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SUBTITLE

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PETROPHYSICAL EVALUATION REPORT
WELL 6407/1-3
PL 073 TYRIHANS FIELD

LET-BERGEN
SEPTEMBER 1984

COMPLETED

04.10.84 Per Seim

APPROVED

4/10-84 J. Hanstveit

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1. SUMMARY

1.1 Introduction

Well 6407/1-3 was the second well to reach the objectives in the Tyrihans field, block 6407/1, and the first well on the A-structure.

The primary objective was to test the Jurassic sands for hydrocarbon accumulations.

The well encountered oil with an overlying gas cap in formation H1-4, and hydrocarbons in group H3.

This report describes the results and conclusions from the electrical logging and core measurements carried out in this well. A structure map of the Tyrihans area is shown in fig. 1.1. Fig. 2.1 shows the 6407/1-3 stratigraphy.

1.2 Objectives

Electrical logs were run over the whole well, with an extensive logging program over the permeable zones. In addition, cores were cut over most of the hydrocarbon bearing interval of formation H1-4.

The main objectives were to gather the necessary information for an evaluation of the petrophysical parameters in the permeable zones and aid in the geological interpretation of the formations encountered. This report is mainly concerned with the petrophysical parameters of the main hydrocarbon bearing zone, but other intervals are briefly discussed.

1.3 Results

The main reservoir section in this well is the upper sandstone member of formation H1-4, containing a gas zone from 3600 m RKB to 3687,5 m RKB, and an oil zone from 3687,5 m RKB to 3709 m RKB, which is also the bottom of the reservoir quality sandstone. It is assumed that this coincides with the oil/water contact, although the data are not conclusive.

The upper sandstone member is a very homogeneous sandstone sequence. The total thickness is 109 m and the log evaluation gives an average porosity of 16.4%, average water saturation of 19.3% and average shale volume of 7.7%. The ratio of net pay to gross sand is 0.994.

In the cored interval, average horizontal permeability to air is 720 mD, and average vertical permeability to air is 494 mD.

The main results from the log and core analysis are presented in table 1.1.

1.4 Conclusion

The upper sandstone member of formation H1-4 consists of a good reservoir quality sandstone containing oil with a gas cap. Lithologically well 6407/1-3 is very similar to well 6407/1-2 drilled on the B structure 8.5 km to the south, but well 6407/1-3 displays a better reservoir quality, and the hydrocarbon system is also different.

In group H3, minor accumulations of hydrocarbons were encountered.

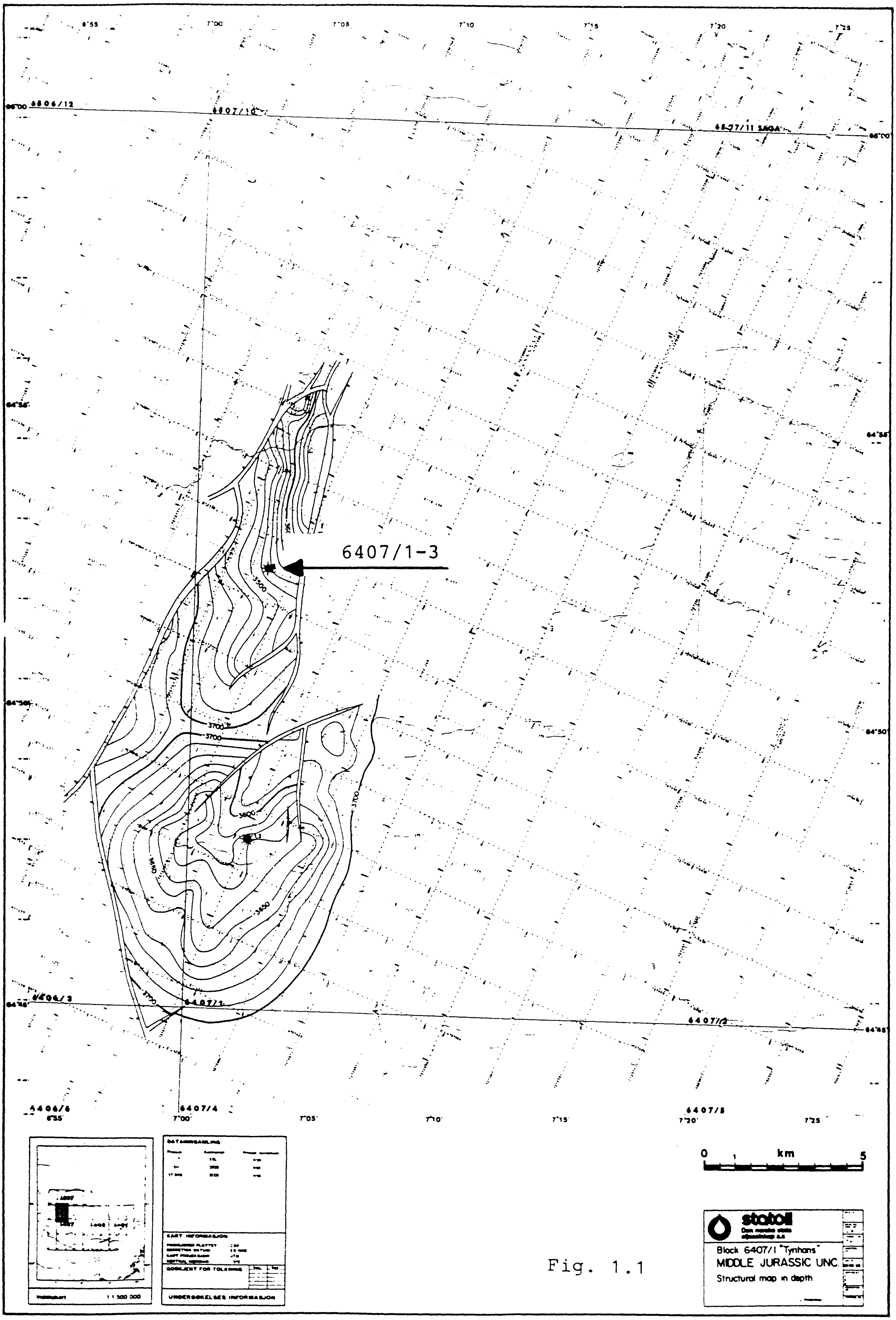

6407/1-3
3500
3700
3600
3650
6406/12
6407/10
6407/11 SAGA
6406/3
6407/1
6406/6
6407/4
6407/5
6°55'
7°00'
7°05'
7°10'
7°15'
7°20'
7°25'
0
km
5
statoil
Block 6407/1 "Tynhans"
MIDDLE JURASSIC UNC.
Structural map in depth
KART INFORMASJON
UNDERSØKELSES INFORMASJON
Fig. 1.1

Table 1.1

MAIN PETROPHYSICAL PARAMETERS

UPPER SANDSTONE MEMBER, FORMATION H1-4

6407/1-3

From logs

Interval 3600-3709 mRKB

	Thickness (m)	Porosity (%)	Water sat. (%)	Shale vol. (%)
Gross sand	109.0	16.4	19.3	7.7
Net sand	108.3	16.4	19.1	7.6
Net pay	108.3	16.4	19.1	7.6

Ratios

Net pay/Gross sand	0.994
Net sand/Gross sand	0.994
Net pay/Net sand	1.000

Cuts-offs:	Net pay	0% < Shale vol. < 40%
		0% < Water sat. < 65%
		10% < Porosity < 100%
	Net sand	0% < Shale vol. < 40%
		10% < Porosity < 100%

From cores

Interval 3619.0-3737 mRKB

Average porosity	17.8%
Average grain density	2.665 g/cm^3
Average horizontal permeability Kah	720.3 mD
Average vertical permeability Kav	494.1 mD

2. GENERAL INFORMATION

2.1 Well data

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

2.2 Lithology

2.2.1 Lithology, formation H1-4

The main objective of well 6407/1-3 was the H1-4 formation which is divided into three members namely the upper sandstone member (3600-3709 mRKB), the siltstone-claystone member (3709-3742 mRKB) and the lower sandstone member (3742-3812 mRKB).

The main reservoir section is the upper sandstone member which is described in this chapter. The member consists of an unusually homogeneous sandstone sequence with a total thickness of 109 m.

The upper part (3600-3656 mRKB) consists of a medium to fine grained sandstone. The sand contains some thin laminae rich in mica, and small coal fragments are not unusual. The mica content is decreasing slightly with depth. The depositional environment was probably a shoreface/foreshore.

