5 m RKB in the H1-2 formation, but they were unsuccessful because of seal failure and tight formation.

See table 3.2 for test details.

Run no. 3: Five pressure test were made between 3993 and 4024 m RKB in the H1-3 formation. One test was supercharged, the remaining were of good quality. The pressure response, however, indicated lower permeability than in the H1-4 formation.

See table 3.3 for test details.

Several attempts were made to obtain RFT tests in the deeper sections of the well, but bad hole condition (6 inch hole) made it impossible to run the tool below 4055 m RKB.

3.2 Sampling, operations and results

A total of 4 segregated sampling runs were made:

Sample no. 1: Oil zone in the H1-4 formation (3695 m RKB).
The tool failed when one chamber was filled,
and the recovery was therefore mainly mud
filtrate.

See table 3.4 for details.

Sample no. 2: Gas zone in the H1-4 formation (3676.2 m RKB),
successful sampling.

See table 3.5 for details.

Sample no. 3: Oil zone in the H1-4 formation (3692.2 m RKB),
successful sampling.

See table 3.6 for details.

Sample no. 4: Attempted sampling at 3993.1 m RKB in the H1-2
formation. No reservoir fluid was recovered
because of low permeability in the formation.

3.3 Analysis

3.3.1 Pressure gradients

The plotting of the good quality pressure tests versus depth clearly defines the pressure gradients of the different reservoir fluid systems. In the H1-4 formation a gas gradient of 0.021 bar/m corresponding to a density of 0.216 g/cm^3 is defined by 12 pressure tests in the interval from 3610 to 3687 m RKB. An oil gradient of 0.068 bar/m (0.693 g/cm^3) is defined by 5 pressure tests in the interval from 3687 to 3702 m RKB. Production tests later confirmed the presence of gas and oil in the respective zones.

Water gradients are defined both in the H1-4 and in the H1-2 formations. In the H1-4 formation, 4 pressure tests define a gradient of 0.101 bar/m (1.026 g/cm³) while the gradient in the H1-2 formation is about 0.103 bar/m (1.05 g/cm³). The quality of the pressure tests in the H1-2 formation is, however, questionable because of some difference in the hydrostatic pressure recorded before and after the tests.

The pressure gradients in the H1-4 formation are illustrated in figure 3.1, while the H1-2 gradient is indicated in figure 1.3.

3.3.2 Fluid contacts

From the gas and oil gradients in the H1-4 formation, the gas oil contact is determined to be at 3687 m RKB (-3658 m MSL), see figure 3.1.

The oil water contact can not be determined from the RFT data because the reservoir sand is filled with hydrocarbons and the water zones below are in a slightly different pressure system.

3.3.3 Pressure regimes

By extrapolating the pressure gradients illustrated in the figures 1.3 and 3.1, it is concluded that the H1-4 hydrocarbon zone, the H1-4 water zone and the H1-2 water zone all are in different pressure regimes.

3.3.4 Comparison with well 6407/1-2

Figure 3.2 shows all the RFT pressure tests made to date in the H1-4 formation in the Tyrihans field (see figure 1.1 for location of the wells). The formation pressure both in the hydrocarbon zone and in the water zone is very close in these two wells, and it is most likely that they are in the

same pressure regime. The small difference in pressure might be due to different tool, run, calibration etc.

The hydrocarbon fluid systems in the two wells are different. The well 6407/1-2 has a medium density system while well 6407/1-3 has a gas zone overlying an oil zone.

The hydrocarbon water contact seen in well 6407/1-2 (at -3687 m RKB) was not confirmed by well 6407/1-3, but the data from this well do not rule out the possibility of an oil water contact at that depth.

Table 3.1.

