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EVALUERING TEKNOLOGISEKSJONEN
AVDELING FOR PETROLEUMSTEKNOLOGI
STATOIL

12 DES 1979
REGISTRERT
OLJEDIREKTORATET

TEST REPORT

34/10-3

REPORT
S. LYNGROTH
K.A. GRINI
SEPT. 1979

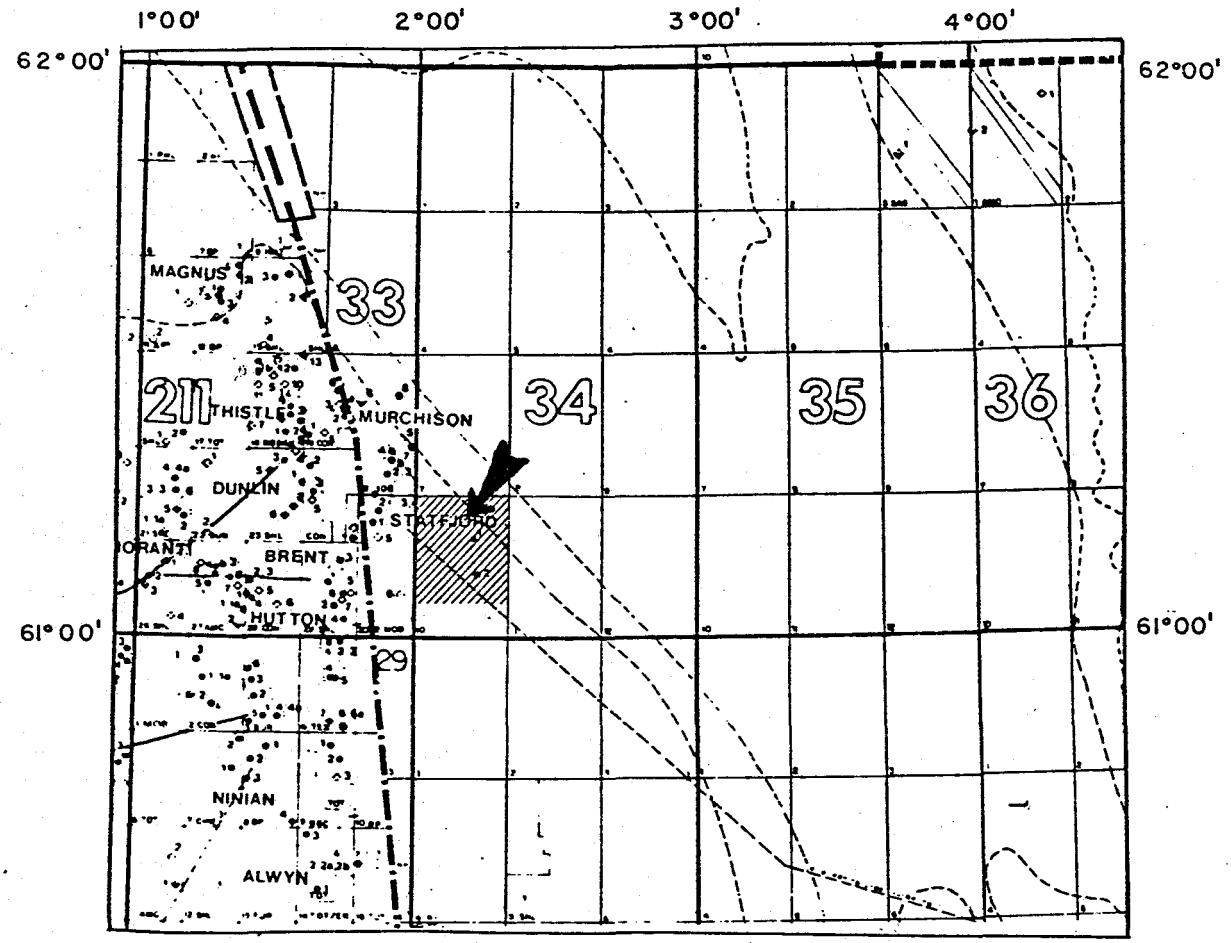
TEST REPORT 34/10-3

CONTENTS:

GENERAL WELL DATA

Norway_offshore

Licence	:	050
Wildcat well	:	34/10-3
Location	:	61°12'49.5"N
		02°11'55.1"E
Spudded	:	14 March 1979
Rig Released	:	8 june 1979
KB-elevation	:	25 m
Water depth	:	179 m
Total depth	:	2802 m
Objective	:	Jurassic sandstone
Operator	:	Statoil
Partners	:	Norsk Hydro, Saga Petroleum
Status	:	Plugged and abandonned



INDEX MAP: NORTHERN NORTH SEA 1:1500 000

1. INTRODUCTION

34/10-3 was the second well drilled in the Delta area in block 34/10. In the first well, 34/10-1, hydrocarbons were tested and proven to be present throughout the Brent sand. That testing indicated high productivity and good reservoir characteristics but also problems with sand production.

The purpose of testing 34/10-3 were therefore to:

- confirm continuity of pressure, temperature, reservoir characteristics and quality of reservoir fluid from 34/10-1 to the 34/10-3 fault block.

- investigate sand production and sand strength on more details.

- obtain sample of formation water.

The test analysis is based on STATOIL test analysis program package.

Comment:
The quality of the DST-data are not satisfactory because the tests were designed and carried out as sand tests. Conventional test analysis are uncertain when applied as such data and the results can therefore only be used as an indication of the reservoir properties.

2. SUMMARY OF TEST RESULTS AND ANALYSIS

2.1 DST no. 1

2.2 DST no. 2

2.3 DST no. 3

2.4 RFT

2.1 DST SUMMARY DATA.

SHEET A: PERFORATION AND TEST STRING

Well no. 34/10-3 ; DST no. 1 Date: 25/5-79

Test engineer in charge: G. Helle

1. Perforated interval: 1990-1995 m Ref. ISF/SONIC
2. Casing size: 7 in
3. Depth to top plug (before test): _____ m
   Tagged bottom at (after test): _____ m
4. Type of test string: Drill pipe 3.½ in
5. Volume calculations:
   Volume STT - circ.valve : 7.04 m^3 (44.3 bbl)
   Volume STT - tester valve (cushion) : 7.28 m^3 (45.8 bbl)
   Volume tester valve - lowest perf. (rathole): 0.57 m^3 (3.6 bbl)
6. Type of cushion: water Density: _____
7. Pressure gauges:

Type	Gauge no	Press.range	Depth	Ran on	Remarks
S-S	MRPG 4	10000 psi	1969.3	wireline	
Am.	RPG-3/9058	8000 psi	1971.7	"	Damaged
Lynes	DMR 314	5000 psi	1973.3	"	
S-S	MRPG 6	10000 psi	1978.4	String	
Am.	RPG-3/34947	8000 psi	1981.1	"	

Temperature gauges:

Type	Gauge no.	Temp.range	Depth	Ran on	Remarks
Am.	RT-7/41679	50-150°C	1982.7	String	

Temperature also recorded with Sperry-Sun and Lynes gauges.

DST SUMMARY DATA

SHEET B: TEST RESULTS

Well no. 34/10-3 DST no. 1 Perforation: 1965-1970 mMSL

(1990-1995 mRKB ref: ISF/SONI

1. Initial flow response: 3bbl in 13 mins
2. Clean up well:
   Time gas surface : _____ mins
   Time mud surface : 65 mins
   Time formation fluid produced : _____ mins
3. Type of formation fluid produced: water
   Oil gravity : _____ API
   Gas sp.gr. : _____ (Air = 1)
   Water density : 1.0294 gr/cc at 15°C
4. Flow data (main flow periods):

Choke size 1/64 inch	Oil/Water rate m^3/d (STB/d)	Gas rate $10^3 Nm^3/d$ (10^3 scf/d)	GOR Nm^3/m^3 (scf/STB)	BHP at 1948 mMSL bar (psi)
12	155 (970)			312.5(4533
14	170 (1080)			313.7(4550
16	255 (1600)			312.9(4539
16+8	320 (2000)			313.8(4552
20	410 (2600)			314.9(4568

5. Extrapolated reservoir pressure : 317.6 bar (4606 psi) at 1948 mMS
6. Max. recorded. temerature: 75.5 °C (168 °F) at 1948 mMSL

DST SUMMARY DATA

SHEET C : TEST ANALYSIS

Well no. 34/10-3 DST no. 1 Perforations: 1965-1970 mMSL

1. Reservoir pressure (extrapolated) at 1948 mMSL: p^* = 317.6 bar (4606 psi
2. Permeability-thickness (capacity): k.h = 20 000 md·ft
3. Formation thickness contributing to production: h = 42 m (138 ft)
4. Permeability: k = 1500 md
5. Skin factor (formation) s = 2
   Skin factor (partly penetration) s = 33
6. Δp skin (formation) Δps = .14 bar (2 psi
   Δp skin (partly penetration) Δps = 1.9 bar (27 psi
7. Radius of investigation 13 hrs flow time r = 1500 m (5000 ft)
8. Actual productivity index PI = 166 m^3/dag/ba
   (72 STB /d/psi
9. No skin productivity index PI = 830 m^3/dag/ba
   (360 STB /d/psi
10. Specific productivity index (no skin) SPI = 20 m^3/d/bar/m
    (2.6 STB/d/psi/f
11. Miscellaneous/comments:

Because of 3 changes of choke size during the last hour prior to final shut in, all these results are uncertain.

2.2 DST SUMMARY DATA.

SHEET A: PERFORATION AND TEST STRING

Well no. 34/10-3 DST no. 2 Date: 30/5-1/6-79

Test engineer in charge: G Helle

1. Perforated interval: 1935-1940 m Ref. ISF/SONIC
2. Casing size: 7 in
3. Depth to top plug (before test): 1964 m
   Tagged bottom at (after test): 1964 m
4. Type of test string: Drill pipe, 3.½ in
5. Volume calculations:
   Volume STT - circ.valve : 6.75 m^3 (42.5 bbl)
   Volume STT - tester valve (cushion) : 7.00 m^3 (44.0 bbl)
   Volume tester valve - lowest perf. (rathole): 0.73 m^3 (4.6 bbl)
6. Type of cushion: Water Density:
7. Pressure gauges:

Type	Gauge no	Press.range	Depth	Ran on	Remarks
Am.	RPG-3/8167	8000 psi	1903.0	wireline	Clock stopped
S-S	MRPG 2	10000 psi	1906.2	"	
Lynes	DMR 314	5000 psi	1909.2	"	Memory full
Am.	RPG-3/34947	8000 psi	1912.7	string	
S-S	MRPG 6	10000 psi	1915.1	"	

Temperature gauges:

Type	Gauge no.	Temp.range	Depth	Ran on	Remarks
Am.	RT-7/416/79	50-150°C	1917.1	String	

Temperatures also recorded with Sperry-Sun and Lynes gauges.

DST SUMMARY DATA

SHEET B: TEST RESULTS

Well no. 34/10-3 DST no. 2 Performation: 1910-1915 mMSL (1935-1940 mRKB ref ISF/SONIC

1. Initial flow response: 3 bbl in 2 mins
2. Clean up well:
   Time gas surface : _____ mins
   Time mud surface : 73 mins
   Time formation fluid produced : _____ mins
3. Type of formation fluid produced: oil
   Oil gravity : 29.2 °API
   Gas sp.gr. : 0.656 (Air = 1)
   Water density : _____ gr/cc
4. Flow data (main flow periods):

Choke size 1/64 inch	Oil/Water rate m^3/d (STB/d)	Gas rate $10^3 Nm^3/d$ (10^3 scf/d)	GOR Nm^3/m^3 (scf/STB)	BHP at 1890 mMSL bar (psi)
10	70 (450)			311.3(4515
12	120 (750)			310.5(4503
14	160 (1000)			309.1(4483
16	190 (1200)	14.9 (550)	78 (460)	309.8(4493
16+8	240 (1500)	17.6 (648)	73 (430)	309.2(4485
20	320 (2000)	23.5 (870)	74 (435)	307.7(4463
20+10	400 (2500)	27.7 (1020)	70 (410)	307.3(4457
20+14	450 (2850)	31.7 (1167)	70 (410)	306.2(4440

5. Extrapolated reservoir pressure : 313.5 bar (4547 psi) at 1890 mMS
6. Max. recorded. temerature: 72 °C (162 °F) at 1890 mMSL

DST SUMMARY DATA

SHEET C : TEST ANALYSIS

Well no. 34/10-3 DST no. 2 Perforations: 1910-1915 mMSL

1. Reservoir pressure (extrapolated) at mMSL: p^* = 313.5 bar (4547 psi
2. Permeability-thickness (capacity): k.h = 108 000 md·ft
3. Formation thickness contributing to production: h = 11 m (36 ft)
4. Permeability: k = 3000 md
5. Skin factor (formation) s = 3
   Skin factor (partly penetration) s = 5
6. Δp skin (formation) Δps = 0.9 bar (13 psi
   Δp skin (partly penetration) Δps = 1.5 bar (22 psi
7. Radius of investigation r = 1520 m (5000 ft)
8. Actual productivity index PI = 62 m^3 /dag/ba
   (27 STB /d/psi
9. No skin productivity index PI = 118 m^3 /dag/ba
   (51 STB /d/psi
10. Specific productivity index (no skin) SPI = 11 m^3/dag/bar/m
    (1.4 STB/d/psi/f
11. Miscellaneous/comments:

DST SUMMARY DATA

SHEET D: SEPARATOR AND BOTTOM HOLE SAMPLING

Wel no. 34/10-3 DST no. 2 Date: 31/5-79

1. Separator samples

Bottle no.	Oil/gas	Time	Oil rate	Gas rate
22478/140	Oil	05.45		
12689/62	"	"	are oil rate	are gas rate
7610	Gas	05.55	05.45-09.15	05.45-09.15
4490	"	"	1205/STB/D	$560 \cdot 10^3$ scf/D
4956	"	06.50		
4965	"	"		
22478/41	Oil	07.02		
20438/27	"	"		
3709	Gas	07.20		
3699	"			
24975	Oil	07.45		
22226/119	"	07.45		

cont.

