SOUTH PIERSON

LOWER AMARANTH POROSITY DETERMINATION

John S. Murray
Glen D. Lawrence

INTRODUCTION

The purpose of this brief report is to obtain approval for a reduction in the open hole logging, recommended in the South Pierson Lower Amaranth Oil Pool.

In the "Evaluation of the Lower Amaranth Formation in the South Pierson Field, Southwestern Manitoba" a recent publication by the Manitoba Government, the author M. Arbez concluded that both the Neutron and Density were necessary in the determination of accurate Lower Amaranth porosities. It was recommended that these logs be run in tandem (or a Sonic log) along with a Dual Induction log for the minimum requirements for proper reservoir evaluation.

This report attempts to demonstrate that accurate porosity determination in the Lower Amaranth can be obtained with the Density log alone.

1. Porosity Determination

The empirically derived equation for calculating total porosity (ϕ T) has been given by the board as:

$$\phi\ T = (0.52\ [\text{Neutron Porosity}] + \text{Density Porosity Value})/1.52$$

(The porosity values are in % - sandstone scale)

This suggests that the porosity determination from logs is biased to the density value and only half of the neutron value contributes to the porosity reading. In the Board's empirically derived equation for calculating effective porosity the Density log is weighted even more heavily (84%).

Glen Lawrence, of Home Oil's petrophysical group has been calculating Lower Amaranth porosities using only the Density log with a small shift for grain density. The 14-9-2-29W1 well is used to help explain Home's methodology used for porosity determination.

2. Grain Density

A grain density histogram of the Lower Amaranth core in 14-9-2-29W1 is shown in Figure 1. The mean density of 2740.2 kg/m^3 does not reflect the grain density of the reservoir rock. The reservoir has been identified through core, petrographic, and petrophysical analysis as a dirty, very fine sandstone to siltstone rather than a clean sand. In fact, the clean sand which has low API gamma ray values (~35) is pervasively cemented with anhydrite and is thus dense as well as tight. An example of this tighter "reservoir" (some streaks do contribute) is shown in Figure 2 in 14-9 from 1025.0m to 1026.0m KB. In this interval the permeability is shown to have an inverse relationship with the Gamma Ray

log. The higher permeability rock is observed immediately above and below this unit where the sand contains more clay, is finer grained and has less anhydrite (less dense).

When the higher grain densities are eliminated we observe in Figure 3 that the mean is 2723 kg/m^3 for the 14-9 well. We have found that for all wells an average of 2730 kg/m^3 is an appropriate grain density to use for evaluating porosities of the reservoir.

3. **Core To Log Correlation Using Density Log**

Figure 4 shows the corrélation of core porosity (CPOR) to the high resolution Density log (limestone matrix) that has been shifted to a grain density of 2730 kg/m^3 (PD 2730). Visually, this is obviously a very good correlation, statistics confirm this with a correlation coefficient of 0.837 and a slope of 1.025 for the best fit line (in Figure 5). For this particular well the **b** value or **y** intercept suggests that a quarter of a percent shift could make a slightly better correlation.

4. **Core To Log Correlation Using Government Equation**

The Board's empirically derived equation $\phi T = (0.52\ \phi N + \phi D)/1.52$ has been called PDTOT here and is correlated with the core porosity of 14-9-2-29W1 in Figure 6. While a good correlation is observed, statistics of the crossplot of these two curves shown in Figure 7 reveal that the correlation coefficient is slightly higher than the density (PD 2730) and PDTOT correlation. The slope of the best fit line calculates to a respectable 0.952 with a **b** value of 1.703. The PD 2730 vs core porosity appears to be a slightly better correlation considering these last two parameters.

5. **Government vs Home's Porosity Log Correlation**

Figure 8 shows a correlation between the Manitoba Governments empirically derived porosity log (PDTOT) and Home's shifted density log (PD 2730). An extremely good correlation exists with a minor shift of a fifth of a porosity percent. A crossplot of these two logs is shown in Figure 9. A high correlation of fit of 0.969 and a slope of 1.036 confirm that an excellent correlation exists between the two logs. This demonstrates that although two different methods were used to calculate porosities both methods are very close to actual total porosity values as well as highly correlatable to each other.

6. **Effective Porosity Correlation**

M. Arbez also determined empirically an equation for correlation of Neutron-Density to effective porosity. This was based on humidity dried core analysis for four wells. The effective porosity can be calculated using the following formula: $\phi E = (0.16\ \phi N + \phi D)/1.16$ (ϕ is porosity percent, sandstone scale).

The curve for this equation is shown along with Home's Density curve in Figure 10.

A crossplot of these two curves show how closely they correlate (Figure 11). Of course these two curves should correlate closely since the PD2730 log is 100% density and the PDEF is 84% density with 16% of the Neutron porosity also contributing. To approximate the effective porosity, a shift of the Density log (PD 2730) of three porosity units (2.945 on y intercept) is all that is required.

7. Porosity Determination From Field Logs

To estimate <u>total</u> porosity from a high resolution Density log, use the limestone matrix and add one (1) porosity unit (pu) to the value on the logs. This can be done since it has been shown that a grain density of 2730 kg/m^3 for Density log closely approximates total porosity from core. Since the grain density for limestone is 2710 kg/m^3 and since 20 kg/m^3 (the difference) is equivalent to 1.2 porosity units, simply add one (1) porosity unit to the value observed. A limestone matrix, high resolution density log which reads 15% porosity would be equal to 16% total porosity.

To estimate <u>effective</u> porosity from a high resolution Density log, use the limestone matrix and subtract 2.0 porosity units. It was shown that a shift of 3 porosity units on the density log with a 2730 kg/m^3 grain density (PD 2730) closely approximates <u>effective</u> porosity. That is, the actual porosity value would be approximately 3 porosity units smaller than the total porosity value. In order to estimate the effective porosity on a limestone matrix (2710 kg/m^3) high resolution density log simply subtract 2 porosity units (ie. add one for grain density and subtract 3 for total to effective porosity correlation).

8. Conclusions

1) Grain Density of the reservoir rock is close to 2730 kg/m^3.

2) Reservoir is very fine sandstone to siltstone that has high Gamma Ray values due to relatively high clay content. This has low anhydrite cement and is less dense than clean anhydrite sand, which does not contribute largely to production.

3) A high resolution Density log (limestone scale) with a 20 kg/m^3 shift for grain density, closely approximates total porosity values in core.

4) A Density log (limestone scale) shifted 2.0 porosity units can closely approximate effective porosity values obtained from humidity dried core.

5) A Neutron log is not necessary for porosity determination.

9. Recommendations

The Manitoba Government has made public a document on the South Pierson field that is valuable to both Home Oil and industry in general, and we fully support further studies.

We recommend that the minimum requirements for logging the Lower Amaranth be changed to "Sonic log or Density log" rather than "Sonic log or Compensated Neutron-Formation Density log in tandem", along with the Dual Induction.

We seek approval to change the logging programs of the 1991 wells by eliminating the neutron tool.

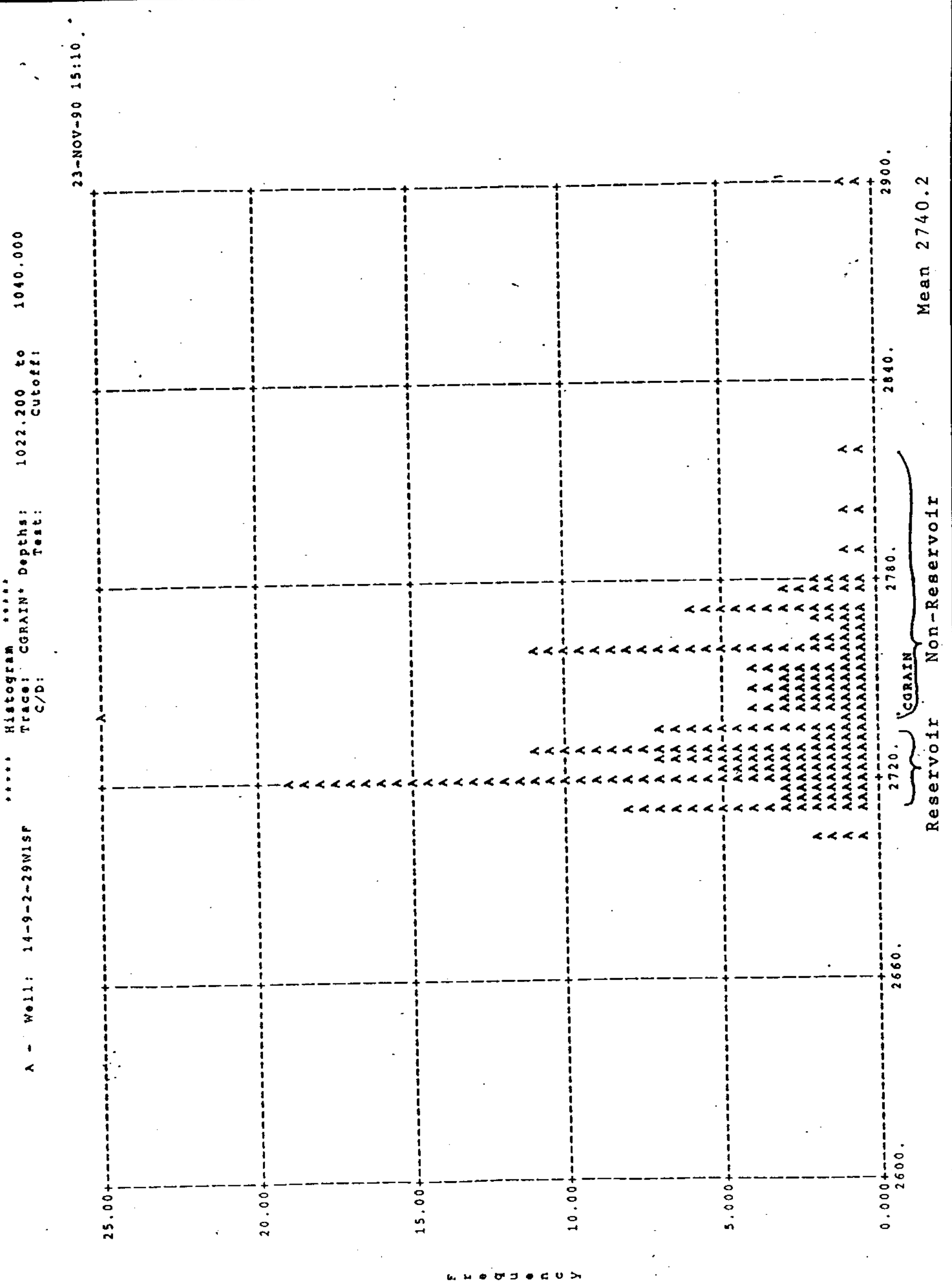

A - Well: 14-9-2-29W1SF
***** Histogram *****
Trace: 'CGRAIN' Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:
23-NOV-90 15:10
25.00
20.00
15.00
10.00
5.000
0.000
2600.
2660.
2720.
2780.
2840.
2900.
CGRAIN
Reservoir
Non-Reservoir
Mean 2740.2
Frequency

Figure 1.

Clean GR with
low KMAX value

(ss with low clay
content but high
anhydrite cmt result-
ing in low por. and
perm.)

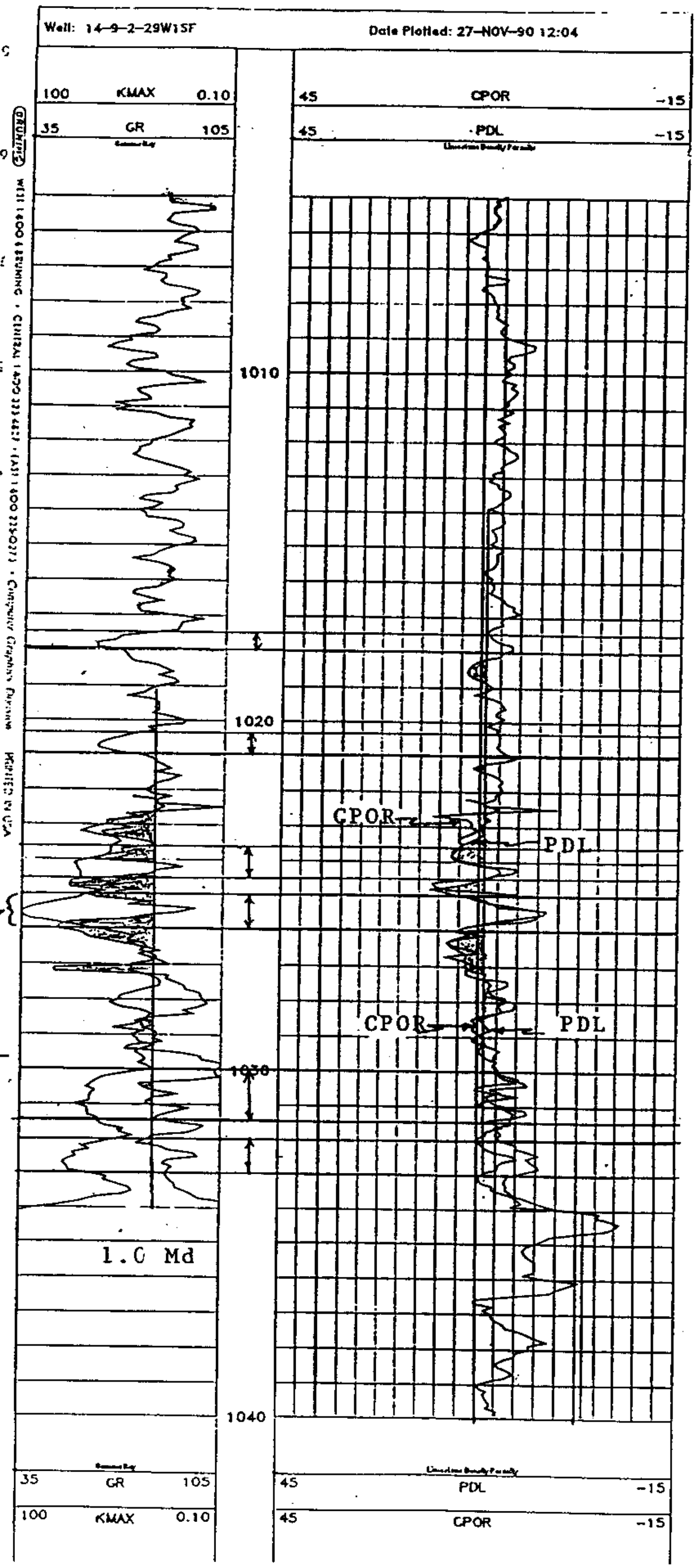


Figure 2.

***** Histogram *****

A - Well: 14-9-2-29W1SF   Trace: CGRAIN* Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:

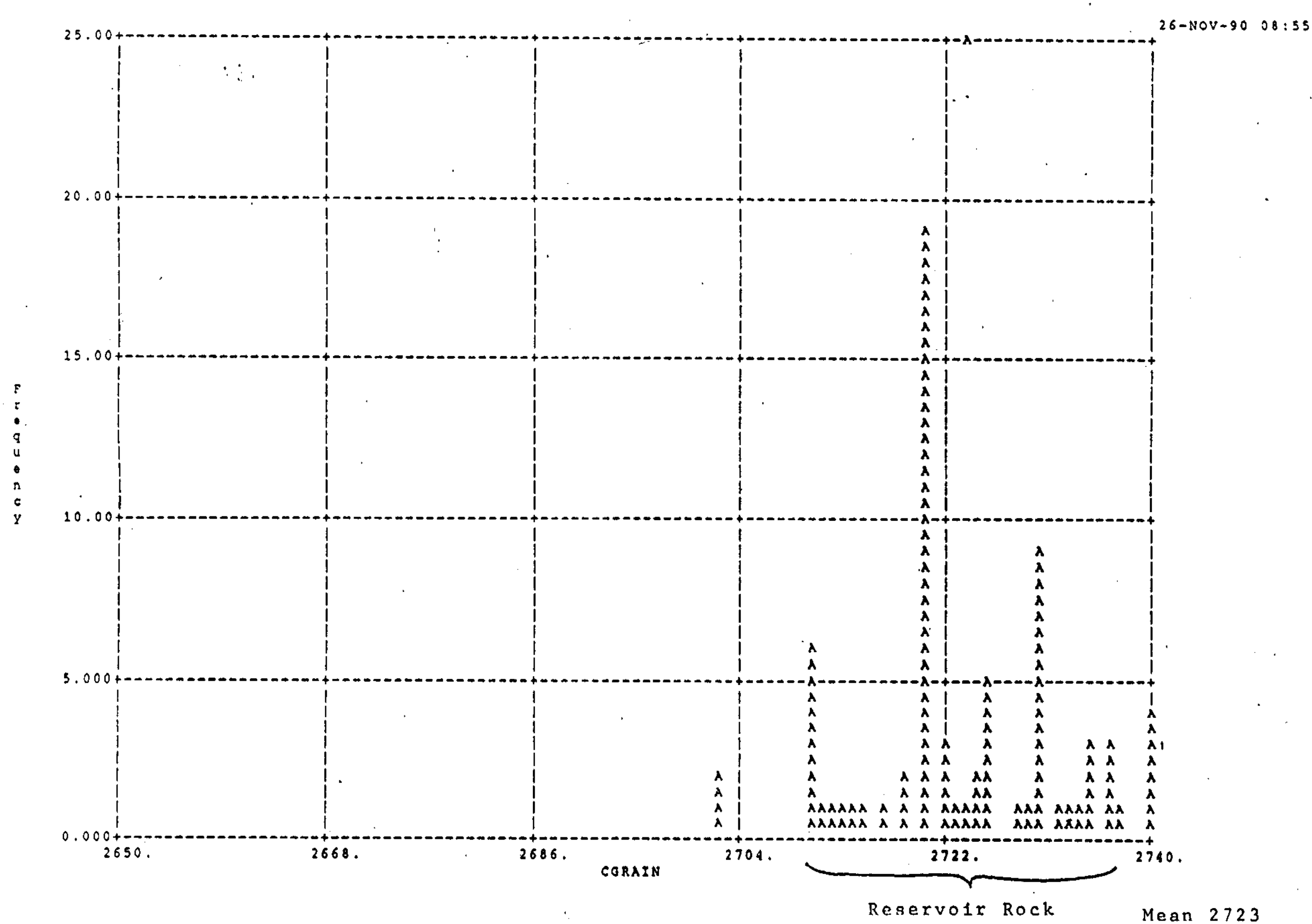
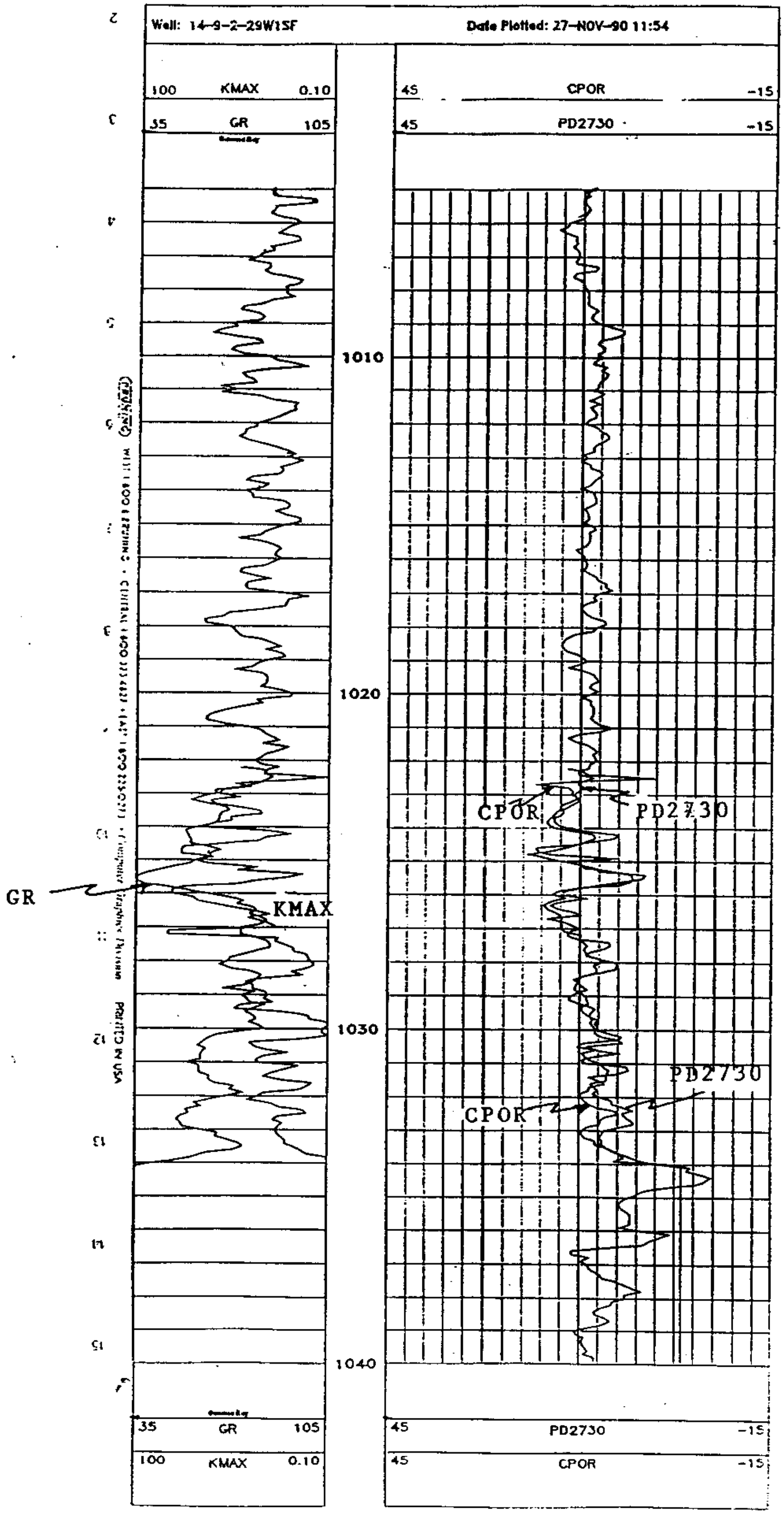


Figure 3.



Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 11:54
100 KMAX 0.10
35 GR 105
45 CPOR -15
45 PD2730 -15
1010
1020
1030
1040
GR
KMAX
CPOR
PD2730
CPOR
PD2730
35 GR 105
100 KMAX 0.10
45 PD2730 -15
45 CPOR -15

Figure 4.

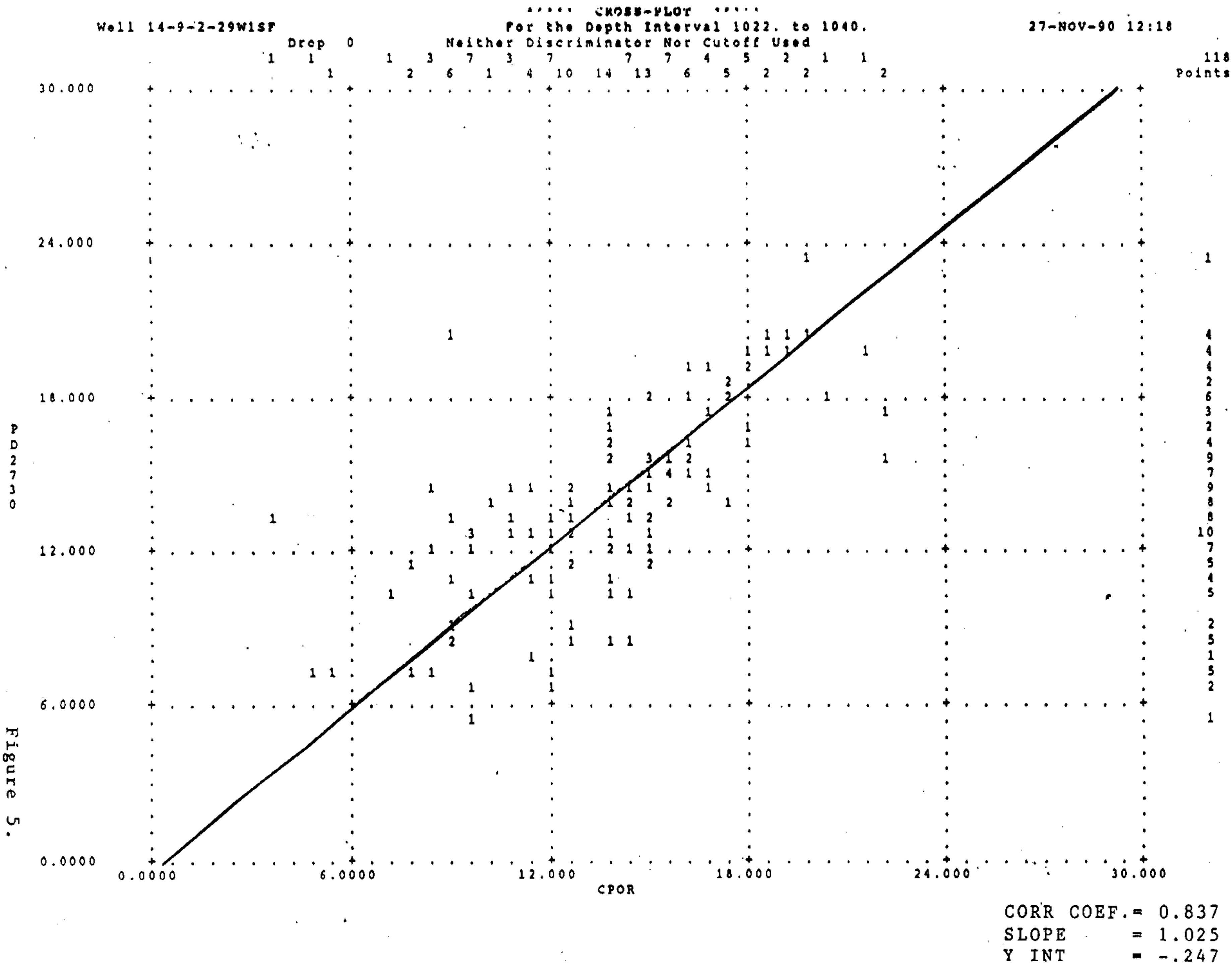

***** CROSS-PLOT *****
Well 14-9-2-29W1SF
For the Depth Interval 1022. to 1040.
27-NOV-90 12:18
Drop 0
Neither Discriminator Nor Cutoff Used
118 Points
PD2730
CPOR
0.0000
6.0000
12.000
18.000
24.000
30.000
CORR COEF.= 0.837
SLOPE = 1.025
Y INT = -.247

Figure 5.

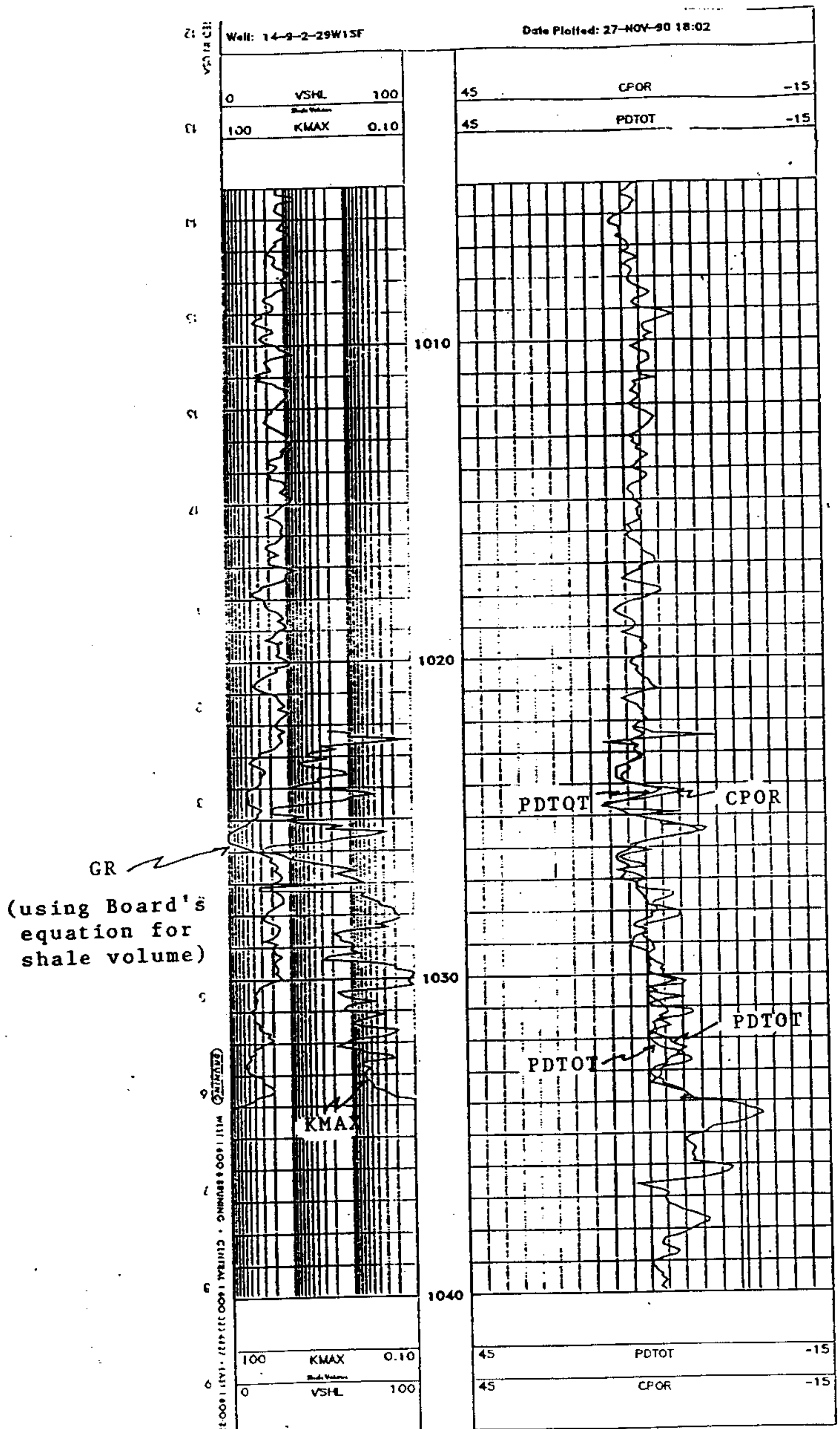

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 18:02
0 VSHL 100
100 KMAX 0.10
45 CPOR -15
45 PDTOT -15
1010
1020
1030
1040
PDTOT
CPOR
PDTOT
PDTOT
GR
(using Board's equation for shale volume)
KMAX
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 CPOR -15

Figure 6

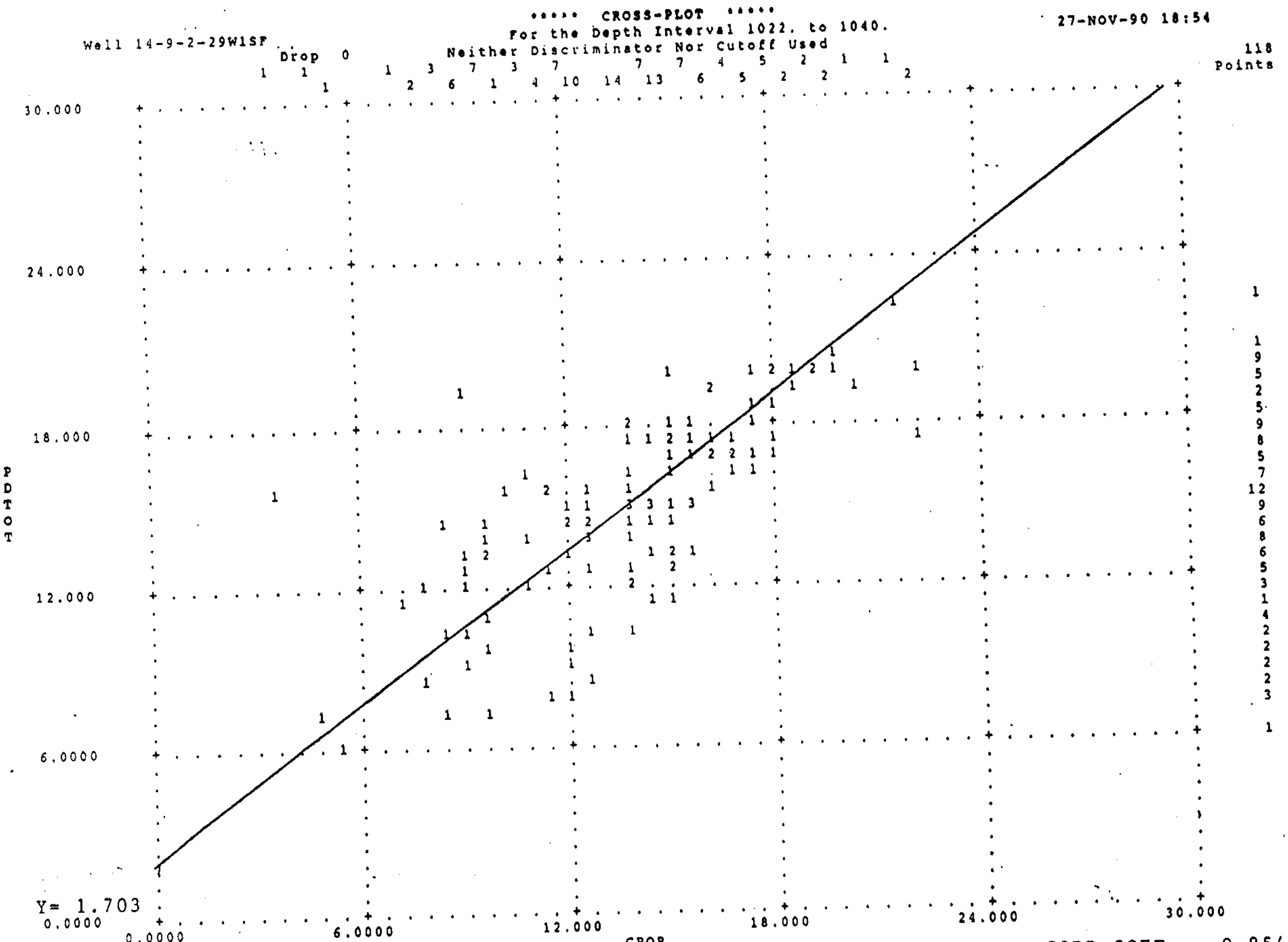


Figure 7.

