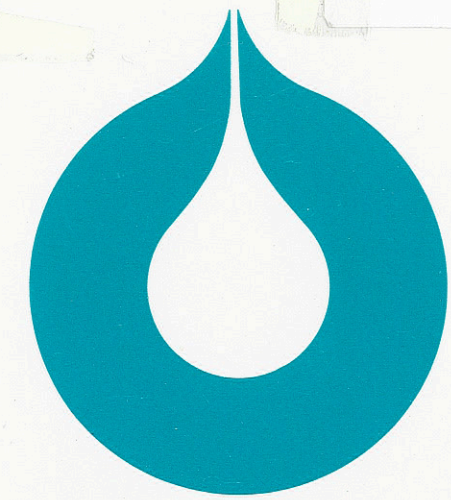

statoil

PETROPHYSICAL REPORT
RFT REPORT
WELL 6610/7-1
BY LET - HARSTAD
OCTOBER 1983

ENGINEER: JAN RAFDAL

Den norske stats oljeselskap a.s

PETROPHYSICAL REPORT
RFT REPORT
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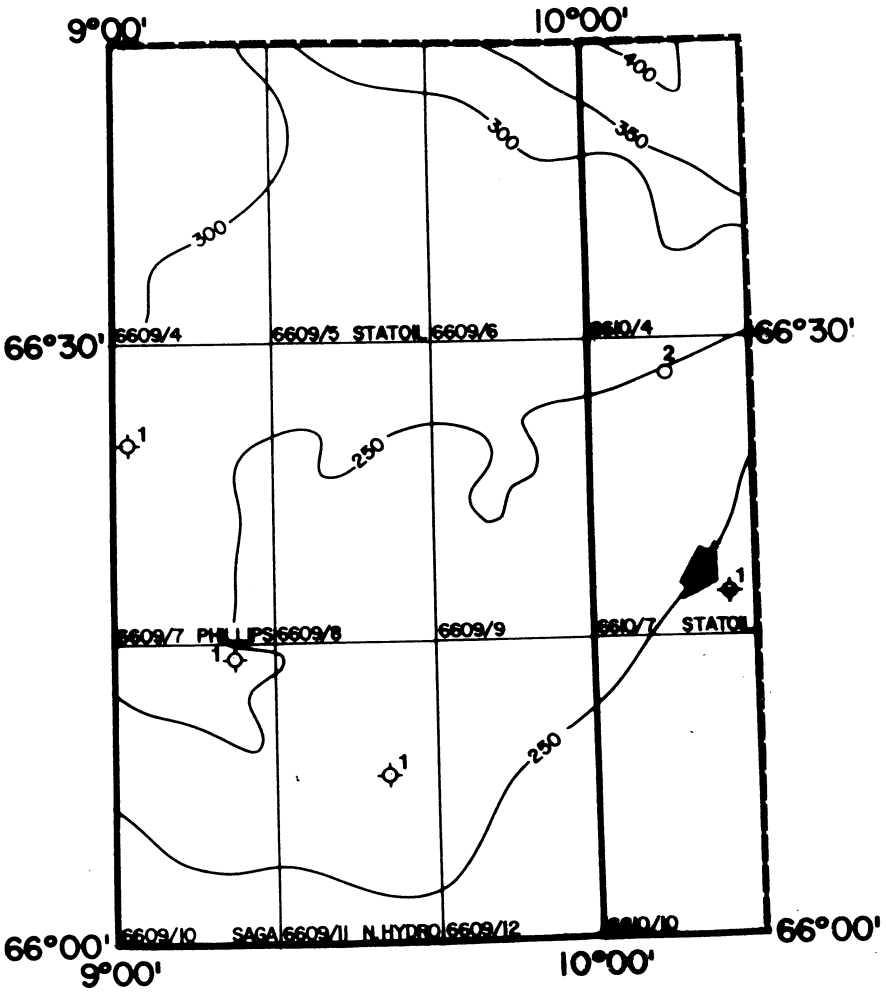
CONTENTS

GENERAL WELL DATA

License	:	PL 084
Wildcat well	:	6610/7-1
Location	:	N 66° 17' 32,3", E 10° 16' 52,5"
Spudded	:	18. April 1983
Rig released	:	19. June 1983
Rig	:	Neptuno Nordraug
KB-elevation	:	25m
Water depth	:	265m
Total depth	:	3333m
Objective	:	Jurassic sandstones
Operator	:	Statoil
Partners	:	Agip, Elf
Status	:	Plugged and abandonned



Introduction

6610/7-1 was the first well drilled on TRÆNABANKEN. The main objective was to test JURASSIC sandstones for hydrocarbon accumulations. The well was however dry and was drilled to a total depth of 3333m RKB in rocks of Triassic age. The objective of the report is to evaluate the reservoir properties of Jurassic and Triassic formations using well logs, RFT-measurements and conventional core data.

SUMMARY

The evaluation shows the well to be waterbearing. Some residual oil has been found on the core and can also be evaluated from the logs.

The petrophysical properties have been summarized in the table below:

Interval	2650-2915	2915-3333
Net sand (m)	122.5	177.75
Average porosity (%)	18.5	16.5
Net/Gross ratio	0.462	0.425

STRATIGRAPHY

The descriptions of depositional environments and lithologies are based on log interpretations, paleontology and cuttings/core descriptions.

INTERVAL	DEPOSITIONAL ENVIRONMENT/LITHOLOGY	REMARKS
2658m-2679m (Toarcian sand)	Marine sandstone. Offshore, very shallow inner shelf (near shore in uppermost part)	coarsning up sand-stone
2679m-2746m (L. Jurassic shale)	Shallow marine claystone. (Possible lagoonal in parts)	Silty claystone
2746m-2854m (L. Jurassic sand)	Littoral and brackish water sandstones with aboundant terrestrial debris	several coarsning up units
2746m-3152m (L. Jur. coal sequ.)	Coastal plain coal swamp association, non marine to shallow brackish environment	clean sands interbedded w/shale-sand coals
3152m-3234m (Triassic grey beds)	Same depositional environment as above, but without coal development	interbedded sands and shales
3234m-3333m(T.D.) (Triassic red beds)	None marine to deltaic environment, close to shore	interbedded sands and shales

LOG QUALITY

The overall quality of the logs is good. GR calibrations on ISF/SONIC run No. 5 is out of range, and this explains the relative high GR-readings on the final runs.

LOGS RUN ON 6610/7-1

Name	Run	Interval
ISF/SONIC-SP-GR	1	353 - 813
ISF/SONIC-SP-GR	2	801 - 1258
ISF/SONIC-SP-GR	3	1251 - 2112,5
ISF/SONIC-MSFL-SP-CAL-GR	4	2098,0- 2921
ISF/SONIC-MSFL-SP-CAL-GR	5	2915 - 3328
LDL-PEF-CAL-GR	1	353 - 814
LDL-PEF-CAL-GR	2	801 - 1259
LDL-PEF-CAL-GR	3	1251 - 2108
LDL-CNL-PEF-CAL-NGS	4	2098 - 3329
HDT	1	801 - 1260
HDT	2	1251 - 1920
S-HDT	3	2098 - 3329
CST	1	1583 - 2108
CST	2	1260 - 1570
CST	3	3053 - 3325
CST	4	2876 - 3045
CST	5	2850 - 3000,1
CST	6	2470 - 2876
CST	7	2117 - 2450
CBL-VDL-GR	1	550 - 1245
CBL-VDL-GR	2	290 - 2092
RFT-GR	1	1293,6- 1304
RFT-GR	2	2659 - 3111
VSP/CHECKSHOTS		315 - 3370

Input parameters

Input parameters are based on physical measurement and empirical relations.

Formation water resistivity

The salinity of the formation water seem to be different above and below the coaly sequence (2915-2970m RKB) :

1. Depth 2748m (ISF/SONIC # 4)
   SP= -26mV Temp= 81.1°C
   Rmf= 0.097 ohm m at 81.1°C
   Rw= 0.052 ohm m ~ 55 000 ppm NaCl

2. Depth 3295m (ISF/SONIC # 5)
   SP= -45mV Temp= 92.8°C
   Rmf= 0.097 ohm m at 92.8°C
   Rw= 0.03 ohm m ~ 95 000 ppm NaCl

This can be verified with the RFT plots which indicates two water gradients and different pressure regimes above and below the coaly shale sequence.

Mud filtrate density

A mud filtrate density of 1.01 g/cc was used.

Shale parameters

Shale parameters are based on crossplots and visual inspection of the logs:

Interval	2650-2915	2915-3333
Density (LDT) (g/cc)	2.60	2.6
Neutron porosity (frac)	.35	.35
GR_{sand} (API units)	40	40
GR_{shale} (API units)	120	120
R_{shale} (ohm m)	5	11

Log corrections

No corrections was made to the log measurements.

Computations

Shale volume was calculated using the GR with the following parameters: $GR_{sand} = 40$ $GR_{shale} = 120$

Porosity was calculated from a combination of LDT and CNL with a standard sandstone model.

Watersaturation was calculated with the "Indonesia" (Schlumberger) equation:

$$\frac{1}{\sqrt{Rt}} = \left[\frac{V_{shale}^{\left(1 - \frac{V_{shale}}{2}\right)}}{\sqrt{R_{shale}}} + \frac{\Phi^{m/2}}{a\ Rw} \right] Sw^{n/2}$$

Where:

Sw	=	water saturation
Rt	=	RILD
V_{shale}	=	Shale volume
R_{shale}	=	Resistivity of shale
Φ	=	Porosity
a	=	lithology factor (=1)
m	=	cementation exponent (=2.15)
n	=	saturation exponent (=2)
Rw	=	formation water resistivity

Core measurements

Three cores were cut in the evaluated interval (core no. 2,3 and 4). The cores have been shifted to fit the log depth using GR from core and porosity. The enclosed core summary log (2650-2750m RKB) shows core data on reported depth and shifted depth compared to log results.

