PL 044

D-16

Poor Quality

statoil

WELL 1/9-3

GEOLOGICAL PROGNOSIS
DRILLING PROGRAM
DRILLING CONSIDERATIONS
DATE: 7 JULY 1977

Den norske stats oljeselskap a.s

WELL 1/9-3

GEOLOGICAL PROGNOSIS
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S T A T O I L

DRILLING PROGRAM

WELL 1/9-3

NOTE: This program is designed to supplement Statoil's JACK-UP DRILLING OPERATIONS MANUAL and JACK-UP BLOWOUT PREVENTION MANUAL.

The procedures as presented in this program will be followed in cases where differences exist between this program and the abovementioned procedures.

P H I L L I P S   P E T R O L E U M   C O M P A N Y   N O R W A Y

G E O L O G I C   W E L L   P R O G N O S I S

WELL NO. 1/9-3 (Obligatory·Jurassic Test)

PROSPECT: Block 1/9 Alpha structure

GENERAL DATA

LOCATION

Country	Norway
Area	North Sea
Licence No.	044
Block No.	1/9
Coordinates:	56^{o} 24' 57,00" N
	02^{o} 54' 13,25" E

Seismic: Shotpoint No. 476 Line No. 404 - 404

5,94 Km west of east Boundary

9,51 Km south of north Boundary

285 Km southwest of Norwegian Coast

3,23 Km from N/UK Median Line

1,58 Km N of nearest well (1/9-1)

11,52 Km S-W of nearest field (Edda)

WATER DEPTH	76	Meters
AIR GAP	18.2	Meters } 16.8
K.B.E.	35	Meters
PROJECTED TOTAL DEPTH	5000	Meters

All depths are given with reference to K.B.E. unless otherwise specified

CONTRACTORS

Drilling Contractor	Dyvi Drilling Co.
Drilling Rig	"Dyvi - Gamma"
Mud Logging Contractor	Exploration Logging
Type Logging Unit	GEMDAS
Electric Logging Contractor	Dresser-Atlas
Rig Positioning Contractor	Decca
Bottom Survey Contractor	Bliksem
Helicopter Service	Helicopter Service A/S
Supply Boats	Phillips
Core Analysis	Statex or Core Lab.
Velocity Survey	
Paleontology	Robertson Research
MUD	Baroid
CEMENTING	~~Halliburton~~ BJ

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Figures

GEOLOGICAL PROGRAM
WELL NO. 1/9 - 3

PURPOSE OF TEST

Well 1/9-3 is an obligatory Jurassic test to evaluate the Jurassic structure at Alpha. The well will be drilled through the Jurassic into older formations or to 5,000 m, which-ever is shallower. It is planned to do this in a 2 stage operation. Phase 1 will drill and set 9 5/8" casing in the Lower Cretaceous. Phase 2 will drill to proposed depth of 5,000 m.

OBJECTIVES

The primary objective is to drill, evaluate and test the Jurassic sandstones if hydrocarbon shows are encountered. The secondary objective is to confirm and further evaluate the hydrocarbon bearing zones encountered in 1/9-1 in the Danian-Maastrichtian.

DRILLING HAZARDS

Swelling clays are expected from 400 m down to top of Danian. Drilling rate should be controlled to avoid mud rings and sticking problems. Increasing formation pore pressures can be expected in the lower Cretaceous shales with further increases in the Jurassic.

Bright spots found on the site survey and on the seismic could indicate high pressured gas-pockets at 547 m and 1750 m. We can expect small gas pockets throughout this interval as seen in 1/9-1. These depths are subject to a ± 50 m error.
Changes in the casing program due to pore pressure or other reasons will be at the discretion of the Drilling Superintendent with consultation and agreement from Statoil.

SURVEY AND POSITIONING

Rig will be positioned by Satnav. Rig location accuracy is requested within a 50 m radius of shot point location. Preferred direction of error is SE.

STRATIGRAPHIC PROGNOSIS

UNIT	DEPTH (Meters sub-sea)	
Upper Miocene	960	
Mid. Miocene	1140	
Lower Miocene	1710	
Oligocene	1800	
Eocene	2360	
Lower Eocene	2710	
Paleocene	2880	
Danian Marl	3020	
Danian Limestone Pay	3050	
Maastrichtian	3105	
Cenomanian	3665	
Lower Cretaceous	3745	
Jurassic	3870 (±50m)	- could be as low as 4175 m due to poor seismic correlations.

All depths are in an accuracy of ± 30 m down to the Maastrichtian. The above structural depths have been derived from seismic line 404 - 404, and results from well 1/9-1. The Cenomanian and Lower Cretaceous depths may be in error by ± 50 m. The top Triassic and top salt are believed to be below proposed TD but could be as high as 4175 m.

MAIN ZONES OF INTEREST

Danian Limestone Pay	3050 m	
Maastrichtian Chalk	3105 m	3905' KB
Jurassic Formation	3870 m	- possible as low as 4175 m.

GEOLOGICAL WELL LOGGING AND SAMPLING PROGRAM.

Mud logging Contractor: Exploration Logging. A GEMDAS Logging Unit will be employed to log the well for hydrocarbon shows, collect samples, prepare sample logs and conduct certain other services throughout drilling operations.

Samples will be collected at 10 m intervals down to 2500 m. Thereafter 3 m intervals or less will be collected. Sample interval could be changed at the discretion of the well site geologist.

At each sample point there will be six sets of washed and dried samples collected and three sets of unwashed samples (½ kg).

One composite sample of unwashed cuttings, for petrochemical studies, will be canned at 30 m intervals from the top of Lower Cretaceous (Est. 3745m) to T.D. of well.

One set of washed and dried samples will be retained on the rig until the well is finished. On the wellsite geologist's instructions the remaining samples will be sent to Statex, Stavanger, periodically during drilling. Storage and distribution to partners and N.P.D. will be handled by Statex as per instructions from Phillips.

LOGGING PROGRAM

RUN	HOLE SIZE	TYPE LOG
1.	17 1/2"	IES, Integrated Acoustic-GR.
2.	17 1/2"	IES, Integrated Acoustic-GR, CDL-GR-CAL
3.	14 3/4"	IES, Integrated Acoustic-GR, CDL-GR-CAL
4.	12 1/4"	IES, Integrated Acoustic-GR, CDL/CNL-GR-CAL, DLL/MLL, Dipmeter SWC*, Velocity Survey
5.	8 1/2"	IES, Integrated Acoustic-GR, CDL/CNL-GR-CAL, DLL/MLL, Dipmeter, SWC*, Velocity Survey

* Approximately 30 SWC total required, primarily for paleontological shale cores in L. Cretaceous and Jurassic shales. Velocity Survey will be run at 9 5/8" casing depth and T.D.

Open hole logs must be quality checked and approved by the field geologist prior to his signing of the service order.

CORING PROGRAM

A minimum of one 18 m core will be cut if sands are encountered in the Jurassic. If Jurassic sands indicate hydrocarbons, the coring will be extended throughout the pay zone. A minimum of one 18 m core will be taken in the Danian and in the Maastrichtian zones.

TESTING PROGRAM

Prior to any Drill Steam Tests/Production Tests a seperate testing program will be forwarded, but testing is planned in intervals with substantial shows.

COMMUNICATION PROCEDURE

Confidentiality:

All data are considered confidential and will be released to third parties only by decision of Statoil.

Delivery to participants:

A daily well report will be sent by telex by the operator (Statoil) to all partners and to the Norwegian Petroleum Directorate. All other wellsite data, including field prints of logs, will be sent by post or messenger.

A final well report will be prepared for distribution to Statoil, partners and to the appropriate Norwegian Government agencies no later than six months after completion of the well.

ATTACHMENTS

No 1. Seismic Profile, Line 404 - 404

No. 2 Structure Map: Top Danian and Jurassic

No. 3. Anticipated Lithology Log

DRILLING PROGRAM

Well Designation	:	1/9-3
Vessel	:	Dyvi Gamma
Air Gap	:	18.2 m
KBE to MSL	:	35m
Water Depth	:	76m
Depths	:	Referred to KBE except where specified otherwise.

I LOCATION

See Geological Program

II MOVE, PRELOADING AND JACKING UP

As per general procedures

III GEOLOGICAL PROGNOSIS

See Geological Program

IV GENERAL DRILLING

Estimated total depth Phase I : 3800 m

Estimated total depth Phase 2 : 5000 m

Operational phase for Phase 1:

Drill 44" hole with 26" x 44" H.O. to 160m. Run 36" casing.

Drill out 36" casing with 17½" bit to 445m. Log and open hole with 26" H.O. (26" underreamer in case of gas problems). Set 20" casing.

Drill 17½" hole to 1365m. Log and open with 19½" underreamer. Set 16" casing.

Drill 14 3/4" hole to 2800m. Log and open with 17½" underreamer. Set 13 3/8" casing.

Drill 12 1/4" hole to 3800 + m. (T.D. Phase 1). Core and log as programmed. The 9 5/8" casing is to be set into the pressure transition zone in the Lower Cretaceous in order to drill the Jurassic formations safely (Phase 2).

REMARKS (DRILLING CONSIDERATIONS)

The nearest off-set well is 1/9-1 which was drilled on the same structure as the proposed well 1/9-3. Mud weights used, casing depths, and formation lithology for the well 1/9-1 and the prognosis for the deliniation well 1/9-3 are shown in Fig. 1 p. 47

The formation pore pressure - and the formation integrity plot for the well 1/9-1 versus depth is shown in Fig. 2 p. 48. Since the well 1/9-3 is on the same level on the structure, the pore pressures are expected to be essentially the same. Additional informations will be gained from the well 1/9-2 before the well 1/9-3 is spudded.

When drilling out the 20" casing, the mud weight should be approx. 1.30 g/cm^3. From the seismic a possible gas zone is indicated at 557 m.

The 16" casing is to be set into the pressure transition zone in order to obtain the best possible formation integrity below the 16" casing shoe (approx. 0.20 bar/m or 2.04 g/cm^3 equiv.)

The 16" casing is to be drilled out with approx. 1.70 g/cm^3 mud weight, which is to be increased to 1.80 - 1.84 g/cm^3 at 1725m. On the seismic there is a bright spot, indicating possible gas pocket at 1760 m.

It is an absolute necessity that the yield point of the mud is kept under control to minimize the equivalent circulating density in order to avoid lost circulation.

The 13 3/8" casing point at 2800 m is may be reduced somewhat, due to lost circulation problems encounted at this depth.

The underreaming from 17½" to 19½" hole and from 14 3/4" to 17½" hole is to be done under the supervision and quidance of a trained operator.

14 ppg

The Danian and Maastrichtian formations are to be drilled with approx. 1.68 g/cm^3 mud weight, which should provide sufficent overbalance. The formation pore pressures obtained from the 1/9-1 Drill Stem Tests varied from 0.156 bar/m to 0.160 bar/m (1.59 - 1.63 sp.gr.)

A pressure transition zone starting at Cenomanian/Lower Cretaceous can be expected. In order to obtain a sufficient formation integrity for drilling the Jurassic formations, (Phase 2), the 9 5/8" casing is to be set into this transition zone. This should be safely accomplished within the allowable mud weight tolerance from 1.68 - 1.78 g/cm^3 for this section of the hole.

Hva slags

The single shot directional survey will be run every bit run below the 20" casing shoe, and every 90 m after setting the 16" casing if hole conditions permit.

Whom?

The mud is to be checked for H_2S content at intervals of 100m below the 13 3/8" casing shoe, using the H_2S Gas Train.

H_2S også gjennom mudlogger?
sjekke systemet periodisk.

V MUD PROGRAM

Interval (m)	Hole size	Mud type	Weight (g/cm^3)	PV	YP	H.T.H.P. W.C.	PH
111 - 160	44"	Sea water w/gel slugs					
160 - 445	17½",26"	Sea water, gel, CMC extra high vis.					
445 - 1350	17½",19½"	Sea water, gel, CMC/Dextrid-Drispac if required.	1.30-1.45	low	15-20		8-9
1350 - 2800	14 3/4"17½"	Lime, surfactant	1.70-1.84	low	15-20	25 or less	12
2800 - 3800	12 1/4"	Low lime surfactant	1.65-1.79	low	10-15	15 or less	10-12

Remarks:
- Rheology properties will be tested and reported at 50^{o} C.
- Maintain drill solids content at a minimum by means of the desander, desilter and mud cleaner (150 and 120 mesh screens).
- Utilize the centrifuge for viscosity control and for barite salvage.

VI HYDRAULICS/BITS

Interval (m)	Hole size	Bit type	Nozzles (32 nds)	WOB (tons)	RPM	Circ. (m^3/min)	Pump press (bars)
111 - 160	44"	H.O.		0-5	50-70		
160 - 445	17½"	DSJ	3 x 16	2.5-7.5	50-110	3.8	
160 - 445	26"	H.O.		0-7.5	110	3.8	
445 - 1365	17½"	DSJ	3 x 18	0-13	130	3.2	205
445 - 1365	19½"	Underreamer					
1365 - 2800	14 3/4"	DSJ,S4j4,OSC1GJ,WVJ	3x16 (15)	2.5-25	120-140	2. -2.	205
1365 - 2800	17½"	Underreamer					
2800 - 3800	12½"	X1G, XV, J 22	3x16 (15)	15-120	80-120	2.4-2.1	205

Remarks: Hydraulics and Drilling Parameters will be optimized on the rig according to actual mud properties and hole conditions.

