Well Logs

You will work on this assignment individually. Each person must complete his or her own drawings and answers to the questions.

Introduction

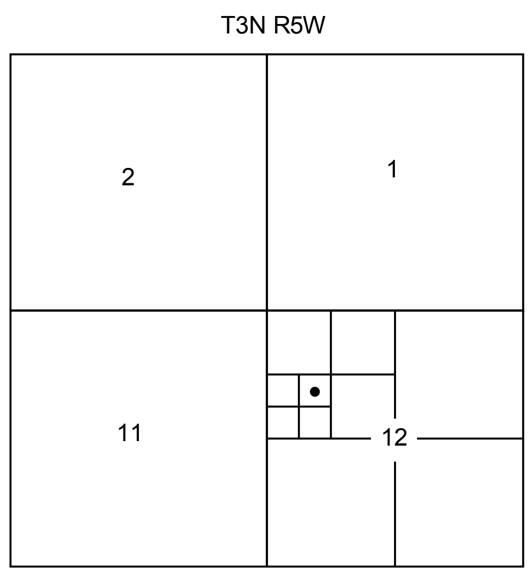
In this lab, you will examine four well logs, correlate major unit boundaries, and construct three figures: a cross-section diagram, a structure map, and an isopach map.

You also will examine another well electric log and associated drilling chips/cuttings, construct a drill cuttings log, and correlate the electric log with the cuttings log.

Skills

The skills you will apply in this lab include:

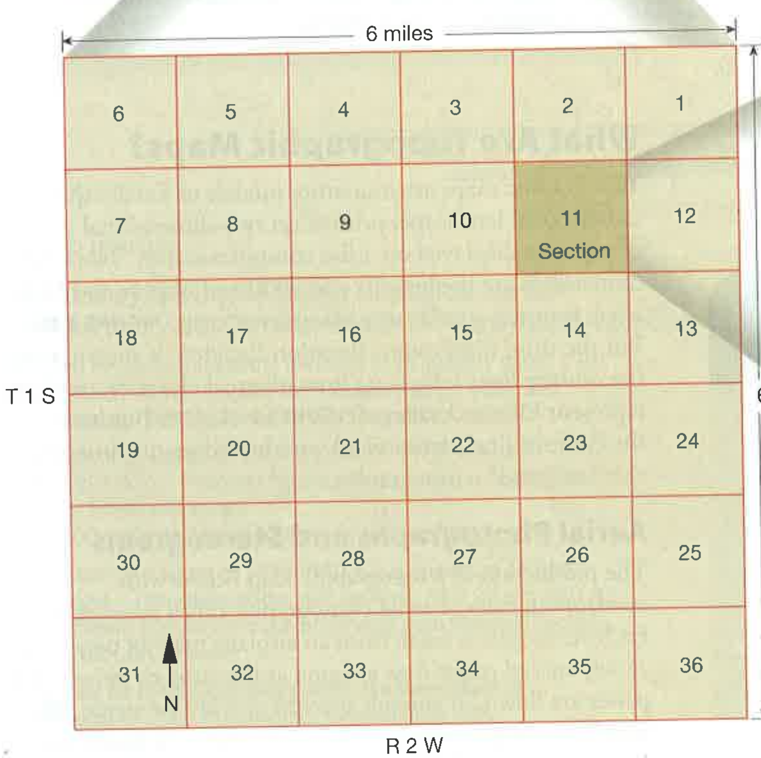
(a) ***Locating wells*** *using the Public Land Survey System information from well log heading information.* The well logs you will be given use the PLSS to locate each well. This system uses “township-range” indicators, “quartering” designations, and finally distances from the finest quarter boundaries (in this lab, we are going to ignore the distances and assume the wells are located in the center of the finest quarter). An example location definition is: NE SW NW 12 T3N R5W. You say the location from left to right: “north-east quarter of the south-west quarter of the north-west quarter of section 12, township 3 north – range 5 west,” but you locate on a map by going from right-to-left (find section 12, go to the north-west quarter, then go to the south-west quarter of that quarter, then go to the north-east quarter of that quarter). The following shows the location of our example:

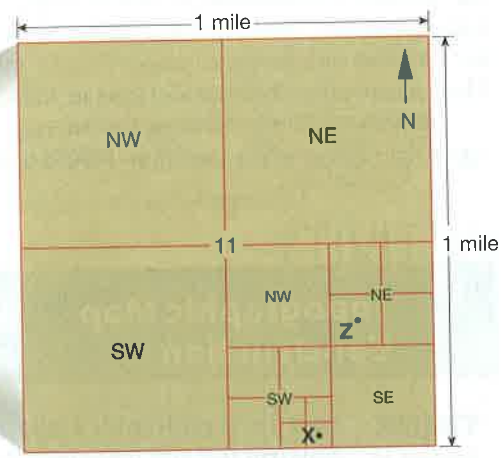


(b) *Making* ***picks*** *from electric logs.* Picks are the analyst’s (geologist’s) determination (pick) of the depths where significant geologic changes occur (typically formation tops/bottoms). Picks are based on interpretation of the various log information. See below for a simplified summary of formation type based on electric log information. Sometime picks are easy to make when the well log displays rapid and distinct changes, but picks can be speculative when limited information, conflicting indicators, and/or non-distinctive changes occur.