CORR COEF. = 0.854
SLOPE = 0.952
Y INT. = 1.703

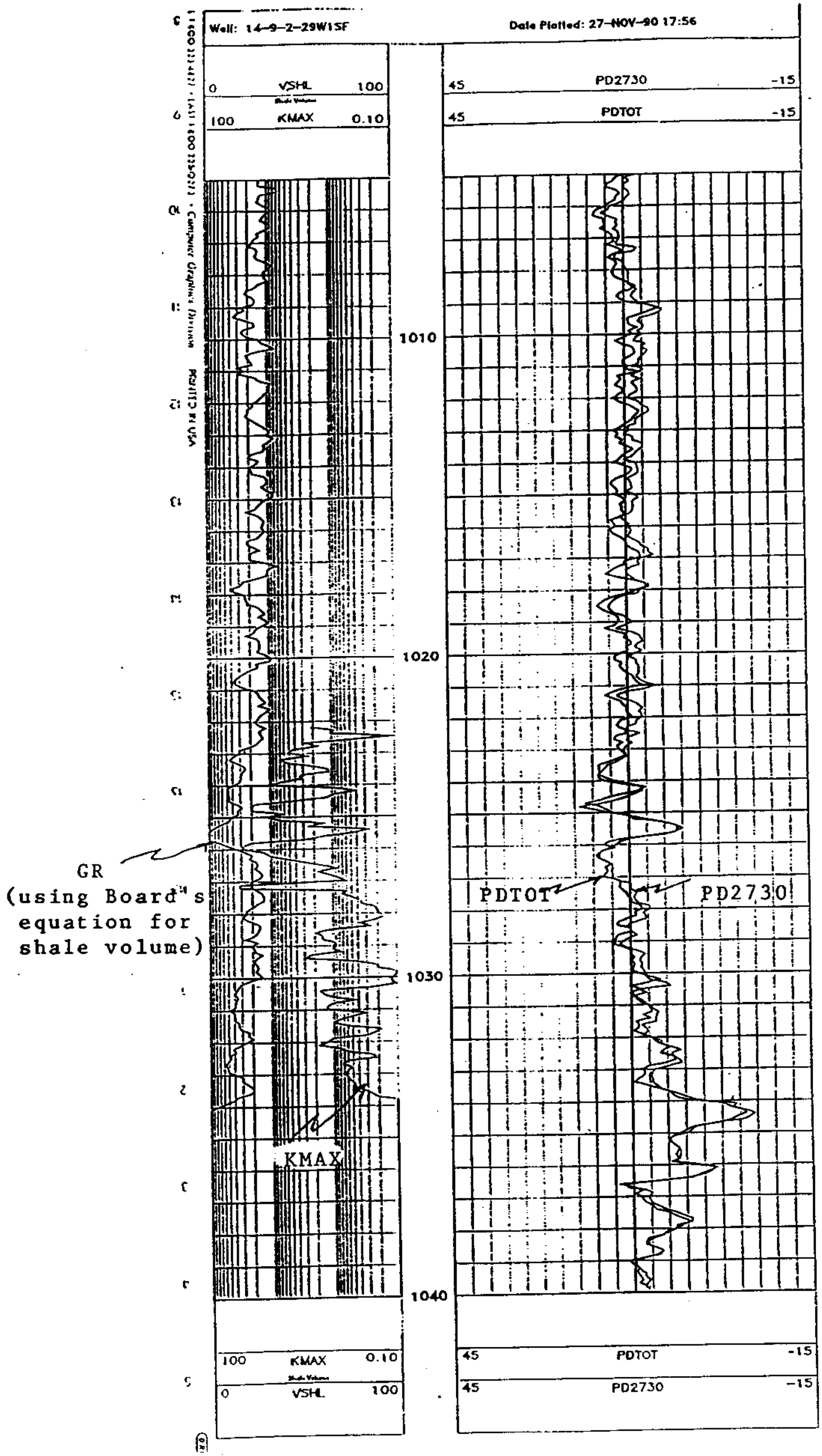

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 17:56
0 VSHL 100
100 KMAX 0.10
45 PD2730 -15
45 PDTOT -15
1010
1020
1030
1040
GR
(using Board's
equation for
shale volume)
KMAX
PDTOT
PD2730
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 PD2730 -15

Figure 8.

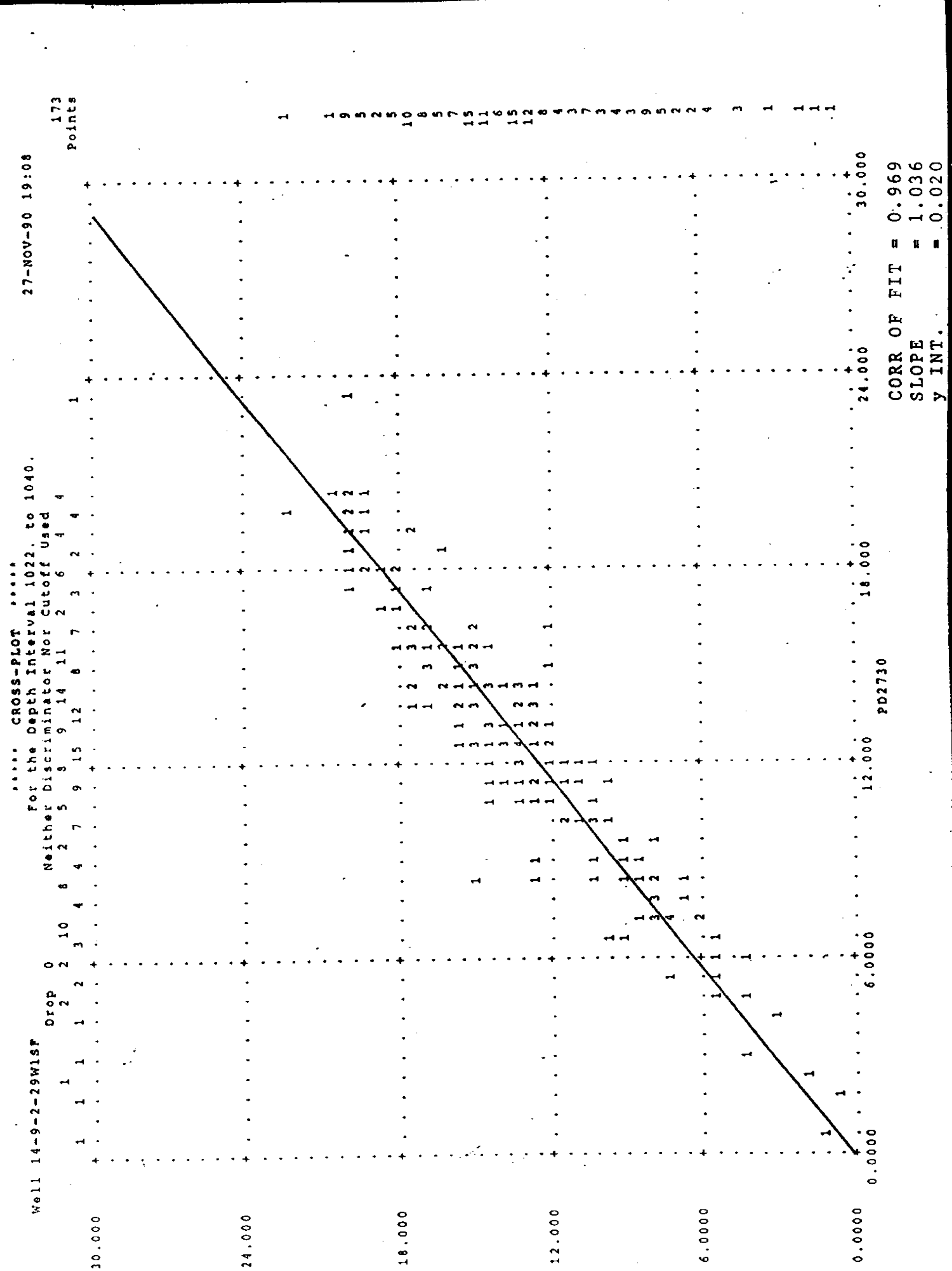

Well 14-9-2-29W1SP
***** CROSS-PLOT *****
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used
27-NOV-90 19:08
173 Points
Drop
PD2730
CORR OF FIT = 0.969
SLOPE = 1.036
y INT. = 0.020

Figure 9.

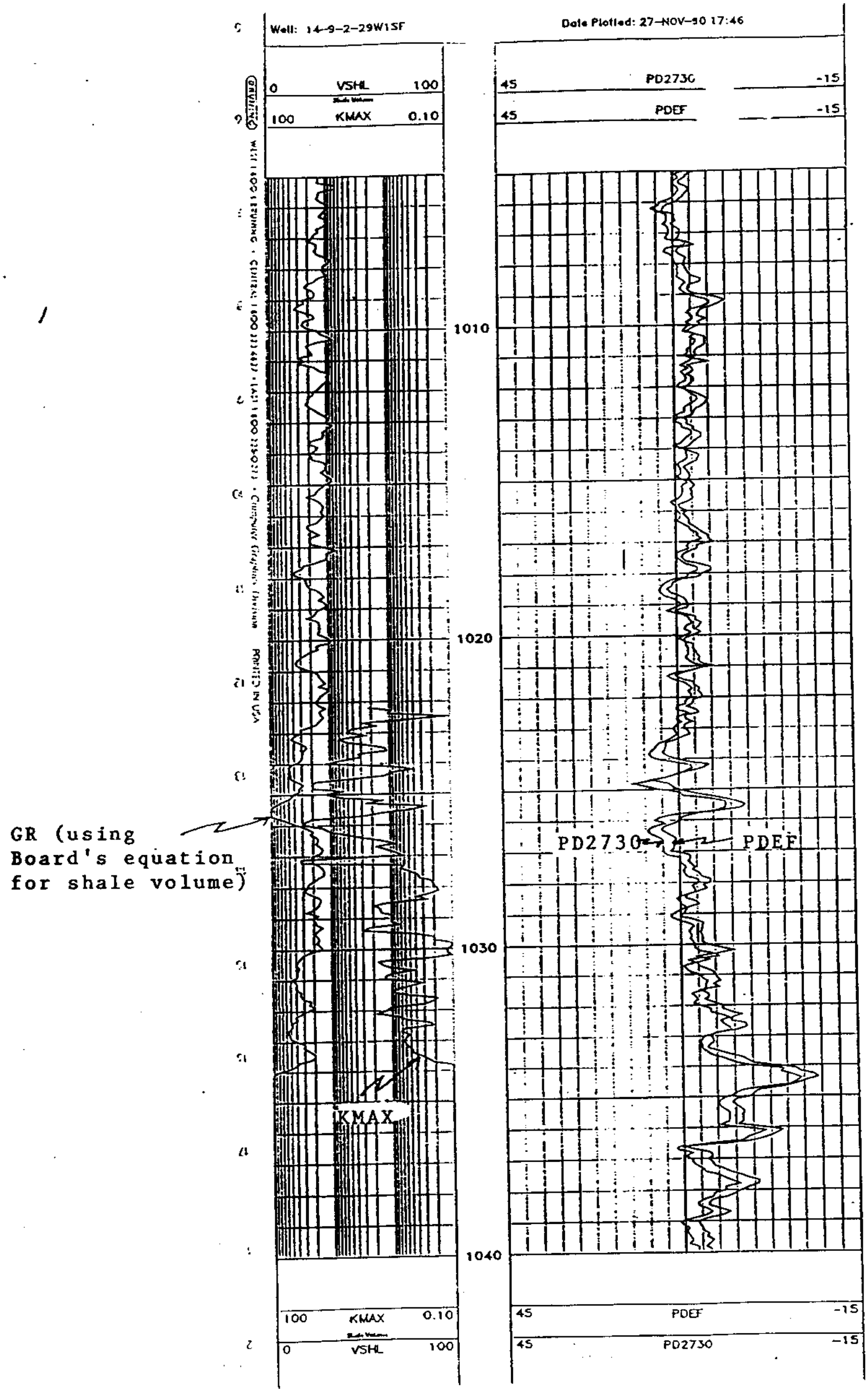
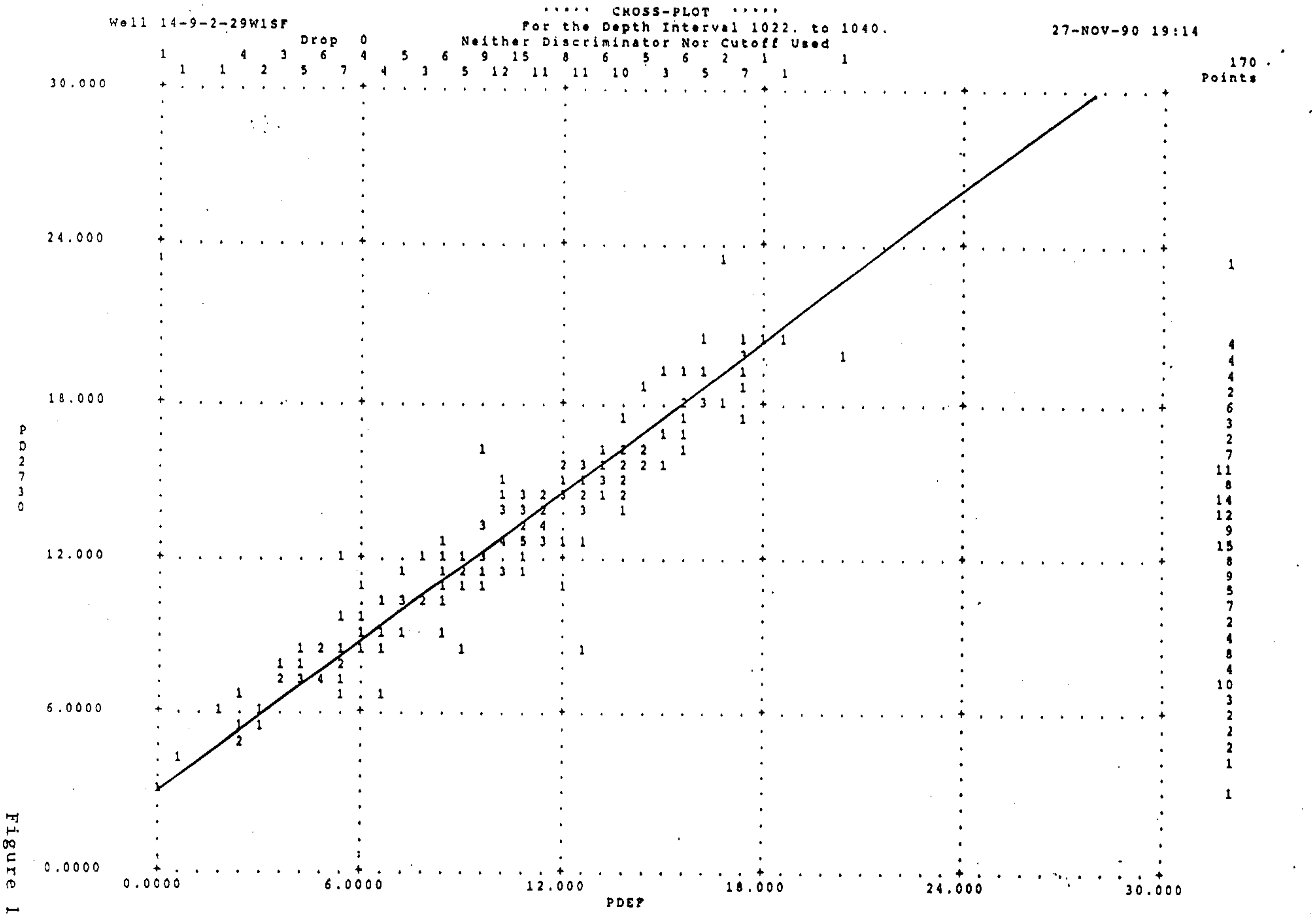

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 17:46
0 VSHL 100
100 KMAX 0.10
45 PD2730 -15
45 PDEF -15
1010
1020
1030
1040
GR (using Board's equation for shale volume)
PD2730
PDEF
KMAX
100 KMAX 0.10
0 VSHL 100
45 PDEF -15
45 PD2730 -15

Figure 10.



CORR OF FIT = 0.974
SLOPE = 0.948
Y INT. = 2.945

Figure 11.

JOHN
- See Marc's
comments
Bob

File: S Pierson
Lower Amaranth
B Pool
Log Analysis Report
or something like
that

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ie ~~[illegible]~~ does the well appear clean or shaly clay rich? test this theory over clay-rich interval.

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To estimate effective porosity from a high resolution Density log, use the limestone matrix and subtract 2.0 porosity units. It was shown that a shift of 3 porosity units on the density log with a 2730 kg/m^3 grain density (PD 2730) closely approximates effective porosity. That is, the actual porosity value would be approximately 3 porosity units smaller than the total porosity value. In order to estimate the effective porosity on a limestone matrix (2710 kg/m^3) high resolution density log simply subtract 2 porosity units (ie. add one for grain density and subtract 3 for total to effective porosity correlation).

8. Conclusions

1) Grain Density of the reservoir rock is close to 2730 kg/m^3.

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3) A high resolution Density log (limestone scale) with a 20 kg/m^3 shift for grain density, closely approximates total porosity values in core.

4) A Density log (limestone scale) shifted 2.0 porosity units can closely approximate effective porosity values obtained from humidity dried core. !

5) A Neutron log is not necessary for porosity determination. &

As clay content increases, this becomes less true! (see my CNF-FDC crossplots in my report)

9. **Recommendations**

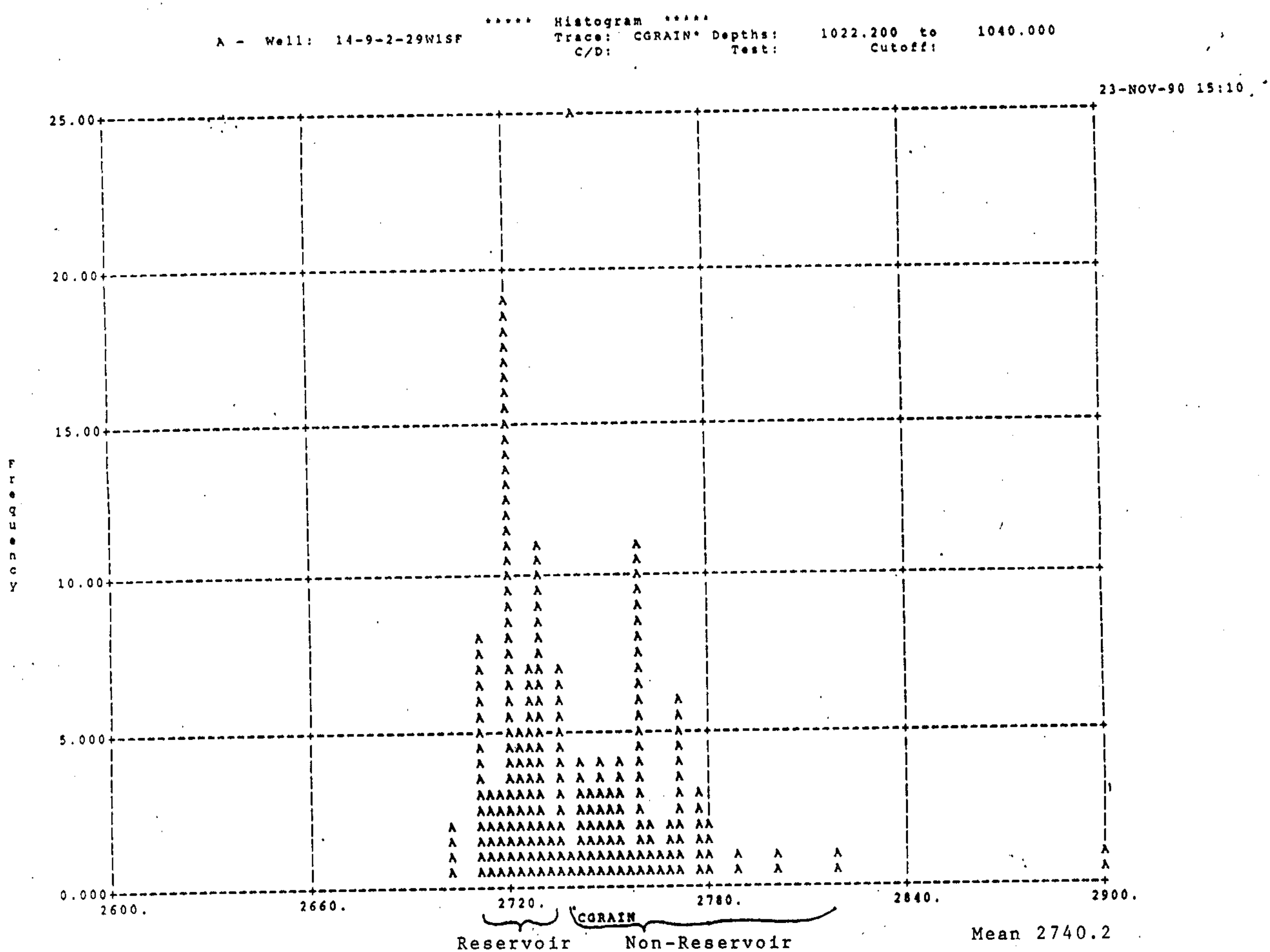
The Manitoba Government has made public a document on the South Pierson field that is valuable to both Home Oil and industry in general, and we fully support further studies.

We recommend that the minimum requirements for logging the Lower Amaranth be changed to "Sonic log or Density log" rather than "Sonic log or Compensated Neutron-Formation Density log in tandem", along with the Dual Induction.

We seek approval to change the logging programs of the 1991 wells by eliminating the neutron tool.

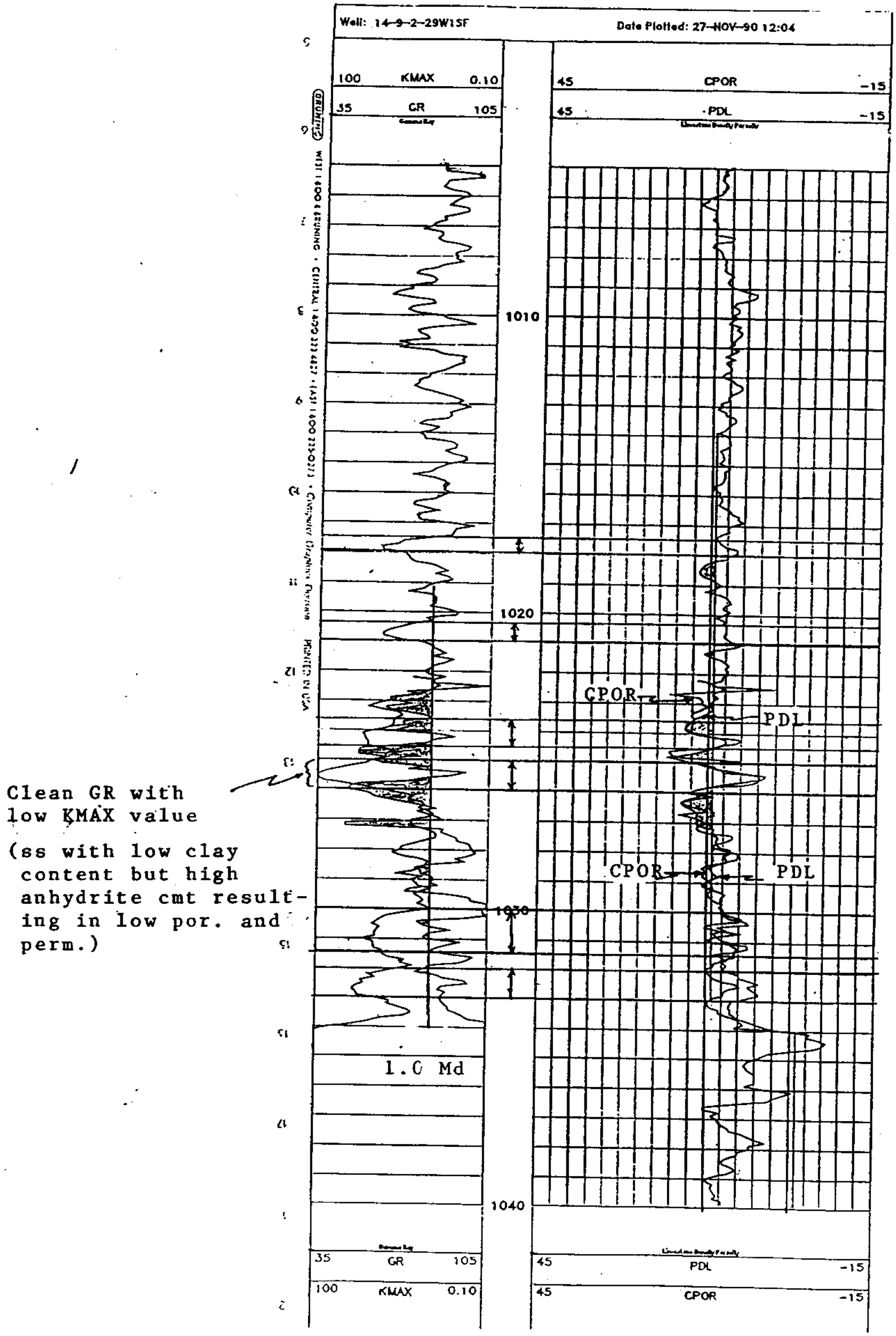
not nearly as bad as before (ie no porosity logs)
- in agreement because ~~Home~~ of different approach Home has
- still think they may be finding oil too low in sandy unit where GR appears clay-rich
- see also M. Husain's appendix to locate residual oil on core samples which appear to match my picks a bit better than Home's (I'm not bitching here, just convinced I guess).
I think Home has placed too much emphasis on core Kmax as opposed to logs suite - the logs don't lie, but core might, having been handled and shaken around prior to measurements - see my memo in file (John)

~~I too ok~~
1 porosity log is much better than none. Home is convinced they can do a good analysis without CNL. OK by me!
Marc



A - Well: 14-9-2-29W1SF
***** Histogram *****
Trace: CGRAIN* Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:
23-NOV-90 15:10
25.00
20.00
15.00
10.00
5.000
0.000
Frequency
2600.
2660.
2720.
2780.
2840.
2900.
CGRAIN
Reservoir
Non-Reservoir
Mean 2740.2

Figure 1.



Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 12:04
100 KMAX 0.10
35 GR 105
45 CPOR -15
45 PDL -15
1010
1020
1030
1040
CPOR
PDL
CPOR
PDL
Clean GR with low KMAX value
(ss with low clay content but high anhydrite cmt resulting in low por. and perm.)
1.0 Md
35 GR 105
100 KMAX 0.10
45 PDL -15
45 CPOR -15

Figure 2.

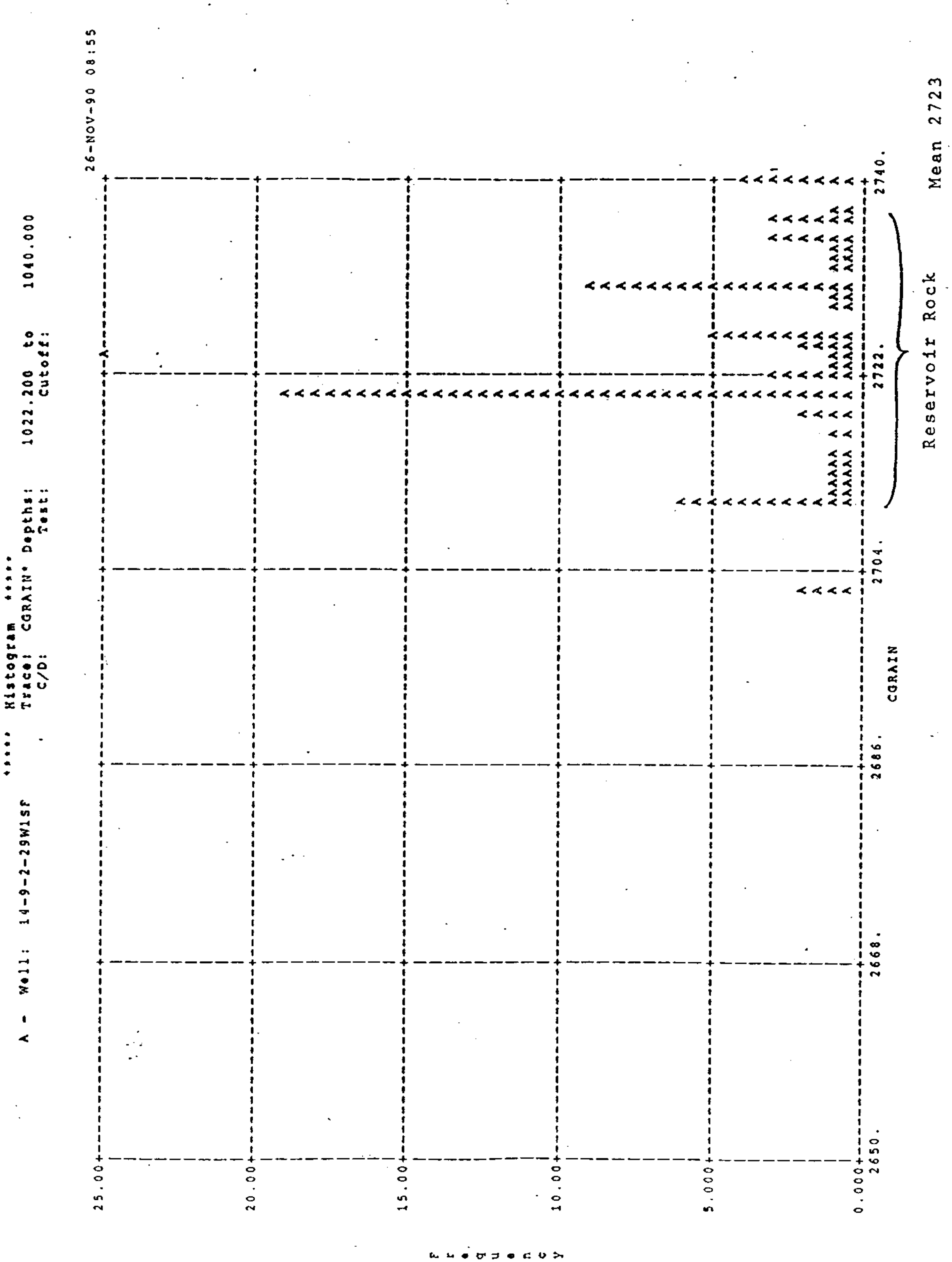
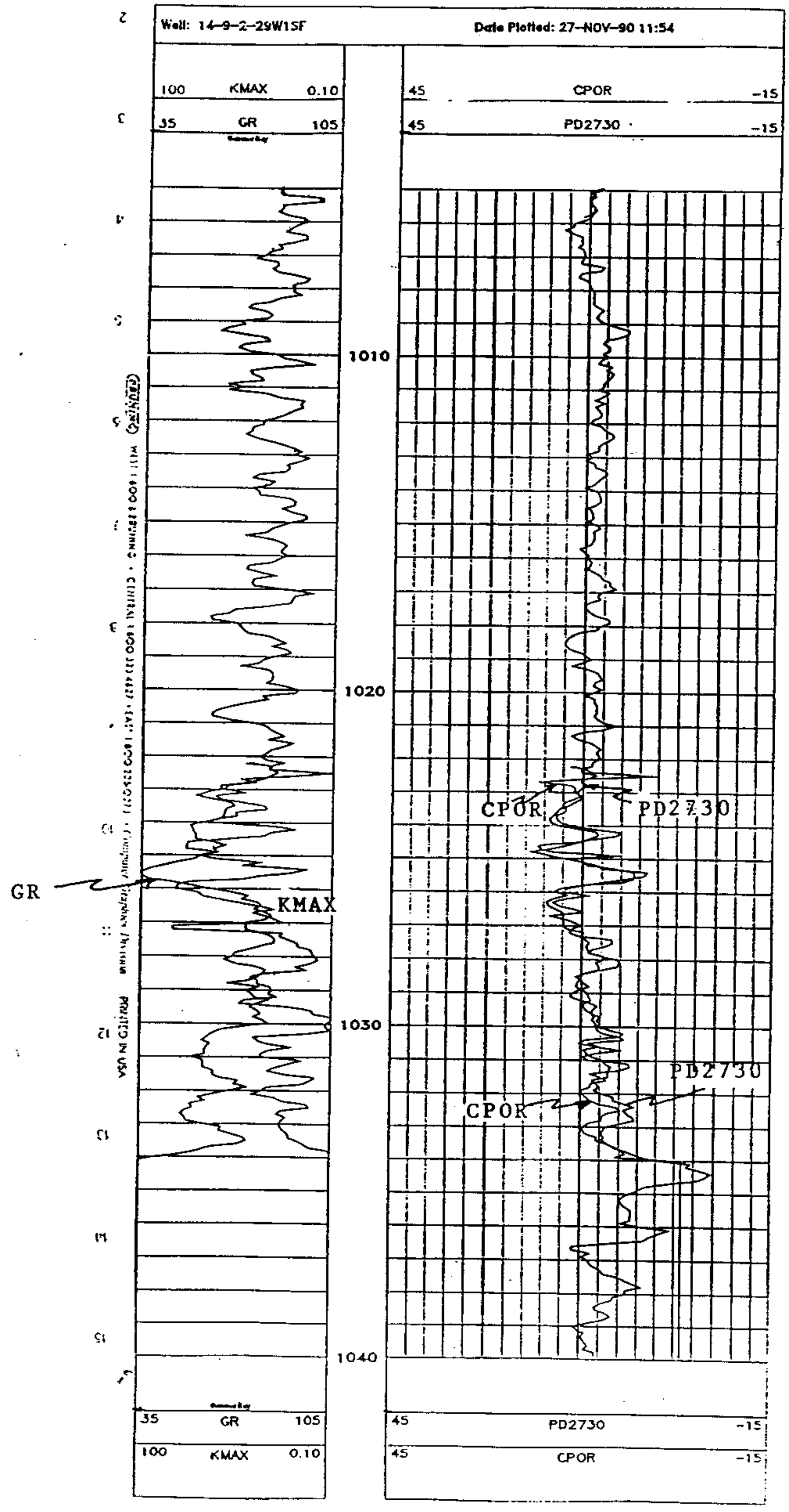

A - Well: 14-9-2-29W1SF
***** Histogram *****
Trace: CGRAIN' Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:
26-NOV-90 08:55
25.00
20.00
15.00
10.00
5.000
0.000
Frequency
2650.
2668.
2686.
2704.
2722.
2740.
CGRAIN
Reservoir Rock
Mean 2723

Figure 3.



Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 11:54
100 KMAX 0.10
35 GR 105
45 CPOR -15
45 PD2730 -15
1010
1020
1030
1040
GR
KMAX
CPOR
PD2730
CPOR
PD2730
35 GR 105
100 KMAX 0.10
45 PD2730 -15
45 CPOR -15

Figure 4.