Comparison of core and log porosity

The porosity from logs and core has been compared in the cleanest part of the cored interval:

INTERVAL	LOG	CORE
2662-2675	.171	.169

Discussion

A relative high hydrocarbonsaturation is calculated in the shales and especially in the coaly/organic rich sequence. The formation is regarded as waterbearing which is proved by the RFT. High hydrocarbonsaturation in shales is also common further north at Tromsøflaket. This may be due to several reasons i.e.: we do not know the petrophysical parameters (m, n, a) for the shales to correctly calculate the saturation or the saturation of hydrocarbons in the shales may be correct.

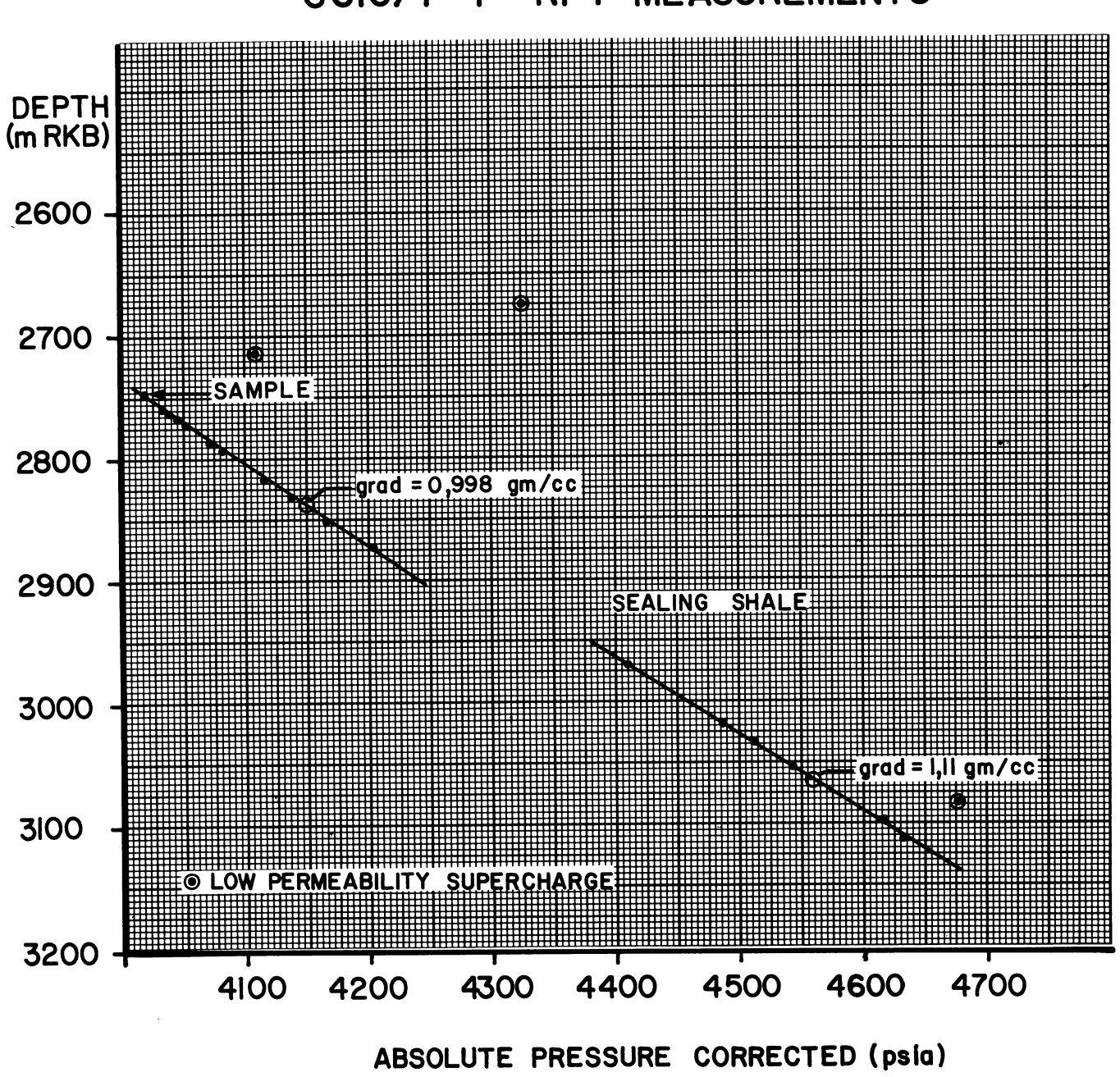
RFT-SUMMARY

21 pressure readings were measured from 2672.5 to 3110 m RKB. One segregated sample was taken at 2748m. No pressures were measured below 3110m due to operational problems of the tool. The sand from 2652-2675m was very tight, hence the sample was taken lower.

The RFT-plot indicates two water gradients in the well (see plot).

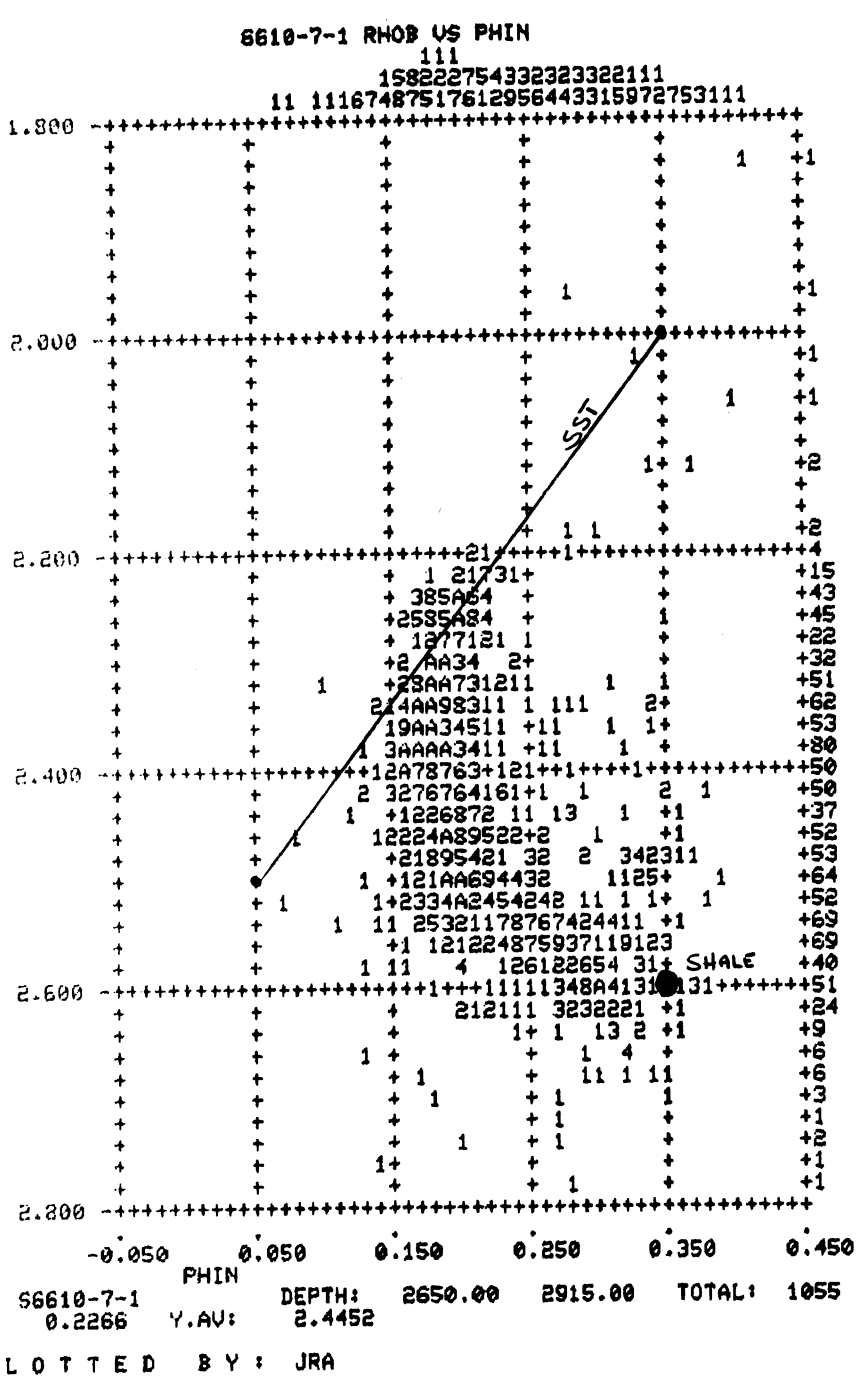
The sample consisted of mud filtrate:

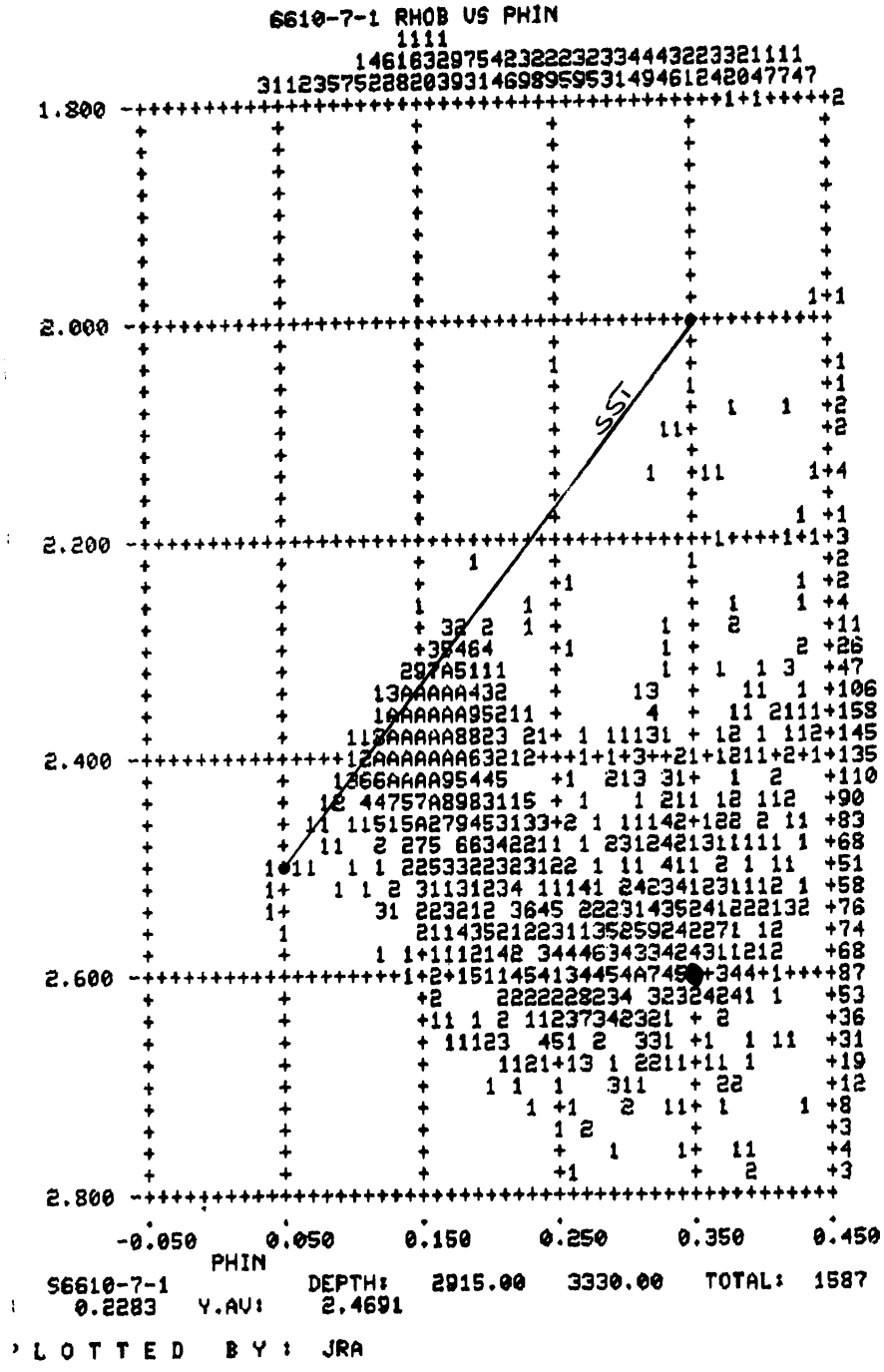
		2 3/4 gal	1 gal	mudfiltrate
cl-, ppm	:	11000	10500	13000
ca+, ppm	:	160		260
density	:		1.015	
ph	:		7.8	10.5


6610/7-1 RFT· MEASUREMENTS
DEPTH (m RKB)
2600
2700
2800
2900
3000
3100
3200
SAMPLE
grad = 0,998 gm/cc
SEALING SHALE
grad = 1,11 gm/cc
◉ LOW PERMEABILITY SUPERCHARGE
4100
4200
4300
4400
4500
4600
4700
ABSOLUTE PRESSURE CORRECTED (psia)

6610/7-1 REPEAT FORMATION TESTER
RUN NO. 2

DEPTH m RKB	MEASURED PRESSURE CORRECTED (bara)			REMARKS
	HYDROSTATIC BEFORE	FORMATION PRESSURE	HYDROSTATIC AFTER	
2659	322.3	-	322.3	tight
2661	322.5	-	322.5	"
2665	322.9	-	322.9	"
2672.5	323.8	298.3	323.8	supercharge
2715	329.3	283.4	328.9	"
2748	332.8	277.0	332.8	very good
2759	333.9	278.1	334.1	good
2763	334.6	278.5	334.6	good
2766	334.8	278.8	332.9	very good
2772	335.5	279.4	335.6	"
2787.5	337.6	280.9	337.4	"
2794	338.1	281.5	338.2	"
2817.5	341.4	283.9	341.0	"
2832.5	342.6	285.4	342.8	good/fair
2850	344.9	287.2	344.9	good
2874	348.0	289.7	347.7	"
2967	358.7	303.9	358.7	"
3017	364.9	309.5	364.6	good/fair
3032.5	366.7	311.2	366.7	"
3051	368.9	313.2	368.7	"
3080.5	372.2	322.5	372.1	supercharge
3095	373.9	-	-	seal failure
3097	374.0	318.2	374.0	good
3110	375.4	319.4	375.5	fair
3135	378.9	-	378.5	seal failure
3136	378.5	-	-	"
3142	379.3	-	-	"
3169	382.5	-	-	"
Sample:				
2748	333.0	277.2	332.8	very good


6610-7-1 RHOB VS PHIN
SST
SHALE
1.800
2.000
2.200
2.400
2.600
2.800
-0.050
0.050
0.150
0.250
0.350
0.450
PHIN
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1055
0.2266 Y.AV: 2.4452
PLOTTED BY: JRA