In the middle part (3656-3662 mRKB), the sandstone is very coarse, occasionally granular. Coal fragments are common, and some feldspar is present. It could be interpreted as beach gravel, but it could possibly be the bottom of a fluvial distribution channel.

The next part of the upper sandstone member (3662-3702 mRKB) is well sorted with medium grain size. It can possibly be classified as a quartz-arenite, and contains some coal fragments and lamicae with mica. The bottom of this part is a sharp erosion boundary. The depositional environment is possibly a braided river system with a more marine influence towards the top.

Below the erosion surface is a 5 m sandstone section down to 3709 m RKB. This sandstone is fine to very fine grained, contains numeral irregular laminae with fines/organic material, and some mica. Depositional environment is clearly marine, probably shoreface.

Porosity reduction in the upper sandstone member is due to quartz overgrowth and clay minerals, mainly pore filling kaolinite. Dissolution of feldspar has contributed to a small increase in porosity.

Paleodata suggests the sand to be of bajocian/bathonian age.

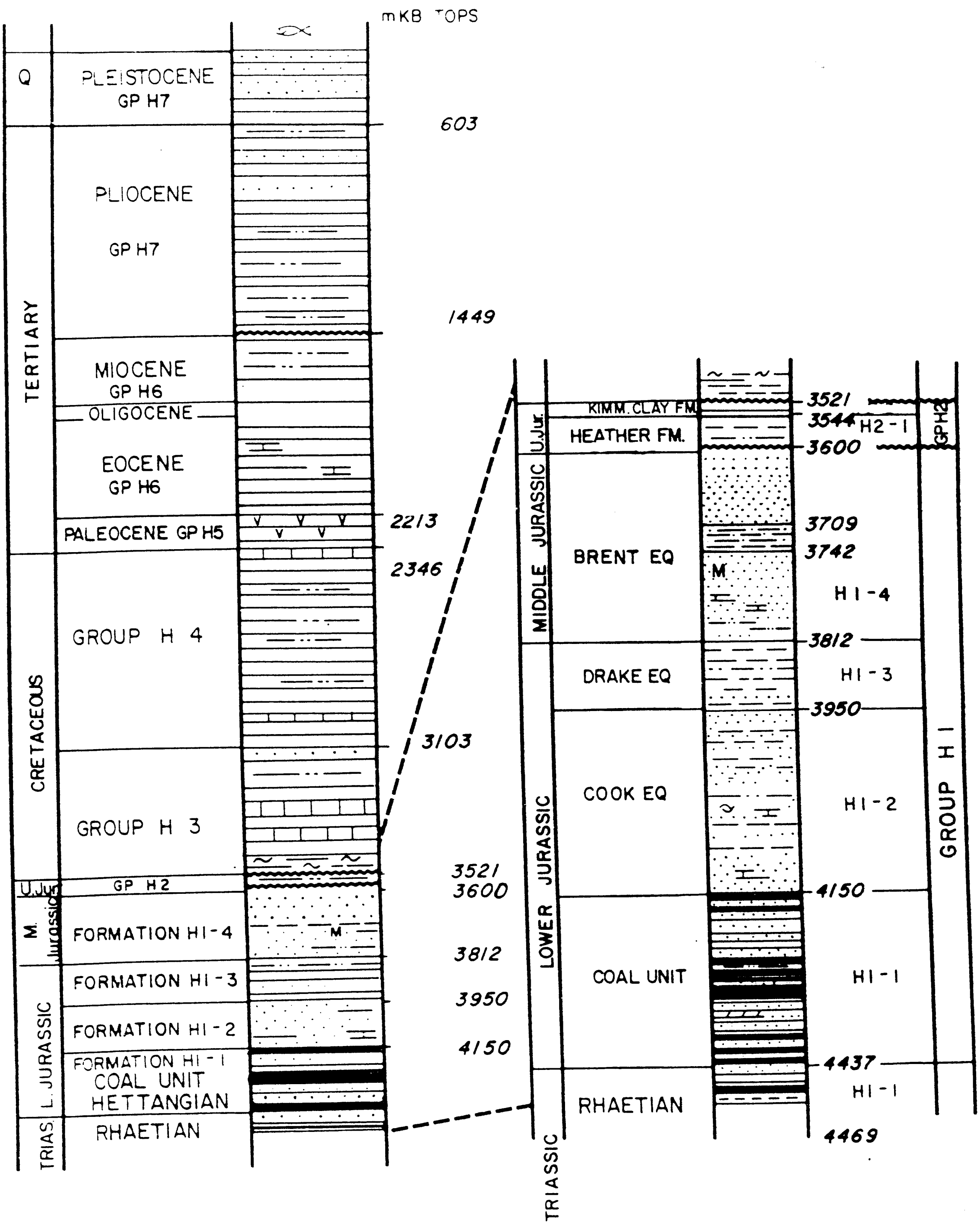
2.2.2 Lithology, group H3

The interpreted interval is a sequence of shale, sandstone and limestone. Reservoir quality is poor due to clay and lime cement reducing porosity and permeability. The sands are described as fine grained, medium sorted, loose and with moderate porosity. They belong to group H3, lower cretaceous.

Figure 2.1 shows the generalized stratigraphy of well 6407/1-3.

6407/1-3

GENERALIZED STRATIGRAPHY



3. PETROPHYSICAL ANALYSIS, FORMATION H1-4

3.1 Log quality

Before setting the 9 5/8" casing at 3595 mRKB, the well had been drilled 8 m into the reservoir with a 12 1/4" bit and a mud weight of 1.7 g/cm^3. Through the reservoir down to 3976 mRKB, an 8 1/2" bit size was utilized. Before setting the 7" liner, the following open hole logs were run:

DLL-MSFL-GR	Run no. 1
LDL-CNL-GR	Run no. 3
RFT-GR	Run no. 2
ISF-BHC-GR	Run no. 4
NGT	Run no. 2
SHDT-GR	Run no. 2
CST	

The technical quality of the logs are good, with very little sticking problems. The logs are well calibrated with little variation between before and after survey calibration, and good repeat sections.

Due to the change in bit size, high mud weight and possibly some cement contamination down to 3608 mRKB, readings at the top of the reservoir can not be fully trusted. Also, the LDL and MSFL readings are adversely affected by rugose hole in the siltstone-claystone member due to loss of pad contact. Apart from this, the logs are of good quality, suitable for interpretation.

3.2 Interpretation method

3.2.1 Input parameters

The parameters used in this interpretation are presented in table 3.1. They are based on information from log headings, crossplots, histograms, pressure measurements and core results, both from this well and other wells in the area. Due to the homogeneous appearance of the reservoir section, no zoning was performed other than varying the hydrocarbon type and density, which are used as inputs in the interpretation.

3.2.2 Resistivity

Input logs for resistivity determinations are DLL-MSFL-CAL. The tool readings are corrected for borehole effects. The resulting curves Rt and Rxo are presented in the graphical log presentation.

3.2.3 Formation water resistivity

Due to the absence of a water zone in direct communication with the hydrocarbon zone, and proximity with well 6407/1-2, the formation water resistivity used in this well has been taken from well 6407/1-2. Comparison with calculations of Rw in the lower sandstone member gives nearly the same result.

3.2.4 Shale indicators

Several shale indicators were calculated over the interval presented in the graphical log presentation in Appendix 2. The two-curve indicators had to be zoned according to fluid contents, and of the single-curve indicators, only the GR was found to give reasonable results. The resulting shale indicator was calculated as the minumum of the indicators based on the GR curve, neutron-denisty, sonic-density and sonic-neutron. In the upper sandstone member, all indicators were utilized. In the siltstone-claystone member only GR and sonic-neutron gave reasonable values, and in the lower sandstone member, GR and neutron-density gave reliable results. However, for most of the interval, the GR-indicator is dominating the final shale indicator.

3.2.5 Porosity

Two different models were used to arrive at final porosity. In the upper sandstone member, a sandstone-heavy mineral model was used, with mica input as the heavy mineral. In the lower sandstone member, a sandstone-limestone model was found to give better results.

For both methods, corrections for borehole effects, shale and hydrocarbon saturation in the invaded zone were applied, giving the final porosity, PHIF, presented in Appendix 2.

3.2.6 Water saturations

Both invaded zone and virgin zone water saturations were calculated using the Nigeria method presented in Schlumberger's "Well Evaluation Conferences" on Nigeria 1974 and North Sea 1974, with input parameters as specified in table 3.1.