2. Bottom hole samples

Bottle no.	Sampling depth	Sampling pressure	Opening pressure	Transfer BPP	True BPP (lab)
8088/50	1671m RKB	not recorded	1880 psi at 53°F	2600 psi at 56°F	217 bar (3147 psi)
20584/96	1673m RBK	not recorded	1930 psi at 51°F	2620 psi at 51°P	218.3 bar (3166 psi at 164°F)

DST SUMMARY DATA

SHEET D: SEPARATOR AND BOTTOM HOLE SAMPLING

Wel no. 34/10-3 DST no. 2 Date: 31/5-79

1. Separator samples continued,

Bottle no.	Oil/gas	Time	Oil rate	Gas rate
3377	Gas	07.55		
9202	"	07.55		
20584/98	Oil	08.30		
2497/7	"	"		
4263	Gas	08.55		
14068/79	Oil	09.10		

2. Bottom hole samples

Bottle no.	Sampling depth	Sampling pressure	Opening pressure	Transfer BPP	True BPP (lab)

2.3

DST SUMMARY DATA.

SHEET A: PERFORATION AND TEST STRING

Well no. 34/10-3 DST no 3 Date: 3-4/6-1979

Test engineer in charge: H. Winston (Exxon)

1. Perforated interval: 1895-1900 m Ref. ISF/SONIC
2. Casing size: 7 in
3. Depth to top plug (before test): 1906 m
   Tagged bottom at (after test): 1898 m
4. Type of test string: Drill pipe 3.½ in
5. Volume calculations:
   Volume STT - circ.valve : _____ m^3 (_____ bbl)
   Volume STT - tester valve (cushion) : _____ m^3 (_____ bbl)
   Volume tester valve - lowest perf. (rathole): _____ m^3 (_____ bbl)
6. Type of cushion: water Density: _____
7. Pressure gauges:

Type	Gauge no	Press.range	Depth	Ran on	Remarks
Am.	RPG-3/34947	8000 psi	1865.9	wireline	
S-S	MRPG 2	10000 psi	1868.4	"	
Lynes	DMR 314	5000 psi	1870.6	"	
Am.	RPG-3/8167	8000 psi	1875.4	String	
S-S	MRPG 6	10000 psi	1877.8	"	

Temperature gauges:

Type	Gauge no.	Temp.range	Depth	Ran on	Remarks
Am.	RT-7/41679	50-150 °C	1880	String	

Temperature also recorded with Sperry-Sun and Lynes gauges

DST SUMMARY DATA

SHEET B: TEST RESULTS

Well no. 34/10-3 DST no. 3 Performation: 1870-1875 mMSL
(1895-1900 mRKB ref: ISF/SONI

1. Initial flow response: 4.5 bbl in 3 mins
2. Clean up well:
   Time gas surface : _____ mins
   Time mud surface : 86 mins
   Time formation fluid produced : _____ mins
3. Type of formation fluid produced: oil
   Oil gravity : 29 API
   Gas sp.gr. : _____ (Air = 1)
   Water density : _____ gr/cc
4. Flow data (main flow periods):

Choke size 1/64 inch	Oil/Water rate m^3/d (STB/d)	Gas rate $10^3 Nm^3/d$ (10^3 scf/d)	GOR Nm^3/m^3 (scf/STB)	BHP at 1846 mMSL bar (psi)
10	(650)	not measured		

5. Extrapolated reservoir pressure : 308.2 bar (4470 psi) at 1846 mMSL
6. Max. recorded. temerature: 69.5 °C (157 °F) at 1846 mMSL

DST SUMMARY DATA

SHEET C : TEST ANALYSIS

Well no. 34/10-3 DST no. 3 Perforations: 1870-1875 mMSL

1. Reservoir pressure (extrapolated) at mMSL: p^* = 308.2 bar (4470 psi
2. Permeability-thickness (capacity): k.h = 1400-2000 md·ft
3. Formation thickness contributing to production: h = 9 m (30 ft)
4. Permeability: k = 50-70 md
5. Skin factor (formation) s = -3.6
   Skin factor (partly penetration) s = 2.2
6. Δp skin (formation) Δps = -7.9 bar (-115 psi
   Δp skin (partly penetration) Δps = 3.5 bar (70 psi
7. Radius of investigation r = 150 m (500 ft)
8. Actual productivity index PI = 2.3-3.5 m^3/dag/ba
   (1.0-1.5 STB/d/psi
9. No skin productivity index PI = 2.1 m^3/dag/ba
   (0.9 STB/d/psi
10. Specific productivity index (no skin) SPI = .23 m^3/dag/bar/m
    (0.03 STB/d/psi/f
11. Miscellaneous/comments:

Because of low flow rates, unaccurate metering and sand plugging in the test string, all these results are very uncertain.

2.4 RFT SUMMARY

Brent formation

Oil gradient	:	0.765 ± 0.015 sp.gr. (0.295 ± 0.005 psi/ft)
Water gradient	:	1.07 ± 0.02 sp.gr. (0.46 ± 0.02 psi/ft)
Oil water contact	:	1945 ± 2 m MSL (1970 ± 2 m RKB)
Reservoir pressure	:	311.9 bar (4524 psi) at 1900 m MSL (oil zone) 320.7 bar (4651 psi) at 2000 m MSL (water zone)

Dunlin formation

Poor data quality. RFT is believed to give uncorrect results.

Statfjord formation

No tests made.

3. INTEGRATION OF THE INDIVIDUAL TEST RESULTS

3.1 Reservoir pressure

3.2 Reservoir temperature

3.3 Sand production

3. INTEGRATION OF THE INDIVIDUAL TEST RESLUTS

3.1 Reservoir pressure

Fig. 3.1 shows the reservoir pressure obtained from RFT and DST vs depth. The DST pressure are corrected and plotted at mid-perforation depth.

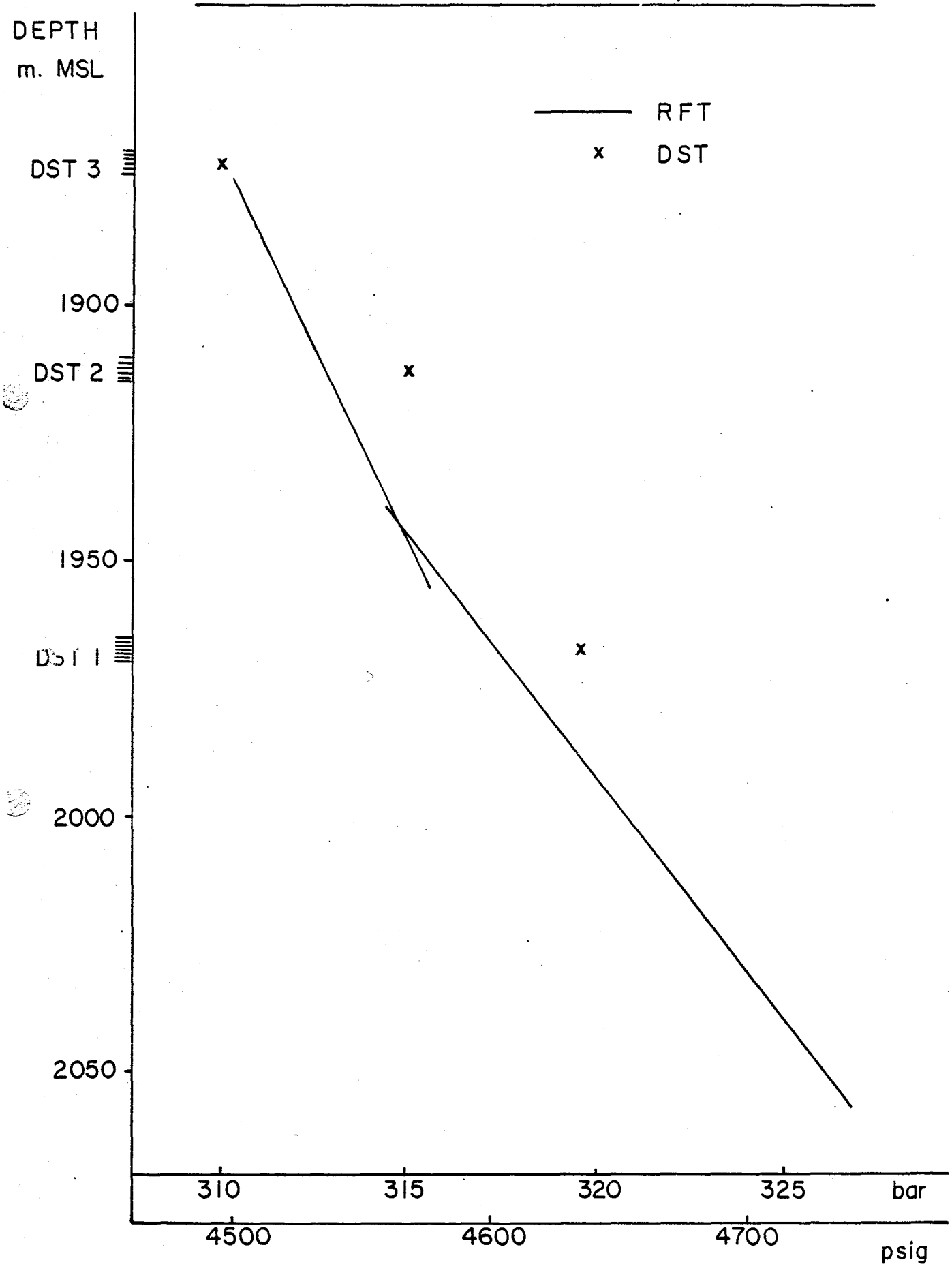
The pressure obtained from the DST pressure gauges are up to about 35 psi higher than the RFT pressures. This is a normal trend also seen in other wells.

The absolute reservoir pressure is, when taking the accuracy of the pressure gauges into consideration, similar to the pressure recorded in 34/10-1.

The pressure gradient in the oil zone is equivalent to a specific gravity of 0.68 while the same in 34/10-1 was 0.79. The problems with the RFT in the Dunlin fm. could indicate that the gradient in 34/10-3 is erroneous.

The water gradient is equivalent to a specific gravity of 1.07 while the lab analysis gave a specific gravity of 1.03 at 15°C and atmospheric pressure.

The oil-water-contact was picked at 1945 $\pm$ 2 m MSL at the RFT pressure vs depth plot while the OWC from log analysis is 1947 m MSL.


34/10-3 RESERVOIR PRESSURE, BRENT fm.
DEPTH
m. MSL
RFT
DST
DST 3
1900
DST 2
1950
DST 1
2000
2050
310
315
320
325
bar
4500
4600
4700
psig

3.2 Reservoir temperature

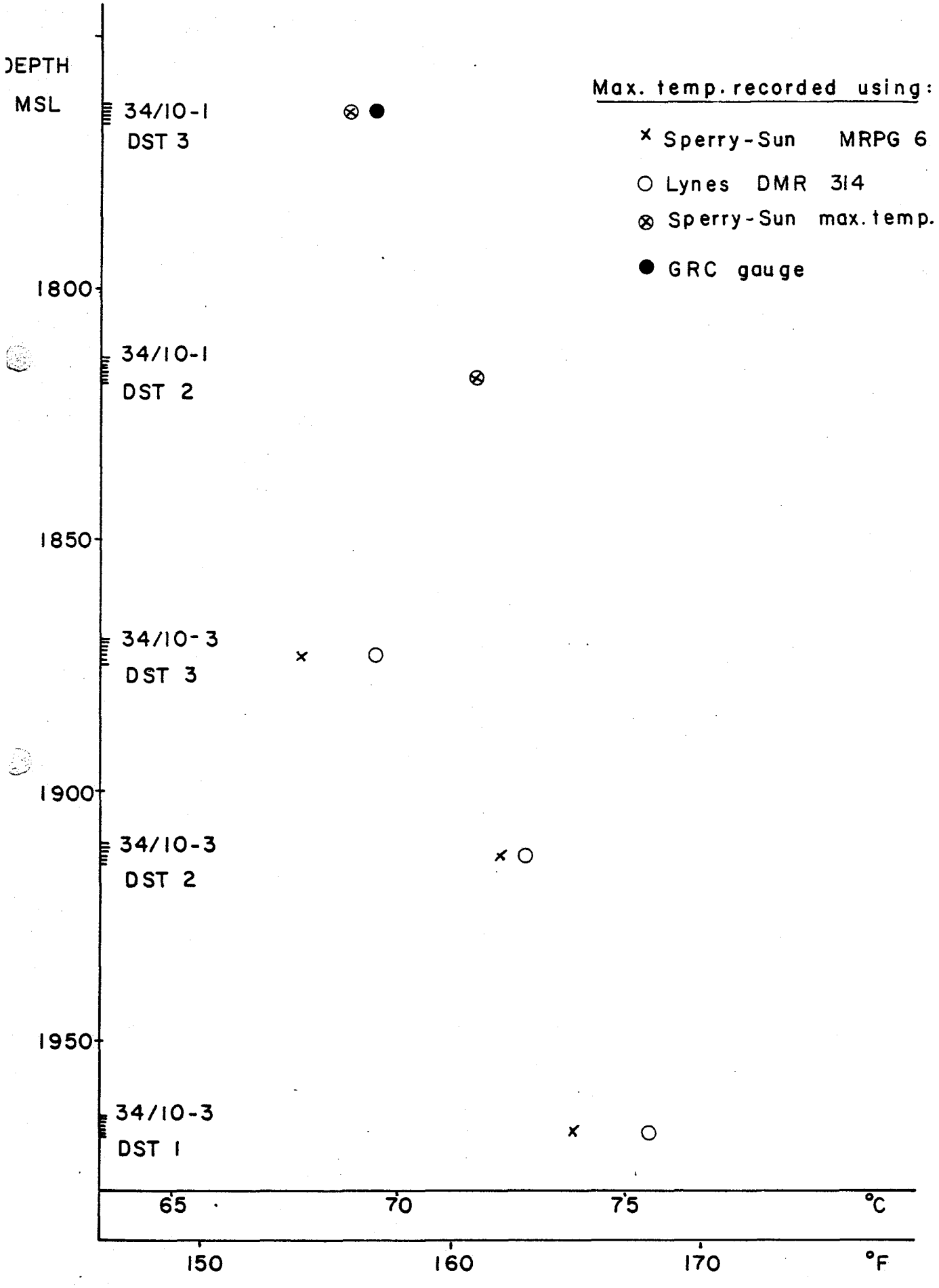
The maximum temperature measured during the DST's in this well and in 34/10-1 are scattered, but they are all within the range 68-77°C (155 - 170°F) at actual reservoir depth.