Underreaming parameters will be optimized by the service company operator at the rig site.

VIII CASING

Set casing as per general procedures

Casing Program:

Size (inches)	Depth (m)	Weight (lbs/ft)	Grade	Tread
36	0 - 160	1½" wall	X-52	Vetco ALT
20	0 - 430	133	K-55	Buttress
16	0 - 1350	75	N 80	Buttress
13 3/8	0 - 2800	72	N 80	Buttress
9 5/8	0 - 2950	47	N 80	Buttress
	2950-3300	53.5 Spec Dr'ft	N 80	Buttress
	3300-3800+	47 8.50"	N 80	Buttress

Note:- 9 5/8", N 80, 53.5lb/ft with special drift 8.50".
-9 5/8", Casing is to be set into the pressure transition zone above the Jurassic formations, Depth: 3 800 m+.

IX CEMENTING

As per general procedures. See "cement Calculations" for slurry composition and slurry amounts. A cement bond log will be run to check the quality of the cement for the 16" 13 3/8" and 9 5/8" casings.

X BOP TESTING

As per general procedures

XI PRESSURE INTEGRITY TESTS

As per general procedures

13 3/8" 72 #/ft, N80; ID: 12.347"

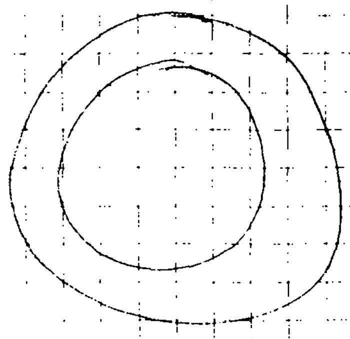
16", 75 #/ft, N80: ID: 15.124

10": Burst: 864 bars

Vekt 9 5/8: 525.000 lbs. 1.2 mill.

8.681

9 5/8



525.000
110.000
415.000

0.79

4.82

72.95
59.14
15.81

8.68

Hvor mye 9 5/8 kan belastes 13 3/8 + 16" uten buckling failure.

Sjekker:

13 3/8 csg radius gyration 4.80 in

free standing [illegible] lengde ca 330 ft

Column length: 330 × 12 = 3960"

Slenderness ratio: 3960/4.8 = 825

(2)

$$P/A = \frac{117.000}{1 + \left(\frac{1}{3400}\right)\left(\frac{L}{r}\right)^2} \qquad A$$

$$= \frac{117.000 \cdot 14.69}{1 + \left(\frac{1}{3400}\right)}$$

201.18

= 8550 lbs

16" rad of gyration 5.52

Slenderness $3960/5.52 = 717$

$$P = \frac{117.000 \cdot 21.50}{1 + \frac{1}{3400}(717^2)} = 16527$$

152.2

Value [illegible] [illegible] [illegible] = 15416 lbs

6.69	134.73		8.0	200.96
				179.46
6.17	119.54	14.69	7.56	21.50
0.52			0.44	

XIII ABNORMAL PRESSURE DETECTION

The most effective abnormal pressure detection operation will be the result of team effort involving the Drilling Supervisor, Drilling Engineer, Wellsite Geologist, and Mud Logging Engineer. Pressure indicators will be monitored continuously and any deviation investigated immediately. The reliability of each abnormal pressure indicator will have to be established during the course of operation.

A Mud Logging Unit will be utilized below the 30 inch casing shoe to collect and monitor abnormal pressure parameters. This unit will be programmed to record and plot the following parameters relating to abnormal pressure:

a) On a depth scale:
1. Drillability
2. ROP
3. "d" exponent

b) On a time scale
1. Rotary torque
2. Mud temperature in
3. Mud temperature out
4. Lagged differential temperature
5. Mud flow in
6. Mud flow out
7. Mud weight in
8. Mud weight out
9. Pit volume
10. Pit volume total change
11. Mud gas

In addition, below the 20" casing shoe, manual plots will be recorded and reviewed continuously by the Drilling Engineer and Drilling Supervisor. These plots will include ROP, "d"-exp., Gas Units, and Shale Density.

Abnormal pressure detection data will be forwarded into the Stavanger Operations Office twice daily on a routine basis and more frequently if drilling a suspect transition zone. Any change in abnormal pressure detection parameters will be immediately reported by the rig to the Stavanger Operations Office.

XIV PRODUCTION TESTS

As per production test manual. A detailed testing program will be issued prior to each production test.

XV PLUG AND ABANDONMENT

As per general procedures.

Approved:

Expl. Manager Statoil	Drilling and Production Manager

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CALCULATIONS

KICK CONTROL

20" Casing: The normal procedure of not shutting in the well will be used.

16" Casing: Setting depth: 1350 m. Formation integrity: equiv. 0.20 bar/m. From Fig. 4 p. 50 it can be seen that a 1106 m column of gas (equiv. volume 10.3m^3) is the maximum that can be circulated out at the 16" casing shoe if the required mud weight increase is 0.05 g/cm^3, (1.84+0.05) g/cm^3.

13 3/8" Casing: Setting depth: 2800 m. Formation integrity: equiv. 0.185 bar/m. From Fig.4 p.50 it can be seen that a 78m column of gas (equiv. volume: 5m^3) is the maximum that can be circulated out at the 13 3/8" casing shoe if the required mud weight increase is 0.05 g/cm^3, (1.78+0.05) g/cm^3.

Note: The pore pressure in the Danian/Maastrichtion pays is known to be 0.157 - 0.160 bars/m. The only place kick could possibly occure with a 1.78 g/cm^3 mud weight is in the transition zone above Jurassic.

9 5/8" Casing: Setting depth: 3800 +m. Formation integrity: 0.210 bar/m. From Fig. 4p.50 it can be seen that a 170 m column of gas (equiv. volume: 4.1 m^3) is the maximum that can be circulated out at the 9 5/8" casing shoe if the required mud weight increase is 0.05 g/cm^3, (2.00 + 0.5) g/cm^3.

Note: The control wells 2/7-1, 2/7-9 and 2/8-3 all drilled Jurassic with mud weights less or equal to 2.00 sp. gravity. There is no reason to believe that a higher mud weight than 2.00 sp. gravity should be necessary for this well.

CASING CALCULATIONS

Co	=	Collapse load (bars)
Co'	=	Collapse load at top of fluid column (0') (bars)
Co"	=	Collapse load at seat while cementing (bars)
Gf	=	Fracture gradient (bars/m)
G gas	=	Gas gravity gradient (bars/m)
Gi	=	Mud gradient at casing setting depth (bars/m)
G'i	=	Maximum mud gradient below casing shoe (bars/m)
Gp	=	Normal pore pressure gradient (burst) = 0.1 bars/m
G'p	=	Normal pore pressure gradient (collapse) (bars/m)
G"p	=	Actual pore pressure gradient (bars/m)
Mc	=	Casing mass-gradient (coupled) (kg/m)
Pbs	=	Burst load at seat (bars)
Pbw	=	Burst load at well-head (bars)
RESb	=	Burst resistance (bars)
RESc	=	Collapse resistance (bars)
RESt	=	Tension resistance (10^3 daN)
S.F.b.	=	Safety factor, burst = 1.10
S.F.c.	=	Safety factor, collapse = 1.25 (1.30 for 13 3/8" CSG)
S.F.t.	=	Safety factor, tension = 1.50
T	=	Tension (10^3 daN)
T%	=	Longitudinal tension stress % of YSm
To'	=	Tensile stress at 0' (N/mm^2)
Wd	=	Well depth (m)
X	=	Casing seat depth (m)
Y	=	Depth (m) to top of fluid column if mud is lost to å formation at the bit
YSm	=	Min. yield strength (n/mm^2)

16" CASING

Wd	=	2800
Wd*	=	2100m (max pore pressure gradient)
X	=	1350m
Gp	=	0.10 bar/m (sea water)
G"p,2100	=	0.177 bar/m (1.80 sp.gr.)
Gi	=	0.140 bar/m (1.43 sp.gr.)
G'i	=	0.181 bar/m (1.84 sp.gr.)
Gf	=	0.204 bar/m (2.08 sp.gr.)

BURST

A design kick of 15 m^3 volume necessitating 0.10 sp.gr. mud weight increase is assumed at Wd. Maximum casing burst pressure is equal to the internal pressure at the mud/gas interface when circulating out the kick, less the hydrostatic pressure of sea water (back-up).

Select N80, 75 lbs/ft casing which has the following properties:

RES_c	=	70 bars
RES_b	=	264 bars
RES_t	=	$762 \cdot 10^3$ daN
Mc	=	110.39 kg/m

Annular Capacity 14 3/4" hole-5" DP: <u>98 l/m</u>

Height of kick: (H_k):

$$Hk = \frac{15\ m^3}{0.098\ m^3/m} = \underline{153\ m}$$

BHP after kick: $Pp = (G'i + 0.01) \cdot Wd^*$

$= (0.18 + 0.01) \cdot 2100$

$= \underline{401 \text{ bars}}$

Determination of internal casing pressure while circulating out the kick using equations from the BOP-manual.

1. $Pg + (Wd^* - Hg) \cdot G'i = Pp$

2. $$\frac{Pp \cdot V_1}{T_1 \cdot Z_1} = \frac{Pg \cdot Vg}{T_2 \cdot Z_2}$$

where

P_g = pressure of gas bubble at surface (bars)

H_g = height of gas bubble at surface (m)

V_g = Volume of gas bubble at surface (m^3)

V_1 = Volume of influx = $15m^3$

T_1 = Bottom hole temp: 72^oC (345^oK)

T_2 = Surface temp. : 25^oC (298^oK9

Z_1 = Gas compr. factor at bottom: 1.06

Z_2 = Gas compr. factor at surface: 0.83

Equation 2:

$$\frac{401 \cdot 15}{345 \cdot 1.06} = \frac{P_g \cdot V_g}{298 \cdot 0.83}$$

where $V_g = H_g \cdot 0.098$

$$H_g = \frac{401 \cdot 15 \cdot 298 \cdot 0.83}{345 \cdot 1.06 \cdot P_g \cdot 0.098}$$

$$= \underline{\frac{41513}{P_g}}$$

Substitute for H_g in equation 1

$$P_g + (2100 - \frac{41513}{P_g}) \cdot 0.18 = 401$$

$$P_g^2 - 20.9\, P_g - 7514 = 0$$

$P_g \simeq 98$ bars

$$H_g = \frac{41513}{98} = 424 \text{ m}$$

From graphical solution P_b max = 173 bars at 1350 m

$$SFb = \frac{RESb}{Pb}$$

$$= \frac{264}{173} = 1.52 \ (>1.10)$$

Collapse

Maximum collapse load:

$$C_o = X \cdot (G_i - G_p)$$
$$= 1350 \ (0.140 - 0.10)$$
$$= 54 \text{ bars}$$

$$SF_c = \frac{RES_c}{C_o}$$

$$= \frac{70}{54} = 1.30 \quad (\geq 1.30)$$

Tension

$$T = M_c \cdot X \cdot \frac{0.98}{1000}$$

$$= 110.39 \cdot 1350 \cdot \frac{0.98}{1000}$$

$$= 146.2 \cdot 10^3 \text{ daN}$$

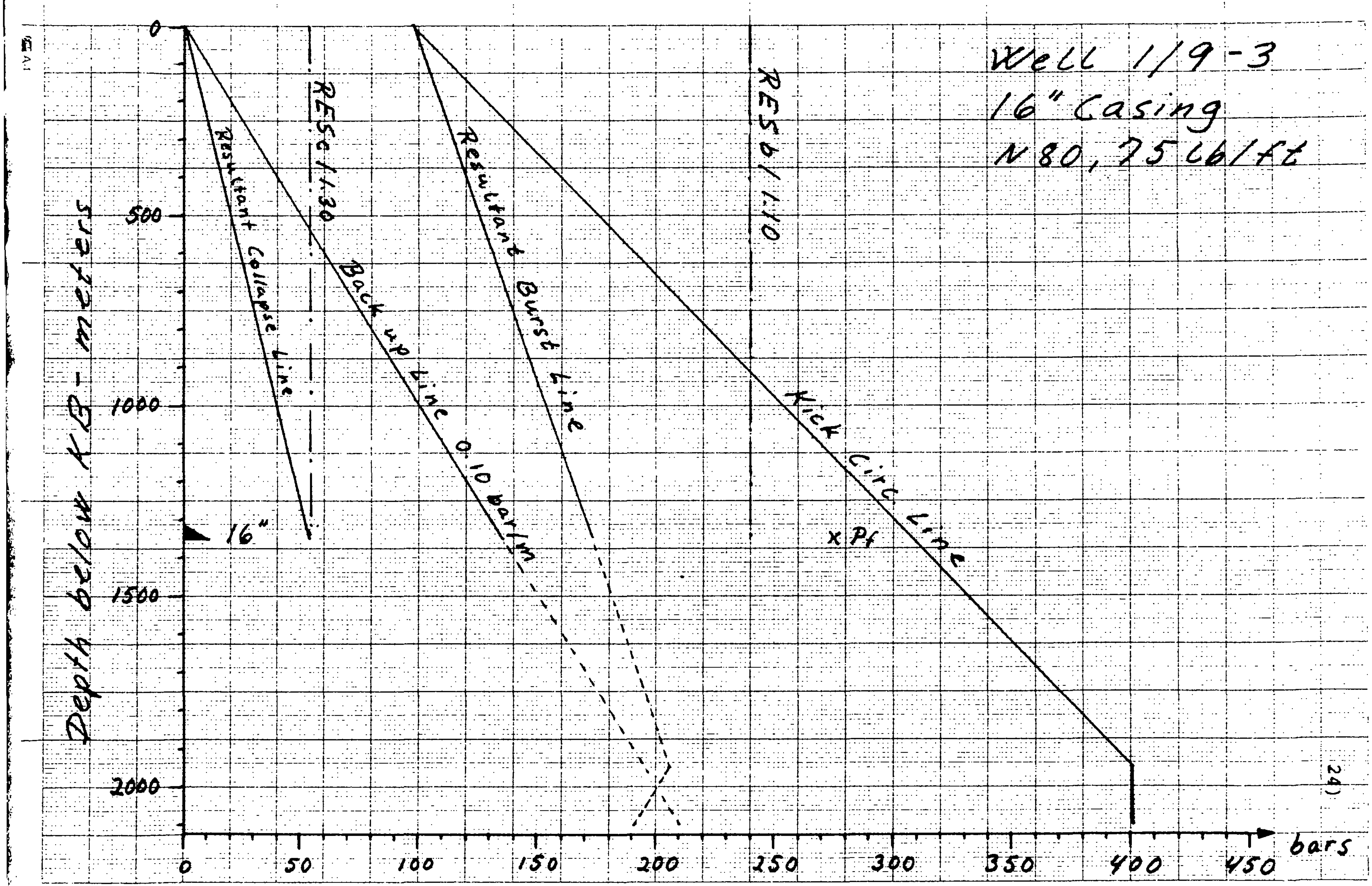
$$SF_t = \frac{RESt}{T}$$

$$= \frac{762 \cdot 10^3}{146.2 \cdot 10^3}$$

$$= 5.2 \ (>1.50)$$

Result:

The selected casing N80, 75lb/ft full fills all requirements.


Well 1/9-3
16" Casing
N80, 75 lb/ft
RESb/1.10
RESc/1.30
Resultant Collapse Line
Back up Line 0.10 bar/m
Resultant Burst Line
Kick Circ Line
x Pf
16"
Depth below KB - metres
0
500
1000
1500
2000
0
50
100
150
200
250
300
350
400
450
bars

13 3/8" CASING

W_d = 3800 m
X = 2800 m
G_p = 0.10 bar/m (sea water)
G''_p Danian = 0.157 bar/m (1.60 sp.gr.)
G gas Danian = 0.027 bar/m ($\bar{p}$ = 440 bar, γ = 0.70, $\bar{T}$ = 80° C)
G_i = 0.180 bar/m (1.83 sp.gr.)
G'_i = 0.175 bar/m (1.78 sp.gr.)
G_f = 0.185 bar/m (1.88 sp.gr.)

Burst

A design kick of 15m^3 volume necessitating a 0.10 sp. gr. mud weight increase is assumed at Wd. Maximum casing burst pressure is equal to the internal pressure at the mud/gas interface when circulating out the kick, less the hydrostatic pressure of sea water (back-up).

Select N80, 72 lb/ft Buttress casing which has the following properties:

RES_c = 184 bars
RES_b = 371 bars
RES_t = $738 \cdot 10^3$ daN
M_c = 107.42 kg/m

Annular capasity 12½" hole-5"DP: 63.4 l/m

$$\text{Height of kick: } H_k = \frac{15 m^3}{0.0634\ m^3/m} = \underline{237\ m}$$

$$\text{BHP after kick: } P_p = (G'_i + 0.01) \cdot Wd = (0.175 + 0.01) \cdot 3800 = \underline{703\ bars}$$

Determination of internal casing pressure while circulating out the kick using equations from the BOP-manual.

1. $P_g + (W_d - H_g) \cdot G'_i = P_p$

2. $\frac{P_p \cdot V_1}{T_1 \cdot Z_1} = \frac{P_g \cdot V_g}{T_2 \cdot Z_2}$

where P_g = pressure of gas bubble at surface (bars)
H_g = height of gas bubble at surface (m)
V_g = volume of gas bubble at surface (m^3)
V_1 = volume of influx ($15m^3$)
T_1 = Bottom hole temp: 130^o C (403^o K)
T_2 = Surface temp.: 45^o C (318^oK)
Z_1 = Gas compr. factor at bottom: 0.80
Z_2 = Gas compr. factor at surface: 1.44

Equation 2:

$$\frac{712 \cdot 15}{403 \cdot 1.44} = \frac{P_g \cdot V_g}{318 \cdot 0.80}$$

where $V_g = H_g \cdot 0.0634$

$$H_g = \frac{712 \cdot 15 \cdot 318 \cdot 0.80}{403 \cdot 1.44 \cdot P_g \cdot 0.0634}$$

$$= \frac{73847}{P_g}$$

Substitute for H_g in equation 1.

$$P_g + (3800 - \frac{73847}{P_g}) \cdot 0.175 = 703$$

$$P_g^2 - 38P_g - 12923 = 0$$

$\underline{P_g \simeq 134 \text{ bars}}$

$$H_g = \frac{73847}{134} = \underline{551 \text{ m}}$$

From graphical solution P_b max = 303 bars at 2800 m

$$SF_b = \frac{RES_b}{P_b}$$

$$= \frac{371}{303} = \underline{1.22\ (> 1.10)}$$

Collapse

Top of fluid column if circulation is lost to a formation with pore pressure equal to the Danian reservoir pressure gradient.

$$y = W_d - \frac{W_d \cdot G''_p \text{ Danian}}{G'_i}$$

$$y = 3800 - \frac{3800 \cdot 0.157}{0.175}$$

$$\underline{= 391 \text{ m}}$$

The collapse load at 391 m

$$C_{o'} = G_i \cdot y$$

$$= 0.180 \cdot 391$$

$$\underline{= 70.4 \text{ bars}}$$

Tension in casing at depth O' (casing set in 1.83 sp.gr. mud)

$$T_{o'} = M_c \cdot (X-y) \cdot \frac{0.98}{1000} \cdot 0.77$$

$$= 107.42\ (2800 - 391) \cdot \frac{0.98}{1000} \cdot 0.77$$

$$\underline{= 195 \cdot 10^3 \text{ daN}}$$

$$T\% = \frac{T_o'}{RES_t}$$

$$= \frac{195}{738} = 26\%$$

Biaxial stress curve gives collapse reduction by 17% i.e.

$$RES_c = 171 \cdot 0.83$$

$$= \underline{142 \text{ bars}}$$

$$SF_c = \frac{RES_c}{C_o'}$$

$$= \frac{142}{70.4} \quad \underline{= 2.01 \ (>1.25)}$$

Tension

Weight of casing in air:

$$T = M_c \cdot X \cdot \frac{0.98}{1000}$$

$$= 107.42 \cdot 2800 \cdot \frac{0.98}{1000}$$

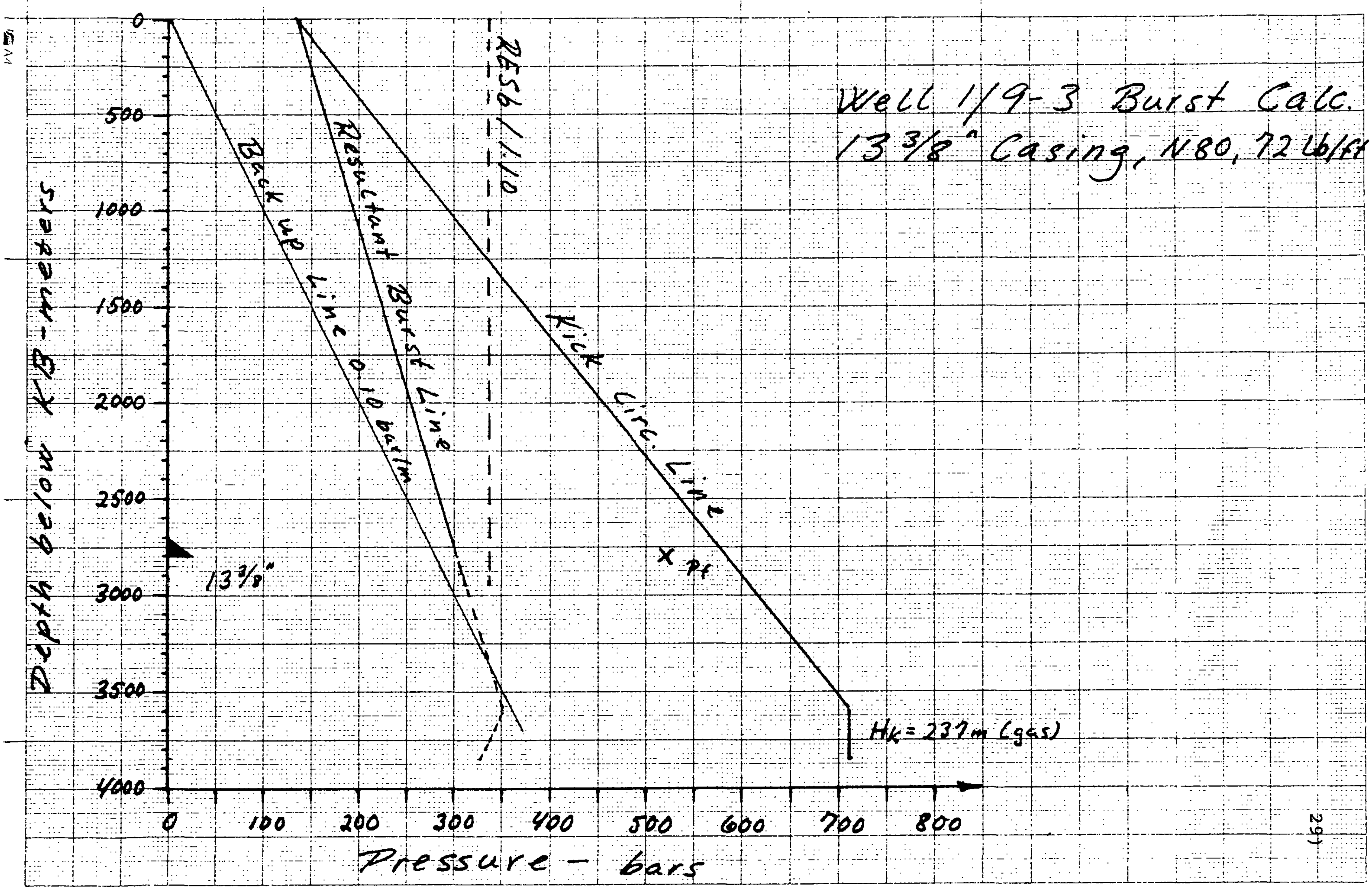
$$\underline{= 295 \cdot 10^3 \text{ daN}}$$

$$SF_t = \frac{RES_t}{T}$$

$$= \frac{738 \cdot 10^3}{295 \cdot 10^3}$$

$$\underline{= 2.50 \ (>1.50)}$$

The selected 13 3/8" N80, 72 lb/ft casing fullfils all requirements.


Well 1/9-3 Burst Calc.
13 3/8" Casing, N80, 72 lb/ft
RESb/1.10
Kick Circ. Line
Resultant Burst Line
Back up Line 0.10 bar/m
X Pf
13 3/8"
Hk = 237m (gas)
0
500
1000
1500
2000
2500
3000
3500
4000
Depth below KB - meters
0
100
200
300
400
500
600
700
800
Pressure - bars

9 5/8" CASING

Wd = 3 800 m and 5 000 m

X = 3 800 m

Gp = 0.10 bar/m (sea water)

G" p Danian = o.157 bar/m (1.60 sp.gr.)

G gas Danian = 0.027 bar/m ($\bar{p}$ = 440 bars, γ = 0.70, $\bar{T}$ = 80^{o}C

G_i = 0.175 bar/m (1.78 sp.gr.)

G_i = 0.196 bar/m (2.00 sp.gr.)

G_f, 3 800 = 0.210 bar/m (2.14 sp.gr.)

G"p, Jurassic = 0.190 bar/m (1.94 sp.gr.)

The 9 5/8 casing calulations are done for two cases:

a) Production casing for Danian/Maastrichtian.

b) Intermediate casing for drilling the Jurassic formations.

a) Production casing for the Danian/Maastrichtian pays

Select the following 9 5/8" production casing: 0 - 2 950 m, N 80 47 lb/ft, 2 950 - 3 300 m, N 80, 53.5 lb/ft, 3 300 - 3 800 m, N 80 47 lb/ft, all Buttress.

9 5/8" casing properties:

	N 80, 47 lb/ft	N 80 53.5 lb/ft
RESc, bars	328	456
RESb' bars	474	547
RESt, 10^3 daN	482	552
Mc, kg/m	69.89	79.74

Burst

The casing is designed to withstand the static wellhead burst pressure over the entire length, i.e.