Lithology factor, a, and cementation exponent, m, were taken from the special core analysis, well 6407/1-2, performed by Geco. The values were derived using a forced fit on measurements perfomed at 230 bar confining pressure.

Saturation exponent was taken from the special core analysis, well 6407/1-2, performed by Statoil.

Although these values are based on a different well, they are expected to be relevant also to well 6407/1-3 due to the short distance between the wells and the geological similarity of the formations.

Table 3.1

INPUT PARAMETERS
UPPER SANDSTONE MEMBER, FORMATION H1-4
6407/1-3

MUD PROPERTIES	
Mud density	1.2 g/cm^3
Mud filtrate density	1.02 g/cm^3
Average mud pressure	430 bar
Mud resistivity at 90°C	0.20 ohm.m
Mud filtrate resistivity at 90°C	0.11 ohm.m
Mudcake resistivity at 90°C	0.25 ohm.m
Mud salinity	12000 ppm
SHALE PARAMETERS	
Shale exponent, c,	1.6
Shale resistivity	3.5 ohm.m
Density response in shale	2.56 g/cm^3
Neutron response in shale	39 p.u.
Sonic response in shale	86 µs/ft
Gamma ray response	118 API
FORMATION PARAMETERS	
Lithology factor, a,	1
Cementation exponent, m,	1.96
Saturation exponent, n,	2.4
Average temperature	100°C
Matrix density, sandstone	2.65 g/cm^3
Matrix density, heavy mineral	2.9 g/cm^3
Matrix neutron response, sandstone	-3.5 p.u.
Matrix neutron response, heavy mineral	25 p.u.
Hydrocarbon density, gas zone	0.22 g/cm^3
Hydrocarbon density, oil zone	0.69 g/cm^3
Gamma ray response	28 API
Water resistivity at 100°C	0.033 ohm.m

3.3 Coring summary

In well 6407/1-3, a total of seven cores were cut. Six cores were cut in the interval 3619-3717 mRKB (drillers depth) and one core from 3748 to 3758 mRKB (drillers depth).

For the upper six cores, gas shows were reported down to 3687.5 mRKB, and oil shows further down to 3709 mRKB, where poor shows were reported. The core from the top of the lower sandstone member was reported to have very poor shows.

Statistics from the routine core measurements are shown in table 3.2.

Depth correlation with wireline logs show only small variations, and no depth adjustments were made to match log and core depths.

As in well 6407/1-2, the core measurements do not show a clear relationship between porosity and permeability when looking at the total cored interval. By dividing the interval into zones based on log deflections and geology, relationships can be established within each zone. It appears that grain size and amount of clay mineral has a greater influence on permeability than changes in prosity.

A plot of permeability versus porosity for the top six cores is presented in figure 3.1. Plots of permeability versus porosity for the gas and oil zones are shown in Appendix 1. Statistics for the same zones are shown in table 5.1.

Individual measurements are plotted on the graphical log presentation given in Appendix 2.

Air permeability data have been used due to poor Klinkenberg corrections in reference 3.

Permeability vs porosity
Upper sandstone member
Formation H1-4

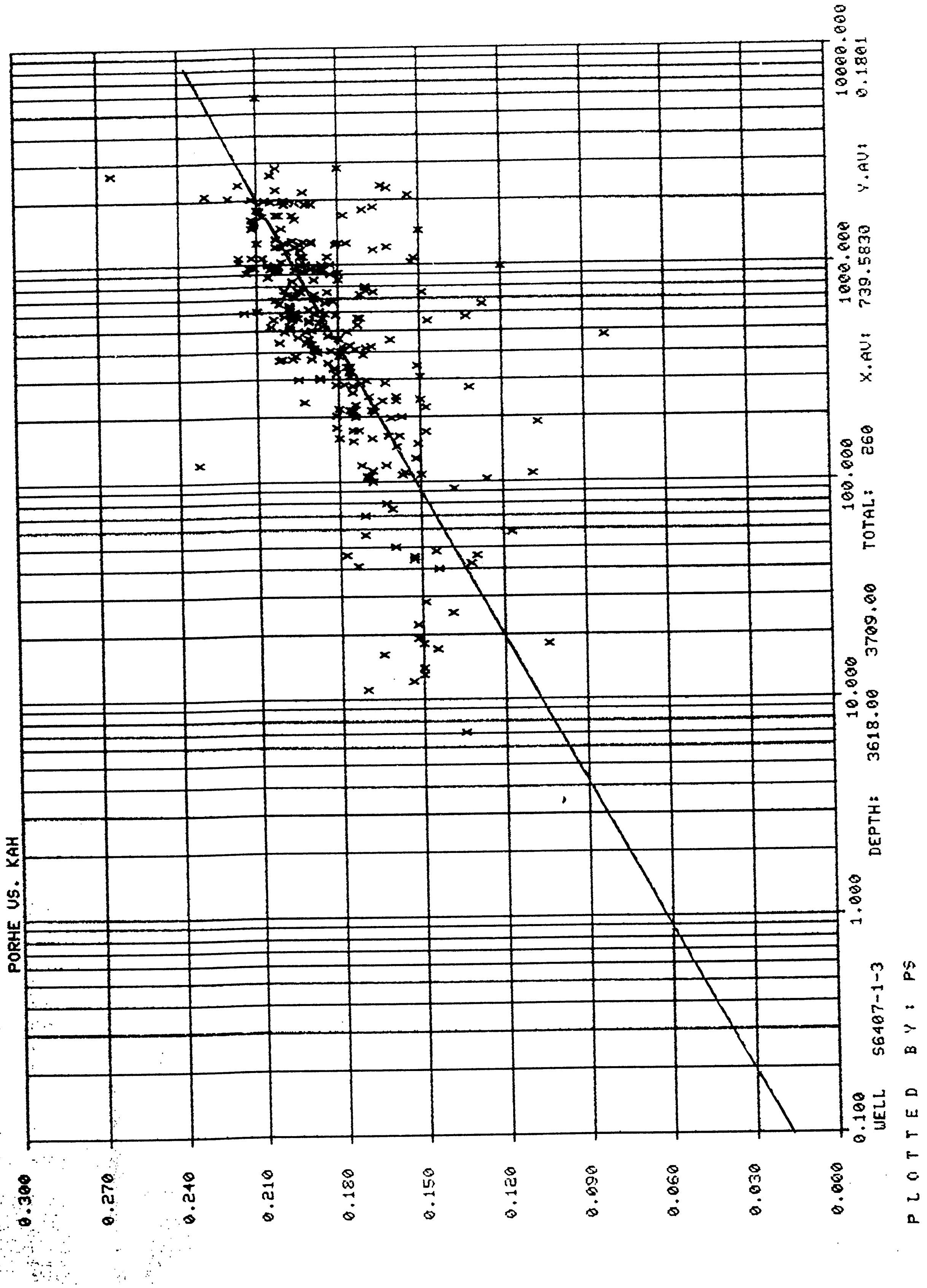


Table 3.2

CORE STATISTICS

UPPER SANDSTONE MEMBER, FORMATION H1-4

6407/1-3

Cored interval, drillers depth	3619.0-3717.0 mRKB
Number of cores	6
Recorded	94.5 m
Average recovery	96%
Porosity range	4.5%-26.5%
Average porosity, PORHE	17.8
Number of measurements	269
Average grain density, RHOMA	2.665
Permeability variations:	
Horizontal permeability to air, KAH	0.17-5982 mD
Number of measurements	267
Vertical permeability to air, KAV	0.05-4942 mD
Number of measurements	247

Average permeabilities:	
Horizontal permeability to air, KAH, arithmetic avg.	720.3 mD
Vertical permeability to air KAV, arithmetic avg.	494.1 mD
Vertical permeability to air Kav, harmonic avg.	3.1 mD

Porosity/permeability relationship, interval 3619-3709 mRKB

$PORHE = 0.045 \times \log KAH + 0.062,\ c_2 = 0.38$

Average porosity, PORHE	18.0%
Average permeability, KAH	739.6 mD

3.4 Results and discussion of the analysis

The main petrophysical parameters from logs and cores over the reservoir zone is given in table 1.1. More detailed statistics are given in Appendix 1, and a graphical presentation of log and core data in Appendix 2.