PUBLIC LAND SURVEY SYSTEM (PLSS)

A. The Township-and-Range Grid.
The grid is made of E-W *township* strips of land and N-S *range* strips of land (columns of land) surveyed relative to a *principal meridian* (N-S line) and its *base line* (E-W line). Township strips are 6 miles high and numbered T1N, T2N, and so on north of the base line and T1S, T2S, and so on south of the base line. Range strips (rows) of land are 6 miles wide and numbered R1E, R2E, and so on east of the principal meridian and R1W, R2W, and so on west of the principal meridian. Each intersection of a township strip of land with a range strip of land forms a square, called a *township*. Note the location of Township T1S, R2W.





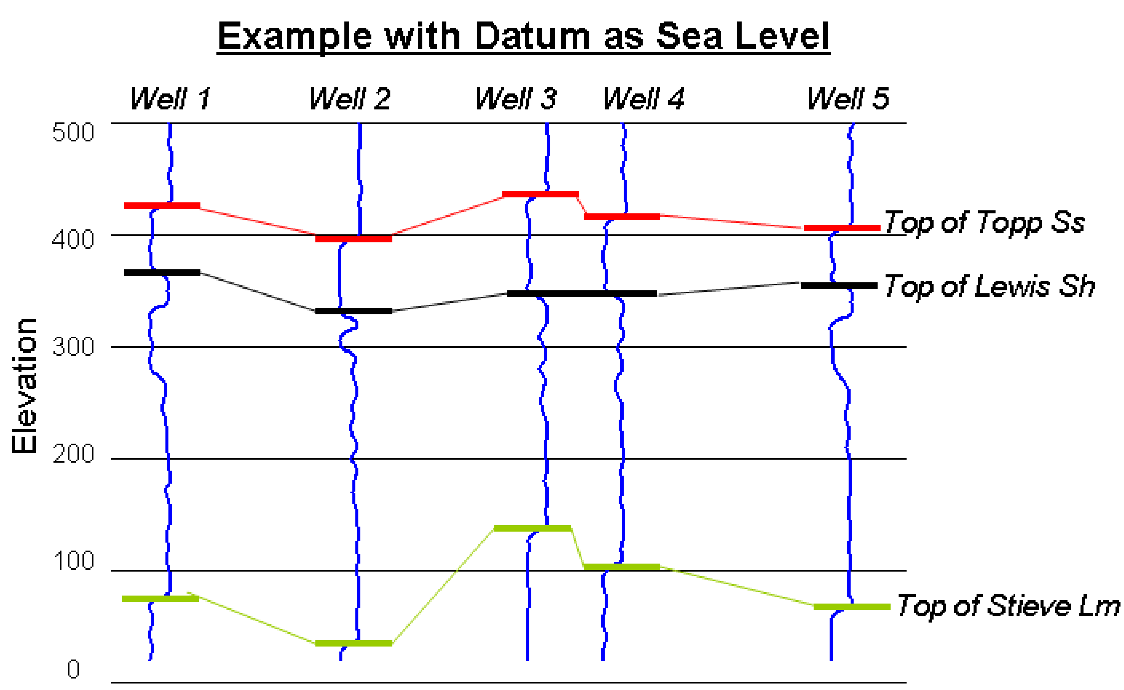
C. How Sections are Subdivided.
Sections are subdivided according to a hierarchy of square *quarters* listed in order of increasing size and direction. For example, point **X** is located in the southeast quarter, of the southeast quarter, of the southwest quarter, of the southeast quarter, of section 11. This is written:
SE ¼, SE ¼, SW ¼, SE ¼, sec. 11, T1S, R2W

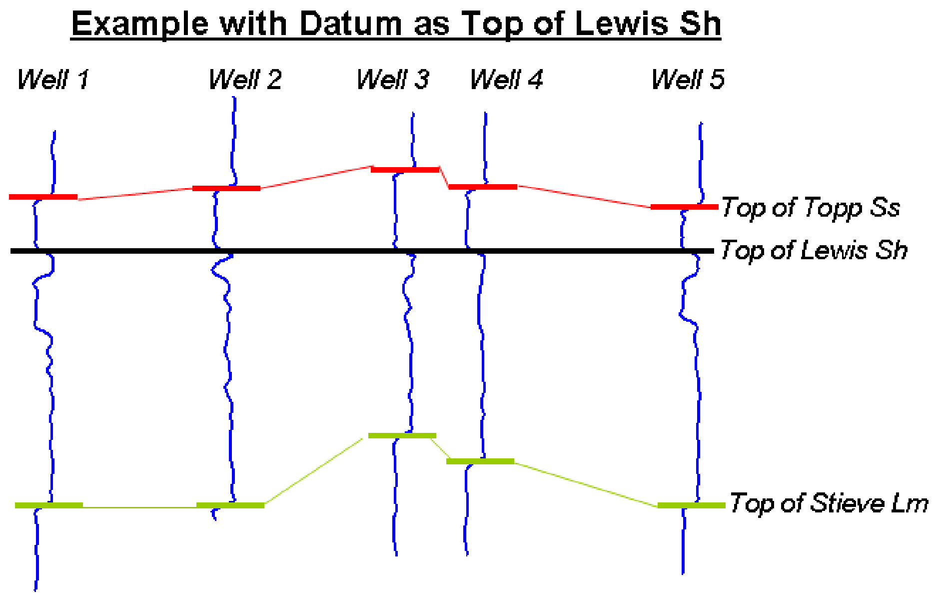
B. A Township Contains 36 Sections.
Each township is 6 miles wide by 6 miles long (36 square miles) and subdivided into 36 sections. Each section is 1 square mile (640 acres), called a *section*, and numbered as shown here.