***** CROSS-PLOT *****

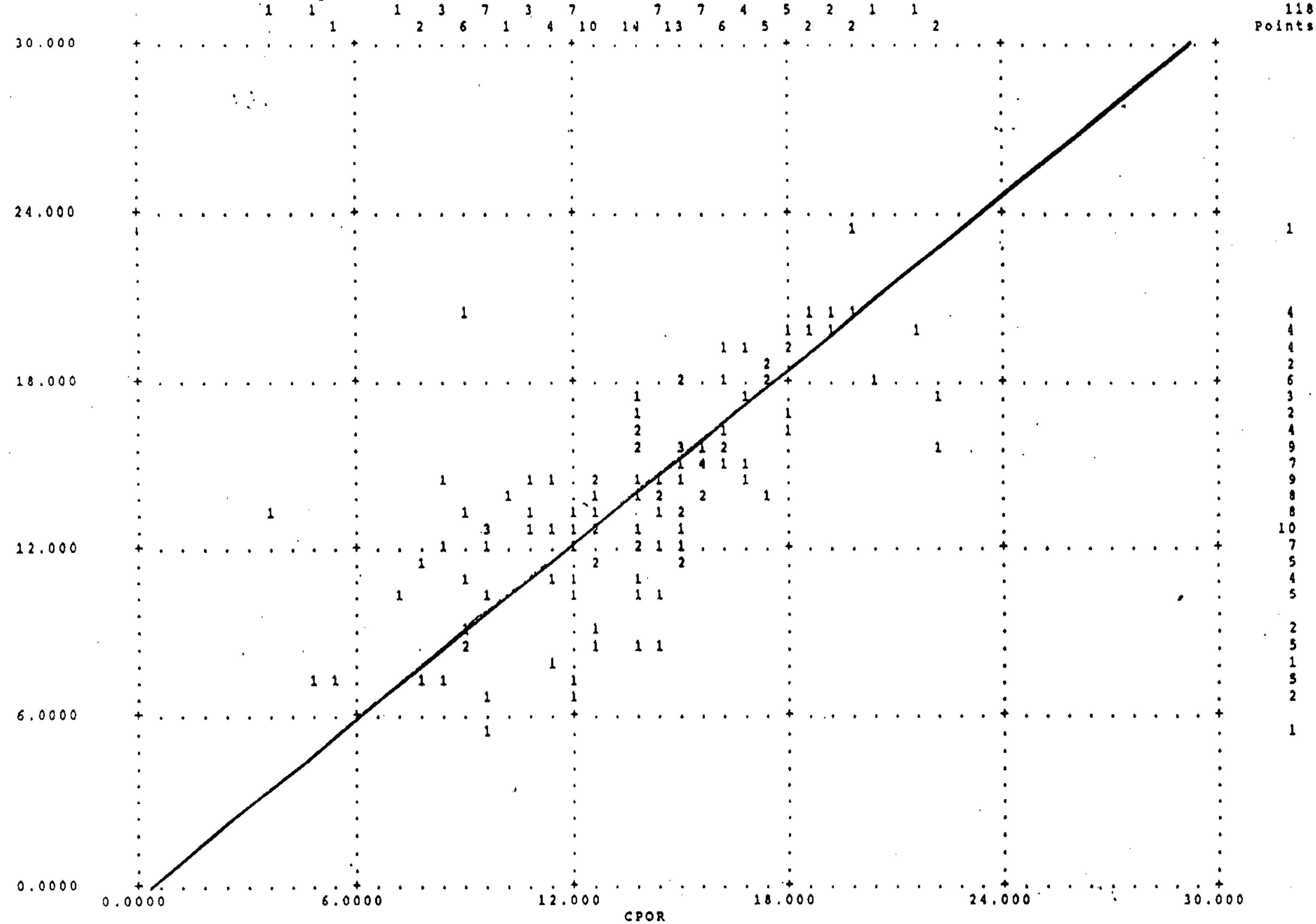
Well 14-9-2-29W1SF

For the Depth Interval 1022. to 1040.

27-NOV-90 12:18

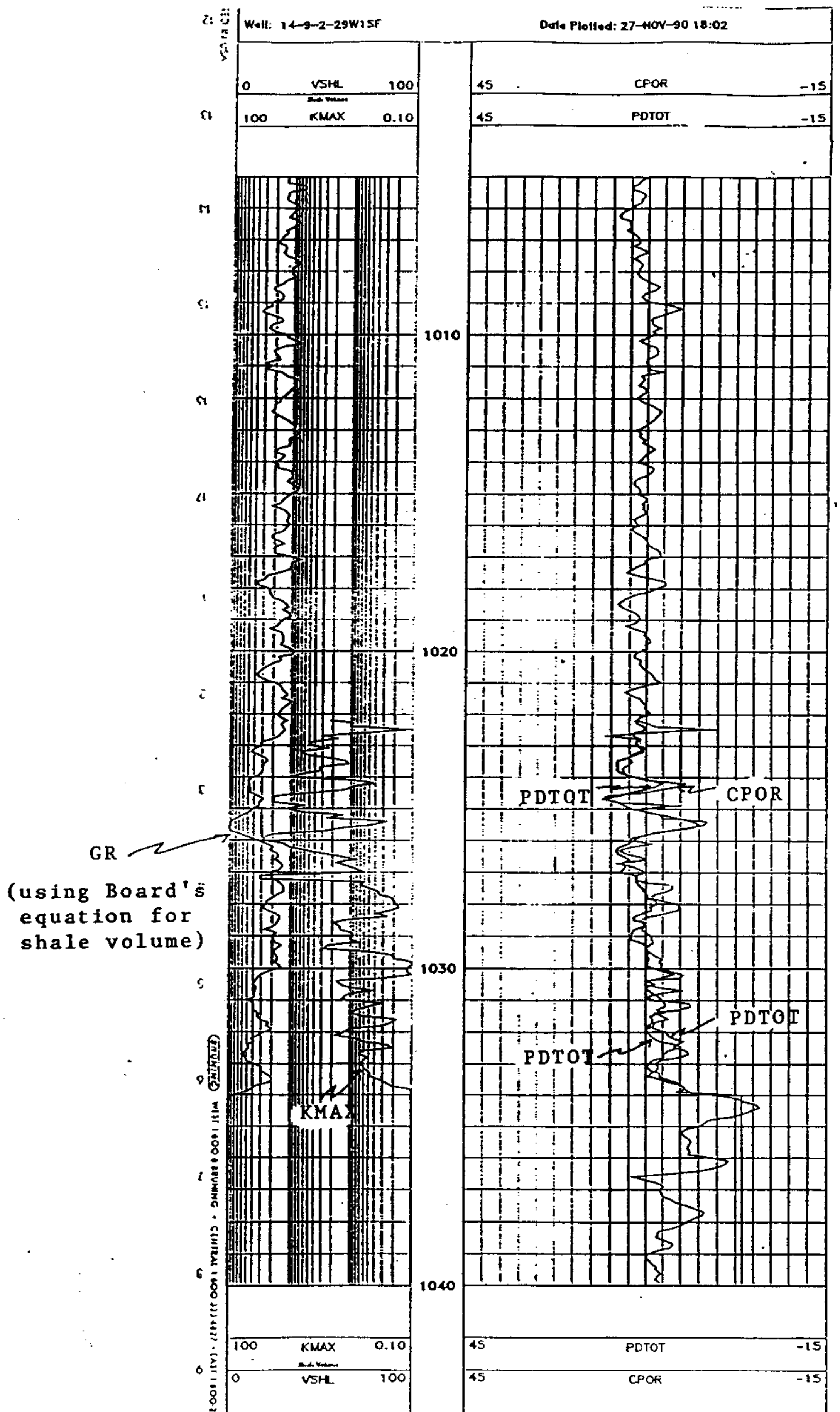
Drop 0

Neither Discriminator Nor Cutoff Used



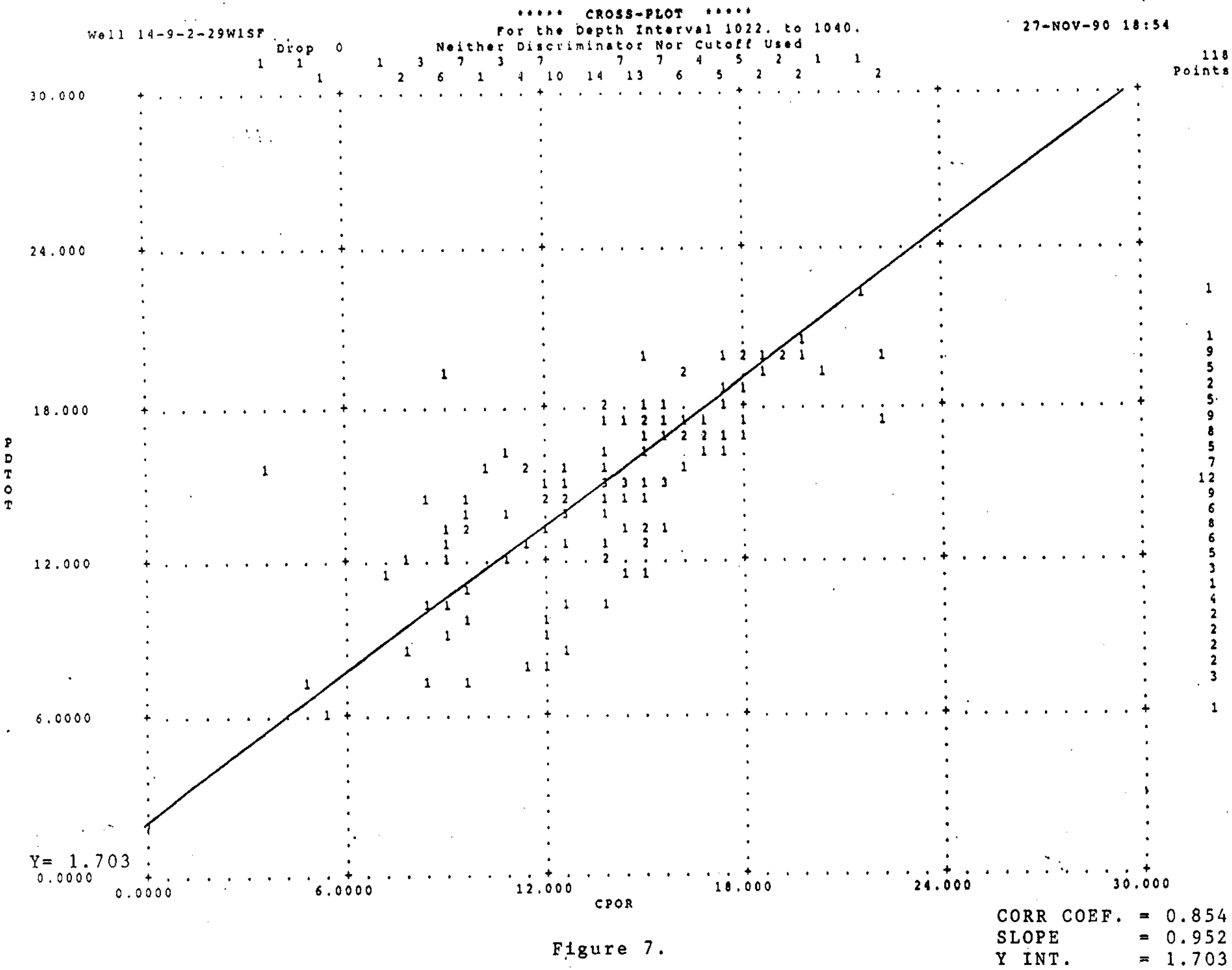
CORR COEF.= 0.837
SLOPE = 1.025
Y INT = -.247

Figure 5.



Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 18:02
0 VSHL 100
100 KMAX 0.10
45 CPOR -15
45 PDTOT -15
1010
1020
1030
1040
PDTOT
CPOR
GR
(using Board's equation for shale volume)
PDTOT
PDTOT
KMAX
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 CPOR -15

Figure 6



***** CROSS-PLOT *****
Well 14-9-2-29W1SF
For the Depth Interval 1022. to 1040.
27-NOV-90 18:54
Drop 0
Neither Discriminator Nor Cutoff Used
118
Points
30.000
24.000
18.000
12.000
6.0000
0.0000
PDTOT
Y= 1.703
0.0000
6.0000
12.000
18.000
24.000
30.000
CPOR
CORR COEF. = 0.854
SLOPE = 0.952
Y INT. = 1.703

Figure 7.

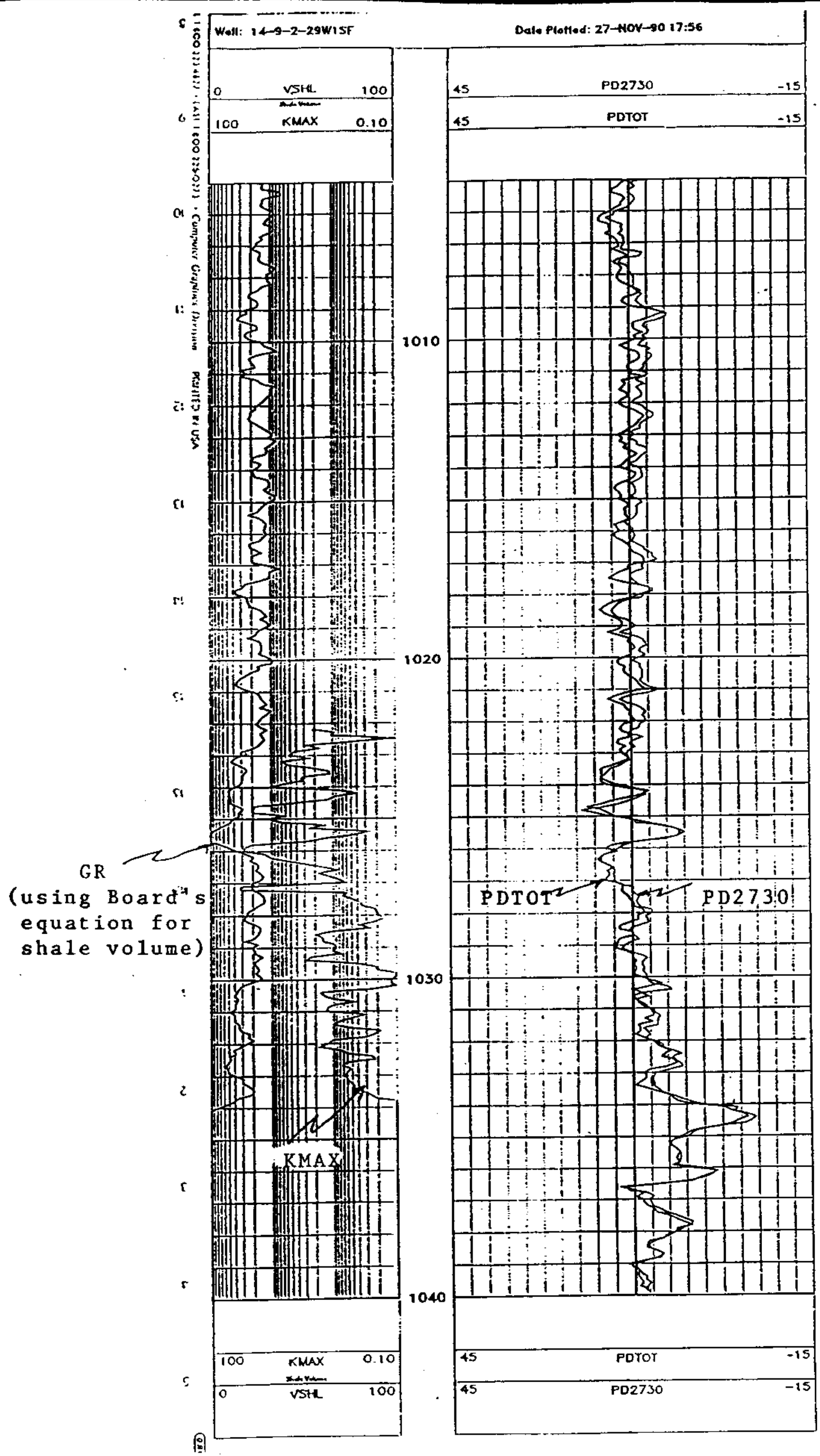

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 17:56
0 VSHL 100
100 KMAX 0.10
45 PD2730 -15
45 PDTOT -15
1010
1020
1030
1040
GR
(using Board's
equation for
shale volume)
PDTOT
PD2730
KMAX
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 PD2730 -15

Figure 8.

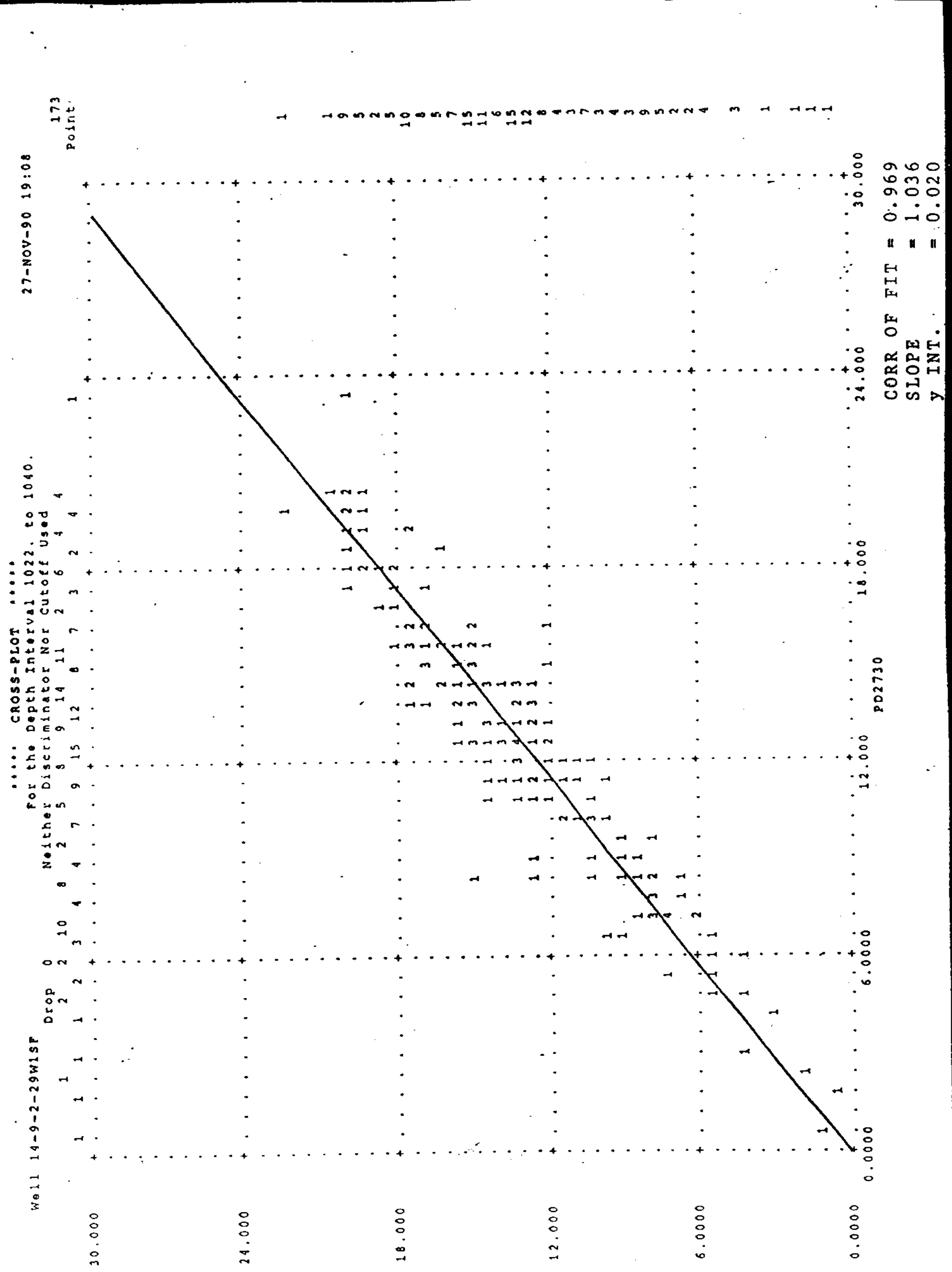

Well 14-9-2-29W1SF
***** CROSS-PLOT *****
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used
27-NOV-90 19:08
Drop
173
Points
0.0000
6.0000
12.000
18.000
24.000
30.000
PD2730
CORR OF FIT = 0.969
SLOPE = 1.036
Y INT. = 0.020

Figure 9.

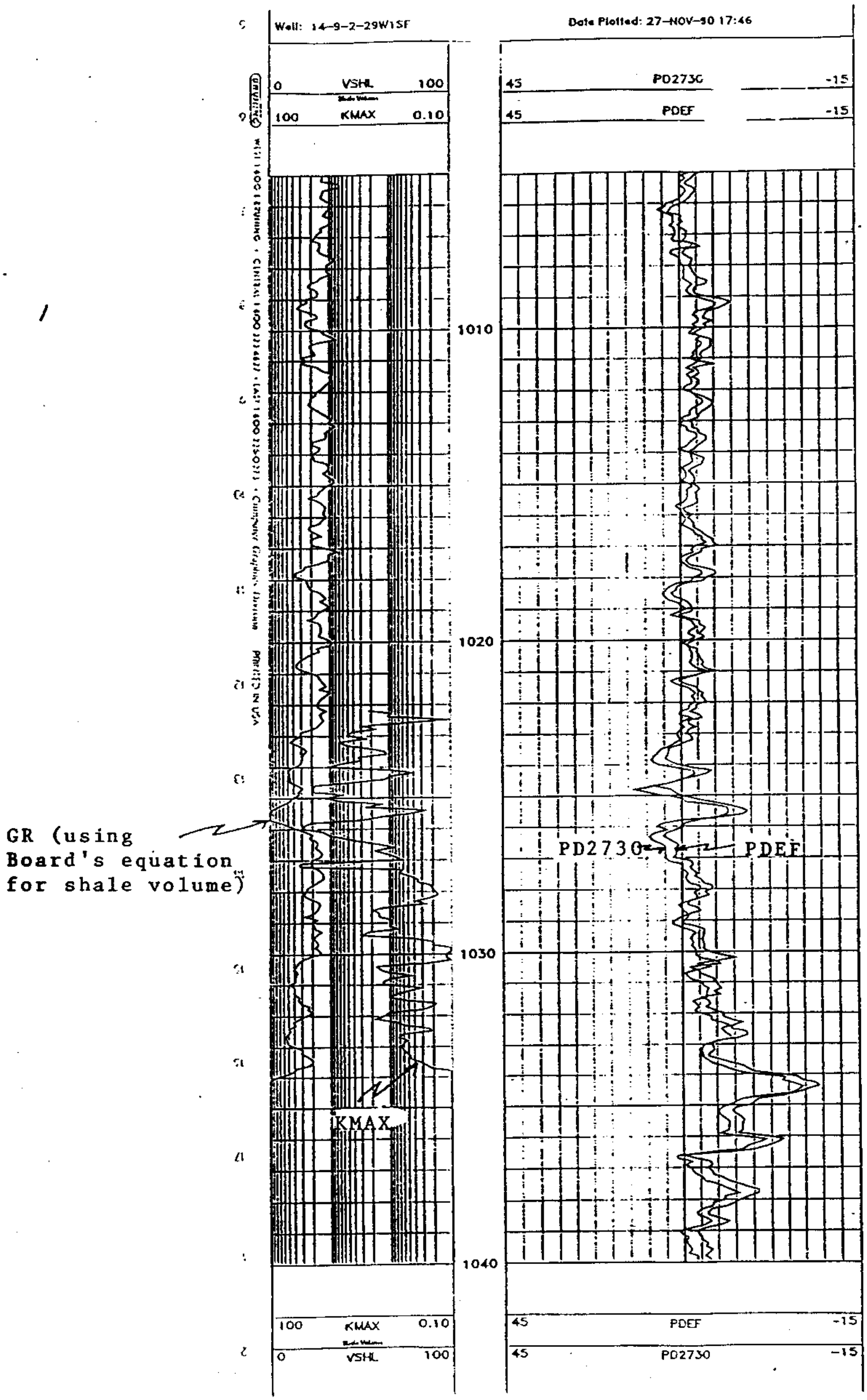
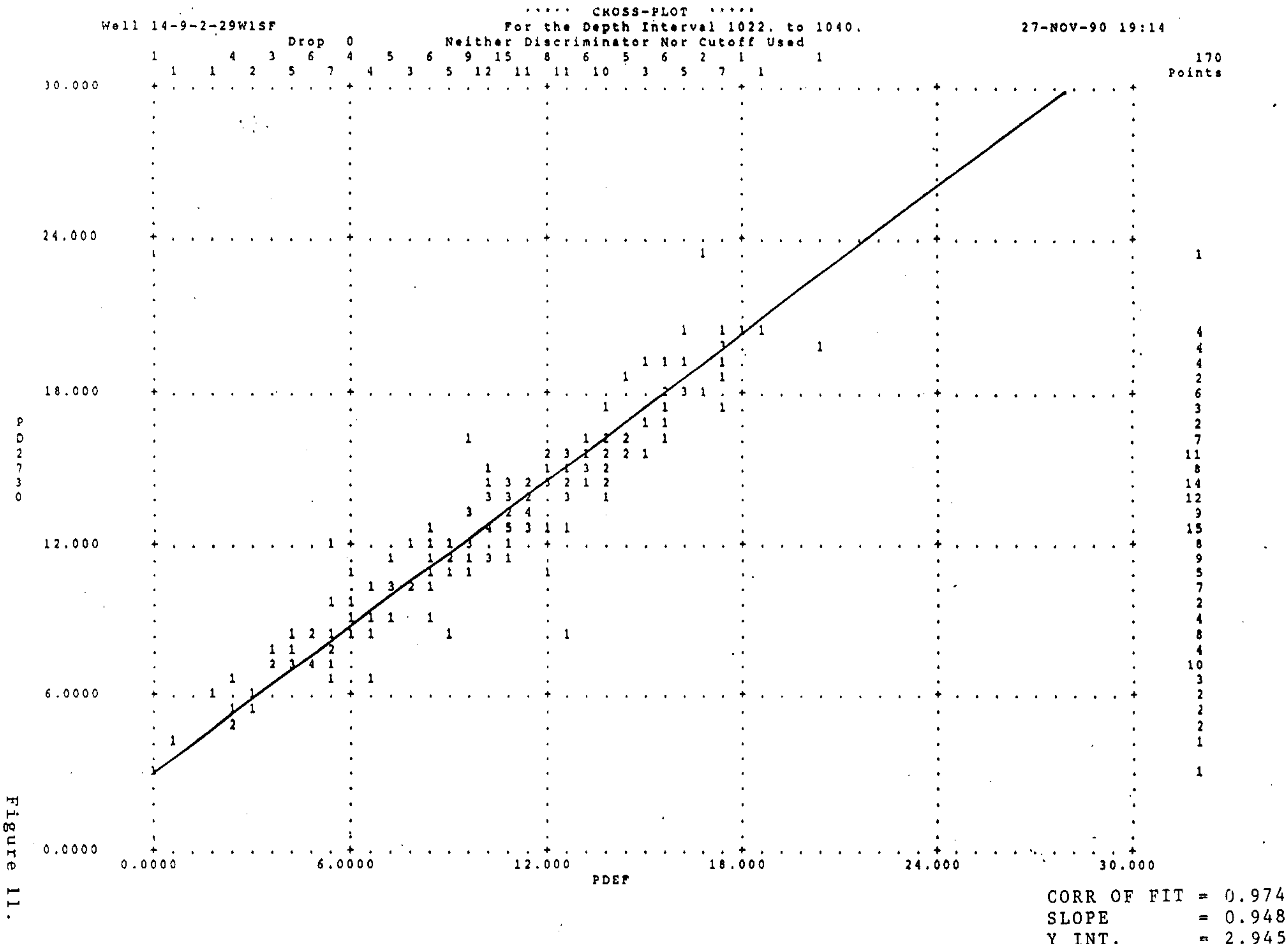

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 17:46
0 VSHL 100
100 KMAX 0.10
45 PD2730 -15
45 PDEF -15
1010
1020
1030
1040
GR (using Board's equation for shale volume)
KMAX
PD2730
PDEF
100 KMAX 0.10
0 VSHL 100
45 PDEF -15
45 PD2730 -15

Figure 10.



..... CROSS-PLOT .....
Well 14-9-2-29W1SF
For the Depth Interval 1022. to 1040.
27-NOV-90 19:14
Drop 0
Neither Discriminator Nor Cutoff Used
170
Points
30.000
24.000
18.000
12.000
6.0000
0.0000
PD2730
0.0000
6.0000
12.000
18.000
24.000
30.000
PDEF
CORR OF FIT = 0.974
SLOPE = 0.948
Y INT. = 2.945

Figure 11.

Manitoba

Energy and Mines

Petroleum

555 — 330 Graham Avenue
Winnipeg, Manitoba, CANADA
R3C 4E3

(204) 945-6577
FAX: (204) 945-0586

February 20, 1991

Mr. D.A. Bertram
Chief Reservoir Engineer
Southern District
Home Oil Company Ltd.
1700 Home Oil Tower
324 - 8th Avenue S.W.
Calgary, Alberta
T2P 2Z5

Dear Sir:

RE: South Pierson - Lower Amaranth
Porosity Determination Report

This letter is to acknowledge receipt of your report entitled "South Pierson, Lower Amaranth Porosity Determination". The Branch believes both the techniques proposed by Home in this report and those outlined in our recent publication yield accurate porosity estimates for the Lower Amaranth Formation in the South Pierson area.

The Branch is prepared to approve a logging program consisting of a density log and dual induction log for most Lower Amaranth locations in the South Pierson area. The Branch however, requests Home Oil consider running a neutron log on exploratory wells.

Yours truly,

L.R. Dubreuil
Director

LRD:cvs

Home Oil Company Limited

1600 Home Oil Tower
324 Eighth Avenue S.W.
Calgary, Alberta T2P 2Z5
Telephone (403) 232-7100
Fax (403) 232-7678

12 February 1991

Manitoba Energy and Mines
Petroleum Branch
555 - 330 Graham Avenue
Winnipeg, Manitoba
R3L 4E5

FEB 19 1991

Attention: Mr. L.R. Dubreuil
Director, Petroleum Branch

Dear Sir:

Re: Logging Requirements
South Pierson, Manitoba

As a result of the recent publication entitled, "Evaluation of the Lower Amaranth Formation in the South Pierson Field, Southwestern Manitoba" by M. Arbez of Manitoba Energy and Mines; Home Oil Company Limited has prepared a report in response which specifically focuses on porosity determination in the Lower Amaranth formation. Three copies of the report titled "South Pierson, Lower Amaranth Porosity Determination" are attached. M. Arbez's report recommends that both the Neutron and Density logs be run as minimum requirements for proper reservoir porosity measurements. Home Oil has complied with these requirements in the past. Home Oil's report illustrates that accurate porosity determination in the Lower Amaranth can be determined from the Density log alone.

Home Oil requests that the Neutron log be eliminated from the logging requirements of future wells and the Density log alone be run for porosity determination in the Lower Amaranth. If you have any questions or concerns, please contact either John Murray at (403)232-7541 or Allan Willms at (403) 232-7362.

Yours truly,
HOME OIL COMPANY LIMITED

D.A. Bertram
Chief Reservoir Engineer
Southern District

ARW/jlc

cc: J.S. Murray (w/o attachment)
A.R. Durda (w/o attachment)
D.A. Cairns (w/o attachment)
G.B. Harrison
S. PIERSON (MAN)(RES)
S. PIERSON (MAN)(TIC)
Day File

SOUTH PIERSON

LOWER AMARANTH POROSITY DETERMINATION

John S. Murray
Glen D. Lawrence

INTRODUCTION

The purpose of this brief report is to obtain approval for a reduction in the open hole logging, recommended in the South Pierson Lower Amaranth Oil Pool.

In the "Evaluation of the Lower Amaranth Formation in the South Pierson Field, Southwestern Manitoba" a recent publication by the Manitoba Government, the author M. Arbez concluded that both the Neutron and Density were necessary in the determination of accurate Lower Amaranth porosities. It was recommended that these logs be run in tandem (or a Sonic log) along with a Dual Induction log for the minimum requirements for proper reservoir evaluation.

This report attempts to demonstrate that accurate porosity determination in the Lower Amaranth can be obtained with the Density log alone.

1. <u>Porosity Determination</u>

The empirically derived equation for calculating total porosity (ϕ T) has been given by the board as:

ϕ T = (0.52 [Neutron Porosity] + Density Porosity Value)/1.52

(The porosity values are in % - sandstone scale)

This suggests that the porosity determination from logs is biased to the density value and only half of the neutron value contributes to the porosity reading. In the Board's empirically derived equation for calculating effective porosity the Density log is weighted even more heavily (84%).

Glen Lawrence, of Home Oil's petrophysical group has been calculating Lower Amaranth porosities using only the Density log with a small shift for grain density. The 14-9-2-29W1 well is used to help explain Home's methodology used for porosity determination.

2. <u>Grain Density</u>

A grain density histogram of the Lower Amaranth core in 14-9-2-29W1 is shown in Figure 1. The mean density of 2740.2 kg/m^3 does not reflect the grain density of the reservoir rock. The reservoir has been identified through core, petrographic, and petrophysical analysis as a dirty, very fine sandstone to siltstone rather than a clean sand. In fact, the clean sand which has low API gamma ray values (~35) is pervasively cemented with anhydrite and is thus dense as well as tight. An example of this tighter "reservoir" (some streaks do contribute) is shown in Figure 2 in 14-9 from 1025.0m to 1026.0m KB. In this interval the permeability is shown to have an inverse relationship with the Gamma Ray

log. The higher permeability rock is observed immediately above and below this unit where the sand contains more clay, is finer grained and has less anhydrite (less dense).

When the higher grain densities are eliminated we observe in Figure 3 that the mean is 2723 kg/m^3 for the 14-9 well. We have found that for all wells an average of 2730 kg/m^3 is an appropriate grain density to use for evaluating porosities of the reservoir.

3. Core To Log Correlation Using Density Log

Figure 4 shows the correlation of core porosity (CPOR) to the high resolution Density log (limestone matrix) that has been shifted to a grain density of 2730 kg/m^3 (PD 2730). Visually, this is obviously a very good correlation, statistics confirm this with a correlation coefficient of 0.837 and a slope of 1.025 for the best fit line (in Figure 5). For this particular well the **b** value or **y** intercept suggests that a quarter of a percent shift could make a slightly better correlation.

4. Core To Log Correlation Using Government Equation

The Board's empirically derived equation $\phi T = (0.52\ \phi N + \phi D)/1.52$ has been called PDTOT here and is correlated with the core porosity of 14-9-2-29W1 in Figure 6. While a good correlation is observed, statistics of the crossplot of these two curves shown in Figure 7 reveal that the correlation coefficient is slightly higher than the density (PD 2730) and PDTOT correlation. The slope of the best fit line calculates to a respectable 0.952 with a **b** value of 1.703. The PD 2730 vs core porosity appears to be a slightly better correlation considering these last two parameters.

5. Government vs Home's Porosity Log Correlation

Figure 8 shows a correlation between the Manitoba Governments empirically derived porosity log (PDTOT) and Home's shifted density log (PD 2730). An extremely good correlation exists with a minor shift of a fifth of a porosity percent. A crossplot of these two logs is shown in Figure 9. A high correlation of fit of 0.969 and a slope of 1.036 confirm that an excellent correlation exists between the two logs. This demonstrates that although two different methods were used to calculate porosities both methods are very close to actual total porosity values as well as highly correlatable to each other.

6. Effective Porosity Correlation

M. Arbez also determined empirically an equation for correlation of Neutron-Density to effective porosity. This was based on humidity dried core analysis for four wells. The effective porosity can be calculated using the following formula: $\phi E = (0.16\ \phi N + \phi D)/1.16$ (ϕ is porosity percent, sandstone scale).

The curve for this equation is shown along with Home's Density curve in Figure 10.

A crossplot of these two curves show how closely they correlate (Figure 11). Of course these two curves should correlate closely since the PD2730 log is 100% density and the PDEF is 84% density with 16% of the Neutron porosity also contributing. To approximate the effective porosity, a shift of the Density log (PD 2730) of three porosity units (2.945 on y intercept) is all that is required.

7. Porosity Determination From Field Logs

To estimate total porosity from a high resolution Density log, use the limestone matrix and add one (1) porosity unit (pu) to the value on the logs. This can be done since it has been shown that a grain density of 2730 kg/m^3 for Density log closely approximates total porosity from core. Since the grain density for limestone is 2710 kg/m^3 and since 20 kg/m^3 (the difference) is equivalent to 1.2 porosity units, simply add one (1) porosity unit to the value observed. A limestone matrix, high resolution density log which reads 15% porosity would be equal to 16% total porosity.

To estimate effective porosity from a high resolution Density log, use the limestone matrix and subtract 2.0 porosity units. It was shown that a shift of 3 porosity units on the density log with a 2730 kg/m^3 grain density (PD 2730) closely approximates effective porosity. That is, the actual porosity value would be approximately 3 porosity units smaller than the total porosity value. In order to estimate the effective porosity on a limestone matrix (2710 kg/m^3) high resolution density log simply subtract 2 porosity units (ie. add one for grain density and subtract 3 for total to effective porosity correlation).