The agreement between log interpretation and core measurements is good. Differences in porosity values can be attributed to the influence of confining pressure and clay content on the core measurements. Influence of confining pressures will be investigated in the special core analysis program.

The porosity cut-off used for calculating statistics is 10% due to the relatively high permeabilitys at lower porosity values in well 6407/1-2 and well 6407/1-3. For water saturation and shale volume, standard values were used. An even lower porosity cutoff could be used, but as shown by the sensitivity plot, figure 6.5, this would not influence the statistics.

The cores show that no shale is present in the reservoir sand, and the shale volume curve in this evaluation should rather be called a clay volume curve. Picking parameters from the adjacent shale beds for use in the shale correction routines are probably not correct, but the chosen values seem to be within the ranges given in the literature for the clay minerals present. The "shale volume" curve is also influenced by the presence of mica. The average "shale volume" of 7.6% in the net sand section seems to be representative of the clay and mica concentration in this interval, and the resulting uncertainty in the final results are considered acceptable.

The main reservoir section in well 6407/1-3 was the upper sandstone member in formation H1-4. The interval from 3600 to 3656 mRKB is a gas bearing sandstone with an average porosity of 15.6%. Although the data quality at the top of the interval is not perfect, the gradual increase of hydrocarbon saturation seems to be real and cannot easily be explained, as the sand quality appears to be rather good. Apart from a relatively clean zone at 3605 mRKB, the interval contains some clay minerals, as indicated by an average shale volume of 10.8%.

From 3656 to 3687.5 mRKB, the sandstone is also gas bearing, but contains less clay than the zone above. Average shale volume is here 2.8%. The first six metres has a somewhat lower porosity, averaging 13.5%, while the rest of the interval averages 17.8%.

The gas-oil contact is encountered at 3687.5%, and the sandstone is oil bearing down to 3709 mRKB. Down to 3704 mRKB, the sand has a low clay content and good porosity, with averages of 2.3% and 19.3%, respectively.

From 3704 to 3709 mRKB, clay content increases and porosity decreases, with average values of 20.3% and 13%, respectively.

At 3709 mRKB water saturation increases sharply. This is also seen in core measurements, and this depth is taken as the oil-water contact. Through the oil zone, an increase in water saturation is seen. This is interpreted as a long transition zone, as was seen in well 6407/1-2. Another similarity with this well is the shape of the SP-curve which can not easily be explained.

Below 3709 mRKB, porosity is reduced further. Although the shale volume curve does not reach 100%, the shale and matrix combined, does and it is thought that the matrix is grading more to silt, thus reducing porosity.

Residual shows were observed in the claystone-siltstone member, and in the top of the lower sandstone member, but no producible hydrocarbons were encountered.

4. PETROPHYSICAL ANALYSIS, GROUP H3

4.1 Log quality

The logs run in group H3 have an acceptable technical standard, but, as the sands are thin, they are not ideal for interpretation due to boundary effects. The following open hole logs are used in this interpretation:

ISF-LSS-GR	Run no. 3
LDL-CNL-GR	Run no. 2

4.2 Interpretation method

4.2.1 Input parameters

The parameters used for this interval are presented in table 4.1. They are based on information from log headings, crossplots and histograms. No zoning of parameters were performed.

4.2.2 Resistivity

Only the ISF-MSFL resistivity measurements are available in this interval. Most of the sands are too thin to give reliable resistivity values from the deep induction measurements. In the best sand the induction compares well with the SFL, except for deconvolution anomalies at the top and bottom. As the purpose of evaluating this interval is only to demonstrate fluid content and porosity, the SFL measurements were therefore utilized as true formation resistivity, RT, with no corrections applied in order to take advantage of the better vertical resolution. The MSFL measurements were used directly as Rxo.

4.2.3 Formation water resistivity

Formation water resistivity was assumed to be the same as in formation H1-4 well 6407/1-2. The SP indicates that the formation water is more saline than the mud, and for qualititative purposes the error should not be too serious.

4.2.4 Shale indicators

Several shale indicators were calculated, but the one used for interpretation is the minimum of the indicators based on the GR-log and the neutron-density crossplot.

4.2.5 Porosity

Porosity was derived from the density-neutron crossplot. Normal corrections for borehole effects and clay content was applied. A sandstone-limestone model was used for the crossplot.

4.2.6 Water saturations

Both invaded and virgin zone saturations were calculated using the Nigeria method presented in references 1 and 2. Standard values for compacted formations were used for a, m and n.

Table 4.1

INPUT PARAMETERS

GROUP H3

6407/1-3

MUD PROPERTIES	
Mud density	1.7 g/cm^3
Mud filtrate density	1.02 g/cm^3
Average mud pressure	575 bar
Mud resistivity at 83^oC	0.147 ohm.m
Mud filtrate resistivity at 83^oC	0.085 ohm.m
Mudcake resistivity at 83^oC	0.267 ohm.m
Mud salinity	19000 ppm
SHALE PARAMETERS	
Shale exponent, c,	1.6
Shale resistivity	1.6 ohm.m
Density response in shale	2.5 g/cm^3
Neutron response in shale	0.31
Gamma ray response	68 API
FORMATION PARAMETERS	
Lithology factor (a)	1
Cementation exponent (m)	2
Saturation exponent (n)	2
Average temperature	83^oC
Matrix density	2.65 g/cm^3
Hydrocarbon density	0.7 g/cm^3
Gamma ray response	33 API
Water resistivity	0.04 ohm.m

4.3 Results and discussion of the analysis

Statistics from the interval 3400 to 3500 mRKB does not give any net sand or net pay when using standard cutoffs, and are not presented. However, the sensitivity plot shown in figure 6.6 clearly demonstrates that the limiting factor is the low porosity. The interval is probably not very productive, but considering the high pressure in these sands, it is assumed that sands could produce small amounts of hydrocarbons. Due to the limited size of these sands, they were not considered for testing in this well, and will only be evaluated further if encountered in new wells in the area.

5. REFERENCES

1. Well Evaluation Conference, Nigeria, 1974, Schlumberger
2. Well Evaluation Conference, North Sea, 1974, Schlumberger
3. Core Analysis Report 6407/1-3, Corelab
4. Special Core Analysis 6407/1-2, Statoil
5. Special Core Analysis 6407/1-2, Geco
6. Funnevalueringsrapport 6407/1-3, Statoil
7. Wireline Formation Testing Report 6407/1.3, Statoil

Logs used in the interpretation:

DLL-MSFL-GR	Run no. 1
LDL-CNL-GR	Run no. 2 and run no. 3
ISF-BHC-GR	Run no. 3 and run no. 4
NGS	Run no. 2

