SCHLUMBERGER WELL SERVICES

-MID-CONTINENT DIVISION-

LOG INTERPRETATION CONFERENCE

U. S. BUREAU OF MINES

BARTLESVILLE, OKLAHOMA

MAY 14, 1974

AGENDA

8:30 - 9:30	Resistivity
9:30 - 10:00	Resistivity Work Session
10:00 - 10:30	Coffee
10:30 - 11:30	Porosity Determination
11:30 - 12:00	Porosity Work Session
12:00 - 1:00	Lunch
1:00 - 2:00	Wellsite Analysis (Overlay Technique)
2:00 - 2:30	Field Interpretation Work Session
2:30 - 3:00	Coffee
3:00 - 3:30	Permeability Determination - Synergetic Logs
3:30 - 5:00	Completion Services (Production Logging - TDT - VDL)

CONFERENCE PERSONNEL

K. N. Thomas	Mid-Continent Sales Manager
H. E. Pickhardt	Senior Sales Engineer
B. R. Ermey	Senior Sales Engineer
W. J. Kelly	Sales Engineer

SCHLUMBERGER SERVICE POINTS

Woodward Open Hole District	District Manager	Chuck Martin
Woodward Cased Hole District	District Manager	Gary Riley
Duncan Cased Hole Depot	Engineer-in-Charge	Ed Baker
Enid District	District Manager	Bill Krueger
Pampa District	District Manager	Stan Harris
Dumas Depot	Engineer-in-Charge	Harold Delay
Duncan District	District Manager	E. R. "Robbie" Robbins
Liberal Station	Station Manager	Paul McRill
Wichita Falls Station	Station Manager	Joe Street
Graham Station	Station Manager	Tom Fett
Fort Smith Station	Station Manager	Larry Hopper
Wichita Station	Station Manager	Ron Parslow

SCHLUMBERGER SALES OFFICES

OKLAHOMA CITY

Ken Kemp
Ed Smith
Jim Thompson
Jim Kelly
Bill Ermey (Cased Hole)

GRAHAM

Jack Davis

AMARILLO

Lee Holley

TULSA

Homer Pickhardt
Rex Benway

WOODWARD C.H.

Jim Young

MANAGERS

DIVISION MANAGER
John Winkler
Okla. City, Okla.
405/528-7471
Res. 405/787-6799

DIVISION SALES MANAGER
Ken Thomas
Okla. City, Okla.
405/528-7471
Res. 405/751-3811

DIVISION ENGINEER
Dale Kennemur
Okla. City, Okla.
405/528-7471
Res. 405/843-7530

WOODWARD, CASED HOLE
Gary Riley
Manager
405/256-5075
Res. 405/256-5965

WICHITA, KANSAS
Ron Parslow
Manager
316/522-4321
Res. 316/942-5555

DUNCAN, OKLAHOMA
Robbie Robbins
Manager
405/255-5516
Res. 405/255-8649

FT. SMITH, ARKANSAS
Larry Hopper
Manager
501/782-0328
Res. 501/785-1982

LIBERAL, KANSAS
Paul McRill
Manager
316/624-6576
Res. 316/624-1563

WICHITA FALLS, TEXAS
Joe Street
Manager
817/692-5917
Res. 817/692-4329

GRAHAM, TEXAS
Tom Fett
Manager
817/549-2220
Res. 817/549-2695

ENID, OKLAHOMA
Bill Krueger
Manager
405/237-6200

WOODWARD, OPEN HOLE
Chuck Martin
Manager
405/256-3178

OKLAHOMA CITY,
CENTRAL PRINT
Les Holdman
Manager
405/525-6613
Res. 405/787-1845

PAMPA, TEXAS
Stan Harris
Manager
806/665-5791
Res. 806/669-3583

Schlumberger

MID CONTINENT DIVISION
2000 CLASSEN BUILDING — 124 EAST
OKLAHOMA CITY, OKLA. 73106
405/528-7471

OKLAHOMA CITY,
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Bill Ermey
Sales Engineer
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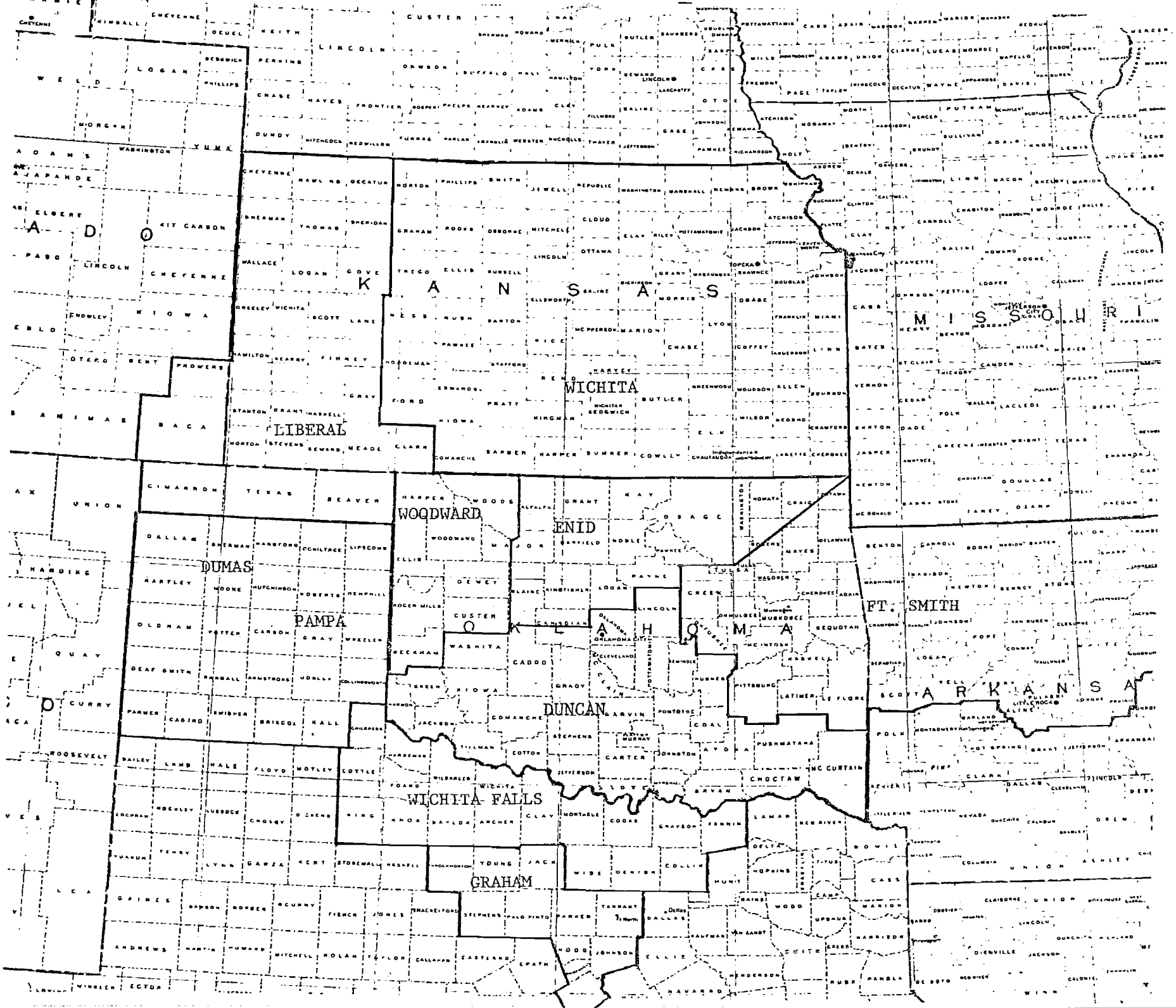
Res. 405/478-0638

OKLAHOMA CITY,
OKLAHOMA
Ken Kemp
Sales Engineer
405/528-7471
Res. 405/751-5387

OKLAHOMA CITY,
OKLAHOMA
Jim Thompson
Sales Engineer
405/528-7471
Res. 405/721-8882

GRAHAM, TEXAS
Jack Davis
Sales Engineer
817/549-2220
Res. 817/549-1389

MID-CONTINENT DIVISION



FEATURES OF CONVENTIONAL LOGS (E.S.)

1. NORMAL CURVES GREATLY AFFECTED BY BOREHOLE, ADJACENT BEDS, BED THICKNESS AND MUD INVASION.

2. LATERAL CURVES GREATLY AFFECTED BY BOREHOLE, ADJACENT BEDS, BED THICKNESS AND MUD INVASION.

3. R_t DETERMINATION POSSIBLE ONLY UNDER CONTROLLED CONDITIONS OF BED THICKNESS, BED UNIFORMITY, AND DIAMETER OF INVASION.

4. LIMITED TO FRESH MUD WELL.

5. TECHNIQUE IS PRACTICALLY OBSOLETE IN THE MID-CONT[illegible].

FEATURES OF LATEROLOGS (LATEROLOG)

1. EXCELLENT THIN BED RESOLUTION.
2. WHEN RESISTIVITY CONTRASTS ARE HIGH AND R_t/R_m RATIOS ARE HIGH IT PERMITS EVALUATIONS OF R_t PROVIDED MUD INVASION IS NOT TOO DEEP.
3. WILL DIFFERENTIATE BETWEEN HYDOCARBON ZONES AND WATER BEARING ZONES IF R_{mf}/R_w RATIO DOES NOT EXCEED 4 PROVIDED MUD INVASION IS NOT TOO DEEP.
4. THE SHALLOW READING LATEROLOGS, AS THE LL_8 GIVES BETTER VERTICAL RESOLUTION AND REDUCED BOREHOLE EFFECT OVER THE 16" NORMAL.
5. REQUIRES A WATER BASE DRILLING FLUID.

FEATURES OF INDUCTION LOGS (I-ES)

1. INDUCTION LOGS MAY BE RUN IN WELLS DRILLED WITH FRESH MUD, SALT MUD, OIL BASE MUD, AND IN AIR OR GAS DRILLED WELLS.

2. VERTICAL RESOLUTION IS GOOD DOWN TO 4 OR 5' BED THICKNESS.

3. THE 6FF40 IS MODERATELY AFFECTED BY INVASION. GOOD R_t DETERMINATIONS ARE POSSIBLE IF R_t IS LESS THAN 3 R_{xo} AN DI DOES NOT EXCEED 100".

FEATURES OF DUAL INDUCTION-LATEROLOG 8 (2IL-LLd)

1. THE THREE RESISTIVITE CURVES OF THE DUAL INDUCTION ALLOW DETERMINATION OF Di, AND HENCE BETTER DETERMINATION OF R_t.

2. THE LOGARITHMIC SCALING ELIMINATES OFF SCALE TRACES. THE LOGARITHMIC SCALING ALLOWS A QUICK DETERMINATION OF RATIOS BETWEEN CURVE READING FOR ENTERING INTERPRETATION CHARTS. BETTER DETAIL IN THE LOW RESISTIVITY RANGES (1-10 OHMS) ENHANCES WELL TO WELL CORRELATIONS.

3 FOR CORRELATION WITH OFFSET LINEARLY SCALED LOGS, A LINEAR 2" SCALING IS POSSIBLE WITH THE DUAL INDUCTION.

FEATURES OF DUAL LATEROLOG (2LL)

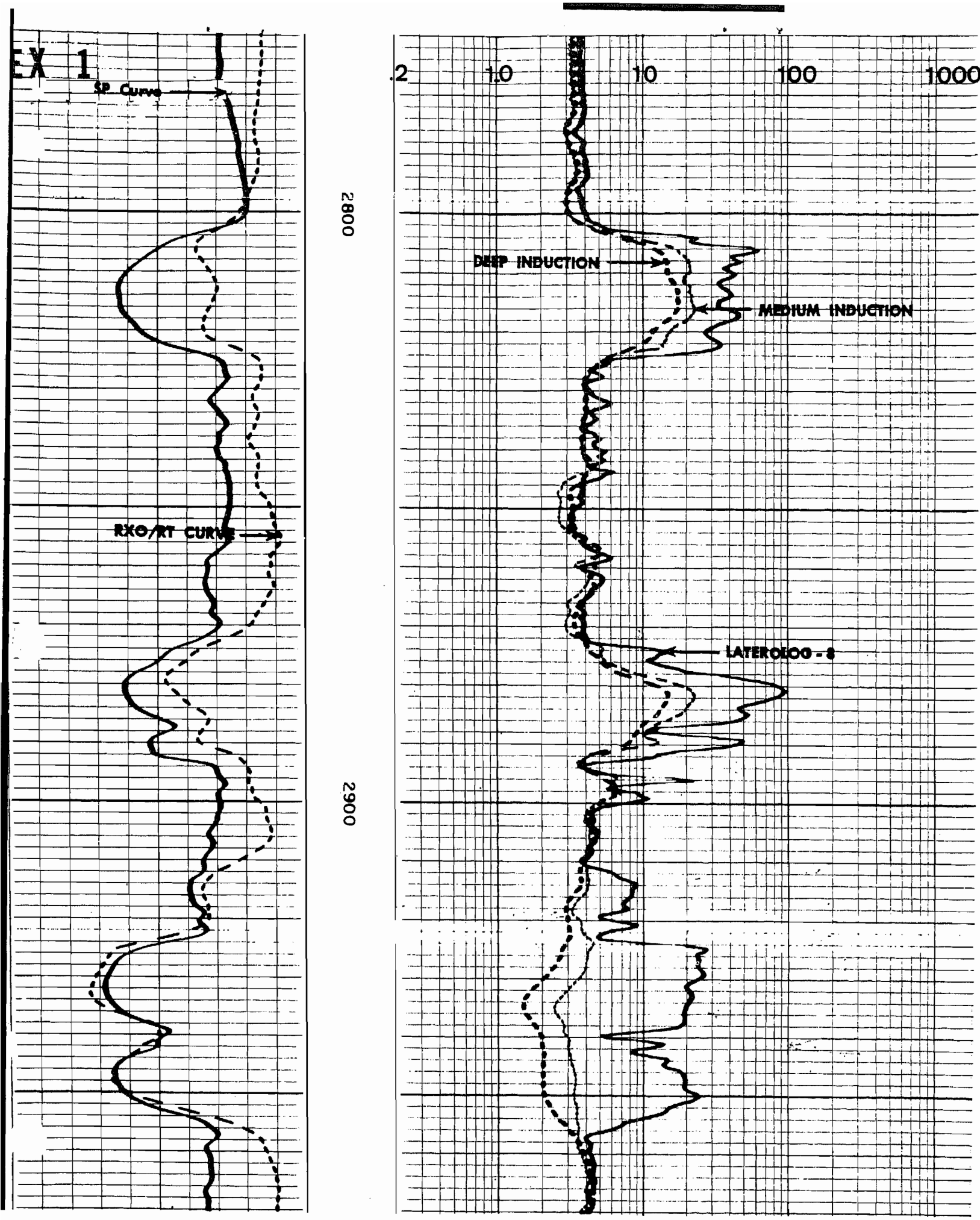
1. LL_d CURVE PROVIDES DEEPER INVESTIGATION THAN ANY OF PREVIOUS LATEROLOGS.