8. Conclusions

1) Grain Density of the reservoir rock is close to 2730 kg/m^3.

2) Reservoir is very fine sandstone to siltstone that has high Gamma Ray values due to relatively high clay content. This has low anhydrite cement and is less dense than clean anhydrite sand, which does not contribute largely to production.

3) A high resolution Density log (limestone scale) with a 20 kg/m^3 shift for grain density, closely approximates total porosity values in core.

4) A Density log (limestone scale) shifted 2.0 porosity units can closely approximate effective porosity values obtained from humidity dried core.

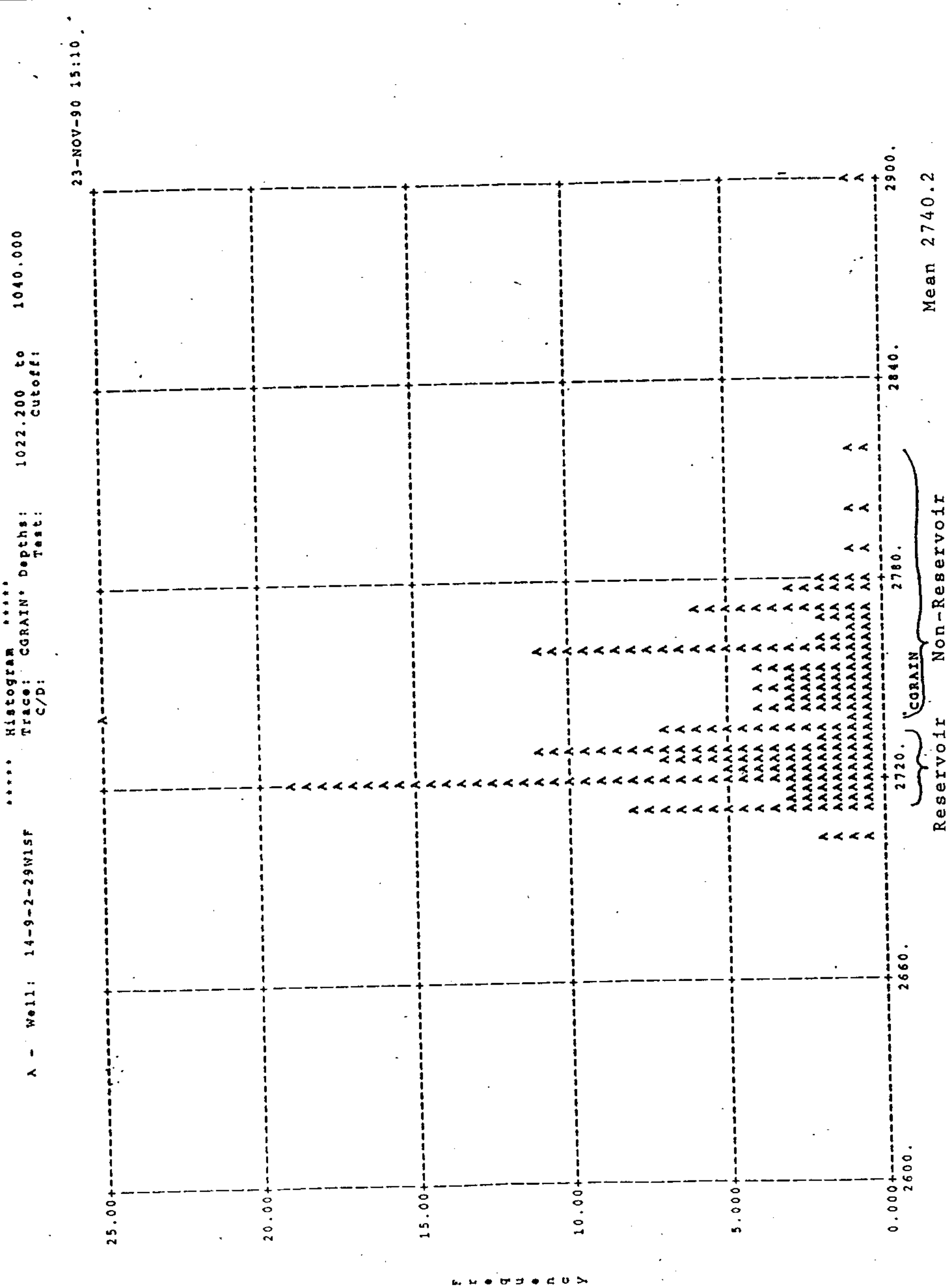
5) A Neutron log is not necessary for porosity determination.

9. Recommendations

The Manitoba Government has made public a document on the South Pierson field that is valuable to both Home Oil and industry in general, and we fully support further studies.

We recommend that the minimum requirements for logging the Lower Amaranth be changed to "Sonic log or Density log" rather than "Sonic log or Compensated Neutron-Formation Density log in tandem", along with the Dual Induction.

We seek approval to change the logging programs of the 1991 wells by eliminating the neutron tool.



A - Well: 14-9-2-29W1SF
***** Histogram *****
Trace: CGRAIN' Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:
23-NOV-90 15:10
Frequency
25.00
20.00
15.00
10.00
5.000
0.000
2600.
2660.
2720.
2780.
2840.
2900.
Mean 2740.2
Reservoir
CGRAIN
Non-Reservoir

Figure 1.

Clean GR with low KMAX value

(ss with low clay content but high anhydrite cmt resulting in low por. and perm.)

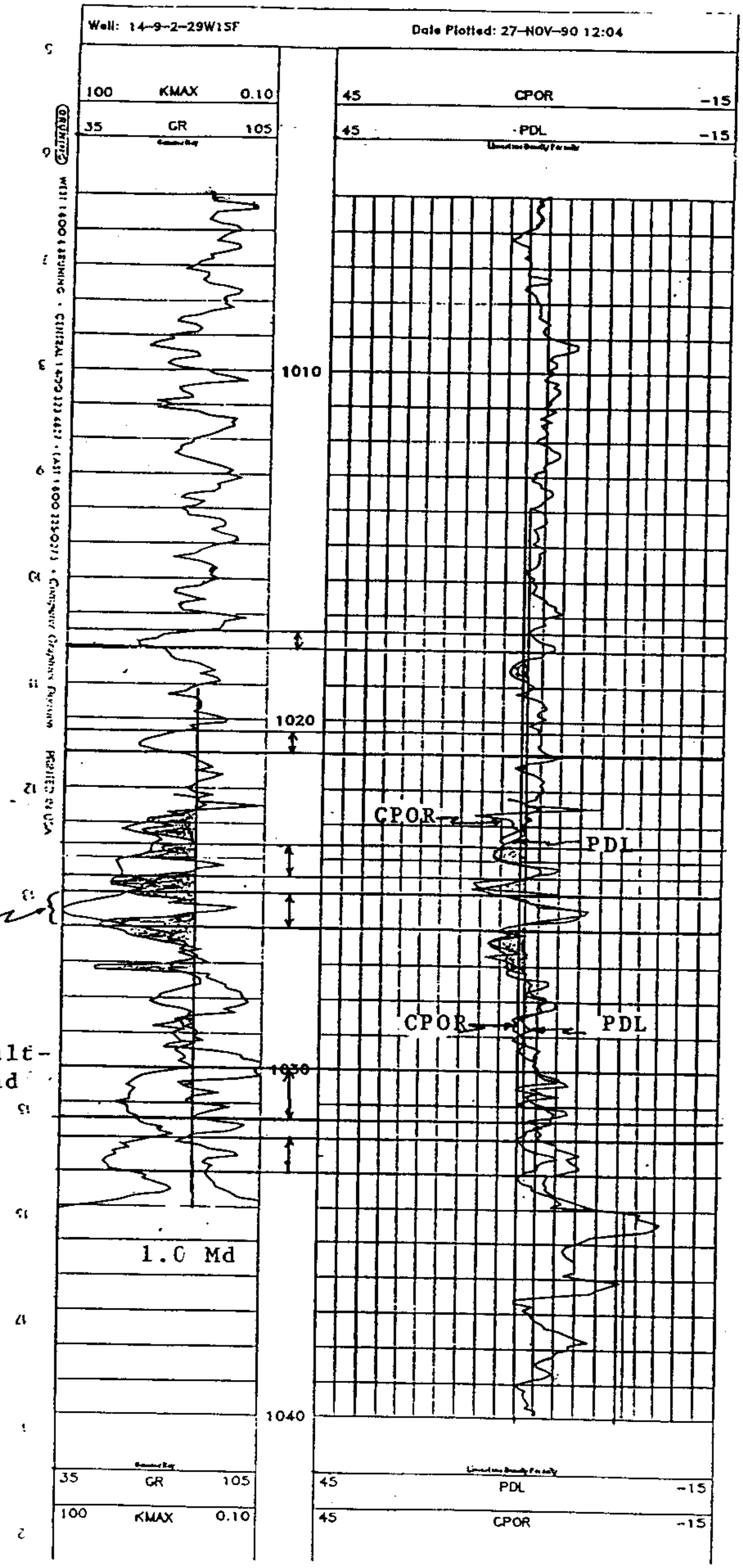


Figure 2.

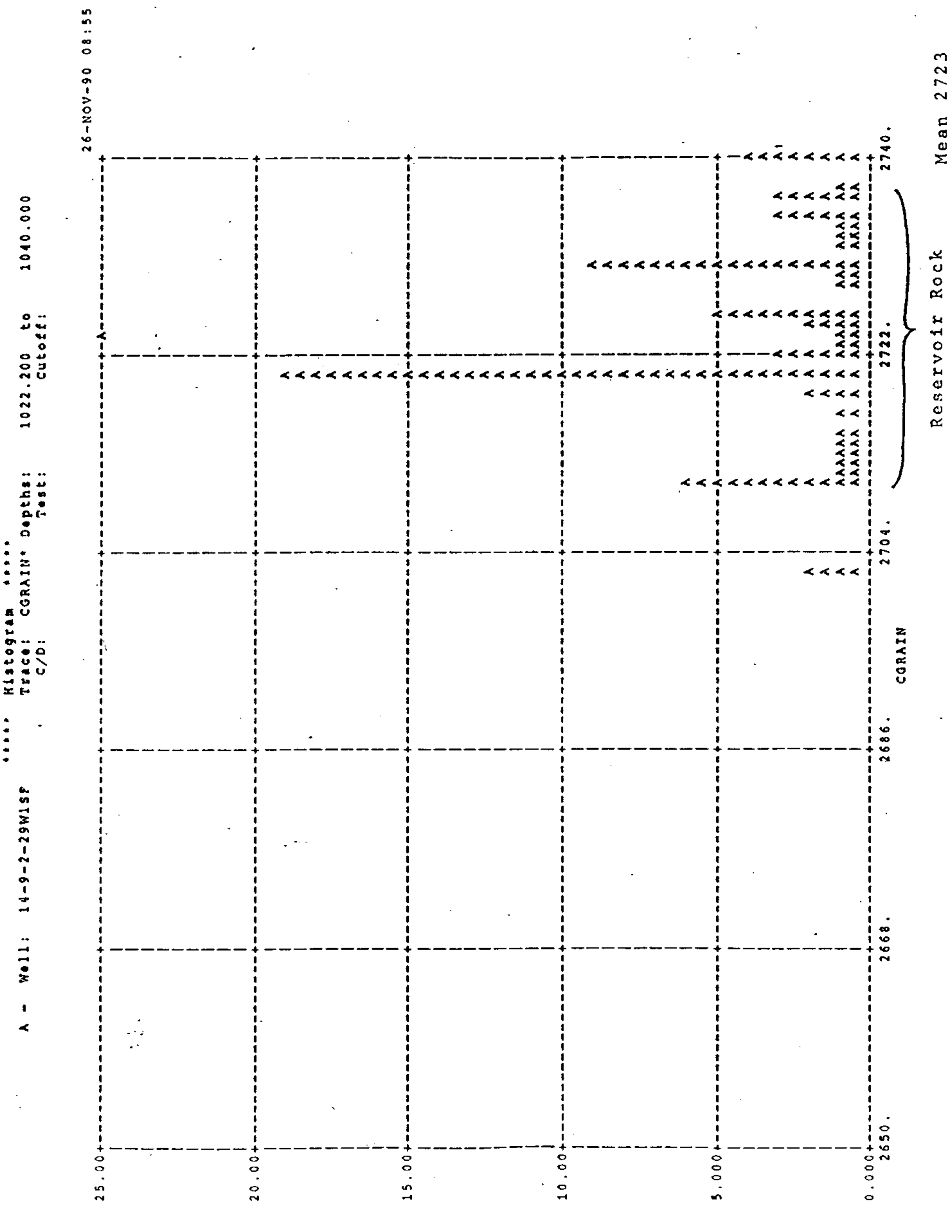

A - Well: 14-9-2-29W1SF
***** Histogram *****
Trace: CGRAIN* Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:
26-NOV-90 08:55
25.00
20.00
15.00
10.00
5.000
0.000
Frequency
2650.
2668.
2686.
2704.
2722.
2740.
CGRAIN
Reservoir Rock
Mean 2723

Figure 3.

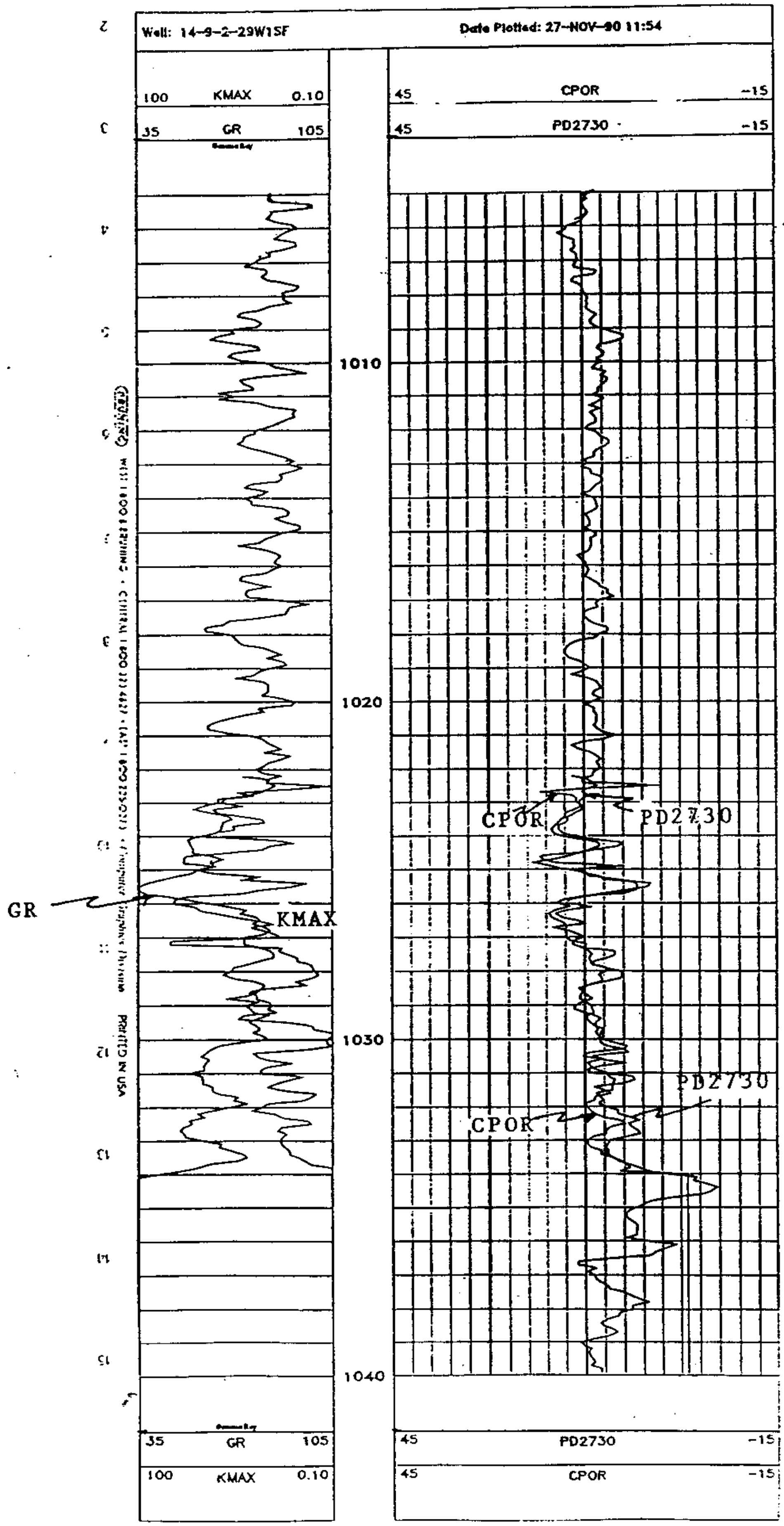
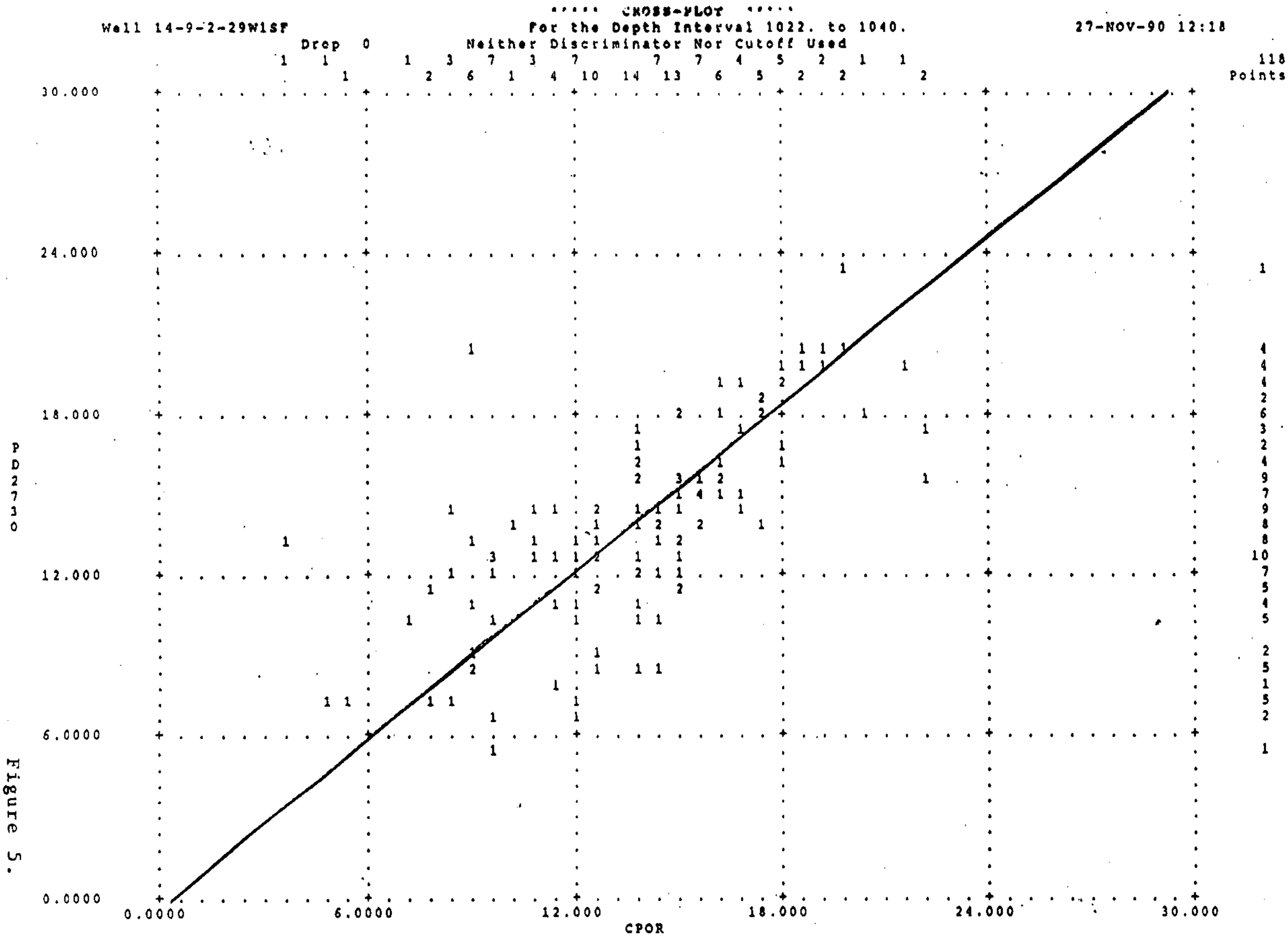
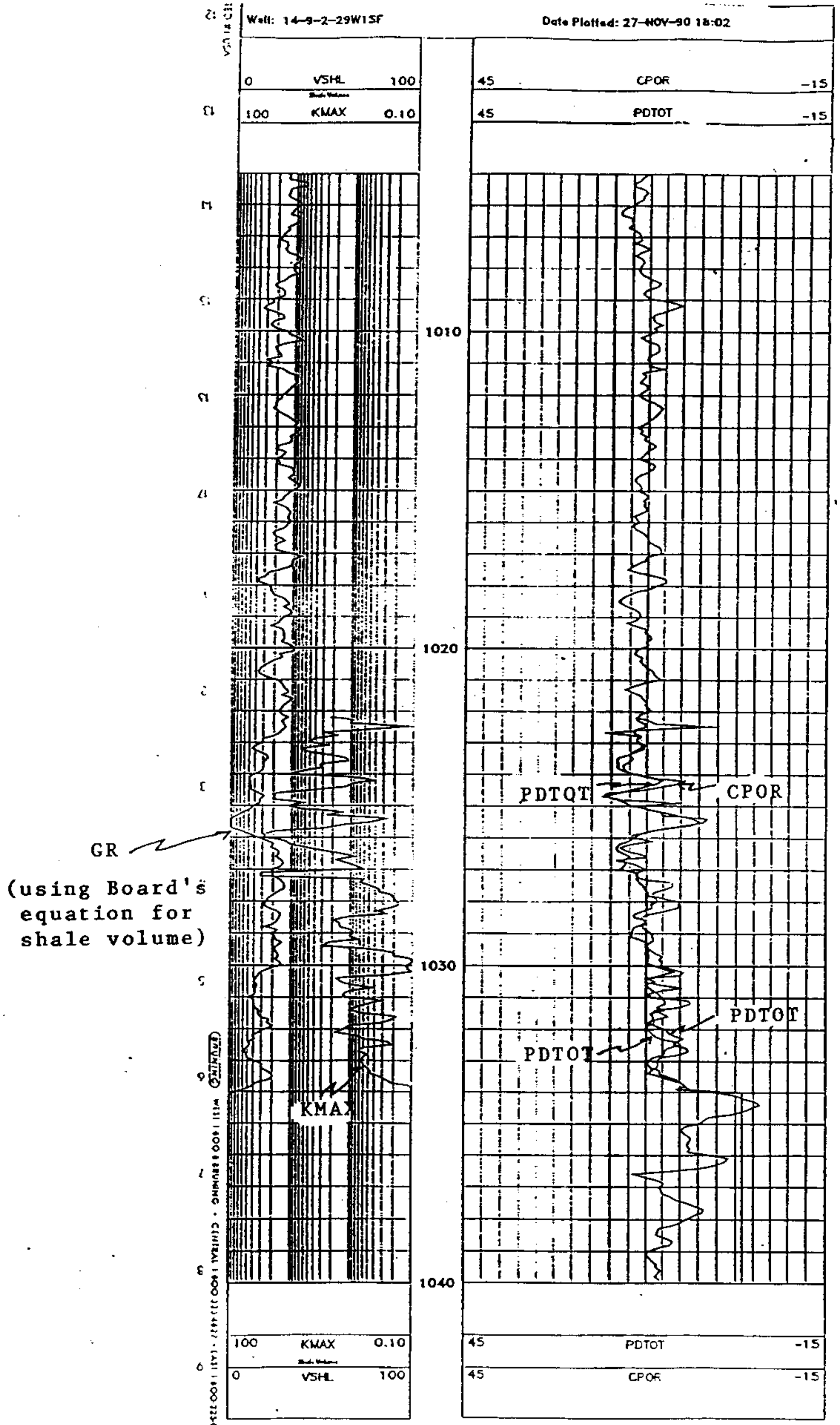

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 11:54
100 KMAX 0.10
35 GR 105
45 CPOR -15
45 PD2730 -15
1010
1020
1030
1040
GR
KMAX
CPOR
PD2730
CPOR
PD2730
35 GR 105
100 KMAX 0.10
45 PD2730 -15
45 CPOR -15

Figure 4.



CORR COEF. = 0.837
SLOPE = 1.025
Y INT = -.247

Figure 5.



Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 18:02
0 VSHL 100
100 KMAX 0.10
45 CPOR -15
45 PDTOT -15
1010
1020
1030
1040
PDTOT
CPOR
GR
(using Board's equation for shale volume)
PDTOT
PDTOT
KMAX
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 CPOR -15

Figure 6

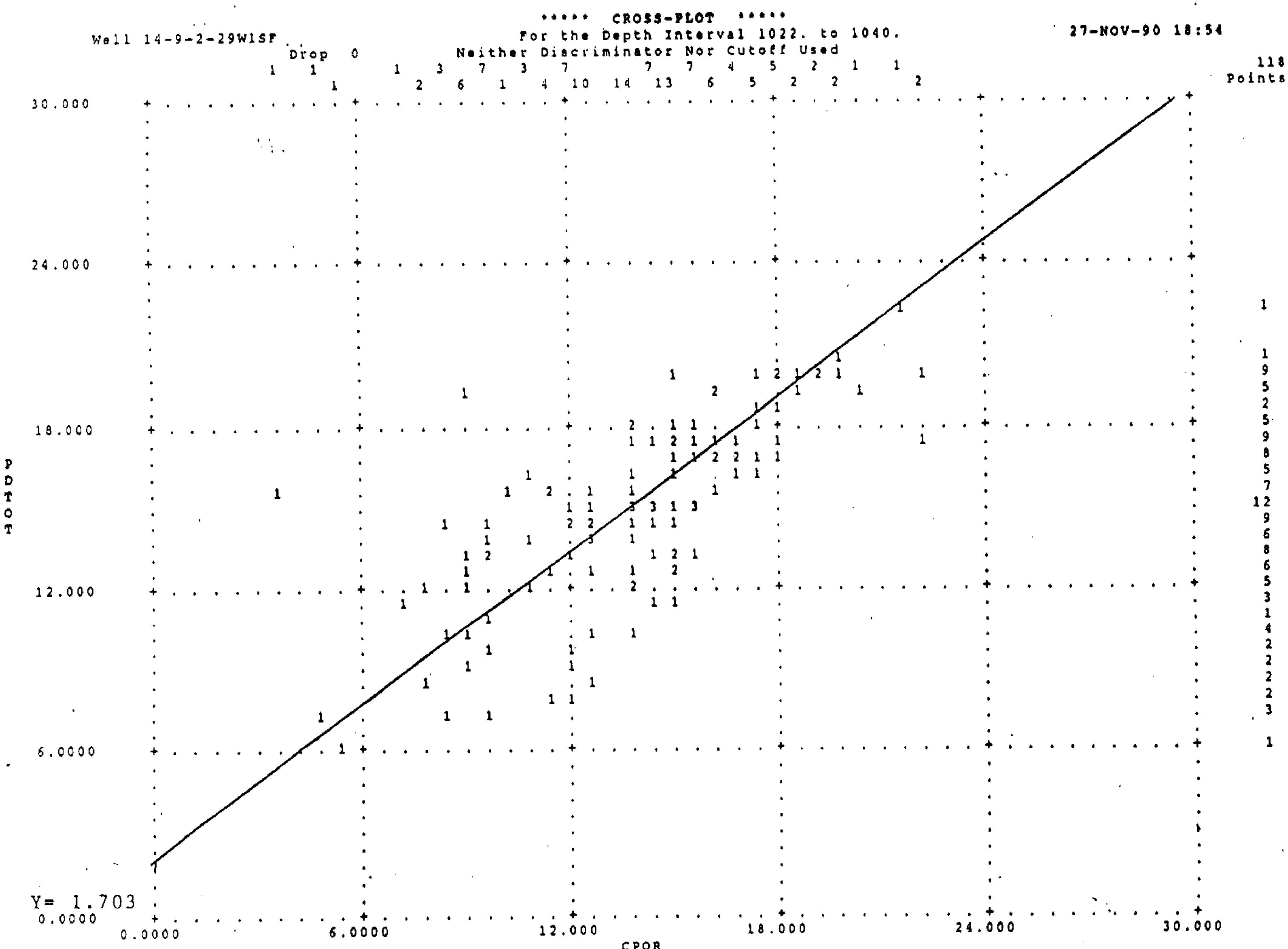


Figure 7.

CORR COEF. = 0.854
SLOPE = 0.952
Y INT. = 1.703

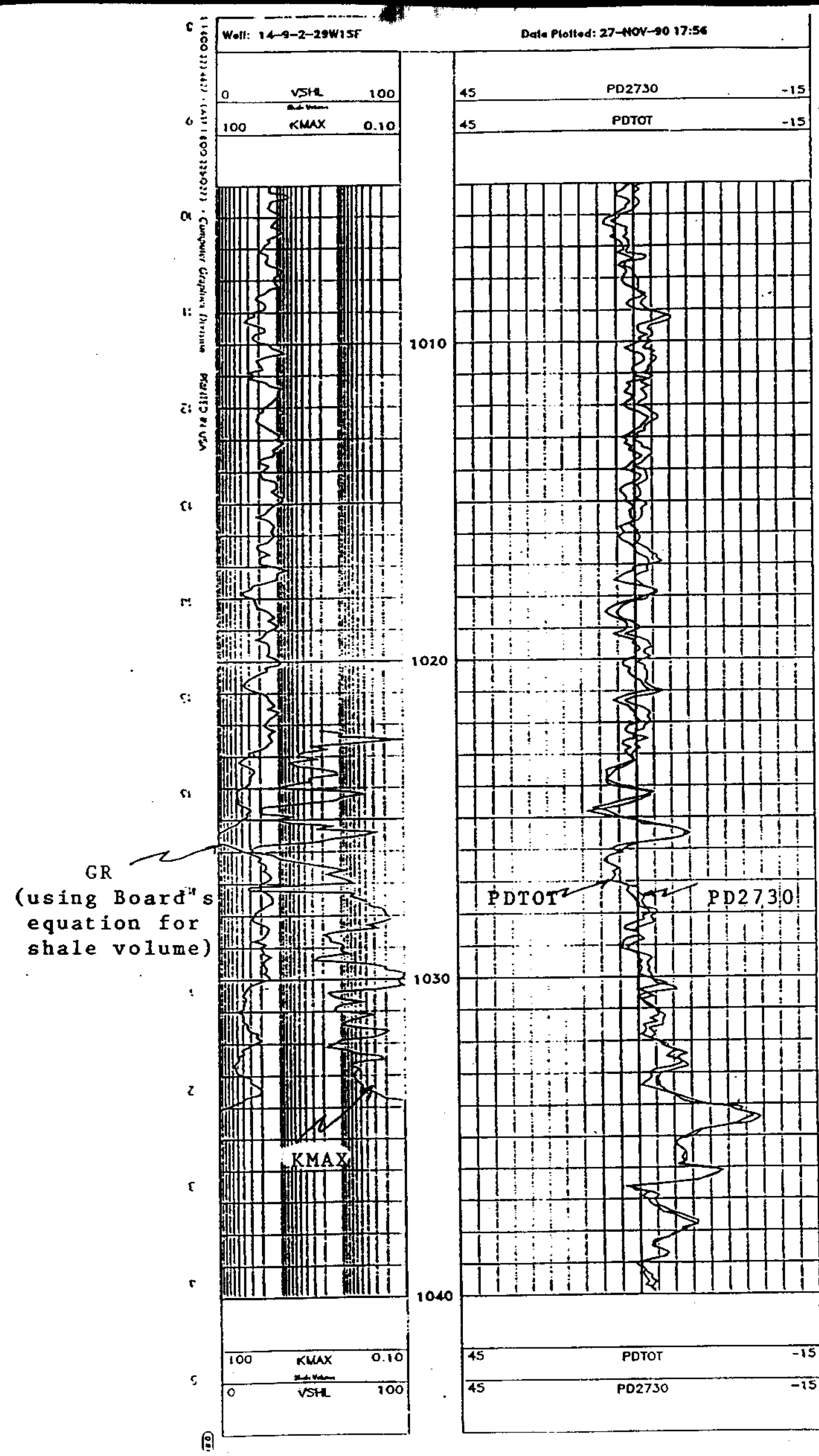
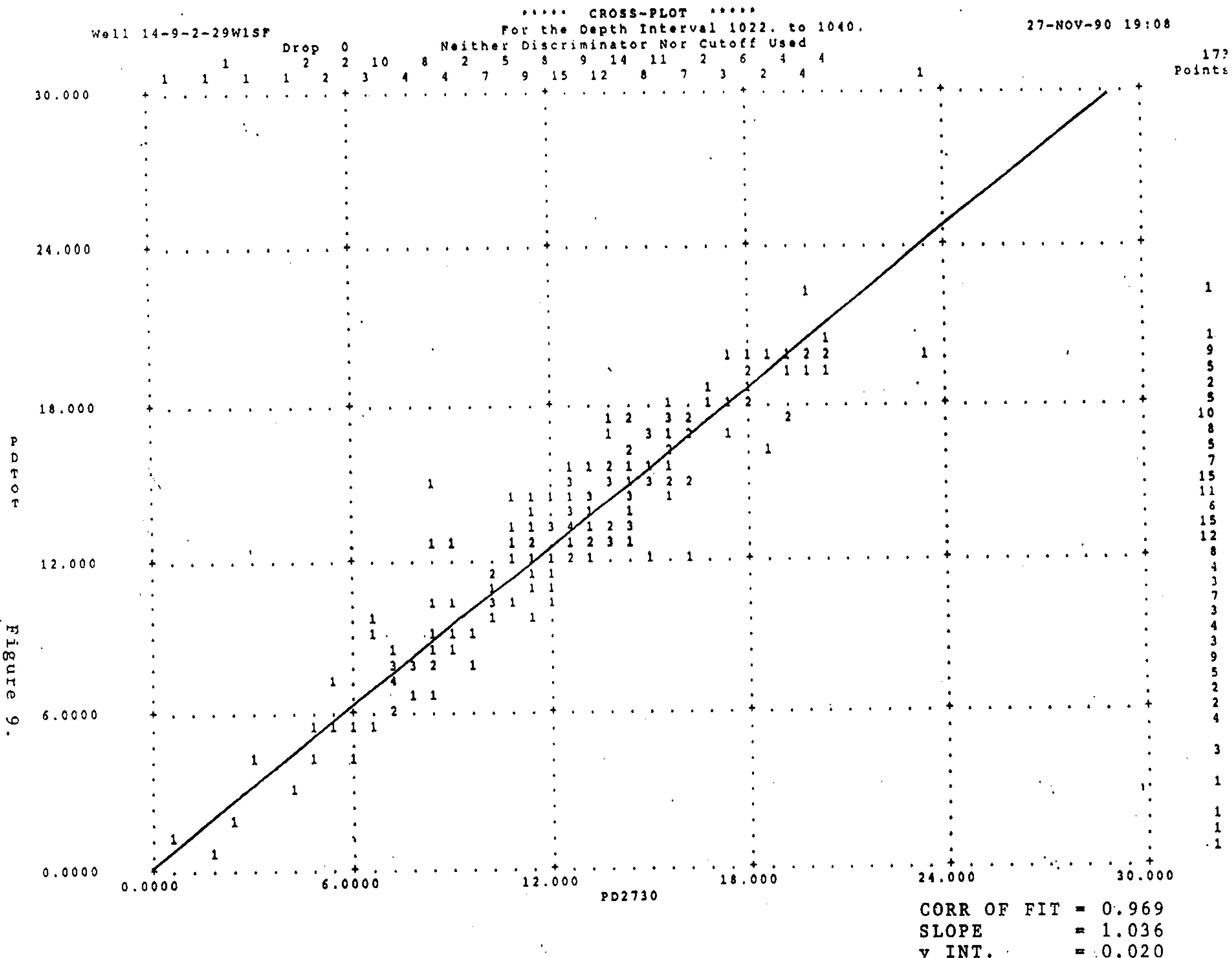

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 17:56
0 VSHL 100
Shale Volume
100 KMAX 0.10
45 PD2730 -15
45 PDTOT -15
1010
1020
1030
1040
GR
(using Board"s
equation for
shale volume)
PDTOT
PD2730
KMAX
100 KMAX 0.10
Shale Volume
0 VSHL 100
45 PDTOT -15
45 PD2730 -15

Figure 8.