An estimated temperature gradient through these points is in the range if the gradient that can be exspected from this depth and temperature, about 3 - 3.5°C/100m (1.7 - 1.9°F/100ft).

Fig. 3.2 shows maximum recorded pressure vs depth for DST's in 34/10-1 and 34/10-3. The temperature recorders were located above the perforation, but it is assumed that the temperature recorded is representative for the actual temperature at mid perforations.

Fig. 3.2

34/10-3 34/10-1 RESERVOIR TEMPERATURE



3.3 Sand production

The intention of this testing was to increase flow rate in steps in order to establish a critical rate for sand production.

Laboratory experiments show that a thin shell of sand arround each perforation will collapse when the rate is increased. A stable arch is then formed and the production is sand-free until the flow rate again is raised. At a critical rate, however, a total failure of the sand will occur and sand production will be continous.

When analysing these tests it is assumed that when a shell of sand is removed from the perforations, the productivity will increase and that flowing bottom hole pressure therefore will increase for a given rate.

In DST no 1 sand slugs were produces to surface when the flowrate was increased. Bottom hole pressure shows, however that there was some lag time before the sand was produced into the wellbore. This lag time (between time of increased flow rate and time of sand production into the wellbore) was 58 mins for step 2, 11 mins for step 4 and 23 mins for step 5. There was no sand production during step 1 (clean-up) and step 4. (Productivity was improved during step 4 because a mud slug was produced when the flow rate was increased). Both step 4 and step 5 showed a sand production of about 0.1% after the main slug was produced to surface. The well was, however, not produced long enough to be sure that this sand production was continuous.

But as long as the sand production dropped after only a few minutes it might be concluded that a total failure of the sand did not occur and that the flow did not reach critical rate during this test.

Max. flow rate (step 5): 2600 BWPD $\triangleq$ 520 BWPD/m perforations or 50 BWPD/perf if 80% of the perforations were open.

In DST no. 2 no sand was observed at the flow rates below 2500 STB/D (step 7). Some mud and silt (barite?) was observed at surface and the Q/Dp improved from 14 to 24 STB/D/psi from step 1 to 6. Opening of additional perforations can explain this.

Step 7 and 8 produced sand slugs, step 7 after 23 mins lag time and step 8 immediately.

Sand production dropped at about 0.1% in 15 mins so the sand production is not believed to be continuous, i.e. the flow rate did not reach the critical level for total failure of the sand.

Max flow rate (step 8) : 2800 STB/d $\hat{=}$ 3500 res.bbl/d $\hat{=}$ 700 res. bbl/d/m perf. or 65 res.bbl/d/perf if 80% of the perforations were open.

In DST no 3 no sand was observed at surface during the first step (approx: 650 STB/D). Sand was produced into the wellbore immediately after increasing the flow rate (to approx. 720 STB/D).

Some of the sand reached surface when the well was flowed bottoms up. Then sand production at surface dropped off while sand probably still was produced into the well-bore and to some degree up the test string. Because the test string was plugged by sand the test was aborted. The only conclusions that can be made from this test are that sand was produced at low flow rate (less than 1000 STB/D) and that this rate was not sufficient to lift the sand to surface.

4. DST NO. 1, DETAILS

4.1 Test string

4.2 Test sequence

4.3 Test analysis

4.4 Sand test

TEST STRING, DST no. I Perf. interval:1990-1995 m RKB

Description	ID inch	OD inch	Length m	Depth mRKB
OTIS Test Tree	2.25		1.18	+7.43
Drill Pipe above RKB	2.76	3.50	6.25	+6.25
Drill Pipe below RKB	2.76	3.50	12.42	12.42
Otis labricaton Valve	2.94	16.00	2.18	14.60
19 jts. DP + 1 pup jt.	2.76	3.50	181.50	196.10
OTIS SSTT, above wellhead	2.00	16.00	4.90	201.00
OTIS SSTT, Below wellhead	2.00	16.00	.70	201.70
Drill Pipe (164 jts.)	2.76	3.50	1536.85	1738.55
Slip joint, open	2.25	5.00	5.54	1744.09
Slip joint, closed	2.25	5.00	4.01	1748.10
4 stds. Drill Collar	2.25	4.75	111.81	1859.91
RTTS Circulating Valve	2.44	4.50	.99	1860.90
X - over	2.25	4.75	.22	1861.12
Slip joint, closed	2.25	5.00	4.01	1865.13
Slip joint, closed	2.25	5.00	4.01	1869.14
3 stds. Drill Collar	2.25	4.75	84.14	1953.28
APR - A Reversing Valve	2.25	5.00	.91	1954.19
APR - N Tester Valve	2.25	5.00	4.10	1958.29
Big John Jars	2.375	4.625	1.52	1959.81
RTTS Circulating Valve	2.44	4.50	.99	1960.80
RTTS Safety Joint	2.44	5.00	.84	1961.64
RTTS Packer, set	2.185	5.75	.52	1962.16
RTTS Packer, below	2.185	5.75	.80	1962.96
Tubing	2.44	2.875	1.16	1964.12
Perforated Tubing	2.44	2.875	2.28	1966.40
X - over	1.96	3.125	.23	1966.63
OTIS XN - nipple	1.79	2.71	.23	1966.86
X - over	1.96	3.125	.23	1967.09
2 jts. Tubing n/BullPlug	2.44	2.875	18.95	1986.04

4.2

TEST SEQUENCE, DST NO. 1

Date	Time	Operations
23-24/5	18.30-02.00 (7½ hrs)	Ran Schlumberger perforation guns (made 2 runs due to misfire) and perforated 1990-1995 m RKB.
24-25/5	02.00-06.17 (28 1/4 hrs)	RIH w/test string, installed surface equipment and pressure tested string and surface lines. RIH pressure recorders on wireline.
25/5	06.17-06.30 (13 mins)	Opened well on 8/64" choke for initial flow. Flowed 3 bbl to surge tank.
	06.30-07.32 (62 mins)	Closed APR-n tester and choke manifold for initial shut-in.
	07.33-10.11 (158 mins)	Opened well on 12/64" positive choke for clean up. Flowed to surge tank at an estimated rate of 970 bbl/day. Rathole mud to surface after 64 mins.
	10.11-13.16 (185 mins)	Flowed through 14/64" positive choke. Estimated flow rate: 1080 BWPD.
	13.16-14.37 (81 mins)	Flowed through 16/64" positive choke. Estimated flow rate: 1600 BWPD
	14.37-15.57 (154 mins)	Flowed thorugh 16/64" and 8/64" chokes in parallell. Estimated flow rate: 2000 BWPD.
25/5	15.57-16.55 (58 mins)	Flowed through 20/64" positive choke. Estimated flow rate: 2600 BWPD. Sand to surface after 49 mins. Sand detector out of scale. All needle valves at surface plugged by sand.
	16.55-17.02 (7 mins)	Flowed through 16/64" positive choke due to sand production.
	17.02-18.34 (92 mins)	Flowed through 20/64" positive choke to check for continuous sand production.
	18.34-19.19 (45 mins)	Flowed through 16/64" positive choke to obtain sandfree production prior to shut-in. Had to flow through a 20/64" choke for 13 mins while repairing a leak in a needle valve next to the 16/64" choke.
	19.19-22.15 (176 mins)	Closed APR-n tester and choke manifold for final shut-in. Reversed out string
26/5	22.15-03.30 (5 1/4 hrs)	Unseated packer and POOH test string with all pressure recorders.

4.3

TEST ANALYSIS DST NO. 1

Perforated interval: 1990-1995 m RKB

It is assumed that the interval from 1984 to 2026 was contributing to flow.

Parameters used in the calculations:

ht = 42 m (138 ft)

$\emptyset$ = 30% (average)

Sw = 100%

Cw = 3×10^{-6} 1/psi

C_f = 3×10^{-6} 1/psi

C_t = Sw · Cw + Cf = 6×10^{-6} 1/psi

Bw = 1

μ = 0.45 cp

rw = 0.35 ft

Lynes DMR 314 pressure gauge is used for all the calculations.

BP@HN 34-10-3 DST# 1
BUILDUP NUMMER 2
GAUGE DMR 314

NR.	TID	TRYKK
1	19.20	4603.000
2	19.22	4603.400
3	19.26	4603.800
4	19.34	4603.800
5	19.36	4604.200
6	19.58	4604.600
7	20.24	4604.600
8	20.26	4611.000
9	20.30	4613.000
10	20.34	4611.000
11	20.38	4598.000
12	20.40	4613.000
13	20.42	4661.000
14	20.46	4602.000
15	21.02	4601.900
16	21.18	4602.700
17	21.36	4603.800
18	21.50	4605.000
19	22.15	4605.400

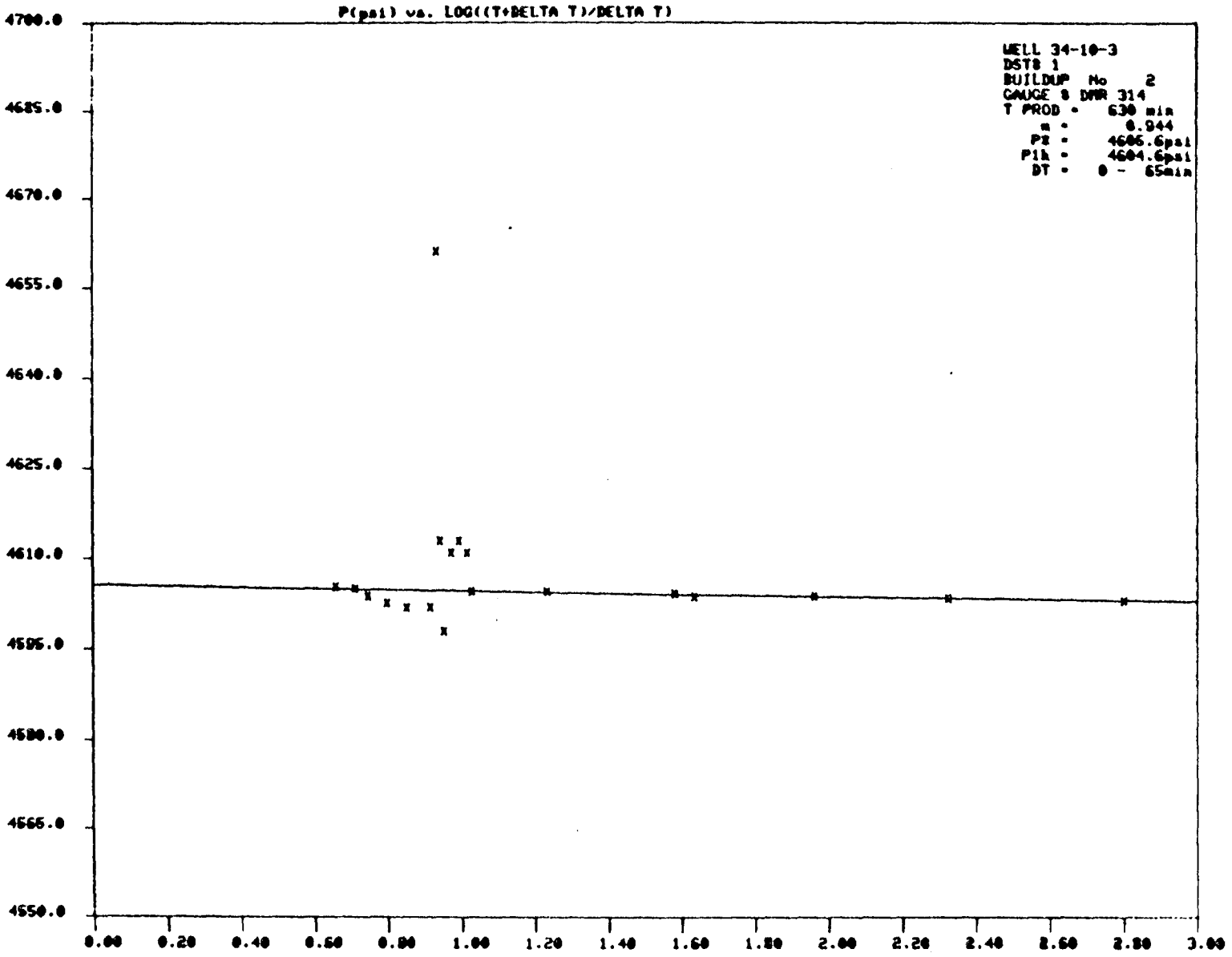

P(psi) vs. LOG((T+DELTA T)/DELTA T)
WELL 34-10-3
DST# 1
BUILDUP No 2
GAUGE # DMR 314
T PROD = 630 min
m = 0.944
P* = 4606.6psi
P1h = 4604.6psi
DT = 0 - 65min
4700.0
4685.0
4670.0
4655.0
4640.0
4625.0
4610.0
4595.0
4580.0
4565.0
4550.0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20
2.40
2.60
2.80
3.00