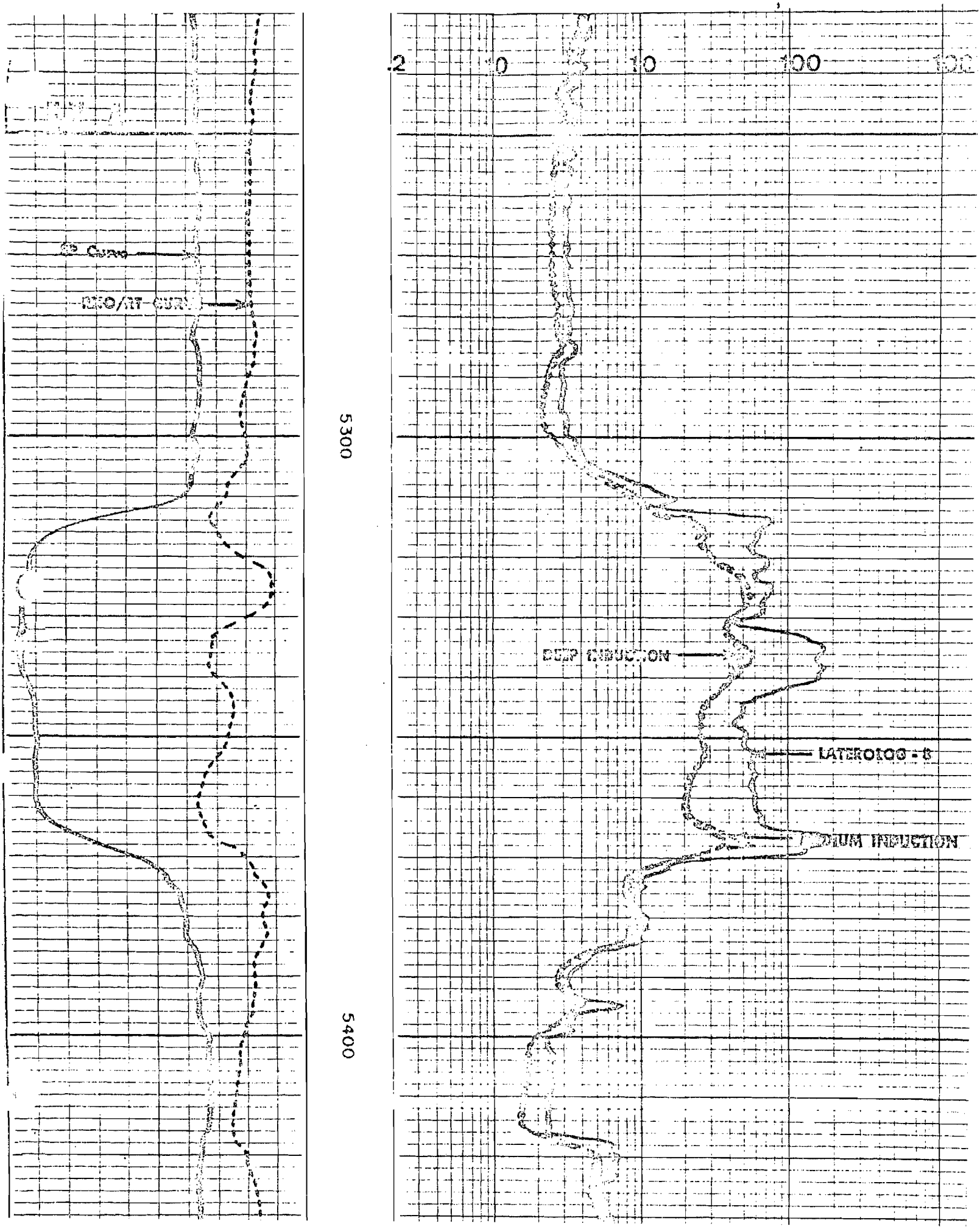
2. WHEN COMBINED WITH AN R_{xo} TOOL PROVIDES R_t DETERMINATION WHEN OIL BEARING ZONES HAVE BEEN DEEPLY INVADED WITH SALT MUD FILTRATE.

3. PROVIDES RESISTIVITY MEASUREMENTS IN LOW RESISTIVE BEDS LYING IMMEDIATELY BELOW HIGHLY RESISTIVE BEDS (DELAWARE GRADIENT EFFECT).

4. PROVIDES BETTER R_t DETERMINATION IN HIGHLY RESISTIVE BEDS.

5. RECOMMENDED WHEN R_{mf}/R_w RATIO IS EQUAL TO OR LESS THAN 3/1.

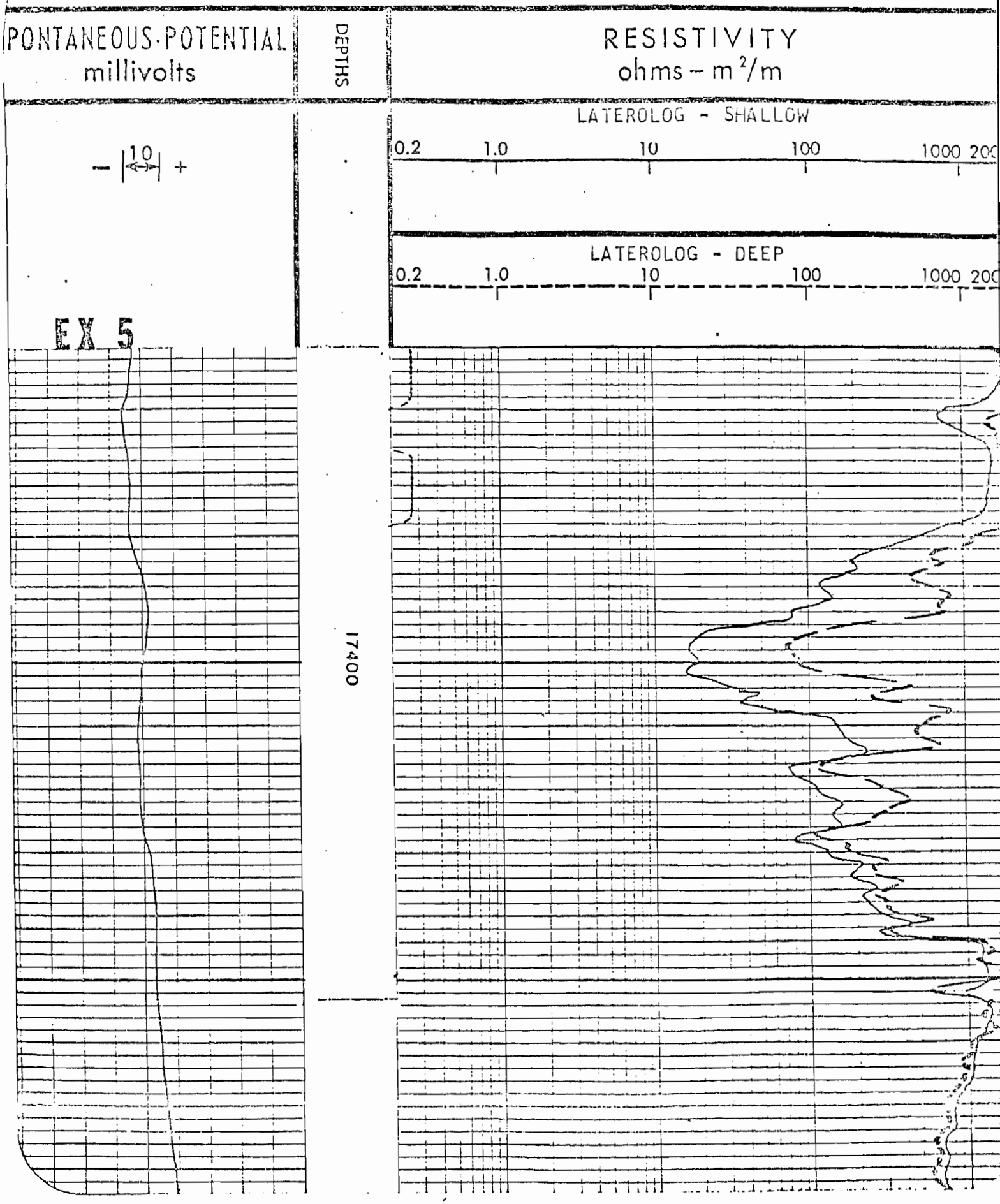

EX 1
SP Curve
RXO/RT CURVE
2800
2900
.2
1.0
10
100
1000
DEEP INDUCTION
MEDIUM INDUCTION
LATEROLOG - 8

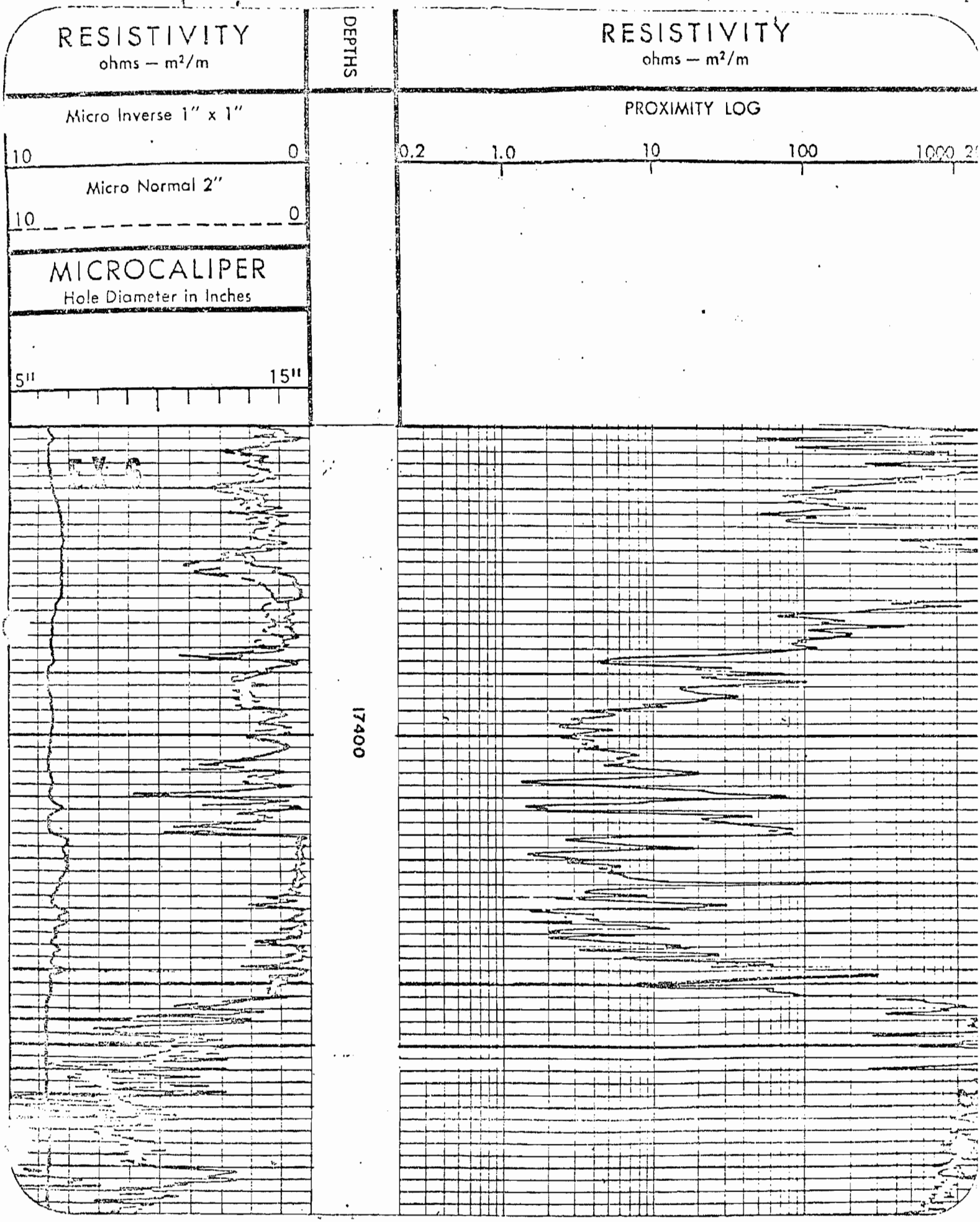


.2
0
10
100
5300
5400
DEEP INDUCTION
LATEROLOG - 8

DETAIL LOG

5" = 100'



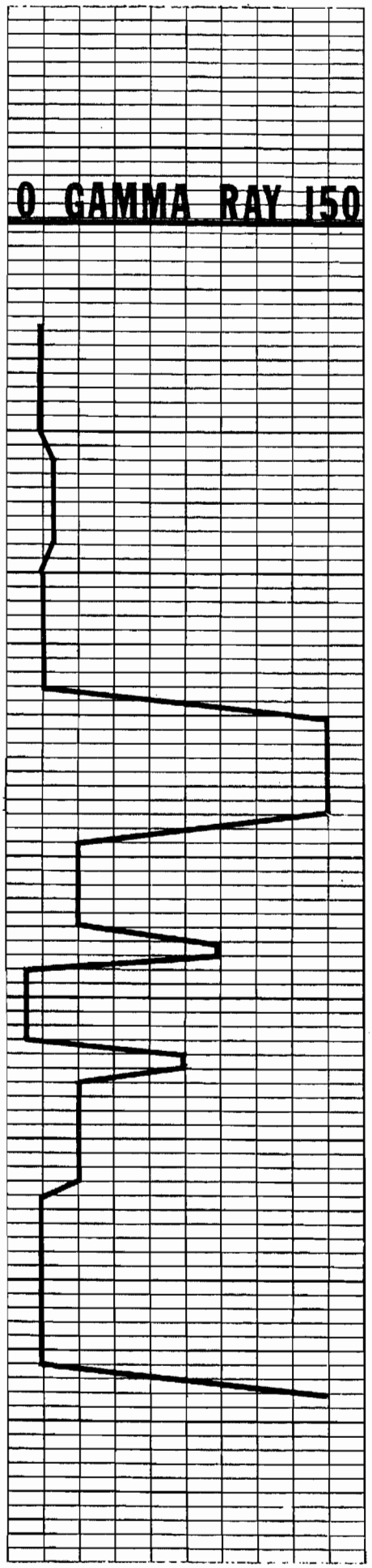

RESISTIVITY
ohms — m²/m
DEPTHS
RESISTIVITY
ohms — m²/m
Micro Inverse 1" x 1"
10
0
PROXIMITY LOG
0.2
1.0
10
100
1000
Micro Normal 2"
10
0
MICROCALIPER
Hole Diameter in Inches
5"
15"
17400