Well 14-9-2-29W1SF
••••• CROSS-PLOT •••••
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used
27-NOV-90 19:08
Drop 0
173 Points
30.000
24.000
18.000
12.000
6.0000
0.0000
PDTOT
PD2730
CORR OF FIT = 0.969
SLOPE = 1.036
y INT. = 0.020

Figure 9.

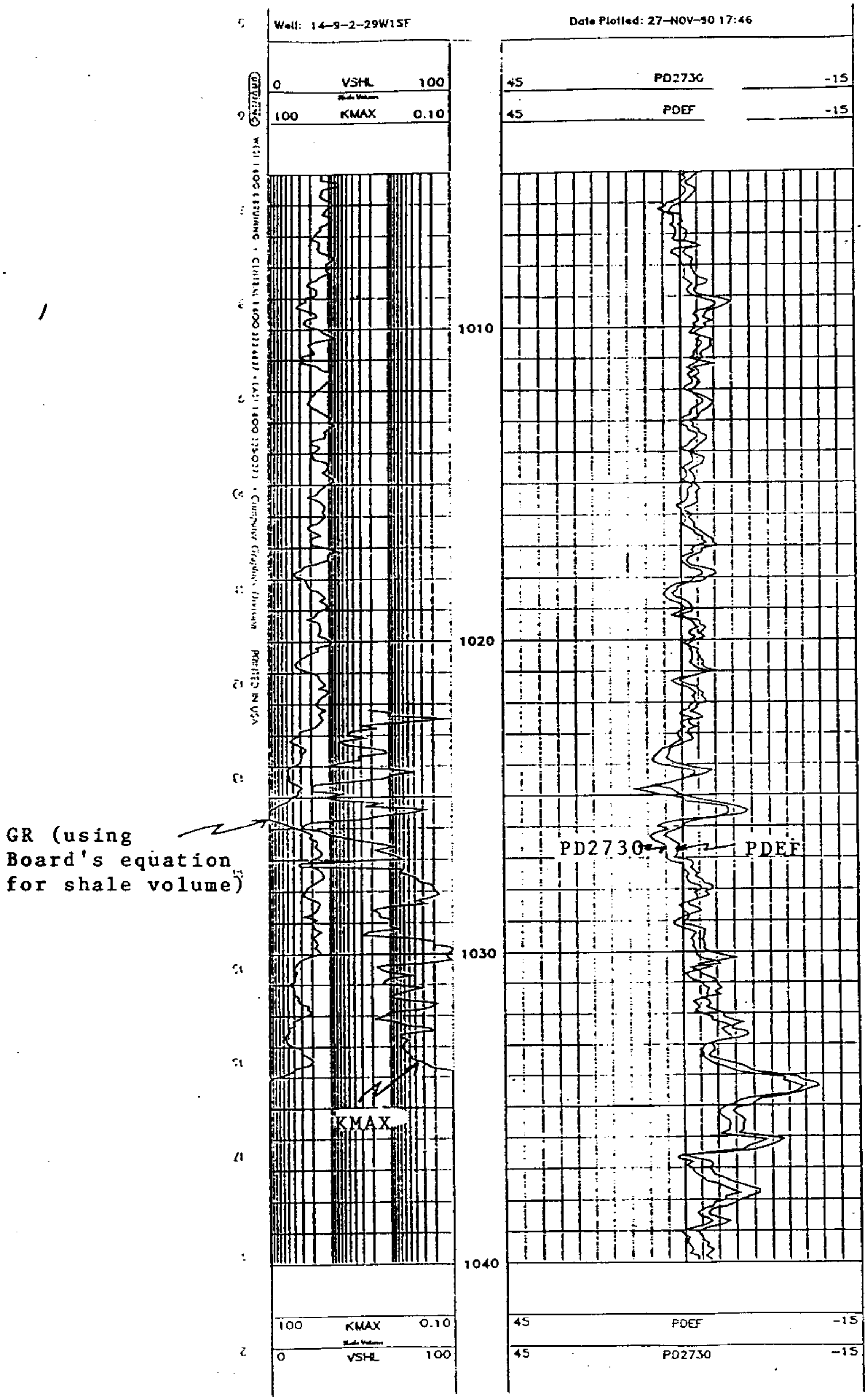
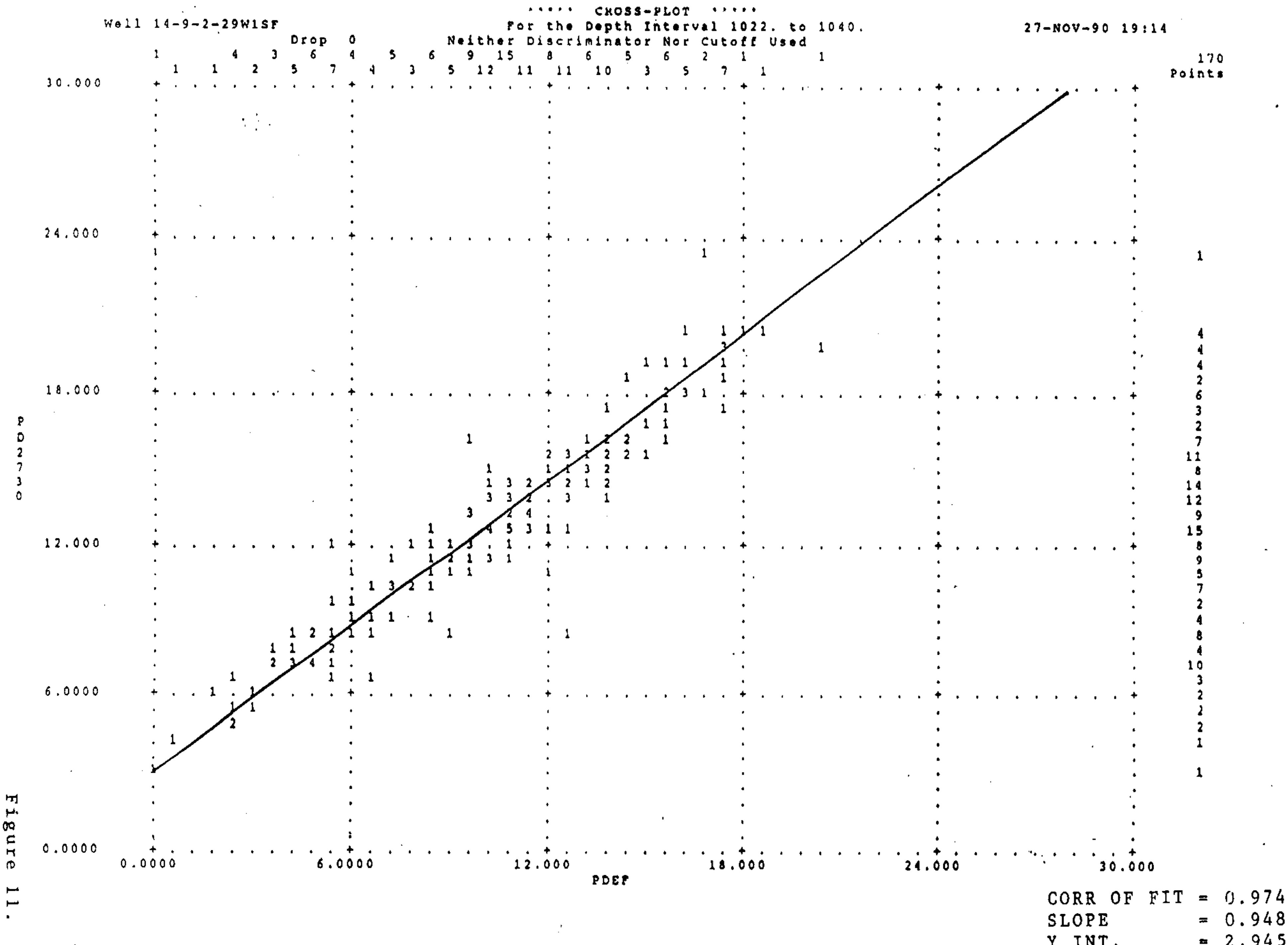

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 17:46
0 VSHL 100
100 KMAX 0.10
45 PD2730 -15
45 PDEF -15
1010
1020
1030
1040
GR (using Board's equation for shale volume)
PD2730
PDEF
KMAX
100 KMAX 0.10
0 VSHL 100
45 PDEF -15
45 PD2730 -15

Figure 10.



***** CROSS-PLOT *****
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used
Well 14-9-2-29W1SF
Drop 0
27-NOV-90 19:14
170 Points
PD2730
PDEF
0.0000
6.0000
12.000
18.000
24.000
30.000
CORR OF FIT = 0.974
SLOPE = 0.948
Y INT. = 2.945

Figure 11.

Manitoba

Energy and Mines Petroleum

555 — 330 Graham Avenue
Winnipeg, Manitoba, CANADA
R3C 4E3

(204) 945-6577
FAX: (204) 945-0586

January 7, 1991

Mr. Allan Willms
Reservoir Engineering
Home Oil Company Ltd.
1700 Home Oil Tower
324 - 8th Avenue S.W.
Calgary, Alberta
T2P 2Z5

Dear Sir:

Re: Logging Program - South Pierson Area

Home Scurry S. Pierson 4-17-2-29 (WPM)
Home et al S. Pierson 10-17-2-29 (WPM)
Home Scurry S. Pierson 12-17-2-29 (WPM)
Home Scurry S. Pierson 16-18-2-29 (WPM)
Home Scurry S. Pierson 16-19-2-29 (WPM)
Home Scurry S. Pierson 4-31-2-29 (WPM)

Your application to modify the logging program for the subject wells and run a single porosity log, the density log, has been reviewed.

For the additional cost of running a combination neutron - density log, estimated at less than $2 000/well, the Petroleum Branch would prefer Home Oil run both porosity logs to allow use of the log interpretation techniques outlined in the Department's report "Evaluation of the Lower Amaranth Formation in the South Pierson Field, Southwestern Manitoba", April, 1990. However, based on the results of Home's log analysis study it appears that porosity can be accurately determined using a grain density adjustment to the density log. Therefore, your request to run only a density log is approved for the subject wells with the exception of 4-31-2-29 (WPM). The Petroleum Branch requests that both a neutron and density log be run on the 4-31 well because it is in an area of minimal well control. In addition Home plans to core the well allowing further confirmation of Home's log analysis methodology.

The Petroleum Branch also requests that if possible on one of the repeat passes of the density log a grain density of 2 730 kg/m^3 be used to allow for the direct reading of corrected porosity values from the log.

If you have any questions please contact John N. Fox, Chief Petroleum Engineer at (204) 945-6574.

Yours truly,

L.R. Dubreuil
Director

LRD:cvs

Manitoba

Action / Route Slip

Date: JAN 3/91

To: MUZAFFAR

From: JOHN

Telephone:

- [x] Take Action
- [ ] Per Your Request
- [ ] Circulate, Initial and Return
- [ ] For Approval and Signature
- [ ] Make ____ Copies
- [ ] May We Discuss
- [ ] For Your Information
- [ ] Return With Comments or Revisions
- [ ] Draft Reply for Signature
- [ ] Please File

Comments: PLEASE REVIEW THE ATTACHED REQUEST BY HOME OIL TO MODIFY IT'S LOGGING PROGRAM AND PROVIDE ME WITH YOUR COMMENTS AS SOON AS POSSIBLE.

J

John

CNL log could be deleted. Geological study requires IES and Sonic or FDC logs. You may check with Marc though.

Muzaffar

MG-1298 PS-I-182 8940100671

Home Oil Company Limited

1600 Home Oil Tower
324 Eighth Avenue S.W.
Calgary, Alberta T2P 2Z5
Telephone (403) 232-7100
Fax (403) 232-7678

21 December 1990

Manitoba Energy and Mines Petroleum Branch
555 - 330 Graham Avenue
Winnipeg, Manitoba
R3L 4E5

Attention: J.N. Fox
Chief Petroleum Engineer

Dear Sir:

Re: Logging Program
South Pierson Area

The purpose of this letter is to request a change in our logging program for the following six licensed wells:

04-17-002-29 W1M — Home [illegible] S. Pierson
10-17-002-29 W1M — Home [illegible] S. Pierson
12-17-002-29 W1M — Home [illegible]
16-18-002-29 W1M — "
16-19-002-29 W1M — "
04-31-002-29 W1M — "

Home Oil is requesting that the Compensated Neutron Log ([redacted] ~~be deleted from the logging program~~. Home Oil believes no accurate porosity measurements are derived from this log. ~~Accurate porosity measurements can be made from the~~ Formation Density Log ~~(FDC)~~ alone.

If you have any further concerns or questions, please give me a call at (403)232-7362.

Yours truly,

HOME OIL COMPANY LIMITED

Allan Willms

A.R. Willms
Reservoir Engineering
ARW/jlc

DRAFT

INTRODUCTION

The purpose of this brief report is to obtain approval for a reduction in the open hole logging, recommended in the South Pierson Lower Amaranth Oil Pool.

In the "Evaluation of the Lower Amaranth Formation in the South Pierson Field, Southwestern Manitoba" a recent publication by the Manitoba Government, the author M. Arbez concluded that [redacted] It was recommended that these logs be run in tandem (or a Sonic log) along with a Dual Induction log for the minimum requirements for proper reservoir evaluation.

This report attempts to demonstrate that [redacted] Lower Amaranth [redacted] alone.

1. Porosity Determination

The empirically derived equation for calculating total porosity (ϕ T) has been given by the board as:

$$\phi\ T = (0.52\ [\text{Neutron Porosity}] + \text{Density Porosity Value})/1.52$$

(The porosity values are in % - sandstone scale)

This suggests that the porosity determination from logs is biased to the density value and only half of the neutron value contributes to the porosity reading. In the Board's empirically derived equation for calculating effective porosity the Density log is weighted even more heavily (84%).

Glen Lawrence, of Home Oil's petrophysical group has been calculating Lower Amaranth porosities using only the Density log with a small shift for grain density. The 14-9-2-29W1 well is used to help explain Home's methodology used for porosity determination.

2. Grain Density

A grain density histogram of the Lower Amaranth core in 14-9-2-29W1 is shown in Figure 1. The mean density of 2740.2 kg/m^3 does not reflect the grain density of the reservoir rock. The reservoir has been identified through core, petrographic, and petrophysical analysis as a dirty, very fine sandstone to siltstone rather than a clean sand. In fact, the clean sand which has low API gamma ray values (~35) is pervasively cemented with anhydrite and is thus dense as well as tight. An example of this tighter "reservoir" (some streaks do contribute) is shown in Figure 2 in 14-9 from 1025.0m to 1026.0m KB. In this interval the permeability is shown to have an inverse relationship with the Gamma Ray

log. The higher permeability rock observed is adjusted to this unit where the sand contains more clay, finer grain and has less anhydrite (less dense).

When the higher grain densities are eliminated we observe in Figure 3 that the mean is 2723 kg/m^3 for the 14-9 well. We have found that for all wells an average of 2730 kg/m^3 is an appropriate grain density to use for evaluating porosities of the reservoir.

3. Core To Log Correlation Using Density Log

Figure 4 shows the correlation of core porosity (CPOR) to the Density log that has been shifted for a grain density of 2730 kg/m^3 (PD 2730). Visually, this is obviously a very good correlation, statistics confirm this correlation with a correlation coefficiencies of 0.837 and a slope of 1.025 for the best fit line (in Figure 5). For this particular well the **b** value or **y** intercept suggests that a quarter of a percent shift could make a slightly better correlation.

4. Core To Log Correlation Using Government Equation

The Board's empirically derived equation $\phi T = (0.52\ \phi N + \phi D)/1.52$ (where ϕN and ϕD are neutron and density porosity values in percent -sandstone matrix) has been called PDTOT here and is correlated with the core porosity of 14-9-2-29W1. While a good correlation is observed, statistics of the crossplot of these two curves shown in Figure 7 reveal that the correlation coefficient is slightly higher than the density (PC 2730) correlation. The slope of the best fit line calculates to a respectable 0.952 with a **b** value of 1.703. The PD 2730 vs core porosity appears to be a slightly better correlation considering these last two parameters. figure 6?

5. Government vs Home's Porosity Log Correlation

Figure 8 shows a correlation between the Manitoba Governments empirically derived porosity log (PDTOT) and Home's shifted density log (PD 2730). An extremely good correlation exists with a minor shift of a fifth of a porosity percent. A crossplot of these two logs is shown in Figure 9. A high correlation of fit of 0.969 and a slope of 1.036 confirm that an excellent correlation exists between the two logs. This demonstrates that although two different methods were used to calculate porosities both methods are very close to actual total porosity values as well as highly correlatable to each other.

6. Effective Porosity Correlation

M. Arbez also determined empirically an equation for correlation of Neutron-Density to effective porosity. This was based on humidity dried core analysis for four wells. The effective porosity can be calculated using the following formula: $\phi E = (0.16\ \phi N + \phi D)/1.16$ (ϕ is porosity percent, sandstone scale).

The curve for this equation is shown along with Home's Density curve in Figure 10. A crossplot of these two curves show how closely they correlate (Figure 11). Of course these two curves should correlate closely since the PD2730 log is 100% density and the PDEF is 84% density with 16% of the Neutron porosity also contributing. To approximate the effective porosity, a shift of the Density log of three porosity units (2.945 on y intercept) is all that is required.

7. Conclusions

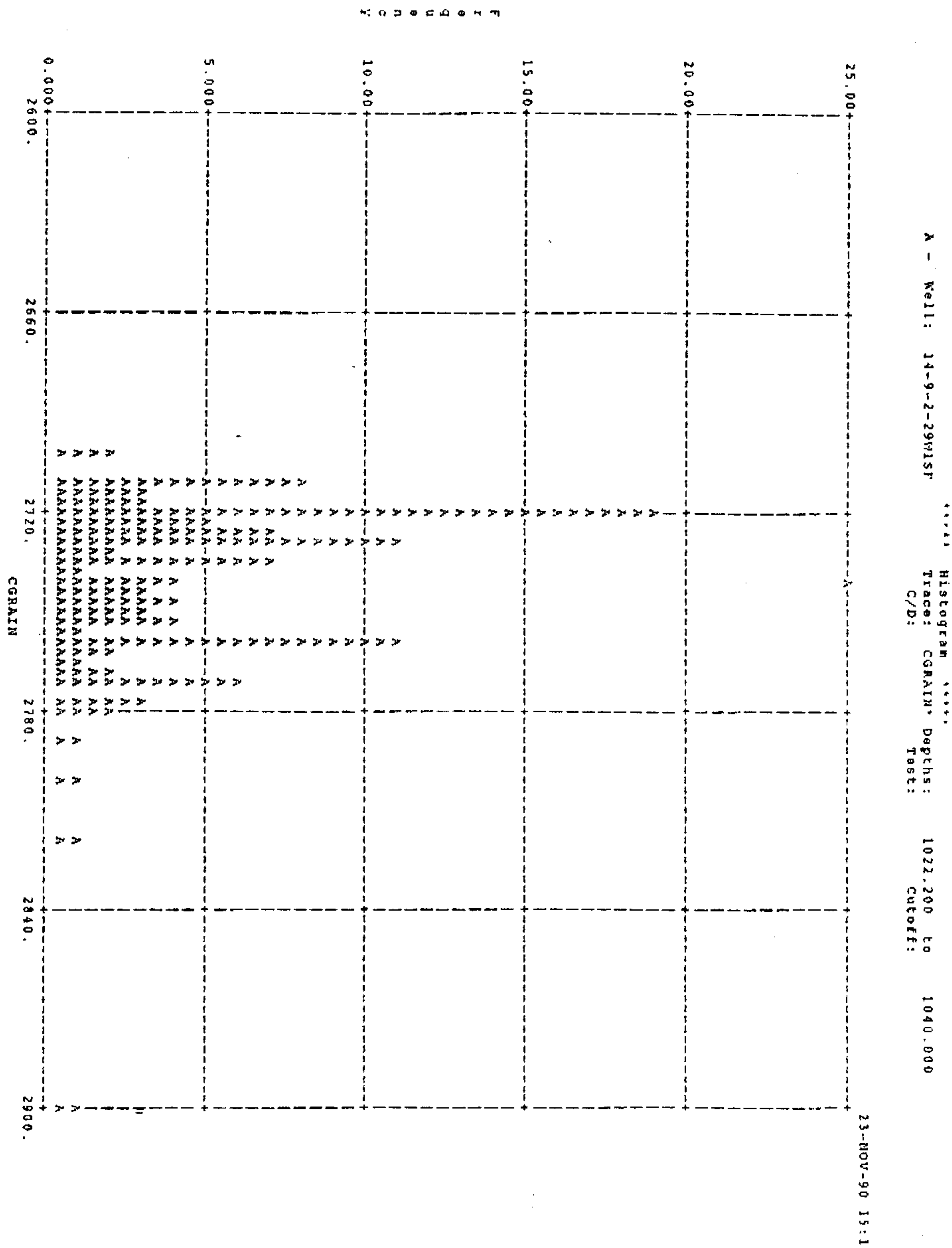
1) Grain Density of the reservoir rock is close to 2730 kg/m^3.
2) Reservoir is very fine sandstone to siltstone that has high Gamma Ray values due to relatively high clay content. This has low anhydrite cement and is less dense than clean anhydrite sand, which does not contribute largely to production.
3) A Density log (limestone scale) with a small shift for grain density, closely approximates total porosity values in core.
4) A Density log (limestone scale) shifted 2.0 porosity units can closely approximate effective porosity values obtained from humidity dried core.
5) A Neutron log is not necessary for porosity determination.

8. Recommendations

The Manitoba Government has made public a document on the South Pierson field that is valuable to both Home Oil and industry in general, and we fully support further studies.

We recommend that the minimum requirements for logging the Lower Amaranth be changed to "Sonic log or Density log" rather than "Sonic log or Compensated Neutron-Formation Density log in tandem", along with the Dual Induction.

We seek approval to change the logging programs of the 1991 wells by eliminating the neutron tool.



Mean 2740.2
Std Dev 0.27

FIGURE 1

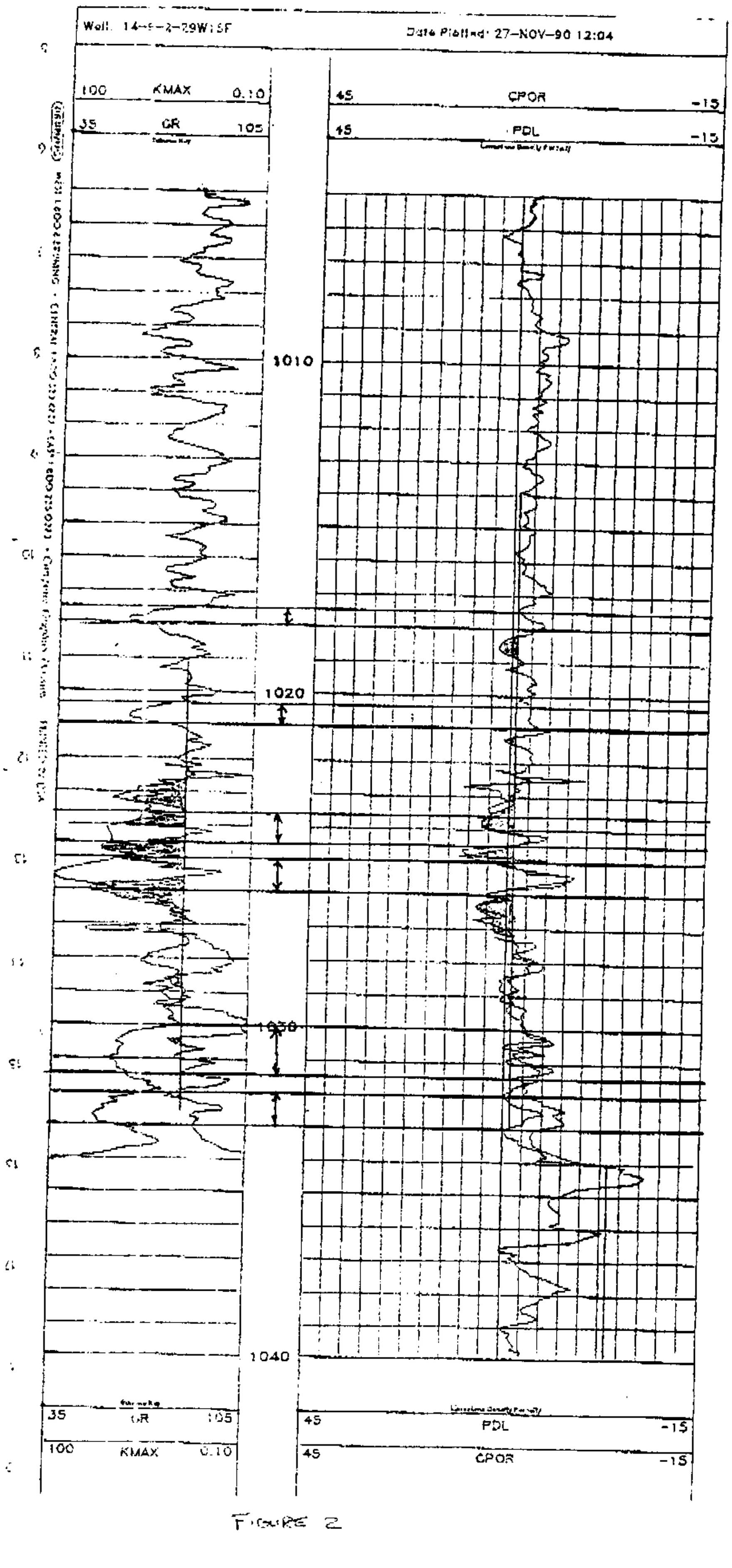

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 12:04
100 KMAX 0.10
35 GR 105
45 CPOR -15
45 PDL -15
1010
1020
1030
1040
35 GR 105
100 KMAX 0.10
45 PDL -15
45 CPOR -15

FIGURE 2

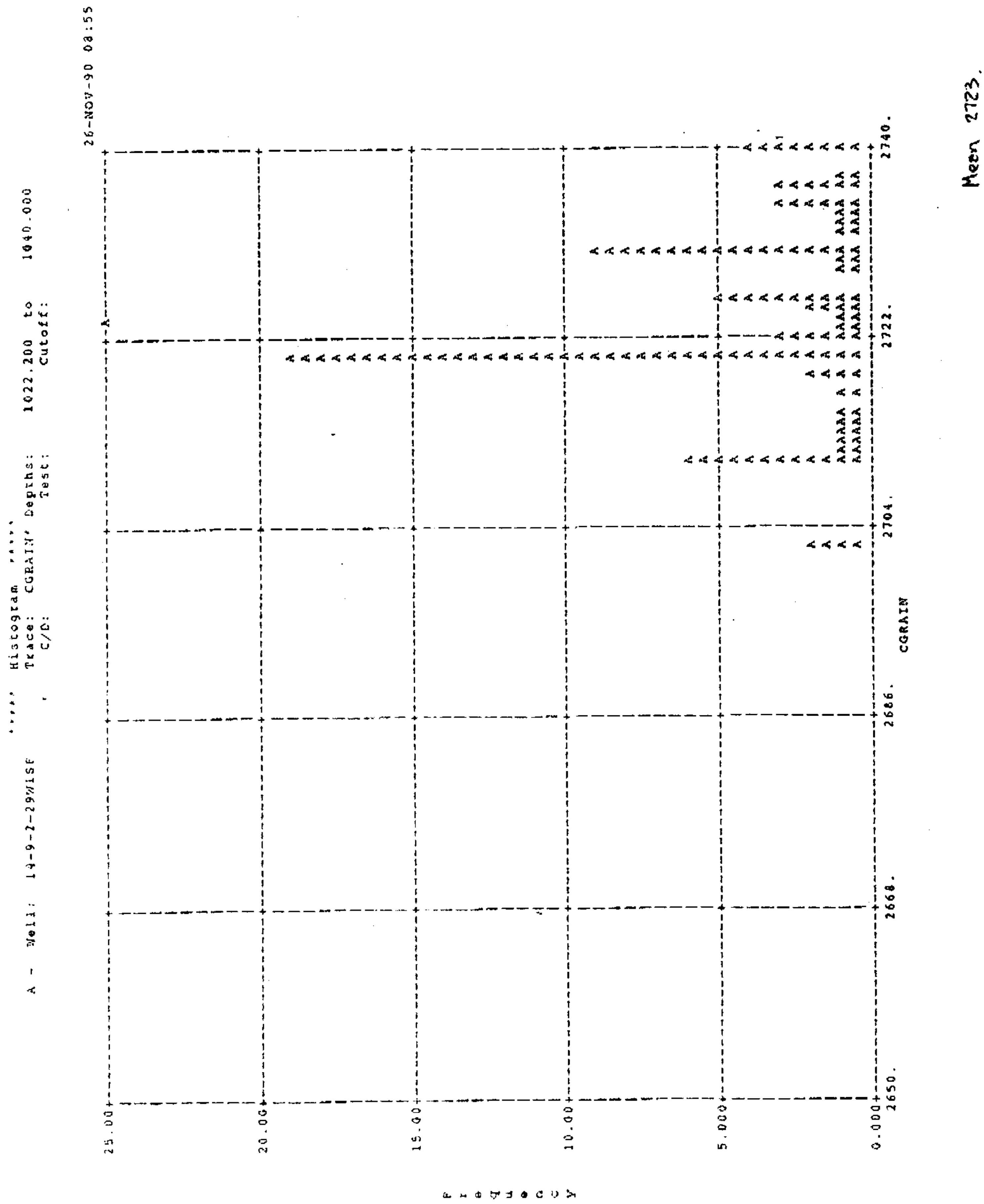

A - Well: 14-9-2-29W1SE
***** Histogram *****
Trace: CGRAIN Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:
26-NOV-90 08:55
25.00
20.00
15.00
10.00
5.000
0.000
2650.
2668.
2686.
2704.
2722.
2740.
CGRAIN
Frequency
Mean 2723.