Pbw = (G"p, Danian - Ggas, Danian)·X Danian

= (0.157 - 0.027) ·3070 = 399 bars

Safety against burst (N 80, 47 lb/ft):

$$SFb = \frac{RESb}{Pbw} = \frac{474}{399} = 1.19 \ (> 1.10)$$

<u>Collapse</u>

The part of the casing above a production packer is designed to withstand the hydrostatic difference between mud and sea water.

$$Co, 2\ 950\ m = (G_i - G_p) \cdot X, (N\ 80,\ 47\ lb/ft)$$
$$= (0.175 - 0.01) \cdot 2\ 950 = \underline{221\ bars}$$

$$SFc = \frac{RESc}{Co,\ 2\ 950} = \frac{328}{221} = 1.48 \ (> 1.25)$$

The part of the casing between a production packer and the plug back depth (2 950 - 3 300 m is designed for a minimum allowable flowing pressure for N 80, 53.5 lb/ft casing).

$$Pwf,\ min = Pmud - \frac{RESc}{SFc} =$$
$$0.175 \cdot 3\ 300 - \frac{456}{1.25} =$$
<u>213 bars which is equivalent to 275 bars drawdown at 3 200 m</u>

<u>Tension</u>

$$T = Mc \cdot X \cdot \frac{0.981}{1\ 000}$$

$$= 69.89 \cdot (2950 - 0) + (3\ 800 - 3\ 300) \cdot \frac{0.981}{1\ 000}$$

$$+ 79.74\ (3\ 300 - 2\ 950) \cdot \frac{0.981}{1\ 000}$$

$$= 236.5 + 27.4$$

$$\underline{= 264 \cdot 10^3\ daN}$$

$$SFt = \frac{RESt}{T}\ (N\ 80,\ 47\ lb/ft)$$

$$= \frac{482 \cdot 10^3}{264 \cdot 10^3}$$
$$\underline{= 1.38\ (> 1.50)}$$

The proposed 9 5/8" production casing:

0 - 2 950 m, N 80, 47 lb/ft Buttress
2 950 - 3 300 m, N 80, 53.5 lb/ft, Buttress
3 300 - 3 800 m, N 80, 47 lb/ft, Buttress
fullfills all requirements.

b) Intermediate casing for drilling the Jurassic formations

Burst

A design kick of 15 m^3 volume necessitating a 0.10 sp.gr. mud weight increase is assumed at T.D. Maximum casing burst pressure is equal to the internal pressure at the mud/gas interface when cirdulating out the kick less the hydrostatic pressure of the mud the casing was set in. (in this case the danian pore pressure gradient 0.157 bar/m or 1.60 sp.gr. is used)

Annular capacity 8.5" hole - 5" DP: 24 l/m

Height of kick: $H_K = \frac{15\ m^3}{0.024\ m^3/m} = \underline{625\ m}$

BHP after kick: $Pp = (G'_i + 0.01) \cdot Wd$

$= (0.196 + 0.01) \cdot 5\ 000$

$\underline{= 1\ 030\ bars}$

Determination of internal casing pressure while circulating out the kick using equations from the BOP Mannual:

1. $Pg + (WD - Hg) \cdot G'i = Pp$

2. $\frac{Pp \cdot V_1}{T_1 \cdot Z_1} = \frac{Pg \cdot Vg}{T_2 \cdot Z_2}$

Where Pg = pressure of gas bubble at surface, bars
Hg = heigh of gas bubble at surface, m
Vg = volume of gas bubble at surface, m^3
Pp = pressure of gas bubble at bottom, 1020 bars
V_1 = volume of influc , 15 m^3
T_1 = bottom hole temperature, 170°C, (443°K)
T_2 = surface temperature, 50°C, (323°K)
Z_1 = gas compr. factor at bottom, 1.55
Z_2 = " surface, 0.85

Equation 2: $\frac{1\ 030 \cdot 15}{443 \cdot 1.55} = \frac{Pg \cdot Vg}{323 \cdot 0.85}$

where $Vg = Hg \cdot 0.024$

$Hg = \frac{1\ 030 \cdot 15 \cdot 323 \cdot 085}{443 \cdot 1.55 \cdot Pg \cdot 0.024}$

$\underline{= \frac{257397}{Pg}}$

Substitute for Hg in equation 1:

$$Pg + (5\ 000 - \frac{257397}{Pg})\cdot 0.196 = 1\ 030$$

$$Pg^2 - 50\ Pg - 50\ 450 = 0$$

$$\underline{Pg = 251 \text{ bars}}$$

$$Hg = \frac{257393}{Pg} = \frac{257397}{251} = \underline{1\ 025 \text{ m}}$$

From graphical solution, p.

Pb max = 310 bars at 3 800 m

$$SFb = \frac{RESb}{Pbmax} \quad (N\ 80,\ 47\ lb/ft)$$

$$= \frac{474}{310}$$

$$\underline{= 1.53\ (> 1.10)}$$

Collapse

See collapse calculations for production casing p. 31 which is stricter than for an intermediate casing.

Tension

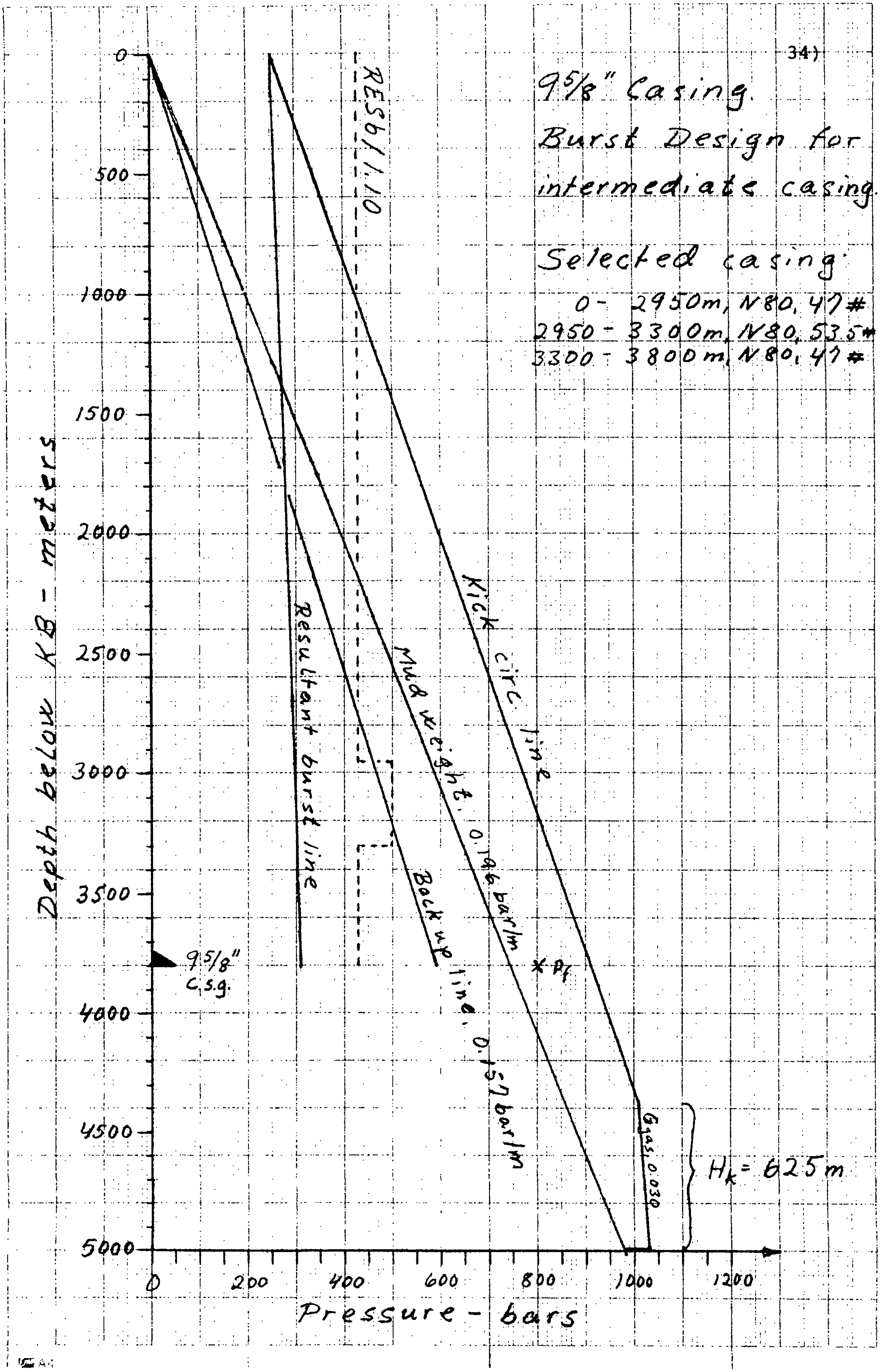
See calculations for production casing p. 31 which are the same af for an intermediate casing.

Result

The prososed 9 5/8" casing:

0 - 2950 m, N 80, 47 lb/ft, Buttress
2950 - 3300 m, N 80, 53.5 lb/ft, Buttress
3300 - 3800 m, N 80, 47 lb/ft, Buttress

Full fills all requirements for Danian/Maastrichtian production casing and for an intermediate casing for drilling the Jurassic formations to T.D. (5000 m).


9 5/8" Casing.
Burst Design for intermediate casing.
Selected casing:
0 - 2950m, N80, 47#
2950 - 3300m, N80, 53.5#
3300 - 3800m, N80, 47#
RES61/1.10
Kick circ. line
Mud weight. 0.196 bar/m
Back up line. 0.157 bar/m
Resultant burst line
Gas, 0.030
H_k = 625m
9 5/8" csg.
Depth below KB - meters
Pressure - bars
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
200
400
600
800
1000
1200

36" CASING CEMENT CALCULATIONS

The cement volume is calculated on the basis of theoretical hole volume, the casing beeing cemented to the surface with 150% excess volume.
The ratio between dry-mixed and prehydrated gel is taken to be 4:1 when using fresh water for hydrating.

Data

Depth KB- Seabed	:	111m
Depth KB- 36" shoe	:	160 m
Hole size	:	44"
Annulus capasity 44" hole - 36" csg:		324 l/m
Mud weight	:	1.09 g/cm^3
BHST	:	10^{o}C

Cement data using sea water

	Class G+8% equiv.gel+2%$CaCl_2$	Class G +3% $CaCl_2$
mix water, l/100 kg, (gal/sx)	88 (10.0)	44 (5.0)
Slurry weight, g/cm^3(ppg)	1.58 (13.2)	1.92 (16.0)
Slurry yield, l/100kg (ft^3/sx)	120 (1.82)	77 (1.16)
Thickening time, hrs	4+	3+
8 hr compr. strength, bars (psi)	-	17 (250)
24 hr. " " " bars (psi)	7 (100)	28 (450)

Note: For prehydrating Wyoming bentonite, 50% of the total mixing water volume of fresh water is needed to hydrate the bentonite. Once hydrated, the other 50% of the water to be added can be sea water. Add the Calcium Chloride to the total volume after hydrating the bentonite.

Volume calculations

Annular volume: 0.324 $m^3/m \cdot (160-111)m = 15.88m^3$

Shoe joint volume	0
Total	$15.88m^3$

Volume + 150% excess: $39.7\ m^3$

Use:

Preflush: $3m^3$ sea water

Lead: Class G +8% equiv. gel+2% $CaCl_2$: 25000 kg (586sx). equal to $30.0m^3$ slurry.

Tail in: Class G +3% $CaCl_2$: 13000 kg (305 sx) equal to $10.0m^3$ slurry.

20" CASING CEMENT CALCULATIONS

The cement volume is calculated on the basis of theoretical annulus volume, the casing beeing cemented to the mudline with 1 0% excess volume. The ratio between dry mixed and prehydrated gel is taken to be 4:1. The bentonite is pre-hydrated in fresh water and sea water is added as required.

DATA

Depth KB - sea bed	:	111 m
Depth KB - 36" shoe	:	160 m
Depth KB - 20" shoe	:	430 m
Annulus capacity 36"-20"	:	349 l/m
Annulus capacity 26"-20"	:	140 l/m
Internal capacity 20",133 lb/ft	:	178 l/m
Mud weight	:	1.09 g/cm^3
Formation intergrity at 20" shoe	:	0.150 bar/m
BHST	:	27^{o}C

Cement data using sea water.

	Class G+8% equiv.gel+ 2% $CaCl_2$	Class G+ 1% $CaCl_2$
Mix water, l/100 kg (gal/sx)	88 (10.0)	44 (5.0)
Slurry weight, g/cm^3 (ppg)	1.58 (13.2)	1.92 (16.0)
Slurry yield, l/100 kg (ft^3/sx)	120 (1.82)	77 (1.16)
Thickening time, hr.: min	3:00+	3:10
8hr compr. strength, bars (psi)	-	30 (450)
24 hr compr.strength, bars (psi)	20 (450)	100 (1500)

Volume calculations

Open hole : 0.140 m^3/m · (430-160)	= 37. 8 m^3
Open hole excess: 150%	= 56. 7 m^3
Cased annulus: 0.349 m^3/m (160-111)	= 17. 1 m^3
12m shoe joint vol: 0.178m^3/· 12	= 2. 1 m^3
Total slurry volume	= 113. 7 m^3

Use:

Preflush: 3 m^3 (20 bbl) mud flush

Lead : Class G+8% equiv. gel+ 2% $CaCl_2$:
80 000 kg (1833 sx) equal to 96m^3 slurry.