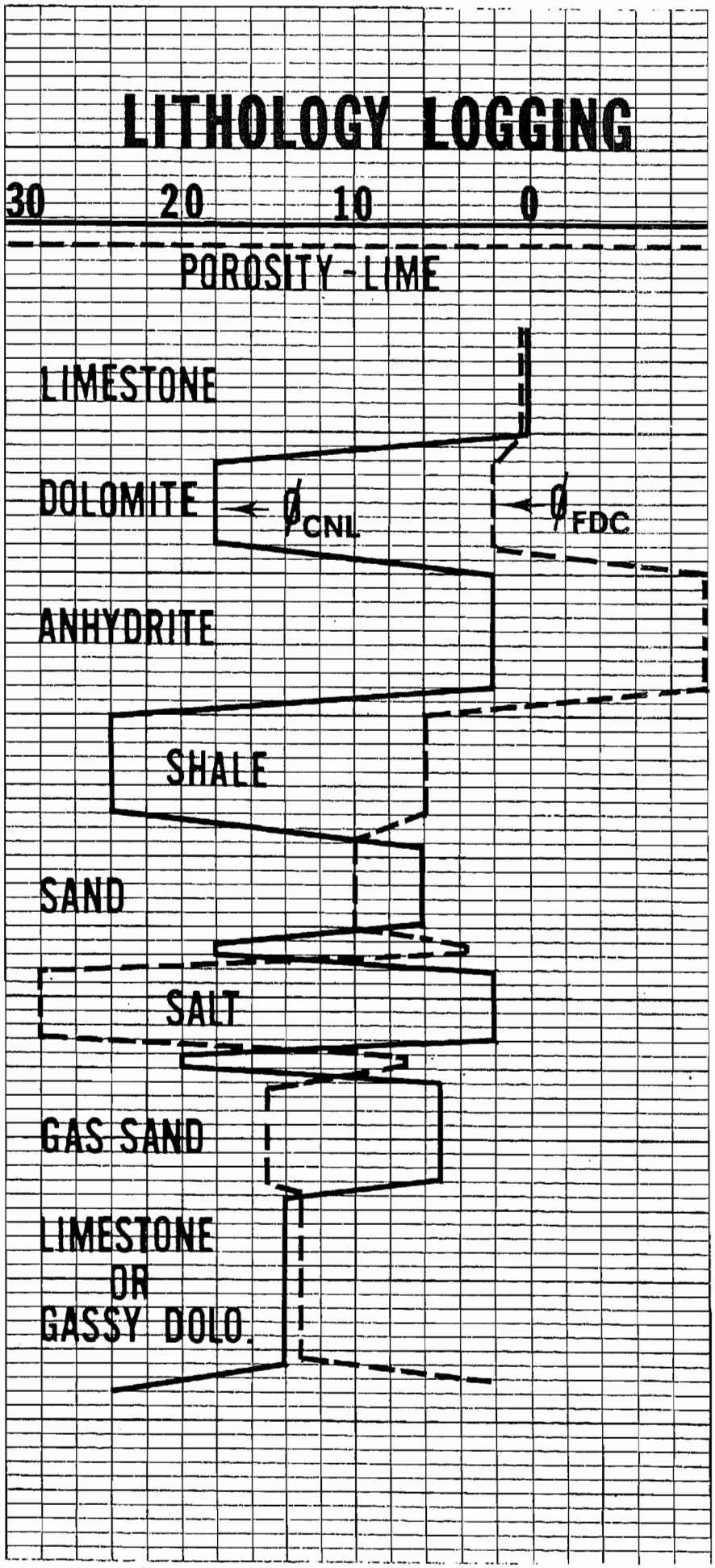
Dual Induction – Laterolog

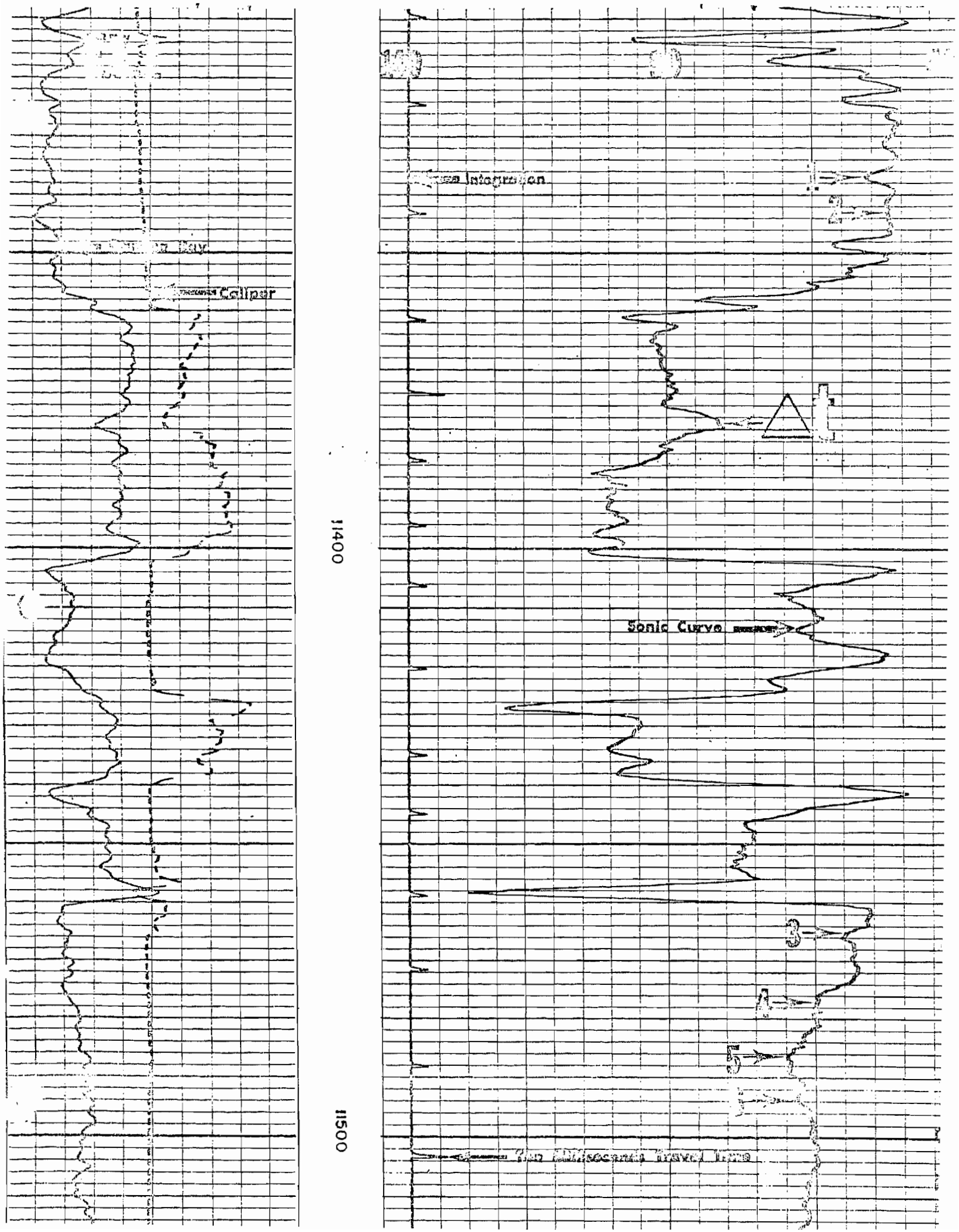
$\frac{Rmf}{Rw} = \frac{}{} =$				
$\frac{RLLs}{RILd} = \frac{}{} =$				
$\frac{RILm}{RILd} = \frac{}{} =$				
$Di =$				
$\frac{Rxo}{Rt} =$				
$\frac{Rt}{ILd} =$				
$Rt =$				
Sw (ratio) =				

Dual Laterolog

$\frac{R_{mf}}{R_w} = \_\_ =$				
$\frac{R_{LLd}}{R_{xo}} = \_\_ =$				
$\frac{R_{LLd}}{R_{LLs}} = \_\_ =$				
$D_i =$				
$\frac{R_t}{R_{xo}} =$				
$\frac{R_t}{R_{LLd}} =$				
$R_t =$				
S_w(ratio)=				

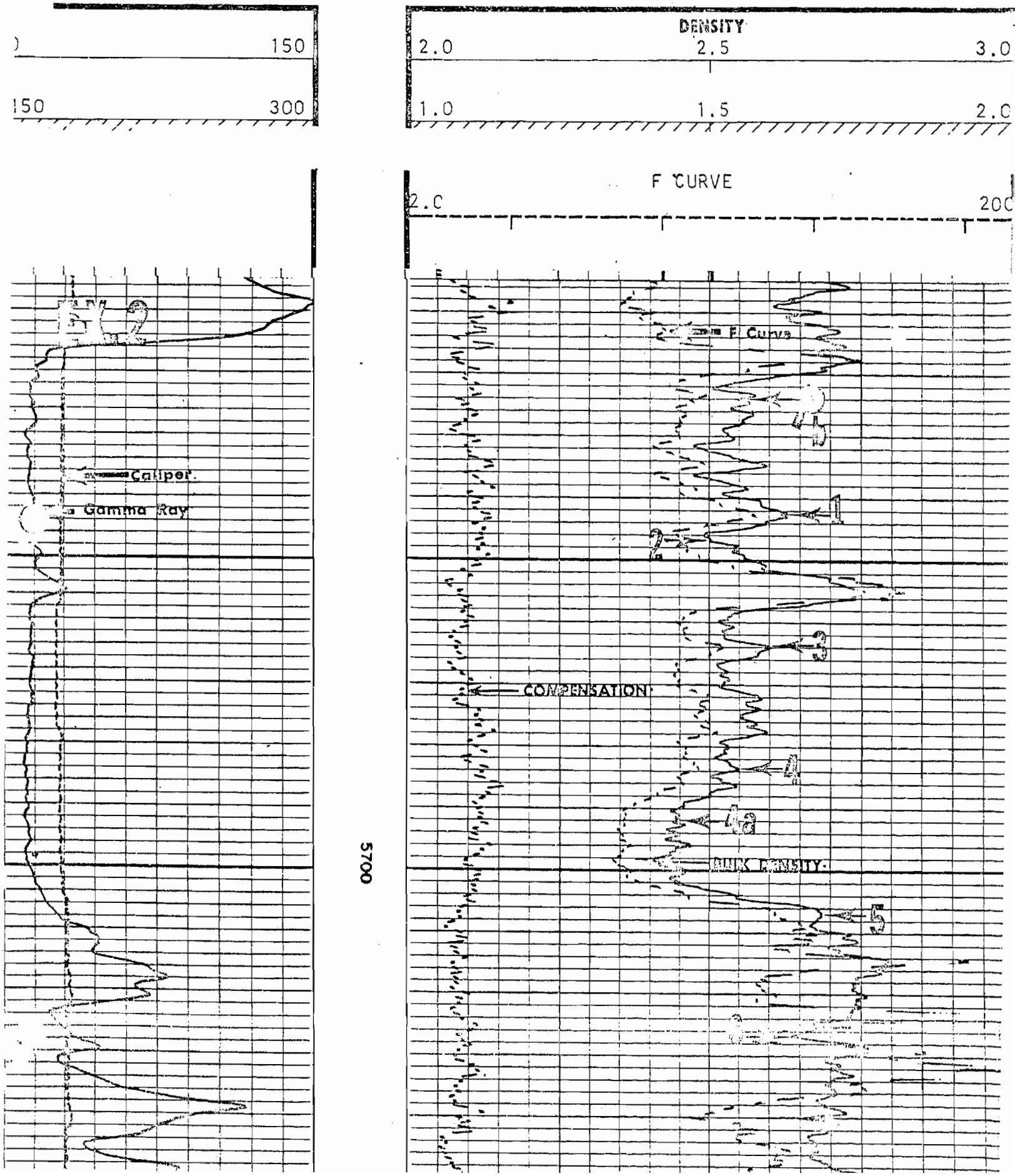

0 GAMMA RAY 150


LITHOLOGY LOGGING
30
20
10
0
POROSITY - LIME
LIMESTONE
DOLOMITE
ϕ_{CNL}
ϕ_{FDC}
ANHYDRITE
SHALE
SAND
SALT
GAS SAND
LIMESTONE
OR
GASSY DOLO.