FIGURE 3

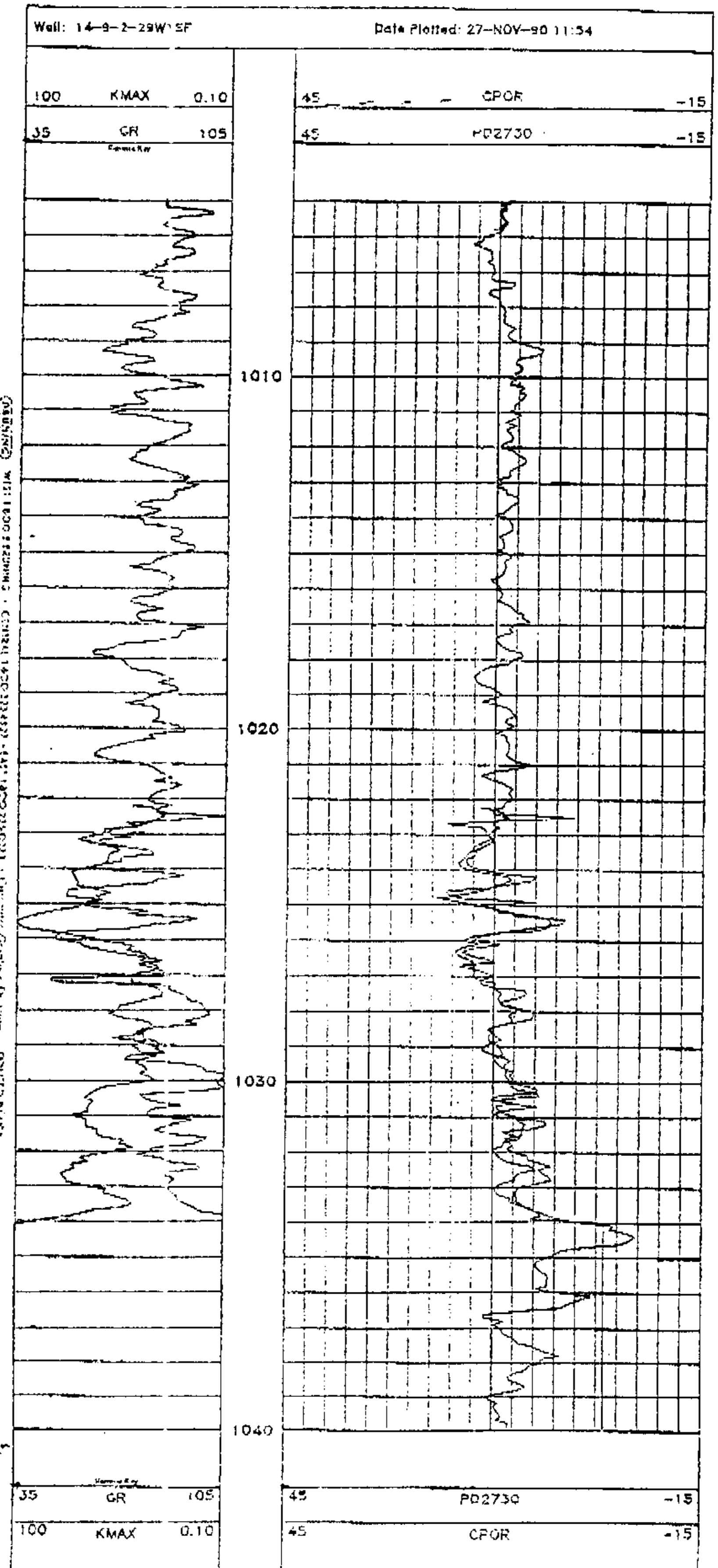
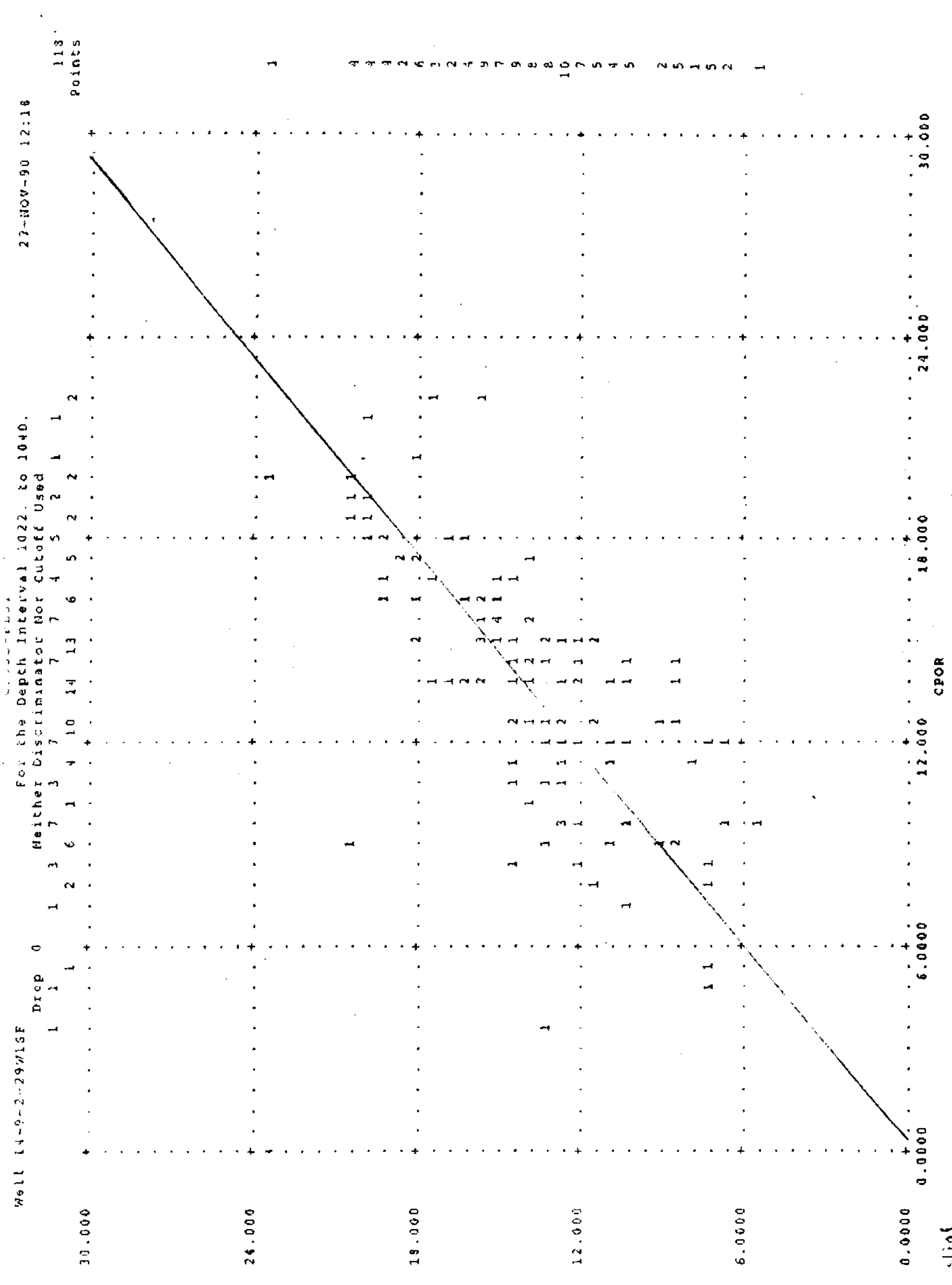

Well: 14-9-2-29W1 SF
Date Plotted: 27-NOV-90 11:54
100 KMAX 0.10
35 GR 105
45 CPOR -15
45 PD2730 -15
1010
1020
1030
1040
35 GR 105
100 KMAX 0.10
45 PD2730 -15
45 CPOR -15

FIGURE 4



Corr Coef. 0.837
Slope 1.025
y int - 0.247

y int
- 0.247

FIGURE 5

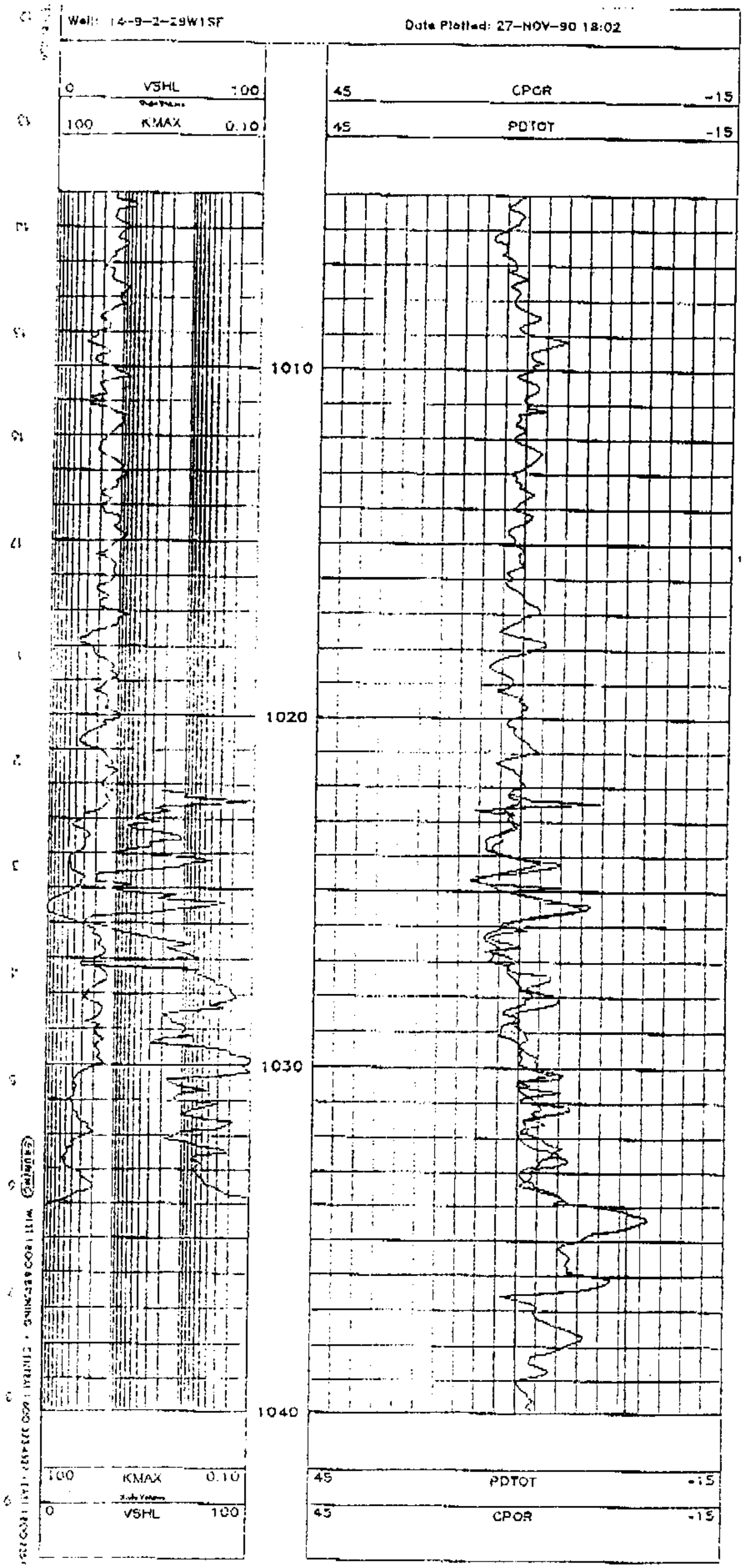

Well: 14-9-2-29W1SF
Date Plotted: 27-NOV-90 18:02
0 VSHL 100
100 KMAX 0.10
45 CPOR -15
45 PDTOT -15
1010
1020
1030
1040
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 CPOR -15

FIGURE 6

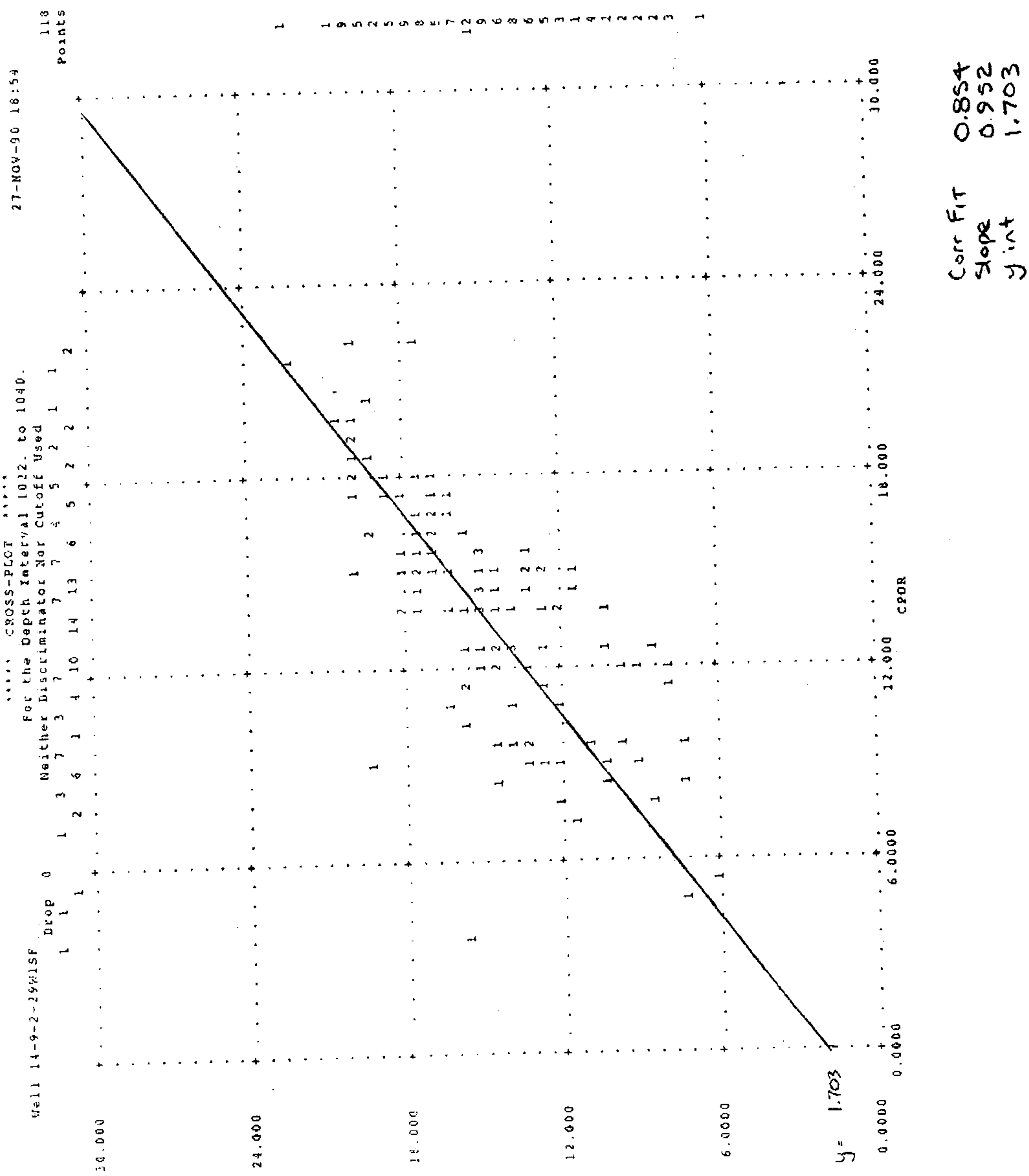
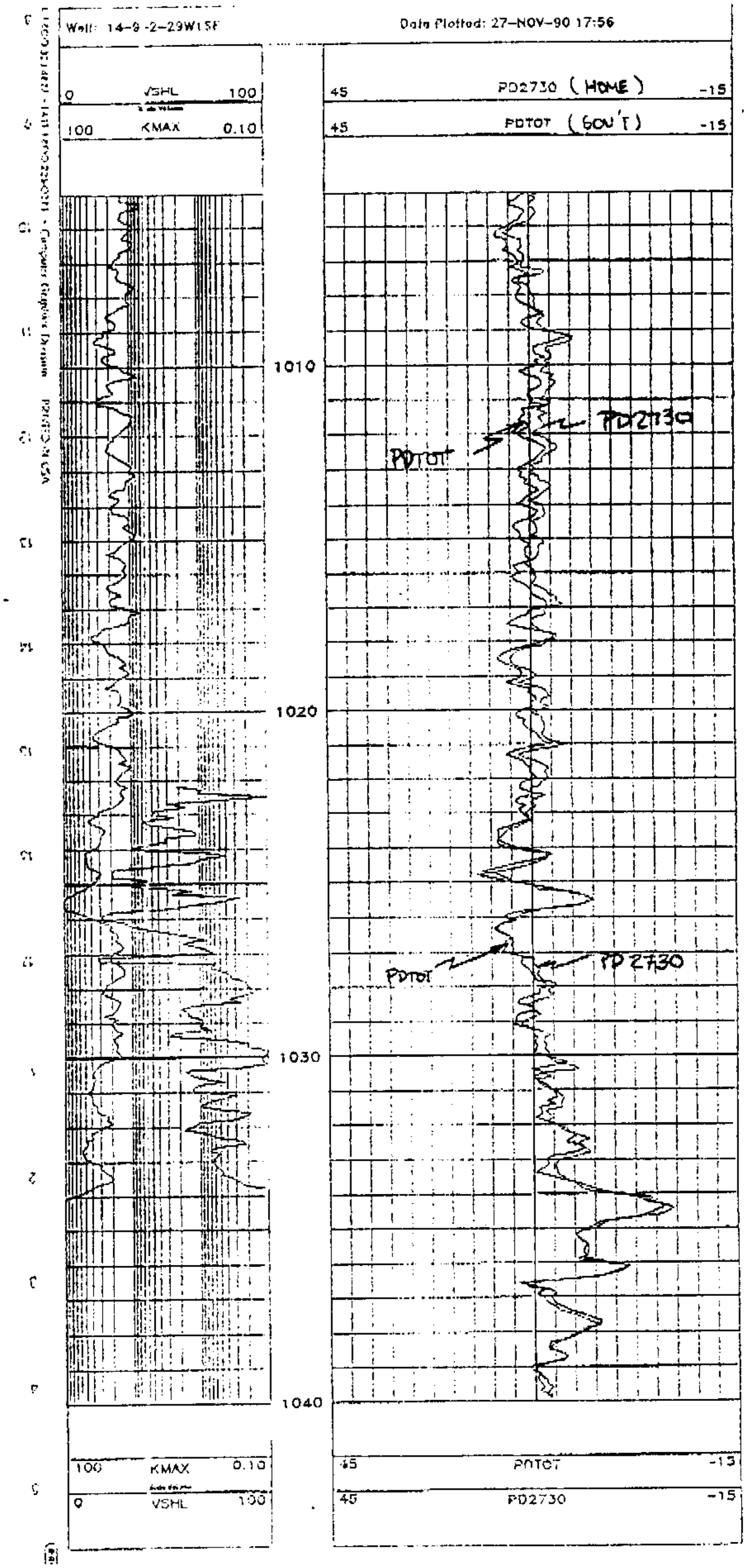
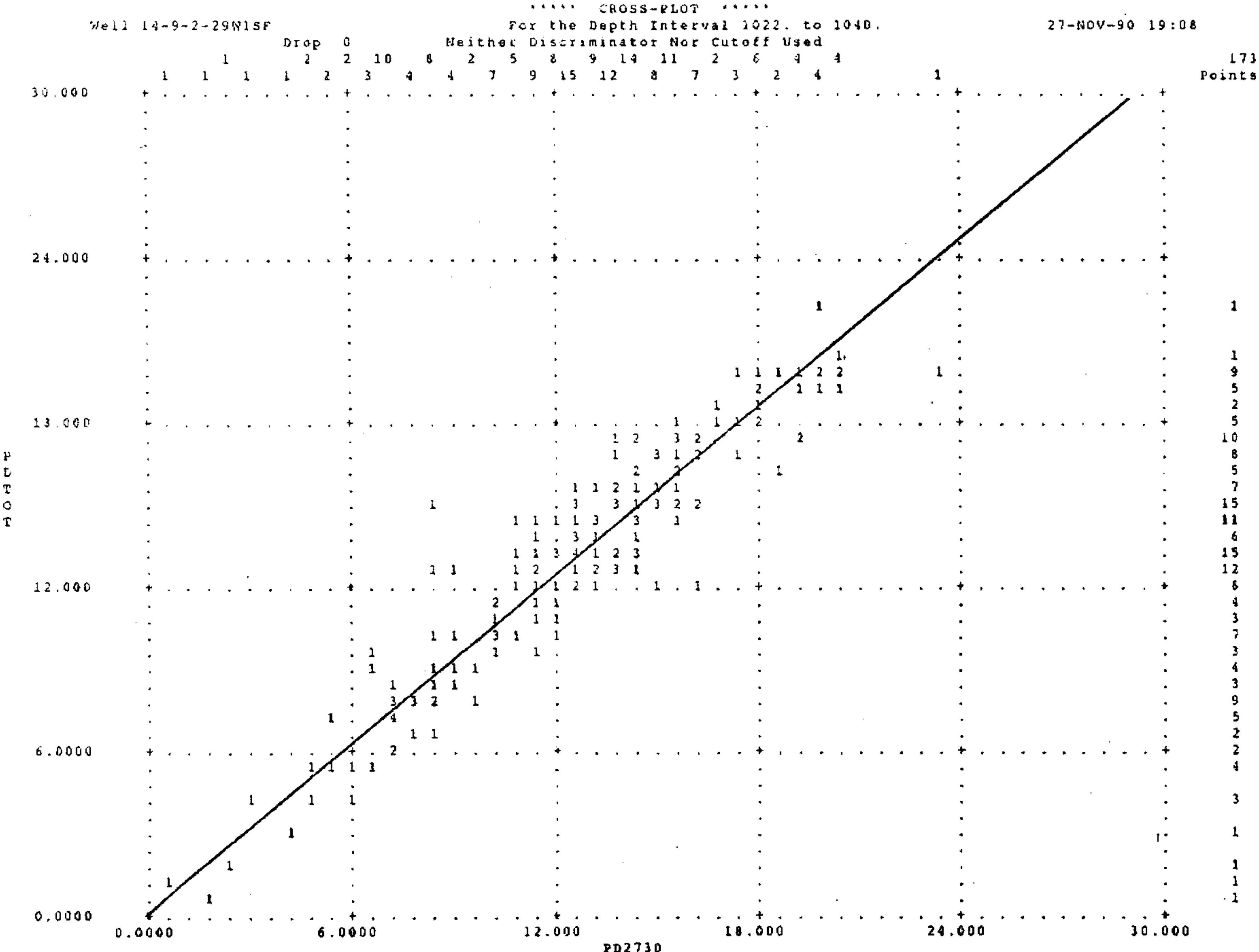

Well 14-9-2-29W1SF
***** CROSS-PLOT *****
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used
27-NOV-90 18:54
118 Points
Drop
CPOR
0.0000
6.0000
12.000
18.000
24.000
30.000
y= 1.703
Corr Fit 0.854
Slope 0.952
y int 1.703

FIGURE 7



Well: 14-9-2-29W1SF
Data Plotted: 27-NOV-90 17:56
0 VSHL 100
100 KMAX 0.10
45 PD2730 (HOME) -15
45 PDTOT (GOV'T) -15
1010
PD2730
PDTOT
1020
PDTOT
PD 2730
1030
1040
100 KMAX 0.10
0 VSHL 100
45 PDTOT -15
45 PD2730 -15

FIGURE B



y int 0.020

Corr of FIT . 0.969
Slope . 1,036
y int : 0.020

FIGURE 9

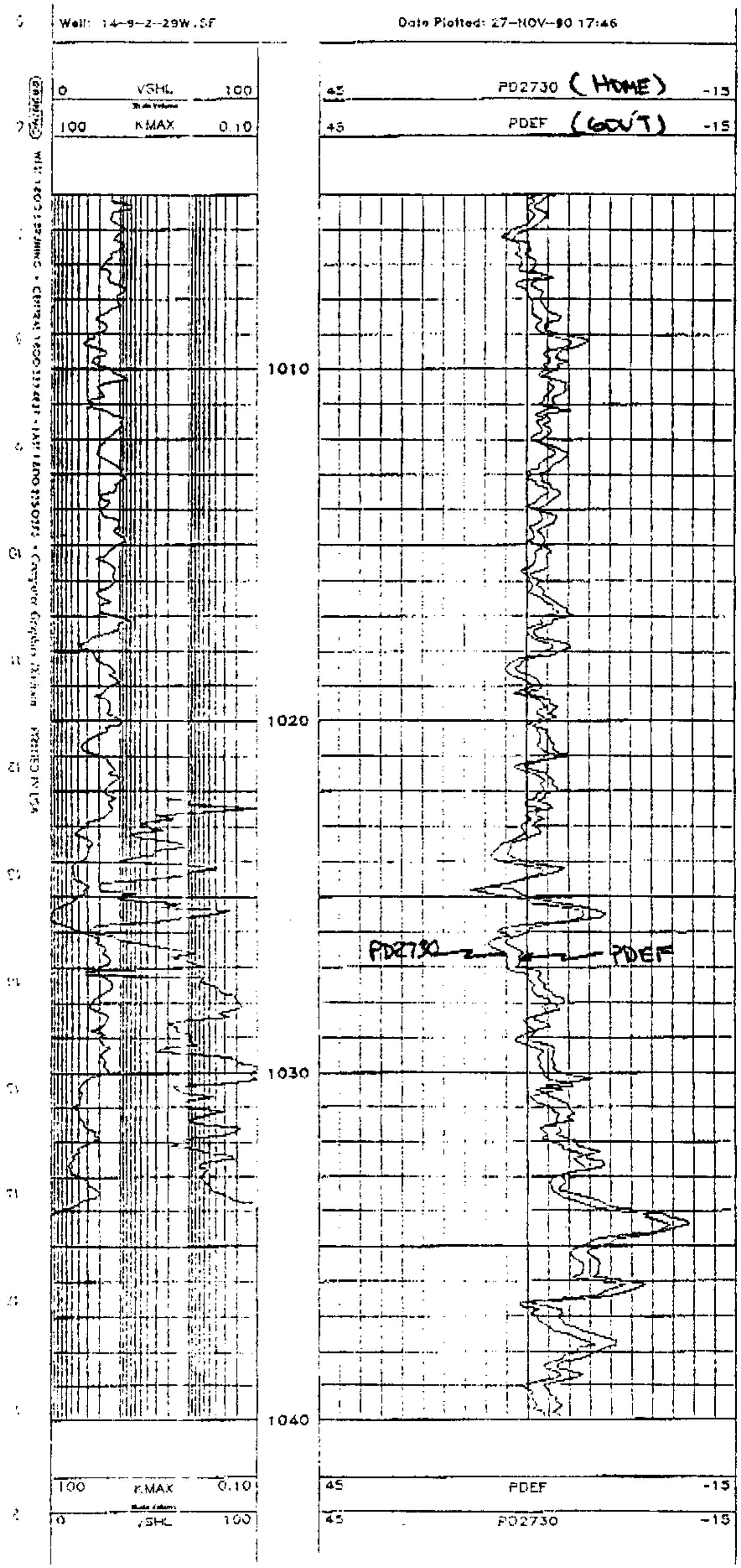

Well: 14-9-2-29W.SF
Date Plotted: 27-NOV-90 17:46
0 VSHL 100
100 KMAX 0.10
45 PD2730 (HOME) -15
45 PDEF (GOV'T) -15
1010
1020
1030
1040
PD2730
PDEF
100 KMAX 0.10
0 VSHL 100
45 PDEF -15
45 PD2730 -15

FIGURE 10

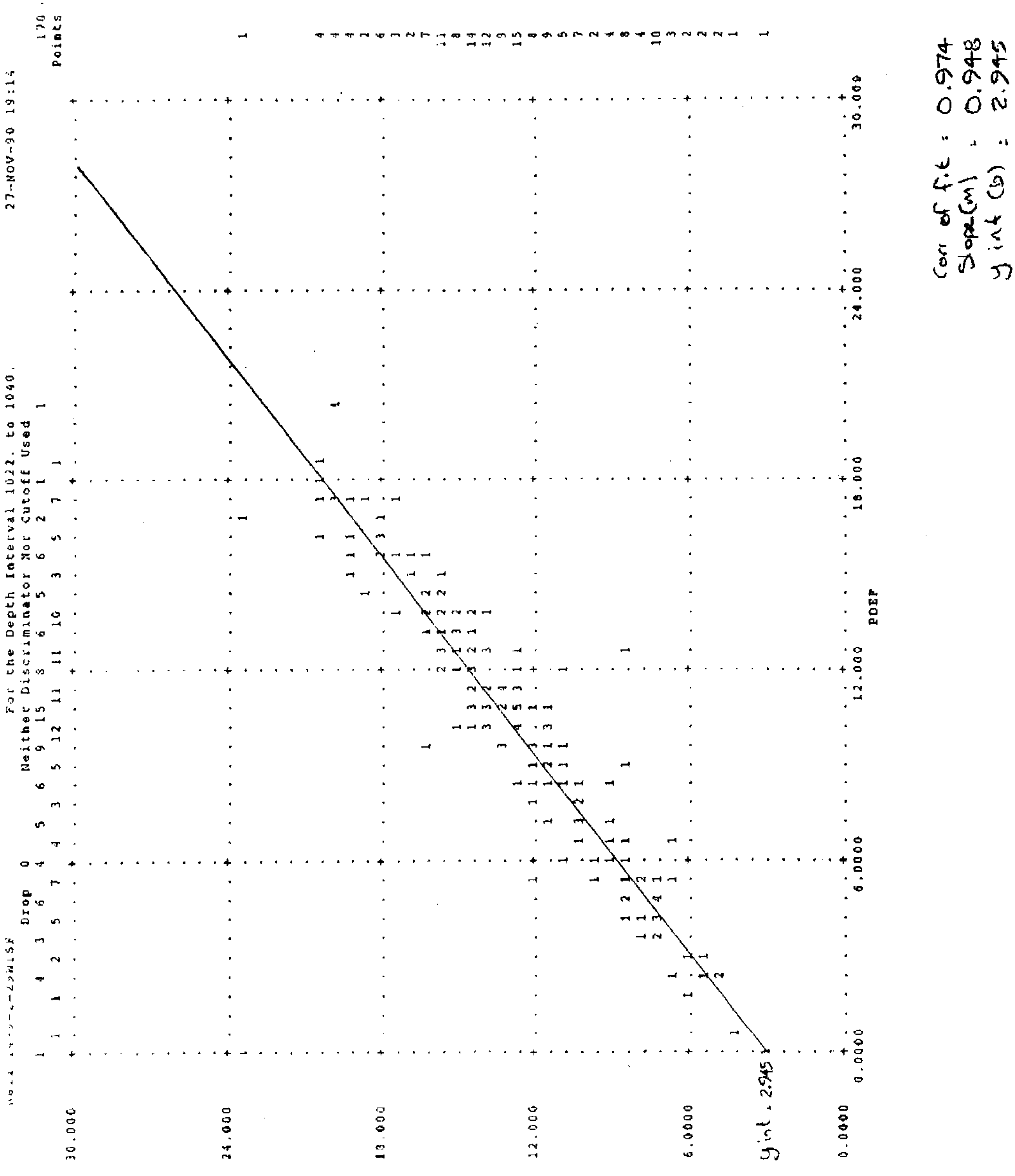

27-NOV-90 19:14
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used
Drop
170. Points
PDEF
0.0000
6.0000
12.000
18.000
24.000
30.000
y int. 2.945
Corr of fit: 0.974
Slope(m): 0.948
y int (b): 2.945

FIGURE 11

Home Oil Company Limited

1600 Home Oil Tower
324 Eighth Avenue S.W.
Calgary, Alberta T2P 2Z5
Telephone (403) 232-7100
Fax (403) 232-7678

21 December 1990

Manitoba Energy and Mines Petroleum Branch
555 - 330 Graham Avenue
Winnipeg, Manitoba
R3L 4E5

Attention: J.N. Fox
Chief Petroleum Engineer

Dear Sir:

Re: Logging Program
South Pierson Area

The purpose of this letter is to request a change in our logging program for the following six licensed wells:

04-17-002-29 W1M (2)
10-17-002-29 W1M (3)
12-17-002-29 W1M (3)
16-18-002-29 W1M (2)
16-19-002-29 W1M (1)
04-31-002-29 W1M (1) Porosity

Home Oil is requesting that the Compensated Neutron Log (CNL) be deleted from the logging program. Home Oil believes no accurate porosity measurements are derived from this log. Accurate porosity measurements can be made from the Formation Density Log (FDC) alone.

If you have any further concerns or questions, please give me a call at (403)232-7362.

Yours truly,

HOME OIL COMPANY LIMITED

Allan Willms

A.R. Willms
Reservoir Engineering
ARW/jlc

DEC 31 1990

[illegible] WELL EVALUATION PROGRAM

4-17-2-29	NO CORE	stepout [illegible] SW
10-17-2-29	" "	infill well
12-17-6-29	" "	infill well
16-18-2-29	" "	step out [illegible] SW
16-19-02-29	" "	step out [illegible] NE
4-21-2-29	- CORE	low well density

COMPUTALOG [illegible] 634-[illegible] cost Book Price

CNL \$1.90/m · on 1ST run pay depth in & out
FDC \$1.90/m · set-up charge \$1800 To Manitoba
GR \$0.50/m cost savings < \$2000

LOGGING REQUIREMENTS [illegible]

· acceptable logs to measure
[illegible], ϕ, GR
· [illegible] [illegible] [illegible] [illegible] logs
[illegible] to [illegible] logs

- request to run FDC as only ϕ trace
complies with regulations

POF 10 - 90 recommends DIL, CNL - FDC in tandem
on a single log

CNL trace used in ϕ_T correlation
ϕ_e correlation
S_w determination (ϕ_T)

Hone's study 10 9 - 2 29

$\phi_N - 8\% = \phi_c$
$\phi_D + 2.0\% = \phi_c$
poor $k - \phi$ correlation

grain density = 2730 kg/m^3 (for correction)

M. Arbez concurs Home conclusion that oil found on shoulders of clean intervals incorrect

- these clay intervals = impossible to accurately evaluate on logs - note: may be thin sand intervals undetected by logs

- Home Oil has developped Lower Amaranth pools on 80 Acre spacing in Steel
- Home Oil claims that a large portion of the L. Am. oil is produced out of intervals directly below those which appear to be 'clean' on logs - on the logs, 'Home's' intervals appear to be predominantly clay-bearing (see figure 1)

- The 'clay' intervals (Home's intervals) appear to be predominantly silty-clayey with thin sand lenses
- logs cannot pick up these thin sand lenses because of the predominance of clay between them; therefore, in my opinion, Sw and ϕ_T calculations cannot be made over those intervals which appear to be clay-bearing
- in my opinion, logs respond mainly to the clay's over these intervals

- Home successfully attempted to match ϕ_D with ϕ_T from core (force-fit).
- in my opinion, ϕ_D or ϕ_T over the clay-bearing intervals is erroneous
- Rob Garton (Core Labs): most clays in L. Amaranth are illitic and preserve fairly well (ie do not react easily with drilling muds while coring)
  - ϕ_t from core for clays can be quite erroneous because of microporosity in the clay.
- in my opinion, core porosities for clay-rich intervals may be erroneous - the same may hold true for log porosities.
-

- Home bases its 'oil' intervals from core permeabilities - there may be a problem with these permeabilities:
- sampling points of plugs for K-determination may be one problem
- are plugs preferentially selected in the core ie - clean sand lenses within clay intervals? If this is the case, 'K' may be erroneously high for the overall interval but may accurately represent K for the sand lenses only.

- another possible source of inaccuracy are desiccation cracks from dehydration of the clays (?) or fracturing of the core with a release of pressure from downhole to surface conditions (are the fractures possibly mechanically induced and are these fractures related to the high permeability zones measured on core?)
- we apparently see a fair bit of fracturing (core sample visual examination) - are these natural or mechanically induced and how do they relate to permeability measured?)

- I looked @ a number of core analyses for cored intervals described by Muz in his S. Pierson report. Here are the results:

location	oil staining + where?
* 9-24-2-29	yes - mostly in the 'clay' (on logs) interval below Main Sand
14-24	yes - 2m of staining in Main Sand, 1.5m in 'clay' below
16-8	yes - all in Main Sand
14-4	" "
16-9	" "
8-10	yes - in Main Sand + in Lower Sand
10-15	no oil staining noted
10-21	yes - top portion of Main Sand
6-19	yes - all in Main Sand
6-7	yes - upper (A+B) sands and in Main Sand.

- with the exception of 9-24-2-29, oil staining observed mostly in "clean" (on logs) intervals in Main Sand.
- I do not disagree that some oil resides in what appears to be the 'clayey' intervals (on logs), but I feel the amount predicted in these intervals by

Horne may be optimistic - the clean sand lenses may contribute most of the oil from these intervals and, in my opinion, a lot of oil resides in the 'clean' intervals

- Sw and ϕ_T estimates that I obtained for the 'clean' sand intervals are believable, in my opinion, and may accurately reflect what's really there (backed up by EPT, Dual Water, Waxman Smits + quick-look methods).