6610-7-1 RHOB VS PHIN
SST
1.800
2.000
2.200
2.400
2.600
2.800
-0.050
0.050
0.150
0.250
0.350
0.450
PHIN
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1587
0.2283 Y.AV: 2.4691
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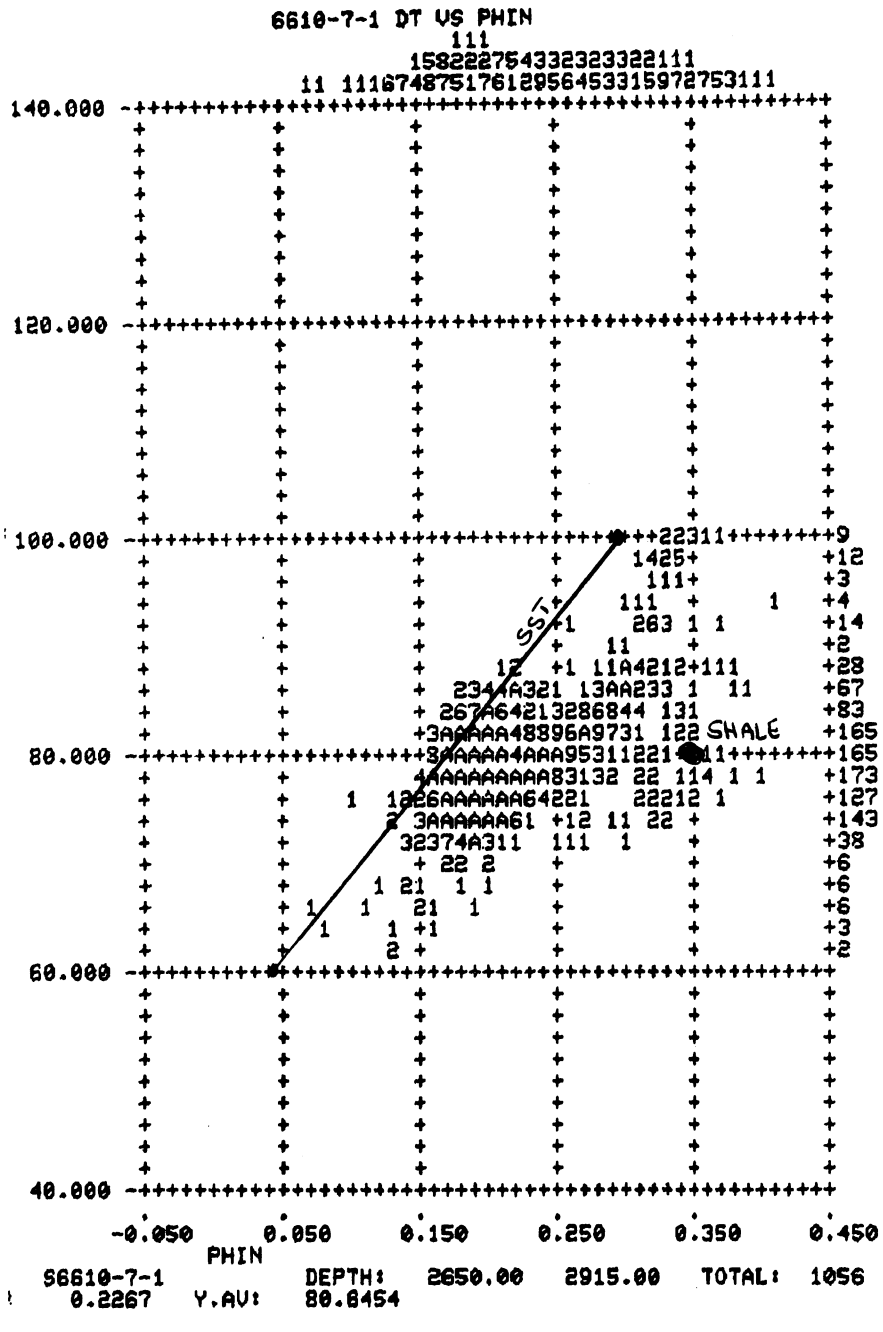
6610-7-1 DT VS PHIN
SST
SHALE
140.000
120.000
100.000
80.000
60.000
40.000
-0.050
0.050
0.150
0.250
0.350
0.450
PHIN
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1056
0.2267 Y.AV: 80.6454
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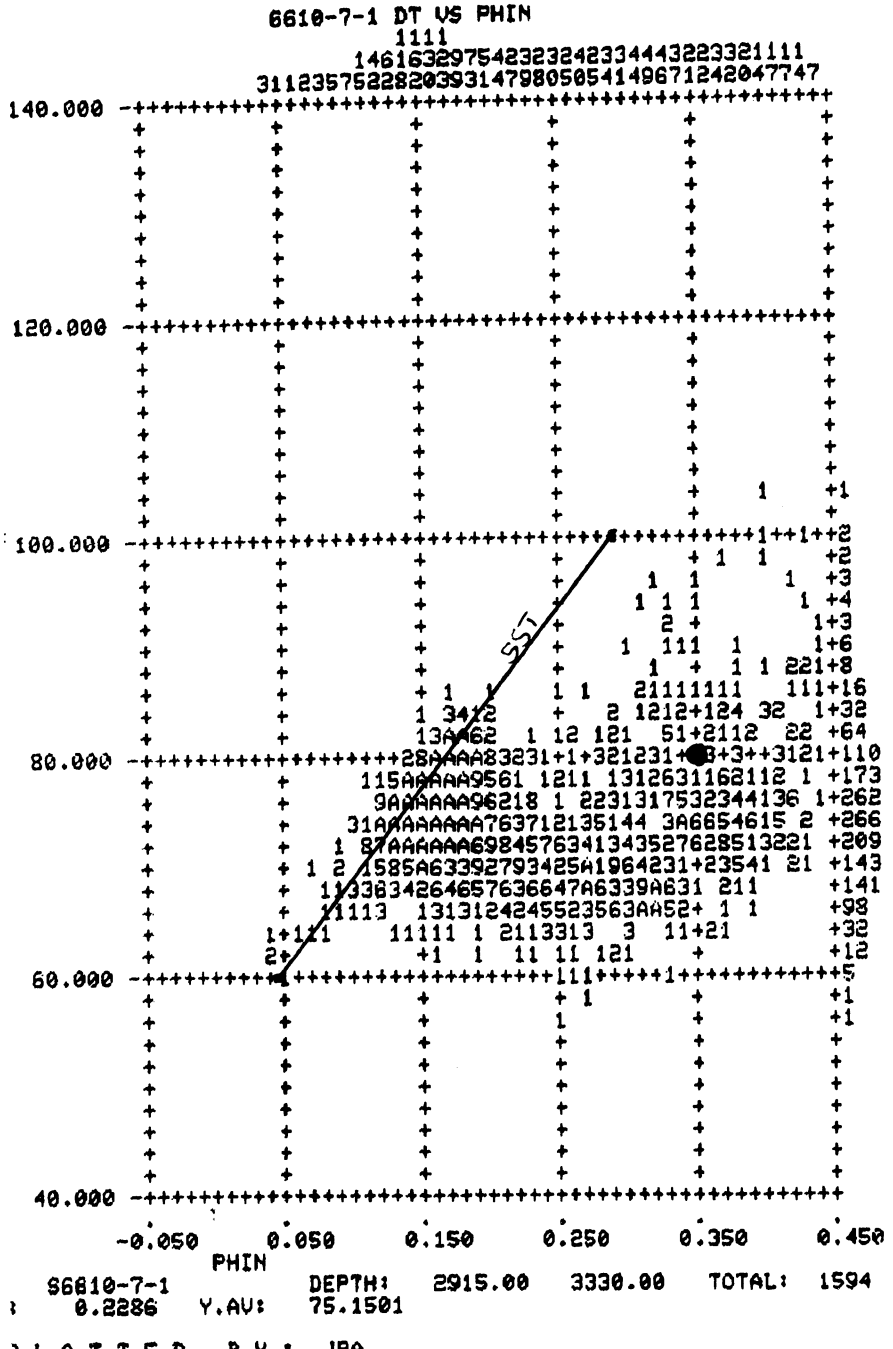
6610-7-1 DT VS PHIN