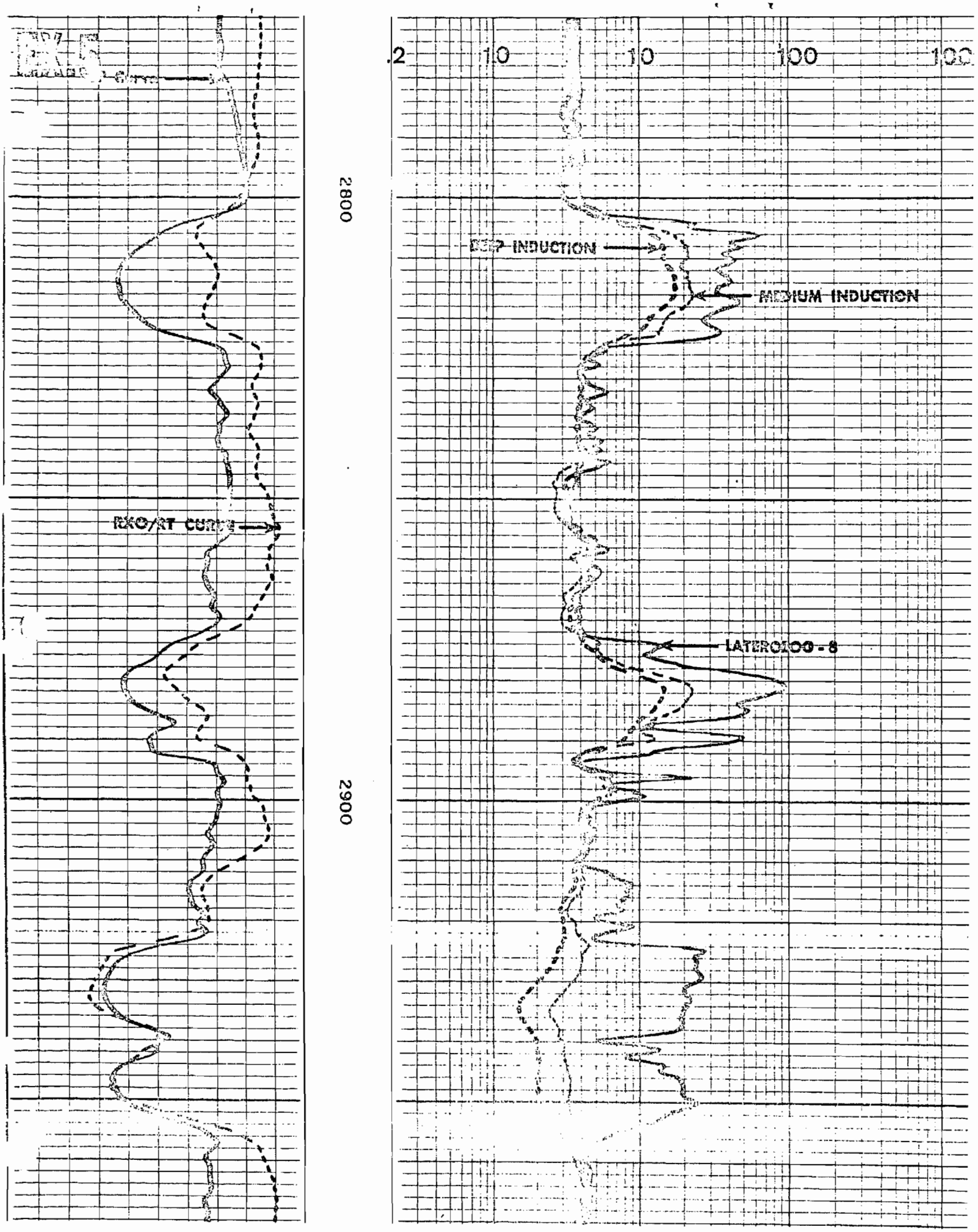

Caliper
Integration
Sonic Curve
11400
11500

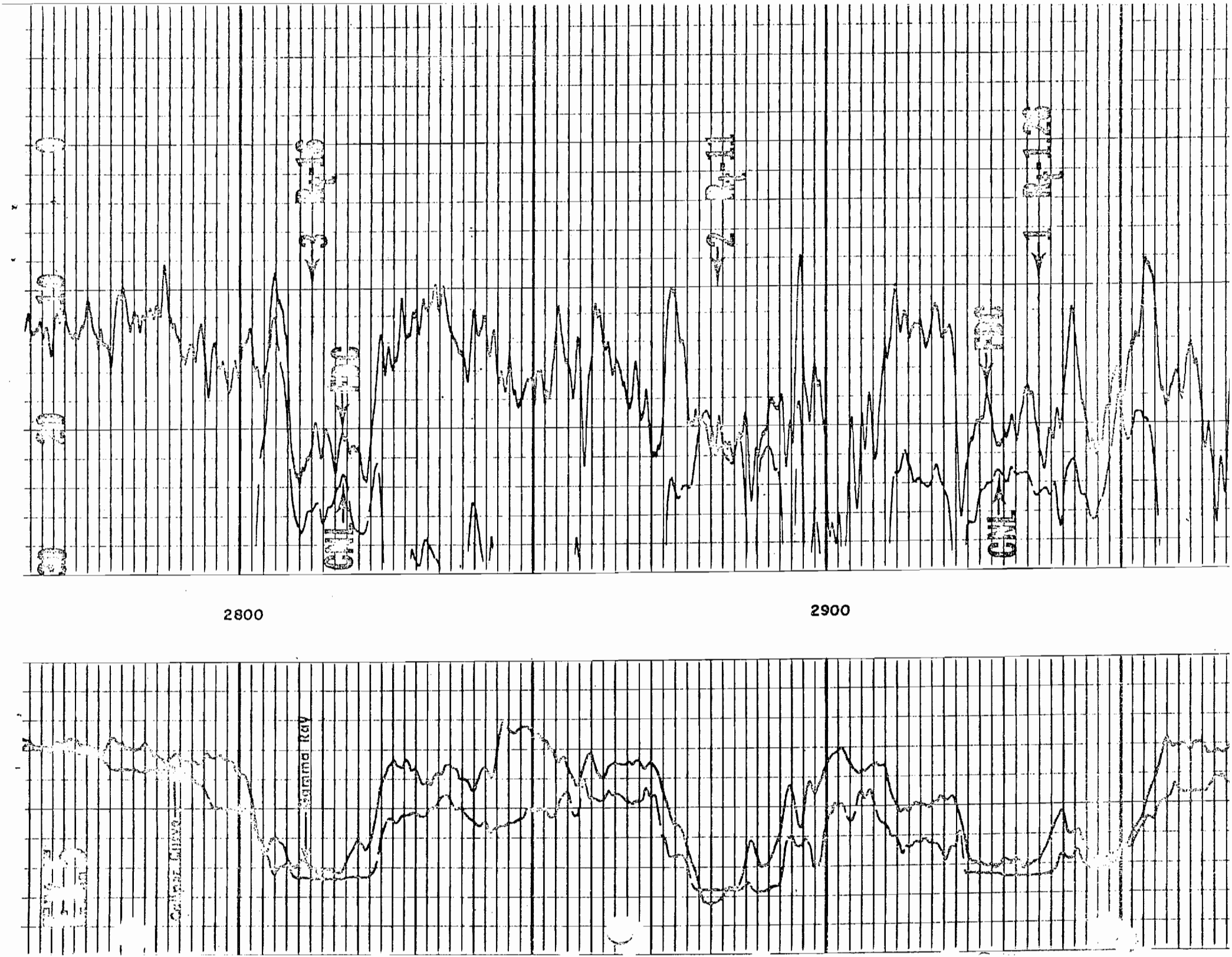
rks: NOTE: DOTTED CURVE ON FDC LOG MARKED "F" IS DERIVED FROM NEUTRON AND DENSITY CROSS PLOT. TO USE THIS CURVE AS RW, IT MUST BE SUPER-IMPOSED OVER A LOGARITHMIC GRID. SEE RO ON DUAL INDUCTION 5" LOG.

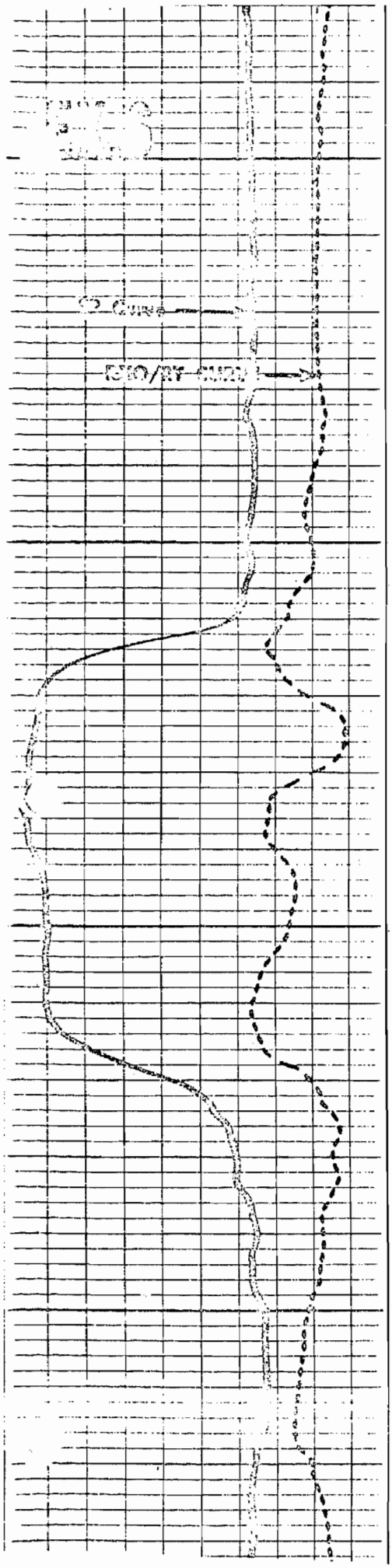
$$\emptyset, xPLOT = \frac{\emptyset D + \emptyset N}{2}$$