- Horne feels they can get an accurate enough 'picture' of S. Pierson without any more resistivity logs + much fewer porosity logging in infilling. - I'm not so sure about this, especially resistivity logging (we are only on 80 Acre spacing, presently)

- we should have a look at S. Pierson L. Amaranth core to see where plugs for 'K' measurements were selected (from sand lenses?) and observe oil staining (if an interval had oil + the oil was flushed out by drilling mud, there should be some residual oil)

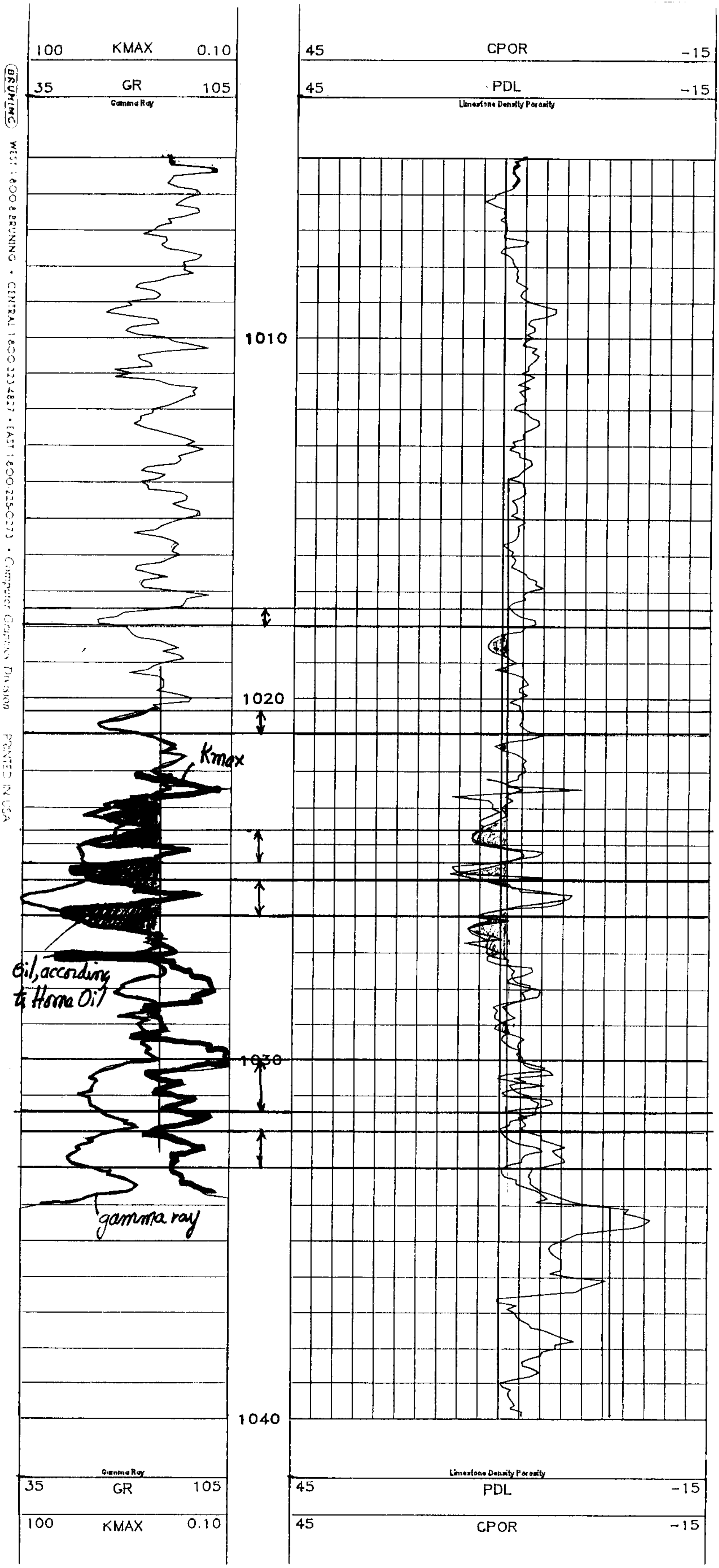

100 KMAX 0.10
35 GR 105
Gamma Ray
45 CPOR -15
45 PDL -15
Limestone Density Porosity
1010
1020
1030
1040
Kmax
Oil, according to Homa Oil
gamma ray
BRUNING
PRINTED IN USA

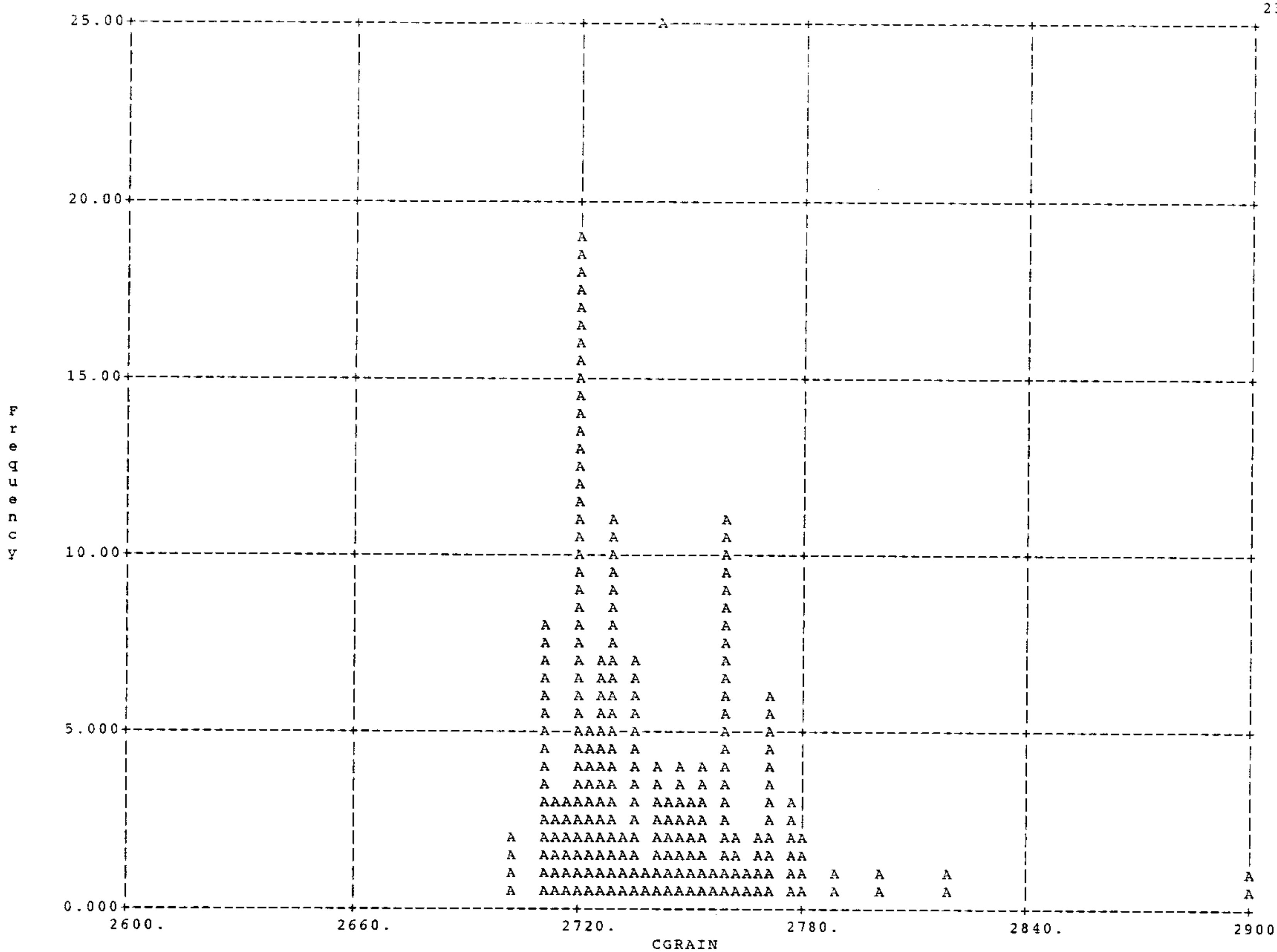
Fig. 1

***** Histogram *****

A - Well: 14-9-2-29W1SF   Trace: CGRAIN* Depths: 1022.200 to 1040.000

C/D: Test: Cutoff:

23-NOV-90 15:10

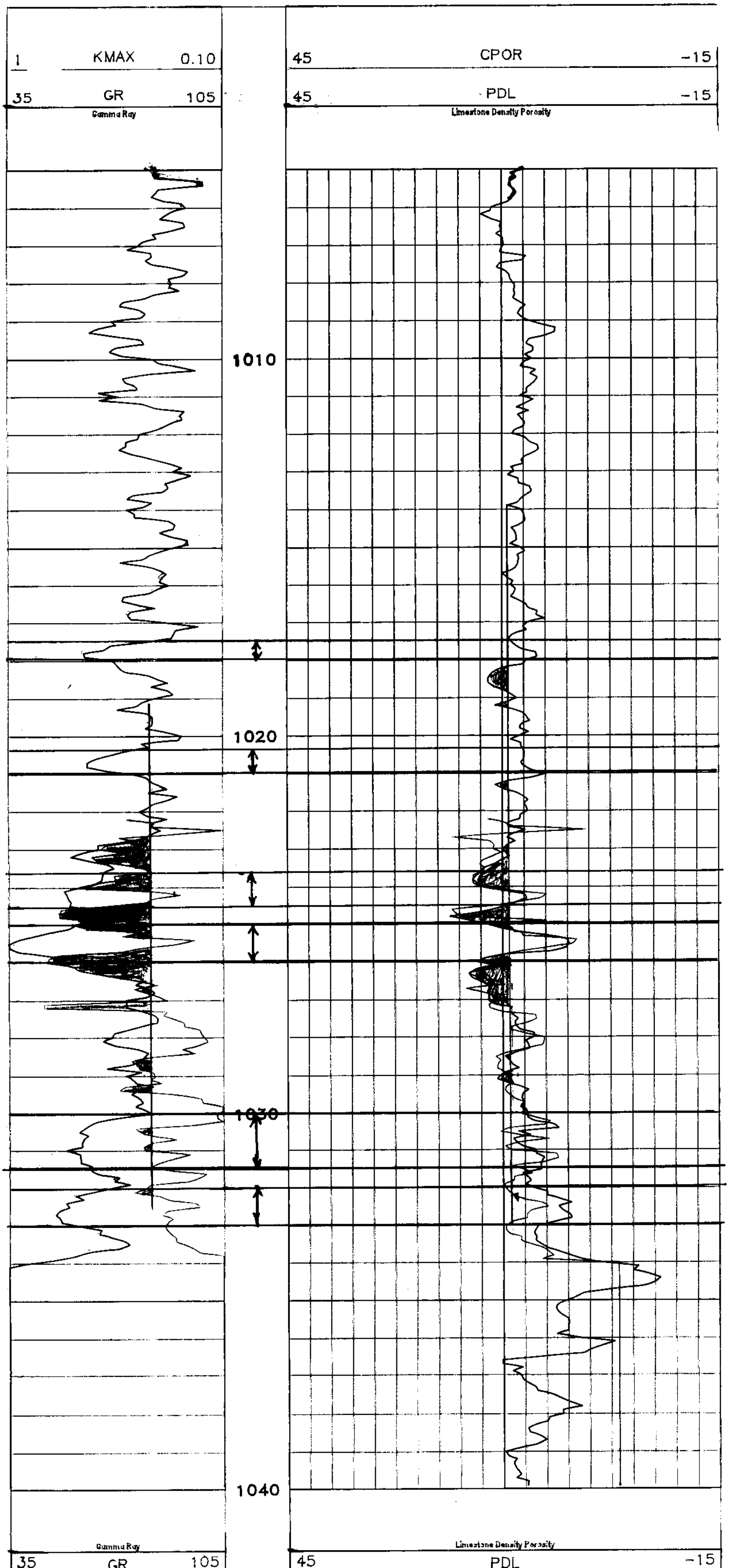


Core Grain Density

Mean 2740.2
Std Dev 0.27

Well: 14-9-2-29W1SF

Date Plotted: 27-NOV-90 12:04



***** CROSS-PLOT *****

Well 14-9-2-29W1SF

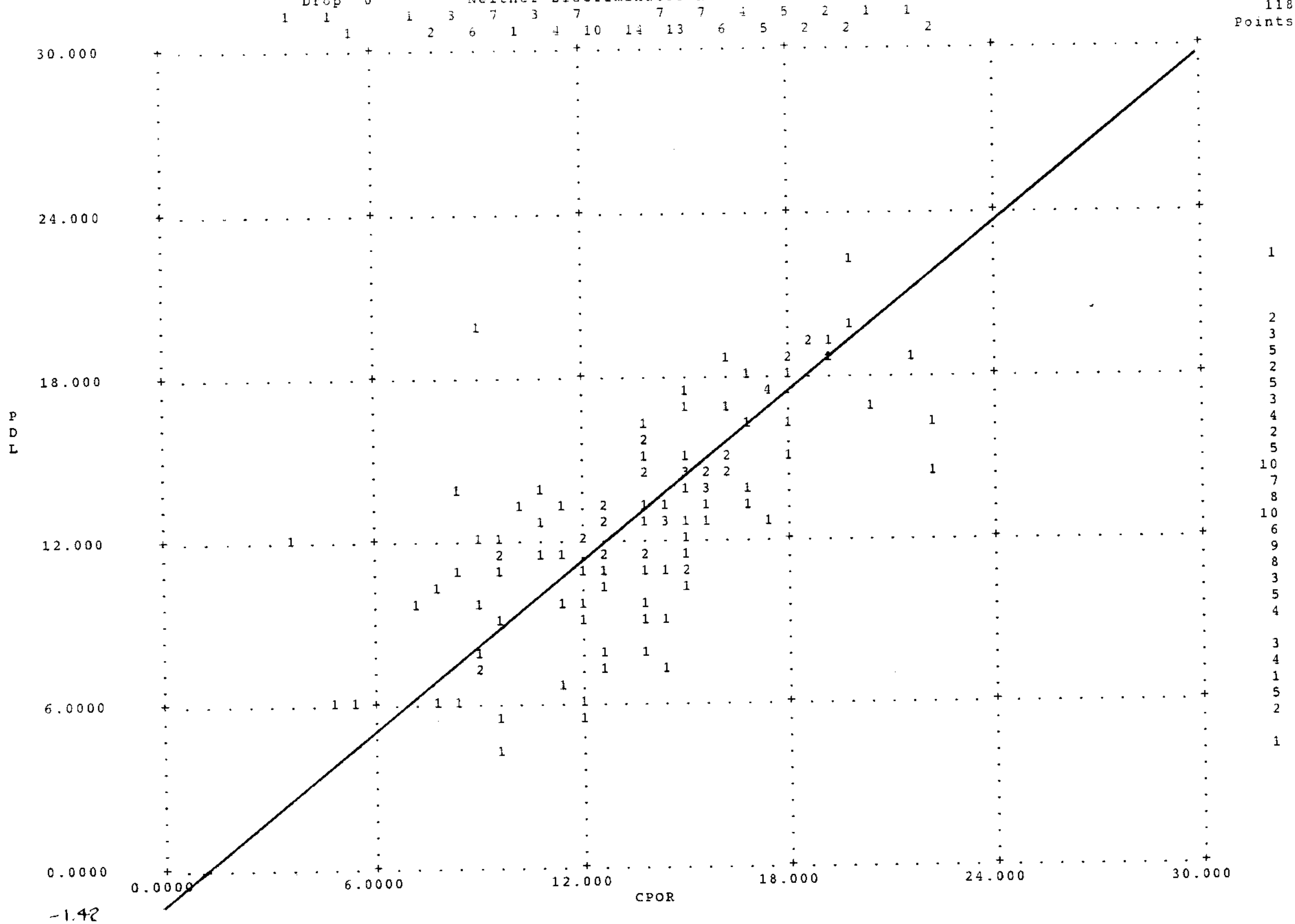
For the Depth Interval 1022. to 1040.

Neither Discriminator Nor Cutoff Used

23-NOV-90 15:03

Drop 0

118 Points



Corr Coef 0.837

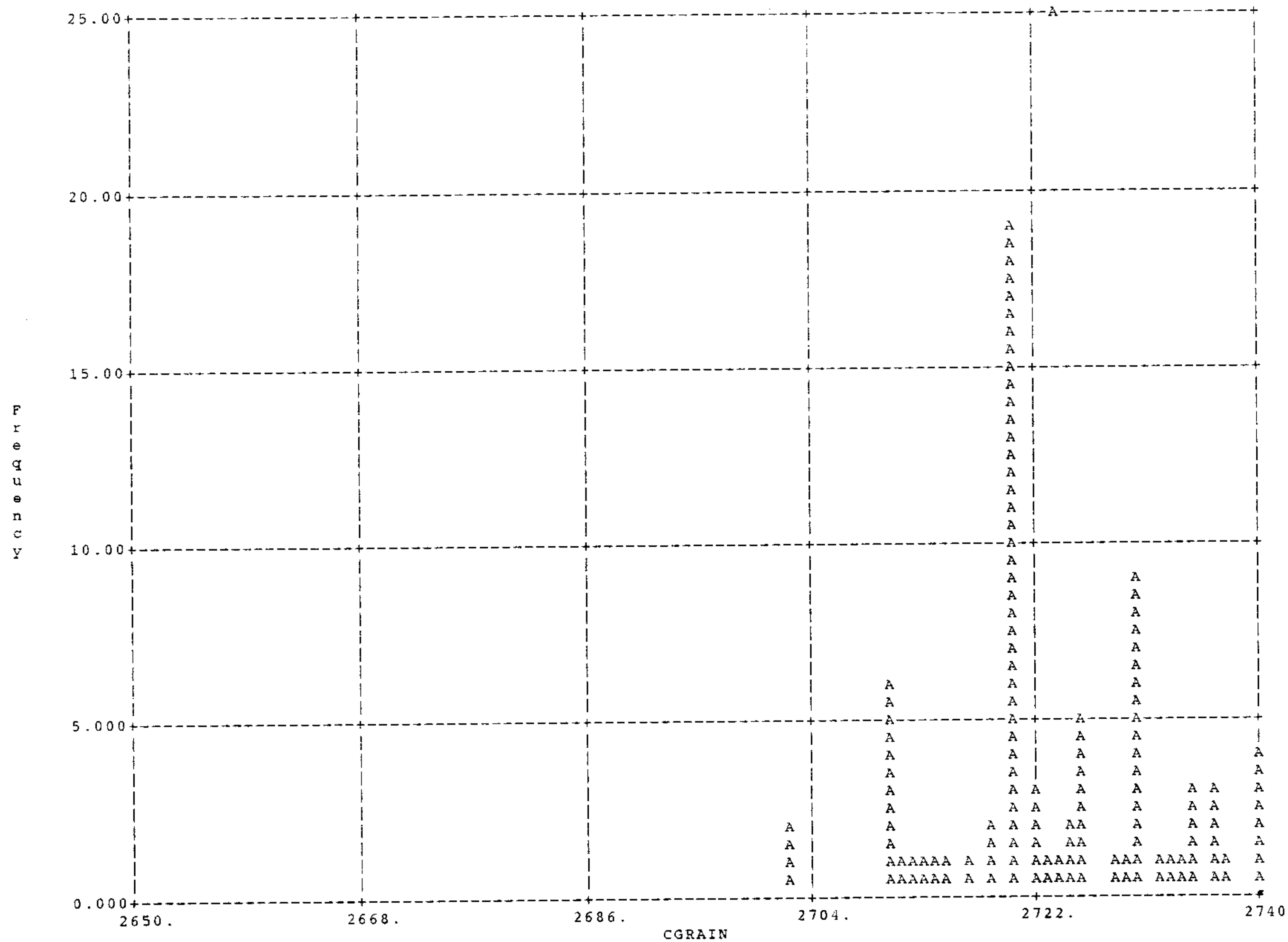
Slope 1.037

y int -1.420

***** Histogram *****

A - Well: 14-9-2-29W1SF   Trace: CGRAIN* Depths: 1022.200 to 1040.000
C/D: Test: Cutoff:

26-NOV-90 08:55



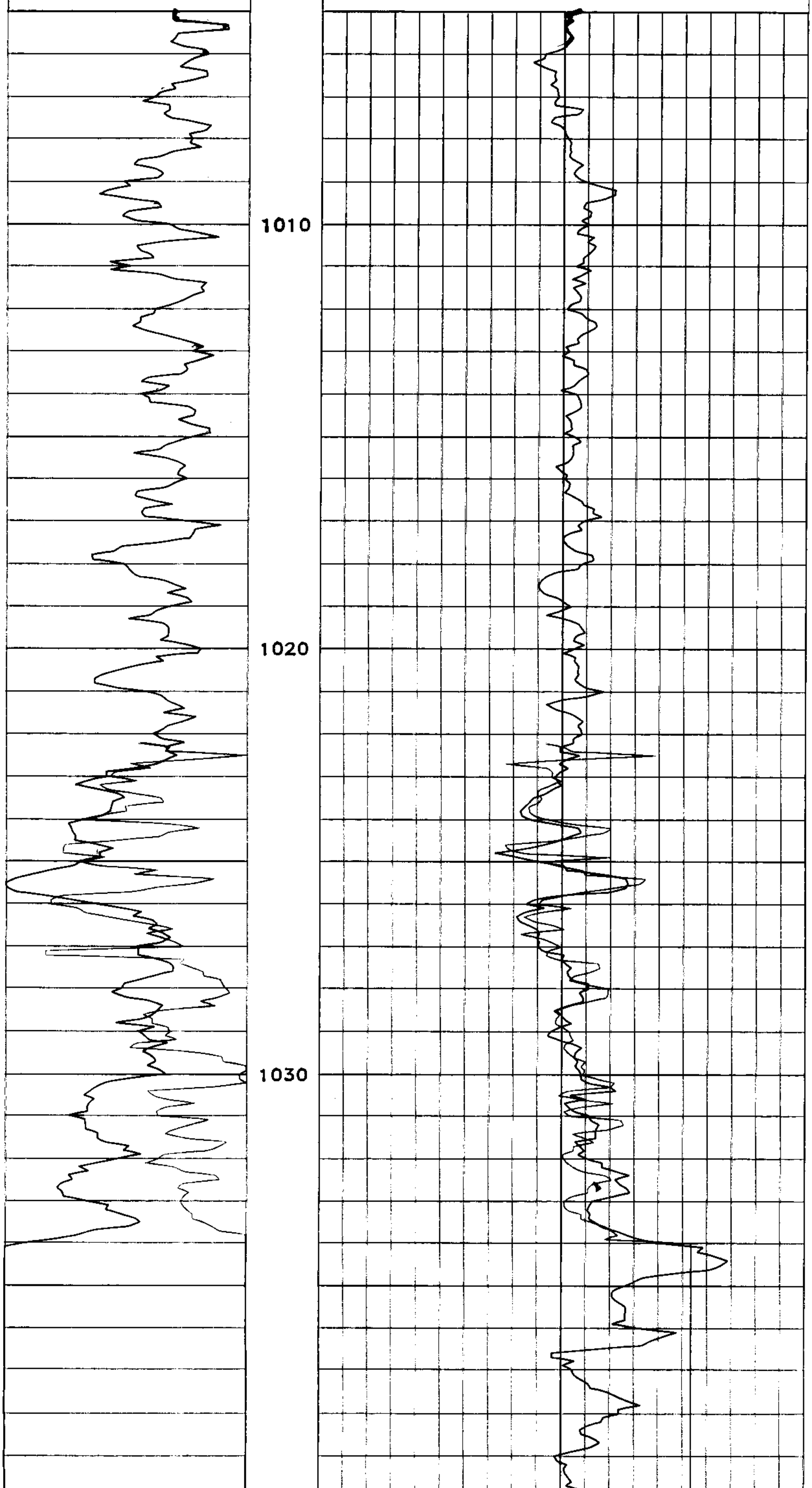
Mean 2723.

Well: 14-9-2-29W1SF

Date Plotted: 27-NOV-90 11:54

1	KMAX	0.10
35	GR	105
	Gamma Ray	

45	CPOR	-15
45	PD2730	-15
	Porosity Rhoma = 2730	

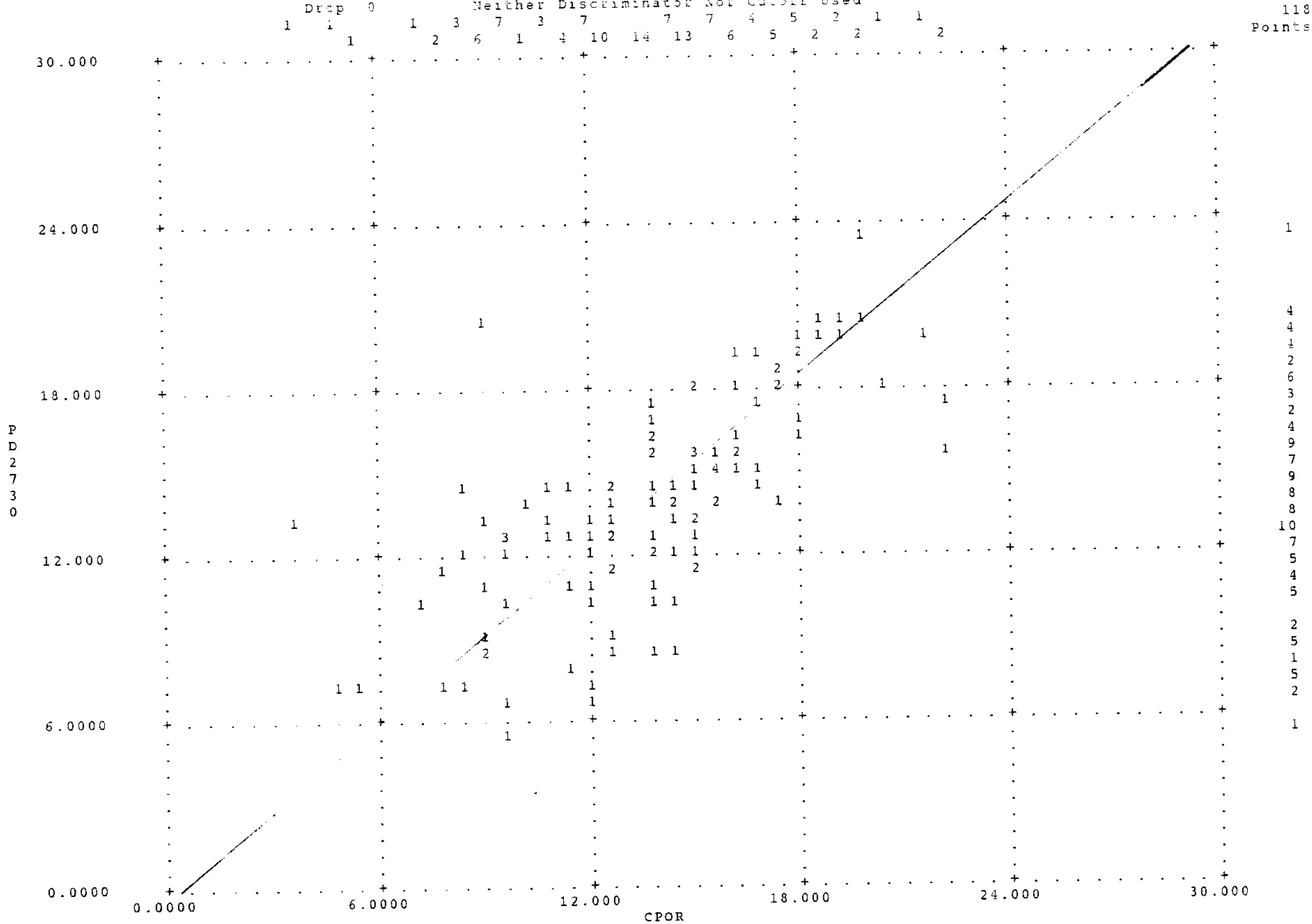


	Gamma Ray	
35	GR	105

45	PD2730	-15

***** CROSS-PLOT *****
For the Depth Interval 1022. to 1040.
Neither Discriminator Nor Cutoff Used

Well 14-4-2-29W1SF   27-NOV-90 12:18

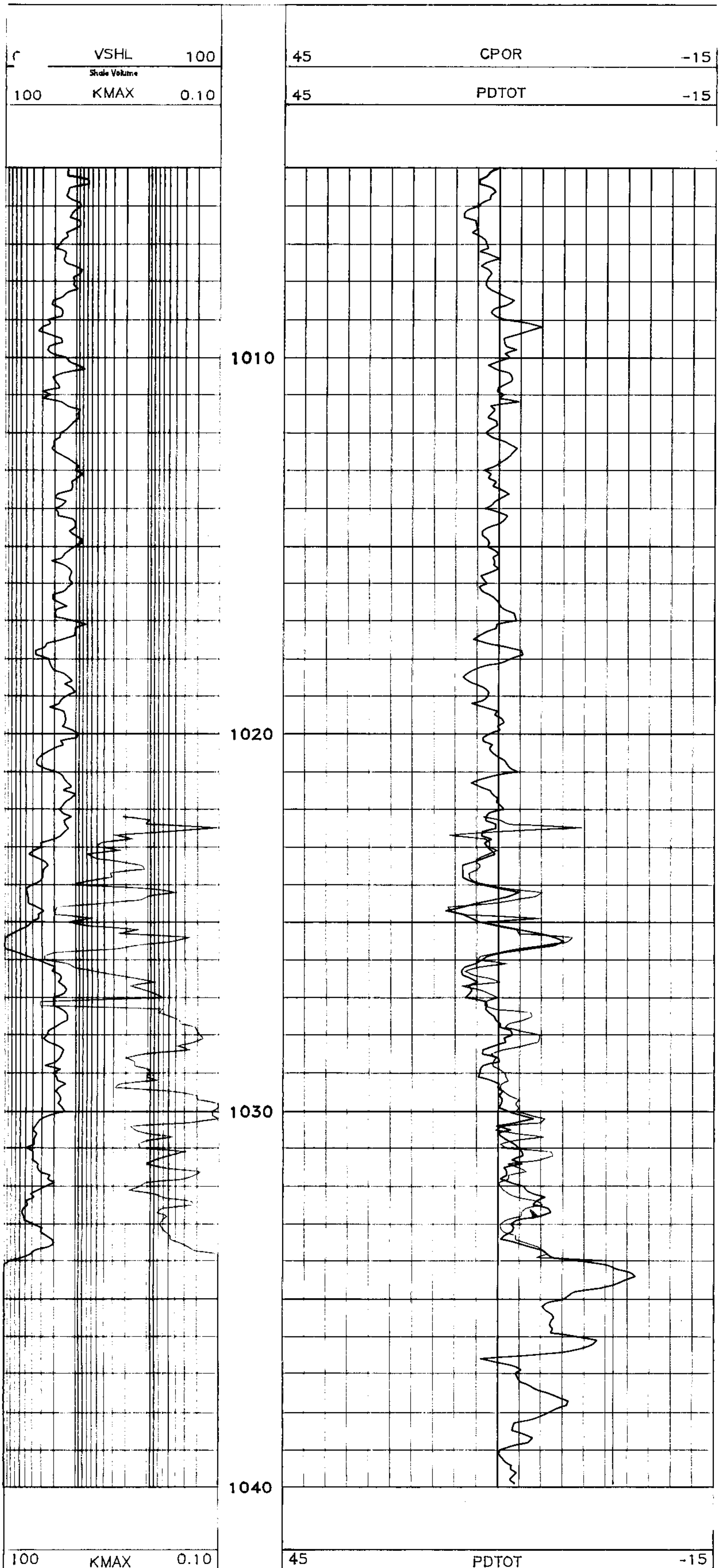


Int
0.247

Corr coef. 0.887
Slope 1.025
Int 0.247

Well: 14-9-2-29W1SF

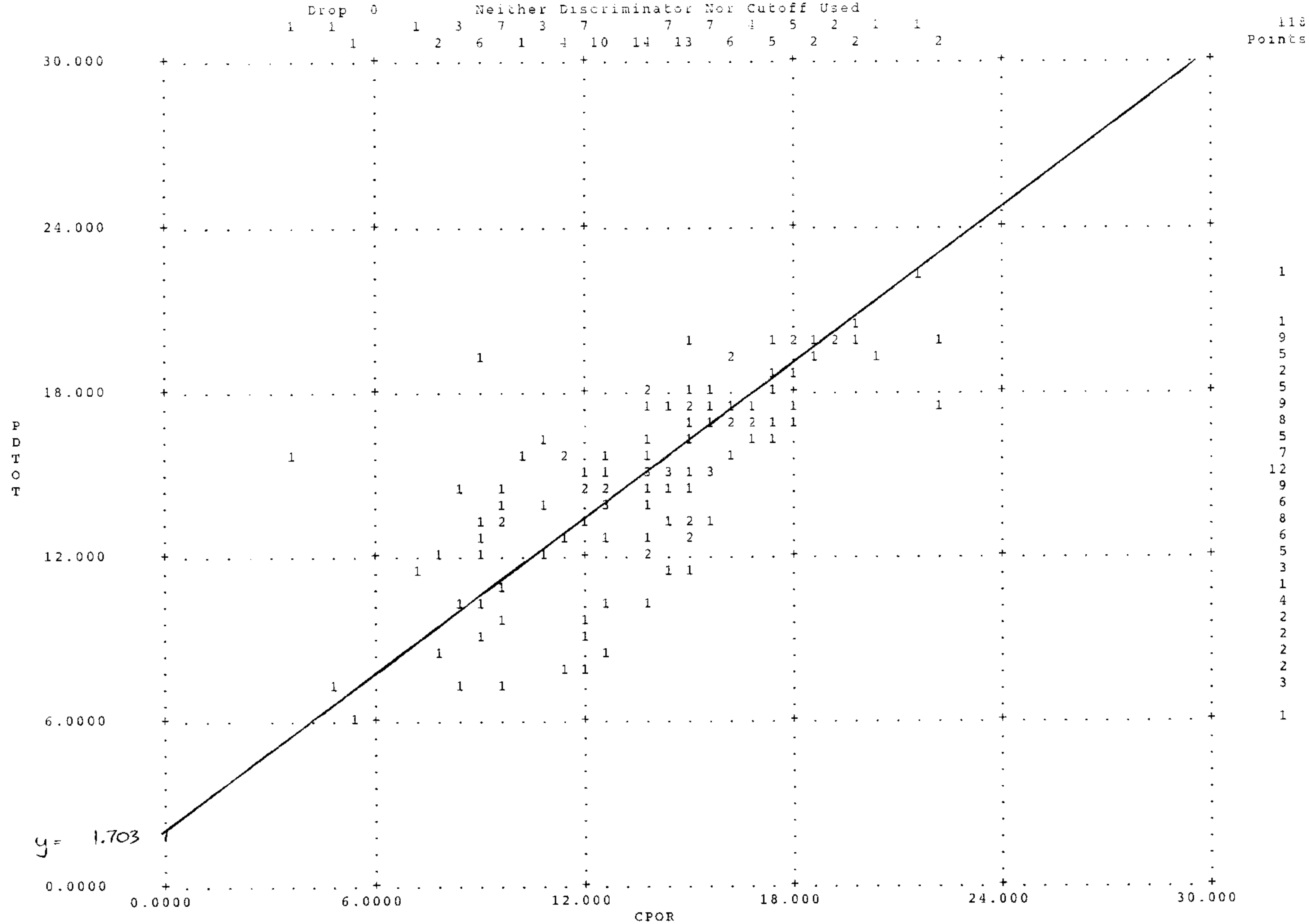
Date Plotted: 27-NOV-90 18:02



***** CROSS-PLOT *****

Well 14-9-2-29W1SF — For the Depth Interval 1022. to 1040. — 27-NOV-90 18:54

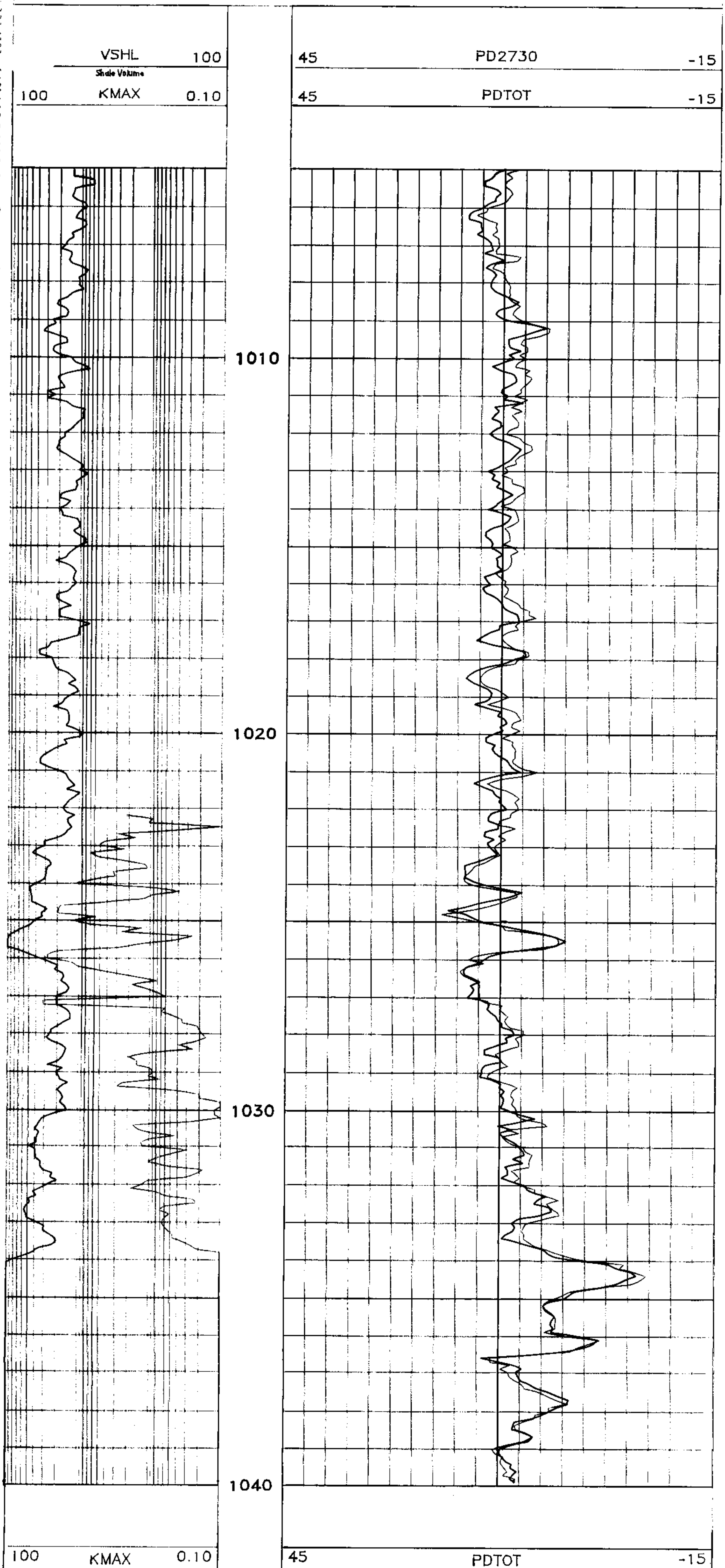
Drop 0 — Neither Discriminator Nor Cutoff Used