Fig 4.1

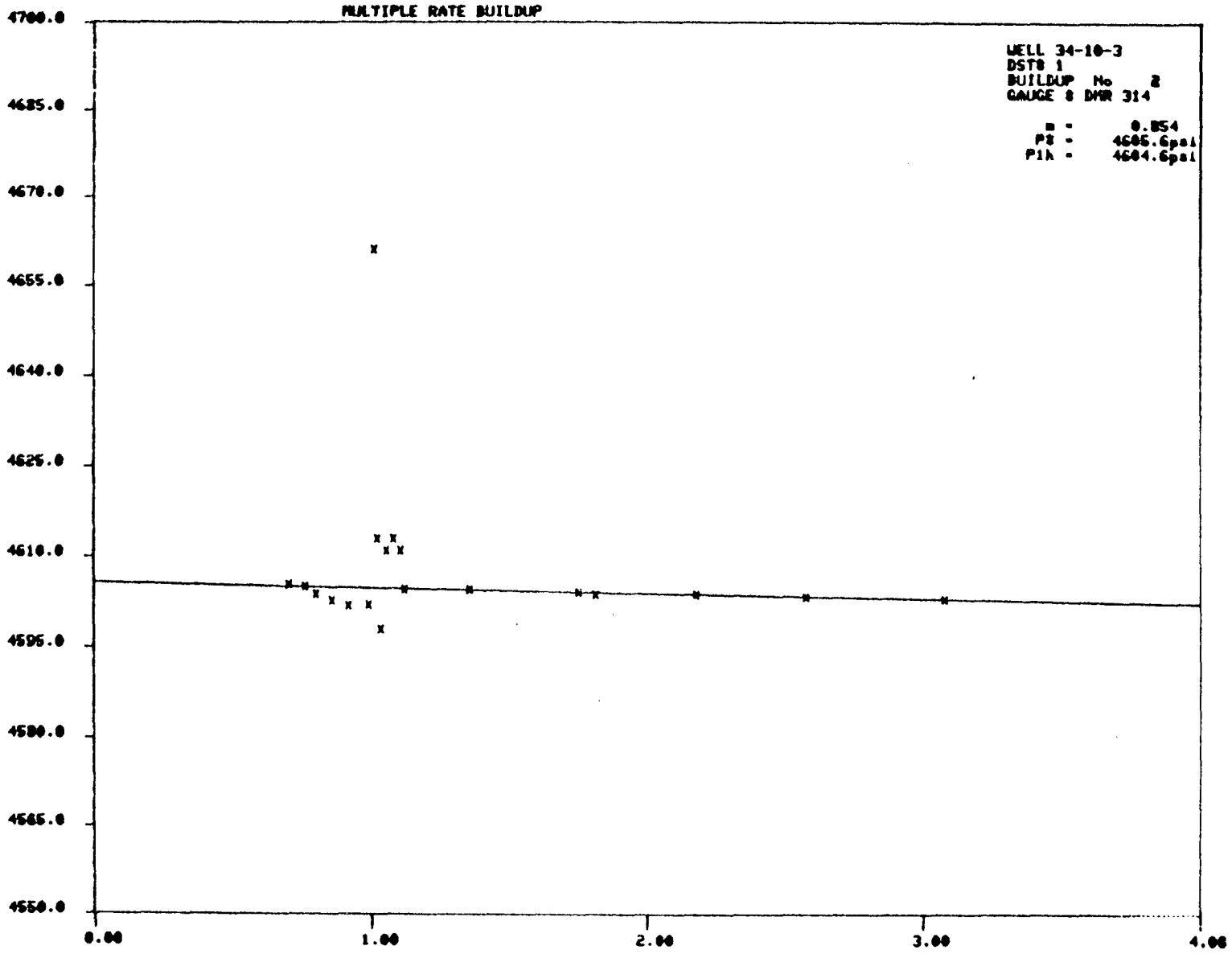

MULTIPLE RATE BUILDUP
WELL 34-10-3
DST# 1
BUILDUP No 2
GAUGE # DMR 314
m = 0.854
P* = 4605.6psi
P1h = 4604.6psi
4700.0
4685.0
4670.0
4655.0
4640.0
4625.0
4610.0
4595.0
4580.0
4565.0
4550.0
0.00
1.00
2.00
3.00
4.00

Fig 4.2

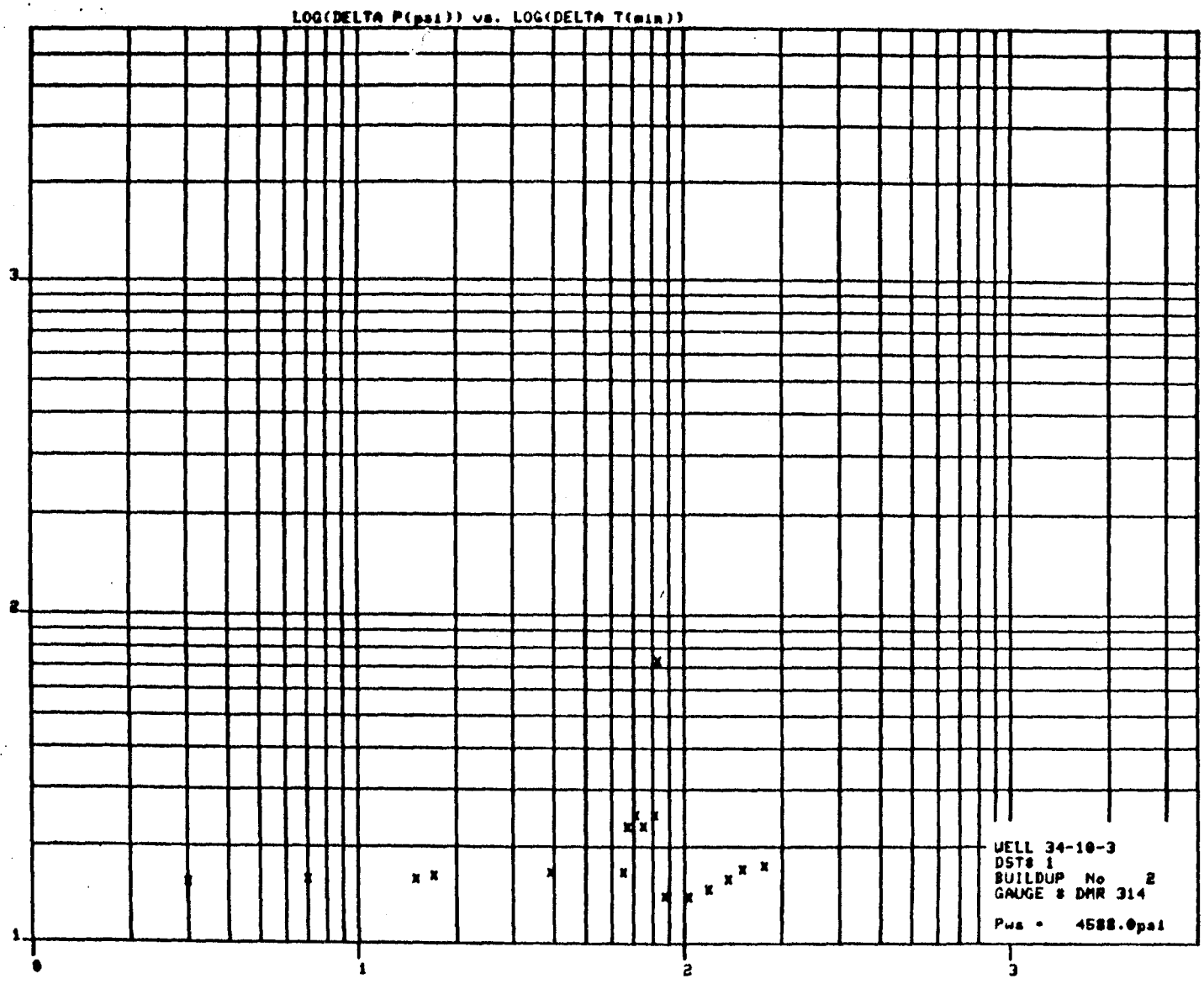

LOG(DELTA P(psi)) vs. LOG(DELTA T(min))
3
2
1
0
1
2
3
WELL 34-10-3
DST# 1
BUILDUP No 2
GAUGE # DMR 314
Pws = 4588.0psi

Fig 4.3

4.4 Sand test, DST 1

In order to establish critical rate for sand production, the flow rate was increased in steps The following were obtained:

Step 1: 12/64" choke
Est. flow rate: 970 BWPD
Est. time for flow bottoms up: 75 mins.

- No sand observed at surface after clean-up.
- Pressure draw-down: 73 psi ($Q/\Delta p$ =13 BWPD/psi)

Step 2: 14/64" choke
Est. flow rate: 1080 BWPD
Est. time for flow bottoms up: 65 mins.

- Pressure draw-down 85 psi ($Q/\Delta p$ =13 BWPD/psi) for the first 58 mins.
- Drawdown starts decreasing after 58 mins and stabilizes at 56 psi ($Q/\Delta p$=19)
- Sand to surface (BSW: 0.15%, sonic sanddetector : 5 millivolt) 61 mins after change in pressure drawdown.
- No sand at surface 10 mins later.

Step 3: 16/64" choke
Est. flow rate: 1600 BWPD
Est. time for flow bottoms up: 44 mins.

- Mud slug to surface in 44 mins.
- Pressure drawdown : 66 psi (stable) ($Q/\Delta p$=24 BWPD/psi)
- No sand observed at surface

Step 4: 16+8/64" choke
Est. flow rate: 2000 BWPD
Est. time for flow bottoms up: 35 mins.

- Pressure drawdown increases to 91 psi ($Q/\Delta p$ =22 BWPD psi) in 11 mins and then starts decreasing to 52 psi ($Q/\Delta p$ =38 BWPD/psi)
- Sand to surface (0.3%, 40-60 mV) 32 mins after change in (decreasing) drawdown)
- Sand production seems to stabilize at 0.1%

Step 5: 20/64" choke

Est. flow rate : 2600 BWPD

Est. time for flow bottoms up: 27 mins.

- Pressure drawdown is 72 psi ($Q/\Delta p = 36$) the first 23 mins after choke change and drops to 36 psi for the rest of this flow period. ($Q/\Delta p = 72$ BWPD/psi)
- Sand to surface (0.6%, 600 - 800 mV) 25 mins. after change in drawdowns.
- Sand production drops to 0.4%, 60-80 mV after 15 mins. and to 0.1%, 40 mV after 75 mins.
- Sand production seems to stabilize at 0.1%.

5 . DST NO. 2 DETAILS

5 .1 Test string

5 .2 Test sequence

5 .3 Test analysis

5 .4 Sand test

5.1

TEST STRING, DST no. 2 — Perf. interval: 1935-1940 m RKB

Description	ID inch	OD inch	Length m	Depth mRKB
OTIS Test Tree	2.25		1.18	+7.43
Drill Pipe above RKB	2.76	3.50	6.25	+6.25
Drill Pipe below RKB	2.76	3.50	12.42	12.42
Otis labricaton Valve	2.94	16.00	2.18	14.60
19 jts. DP + 1 pup jt.	2.76	3.50	181.50	196.10
OTIS SSTT, above wellhead	2.00	16.00	4.90	201.00
OTIS SSTT, Below wellhead	2.00	16.00	.70	201.70
Drill Pipe (157 jts.)	2.76	3.50	1471.24	1672.94
Slip joint, open	2.25	5.00	5.54	1678.48
Slip joint, closed	2.25	5.00	4.01	1682.49
4 stds. Drill Collar	2.25	4.75	111.81	1794.30
RTTS Circulating Valve	2.44	4.50	.99	1795.29
X - over	2.25	4.75	.22	1795.51
Slip joint, closed	2.25	5.00	4.01	1799.52
Slip joint, closed	2.25	5.00	4.01	1803.53
3 stds. Drill Collar	2.25	4.75	84.14	1887.67
APR - A Reversing Valve	2.25	5.00	.91	1888.58
APR - N Tester Valve	2.25	5.00	4.10	1892.68
Big John Jars	2.375	4.625	1.52	1894.20
RTTS Circulating Valve	2.44	4.50	.99	1895.19
RTTS Safety Joint	2.44	5.00	.84	1896.03
RTTS Packer, set	2.185	5.75	.52	1896.55
RTTS Packer, below	2.185	5.75	.80	1897.35
Tubing	2.44	2.875	1.16	1898.51
Perforated Tubing	2.44	2.875	2.28	1900.79
X - over	1.96	3.125	.23	1901.02
OTIS XN - nipple	1.79	2.71	.23	1901.25
X - over	1.96	3.125	.23	1901.48
2 jts. Tubing n/Bull Plug	2.44	2.875	18.95	1920.43

5.2

TEST SEQUENCE, DST NO. 2

DATE	TIME	OPERATIONS
29/5	15.00-18.00 (3 hrs)	Ran Schlumberger perforating guns (made 2 runs due to misfire) and perforated 1935-1940 mRKB
29-30/5	18.00-17.06 (23hrs)	RIH w/test string, installed surface equipment and pressure tested string and surface lines. RIH pressure recirders on wireline (one misrun)
30/5	17.06-17.08 (2 mins)	Opened well on 20/64" choke for initial flow. Flowed 3 bbl to surge tank.
	17.08-18.12 (64 mins)	Closed APR-n tester and choke manifold for initial shut in.
	18.12-22.11 (239 mins)	Opened well on 10/64" choke for clean up. Rathole mud to surface after 73 mins. Flowed to surge tank at an estimated rate of 450 BOPD.
	22.11-22.40 (29 mins)	Flowed through 12/64" choke. Estimated flow to surge tank: 750 BOPD.
30-31/5	22.40-00.36 (116 mins)	Flowed through 14/64" choke. Estimated flow to surge tank: 1000 BOPD. Sand slug to surface at 23.15 hrs.
31/5	00.36-09.44 (548 mins)	Flowed through 16/64" choke. Flow directed through separator at 02.30 hrs. Average flow rate: 1200 STB/day.
	09.44-11.55 (131 mins)	Tried to establish a flow rate of 200 BOPD for bottom hole sampling - unsucceeded.
	11.55-16.22 (267 mins)	Pressure tested lubricator, RIH two BHS on wireline flowed through 13/64" adj.choke while sampling and POOH. Started sample transfer.
	16.22-17.29 (53 mins)	Opened well on 16/64" positive choke for 3rd flow period. Directed flow through separator at 16.30 hrs.
	17.29-19.21 (112 mins)	Flowed through 16/64" and 8/64" chokes (in paralell to separator.
	19.21-21.23 (122 mins)	Flowed through 20/64" choke to sep.
31/5-1/6	21.23-00.08 (165 mins)	Flowed through 20/64" and 10/64" chokes (in paralel to sep. Slug of sand to surface at 22.13 hrs. Separator bypassed for 30 mins.

Date	Time	Operation
1/6	00.08-00.46 (38 mins)	Flowed through 20/64 and 14/64" chokes (in parallell) to sep.
	00.46-01.52 (66 mins)	Sonic sand detector malfunctioned. Decided to end test when flowed bottoms up at lower ("sand-free") rate. Choked back to 20/64" choke.
	01.52-03.37 (105 mins)	Closed APR-n tester and choke manifold for final shut-in.
	03.37-04.30 (53 mins)	RIH w/wireline and POOH pressure recorders.
	04.30-16.00 (11½ hrs)	Flushed surface lines, bullheaded formation. POOH test string
		RIH w/bit to 1964 mRKB. No indication of sand in the well.