FIGURE 9.8 U.S. Public Land Survey System (PLSS). This survey system is based on grids of square townships, which are identified relative to *principal meridians* (N-S lines) of longitude and *base lines* (E-W lines, surveyed perpendicular to the principal meridian) that are unique to specific states or regions.

Spontaneous Potential	Resistivity	Simple Interpretation
High	Low	Shale
Medium	Medium	Shaly Sand
Low	High	Sandstone with oil
High	Very High	Limestone
Very High	High	Sandstone with Fresh Water
Low	Medium to Low	Sandstone with Salt Water

(c) ***Correlating** picks amongst various well logs, choosing a **datum**, and constructing a **cross-section** diagram.* A cross-section diagram is a vertical section through the subsurface, along a roughly straight line of data – commonly with the perspective of looking northward perpendicular to the line. It is constructed by first determining the well line/order and spacing the well locations along the cross-section based on distances from each well. The next step is to choose a datum – a defined indicator that is assumed to be horizontal. Often that datum is sea-level, but any formation top/bottom can be used depending on the purpose of the cross-section. The final step is to plot the picks of each well on the cross-section (according to the datum) and connecting the picks that represent the same geologic change (this is the correlation part). Often, dotted lines are used to indicate correlations that are suspect and/or assumed. Here are two examples of datum choices:





(d) ***Constructing maps*** *based on well locations and picks.* Structure and isopach maps are essentially just contour maps of information. Structure maps show the contours of the elevation of a particular formation boundary (top or bottom). An isopach map is a contour map of a thickness of a desired type of information (a formation thickness, the thickness of certain types of material, etc.). As with cross-sections, dashed lines are used to indicate contour lines that are minimally supported by the data and/or assumed.

(e) *Create a* ***drill-cuttings log****.* A drill-cuttings log (sometimes called a "mud log") is a descriptive record of the characteristics of the drill-cuttings returned to the surface when drilling a well. The description is recorded for the current depth of the drilling – even though there is a lag in time for the cuttings to reach the surface. In addition to a cuttings description, the drill-rate (i.e., feet drilled per minute) can/should be recorded as different rock types will drill at different "speeds" – another indicator of formation changes.

Activity #1 – Correlation

1. You have been given copies of a portion of four actual Illinois oil-well logs. Line up the logs from Northwest to Southeast, left to right. Use locations from the headings. Note the geologic interpretations provided on logs for Wells #4 and #5. Pick the base of the persistent limestone (Bottom of Glen Dean Limestone) on each log, then align the logs with this boundary as datum (i.e., arrange the logs so the datum is a single horizontal line across all logs). Tape the logs together to construct your cross-section. Pick the following additional boundaries and connect them across all logs (note: the connections will likely not be horizontal):
    a. Top of Tar Springs Sandstone
    b. Top & Bottom of Golconda Limestone
    c. Top & Bottom of Barlow Limestone
    d. Top & Bottom of Cypress Sandstone "doublet"

Activity #2 – Mapping

1. You have been given copies of a two additional actual Illinois oil-well logs. Fill out the following table to get the elevation of the base of the Glen Dean Limestone and the thickness of the "pay zone" (i.e., the thickness of the Glen Dean Limestone).
2. Plot the location of all six wells on graph paper. Use locations from the headings. Using the calculated values in the table, construct a structure map using the base of the Glen Dean Limestone. Don't forget a legend, north arrow, and scale.
3. On a second sheet of graph paper, again plot the location of all six wells. Using the calculated values in the table, construct an isopach map of the "pay zone". Don't forget a legend, north arrow, and scale.

Well #	Well Datum (Kelly Bushing, KB) [ft amsl]	Depth to Base of Glen Dean Ls [ft]	Elevation of Base of Glen Dean Ls [ft amsl]	Thickness of Pay Zone [ft]
1-A				
4				
5				
6				
25				
36				