WIRELINER FORMATION TESTER

Well: 6407/1 - 3 Run no.: 1

TEMP. CORRECTED RESULTS

Formation: H - 3

TEST NO.	DEPTH mRKB	Hydr. Pressure before test		Formation Pressure		Hydr. Pressure after test		REMARKS
		bar	g/cm ³	bar	g/cm ³	bar	g/cm ³	
1	3465.0	581.8	1.709	530.5	1.558	582.0	1.710	Supercharged
2	3466.0	582.0	1.709	536.0	1.574	582.1	1.710	Supercharged
3	3466.8	581.8	1.708	534.0	1.568	583.4	1.713	Supercharged

Table 3.2.

WIRELINER FORMATION TESTER

Well: 6407/1 - 3 Run no.: 2

TEMP. CORRECTED RESULTS

Formation: H1 - 4

TEST NO.	DEPTH mRKB	Hydr. Pressure before test		Formation Pressure		Hydr. Pressure after test		REMARKS
		bar	g/cm ³	bar	g/cm ³	bar	g/cm ³	
1	3603.0	426.3	1.204			426.3	1.204	Seal failure
2	3610.0	427.2	1.204	375.8	1.059	427.2	1.204	
3	3616.0	427.8	1.204	375.9	1.057	427.9	1.204	
4	3620.0	428.1	1.203	375.9	1.056	428.2	1.203	
5	3625.0	428.8	1.203	376.1	1.055	428.8	1.203	
6	3635.0	430.0	1.203	376.2	1.053	429.8	1.203	
7	3645.0	430.8	1.202	376.4	1.050	430.9	1.203	
8	3653.0	431.9	1.202	376.7	1.049	431.8	1.202	
9	3658.0	432.3	1.202	376.8	1.047	432.3	1.202	
10	3667.0	433.3	1.202	377.0	1.045	433.4	1.202	
11	3675.0	434.1	1.202	377.1	1.044	434.3	1.202	
12	3681.0	434.8	1.202	377.3	1.042	435.0	1.202	
13	3687.0	435.6	1.202	377.4	1.041	435.7	1.202	

WIRELINE FORMATION TESTER

Well: 6407/1-3 Run no.: 2

TEMP. CORRECTED RESULTS

Formation: H1 - 4

TEST NO.	DEPTH mRKB	Hydr. Pressure before test		Formation Pressure		Hydr. Pressure after test		REMARKS
		bar	g/cm ³	bar	g/cm ³	bar	g/cm ³	
14	3690.0	435.9	1.202	377.6	1.041	435.9	1.202	
15	3695.0	436.5	1.202	377.9	1.040	436.5	1.202	
16	3699.0	436.9	1.202	378.2	1.040	436.9	1.202	
17	3702.0	437.3	1.202	378.4	1.040	437.2	1.202	
18	3706.0	437.7	1.201	379.5	1.042	437.7	1.202	Supercharged
19	3708.5	438.1	1.202	379.4	1.040	438.0	1.202	Supercharged
20	3747.0	442.3	1.201	380.4	1.032	442.3	1.201	Supercharged
21	3756.0	443.4	1.201	380.7	1.031	443.3	1.201	
22	3765.0	444.3	1.201	381.6	1.031	444.3	1.201	
23	3776.0	445.6	1.201	382.7	1.031	445.7	1.201	
24	3787.0	447.0	1.201	383.8	1.031	447.0	1.201	

Table 3.2 Contd.

WIRELINE FORMATION TESTER

Well: 6407/1-3 Run no.: 2

TEMP. CORRECTED RESULTS

Formation: H1 - 2 and H1 - 4 (sampling)

TEST NO.	DEPTH mRKB	Hydr. Pressure before test		Formation Pressure		Hydr. Pressure after test		REMARKS
		bar	g/cm ³	bar	g/cm ³	bar	g/cm ³	
25	3950.5	465.1	1.198			465.0	1.198	Seal failure
26	3950.5	465.3	1.198			465.3	1.198	Tight
27	3695.0	436.8	1.203	378.5	1.042			Sample no. 1
28	3676.2	434.0	1.201	376.9	1.043	434.1	1.201	Sample no. 2 *
29	3692.2	436.0	1.201	377.7	1.040	436.3	1.202	Sample no. 3 *