SST
140.000
120.000
100.000
80.000
60.000
40.000
-0.050
0.050
0.150
0.250
0.350
0.450
PHIN
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1594
0.2286 Y.AV: 75.1501
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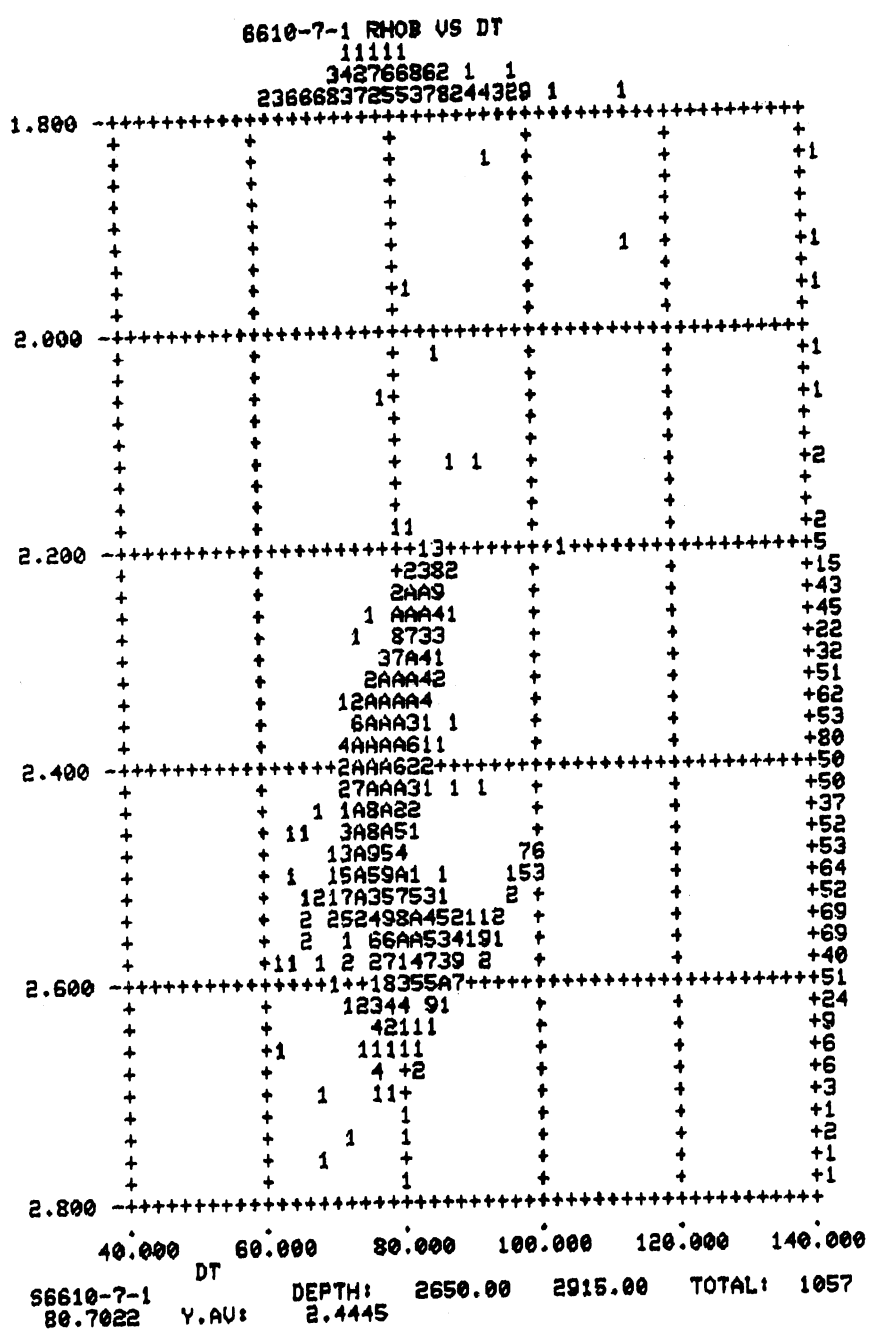
6610-7-1 RHOB VS DT
1.800
2.000
2.200
2.400
2.600
2.800
40.000
60.000
80.000
100.000
120.000
140.000
DT
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1057
80.7022 Y.AV: 2.4445
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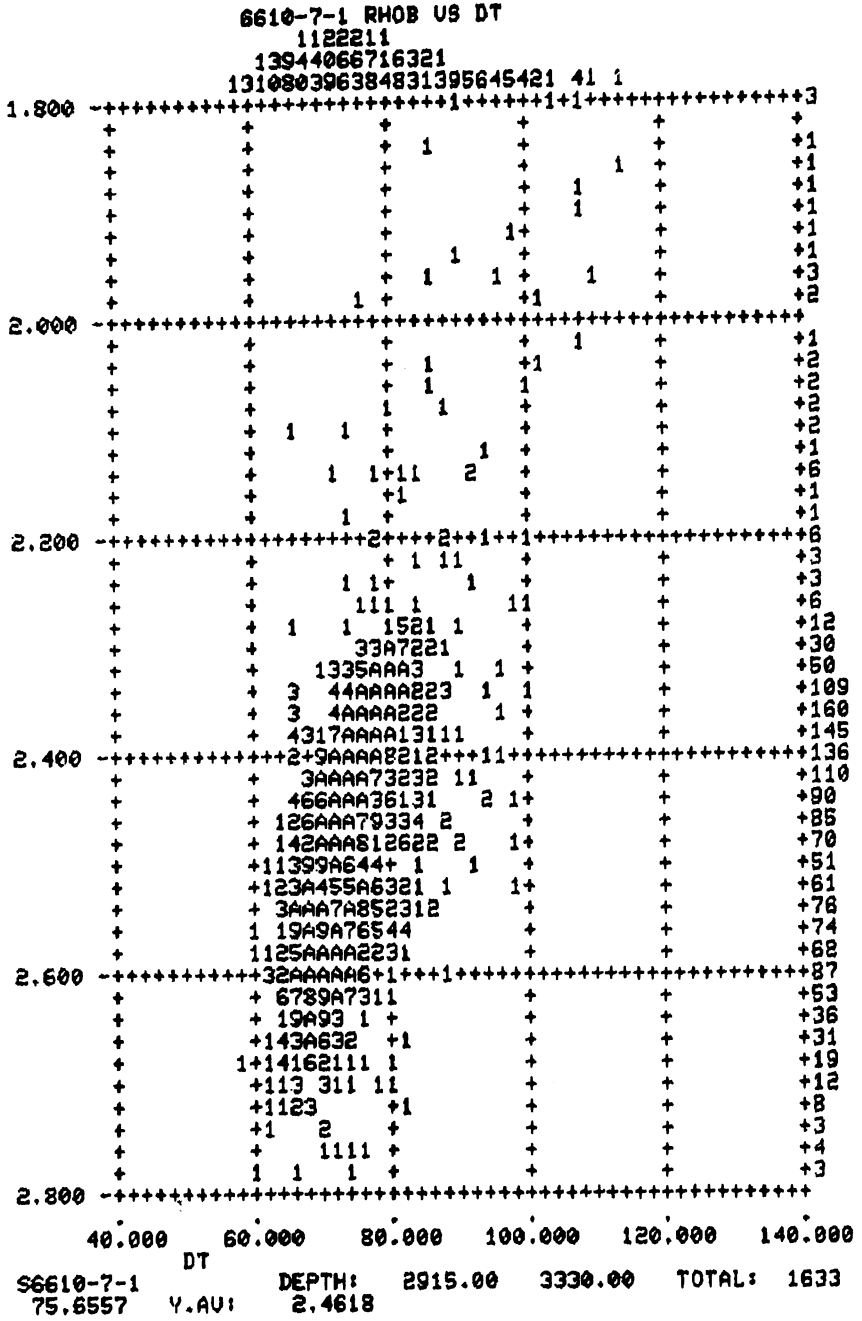
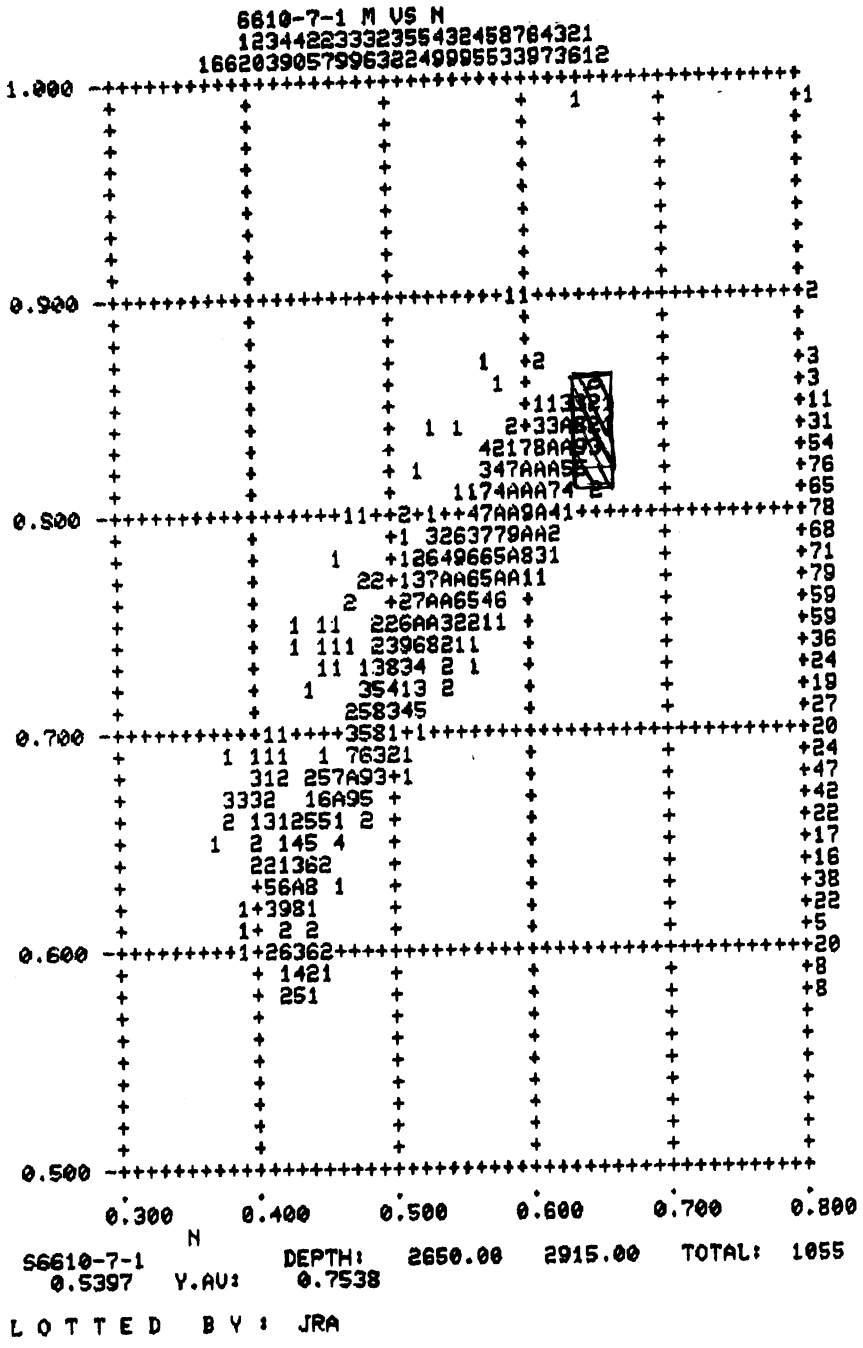