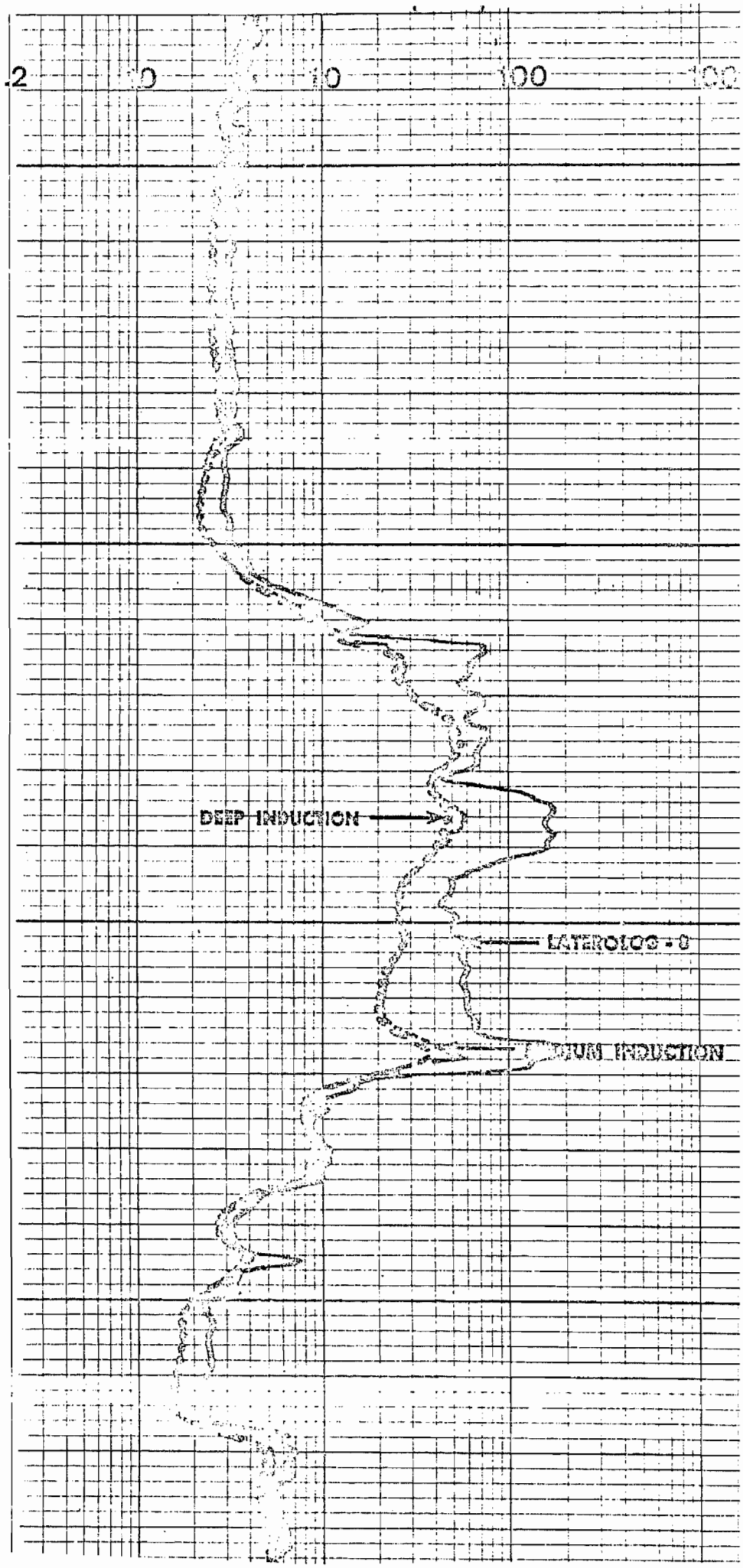


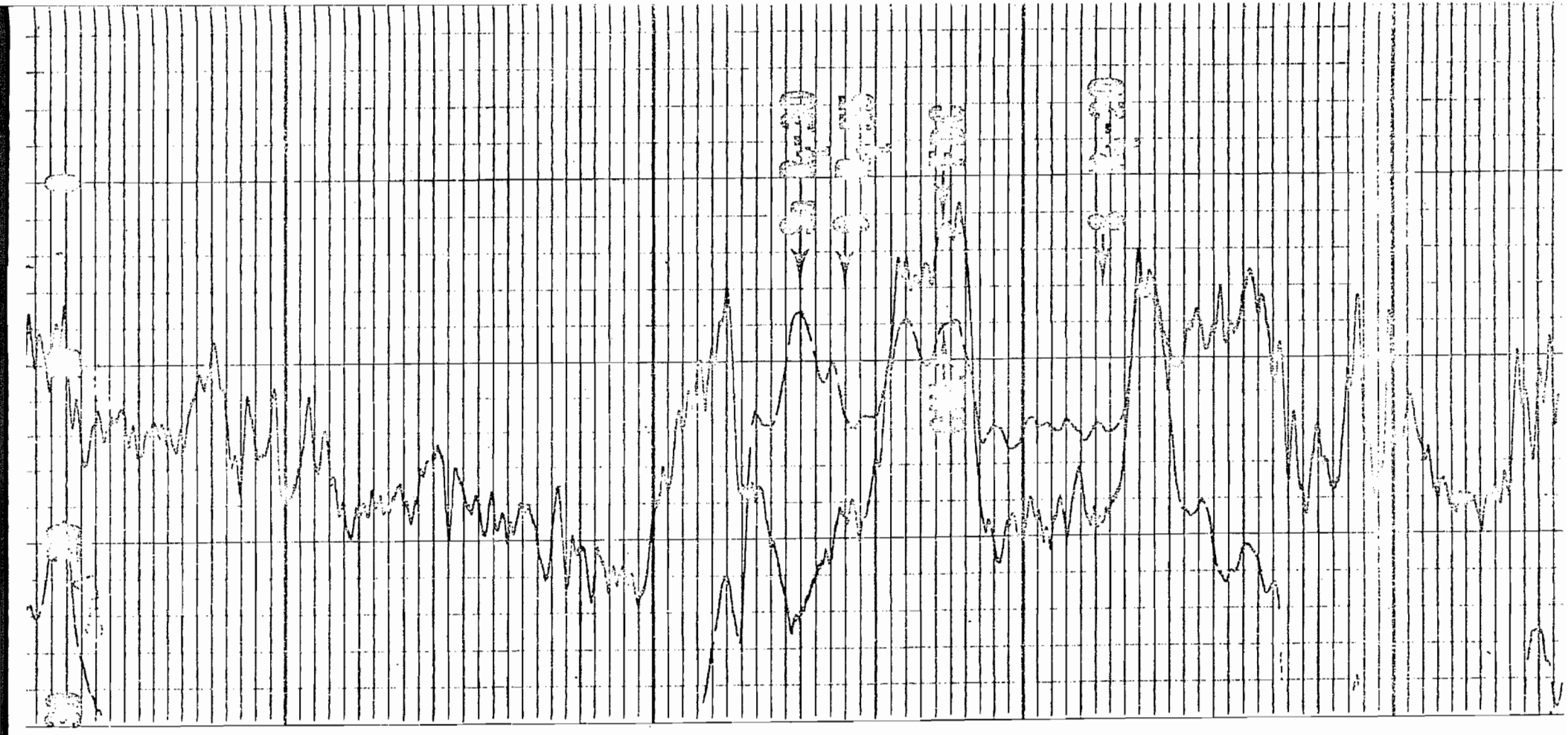
5700

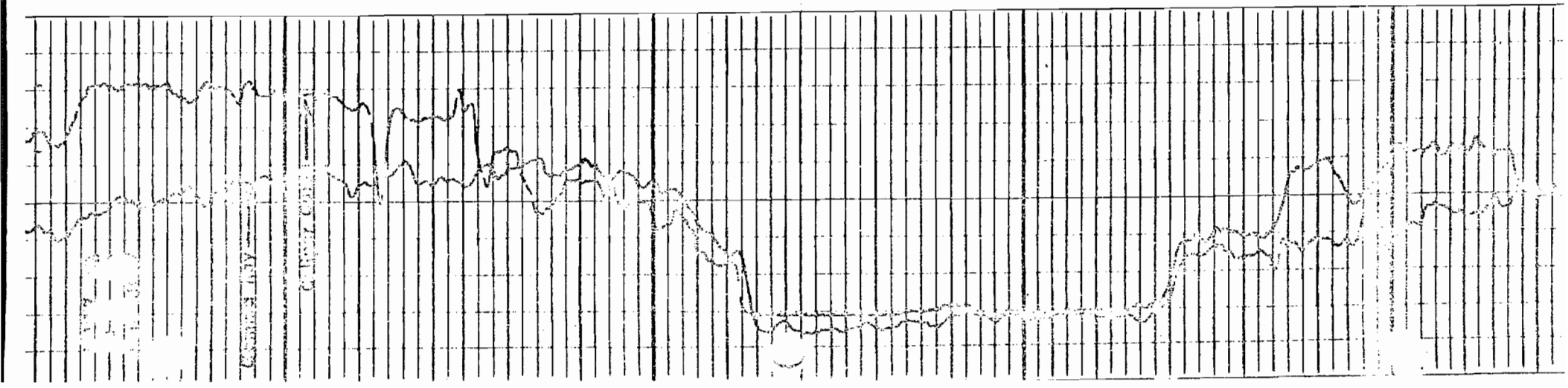

.2
10
10
100
100
2800
2900
DEEP INDUCTION
MEDIUM INDUCTION
LATEROLOG-8
IXO/XT CURVE


2800
2900
Gamma Ray


5300
5400


DEEP INDUCTION
LATEROLOG - 8
DIUM INDUCTION


5300
5400



Log Analysis POROSITY

SCHLUMBERGER

COMPANY | WELL

EX. 1 | COUNTY | STATE

DEPTH	Δt	sd ϕ_s	lm ϕ_s	dol ϕ_s	ρ_b	sd ϕ_D	lm ϕ_D	dol ϕ_D			% POROSITY	% WATER	REMARKS
1													
2													
3													
4													
5													
6													

EX. 2

				1									
				2									
				3									
				4									
				5									
				6									

EX. 3

								R_t	ϕ_N	ϕ_D			
							1						
							2						
							3						
							4						
							5						
							6						
							7						
							8						
							9						

All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to Clause 7 of our General Terms and Conditions as set out in our current Price Schedule.