ft amsl = feet above mean sea level

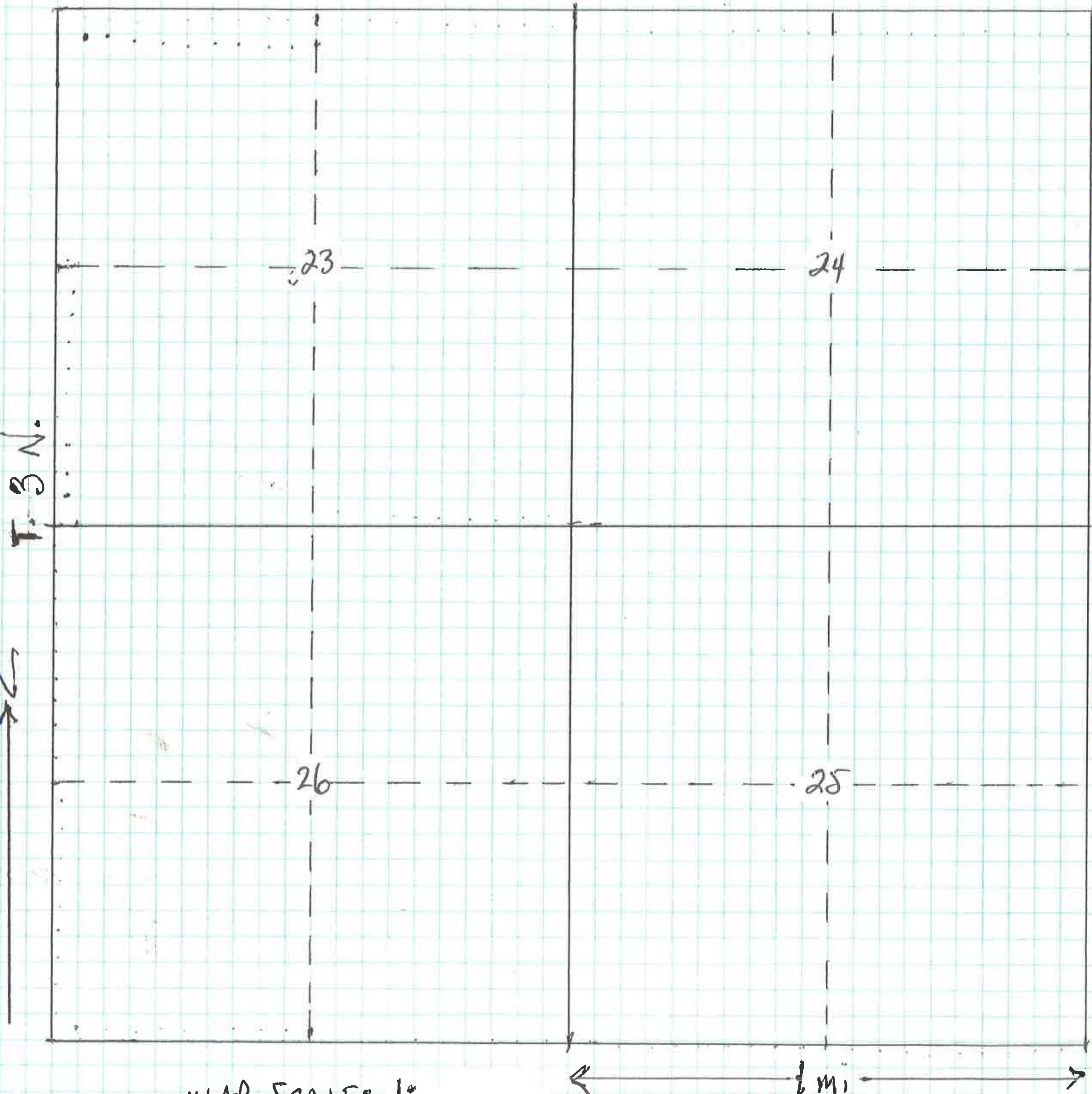
4. Using your constructed maps and cross-section, speculate as to why there is no oil in this "pay zone". Note that the overlying shale should act as a barrier to petroleum migration.

Activity #3 – Mud Logging

1. Set out for you in the lab is a series of boxes with drilling chips from 1850 feet to 2275 feet depth for Well Post No. 1. You have also been given the well electric log acquired for the same interval.
2. Create a "Mud Log" (drill-cuttings log) based on your observations of the drilling chips. Use the form provided.
3. Compare your Mud Log to the electric log provided. Assuming the electric log elevations/depths are correct, about how far off, in feet, is your Mud Log?

BASE MAP BILLET OIL FIELD

LAWRENCE, IL R. 12 W.



MAP SCALE: 1: ______

SCHLUMBERGER WELL SURVEYING CORPORATION
HOUSTON, TEXAS

SCHLUMBERGER

Electrical Log

COUNTY	LAWRENCE
FIELD or LOCATION	BILLET 25-3N-12W
WELL	WILLIAM FINLEY NO. 1-A
COMPANY	PRUDENTIAL OIL INC

COMPANY PRUDENTIAL OIL, INCORPORATED

COUNTY No. 5635

WELL WILLIAM FINLEY NO. 1-A 20

FIELD BILLET

COUNTY LAWRENCE STATE ILLINOIS

LOCATION 330'S
330'E
NW SW NE

Sec. 25 Twp. 3N Rge. 12W

Other Services:
NONE

Permanent Datum: GROUND LEVEL, Elev. 466.6
Log Measured From KB, 4 Ft. Above Perm. Datum
Drilling Measured From KB 4' ABOVE GL

Elev.: K.B. 470.6
D.F. -
G.L. 466.6

Date 1962	OCTOBER 15							
Run No.	ONE							
Depth—Driller	1828							
Depth—Logger	1827							
Btm. Log Interval	1826							
Top Log Interval	125							
Casing—Driller	8 5/8 @ 76		@		@		@	
Casing—Logger	-							
Bit Size	7 7/8"							
Type Fluid in Hole	GEL							
Dens. | Visc.	-	37						
pH | Fluid Loss	-	- ml		ml		ml		ml
Source of Sample	PIT							
R_m @ Meas. Temp.	4.0	@ 72 °F	@	°F	@	°F	@	°F
R_{mf} @ Meas. Temp.	3.7	@ 72 °F	@	°F	@	°F	@	°F
R_{mc} @ Meas. Temp.	-	@ - °F	@	°F	@	°F	@	°F
Source: R_{mf} | R_{mc}	MP	MP						
R_m @ BHT	3.5	@ 83 °F	@	°F	@	°F	@	°F
Time Since Circ.	-							
Max. Rec. Temp.		83 °F		°F		°F		°F
Equip. | Location	2929	MT.C						
Recorded By	TURNER							
Witnessed By	WOLFE-SIDDENS							