6610-7-1 RHOB VS DT
1.800
2.000
2.200
2.400
2.600
2.800
40.000
60.000
80.000
100.000
120.000
140.000
DT
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1633
75.6557 Y.AV: 2.4618
PLOTTED BY: JRA


6610-7-1 M VS N
1.000
0.900
0.800
0.700
0.600
0.500
0.300
0.400
0.500
0.600
0.700
0.800
N
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1055
0.5397 Y.AV: 0.7538
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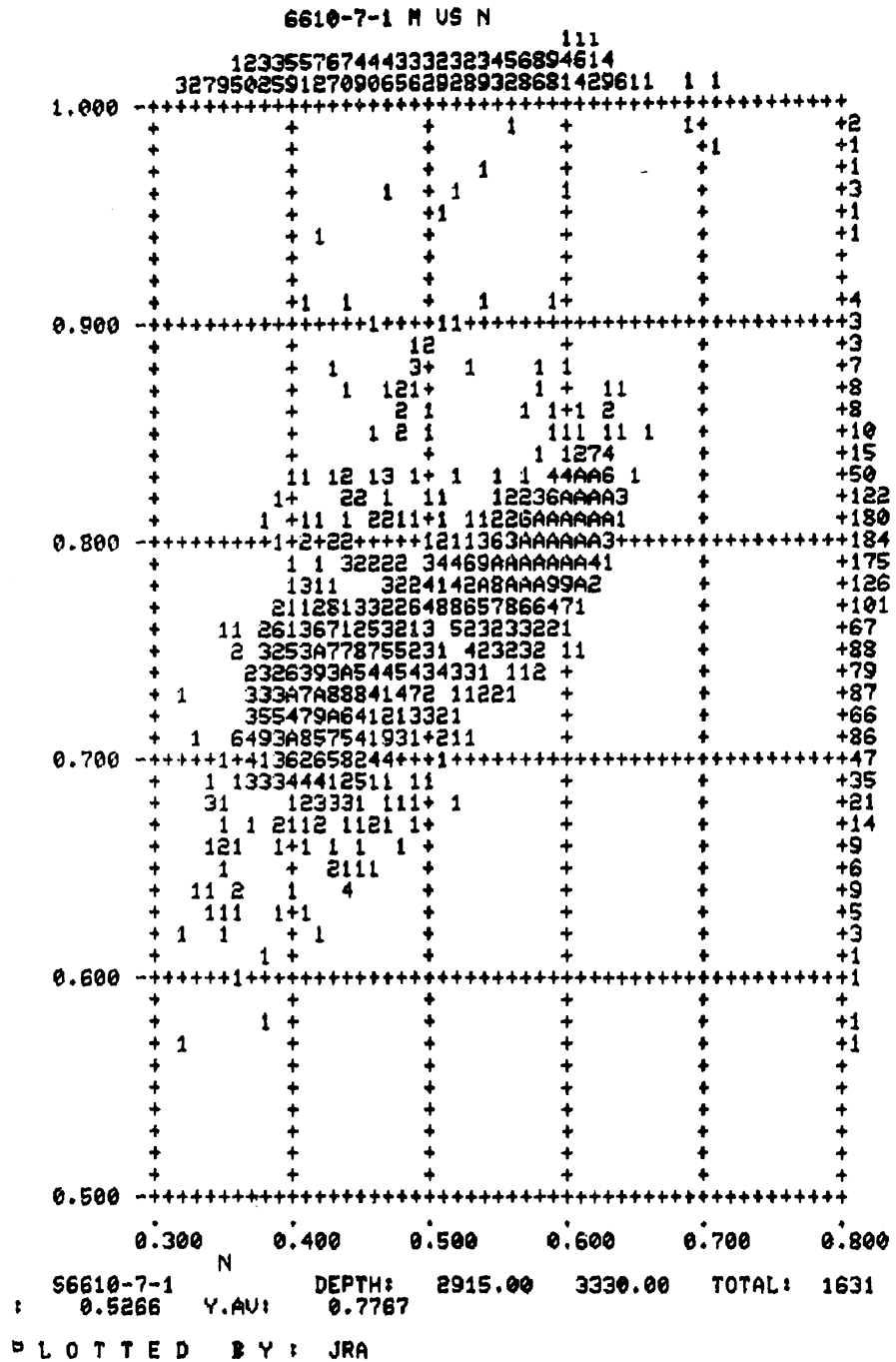