5.3

TEST ANALYSIS FOR DST NO. 2

Perforated interval: 1935-1940 mRKB

It is assumed that the interval from 1929 to 1941 m (except a 1 m coal layer at 1935 m) is contributing to flow. The coal is believed to be impermeable, but the CBL indicates communication outside the casing in this zone.

Parameters used in the calculations:

$h = 11$ m (36 ft)

$\emptyset = 31\%$ (average)

$Sw = 31\%$, $So = 69\%$ (average)

$Co = 7.5 \times 10^{-6}$ psi^{-1}

$Cw = 3.0 \times 10^{-6}$ psi^{-1}

$Ct = CoSo + CwSw + Cf = 9.1 \times 10^{-6}$ 1/psi

$Bo = 1.24$ res. bbl/STB

$\mu o = 1.32$ cp (From SINTEF report)

$rw = 0.35$ ft

Sperry-Sun pressure gauge MRPG no. 6 is used for all the calculations.

Pressures from SS MRPG no. 2 are used in some calculations for comparions.

BP@NN 34-10-3 DST# 2
BUILDUP NUMMER 2
GAUGE SS MRPG#6

NR.	TID	TRYKK
1	1.56	4530.000
2	2.00	4537.000
3	2.04	4537.000
4	2.08	4538.000
5	2.20	4539.000
6	2.40	4541.000
7	2.52	4540.000
8	3.12	4542.000
9	3.37	4542.000

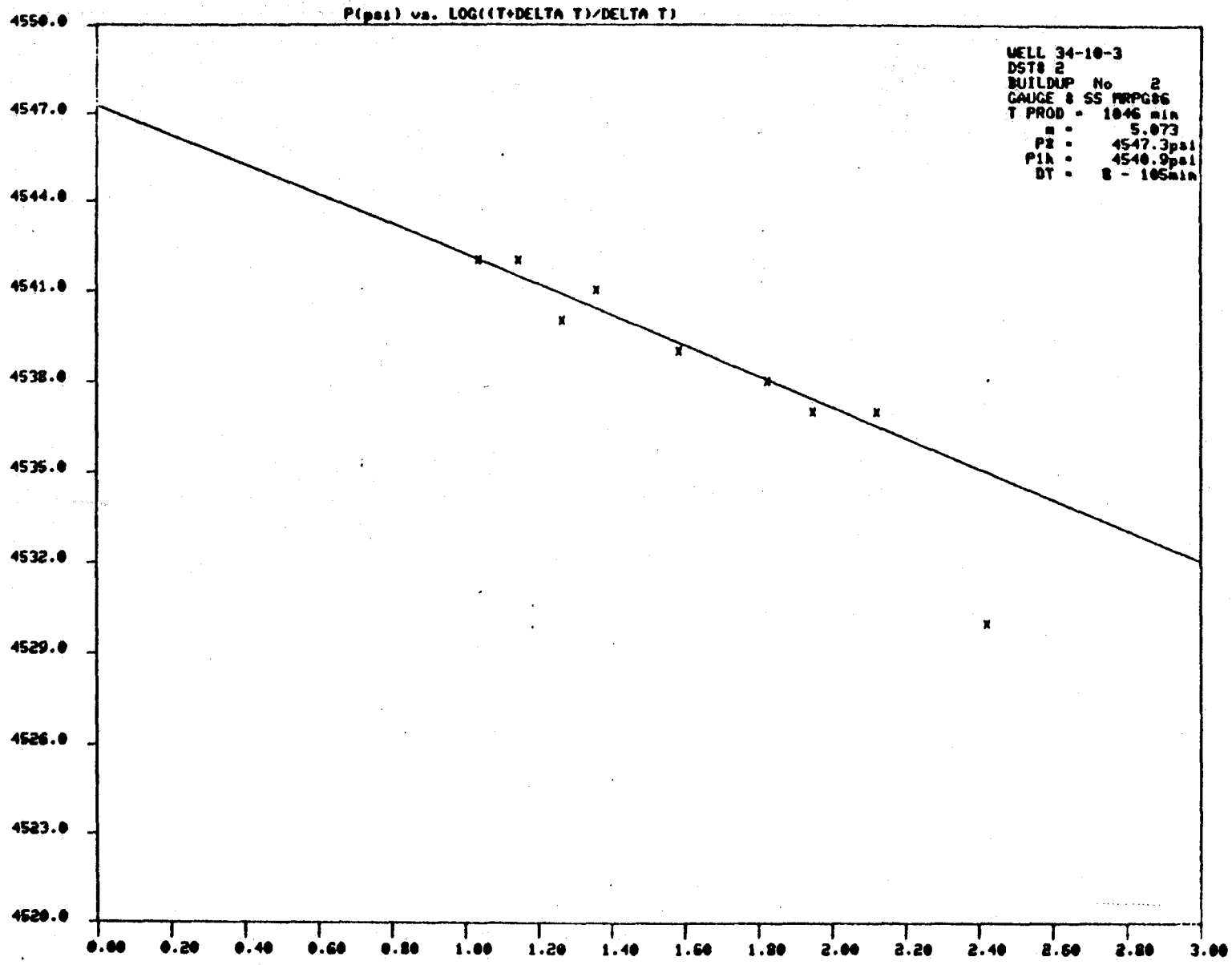

P(psi) vs. LOG((T+DELTA T)/DELTA T)
WELL 34-10-3
DST# 2
BUILDUP No 2
GAUGE # SS MRPG86
T PROD = 1046 min
m = 5.073
P2 = 4547.3psi
P1h = 4540.9psi
DT = 8 - 105min
4550.0
4547.0
4544.0
4541.0
4538.0
4535.0
4532.0
4529.0
4526.0
4523.0
4520.0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20
2.40
2.60
2.80
3.00

Fig 5.1

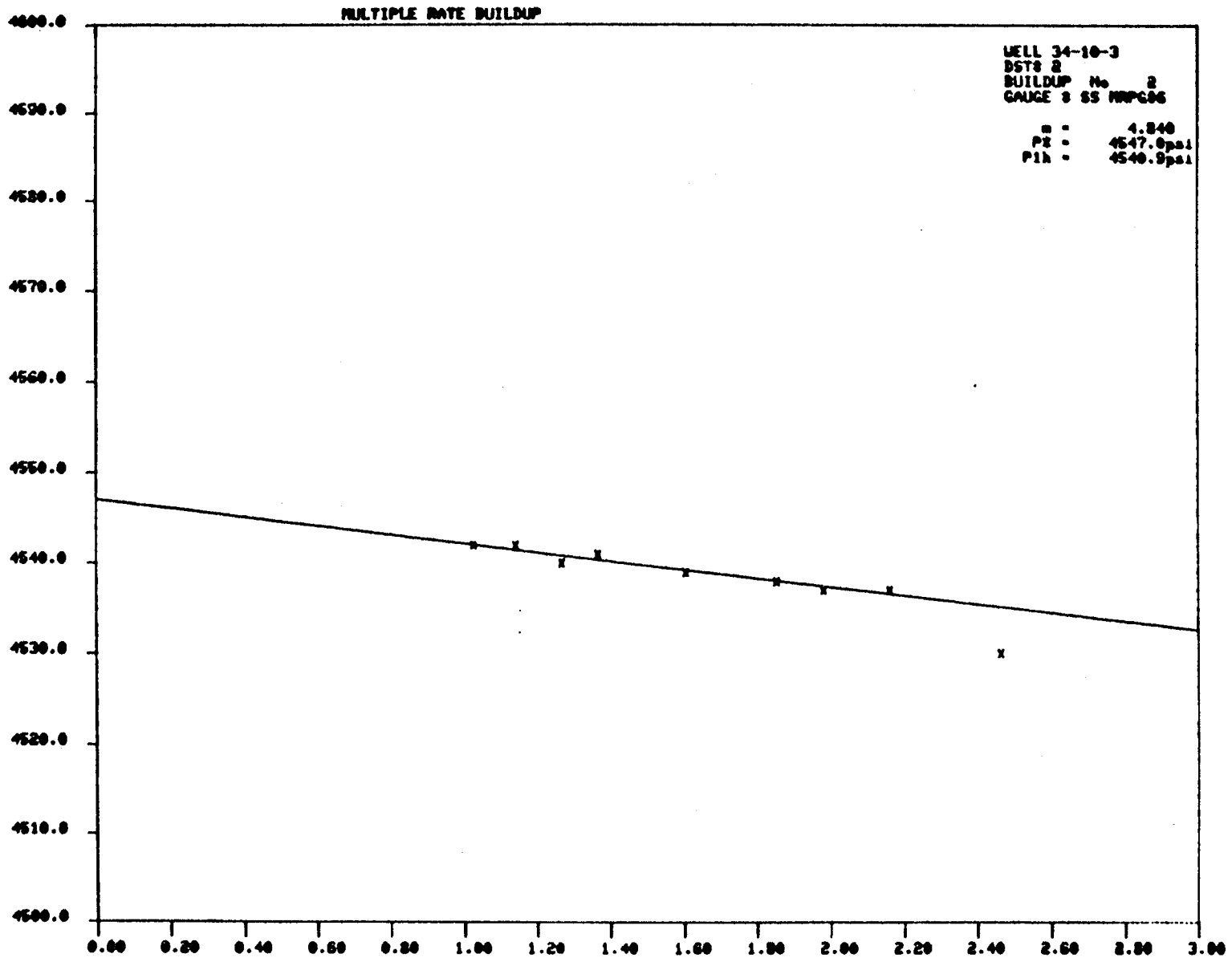

MULTIPLE RATE BUILDUP
WELL 34-10-3
DST8 2
BUILDUP No 2
GAUGE 3 SS MRPG86
m : 4.840
Pi : 4547.8psi
Pih : 4540.9psi
4600.0
4590.0
4580.0
4570.0
4560.0
4550.0
4540.0
4530.0
4520.0
4510.0
4500.0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20
2.40
2.60
2.80
3.00

Fig. 5.2

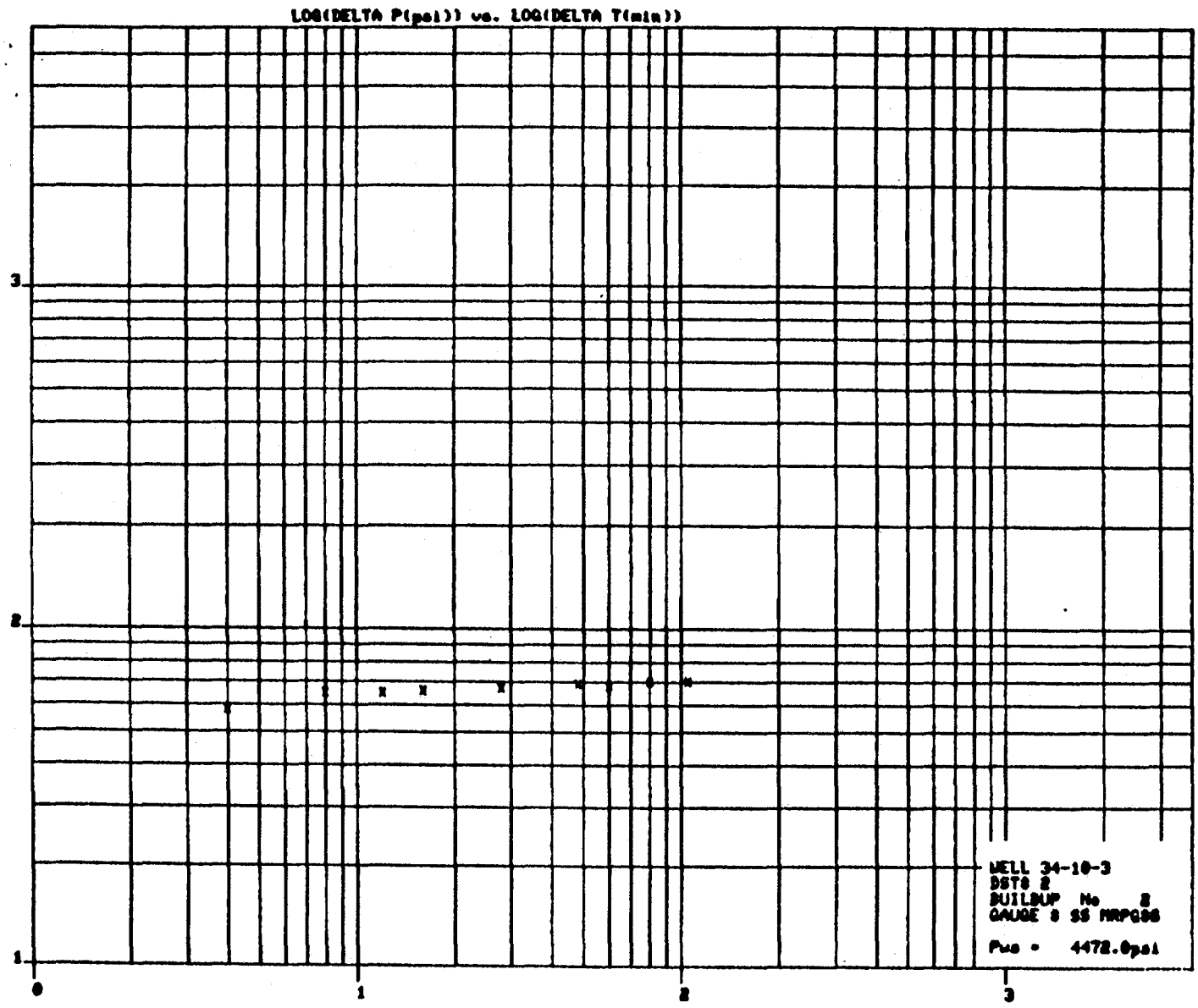

LOG(DELTA P(psi)) vs. LOG(DELTA T(min))
3
2
1
0
1
2
3
WELL 34-10-3
DST# 2
BUILDUP No 2
GAUGE # SS MRPG96
Pwa = 4472.0psi

Fig. 5.3

5.4 Sand test, DST 2

In order to establish critical rate for sand production, the flow rate was increased in steps. The following results were obtained:

Step 1: 10/64" choke
Est. flow rate: 450 STB/D
Est. time for flow bottoms up: 155 mins.

- No sand observed at surface after clean-up.
- Pressure drawdown: 32 psi ($Q/\Delta p$ = 14 STB/D/psi)

Step 2: 12/64" choke
Est. flow rate: 750 STB/D
Est. time for flow bottoms up: 93 mins.