DATE | LOCATION | ENGINEER

Log Analysis POROSITY

Schlumberger

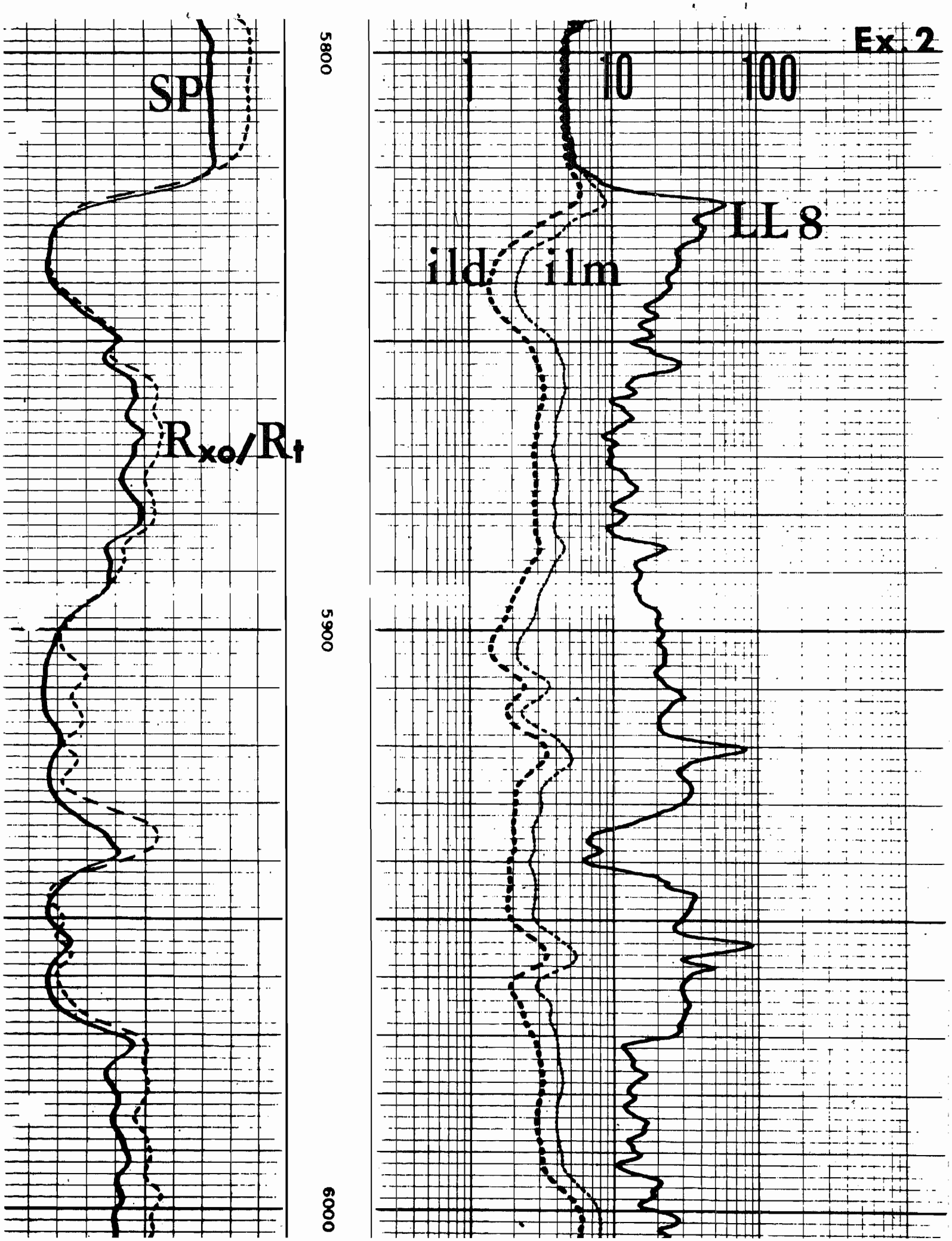
COMPANY | WELL

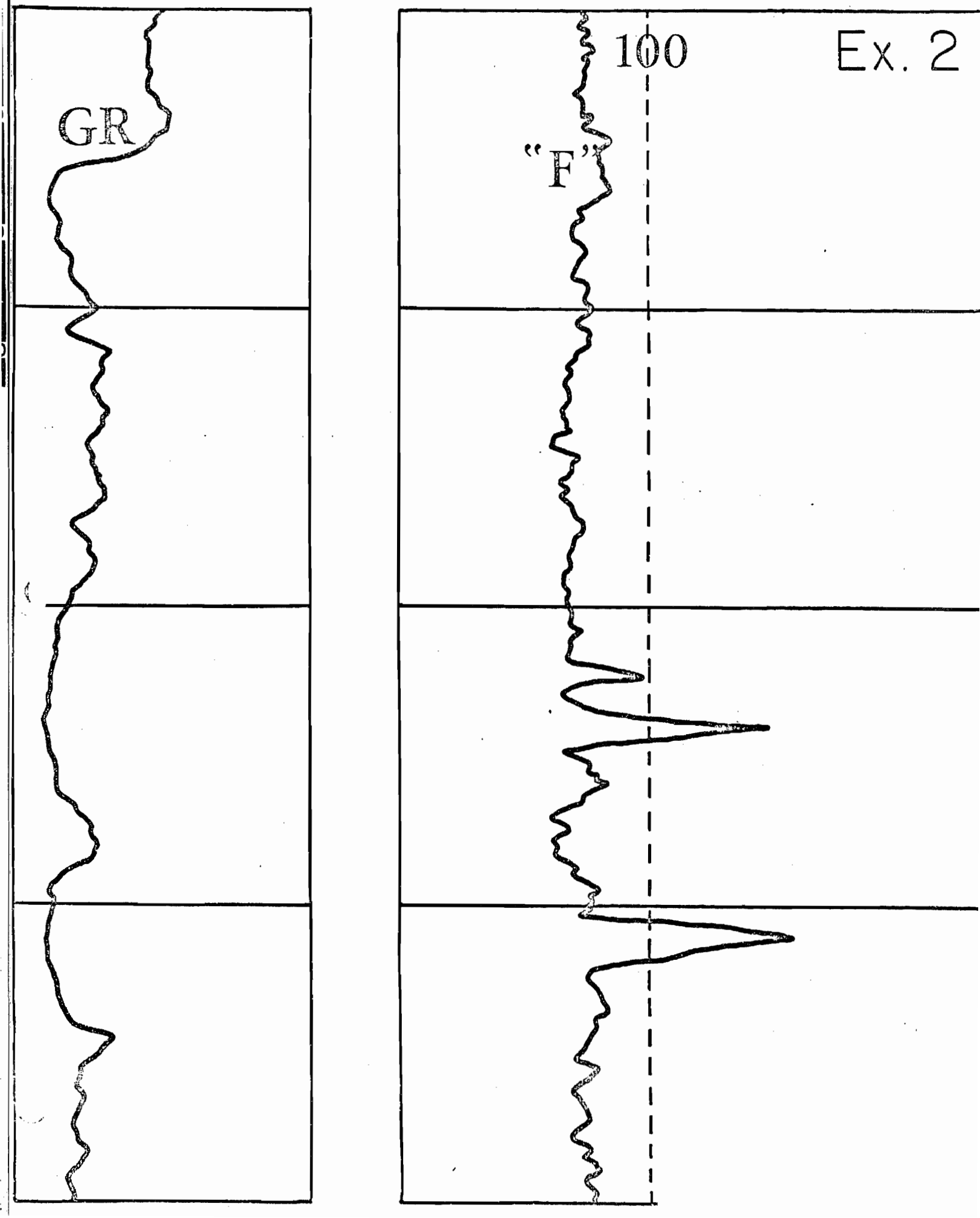
COUNTY | STATE

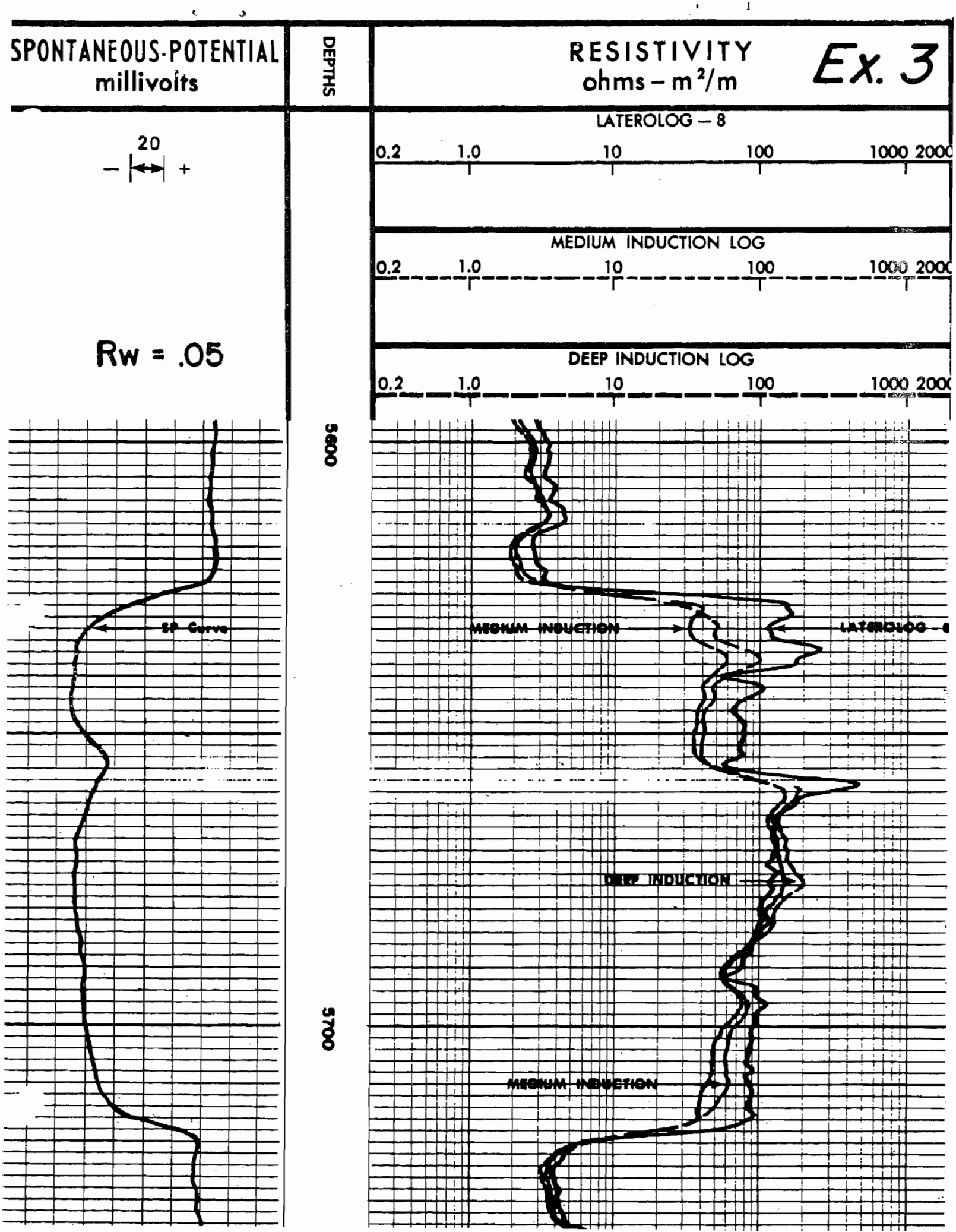
DEPTH							R_t	ϕ_N	ϕ_D	% POROSITY	% WATER	REMARKS
EX.4												
1												
2												
3												
4												
5												
6												
7												
8												
9												
EX.5												
1												
2												
3												
EX.6												
8												
9												
9a												

All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to Clause 7 of our General Terms and Conditions as set out in our current Price Schedule.

DATE | LOCATION | ENGINEER

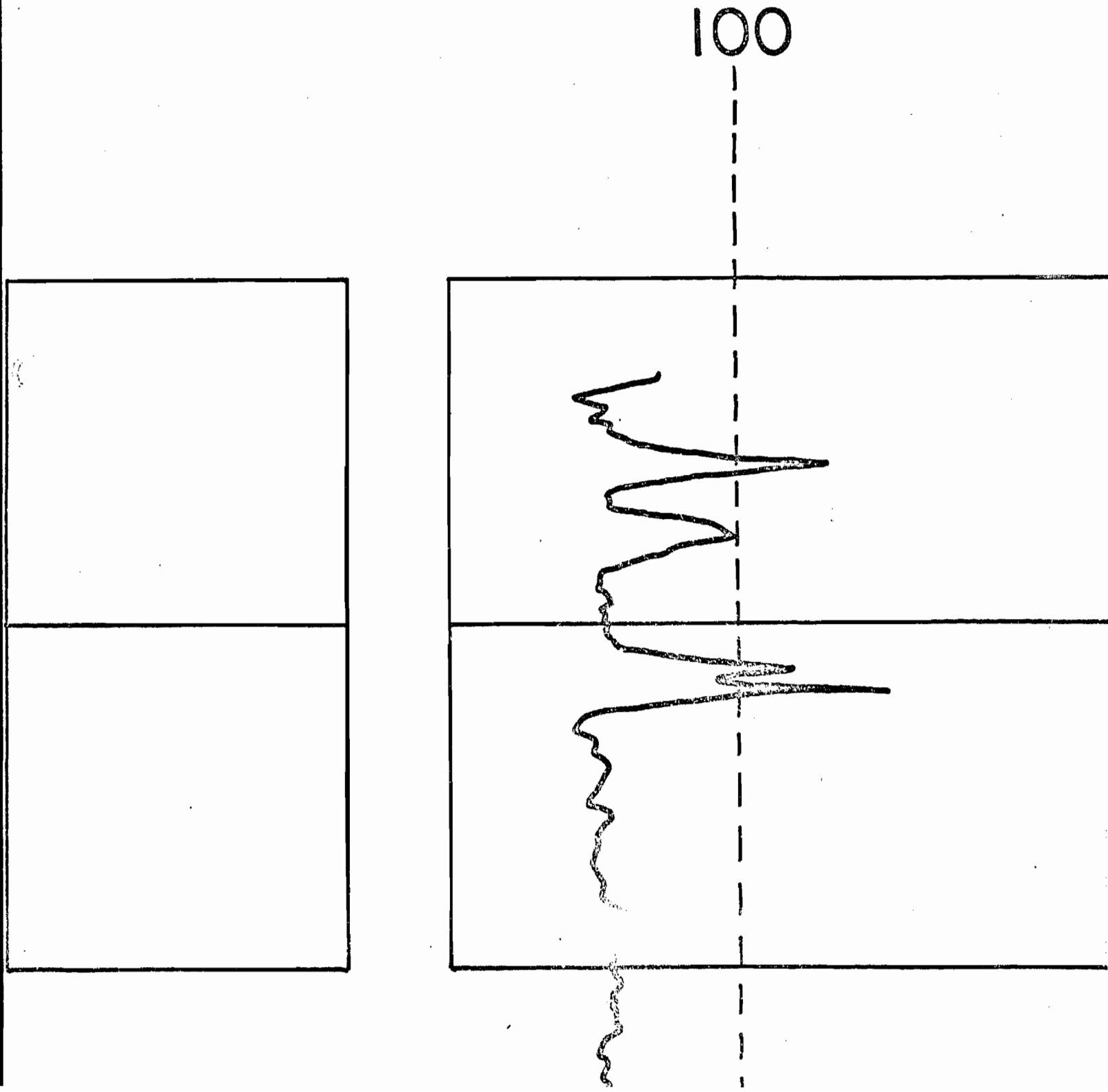

Ex. 2
SP
R_{xo}/R_t
1
10
100
LL 8
ild
ilm
5800
5900
6000


GR
"F"
100
Ex. 2

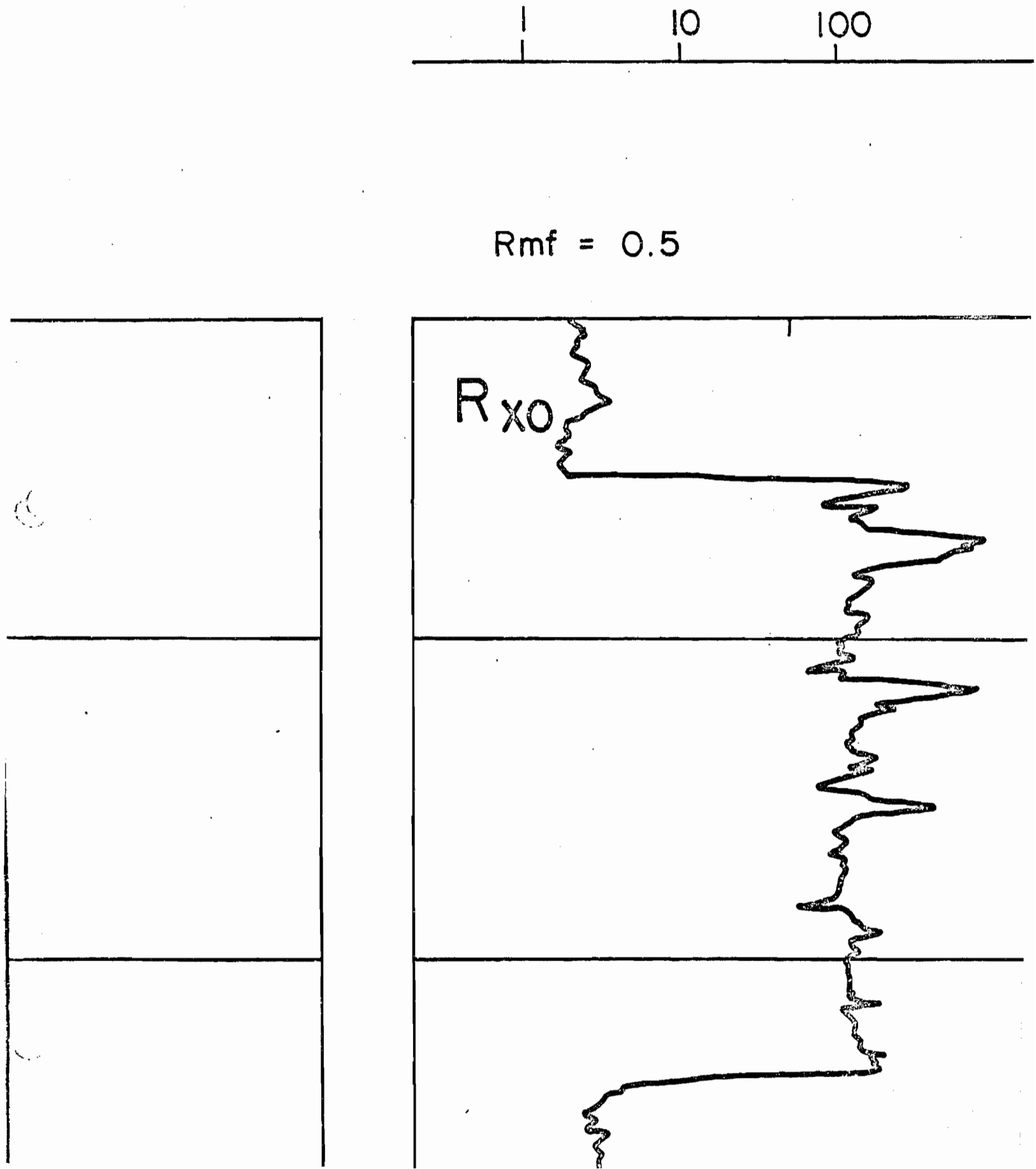

SPONTANEOUS-POTENTIAL
millivolts
DEPTHS
RESISTIVITY
ohms – m²/m
Ex. 3
LATEROLOG – 8
0.2
1.0
10
100
1000
2000
20
–
+
MEDIUM INDUCTION LOG
0.2
1.0
10
100
1000
2000
Rw = .05
DEEP INDUCTION LOG
0.2
1.0
10
100
1000
2000
5600
SP Curve
MEDIUM INDUCTION
LATEROLOG - 8
DEEP INDUCTION
5700
MEDIUM INDUCTION

Ex. 3

"F" LOG



Ex. 3



WELL SITE ANALYSIS

WORK SESSION LOG EXAMPLE 3

GIVEN

1. Dual Induction-Laterolog-Eight (DIL)
2. "F" Log with F Value of 100 Ohms indicated
3. Rxo Log with Rxo Value of 50 ohms indicated
4. Rw = .05 ohms
5. Rmf = 0.5 ohms

HOW TO CONSTRUCT AN Ro CURVE (Ro)

The "F" or Formation Factor log has been recorded from the Density Log by using the relation of $F = \frac{1}{\phi^2}$.

We want to trace the "F" curve onto the DIL as a resistivity curve representing the resistivity the zone would have if filled with water. This would be the Ro curve.

We know that Ro = F x Rw (Basic Archie Equation). If we multiply the "F" curve by Rw it will become an Ro curve. To do this, we take the "F" scale point of 100 and multiply it by Rw of .05 (Given). This gives Ro = 5 at "F" of 100. At the "F" scale point of 100 the resistivity is 5 ohms.

Slip the "F" log under the DIL log so that "F" of 100 aligns with 5 ohms of the DIL log. Be sure depths are matched or the "F" curve correlates with the resistivity curves. Then trace the "F" curve onto the DIL log at all points that it falls below the heavy dashed curve ILD.

This trace is the Ro curve. It represents the resistivity the formation would have if 100% water bearing.

HOW TO DETERMINE WATER SATURATION (Sw)

At any point you want to read a Sw value, place 100 of the water saturation scale of the quick look scaler on the heavy dashed curve ILD. Where the Ro curve intersects the scale read Sw.

HOW TO DETERMINE POROSITY (Ø)

Again use the quick look scaler. Place the little black index triangle of the porosity scale M = 2 on the 5 ohm line of the DIL log, the high porosity end of the scale toward the depth column. Where the Ro curve intersects the scale read porosity.

HOW TO CONSTRUCT A MOVABLE OIL PLOT (MOP)

We position the Rxo log on the DIL log to get a quick-look movable oil indication.

In the flushed zone, we are dealing with mud filtrate of resistivity Rmf as the water, whereas, in the uncontaminated zone, it is water of resistivity Rw.

To make the Rxo curve compatible with the Ro curve already added to the DIL log, we simply multiply the Rmf value 0.5 x 100 = 50 ohms and align this value with the value Rw .05 x 100 = 5 ohms.

In other words, place the Rxo log under the DIL log so its resistivity point of 50 ohms aligns with 5 ohms on the DIL resistivity scale. Match depths and trace on the Rxo curve where it falls below the ILD curve and above the Ro curve.

The separation between the Ro curve and the Rxo curve on the DIL log represents residual hydrocarbons. The separation between the Rxo curve and the ILD curve represents movable hydrocarbons.

THE CBL/VDL

A PRACTICAL GUIDE TO WHAT WE PRESENT
AND
HOW IT CAN BE USED

WHAT WE PRESENT:

In Track One -

We present "single receiver travel time" in microseconds. The usual scale is 200-400 Microseconds increasing to the left. However, as with any log, the scale should be checked before any reading is taken. It should be emphasized that the Δt curve is time of the first arrival that exceeds the threshold amplitude of the receiver system. It can be pipe signal or formation signal: It can be the actual first arrival or a later cycle: It is the first arrival that has sufficient amplitude to trigger the receiver system.

In Track Two -

We present amplitude, in millivolts, of the arrival whose travel time is measured in track one. An amplified curve is usually presented and the scale can vary. It has been 0-100 millivolts on the first logs, but this cuts down detail in sections of good bond, and we are experimenting with a return to a 0-50 scale. Check the scale on a log before attempting an interpretation.