Tail in : Class G+ 1% $CaCl_2$: 22000 kg (516 sx)
equal to 15.94m^3 slurry.

Displacement: 0.178m^3/m · (430-12)m = 74.4 m^3

Pressure gradient at the 20" shoe

Pressure of tail in: $0.189\ \text{bar/m} \cdot \frac{(17.0-2.1)\,m^3}{0.140\,m^3/m}$ = 20.0 bars

Pressure of lead: 0.155 bar/m (430-106) = 50.2 bars

Pressure at 20" shoe = 70.2 bars

Pressure gradient: 70.2 bars/430m = 0.163 bar/m

Estimated formation integrity 0.150 bar/m

Note: There is a possibility to loose cement to the formation.

16" CASING CEMENT CALCULATIONS

The cement volume is calculated on the basis of theoretical annulus volume, the casing beeing cemented 100 m into the 20" casing shoe with 50% excess for the open hole section. The ratio dry-mixed/ prehydrated gel is 4:1.

Data

Depth KB - sea bed	:	111 m
Depth KB - 20" shoe	:	430 m
Depth KB - 16" shoe	:	1350 m
Annulus capacity 20" csg-16" csg.	:	48 l/m
Annulus capacity 19½" hole-16" csg.	:	63 l/m
Internal capacity 16" csg.	:	116 l/m
Mud weight:	:	1.40 g/cm^3
Formation integrity 16" shoe	:	0.20 bar/m
BHST	:	45°C

Cement data using fresh water for the gel cement and sea water for the neat cement.

	Class G + 8% equiv. gel+ 0.5% CFR-2	Class G+1% CFR-2 + 0.1 % HR-7
mix water , l/100 kg (gal/sx)	88 (10.0) fresh	44 (5.0) sea
Slurry weight, g/cm^3 (ppg)	1.58 (13.2)	1.89 (15.8)
Slurry yield, l/100 kg (ft^3/sx)	120 (1.82)	76 (1.15)
Thickening time (hr:min)	5:00	4:00
16 hr. comp. strength 45°C, bars (psi)	-	100 (1500)
24 " " " " " " "	35 (500)	170 (2500)

Volume calculations

Open hole: 0.063m^3/m · (1350-430)m	=	58.0 m^3
Open hole excess 50%	=	29.0 m^3
Cased hole annulus: 0.048m^3/m·100m	=	4.8 m^3
24 m shoe joint: 0.116m^3 · 24 m	=	2.8 m^3
Total slurry volume	=	94.6 m^3

Use:

Preflush: 1.5 m^3 sea water.

Lead: Class G +8% equiv. gel+ 0.5% CFR-2 : 65000 kg
(1525sx) equal to 78.0 m^3 slurry

Tail in: Class G + 1% CFR2 + 0.1% HR7: 22000 kg
(516 sx) equal to 16.7m^3 slurry

Displacement: 0.116 m^3/m (1350-12) m = 155.2m^3

Pressure gradient at the 16" shoe.

Pressure of tail in: $0.186\ \text{bar/m} \cdot \frac{(16.7-2.8)\,m^3}{0.063\ m^3/m}$ = 41.1 bars

Pressure lead: $0.155\ \text{bar/m} \cdot (1350-221)\,m$ = 175.0

Pressure at 16" shoe 216.1 bars

Pressure gradient at 16" shoe: 216.1 bar/1350m
= 0.150 bar/m

Estimated formation integrity: 0.20 bar/m

13 3/8" CASING CEMENT CALCULATIONS

The casing is to be cemented in two stages, 2800 - 1450 m and 1450 - 850 m. The cement volumes are calculated on the basis of theoretical annulus volume with 25% excess.

Data

Depth KB - sea bed	:	111 m
Depth KB - 16" shoe	:	1350 m 1345
Depth KB - DV-tool	:	1450 m
Depth KB - 13 3/8" Shoe	:	2800 m
Annulus capacity : 17½" hole - 13 3/8" csg.	:	64.5 l/m
Annulus capacity: 16" csg. - 13 3/8" csg.	:	25.2 l/m
Internal capacity 13 3/8" csg		77.2 l/m
Mud weight:	:	1.84 g/cm^3
BHST:	:	110^{o}C

Cement data

	Class G+0.7% CFR-2 +0.1% HR-7	Class G+0.7% CFR-2 +0.2% HR-7
Mix water, fresh, l/100 kg (gal/sx)	44 (5.0)	44 (5.0)
Slurry weight, g/cm^3 (ppg)	1.89 (15.8)	1.89 (15.8)
Slurry yield, l/100kg (ft^3/sx)	76 (1.15)	76 (1.15)
Thickening time, hr: min	4:00+	4:00+
12 hrs compr. strength, bars (psi)	70(1000),45^{o}C	240(3500), 110^{o}C
24 hrs compr. strength, bars (psi)	150 (2200),45^{o}C	255 (3700), 110^{o}C

radio telex from dyvi gamma / lfqx 3.10.77

to: telex no 33349 statoil base, stavanger

attn. ed diamond and paul gautreaux

re: 13-3/8'' cementing job.

we have rewiewed the coming cmt.-job, and have the following comments:

1: would like to have a telex stating what prosentages of additives should be used on each stage.

2: also need the new thickening times stated. suppose fresh water only being used for this job.

3: first stage seems to be rather unrealistic in volume.
   a: mixing time for 3300 sx of cmt will be at least 1,5 hrs.
   b: displacing this stage at 8 bbl/min will take about 3 hrs. we consider this pumping rate being close to maximum.
   c: conclusion: need at least 4,5 hrs to do this job if everything works fine.
   d: we do not recomment pumping top of cement up to d.v. tool, as this may create problems with the latter.

suggestions:

first stage: bring cmt 500 m above shoe of 13-3/8'' csg. no additional cmt.

second stage: use calculated volume to bring cmt 500 m above 16'' csg shoe. no excess cmt to be added.

re: balling of drillpipe and drillcollars.

due to excessive balling on the drillstring which may create problems for the underreaming, we would like to try to reduce this by adding a chemical to the mud.

suggest: magcobar: lub-coat, 4 ppb.
this is a graphite product.

regards

pillow/kjeldstad

1/9-3 . DYVI GAMMA.

Cementing program 13 3/8" casing.

Addition to drilling program.

VOLUME REQUIREMENTS.

First stage 2750 - 2250 m

Assume 18" hole (based on caliper from 14 3/4" hole)

Open hole: 0.07 m^3/m × (2750 - 2250)	= 34.2 m^3
Open hole excess 25%	= 8.6 "
24 m shoe joint: 0.0792 m^3/m × 24	= 1.9 "
Total slurry volume stage one:	44.7 m^3

Total dry cement requirement: 60000 kg (1390 sx)

Second stage 1450 - 250 m

Open hole: 0.07 m^3/m × (1450 - 1345)	= 7.3 m^3
Washout: 0.16 m^3/m × 15 m	= 2.3 "
Cased annulus: 0.0252 × (1345 - 245)	= 27.7 "
Excess cement: 0%	0.0 "
Total slurry volume stage two:	= 37.3 m^3

Total dry cement requirements: 50 000 kg (1155 sx)

CHEMICALS:

First stage: 0.7% CFR-2
% HR 7

Second stage: 0.7% CFR-2
% HR 7

Note! With red. CFR 2 add defoamer NF1 to mix water at a concentration of 2 pints NF1 / 10 bbls mix water.

Arne W. Christensen

0.2 HEC 0.5 HEC

5.8 gals/sack fresh water

15.8 ppg

Yld 1.16 ft³

5.5 hrs in turb rate

2.3+ thickening time

.4 HEC. Thick 5.38 in.

24 hrs .5 HEC 23° 4200 psi
115° 500

.4 HEC

2nd stage 2% CP 0.6 HEC.

5.7 gals/sack

OH. 38 in. no retarder; 5 hrs 2 in.

24 H: 100° 2875 psi | OH 80 in
| 5 H 20 in

DWC 5/10-77.

1/9-3. DYVI GAMMA.

CEMENTING PROGRAM 13 3/8" CASING.

8/10 - 87

<u>16-3 DYNI GAMMA</u>

<u>Cementing 13 3/8" csg.</u>

<u>Volumes from caliper.</u>

1st stage . 2750 - 2250 m

2750 - 2700 :	16"
2700 - 2650 :	15.5"
2650 - 2600 :	15.75"
2600 - 2550 :	15.75"
2550 - 2500 :	15.75"
2500 - 2450 :	15.5"
2450 - 2400 :	16"
2400 - 2350 :	16"
2350 - 2300 :	16.5"
2300 - 2250 :	17.5
	<u>Average : 16"</u>

2nd stage (open hole)

1450 - 1400 :	17"
1400 - 1365 :	17"
1365 - 1345 :	Assume 30" Factor 4.0.

Volume requirements. (2)

1. stage

2350 - 2250

Assume 18" hole

Open hole. $0.0645 \left(\frac{18}{12.5}\right)^2 x(2350-2250)$ = 34.2 m^3
Open hole excess 25% = 8.6 "
24 m shoe joint: 0.0782 m^3/m x24 = 1.9 "
Total slurry volume stage one: = 44.7 m^3

2. stage
Open hole: $0.0645 \left(\frac{18}{12.5}\right)^2 \times 100$ = 6.8 m^3
Cased annulus: 0.0252 · (1345 - 245) = 27.7
Excess cement: 0% = 0
Total slurry volume stage two: = 34 m^3

Use:

First stage: ~~Preflush weighted spacer, 1.87 g/cm³~~
Cement quantity: ~~weight~~: 60 000 kg (1390 sxs)

Class G + 0.7% CFR-2 + % HR7.

Second stage
Cement quantity ~~weight~~: 45000 kg (1070 sxs)

Class G + 0.7% CFR-2 + % HR7

AWC. 3/10 - 77

CEMENTING 13 3/8" csg, 1/9 - 3 Dyn Gamma.

1. Stage

Open hole: 0.0645 m³/m · 500	=	32.25 m³
Open hole excess, 25 %	-	8.06 "
24 m shoe joint: 0.0722 m³/m · 24	=	1,9 "
Total slurry for stage one:	=	42.2 m³
	=	258 BBLs

2. Stage

As before:		23,85 m³
	=	145 BBLs

USE:

1. stage: 56000 kg

(1302 sks equal to 42.2 m³)

2. stage: As before.

Defoamer NF1 w/ red CFR 2 : 2 pints/10bbls mix water.

1522 - 34

1574 - 79 Grasslamme Slight possibility.

1620 - 85 Grasslamme

1666 - 74 Grasslamme.

[illegible] - 40

1980 - 84

2176 - 82

2352 - 56

2402 - 10

3580 - 32

2323 - 27

2680 - 83

3227 - 40

2343 - 51

Dr. Miller. Rep.
Dem.

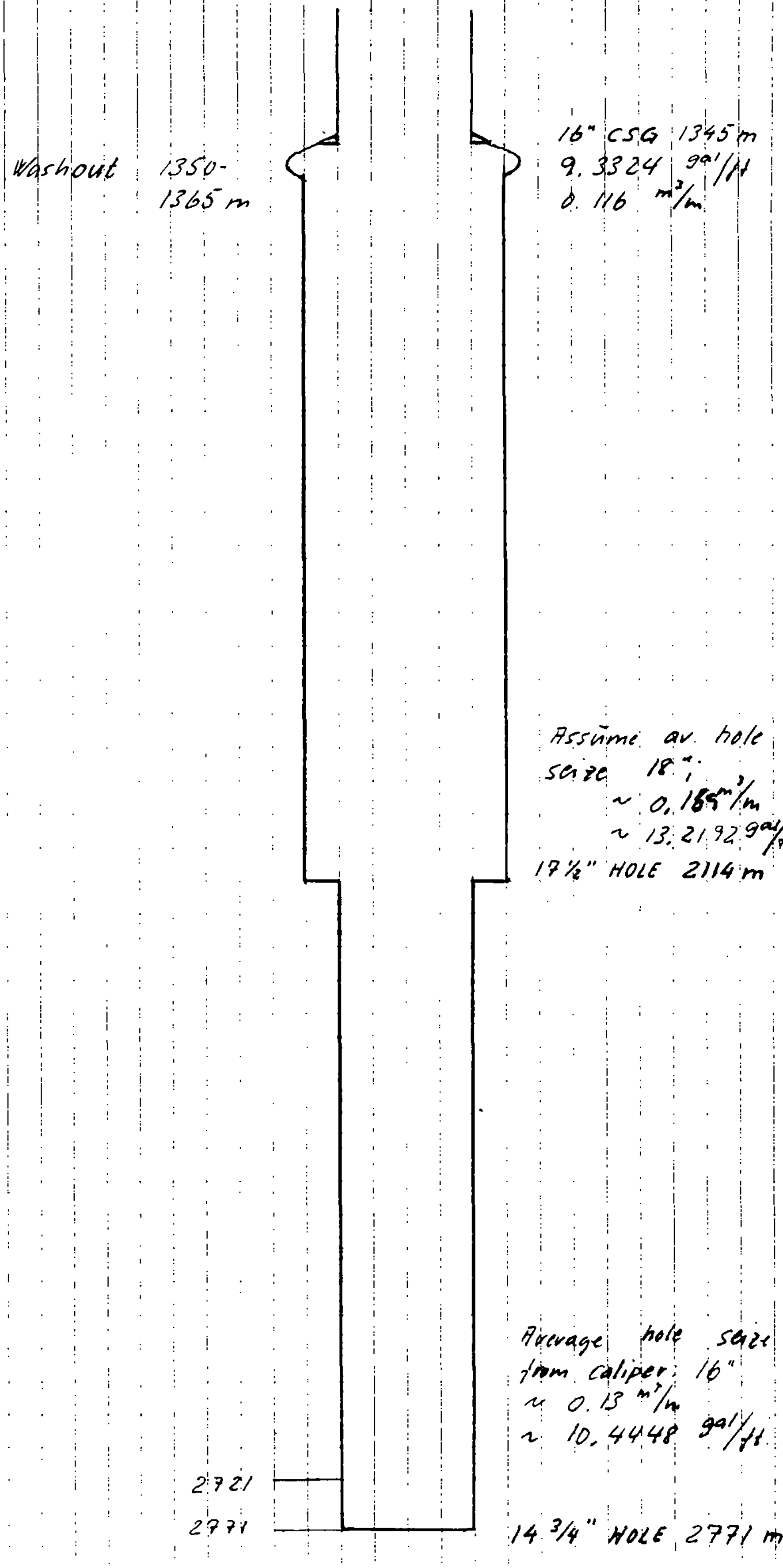
[illegible] [illegible] [illegible]
[illegible] [illegible] candidate.