- No sand observed at surface
- Pressure drawdown: 43 psi ($Q/\Delta p$ =17 STB/D/psi)
- Flow rate was increased before bottoms up Taking this into account the time of bottoms up should be 77 mins. The SSD had a peak of 250 mV after 64 mins dropping to 50 mV 5 mins later. Mud and trace of silt was reported at surface.

Step 3: 14/64" choke
Est. flow rate: 1000 STB/D
Est. time for flow bottoms up: 70 mins

- SSD increased from 50 mV to 800 mV after 65 mins and then dropped to 0. Only mud reported at surface.
- Pressure drawdown 64 psi ($Q/\Delta p$ = 16 STB/D/psi)

Step 4: 16/64" choke
Est. flow rate: 1200 STB/D
Est. time for flow bottoms up: 58 mins

- Pressure drawdown : 85 psi ($Q/\Delta p$ = 14 STB/D/psi) for the first 24 mins.
- Drawdown dropped to 58 psi: ($Q/\Delta p$ = 22 STB/D/psi) after 24 mins.
- No sand observed at surface

Bottom hole sampling at lower rates.

Step 5: 16+8/64" choke
Est. flow rate: 1500 STB/D
Est. time for flow bottoms up: 47 mins.

- Pressure drawdown: 62 psi ($Q/\Delta p$ = 2 STB/D/psi)
- Trace of silt observed at surface.

Step 6: 20/64" choke
Est. flow rate: 2100 STB/D
Est. time for flow bottoms up: 33 mins.

- Pressure drawdown: 86 psi ($Q/\Delta p$ = 24 STB/D/psi)
- 05.%$^{+}_{-}$ silt observed at surface.

Step 7: 10+20/64" choke
Est. flow rate: 2500 STB/D
Est. time for flow bottoms up: 28 mins

- Pressure drawdown: 102 psi ($Q/\Delta p$ = 24 STB/D/psi) for the first 23 mins.
- Drawdown dropped to 90 psi ($Q/\Delta p$ =28/STB/D/psi) after 23 mins.
- Sand slug (0.3%, 300 mV) observed at surface 27 mins after change in drawdown.
- Sand (silt?) production dropped to 0.1% ,0mV

Step 8: 14+20/64" choke
Est. flow rate: 2800 STB/D
Est. time for flow bottoms up: 25 mins.

- Pressure drawdown: 106 psi ($Q/\Delta p$ =26 STB/D/psi)
- Sand slug to surface (0.25%) after 22 mins
- Sand dropped to 0.1% in 15 mins.

Test was aborted because of SSD malfunction.

6. DST NO. 3, DETAILS

6.1 Test string

6.2 Test sequence

6.3 Test analysis

6.4 Sand test

TEST STRING, DST no. 3 Perf. interval: 1895-1900 m RKB

Description	ID inch	OD inch	Length m	Depth mRKB
OTIS Test Tree	2.25		1.18	+7.43
Drill Pipe above RKB	2.76	3.50	6.25	+6.25
Drill Pipe below RKB	2.76	3.50	12.42	12.42
Otis labricaton Valve	2.94	16.00	2.18	14.60
19 jts. DP + 1 pup jt.	2.76	3.50	181.50	196.10
OTIS SSTT, above wellhead	2.00	16.00	4.90	201.00
OTIS SSTT, Below wellhead	2.00	16.00	.70	201.70
Drill Pipe (153 jts.)	2.76	3.50	1433.89	1635.59
Slip joint, open	2.25	5.00	5.54	1641.13
Slip joint, closed	2.25	5.00	4.01	1645.14
4 stds. Drill Collar	2.25	4.75	111.81	1756.95
RTTS Circulating Valve	2.44	4.50	.99	1757.94
X - over	2.25	4.75	.22	1758.16
Slip joint, closed	2.25	5.00	4.01	1762.17
Slip joint, closed	2.25	5.00	4.01	1766.18
3 stds. Drill Collar	2.25	4.75	84.14	1850.32
APR - A Reversing Valve	2.25	5.00	.91	1851.23
APR - N Tester Valve	2.25	5.00	4.10	1855.33
Big John Jars	2.375	4.625	1.52	1856.85
RTTS Circulating Valve	2.44	4.50	.99	1857.84
RTTS Safety Joint	2.44	5.00	.84	1858.68
RTTS Packer, set	2.185	5.75	.52	1859.20
RTTS Packer, below	2.185	5.75	.80	1860.00
Tubing	2.44	2.875	1.16	1861.16
Perforated Tubing	2.44	2.875	2.28	1863.44
X - over	1.96	3.125	.23	1863.67
OTIS XN - nipple	1.79	2.71	.23	1864.13
X - over	1.96	3.125	.23	1864.13
2 jts. Tubing n/BullPlug	2.44	2.875	18.95	1883.08

6.2

TEST SEQUENCE, DST NO. 3

DATE	TIME	OPERATIONS
2/6	07.30-10.00 (2½hrs)	Ran Schlumberger perforating guns and perforated 1895-1900 mRKB
2-3/6	10.00-13.16 (27½hrs)	RIH w/test string, installed surface equipment and pressure tested string and surface lines RIH pressure recorders on wireline.
3/6	13.16-13.19 (3mins)	Opened well on 20/64" choke for initial flow. Flowed 4.5 bbl to surge tank.
	13.19-14.20 (61 mins)	Closed APR-n tester and choke manifold for initial shut in.
	14.20	Opened APR-n tester.
	14.25-17.15 (170 mins)	Opened well on 10/64" positive choke for clean up. Flowed to surge tank at an estimated rate of 650 bbl/day. Rathole mud to surface after 86 mins.
	17.15-19.58 (163 mins)	Flowed through 12/64" positive choke. Flow directed to separator. To low flow rate to meter oil rates. Sand slug to surface at 18.40 hrs. Flowed to surge tank for 30 mins at an estimated average rate of 720 BOPD. WHP decreased 300 psi while BHP remained constant.
3/6	19.58-23.22 (204 mins)	Flowed through 10/64" positive choke. Estimated flow to surge tank: 350 BOPD. WHP decreased 300 psi while BHP remained constant.
	23.22-23.50 (28 mins)	Flowed through 8/64" positive choke. Estimated flo to surge tank: 300 BOPD.
3-4/6	23.50-03.47 (4 hrs)	Shut in well and ran dummy run prior to run BHS. Unable to RIH w/wireline because of sand bridge in the test string. RIH w/sand bailer.
4/6	03.47-04.06 (19 mins)	Opened well on 8/64" positive choke to assist sand bailer. Did not succeed in bailing the sand.
	04.06-06.08 (2 hrs)	Closed at choke manifold and prepared to bullhead formation.
	06.08-19.30 (13½ hrs)	Bullheaded formation. rev. circulated and POOH test string with all pressure recorders.
		RIH w/bit and tagged sand at 1898 m RKB. This indicates 8 m of sand fill-up in the well.

TEST ANALYSIS FOR DST no. 3

Perforated interval: 1895-1900 m RKB

It is assumed that the interval from 1894 to 1903 m is contributing to flow.

Parameters used in the calculations:

h = 9 m (30ft)

Ø = 22% (average)

Sw = 44%, So= 56% (average)

Co = $7.5 \cdot 10^{-6}$ psi^{-1}

Cw = $3 \cdot 10^{-6}$ psi^{-1}

Ct = CoSo + CwSw + Cf = $8.5 \cdot 10^{-6}$ 1/psi

Bo = 1.24 res bbl/STB

μo = 1.32 cp (from SINTEF report).

rw = 0.35 ft

Lynes DMR 314 pressure gauge is used for all the calculations.

All calculations are very uncertain because of low flow rates, unaccurate metering, sand production and sand plugging in the test string.

BP0NN 34-10-3 DST# 3
BUILDUP NUMMER 1
GAUGE DNR 314

HR.	TID	TRYKK
1	13.22	4417.000
2	13.24	4437.000
3	13.28	4449.000
4	13.30	4453.000
5	13.32	4455.000
6	13.36	4459.000
7	13.44	4462.000
8	13.52	4465.000
9	14.10	4466.000
10	14.24	4467.000

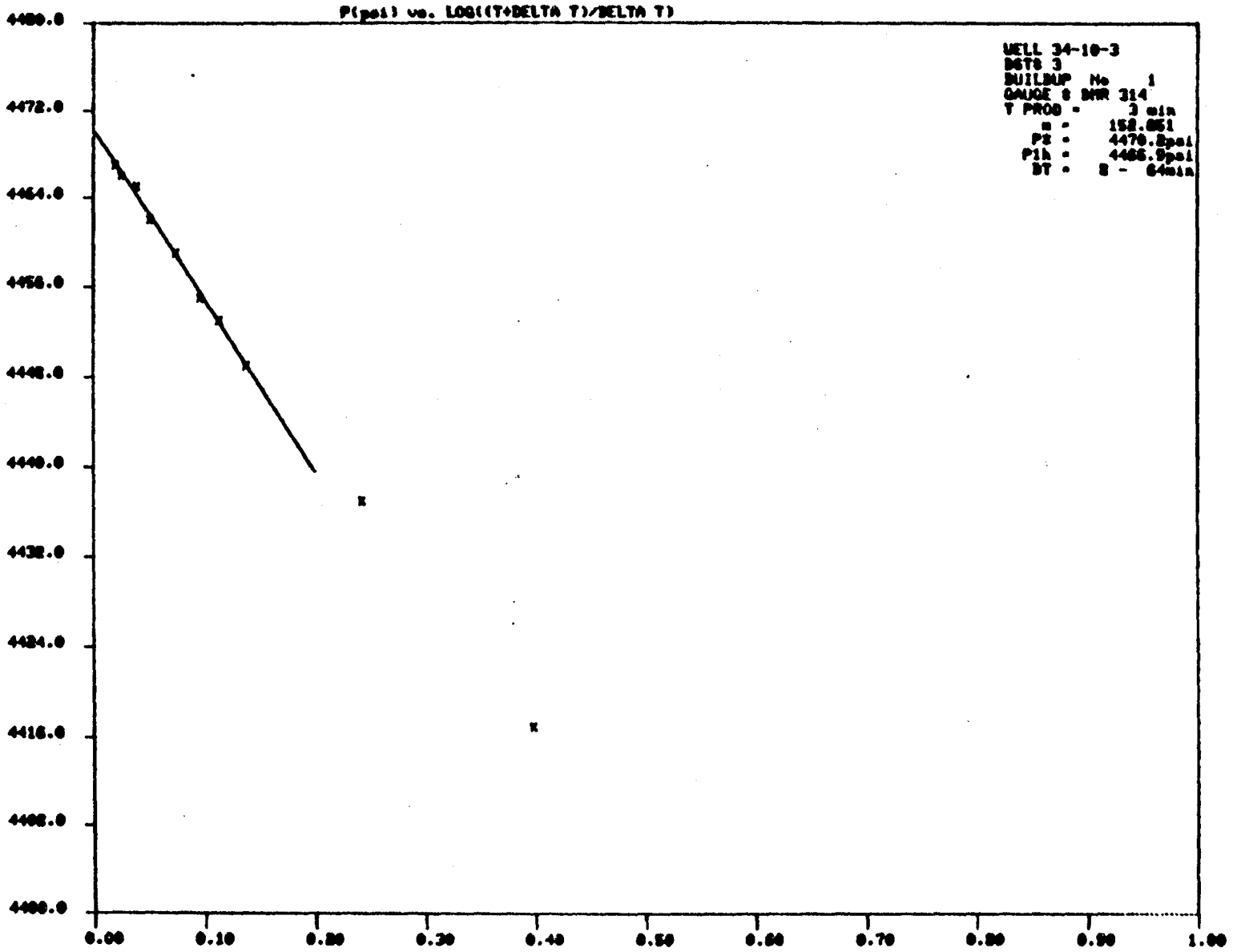

P(psi) vs. LOG((T+DELTA T)/DELTA T)
WELL 34-10-3
DST# 3
BUILDUP No 1
GAUGE # RMR 314
T PROD = 3 min
m = 152.051
P* = 4470.8psi
P1h = 4465.9psi
DT = 8 - 64min
4480.0
4472.0
4464.0
4456.0
4448.0
4440.0
4432.0
4424.0
4416.0
4408.0
4400.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

Fig. 6.1

BRONN 34-10-3 DST# 3
BUILDUP NUMMER 2
GAUGE DMR 314

NR.	TID	TRYKK
1	23.56	4340.000
2	0.00	4374.000
3	0.02	4381.000
4	0.04	4385.000
5	0.08	4391.000
6	0.10	4392.000
7	0.12	4395.000
8	0.18	4399.000
9	0.24	4402.000
10	0.28	4405.000
11	0.32	4406.000
12	0.36	4408.000
13	0.48	4412.000
14	0.58	4415.000
15	1.04	4367.000
16	1.06	4374.000
17	1.08	4372.000
18	1.12	4398.000
19	1.14	4406.000
20	1.16	4410.000
21	1.20	4414.000
22	1.24	4417.000
23	1.36	4421.000
24	1.54	4425.000
25	2.20	4429.000
26	2.52	4434.000
27	3.20	4437.000
28	3.40	4439.000
29	3.47	4440.000