Permeability vs porosity
Upper sandstone member
Formation H1-4
Gas zone

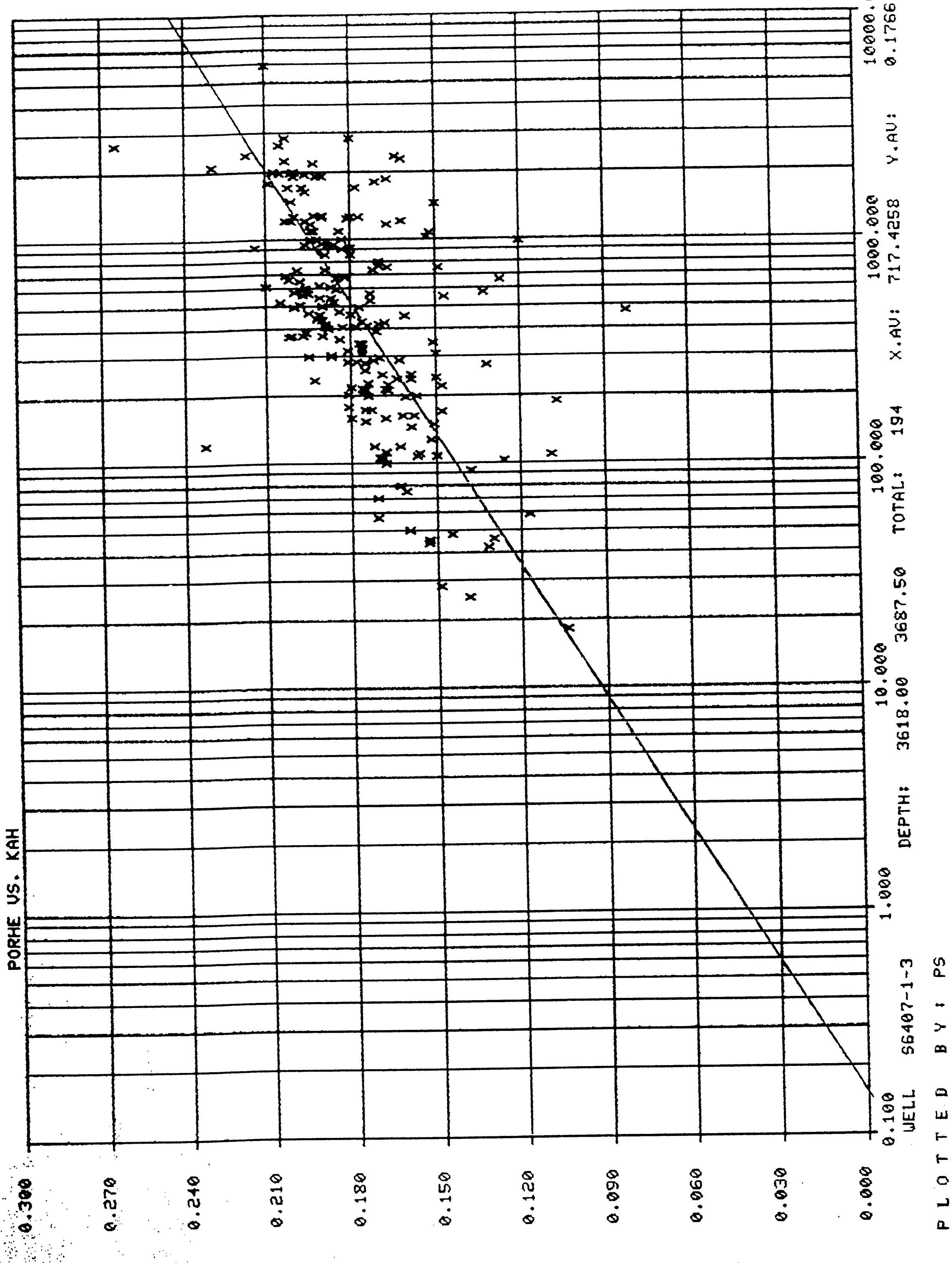


Fig. 6.2

Permeability vs porosity
Upper sandstone member
Formation H1-4