Depth m

1610 - 1665	PROBABLE PERM SD → SDISH Logs clear. Lith. clear.	Max. 280 Units.
1755 - 1770	SD or LIMESTONE POSSIBLE PERMEABILITY Logs not clear, but indication.	Max. 470 units
1775 ± 2½	SD described on lith description.	
1810	POSSIBLE PERM No indications on logs ~~or lith~~. LS - streaks from lith.	Max. 665 units
1950	PROBABLE PERM. No indications on logs ~~or lith~~. Only claystone	Max 280 units.
1990	PROBABLE No SD indications on logs ~~or lith~~. Silty, slight calcareous shale.	Max. 980 units.
2100	PROBABLE Indications of SD on logs (caliper / gamma ray) Nothing on lith.	Max 500 units.
2220 - 2300	SOME SD. Shaly PROBABLE	Max 200 units.
2870	POSSIBLE ? SOME LIMEST from Lith. ?	Max 200 "
? 2400 - 2410	Limestone, silt, ?	
2590	Limest. Insig. gas.	
2625		Max 180 "
2775 35	PROBABLE LS / SD / from logs Gamma ray + density	

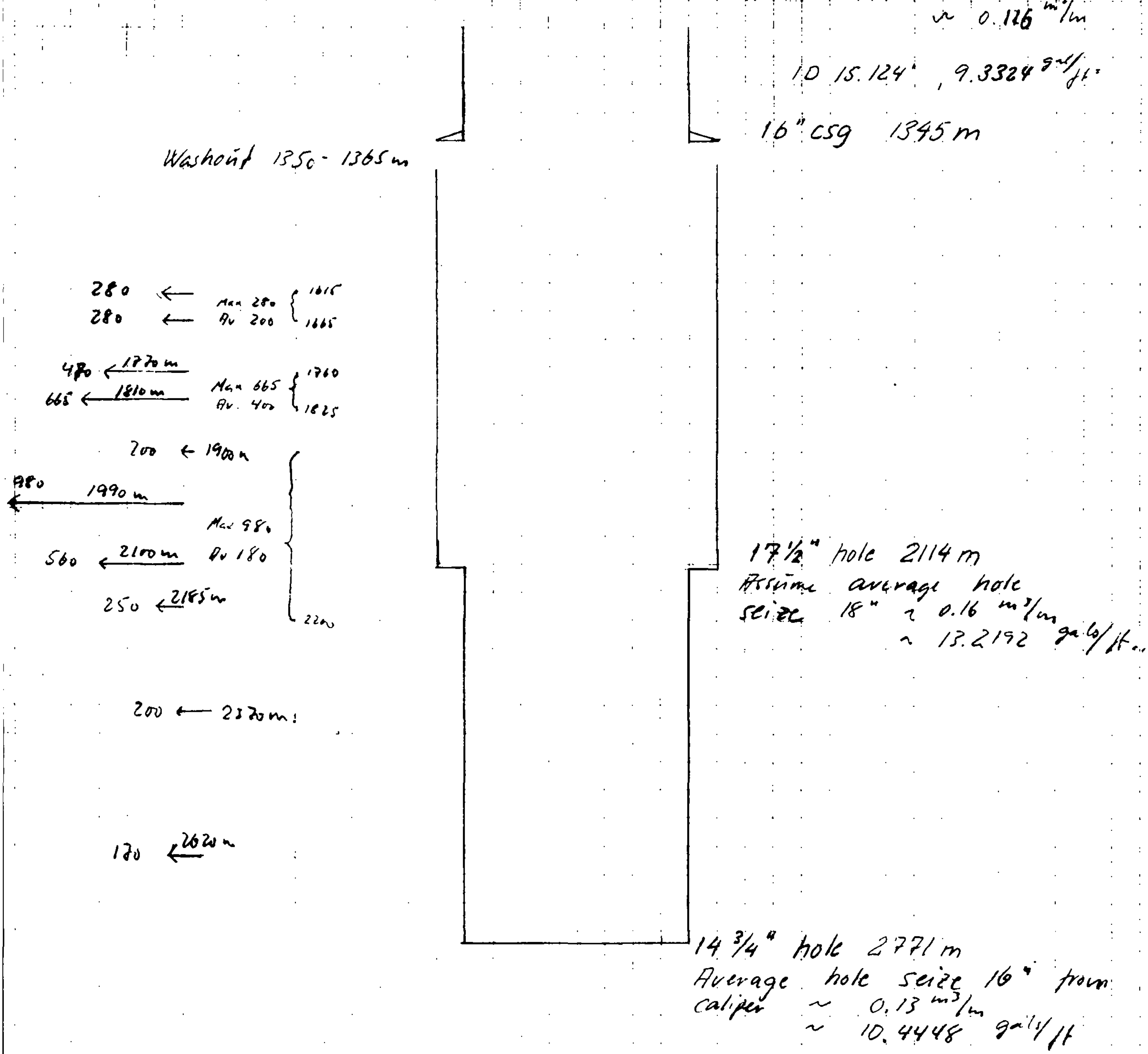
AWC. 10/10-77

1/9-3. TEMPORARY ABANDONMENT. OPEN HOLE PLUGS.



AWC 11.10.77.

1/9-3. TEMPORARY ABANDONEMENT. OPEN HOLE PLUGS.



Volume calculations:

1. stage

Open hole: 0.0645 $m^3/m \cdot (2800-1450)m$	=	87.1 m^3
Open hole excess, 25%	=	21.8 m^3
24 m shoe joint: 0.0772 $m^3/m \cdot 24m$	=	1.9 m^3
Total slurry for stage one:		110.8 m^3

2. stage

Open hole: 0.0645 $m^3/m \cdot (1450-1350)m$	=	6.45 m^3
Cased annulus: 0.0252 $m^3/m \cdot 500$ m	=	12.6 m^3
Excess cement: 25% $\cdot$ (6.45+12.6)	=	4.8 m^3
Total slurry for stage two:	=	23.85 m^3

Use:

First stage

Preflush: 3.0 m^3 weighted spacer, 1.87 g/cm^3

Cement: Class G+ 0.7% CFR-2 + 0.2% HR7: 146000 kg
(3425 sx) equal to 111 m^3 slurry

Turbulent rate: 0.65 m^3/min (4bbls/min)
Displacement: 0.0772 m^3/m (2800-24)m = 214.3 m^3

Second stage

Preflush: 1.5 m^3 weighted spacer, 1.87 g/cm^3
Cement: Class g+ 0.7% CFR-2 + 0.1% HR-7:
32000 kg (750 sx) equal to 24.2 m^3 slurry.

Turbulent rate: 0.65 m^3/min (4 bbls/min)

Displacement: $0.0772\ m^3/m \cdot 1450\ m = 112\ m^3$

Estimated formation integrity for the open hole section:0.20 bar/m which is greater than 0.186 bar/m cement gradient.

9 5/8" CASING CEMENT CALCULATIONS

The casing is to be cemented 500 m above the 13 3/8" casing shoe. The cement volume is calculated on the basis of theoretical annulus volume with 20% excess.

Data

Depth KB - 13 3/8" shoe	:	2 800 m
Depth KB - 9 5/8" shoe	:	3 800 m
Annulus capacity 12 1/4" hole - 9 5/8" csg	:	29.1 l/m
" " 13 3/8" csg - 9 5/8" csg	:	30.3 "
Internal capacity 9 5/8" csg. 47 lb/ft	:	38.2 "
" " 9 5/8" csg. 53.5 lb/ft	:	36.9 "
Mud weight	:	1.68 - 1.78 g/cm^3
BHST	:	135°C

Cement data

Class G + 35% SSA - 1
+ 0.7% CFR-2, + 0.5% Halad 9
+ 0.1% HR 12

Mix water, fresh, l /100kg (gal/sx):	46	(5.2)
Slurry weight, g/cm^3 (ppg):	1.90	(15.86)
Slurry yield, l/lookg (ft^3/sx):	102	(1.53)
Fluid loss, cm^3/30 min:	120-150	
Thickening time, hr: min:	4:30+	
12 hr compr. strength at 135°C, bars (PSI):	225	(3250)

Volume calculations

Open hole:	0.0291 m^3/m (3800-2800)m	=	29.1 m^3
Cased annulus:	0.0303 m^3/m · 500 m	=	15.2 "
20% excess:	(29.1 + 15.2) · 0.20	=	8.9 "
24 m shoe joint:	0.0382 m^3/m · 24	=	0.9 "
Total slurry volume		=	54.1 m^3

Use:

Preflush: 3.0 m^3 weighted spacer, 1.80 g/cm^3

Cement: <u>Class G + 35% SSA - 1 + 0.7% CFR - 2 + 0.5% Halad 9 + 0.1% HR 12:</u>
53 000 kg (1243 sx) equal to 54.1 m^3 slurry

Turbulent rate: 1.1 m^3/min. (7 bbls/min)

Formation pressure integrity

The critical interval is Paleocene, approx. 100 m below the 13 3/8" casing shoe. Pressure while cementing at this point:

Pressure of mud:	0.175 bar/m · 2300 m	= 403 bars
Pressure of cement:	0.187 bar/m · 600 m	= 112 "
Pressure at 2900 m:		515 bars

Pressure gradient:	515 bars/2900 m	= 0.178 bar/m
Estimated formation integrity:		0.185 bar/m

NOTE

The following additives from Halliburton are used:

CFR - 2	:	Friction reducer/water loss control additive
HR - 7	:	Cement retarder
HR - 12	:	Cement retarder
Halad - 12	:	Water loss control additive
SSA - 1	:	Silica Flour

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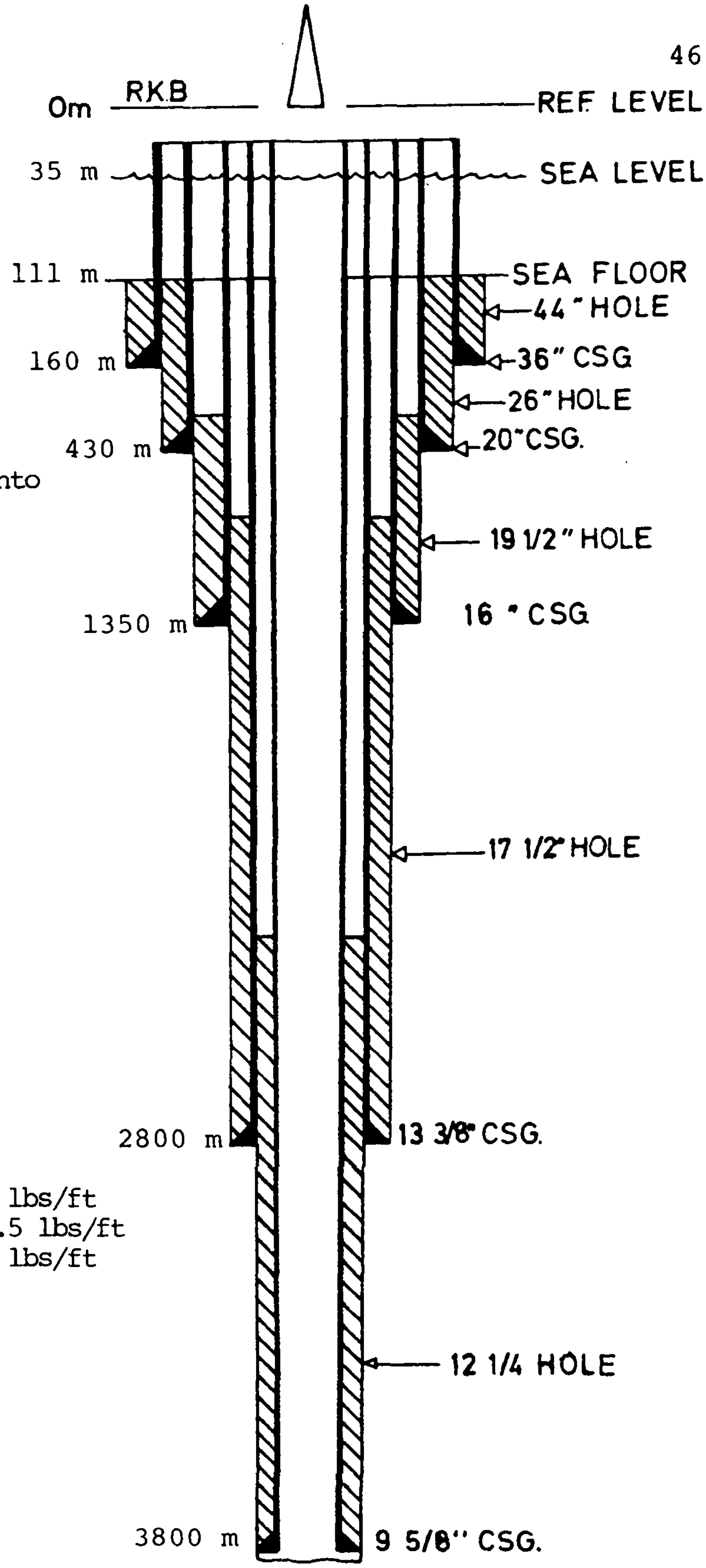
WELL NO. 1/9-3 PHASE I