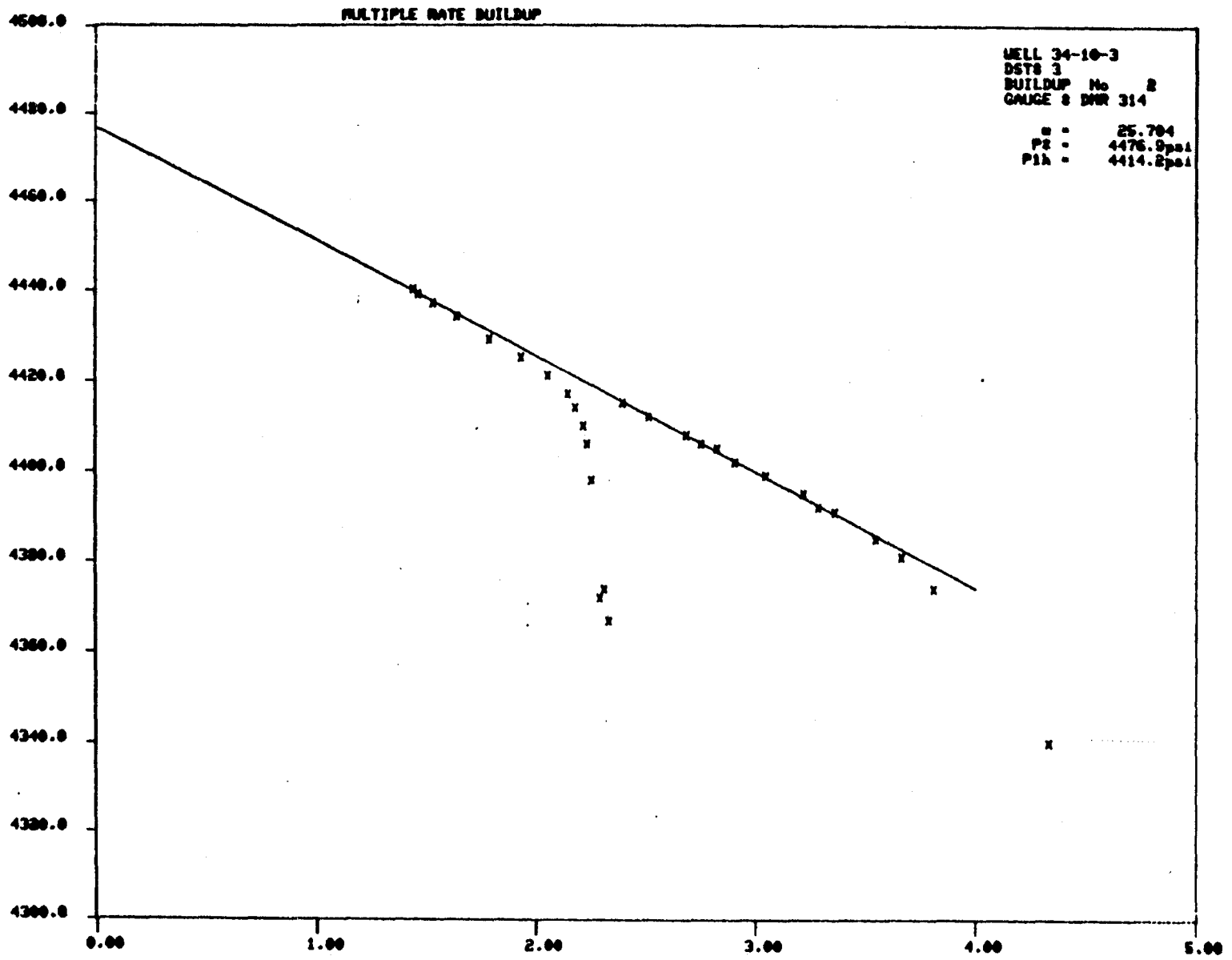

MULTIPLE RATE BUILDUP
WELL 34-10-3
DST# 3
BUILDUP No 2
GAUGE # DHR 314
m = 25.704
Pi = 4476.9psi
P1h = 4414.2psi
4500.0
4480.0
4460.0
4440.0
4420.0
4400.0
4380.0
4360.0
4340.0
4320.0
4300.0
0.00
1.00
2.00
3.00
4.00
5.00

Fig. 6.2

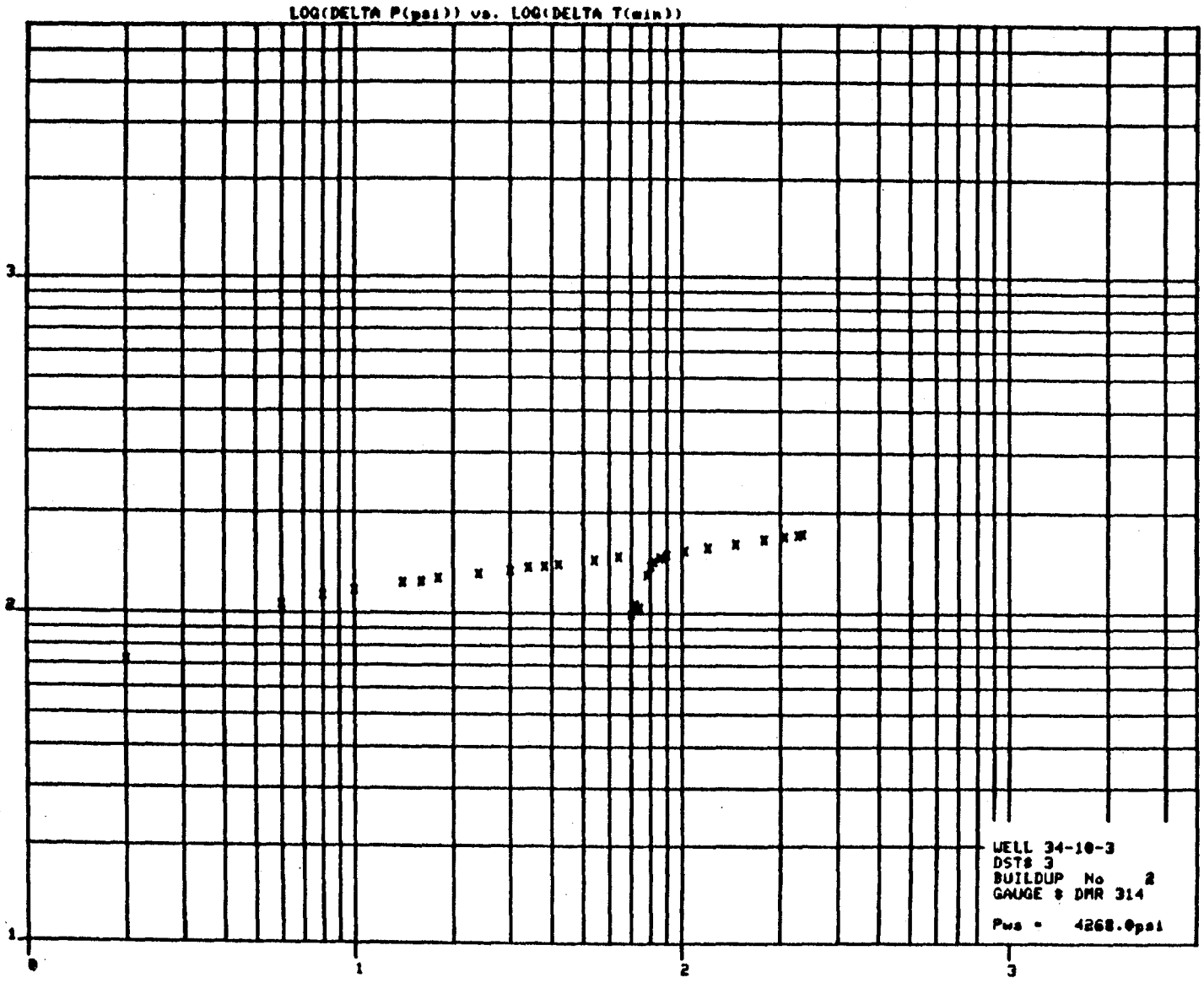

LOG(DELTA P(psi)) vs. LOG(DELTA T(min))
3
2
1
0
1
2
3
WELL 34-10-3
DST# 3
BUILDUP No 2
GAUGE # DMR 314
Pws = 4268.0psi

Fig. 5.3

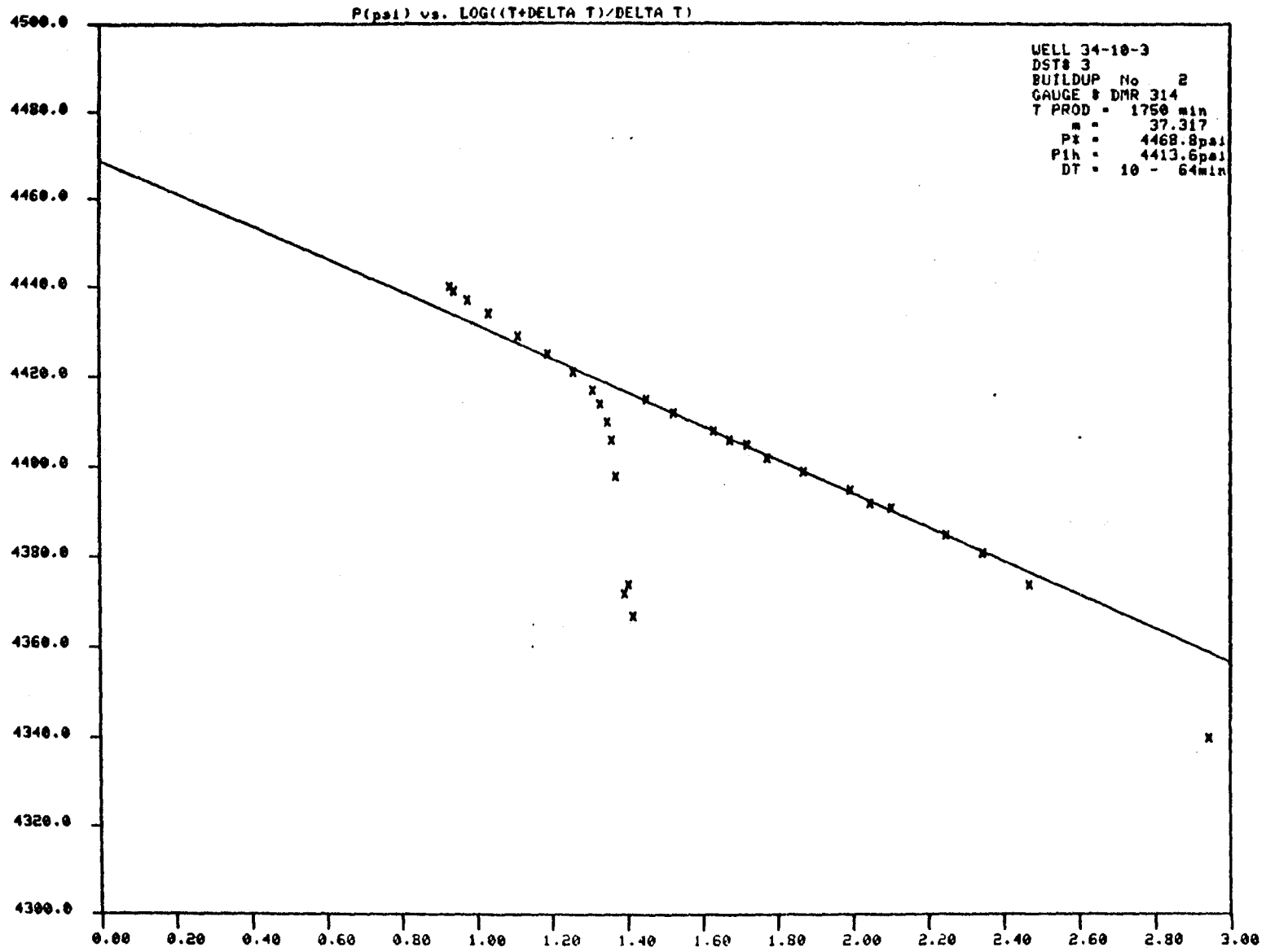

P(psi) vs. LOG((T+DELTA T)/DELTA T)
WELL 34-10-3
DST# 3
BUILDUP No 2
GAUGE # DMR 314
T PROD = 1750 min
m = 37.317
Pi = 4468.8psi
P1h = 4413.6psi
DT = 10 - 64min
4500.0
4480.0
4460.0
4440.0
4420.0
4400.0
4380.0
4360.0
4340.0
4320.0
4300.0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20
2.40
2.60
2.80
3.00

Fig. 6.4

6.4 Sand test, DST 3

In order to establish critical rate for sand production, the flow rate was increased in steps. During this test the Sonic Sand Detector did not work.

The following resluts were obtained:

Step 1: 10/64" choke
Est. flow rate: 650 STB/D
Est. time for bottoms up: 100 mins

- No sand observed at surface after clean-up
- Pressure drawdown: 260 psi ($Q/\Delta p$ = 2.5 STB/D/psi)

Step 2: 12/64" choke
Est. flow rate: 720 STB/D
Est. time for flow bottoms up: 90 mins.

- BHP stable while WHP starts decreasing immediately
- Sand slug to surface in 85 mins, WHP increased when the sand was produced and then started decreasing again.
- Sand production at surface dropped to zero 1 hr after the sand slug.
- Pressure drawdown : 350 psi ($Q/\Delta p$ = 2 STB/D/psi)

- The well was choked back and produced sandfree for 4 hours.
- The test string was plugged by sand (just below rotary table) unable to run wireline for bottom hole sampling.
- 8 m of sand (approx 1 bbl) was filled up in the wellhole during this test.

7. RFT DETAILS

7.1 Test sequence

7.2 Test results and analysis

7. RFT DETAILS

7.1 RFT operations

Repeat formation tester was run during the final logging through Brent and Dunlin formations at April 17, 1979.

37 pressure tests were made (26 in Brent and 11 in Dunlin formation).

The test program included one segregated sample to check for oil-water-contact and one segregated sample in the oil zone. Because of problems with sand plugging the probe in the zones of interest (while pressure testing), no attempt was made to collect samples.

2 Amerada pressure gauges were run with the RFT. The pressure readings from these gauges are very scattered and can not be used in any analysis It seems, however, that the Amerada pressures are higher (varying from 0 to 100 psi) than the RFT pressures.

No RFT was run in the Statfjord formation.

7.2 RFT results and analysis

- Temperature and pressure corrections:

The calibration certificate for the RFT tool used is dated June-76. Since the tool has not been calibrated for 3 years, Schlumberger does not recommend to include their corrections. The tool was, however, calibrated vs dead weight tester (at room temperature) one week before the test was run. At the pressure range of interest the RFT pressure was only 2 or 3 psi lower than the DWT pressure.

Based on this no corrections are made.

- Results:

Test no	Depth (mMSL)	P-hyd(psig) Before/after	Set time (mins)	P-final (psig)	Remarks
1	1907.5	4807/4803	2½	4531	
2	2229	5615/5617	4½	5061	long build up
3	2215	5583/5575	10	5011	long build up
4	2214.5	5577/5573	½		tight
5	2206.5	5551/5549	3	4971	
6	2199.5	5531/5525	6	4957	long build up
7	2191.5	5505/5503	5	4958	long build up
8	2192	5505/5503	5½	4922	long build up
9	2188.5	5495/5492	3	4933	
10	2182	5475/5473	3	4921	
11	2180	5468/5466	3	4918	
12	2177.5	5458/5458	4	4910	
13	2055	5167/5164	4	4734	
14	2050	5154/5151	3	4727	
15	2042	5134/5132	3½	4716	
16	2033	5113/5109	3	4702	
17	2020	5079/5076	4	4682	
18	2012.5	5061/5058	4	4672	
19	1997	5025/5023	4	4647	long build up
20	1991	5008/5007	4	4643	
21	1982	4988/4986	3½	4633	
22	1977	4972/4971	4	4622	
23	1969	4947/4945	3½	4605	

cont...