Oil zone

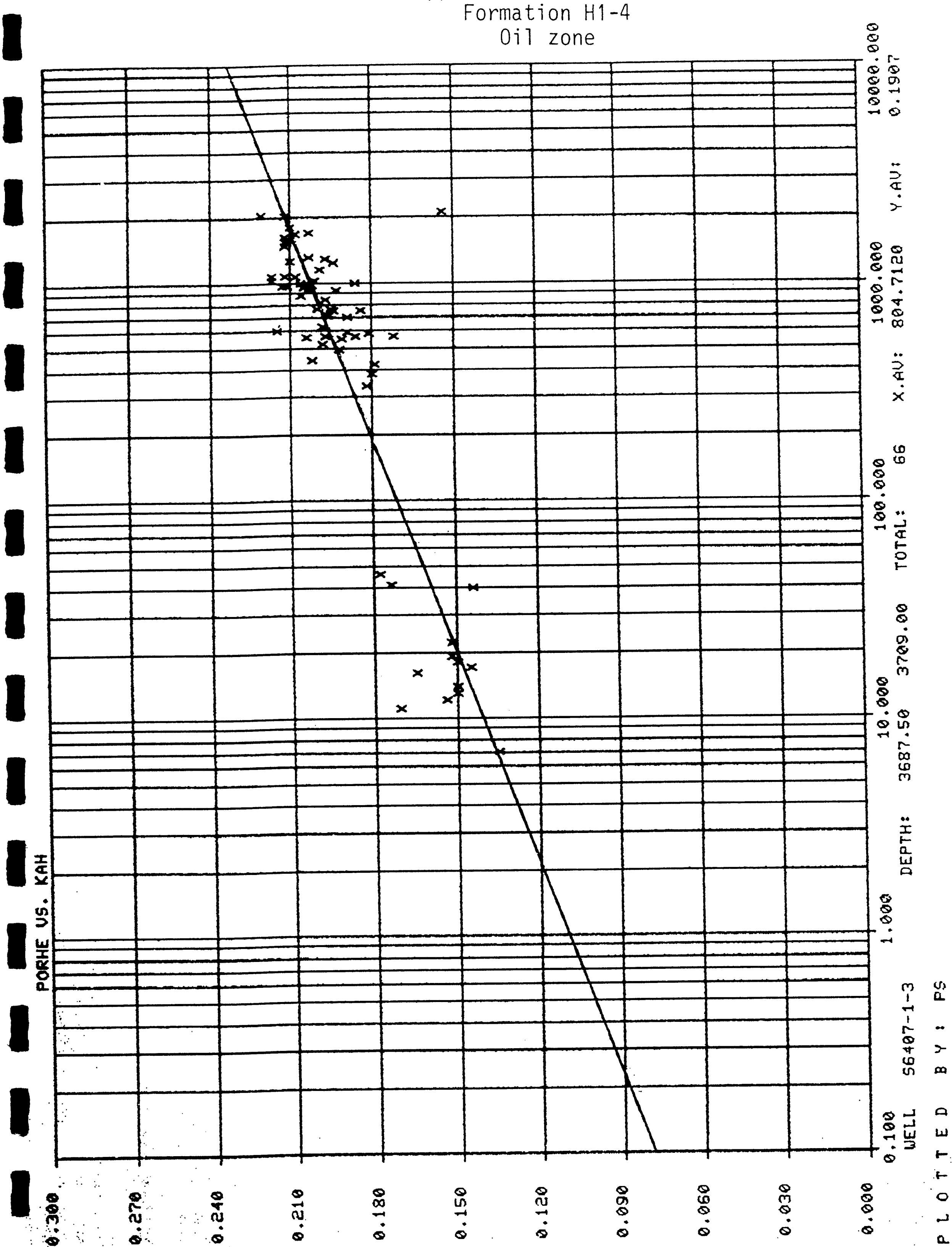


Fig. 6.3

RHOB vs PHIN
Upper sandstone member
Formation H1-4

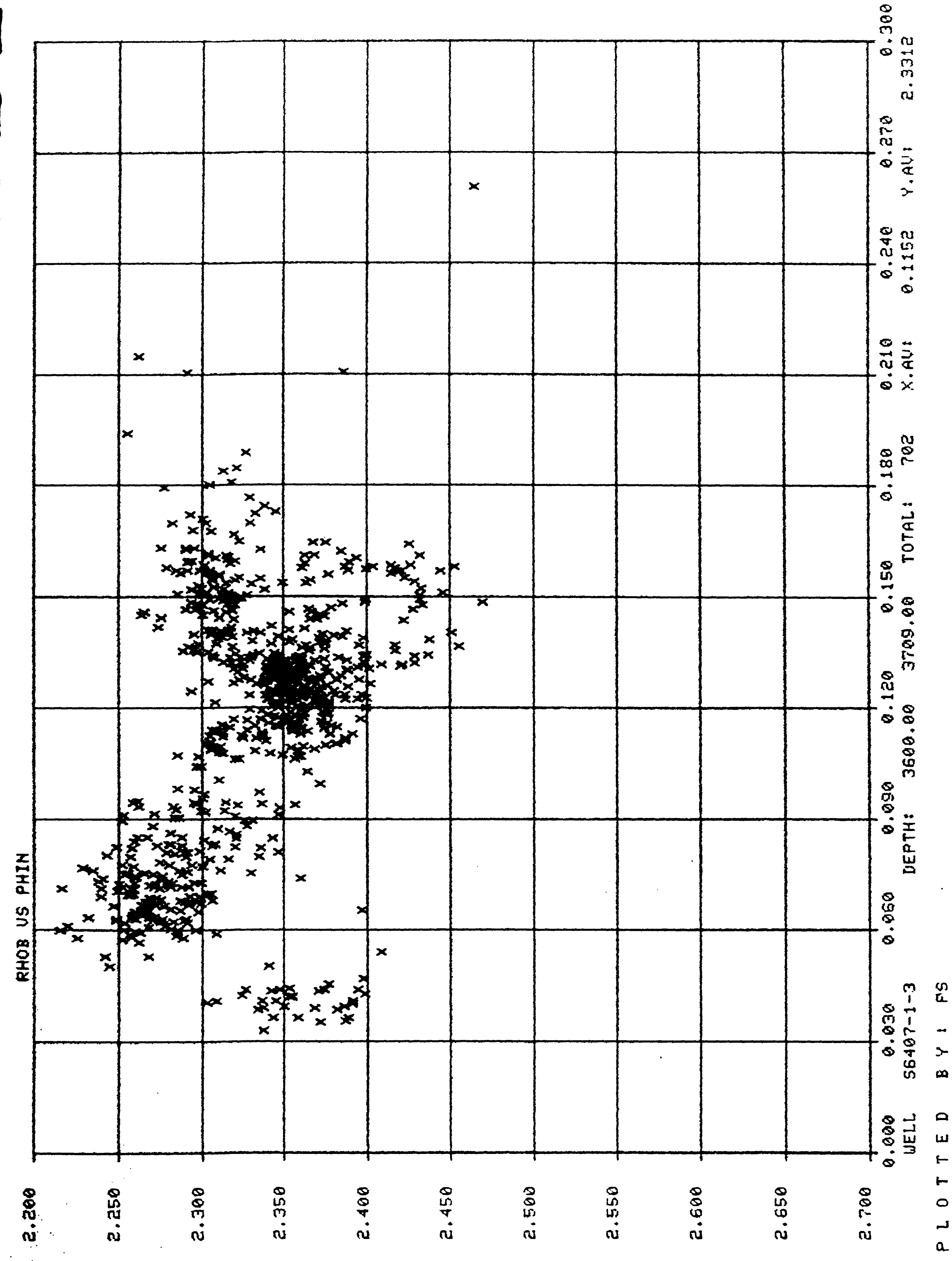
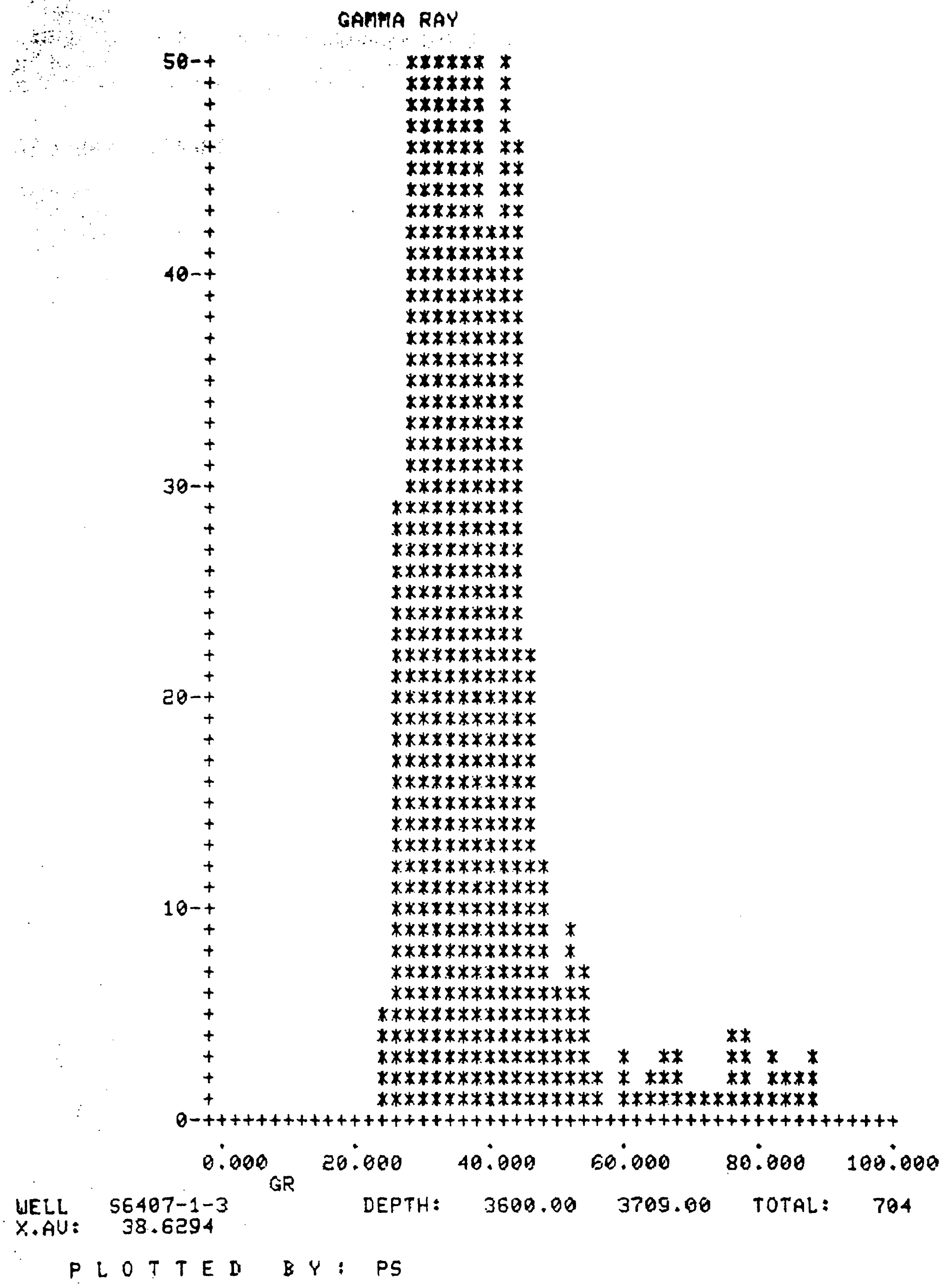