* Separate runs

Table 3.3

WIRELINE FORMATION TESTER

Well: 6407/1-3 Run no.: 3

TEMP. CORRECTED RESULTS

Formation: H1 - 2

TEST NO.	DEPTH mRKB	Hydr. Pressure before test		Formation Pressure		Hydr. Pressure after test		REMARKS
		bar	g/cm ³	bar	g/cm ³	bar	g/cm ³	
1	3993.0	528.4	1.347	436.2	1.111	528.7	1.348	Supercharged Sample no. 4
2	3997.0	529.6	1.349	436.5	1.111	529.8	1.349	
3	4024.0	533.3	1.349	442.3	1.118	533.7	1.350	
4	4023.0	533.1	1.349	439.3	1.111	533.2	1.349	
5	3995.0	528.5	1.346	436.4	1.111	528.7	1.347	
6	3993.1	528.9	1.348	436.3	1.114	529.3	1.349	

Table 3.4

WIRELINER FORMATION TESTER - SAMPLING DATA

Run no: 2
Sample no: 1
Type of sample: Segregated
Depth: 3695.0 mRKB

Chamber size (gallons):	6	1
Pretest corr. hydrostatic pressure (bar):	436.8	-
Pretest corr. formation pressure (bar):	378.5	-
Flowing time (sec):	930	-
Final flowing pressure (bar):	379.6	-
Surface opening pressure (bar):	31	-

Recovery: 0

Gas (Sm ³)	0.08
Oil (liter)	0.3
BSW (liter)	16
Oil density (g/cm ³)	0.87

Comments:

The tool failed after the 6 gal. chamber was filled.
The 6 gal. chamber was sealed on site and opened in
the laboratory.

For fluid analysis results, see Corelab report no. RFLN 830005.

Table 3.5

WIRELINE FORMATION TESTER - SAMPLING DATA

Run no:	2	
Sample no:	2	
Type of sample:	Segregated	
Depth:	3676.2 mRKB	
Chamber size (gallons):	2 3/4	1
Pretest corr. hydrostatic pressure (bar):	434.0	-
Pretest corr. formation pressure (bar):	376.9	-
Flowing time (sec.):	480	90
Final flowing pressure (bar):	375.4	376.1
Surface opening pressure (bar):	180	180
Recovery:		N/A
Gas (Sm ³)	2.14	
Condensate (liter)	0.6	
BSW (liter)	0.6	
Condensate density (g/cm ³)	0.79	

Comments:

The 2 3/4 gal. chamber was bled off on site.

The 1 gal. chamber was sealed on site and opened in the laboratory.

Corelab report no. RFLN 830007 shows a summary of data from examination of this sample and a "fingerprint" chromatography analysis where the condensate from this sample is compared with oil from sample no.3 and with condensate from well 6407/1-2. No detailed analysis on this sample (no. 2) was performed because of questionable sample quality. Samples collected during a production test in the gas zone was later analyzed in detail.

Table 3.6

WIRELINER FORMATION TESTER - SAMPLING DATA

Run no: 2
 Sample no: 3
 Type of sample: Segregated
 Depth: 3692.2 mRKB

Chamber size (gallons):	2 3/4	1
Pretest corr. hydrostatic pressure (bar):	436.0	-
Pretest corr. formation pressure (bar):	377.7	-
Flowing time (sec.):	480	N/A
Final flowing pressure (bar):	371.2	377.7
Surface opening pressure (bar):	150	133

Recovery:

Gas (Sm ³)	0.75	0.17
Oil (liter)	7.0	1.46
BSW (liter)	0	0.15
Oil density (g/cm ³)	0.91	0.87

Comments:

The 2 3/4 gal. chamber was bled off on site.
 The 1 gal. chamber was sealed on site and opened
 in the laboratory.