ACKNOWLEDGED
NOV 13 1962

FOLD HERE

SCHLUMBERGER WELL SURVEYING CORPORATION

HOUSTON, TEXAS

SCHLUMBERGER

Electrical Log

COUNTY LAWRENCE
FIELD or LAWRENCEVILLE
LOCATION SEC: 24-3N-12W
WELL PHILIP LEWIS
NO. 4
COMPANY W. LEON WRIGHT

COMPANY W. LEON WRIGHT

WELL PHILIP LEWIS
NO. 4

FIELD LAWRENCEVILLE

LOCATION SEC: 24-3N-12W

COUNTY LAWRENCE

STATE ILLINOIS

Other Surveys

-

Location of Well

COUNTY No. 2574

SW SE NW

Elevation: D.F.:
K.B.: 472
or G.L.: 469

FILING No.

RUN No.	ONE				
Date 1959	Nov. 6				
First Reading	1858				
Last Reading	100				
Feet Measured	1758				
Csg. Schlum.	-				
Csg. Driller	46				
Depth Reached	1859				
Bottom Driller	1859				
Depth Datum	KB 3.0'	Above GL			
Mud Nat.	Aquagel				
Dens. Visc.	10.1 43				
Mud Resist.	3.0 @ 34 °F	@ °F	@ °F	@ °F	@ °F
" Res. BHT	1.8 @ 80 °F	@ °F	@ °F	@ °F	@ °F
Rmf M	2.8 @ 36 °F	@ °F	@ °F	@ °F	@ °F
Rmc	@ °F	@ °F	@ °F	@ °F	@ °F
" pH	@ °F	@ °F	@ °F	@ °F	@ °F
" Wtr. Loss	CC 30 min.	CC 30 min.	CC 30 min.	CC 30 min.	CC 30 min.
Bit Size	7 7/8 from Csg. to 1420; 7 5/8 to TD				
Spcgs.—AM	16"				
A M	64"				
AO	19'				
Opr. Rig Time	60 Min.				
Truck No.	2809-Mt. Carmel				
Recorded By	Pettyjohn				
Witness	Fisher				

ACKNOWLEDGED

FEB 17 1961

SCHLUMBERGER WELL SURVEYING CORPORATION D-2

HOUSTON, TEXAS

SCHLUMBERGER

Induction - Electrical Log

COUNTY LAWRENCE
FIELD or LAWRENCEVILLE S.
LOCATION SEC: 24-3N-12W
WELL PHILIPS LEWIS
NO. 5
COMPANY W. LEON WRIGHT

COMPANY W. LEON WRIGHT

WELL PHILIP LEWIS

NO. 5

FIELD LAWRENCEVILLE S.

LOCATION SEC: 24-3N-12W

COUNTY LAWRENCE

STATE ILLINOIS

Other Surveys

NONE

Location of Well

(Permit)

NE NE

~~NE/C SW~~ SW

COUNTY No. 2700

Elevation: D.F.: -
K.B.: 477
or G.L.: 474

FILING No.

RUN No.	ONE				
Date 1960	MAY 6				
First Reading	1734				
Last Reading	100				
Feet Measured	1634				
Csg. Schlum.	-				
Csg. Driller	40				
Depth Reached	1740				
Bottom Driller	1740				
Depth Datum	KB 3.0' ABOVE GL				
Mud Nat.	GEL				
Dens. Visc.	10.1 38				
Mud Resist.	3.8 @ 68 °F	@ °F	@ °F	@ °F	@ °F
" Res. BHT	2.5 @ 79 °F	@ °F	@ °F	@ °F	@ °F
Rmf M	2.3 @ 79 °F	@ °F	@ °F	@ °F	@ °F
Rmc M	3.7 @ 79 °F	@ °F	@ °F	@ °F	@ °F
" pH	@ °F	@ °F	@ °F	@ °F	@ °F
" Wtr. Loss	CC 30 min.	CC 30 min.	CC 30 min.	CC 30 min.	CC 30 min.
Bit Size	7 7/8				
Spcgs.—AM	16"				
MN					
IND.	40"				
Opr. Rig Time	60 MIN.				
Truck No.	2808-MT. CARMEL				
Recorded By	PHILLIPS				
Witness	FISHER				

ACKNOWLEDGED
FEB 17 1961

SCHLUMBERGER WELL SURVEYING CORPORATION

HOUSTON, TEXAS

D-7

SCHLUMBERGER

Induction-Electrical Log

COUNTY LAWRENCE
FIELD or LAWRENCEVILLE
LOCATION SEC: 24-3N-12W
WELL PHILIPS LEWIS NO. 6
COMPANY W. LEON WRIGHT

COMPANY W. LEON WRIGHT

WELL PHILIPS LEWIS

NO 6

FIELD LAWRENCEVILLE

LOCATION SEC: 24-3N-12W

COUNTY LAWRENCE

STATE ILLINOIS

Other Surveys

SONIC

Location of Well

SE SE NW

COUNTY No. 2701

Elevation: D.F.: - EST.
K.B.: 481
or G.L.: 478

FILING No.