Fig. 6.4

Gamma ray histogram
Upper sandstone member
Formation H1-4



Sensitivity plot
Formation H1-4

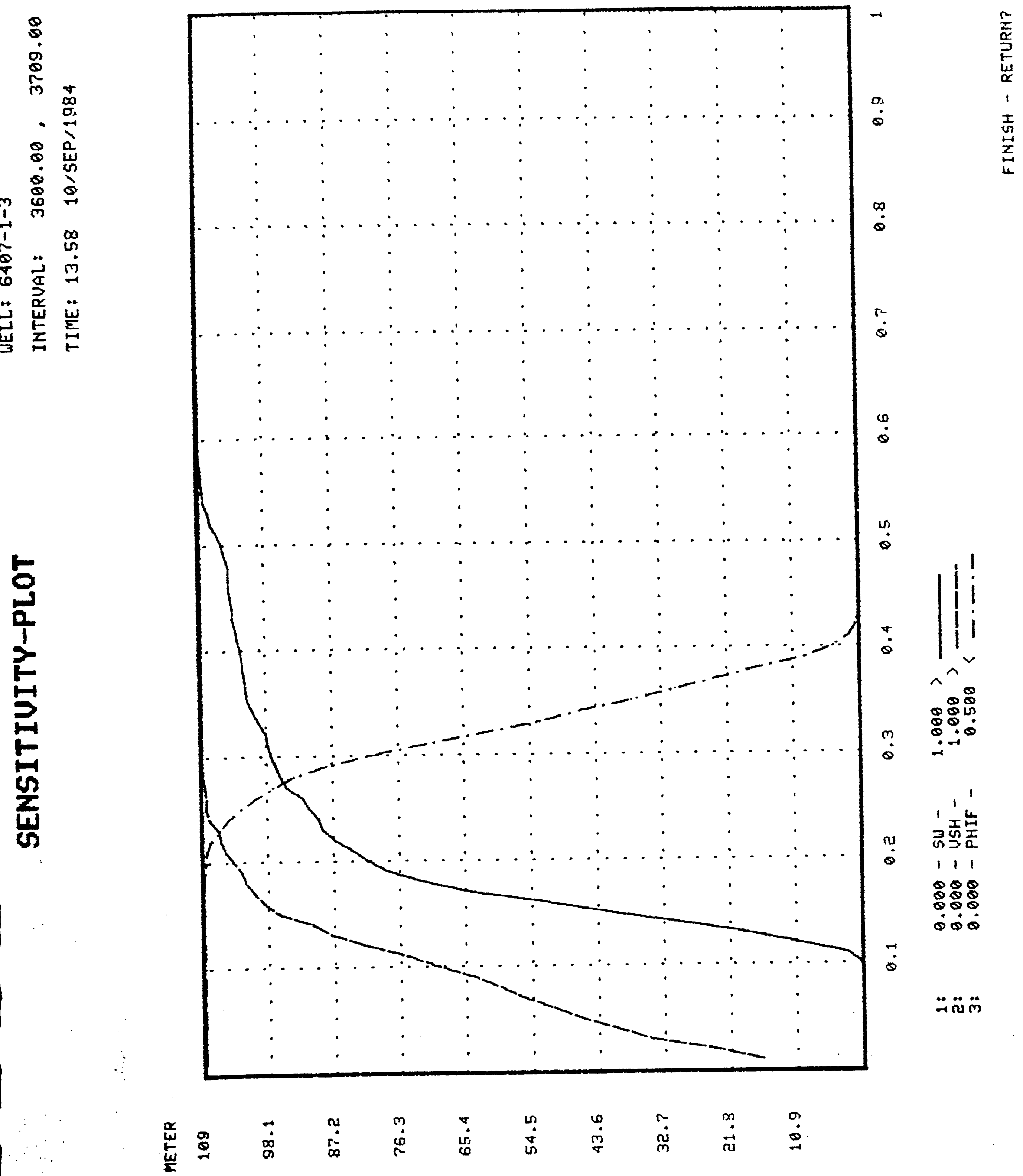


Fig. 6.6

Sensitivity plot
Group H3

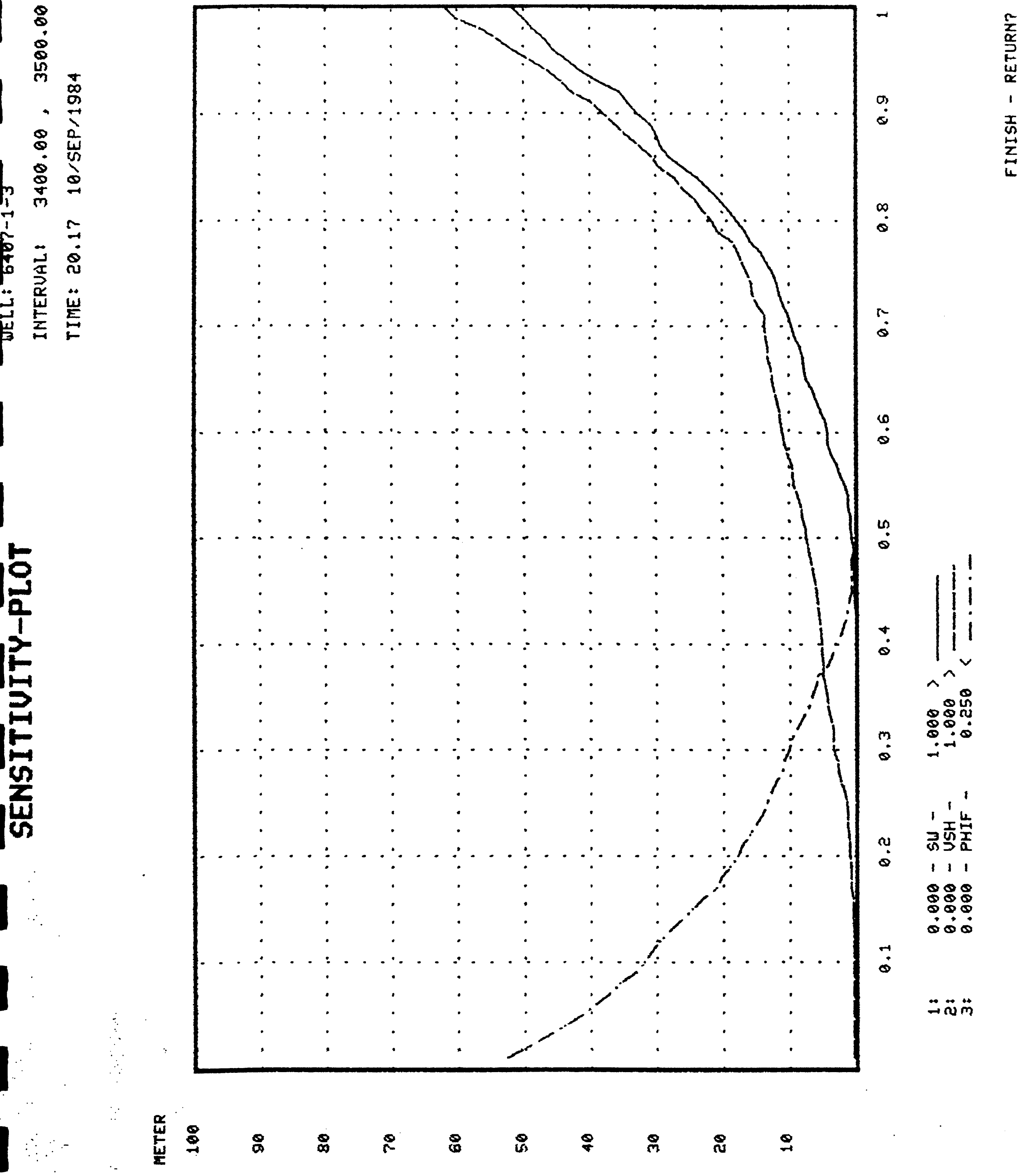


Table 6.1

CORE STATISTICS BY ZONES
UPPER SANDSTONE MEMBER, FORMATION H1-4
6407/1-3

GAS ZONE

Interval	3619.0-3687.5 MRKB
Average porosity, PORHE	17.7%
Average grain density, RHOMA	2.665 g/cm^3
Average horizontal permeability to air, KAH	718.5 mD
Average vertical permeability to air, KAV	473.5 mD
Harmonic vertical permeability to air, KAV	28.6 mD

Porosity/permeability relationship

PORHE = 0.051 log KAH + 0.042, C_2 = 0.32

OIL ZONE

Interval	3687.5-3709 mRKB
Average porosity, PORHE	19.1%
Average grain density, RHOMA	2,663 g/cm^3
Average horizontal permeability to air, KAH	804.7 mD
Average vertical permeability to air, KAV	621.5 mD
Harmonic vertical permeability to air, KAV	31.9 mD

Porosity/permeability relationship

PORHE = 0.031 log KAH + 0.110, C_2 = 0.73

Table 6.2

Upper sandstone member
Formation H1-4

```
 S T A T I S T I C S
*********************

FIELD: . . . . . . . . . . .         TYRIHANS
WELL:  . . . . . . . . . . .         6407-1-3
ENGINEER:  . . . . . . . . . PS
DATE:  . . . . .             13.52   10 SEP 1984

DEPTH INTERVAL:  . . .  3600.00 TO  3709.00
APPLIED CUTOFFS:
.              USH:  GREATER THAN      0.40
.             PHIF:      LESS THAN     0.10
.               SW:  GREATER THAN      0.65

 T O T A L    D E P T H
******************************************
THICKNESS: . . . . . . . . .     108.965
AVERAGE  . . . 'PHIF'  . . .       0.164
AVERAGE  . . . 'VSHALE'  . .       0.077
AVERAGE  . . . 'SW'  . . . .       0.193
W.AVERAGE  . . 'SW' * 'PHIF'       0.190
AVERAGE  . . . 'SH'  . . . .       0.807
VOID VOLUME: . . . ('PHIF').      17.879
HC VOID VOLUME . . ('SH'*) .      14.484
RES HC VOID VOLUME ('SHR'*).       3.549
MOV HC VOID VOLUME . . . . .      10.936
******************************************

 N E T    P A Y
******************************************
THICKNESS: . . . . . . . . .     108.345
AVERAGE  . . . 'PHIF'  . . .       0.164
AVERAGE  . . . 'VSHALE'  . .       0.076
AVERAGE  . . . 'SW'  . . . .       0.191
W.AVERAGE  . . 'SW' * 'PHIF'       0.189
AVERAGE  . . . 'SH'  . . . .       0.809
VOID VOLUME: . . . ('PHIF').      17.819
HC VOID VOLUME . . ('SH'*) .      14.451
RES HC VOID VOLUME ('SHR'*).       3.549
MOV HC VOID VOLUME . . . . .      10.903
******************************************

 N E T    S A N D
******************************************
THICKNESS: . . . . . . . . .     108.345
AVERAGE  . . . 'PHIF'  . . .       0.164
AVERAGE  . . . 'VSHALE'  . .       0.076
AVERAGE  . . . 'SW'  . . . .       0.191
W.AVERAGE  . . 'SW' * 'PHIF'       0.189
AVERAGE  . . . 'SH'  . . . .       0.809
VOID VOLUME: . . . ('PHIF').      17.819
HC VOID VOLUME . . ('SH'*) .      14.451
RES HC VOID VOLUME ('SHR'*).       3.549
MOV HC VOID VOLUME . . . . .      10.903
******************************************

 N E T / G R O S S    R A T I O S
*****************************************

HNETPAY /HGROSS SAND =  0.99399
HNETSAND/HGROSS SAND =  0.99399
HNETPAY /HNETSAND    =  1.00000
*****************************************
```