For fluid analysis results, see Corelab report no. RFLN 830006

Fig. 3.1 WIRELINE FORMATION TESTER PRESSURE VS DEPTH (RFT)

HI-4 FORMATION

WELL 6407/1-3

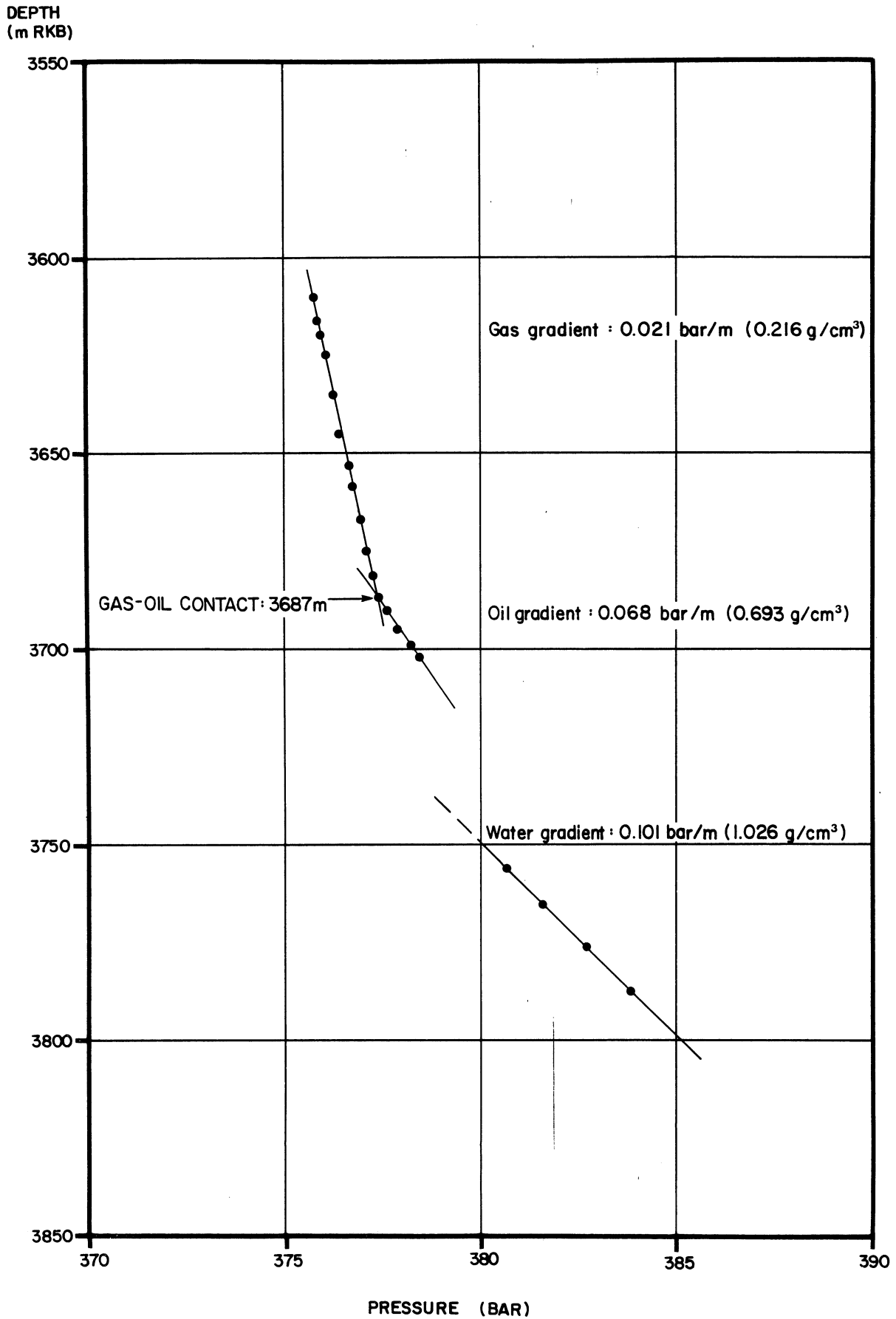


Fig. 3.2

WIRELINe FORMATION TESTER VS DEPTH (RFT)

HI-4 FORMATION
TYRIHANS FIELD