In Track Three -

We present the VDL. The receiver signal controls the intensity of the sweep beam of a cathode ray tube, and this is optically presented. Negative half-cycles cut off the beam and result in white traces on the log. Positive half cycles darken the beam with higher amplitudes resulting in darker readings. The hard thing is to adjust your eye to the dark areas just to the left of each white area. White is white, and the white areas do not give an index to variations in half-cycle amplitudes. Amplitude variations are indicated by variations in the intensity of "darkness" just to the left of white traces. Two scales are in use for the VDL. The first, and, to-date, most common is 200-1200 microseconds increasing to the right. Please note that the sweep width is not always exactly one track wide, but the scale refers to sweep width - 200 is where the trace starts, and 1200 is where it ends. It is divided into 10 divisions of 100 microseconds each.

The second possible presentation of the VDL is to show the whole time sequence from T_0 onward. In this case, the scale is 0-1000. In free pipe, a cross check can be made to see which VDL presentation is being used (of course, the scale on the heading should show it, but a cross check never hurt). In free pipe (how to detect this will be covered later) read the time in microseconds on the single receiver curve (called Δt through most of this report) against the distance in Cathode ray sweep divisions from the left edge to the first positive signal (first dark trace in front of a white space). Then CR (Cathode Ray)

Divisions x 100 should equal Δt time, plus 57 times the difference in spacing of the two systems (determining differences in spacing will be demonstrated in the following material).

It is worthy of note that when the optics are perfect, and the whole time sequence is recorded, T_0 can be seen as a slight darkening (it is a weak signal) immediately to the right of the left edge of the CR trace.

HOW IT CAN BE USED:

To show how to use the CBL/VDL, we will present examples of various bonding and cement conditions in the form of sections from an actual log. We will point out the characteristics of the logs in the various zones and relate the interpretation the specific characteristics suggest.

These examples were made from Sepias, therefore, are not as clear as they would have been from the film.

CEMENT BOND LOG

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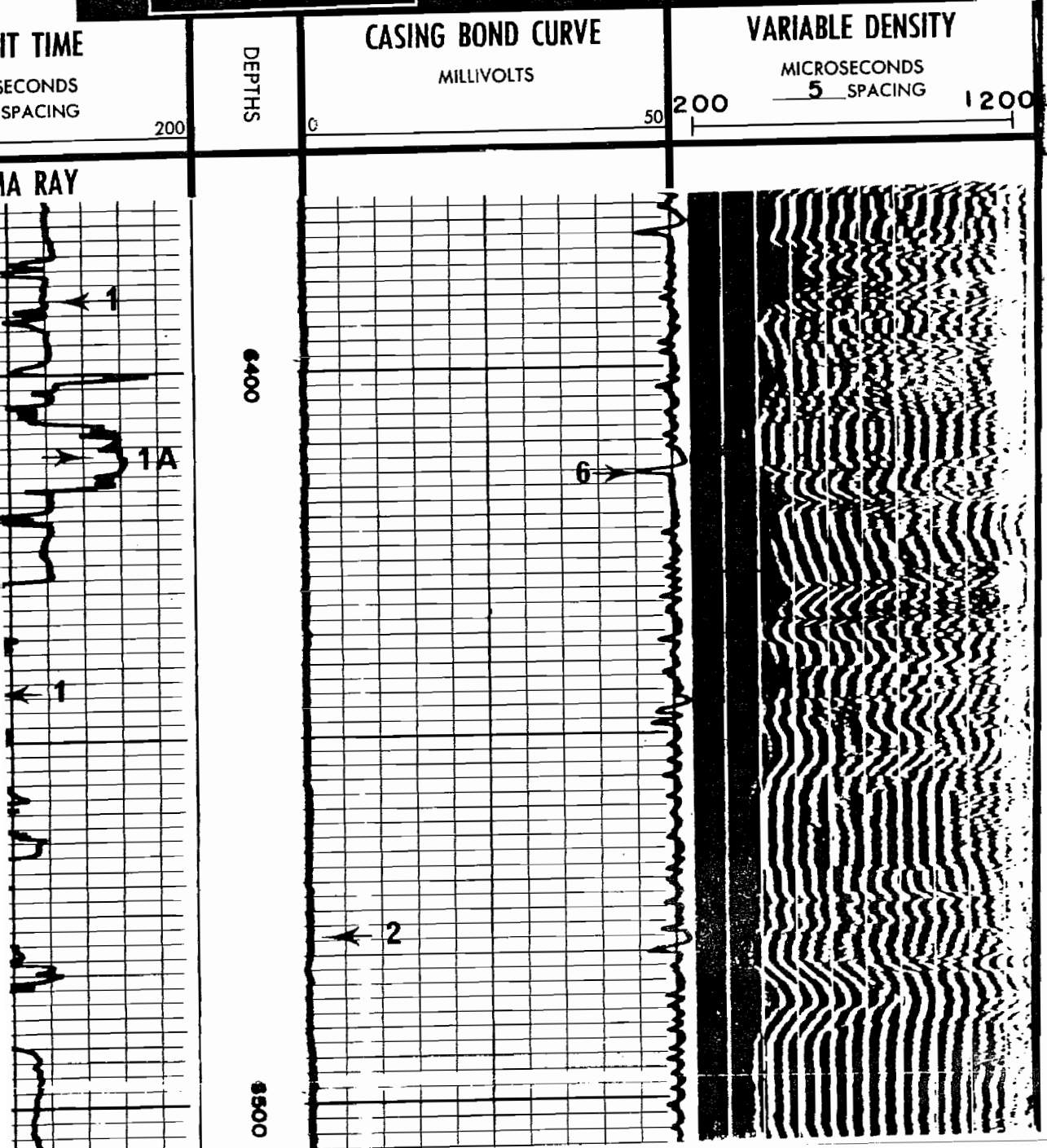
VARIABLE DENSITY



This whole section has excellent pipe bond and formation coupling with annulus cement. Section is over formations of widely varying attenuation characteristics.

CHARACTERISTICS	INTERPRETATION
1. Δt hunting between theoretical value and longer times.	Hunting occurs as strength of signals varies with formation and casing attenuation.
1a. Δt indicates a shorter time than theoretical value. This is caused by a fast formation arrival.	Good to excellent pipe attenuation is indicated by longer Δt times.
2. Amplitude or bond curve reads very low value indicating excellent cement bond to pipe.	
3. VDL early arrivals are gone indicating good cement bond to pipe. Late arrivals are strong & vary with time. This means formation cement coupling is good.	
3a. Fast formation arrival indicated on VDL.	
6. Casing collars indication must be corrected for depth.	

CEMENT BOND LOG

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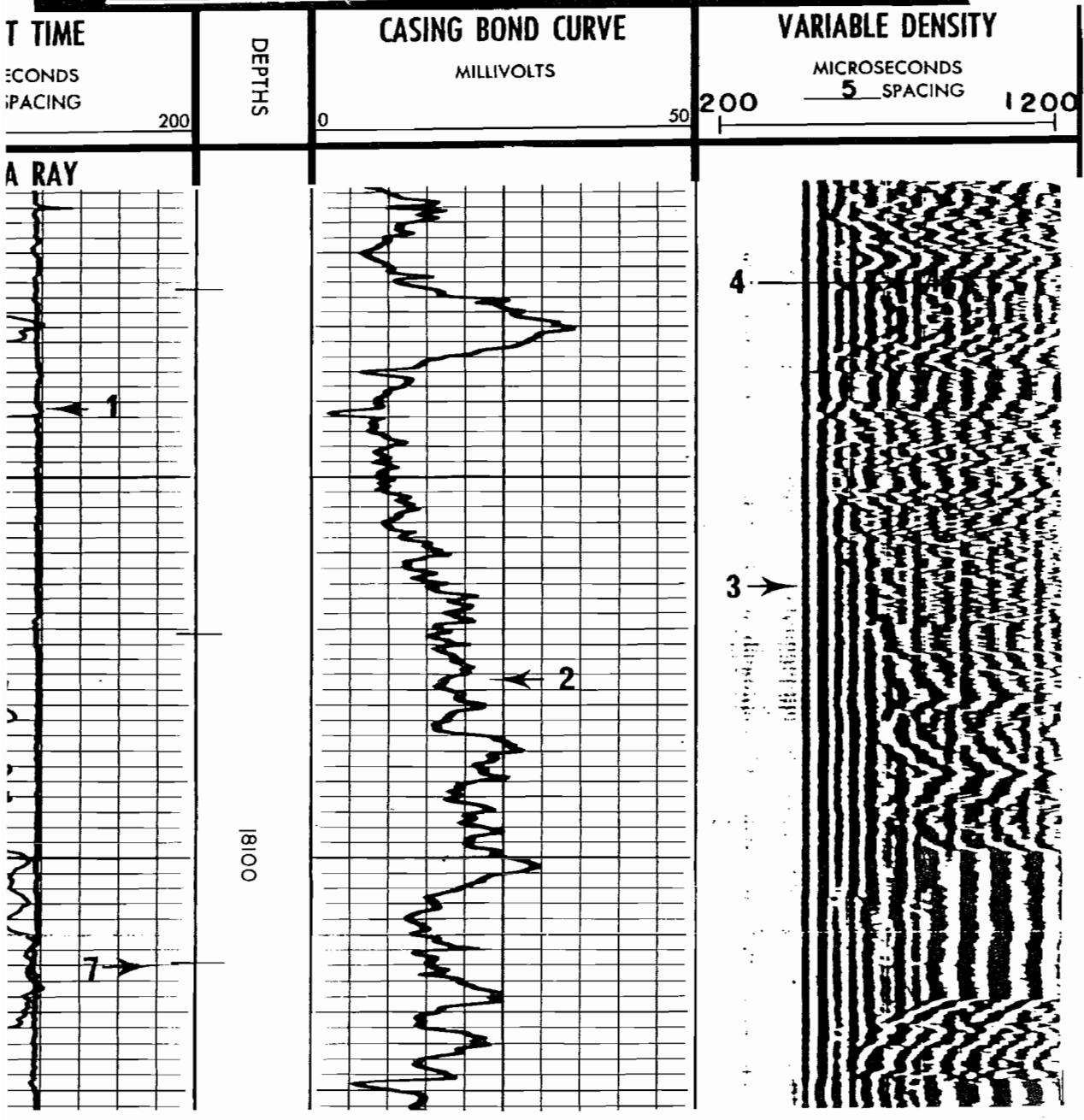
VARIABLE DENSITY

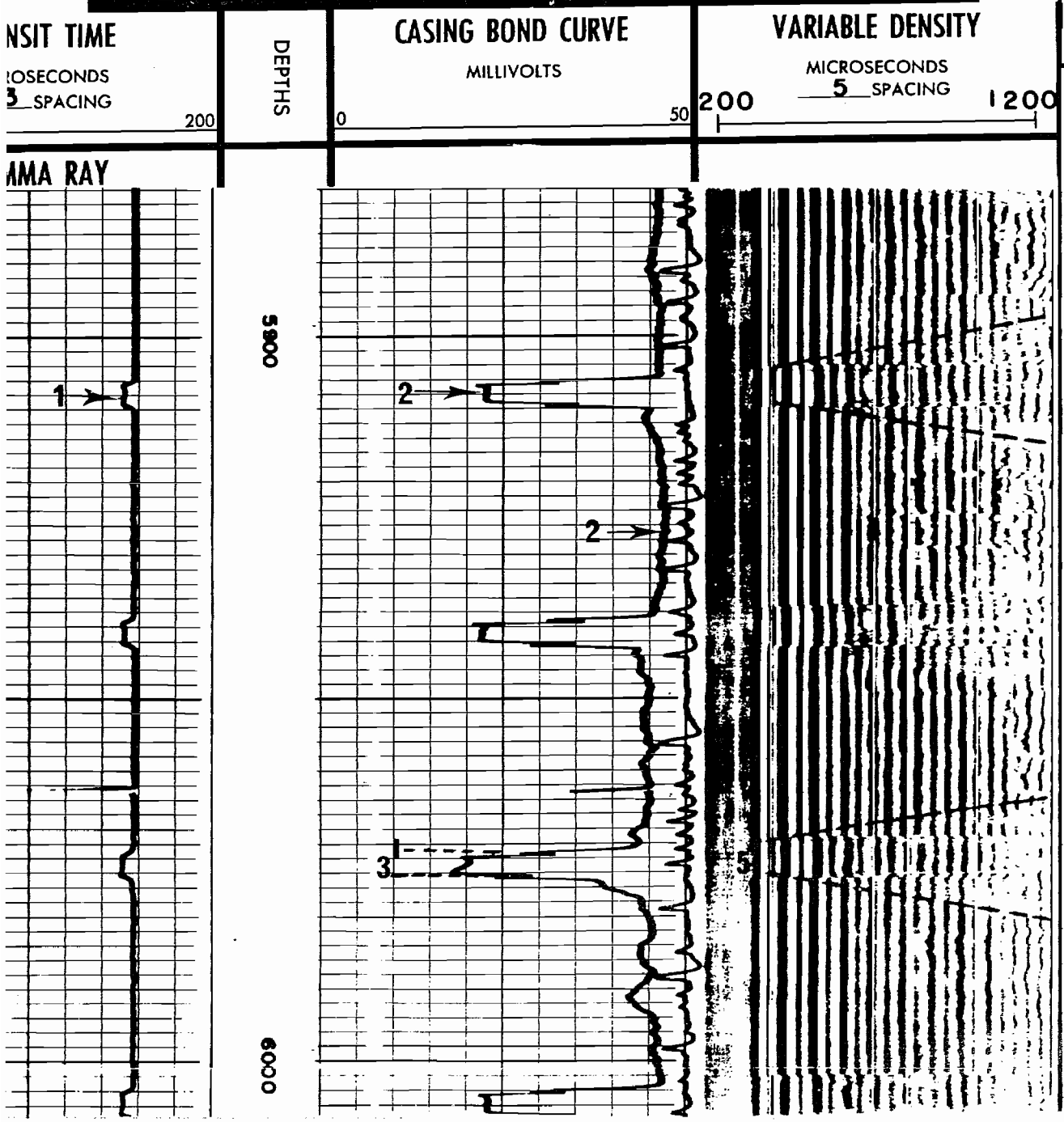


CHARACTERISTICS	INTERPRETATION
1. Δt at theoretical value.	Pipe bond is poor. Strong late arrivals imply cement formation coupling is good.
2. Amplitude fairly high.	This is probably a Micro-annulus but could also indicate possible channeling.
3. First arrivals on VDL are straight and strong.	
4. Medium and late VDL signals strong and "crooked".	The only sure way to differentiate is to rerun under pressure. If amplitude decreases under pressure, it is a Micro-annulus.