NOT TO SCALE



36" grade B, 1½" thickness. Cement to sea floor + 150%

20", K-55, 133 lbs/ft. Cement to sea floor + 150%

16" N 80, 75 lbs/ft. Cement 100 m into 20" shoe + 50%

13 3/8", N 80, 72 lbs/ft
Cement 2 stages: 2800 - 1450 m
and 1450 - 850 m
Excess: 25%

9 5/8", N 80: 0 - 2950 m: 47 lbs/ft
2950 - 3300 m: 53.5 lbs/ft
3300 - 3800 m: 47 lbs/ft
Cement 500 m into 13 3/8" shoe + 20%

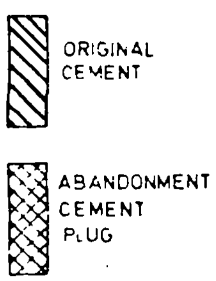


Fig. 1 Comparison between 1/9-1 and 1/9-3

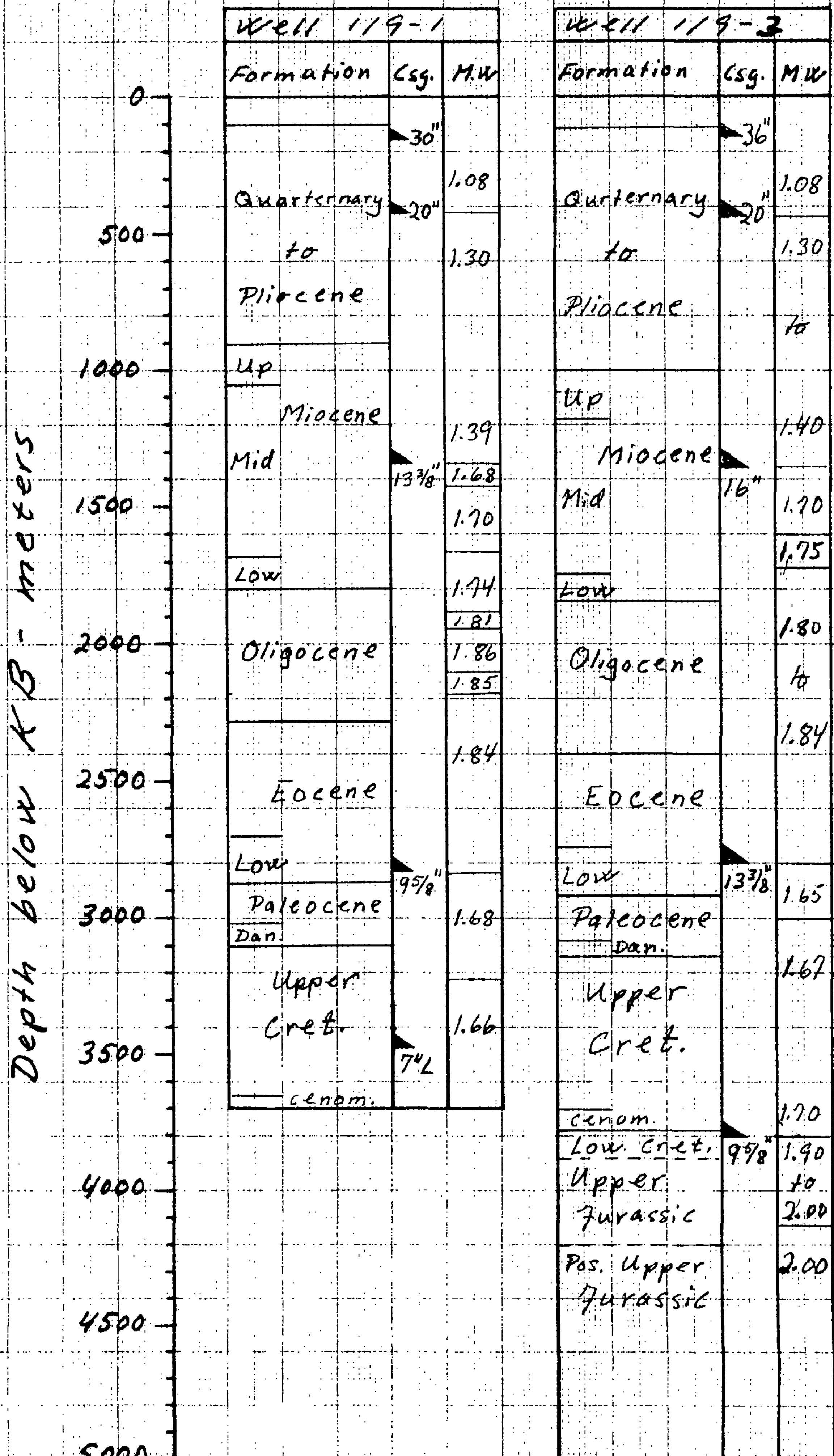
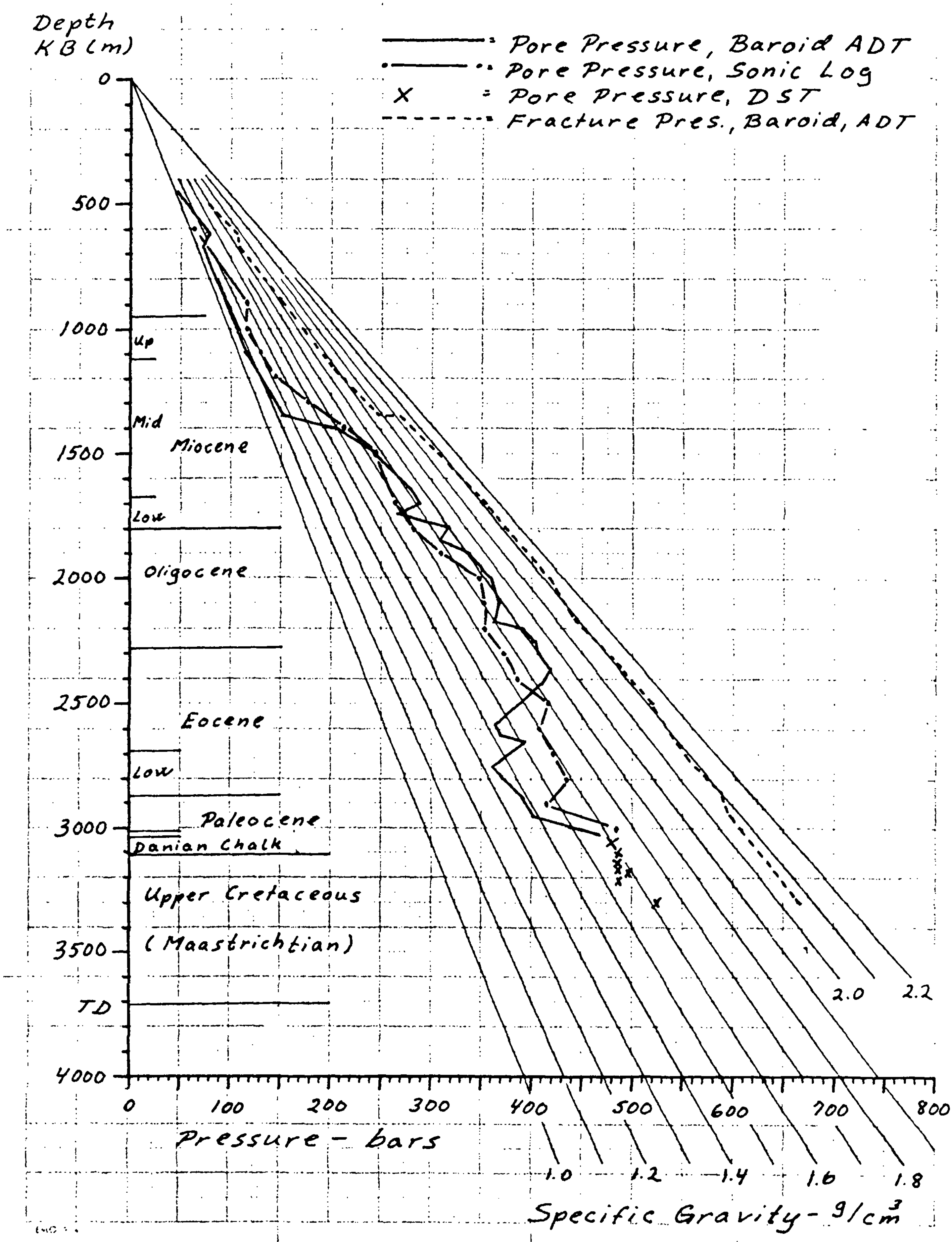


Fig. 2. Well 1/9-1 Formation Pore Pressure and Fracture Pressure Evaluation.