RUN No.	ONE				
Date 1960	MAY 13				
First Reading	1653				
Last Reading	100				
Feet Measured	1553				
Csg. Schlum.	-				
Csg. Driller	40				
Depth Reached	1659				
Bottom Driller	1660				
Depth Datum	KB 3.0' ABOVE GL				
Mud Nat.	GEL				
Dens. / Visc.	9.8 / 40				
Mud Resist.	2.4 @ 70 °F	@ °F	@ °F	@ °F	@ °F
" Res. BHT	1.97 @ 85 °F	@ °F	@ °F	@ °F	@ °F
Rmf M	2.7 @ 85 °F	@ °F	@ °F	@ °F	@ °F
Rmc M	2.8 @ 85 °F	@ °F	@ °F	@ °F	@ °F
" pH	@ °F	@ °F	@ °F	@ °F	@ °F
" Wtr. Loss	CC 30 min.	CC 30 min.	CC 30 min.	CC 30 min.	CC 30 min.
Bit Size	7 7/8 FROM 70 TO 1649 ; 7 5/8 FROM 1649 TO TD				
Spcgs.—AM	16"				
MN					
IND.	40"				
Opr. Rig Time	60 MIN.				
Truck No.	2808-MT. CARMEL				
Recorded By	PHILLIPS				
Witness	FISHER				

ACKNOWLEDGED

FEB 17 1961

Birdwell

Birdwell
TULSA
OKLAHOMA

Electric Log

D-2

6

COMPANY WAYNE SMITH, OPERATOR

E

WELL GEORGE LEIGHTY #25 CP

FIELD LAWRENCEVILLE SOUTH

COUNTY No. 6499

COUNTY LAWRENCE STATE ILLINOIS

LOCATION: 380"N-380"W SE/C-NE/4-NE/4

SEC. 26 TWP. 3N RGE. 12W

OTHER SERVICES:

PERMANENT DATUM GROUND LEVEL ELEV. 485'
LOG MEASURED FROM K. B., 3 FT. ABOVE PERM. DATUM
DRILLING MEASURED FROM KELLY BUSHING

ELEV. K.B. 488'
D.F.
G.L. 485'

DATE	4-26-65			
RUN NO.	ONE			
DEPTH—DRILLER	1731'			
DEPTH—LOGGER	1731'			
BTM. LOG INTER.	1729'			
TOP LOG INTER.	800'			
CASING—DRILLER	8 5/8 @ 21	@	@	@
CASING—LOGGER				
BIT SIZE	7 7/8"			
TYPE FLUID IN HOLE	GEL			
DENS. | VISC.	9.5 | N.A.	|	|	|
pH | FLUID LOSS	N.A. | N.A. ml	| ml	| ml	| ml
SOURCE OF SAMPLE	PIT			
Rm @ MEAS. TEMP.	5.0 @ 66 °F	@ °F	@ °F	@ °F
Rmf @ MEAS. TEMP.	4.5 @ 64 °F	@ °F	@ °F	@ °F
Rmc @ MEAS. TEMP.	2.4 @ 64 °F	@ °F	@ °F	@ °F
SOURCE Rmf | Rmc	PRESS | PRESS	|	|	|
Rm @ B.H.T.	4.1 @ 79 °F	@ °F	@ °F	@ °F
TIME SINCE CIRC.	1.5 HOURS			
MAX. REC. TEMP.	79 °F	°F	°F	°F
EQUIP. | LOCATION	1659 | ROB.	|	|	|
RECORDED BY	D. MANION			
WITNESSED BY	L. SMITH			

(2D)

Birdwell

DIVISION OF SSC Birdwell TULSA OKLAHOMA

Birdwell

Electric Log

W. C. McBRIDE, INC.
H. D. HINKLE #GG-36
26 - 3N - 12W

COMPANY W. C. McBRIDE, INC.

COUNTY No. 6280

WELL H. D. HINKLE #GG-36

FIELD BRIDGEPORT

COUNTY LAWRENCE STATE ILLINOIS

LOCATION: 635'N-50'E SW/C-NW/4

SEC. 26 TWP. 3N RGE. 12W

OTHER SERVICES:

PERMANENT DATUM GROUND LEVEL ELEV. 474

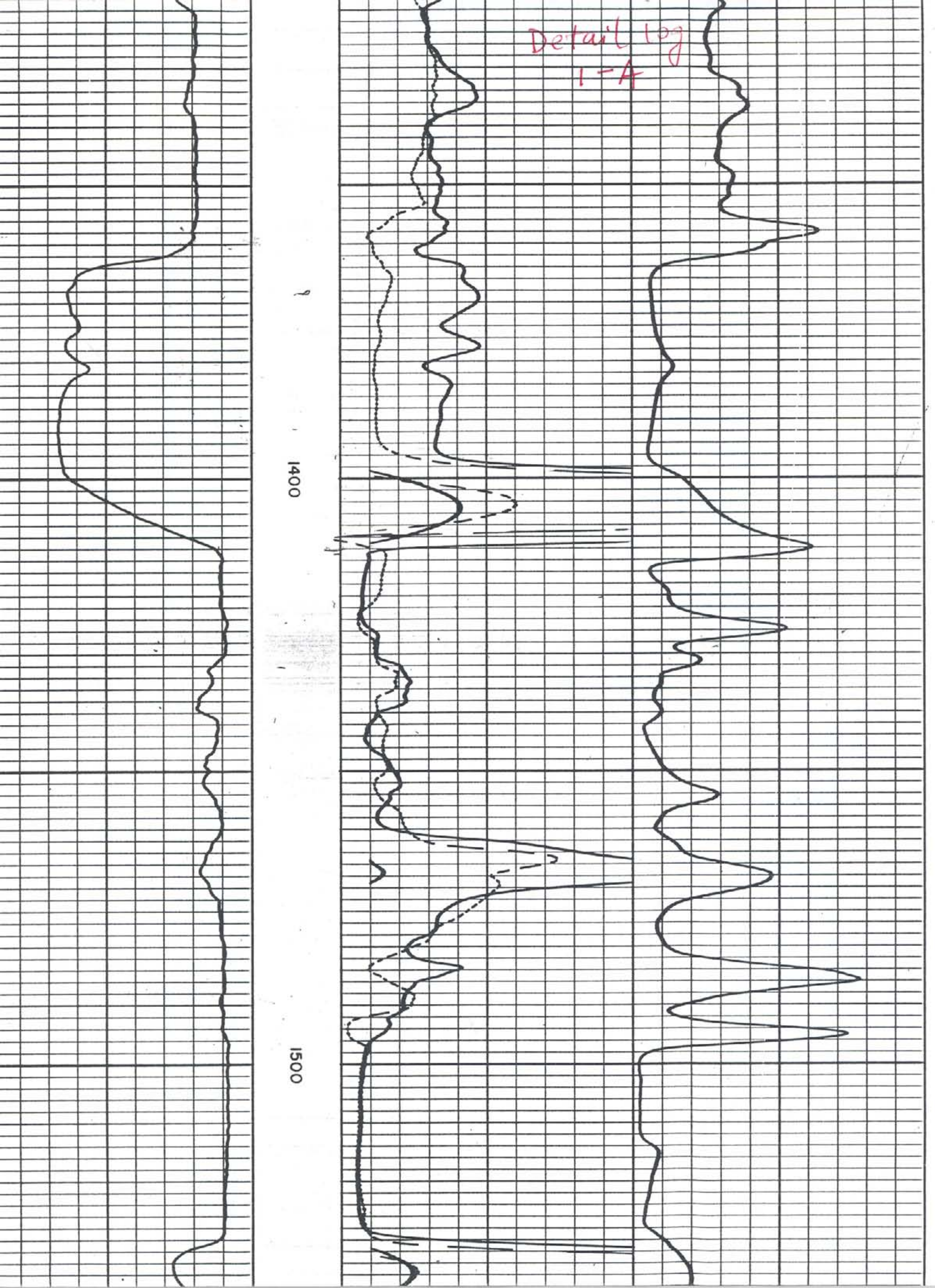
LOG MEASURED FROM K. B., 5 FT. ABOVE PERM. DATUM