CEMENT BOND LOG

Schlumberger

VARIABLE DENSITY



UNBONDED SECTION ABOVE CEMENT TOP

1. Δt at theoretical value. Casing collars indicated by longer transit time.

2. Amplitude or bond curve high (saturated) with casing collars very apparent. "Ticks" in upper and lower collar breaks define spacing in use. "Ticks" are seen as time increases on Δt and VDL display.

3. 3' spacing on amplitude or bond curve.

4. Straight lines on VDL arrivals & weaker signals on later arrivals indicates pipe above all cement.

5. 5' spacing on VDL early arrivals are strong and straight Chevron effect at casing collars substantiates pipe is above cement.

1. Distance between collar "Ticks" defines spacing used. In this example Δt and amplitude are on 3' spacing. The VDL is on a 5' spacing.

2. Clear Chevrons indicates good optical alignment and focus. This is a properly calibrated tool.

DATA FOR THREADED NON-UPSET CASTING

O. D.	Weight* per foot	Nominal I. D.	Drift Diam.**
4″	11.60	3.428	3.303
4 - 1/2″	9.50	4.090	3.965
	11.60	4.000	3.875
	13.50	3.920	3.795
4 - 3/4″	16.00	4.082	3.957
5″	11.50	4.560	4.435
	13.00	4.494	4.369
	15.00	4.408	4.283
	17.70	4.300	4.175
	18.00	4.276	4.151
	21.00	4.154	4.029
5 - 1/2″	13.00	5.044	4.919
	14.00	5.012	4.887
	15.00	4.974	4.849
	15.50	4.950	4.825
	17.00	4.892	4.767
	20.00	4.778	4.653
	23.00	4.670	4.545
5 - 3/4″	14.00	5.290	5.165
	17.00	5.190	5.065
	19.50	5.090	4.965
	22.50	4.990	4.865
6″	15.00	5.524	5.399
	16.00	5.500	5.375
	18.00	5.424	5.299
	20.00	5.352	5.227
	23.00	5.240	5.115
6 - 5/8″	17.00	6.135	6.010
	20.00	6.049	5.924
	22.00	5.989	5.864
	24.00	5.921	5.796
	26.00	5.855	5.730
	26.80	5.837	5.712
	28.00	5.791	5.666
	29.00	5.761	5.636
	32.00	5.675	5.550
7″	17.00	6.538	6.413
	20.00	6.456	6.331
	22.00	6.398	6.273
	23.00	6.366	6.241
	24.00	6.336	6.211
	26.00	6.276	6.151
	28.00	6.214	6.089
	29.00	6.184	6.059
	30.00	6.154	6.029
	32.00	6.094	5.969
	35.00	6.004	5.879
	38.00	5.920	5.795
	40.00	5.836	5.711
7 - 5/8″	20.00	7.125	7.000
	24.00	7.025	6.900
	26.40	6.969	6.844
	29.70	6.875	6.750
	33.70	6.765	6.640
	39.00	6.625	6.500
8 - 5/8″	24.00	8.097	7.972
	28.00	8.017	7.892
	32.00	7.921	7.796
	36.00	7.825	7.700
	38.00	7.775	7.650
	40.00	7.725	7.600
	43.00	7.651	7.526
	44.00	7.625	7.500
	49.00	7.511	7.386
9″	34.00	8.290	8.165
	38.00	8.196	8.071
	40.00	8.150	8.025
	45.00	8.032	7.907
	55.00	7.812	7.687
9 - 5/8″	29.30	9.063	8.907
	32.30	9.001	8.845
	36.00	8.921	8.765
	40.00	8.835	8.679
	43.50	8.755	8.599
	47.00	8.681	8.525
	53.50	8.535	8.379
10″	33.00	9.384	9.228
10 - 3/4″	32.75	10.192	10.036
	40.00	10.054	9.898
	40.50	10.050	9.894
	45.00	9.960	9.804
	45.50	9.950	9.794
	48.00	9.902	9.746
	51.00	9.850	9.694
	54.00	9.784	9.628
	55.50	9.760	9.604
11 - 3/4″	38.00	11.150	10.994
	42.00	11.084	10.928
	47.00	11.000	10.844
	54.00	10.880	10.724
	60.00	10.772	10.616
12″	40.00	11.384	11.228
13″	40.00	12.438	12.282
13 - 3/8″	48.00	12.715	12.559
16″	55.00	15.375	15.187
18 - 5/8″	78.00	17.855	17.667
20″	90.00	19.190	19.002
21 - 1/2″	92.50	20.710	20.522
	103.00	20.610	20.422
	114.00	20.510	20.322
24 - 1/2″	100.50	23.750	23.562
	113.00	23.650	23.462

*Weight per foot (in pounds) is given for plain pipe (no threads or coupling).

**Drift diameter is the guaranteed minimum internal diameter of any part of the casing. Use drift diameter to determine the largest-diameter equipment that can be safely run inside the casing. Use internal diameter (I.D.) for volume capacity calculations.

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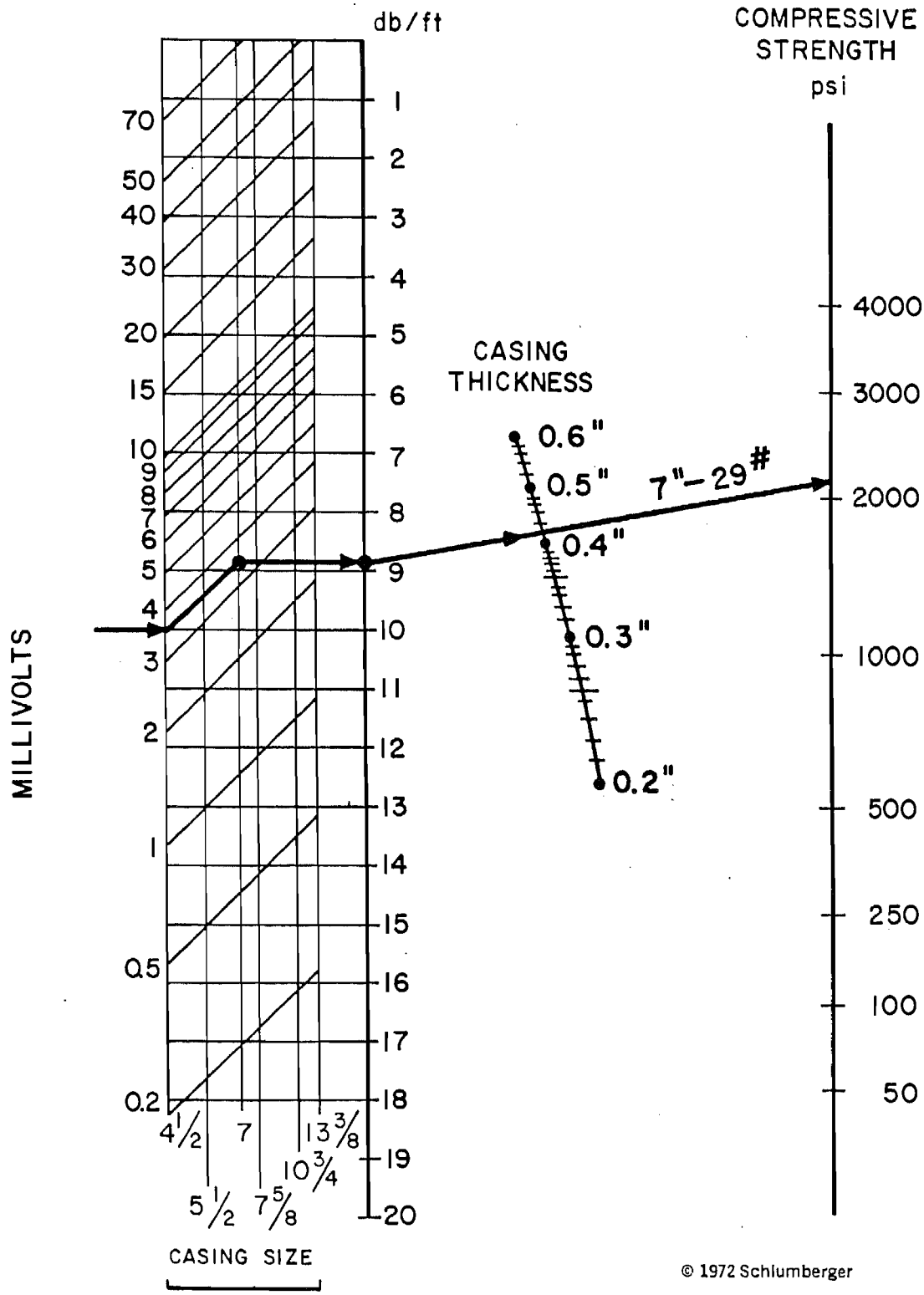
CBL INTERPRETATION CHART

CENTERED TOOL ONLY
3-FOOT SPACING



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CHARGE PERFORMANCE DATA

AUGUST, 1973

EH = Entrance Hole
OAP = Overall Penetration
TTP = Total Target Penetration
TCP = Total Core Penetration
CFE = Core Flow Efficiency
ECP = Effective Core Penetration

Classification	Gun Size Inches	Gun Type	Charge Type	Rating PSI/°F	Gun Phasing	Explosive Load(Grams)	Second Edition API RP-43 Section I Pene. (in) Sand-Cement	Casing Hole Dia.	Second Edition API RP-43 Sec II Berea Sand Formation EH	OAP	TTP	TCP	CFE	ECP
Thru-Tubing Expendable	1-11/16"	Uni-Jet	Alum (No plug)	7,500/ 300°	0°/180°	10.5	6.36	.33	.34	6.23	6.23	5.11	.88	4.49
	1-11/16"	Uni-Jet	Ceramic (DPC)	15,000/ 300°	"	8.0	* 5.11	.34	.30	4.80	4.80	3.68	.83	3.07
	2-1/8"	Uni-Jet	Ceramic (DPC)	15,000/ 300°	"	16.2	* 6.43	.41	.40	5.73	5.73	4.61	.93	4.29
	1-3/8"	Magna-Jet	Alum (No-plug)	10,000/ 300°	0°/120°	6.3	* 5.59	.24	.30	5.30	5.30	4.18	.80	3.34
Thru-Tubing Hollow Carrier	1-5/16"	Scallop	Hyper-Jet	15,000/ 340°	0°	1.8	3.95	.22	.23	2.93	2.62	1.50	.70	1.06
	1-9/16"	Scallop	Hyper-Jet	"	0°	3.2	5.71	.24	.26	4.77	4.03	2.91	.83	2.42
	2"	Scallop	Hyper Jet II	"	0°/180°	6.5	9.45	.33	.37	7.02	6.50	5.38	.81	4.36
Casing Expendable	3-1/8"	Uni-Jet	Alum (No-plug)	10,000/ 300°	0°/180°	27.0	10.31	.62	.55	8.54	8.54	7.41	.82	6.08
	3-1/8"	Uni-Jet	Ceramic (DPC)	15,000/ 300°	"	20.5	* 10.74	.54	.46	8.04	8.04	6.92	.81	5.61
Casing Hollow Carrier	3-3/8"	Carrier	No-plug	20,000/ 340°	90°	13.5	* 8.80	.41	-	-	-	-	-	-
	3-3/8"	Carrier	Hyper-Jet	"	"	13.5	14.23	.43	.52	9.12	9.12	8.00	.80	6.36
	4"	Carrier	No-plug	"	"	15.5	* 11.11	.47	.50	9.50	9.50	8.38	.78	6.54
	4"	Carrier	Hyper-Jet II	"	"	19.5	23.07	.40	.46	16.13	14.13	13.01	.84	10.88
Selective Shot-by-Shot	3-3/8"	Sharp-Shooter	(DPC)	"	0°	6.5	* 5.10	.36	.40	5.40	5.40	4.28	.55	2.35
	3-3/8"	Sharp-Shooter	Hyper-Jet	"	"	6.5	* 9.75	.32	.32	5.80	5.80	4.68	.61	2.86
	4"	Sharp-Shooter	Hyper-Jet	"	"	12.0	* 13.00	.50	.50	8.00	8.00	6.88	.50	3.44
Sand Control Big Hole Gun	4"	Carrier	No-plug	"	0°	15.0	4.60	.91	.96	4.60	4.48	3.36	.73	2.47

High Temperature Packages are also available.

* 1st Edition Data

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CHARGE PERFORMANCE DATA

HI - TEMPERATURE PACKAGES

AUGUST, 1973

Classification	Gun Size Inches	Gun Type	Charge Type	Rating PSI/°F	Gun Phasing	Explosive Load(Grams)	Second Edition API RP-43 Section I Pene. (in) Sand-Cement	Second Edition API RP-43 Section I Casing Hole Dia	Second Edition API RP-43 Sec II Berea Sand Formation EH	OAP	TTP	TCP	CFE	ECP
Thru-Tubing Hollow Carrier	* 1-5/16"	Scallop	No-plug	25,000/ 470°	0°	1.8	3.03	-	.18	2.62	2.25	1.13	.84	.95
	1-9/16"	Scallop	Hyper-Jet	25,000/ 470°	0°	3.4	4.78	.22	.25	3.25	2.83	1.71	.75	1.27
	* 1-9/16"	Scallop	Hyper-Jet	25,000/ 600°	0°	3.4	3.75	.18	.20	3.00	2.00	.88	.89	.78
	2"	Scallop	Hyper-Jet	25,000/ 470°	0°/180°	6.2	8.65	.31	.34	6.03	5.70	4.58	.76	3.48
Casing Hollow Carrier	3-3/8"	Carrier	Hyper-Jet	25,000/ 470°	90°	13.5	10.65	.34	.43	7.73	5.67	4.55	.67	3.11
	* 4"	Carrier	Hyper-Jet II	25,000/ 470°	90°	19.5	-	-	.40	11.88	11.78	10.66	.84	8.92

EH = Entrance Hole
OAP = Overall Penetration
TTP = Total Target Penetration
TCP = Total Core Penetration
CFE = Core Flow Efficiency
ECP = Effectlve Core Penetration

* Not officially published data