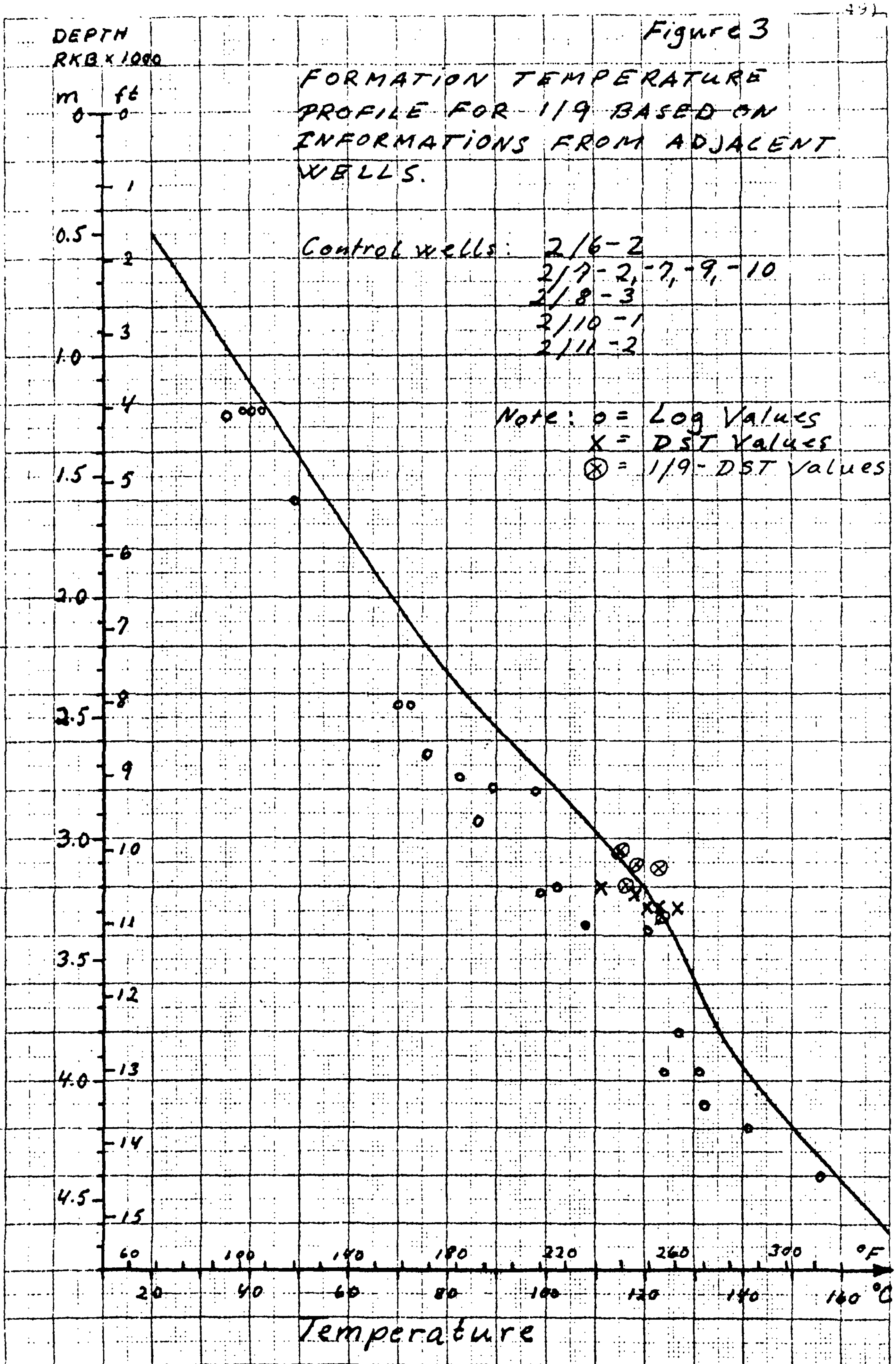
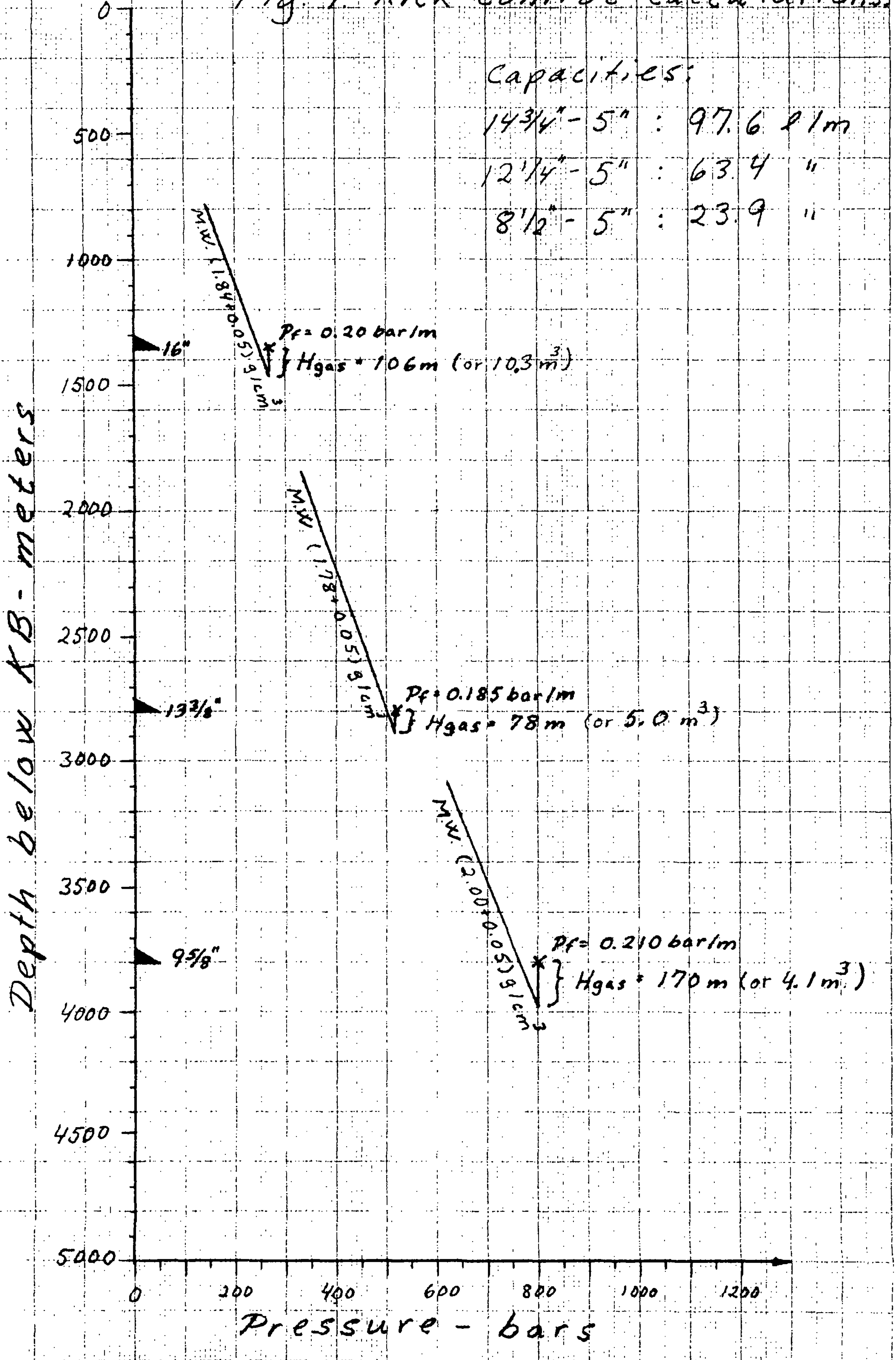
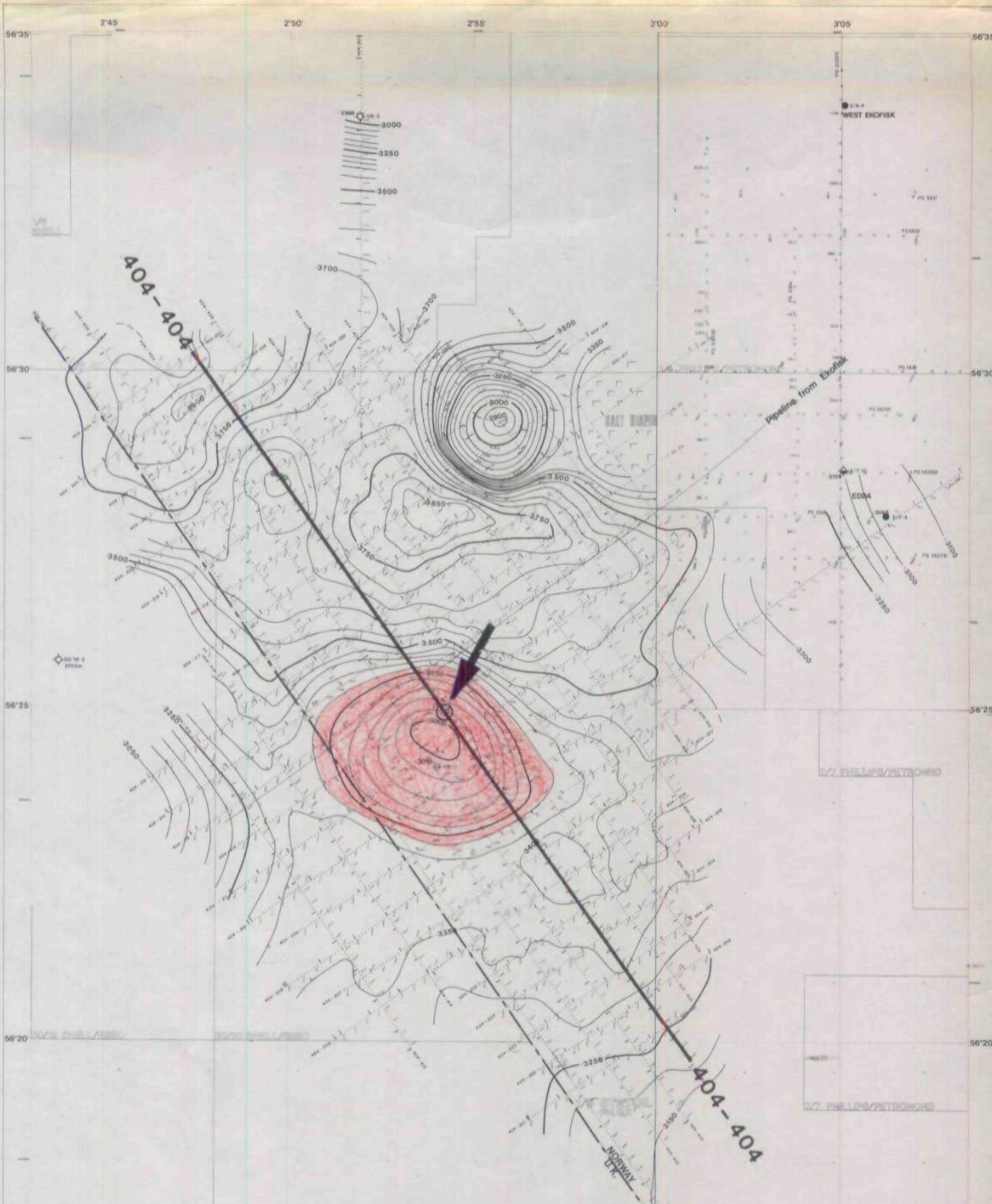


Figure 3

FORMATION TEMPERATURE PROFILE FOR 1/9 BASED ON INFORMATIONS FROM ADJACENT WELLS.

Fig. 4. Kick Control Calculations.





WELL	1/6-2	2/7-4	1/9-1
DEPTH (MSL)	-2988m	-3066m	-3019m
Va (TRUE)	2017m/s	2035m/s	1987m/s
T (TRUE)	2.962s	3.013s	3.039sec
T (SEISMIC)	2.982s	3.033s	3.066sec
V (SEISMIC)	2004m/s	2022m/s	1989m/sec
LAG	0.020s	0.020sec	0.027sec

0 1 3 5 Km

1:

INDEKS KART 1:1000000

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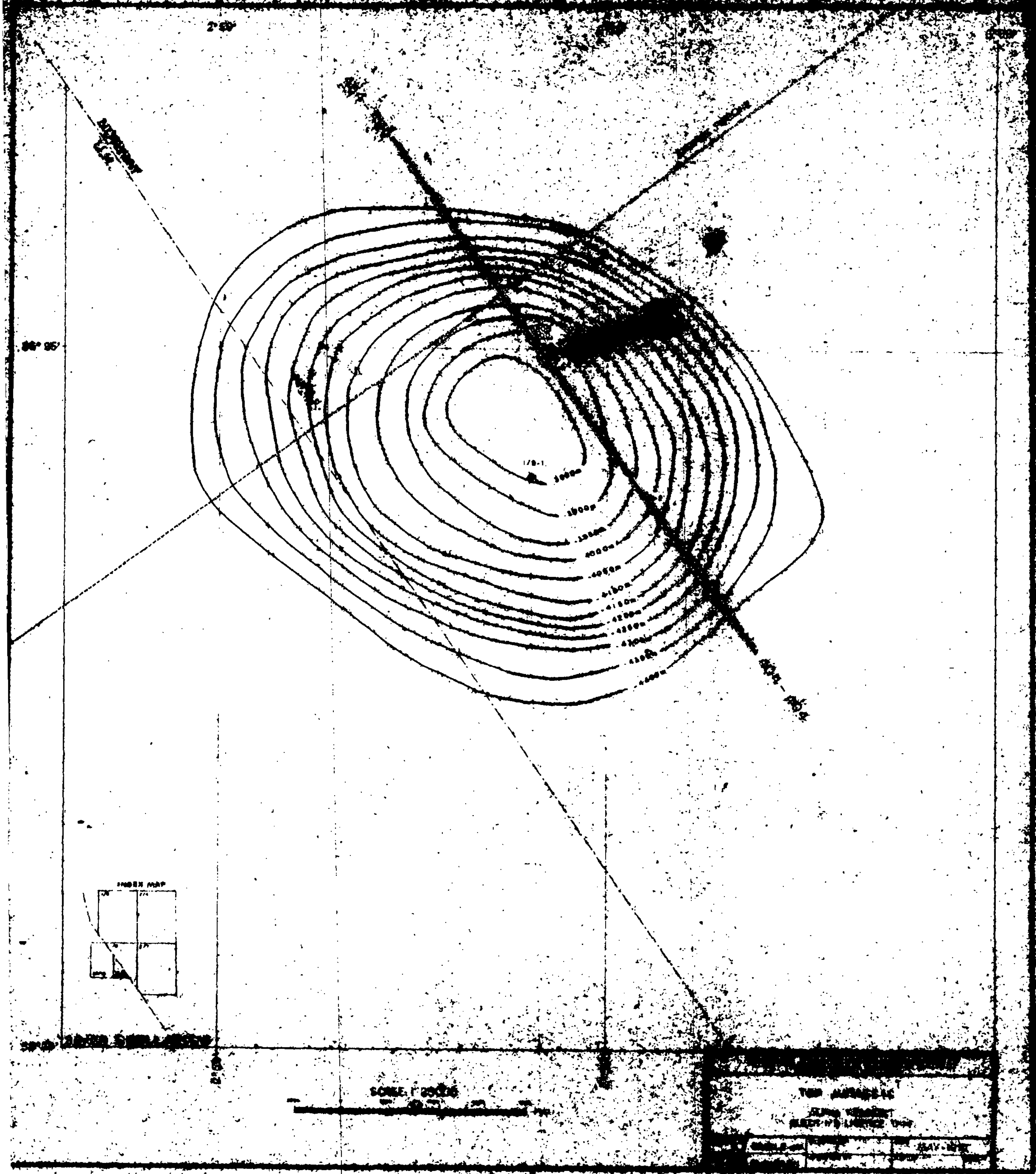
Block 1/9

TOP DANIAN CHALK

Structure map in depth

Ref plane MSL

C.I. 50meters


INDEX MAP