6610-7-1 M VS N
1.000
0.900
0.800
0.700
0.600
0.500
0.300
0.400
0.500
0.600
0.700
0.800
N
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1631
0.5266 Y.AV: 0.7767
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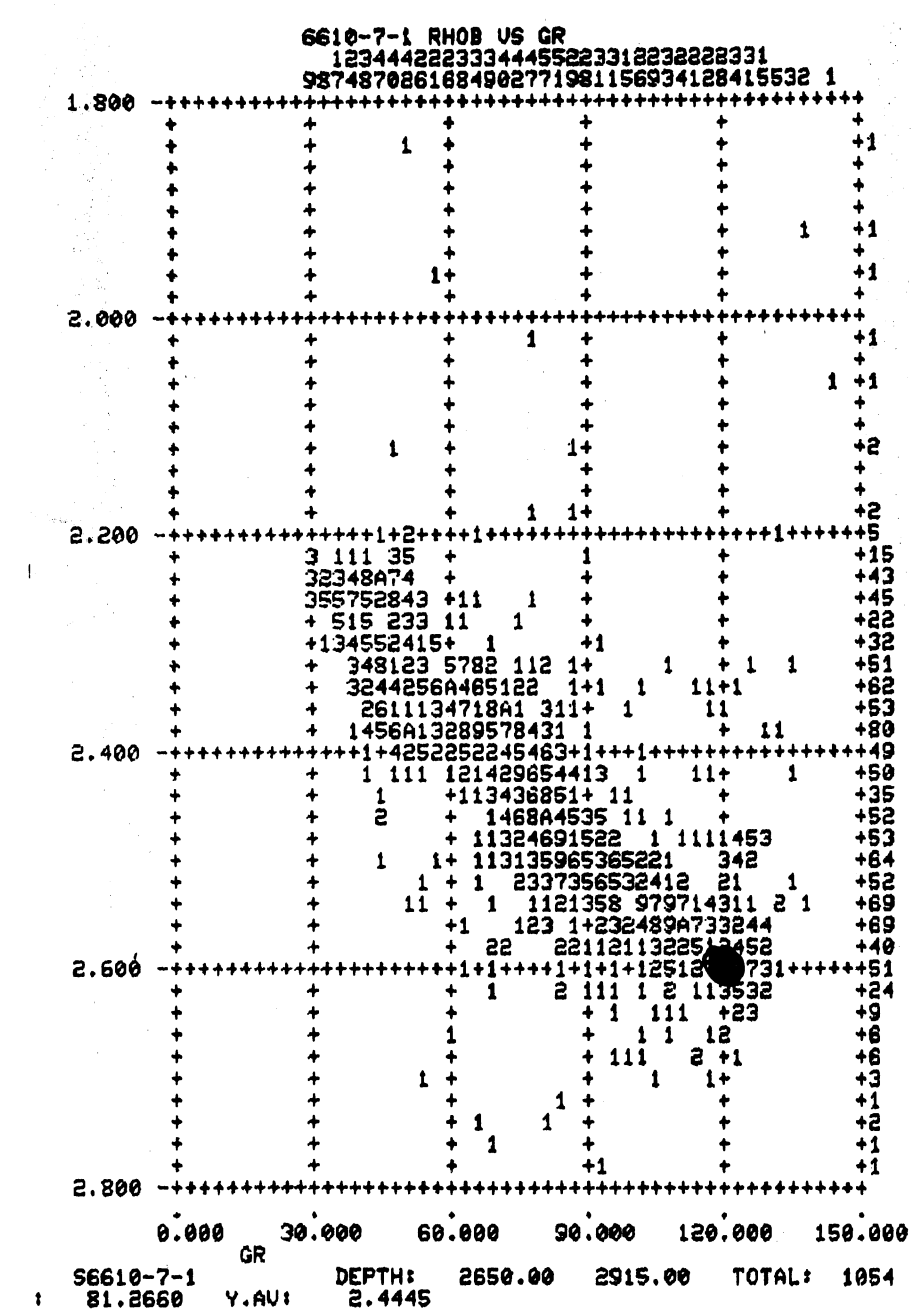
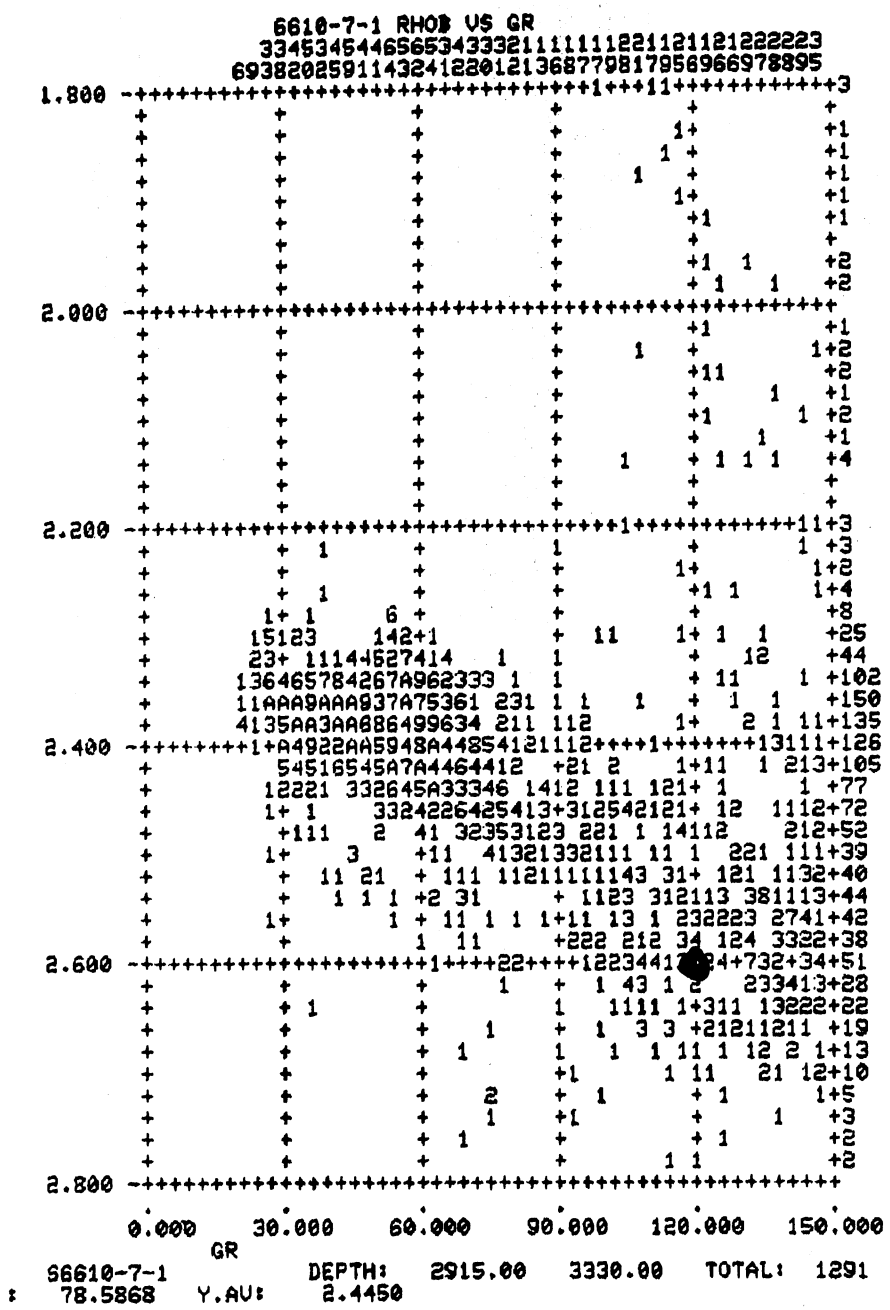
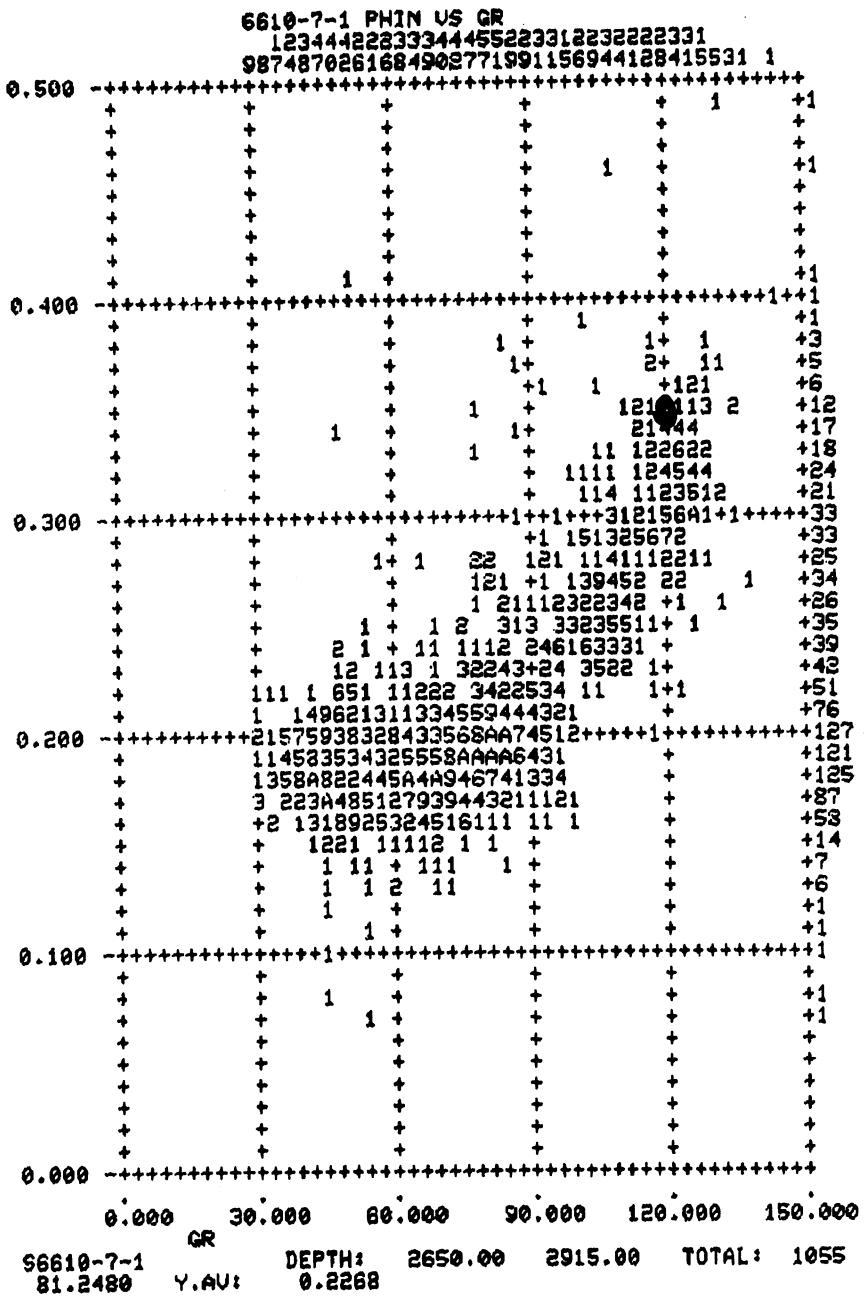
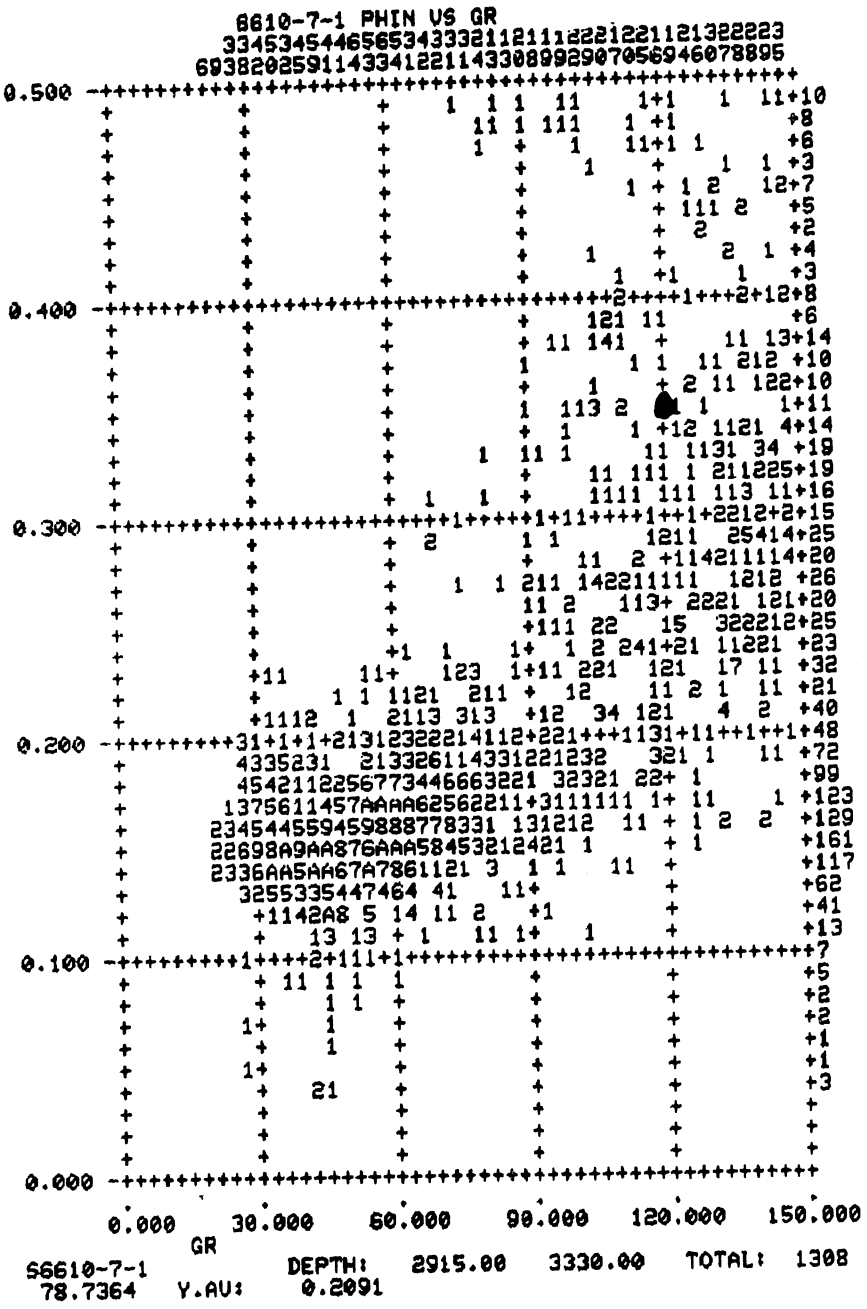
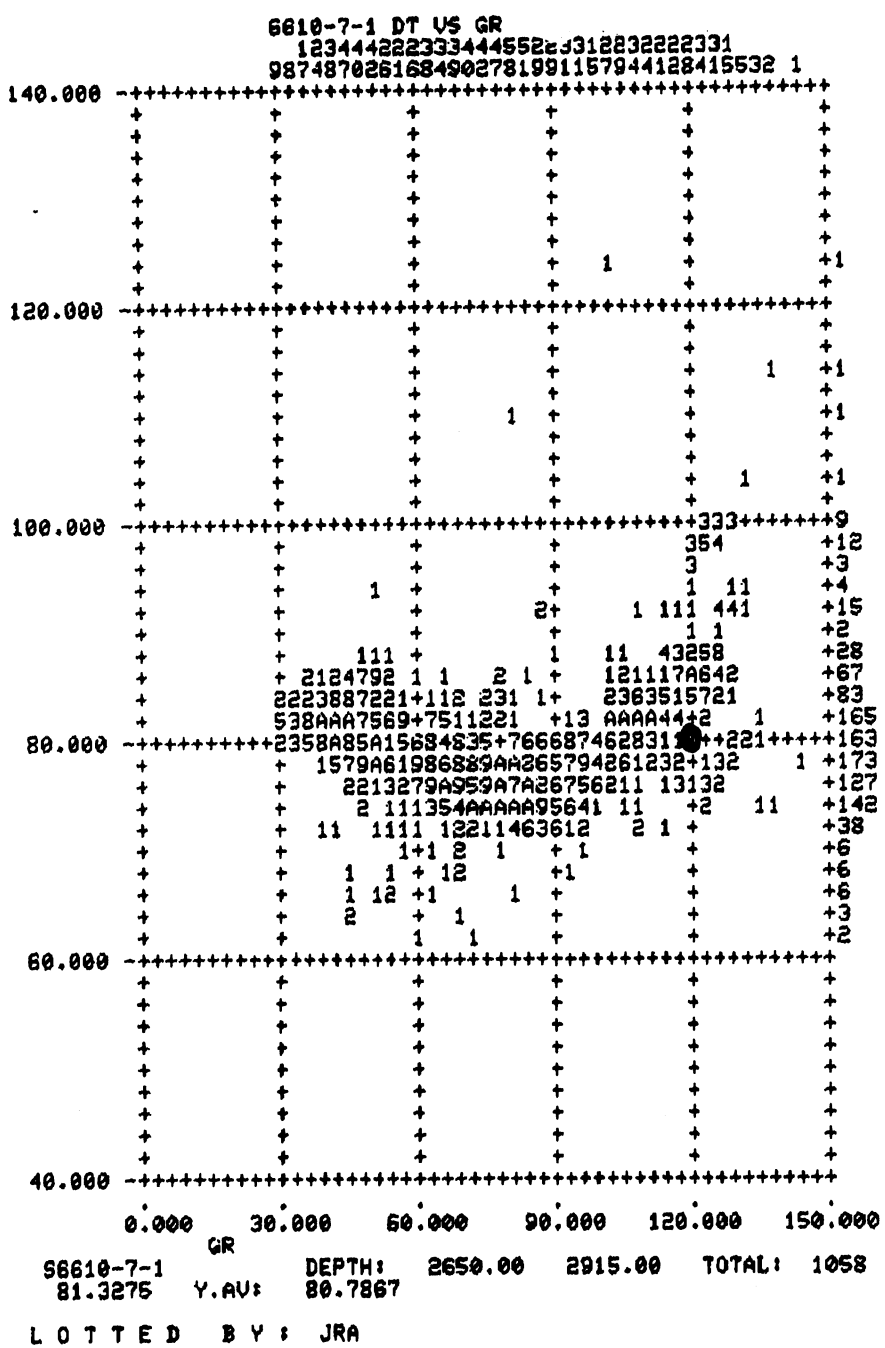
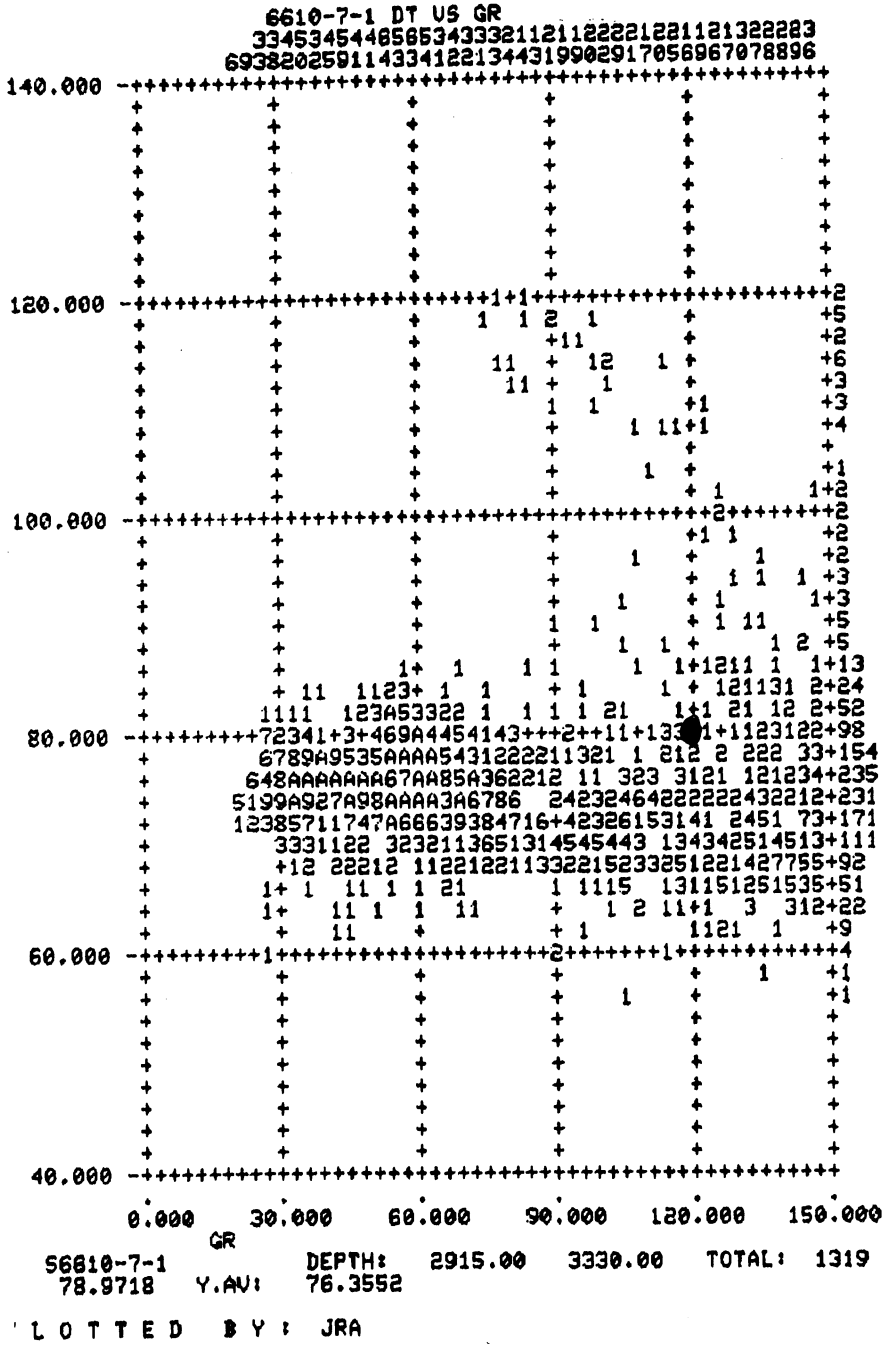