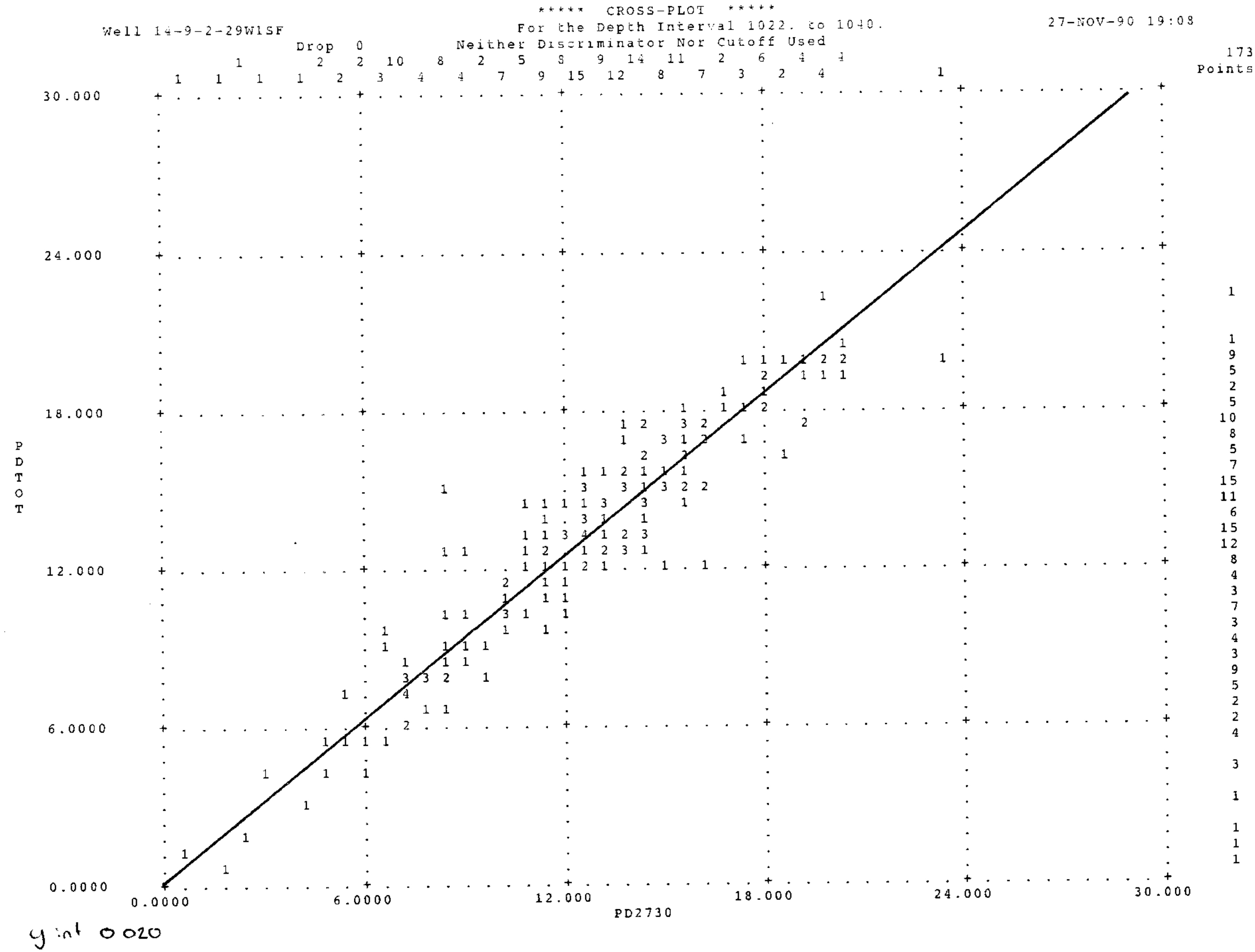


Corr Fit 0.854
Slope 0.952
y int 1.703

Well: 14-9-2-29W1SF

Date Plotted: 27-NOV-90 17:56





Corr of Fit : 0.969
Slope . 1.036
y int : 0.020

***** CROSS-PLOT *****

Well 14-9-2-29W1SF

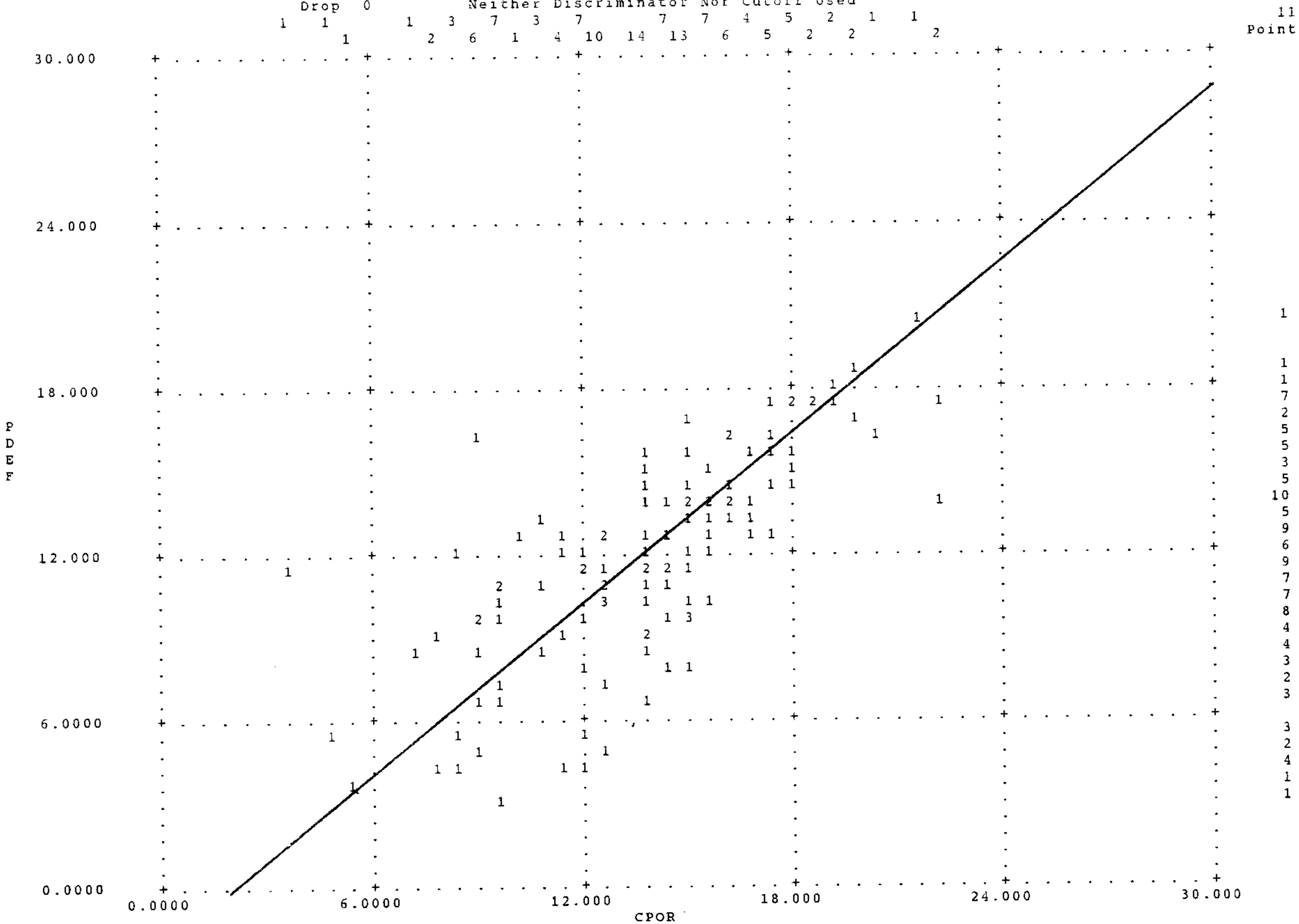
For the Depth Interval 1022. to 1040.

27-NOV-90 19:03

Drop 0

Neither Discriminator Nor Cutoff Used

118 Points



y int
-2.456

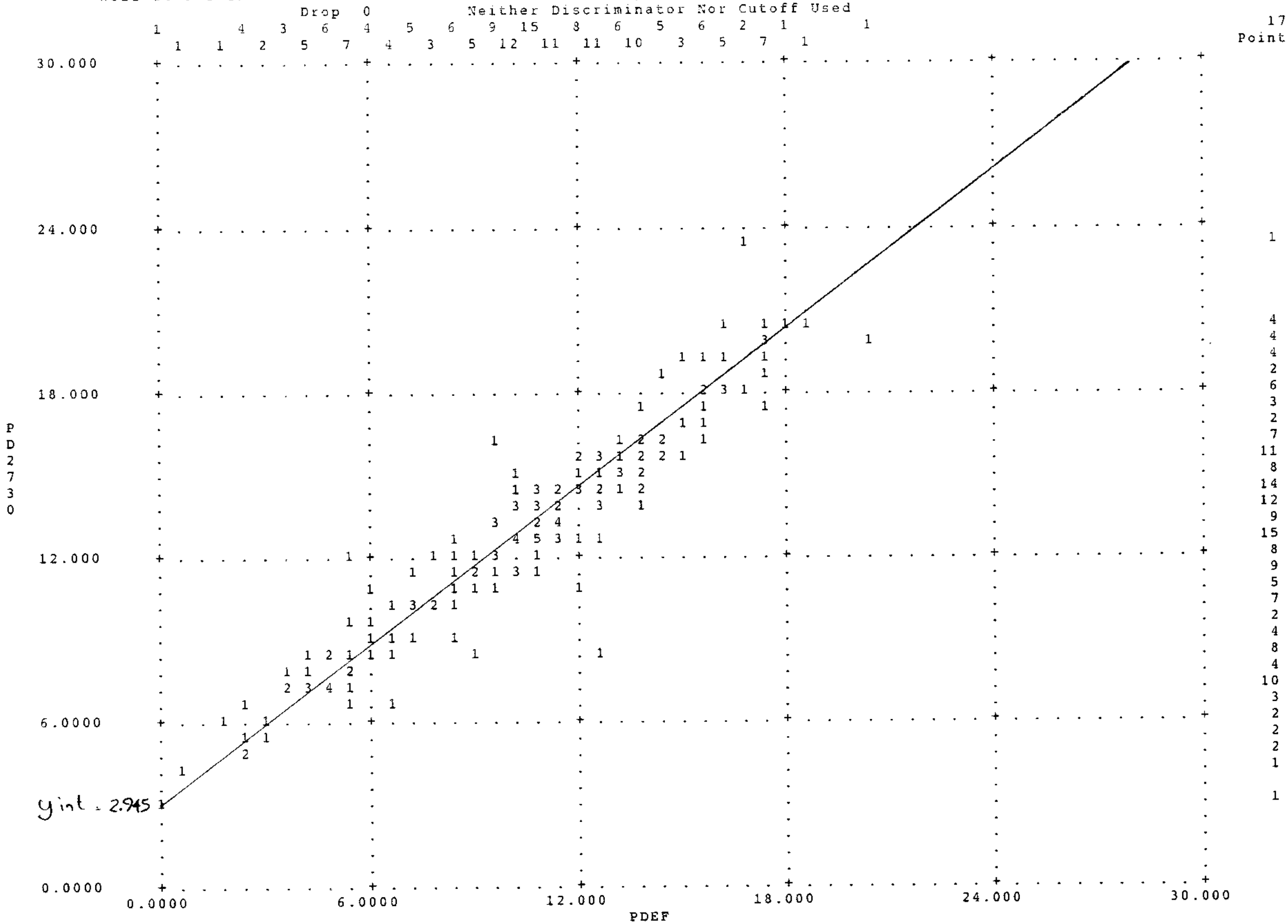
Corr of Fit , 0.854
Slope = 1.031
y int = -2.456

0 VSHL 100
Shale Volume
100 KMAX 0.10
45 PD2730 -15
45 PDEF -15
1010
1020
1030
1040
100 KMAX 0.10
Shale Volume
45 PDEF -15

***** CROSS-PLOT *****

Well 14-9-2-29W1SF — For the Depth Interval 1022. to 1040. — 27-NOV-90 19:14

Neither Discriminator Nor Cutoff Used



Corr of fit : 0.974

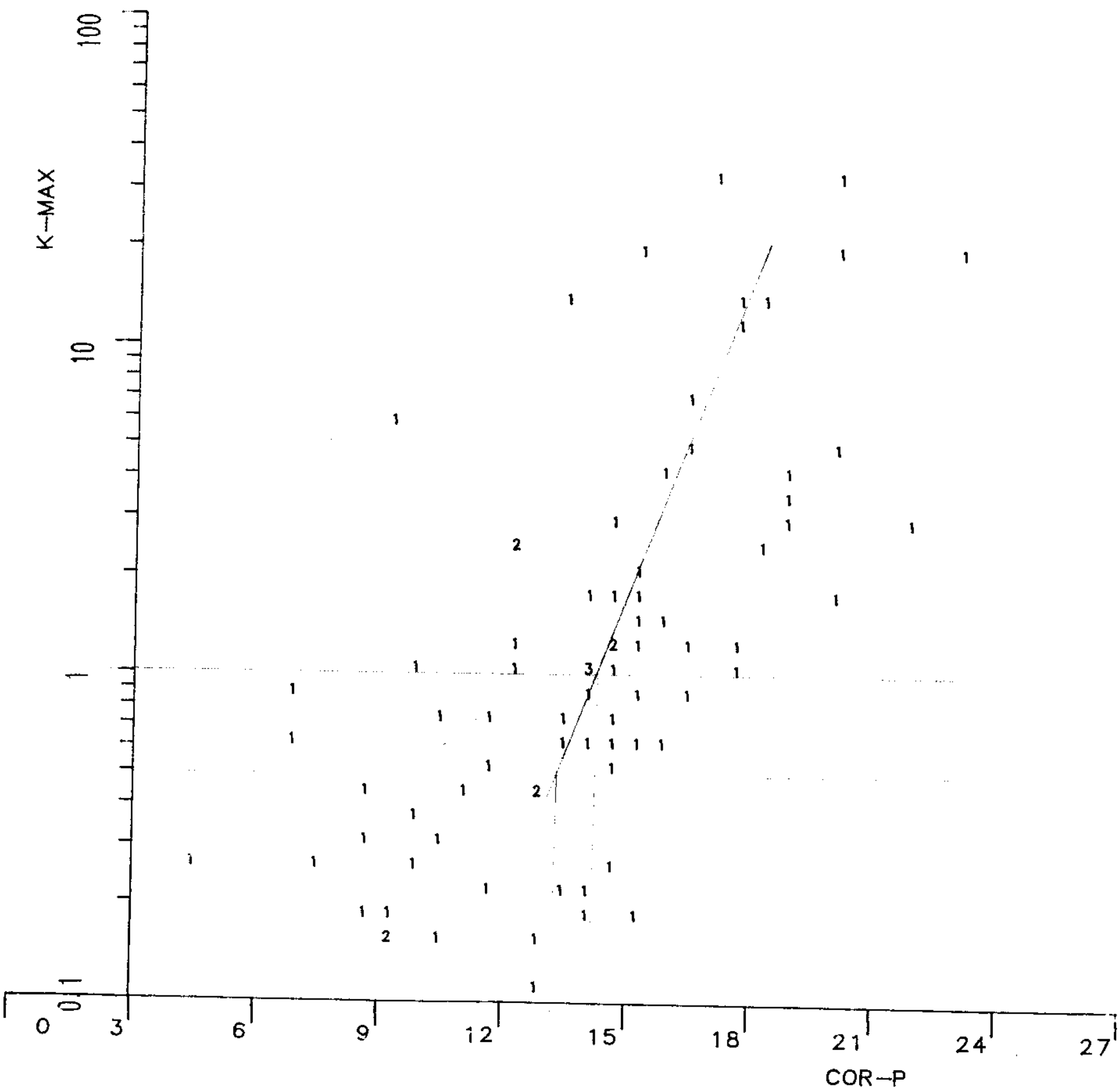
Slope (m) : 0.948

y int (b) : 2.945

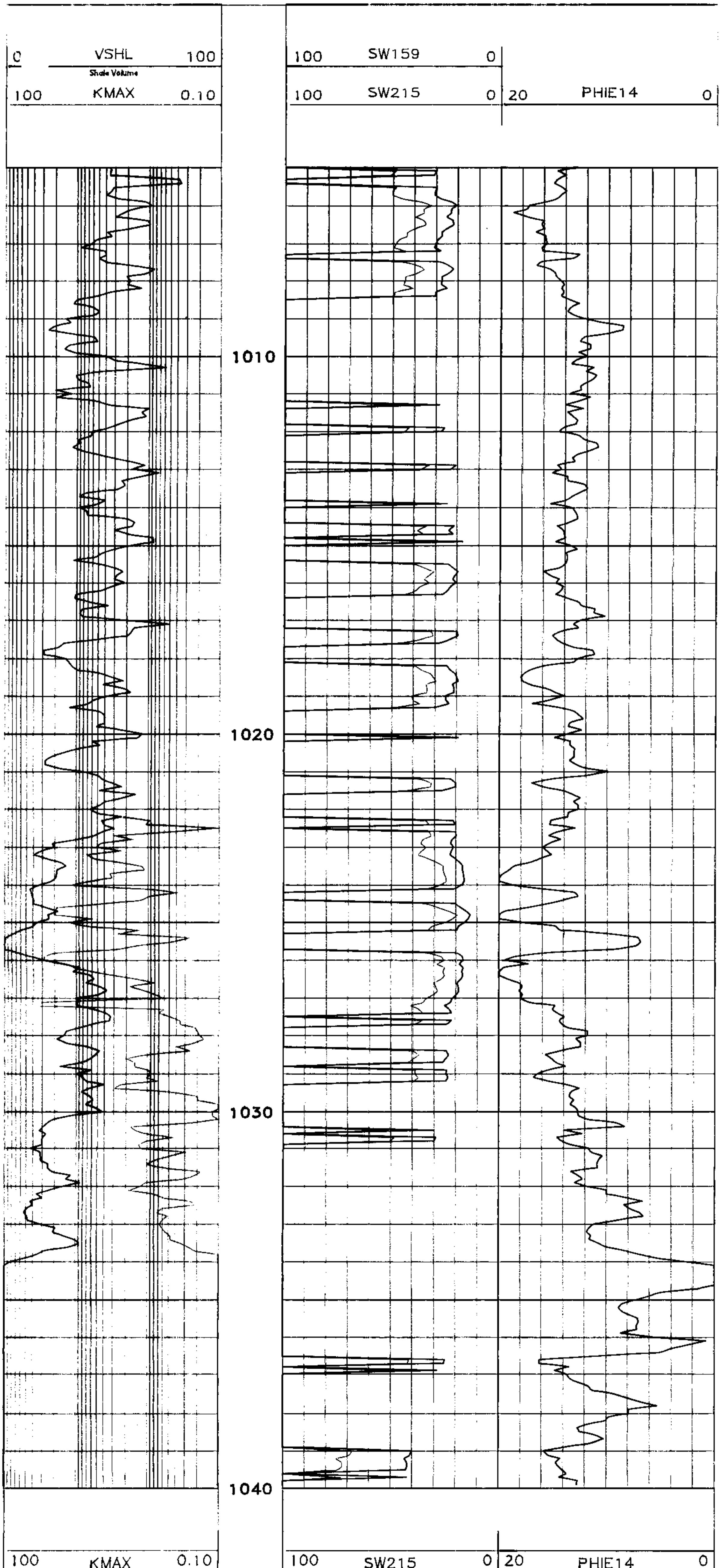
14-9-2-29W1CORE

1022.2 - 1058.2

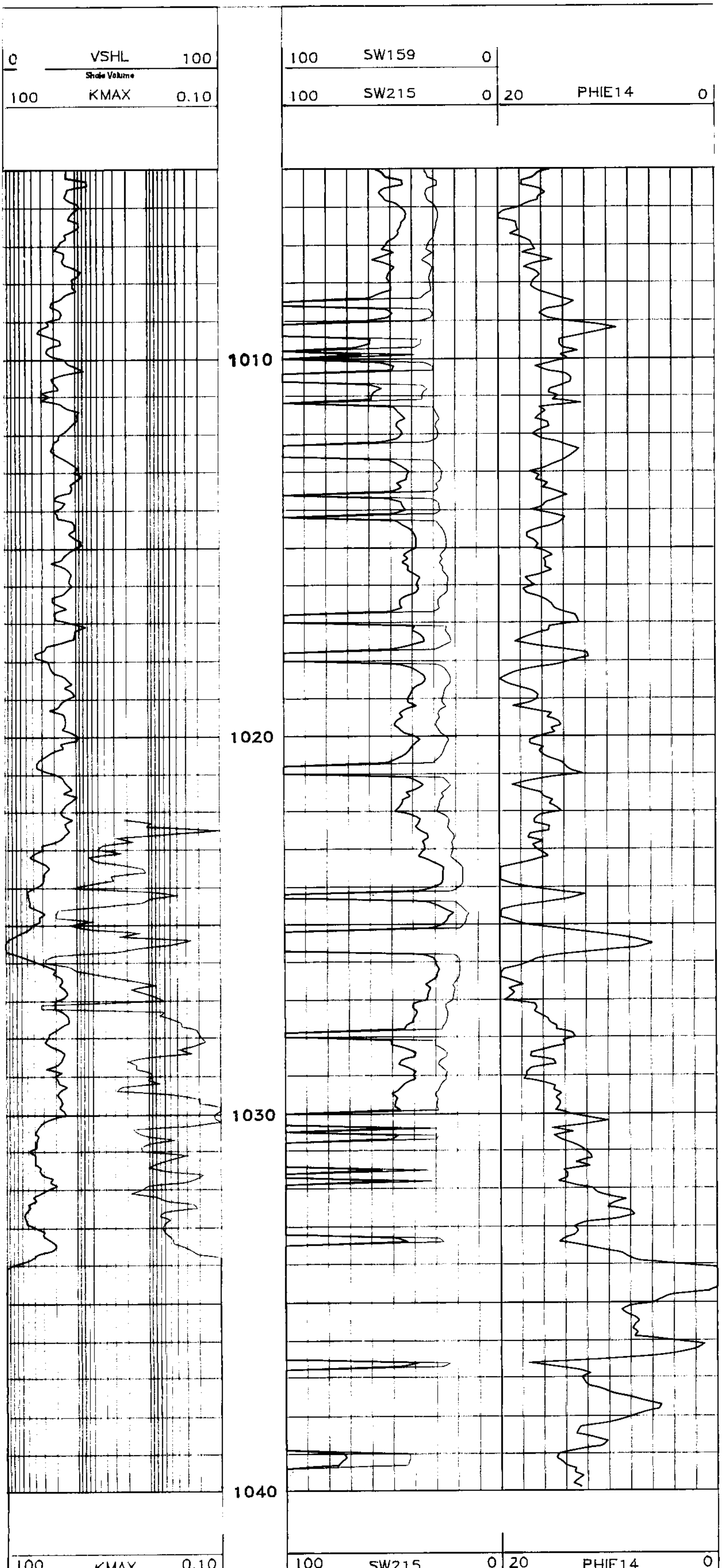
Z=FREQ Low= 0; High= 100
W-Axis not used
GL



Well: 14-9-2-29W1SF   Date Plotted: 27-NOV-90 16:37

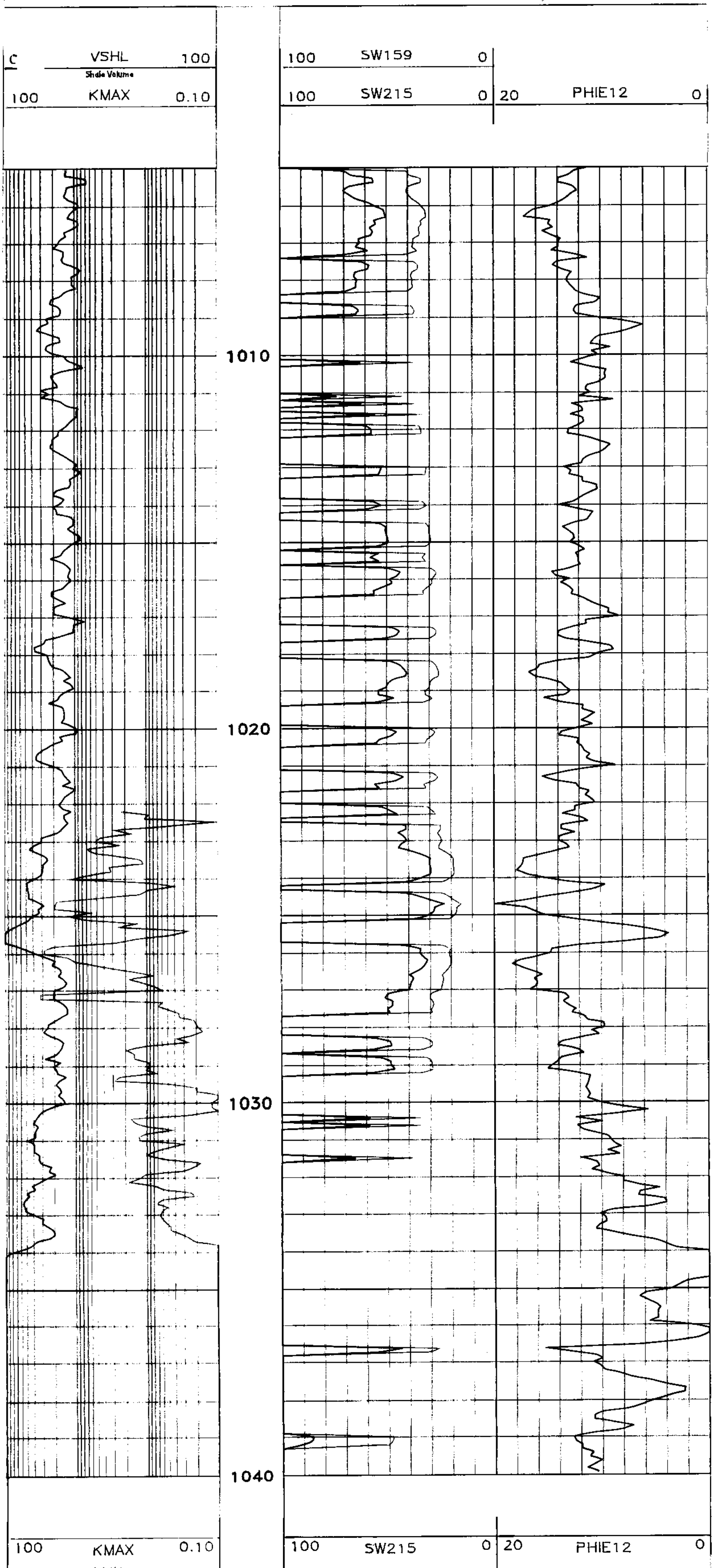


Well: 14-9-2-29W1SF Date Plotted: 27-NOV-90 18:14



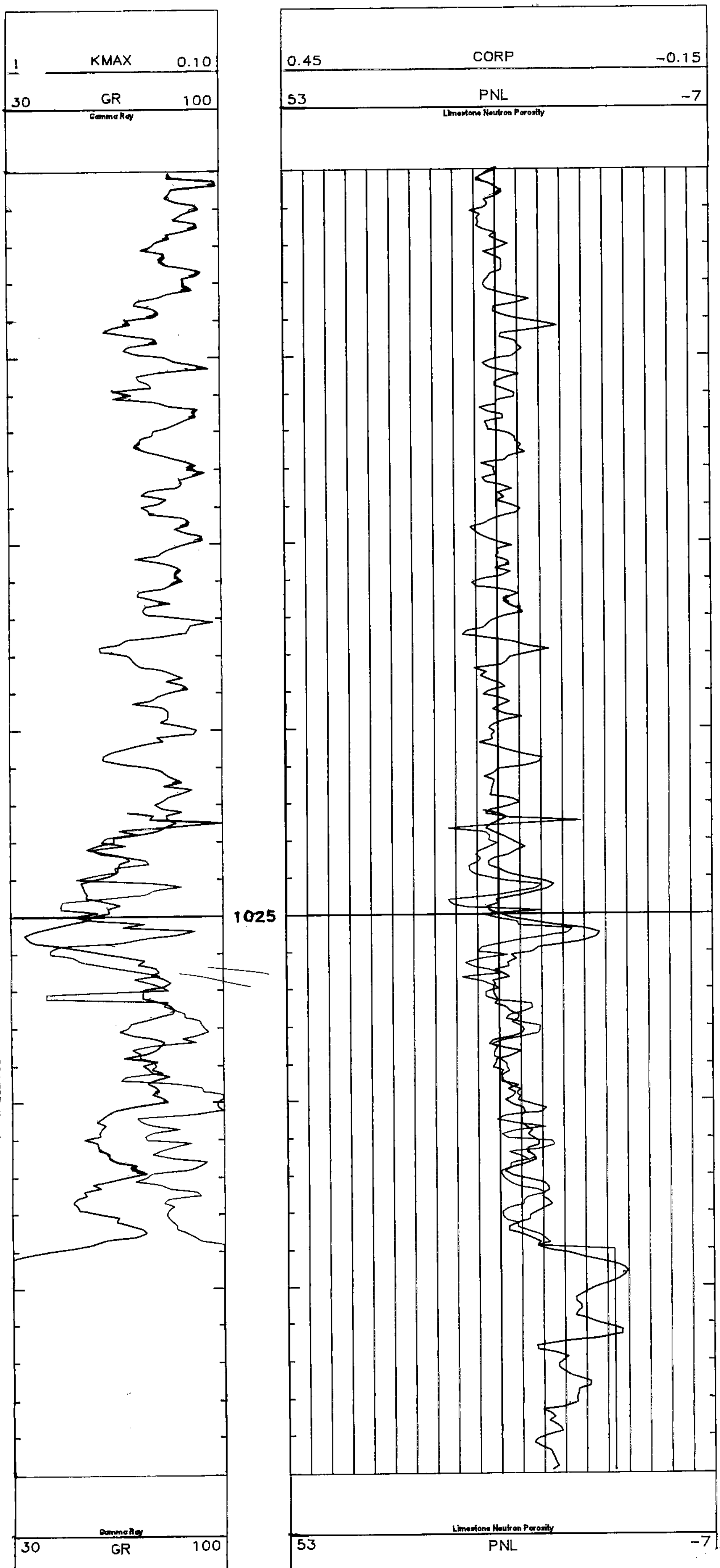
Well: 14-9-2-29W1SF

Date Plotted: 27-NOV-90 18:24



Well: 14-9-2-29W1SF

ate Plotted: 26-NOV-90 07:42



***** CROSS-PLOT *****

Well 14-9-2-29W1SF

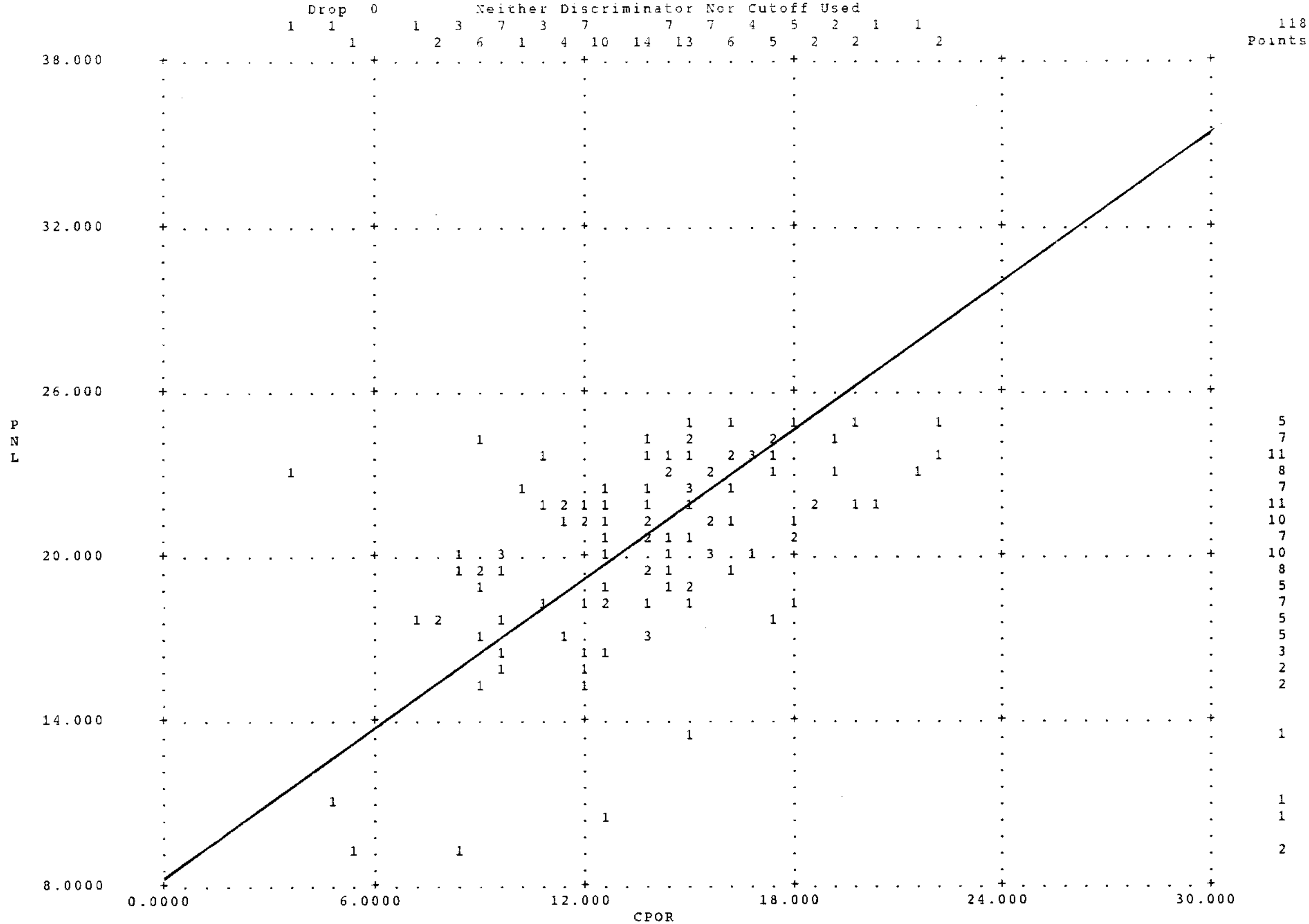
For the Depth Interval 1022. to 1040.

23-NOV-90 15:38

Drop 0

Neither Discriminator Nor Cutoff Used

118 Points



Correl fit = 0.730
Slope (m) = 0.893
y int = 8.097