Table 6.3

Upper sandstone member
Formation H1-4
Gas zone

```
 S T A T I S T I C S
********************

FIELD: . . . . . . . . . . .               TYRIHANS
WELL:  . . . . . . . . . . .               6407-1-3
ENGINEER:  . . . . . . . . . PS
DATE:  . . . . .              13.54     10 SEP 1984

DEPTH INTERVAL:  . . .  3600.00 TO  3687.50
APPLIED CUTOFFS:
.             VSH:  GREATER THAN       0.40
.            PHIF:     LESS THAN       0.10
.              SW:  GREATER THAN       0.65

 T O T A L   D E P T H
*****************************************
THICKNESS: . . . . . . . . .       87.575
AVERAGE  . . . 'PHIF'  . . .        0.160
AVERAGE  . . . 'VSHALE'  . .        0.080
AVERAGE  . . . 'SW'  . . . .        0.164
W.AVERAGE  . . 'SW' * 'PHIF'        0.162
AVERAGE  . . . 'SH'  . . . .        0.836
VOID VOLUME: . . . ('PHIF').       14.053
HC VOID VOLUME . . ('SH'*) .       11.780
RES HC VOID VOLUME ('SHR'*).        2.792
MOV HC VOID VOLUME . . . . .        8.987
*****************************************

 N E T   P A Y
*****************************************
THICKNESS: . . . . . . . . .       87.110
AVERAGE  . . . 'PHIF'  . . .        0.161
AVERAGE  . . . 'VSHALE'  . .        0.079
AVERAGE  . . . 'SW'  . . . .        0.162
W.AVERAGE  . . 'SW' * 'PHIF'        0.161
AVERAGE  . . . 'SH'  . . . .        0.838
VOID VOLUME: . . . ('PHIF').       14.008
HC VOID VOLUME . . ('SH'*) .       11.753
RES HC VOID VOLUME ('SHR'*).        2.792
MOV HC VOID VOLUME . . . . .        8.961
*****************************************

 N E T   S A N D
*****************************************
THICKNESS: . . . . . . . . .       87.110
AVERAGE  . . . 'PHIF'  . . .        0.161
AVERAGE  . . . 'VSHALE'  . .        0.079
AVERAGE  . . . 'SW'  . . . .        0.162
W.AVERAGE  . . 'SW' * 'PHIF'        0.161
AVERAGE  . . . 'SH'  . . . .        0.838
VOID VOLUME: . . . ('PHIF').       14.008
HC VOID VOLUME . . ('SH'*) .       11.753
RES HC VOID VOLUME ('SHR'*).        2.792
MOV HC VOID VOLUME . . . . .        8.961
*****************************************

 N E T / G R O S S   R A T I O S
*****************************************

HNETPAY /HGROSS SAND =  0.99554
HNETSAND/HGROSS SAND =  0.99554
HNETPAY /HNETSAND    =  1.00000
*****************************************
```

Table 6.4

Upper sandstone member
Formation H1-4
Oil zone

```
 S T A T I S T I C S
********************

FIELD: . . . . . . . . . . .          TYRIHANS
WELL:  . . . . . . . . . . .          6407-1-3
ENGINEER: . . . . . . . . . . PS
DATE:  . . . . .             15.53    10 SEP 1984

DEPTH INTERVAL:  . . .  3687.50 TO  3709.00
APPLIED CUTOFFS:
.             VSH:  GREATER THAN       0.40
.            PHIF:     LESS THAN       0.10
.              SW:  GREATER THAN       0.65

 T O T A L    D E P T H
*****************************************
THICKNESS: . . . . . . . . .       21.390
AVERAGE  . . . 'PHIF'  . . .        0.179
AVERAGE  . . . 'VSHALE'  . .        0.065
AVERAGE  . . . 'SW'  . . . .        0.311
W.AVERAGE  . . 'SW' * 'PHIF'        0.293
AVERAGE  . . . 'SH'  . . . .        0.689
VOID VOLUME: . . . ('PHIF').        3.826
HC VOID VOLUME . . ('SH'*) .        2.704
RES HC VOID VOLUME ('SHR'*).        0.756
MOV HC VOID VOLUME . . . . .        1.948
*****************************************

 N E T    P A Y
*****************************************
THICKNESS: . . . . . . . . .       21.235
AVERAGE  . . . 'PHIF'  . . .        0.179
AVERAGE  . . . 'VSHALE'  . .        0.063
AVERAGE  . . . 'SW'  . . . .        0.309
W.AVERAGE  . . 'SW' * 'PHIF'        0.292
AVERAGE  . . . 'SH'  . . . .        0.691
VOID VOLUME: . . . ('PHIF').        3.811
HC VOID VOLUME . . ('SH'*) .        2.698
RES HC VOID VOLUME ('SHR'*).        0.756
MOV HC VOID VOLUME . . . . .        1.942
*****************************************

 N E T    S A N D
*****************************************
THICKNESS: . . . . . . . . .       21.235
AVERAGE  . . . 'PHIF'  . . .        0.179
AVERAGE  . . . 'VSHALE'  . .        0.063
AVERAGE  . . . 'SW'  . . . .        0.309
W.AVERAGE  . . 'SW' * 'PHIF'        0.292
AVERAGE  . . . 'SH'  . . . .        0.691
VOID VOLUME: . . . ('PHIF').        3.811
HC VOID VOLUME . . ('SH'*) .        2.698
RES HC VOID VOLUME ('SHR'*).        0.756
MOV HC VOID VOLUME . . . . .        1.942
*****************************************

 N E T / G R O S S    R A T I O S
*****************************************

HNETPAY /HGROSS SAND =  0.98767
HNETSAND/HGROSS SAND =  0.98767
HNETPAY /HNETSAND    =  1.00000
*****************************************
```

Table 6.5

Lower sandstone member
Formation H1-4

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S T A T I S T I C S
********************

FIELD: . . . . . . . . . . .               TYRIHANS
WELL:  . . . . . . . . . . .               6407-1-3
ENGINEER: . . . . . . . . . PS
DATE:  . . . . .            12.36          12 JUL 1984

DEPTH INTERVAL:  . . .  3742.00 TO  3812.00
APPLIED CUTOFFS:
.               VSH:  GREATER THAN       0.40
.              PHIF:      LESS THAN      0.10
.                SW:  GREATER THAN       0.65

 T O T A L    D E P T H
******************************************
THICKNESS: . . . . . . . . .         70.060
AVERAGE   . . . 'PHIF'  . . .         0.098
AVERAGE   . . . 'VSHALE'  . .         0.206
AVERAGE   . . . 'SW'  . . . .         1.563
W.AVERAGE  . . 'SW' * 'PHIF'          1.065
AVERAGE   . . . 'SH'  . . . .         0.039
VOID VOLUME: . . . ('PHIF').          6.894
HC VOID VOLUME . . ('SH'*) .          0.325
RES HC VOID VOLUME ('SHR'*).          0.612
MOV HC VOID VOLUME . . . . .          0.000
******************************************

 N E T    P A Y
******************************************
THICKNESS: . . . . . . . . .          0.000
******************************************

 N E T    S A N D
******************************************
THICKNESS: . . . . . . . . .         38.130
AVERAGE   . . . 'PHIF'  . . .         0.134
AVERAGE   . . . 'VSHALE'  . .         0.108
AVERAGE   . . . 'SW'  . . . .         0.978
W.AVERAGE  . . 'SW' * 'PHIF'          0.977
AVERAGE   . . . 'SH'  . . . .         0.058
VOID VOLUME: . . . ('PHIF').          5.105
HC VOID VOLUME . . ('SH'*) .          0.289
RES HC VOID VOLUME ('SHR'*).          0.410
MOV HC VOID VOLUME . . . . .          0.000
******************************************

 N E T / G R O S S    R A T I O S
******************************************
HNETPAY /HGROSS SAND =  0.00000
HNETSAND/HGROSS SAND =  0.54471
HNETPAY /HNETSAND    =  0.00000
******************************************
```