6610-7-1 RHOB VS GR
1.800
2.000
2.200
2.400
2.600
2.800
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1054
: 81.2660 Y.AV: 2.4445
PLOTTED BY : JRA

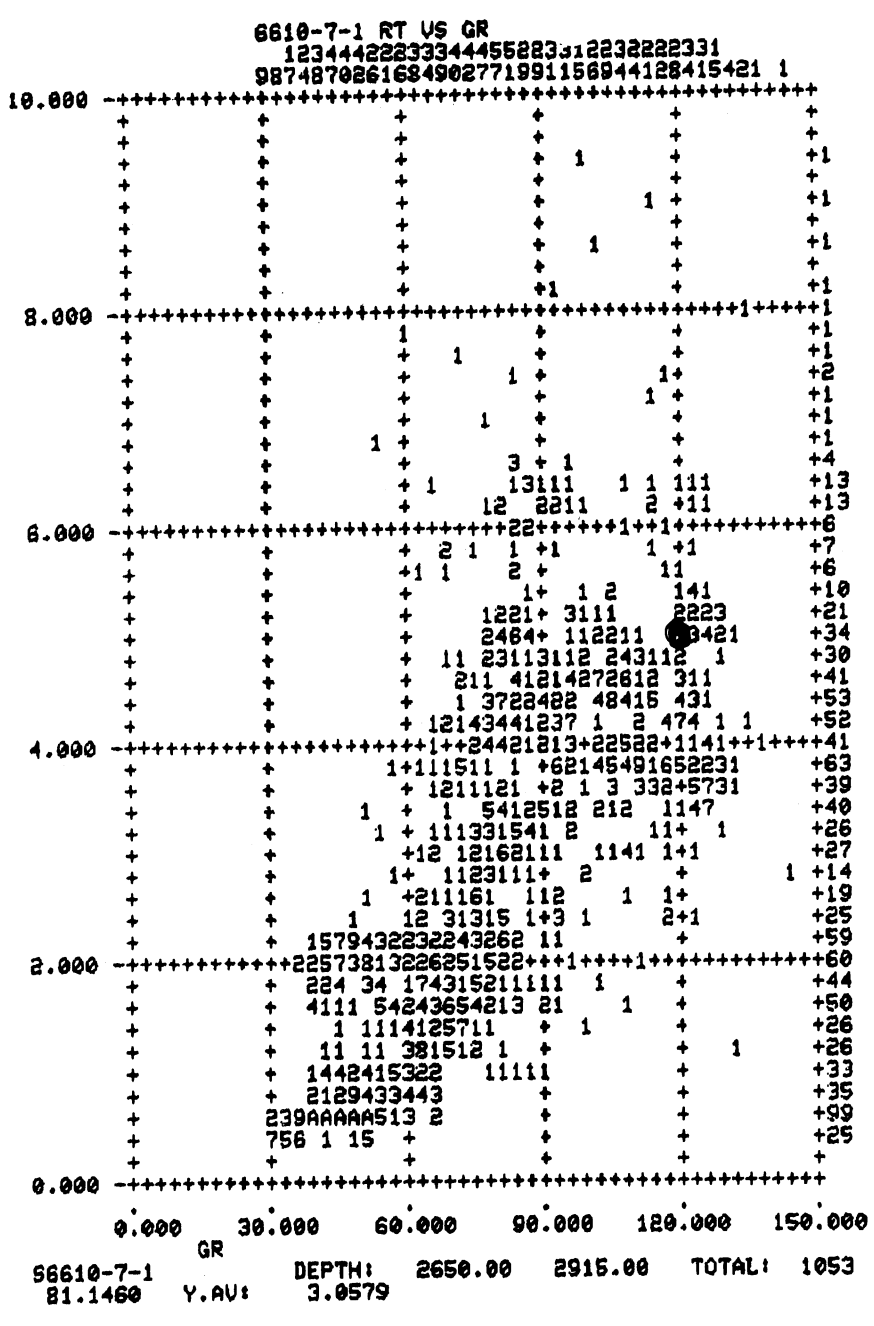

6610-7-1 RHOB VS GR
1.800
2.000
2.200
2.400
2.600
2.800
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1291
: 78.5868 Y.AV: 2.4450
PLOTTED BY : JRA

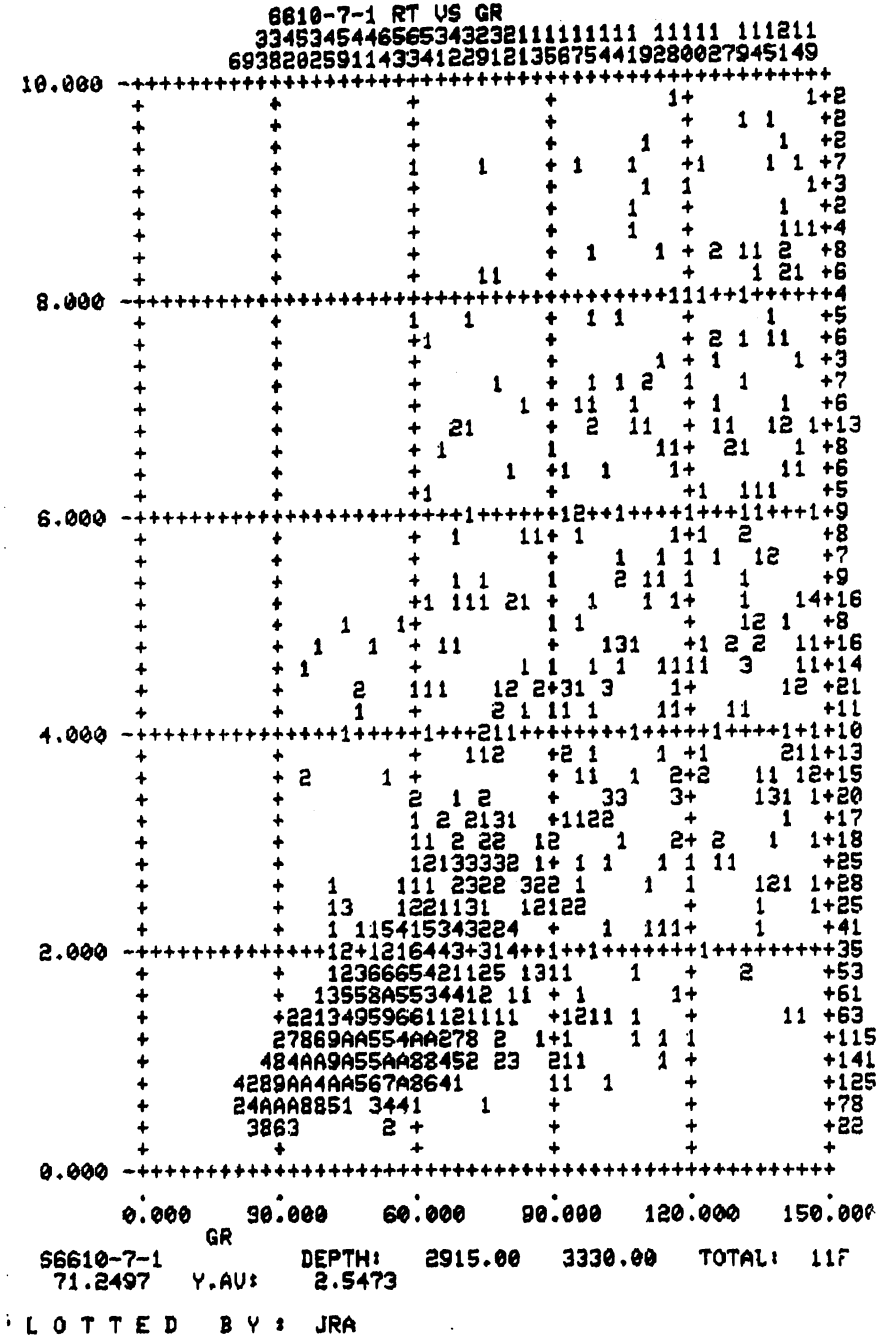

6610-7-1 PHIN VS GR
0.500
0.400
0.300
0.200
0.100
0.000
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1055
81.2480 Y.AV: 0.2268
L O T T E D B Y : JRA


6610-7-1 PHIN VS GR
0.500
0.400
0.300
0.200
0.100
0.000
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1308
78.7364 Y.AV: 0.2091
L O T T E D B Y : JRA


6610-7-1 DT VS GR
140.000
120.000
100.000
80.000
60.000
40.000
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1 DEPTH: 2650.00 2915.00 TOTAL: 1058
81.3275 Y.AV: 80.7867
L O T T E D B Y : JRA


6610-7-1 DT VS GR
140.000
120.000
100.000
80.000
60.000
40.000
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1 DEPTH: 2915.00 3330.00 TOTAL: 1319
78.9718 Y.AV: 76.3552
L O T T E D B Y : JRA


6610-7-1 RT VS GR
10.000
8.000
6.000
4.000
2.000
0.000
0.000
30.000
60.000
90.000
120.000
150.000
GR
S6610-7-1
DEPTH: 2650.00 2915.00 TOTAL: 1053
81.1460 Y.AV: 3.0579
PLOTTED BY: JRA


6610-7-1 RT VS GR
10.000
8.000
6.000
4.000
2.000
0.000
0.000
90.000
60.000
90.000
120.000
150.000
GR
S6610-7-1
DEPTH: 2915.00 3330.00 TOTAL: 11F
71.2497 Y.AV: 2.5473
PLOTTED BY: JRA