Test no	Depth (mMSL)	P-hyd(psig) before/after	Set time (mins)	P-final (psig)	Remarks
24	1870	4714/4711	3½	4485	long build up *
25	1872	4719/4715	5	4493	long build up *
26	1875.5	4724/4726	4½	4501	
27	1893	4773/4766	3	4519	
28	1895	4773/4771	3½	4520	
29	1903	4789/4787	3½	4527	decreasing perssure *
30	1910	4804/4803	3	4537	
31	1914	4817/4813	3	4537	
32	1925	4845/4841	4	4549	
33	1928.5	4851/4847	4	4555	long build up *
34	1936	4871/4865	4	4559	
35	1944	4885/4883	3	4567	
36	1956	4920/4911	4	4582	
37	1972	4956/4950	3½	4605	

* : not included in analysis

- Analysis:

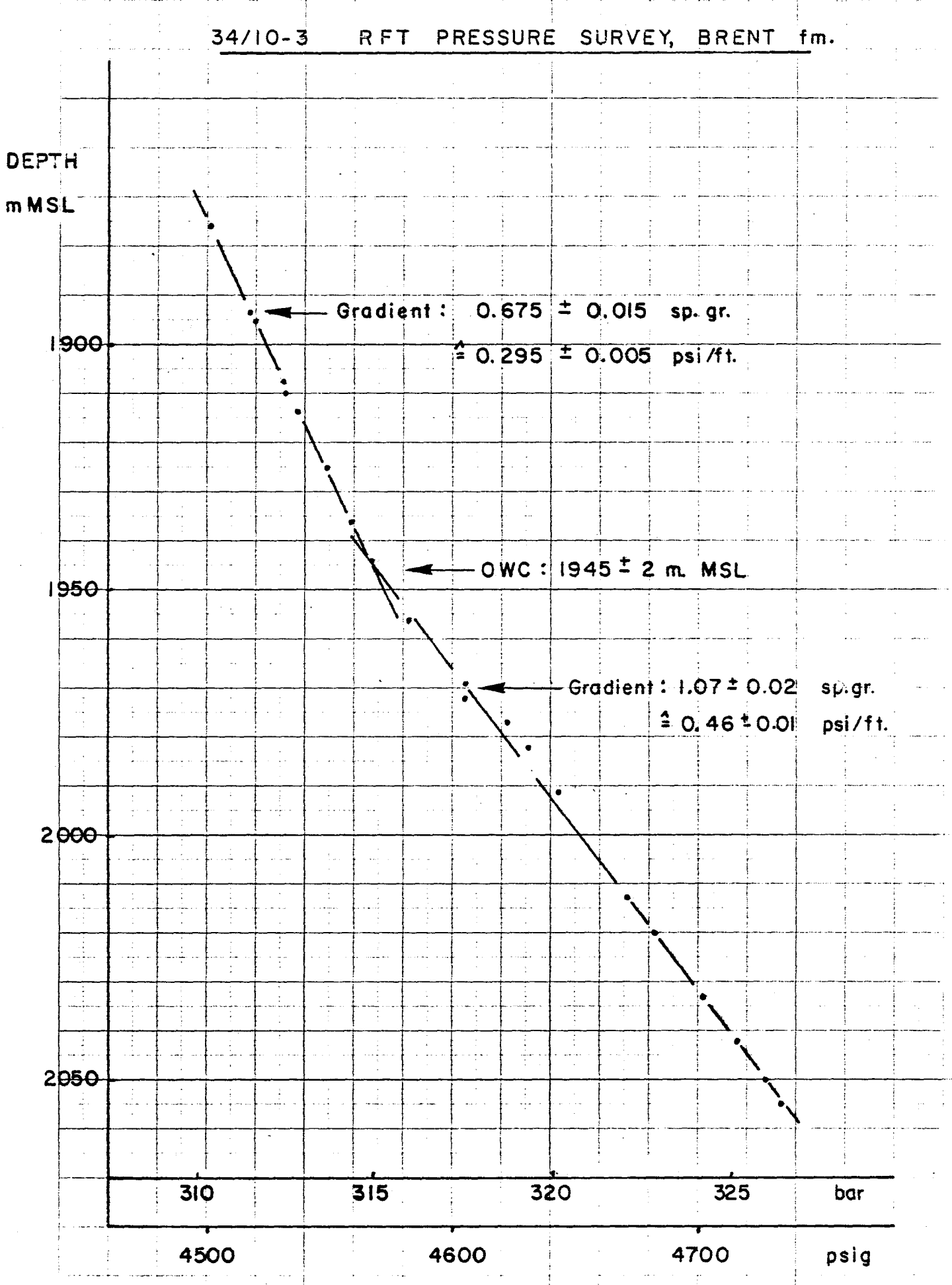
In order to control the quality of the recorded pressures, a plot of hydrostatic pressure (recorded after tool is released) vs depth was made. This plot shows a hydrostatic gradient of 1.72 in the interval from 1870-2055 mMSL and a gradient of 2.17 in the interval from 2177.5-2229 m. The mud is reported to have a density of 1.74.

A plot of reservoir pressure vs depth in the lower interval (Dunlin fm.) shows a gradient of 1.45 (pure water =1.0). These high gradients in the lower interval can not be true and it is obvious that the RFT tool was out of order in that interval. These pressure recordings are therefore not included in the analysis.

Fig. 7.2 shows reservoir pressure (RFT) plotted vs depth. The gradients are 0.68 (0.29 psi/ft) in the oil zone and 1.07 (0.46 psi/ft) in the water zone. The oil-water contact is picked at 1945 ± 2 mMSL.

Taking the RFT malfunction in the lower interval and the relative (to 34/10-1) low oil gradient into consideration, the gradients obtained are not believed to be correct.

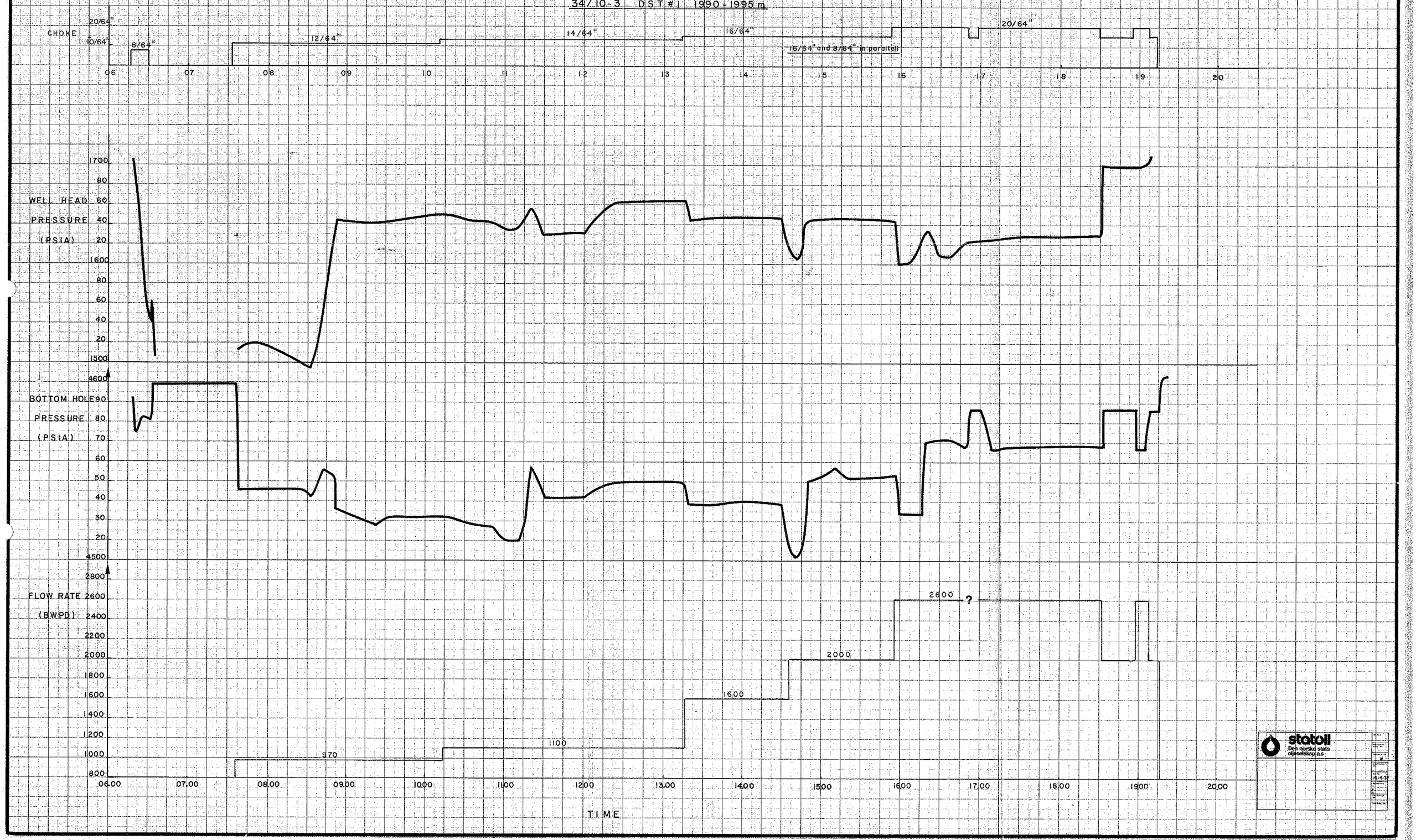
Fig. 7.1


34/10-3 RFT PRESSURE SURVEY, BRENT fm.
DEPTH
m MSL
1900
1950
2000
2050
Gradient : 0.675 ± 0.015 sp. gr.
≙ 0.295 ± 0.005 psi/ft.
OWC : 1945 ± 2 m. MSL
Gradient : 1.07 ± 0.02 sp.gr.
≙ 0.46 ± 0.01 psi/ft.
310
315
320
325
bar
4500
4600
4700
psig

8. REFERENCES

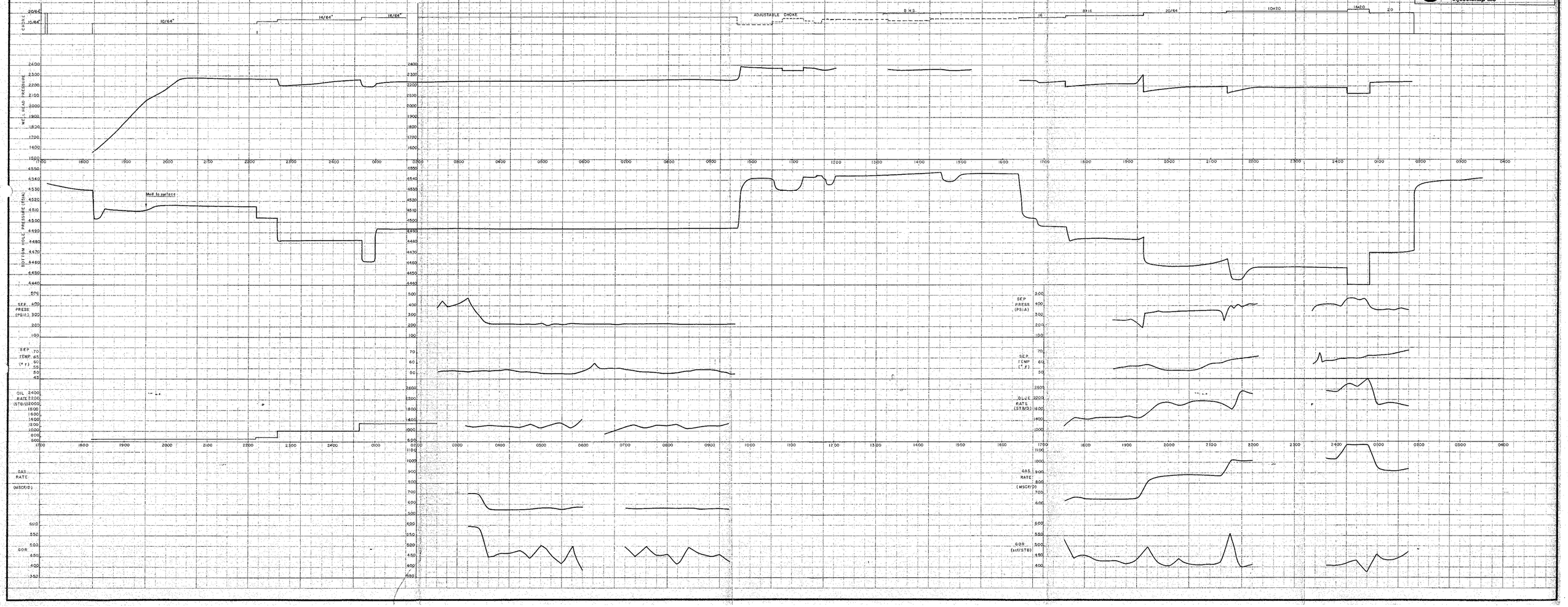
1. Odeh: Steady-State Flow Capacity of Wells with limited Entry to Flow. Trans AIME no 1 243.

34/10-3 DST #1 1990 - 1995 m



statoil
Den norske stats oljeselskap a.s

DST 2# 1935 - 40 m



34/10-3 DST#3 1895–1900

statoil
Den norske stats oljeselskap a.s

CHOKE 20/64"
10/64"

10/64" 12/64" 10/64" 8/64" 8/64"

1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 0100 0200 0300 0400

WELL HEAD PRESSURE (PSIA)
2400 2200 2000 1800 1600 1400 1200 1000

BOTTOM HOLE PRESSURE (PSIA)
4500 4400 4300 4200 4100

AVERAGE FLOW RATE (BOPD)
1000 800 600 400 200 0

1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 0100 0200 0300 0400