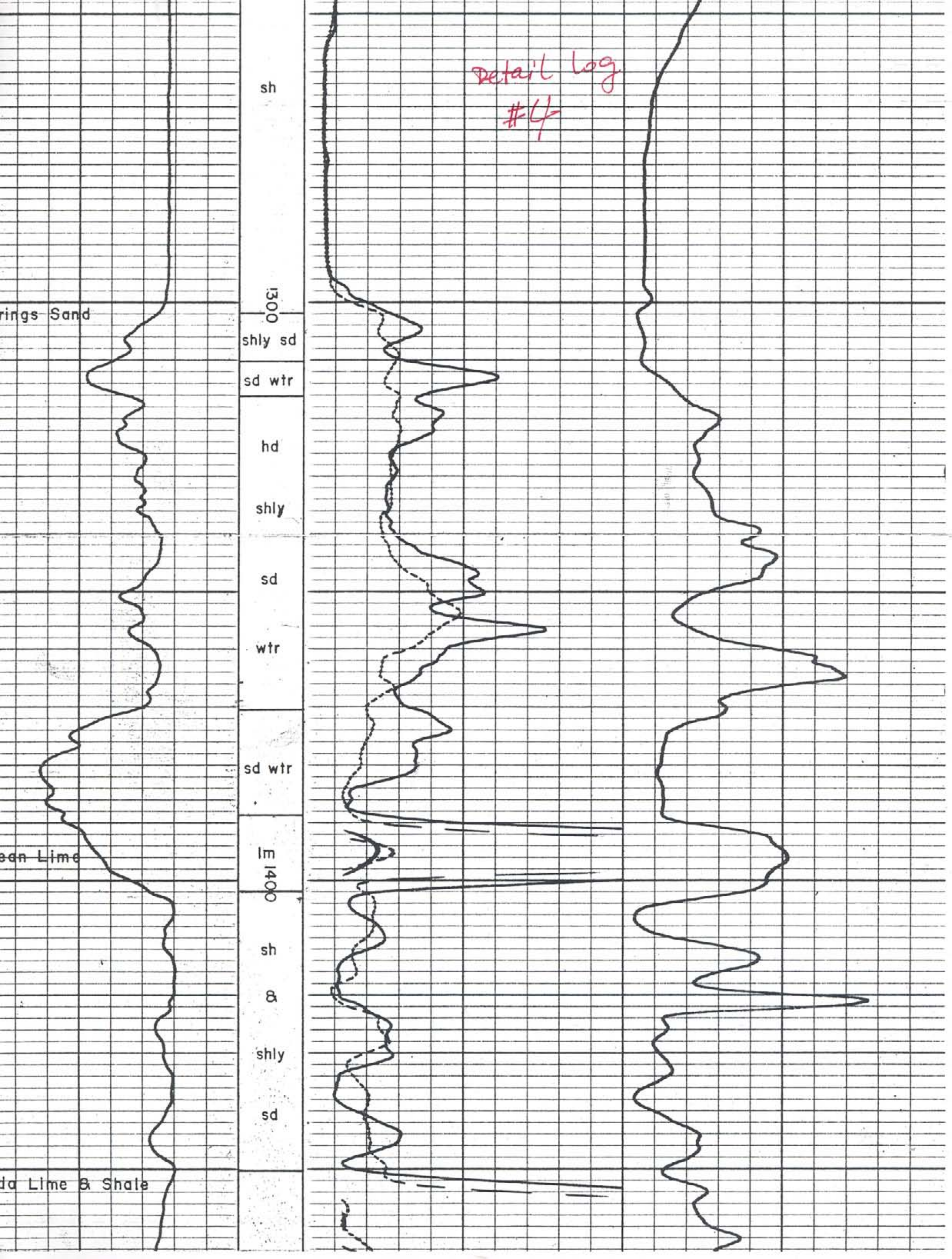
DRILLING MEASURED FROM KELLY BUSHING

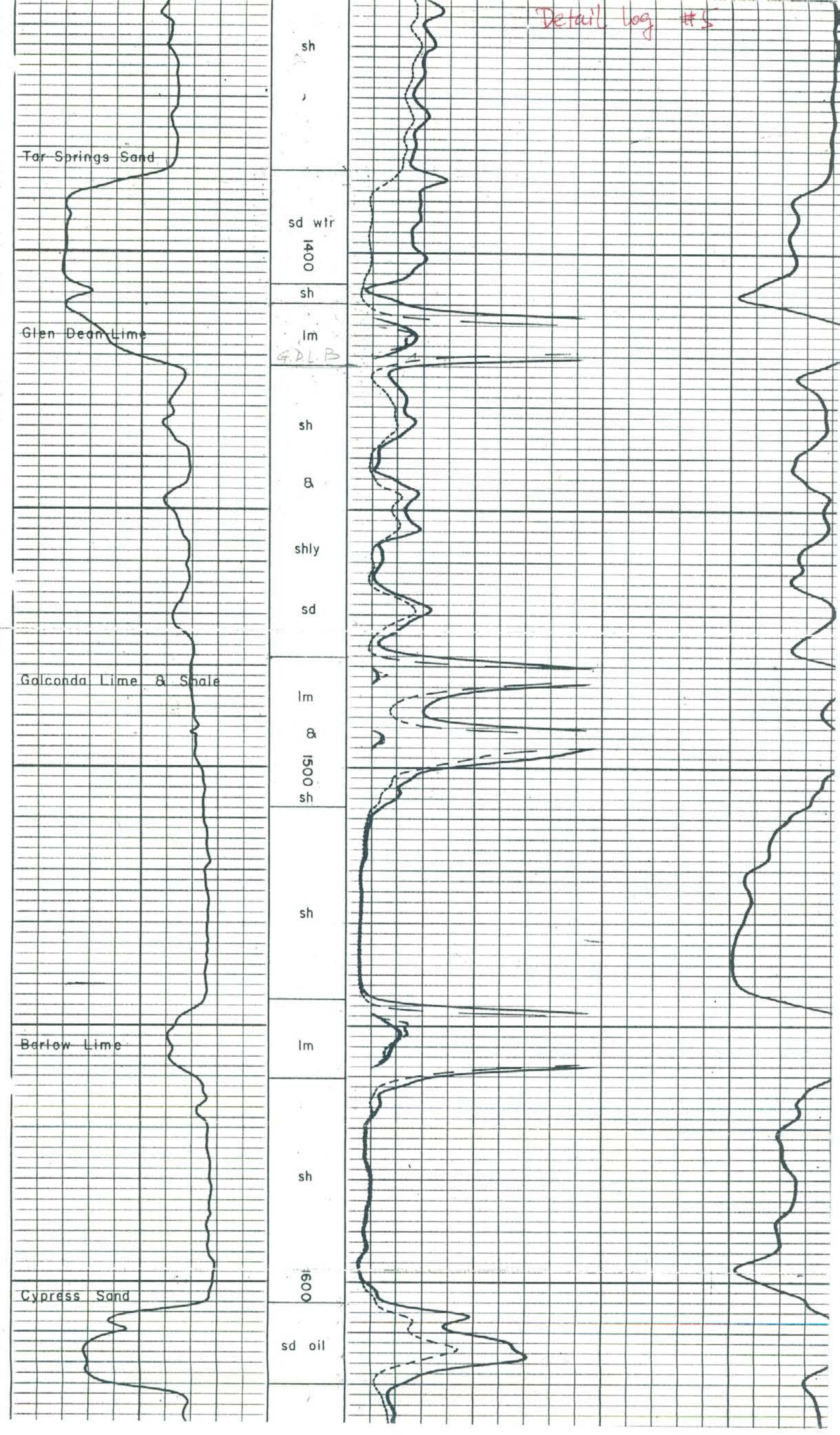
ELEV. K.B. 479
D.F.
G.L. 474

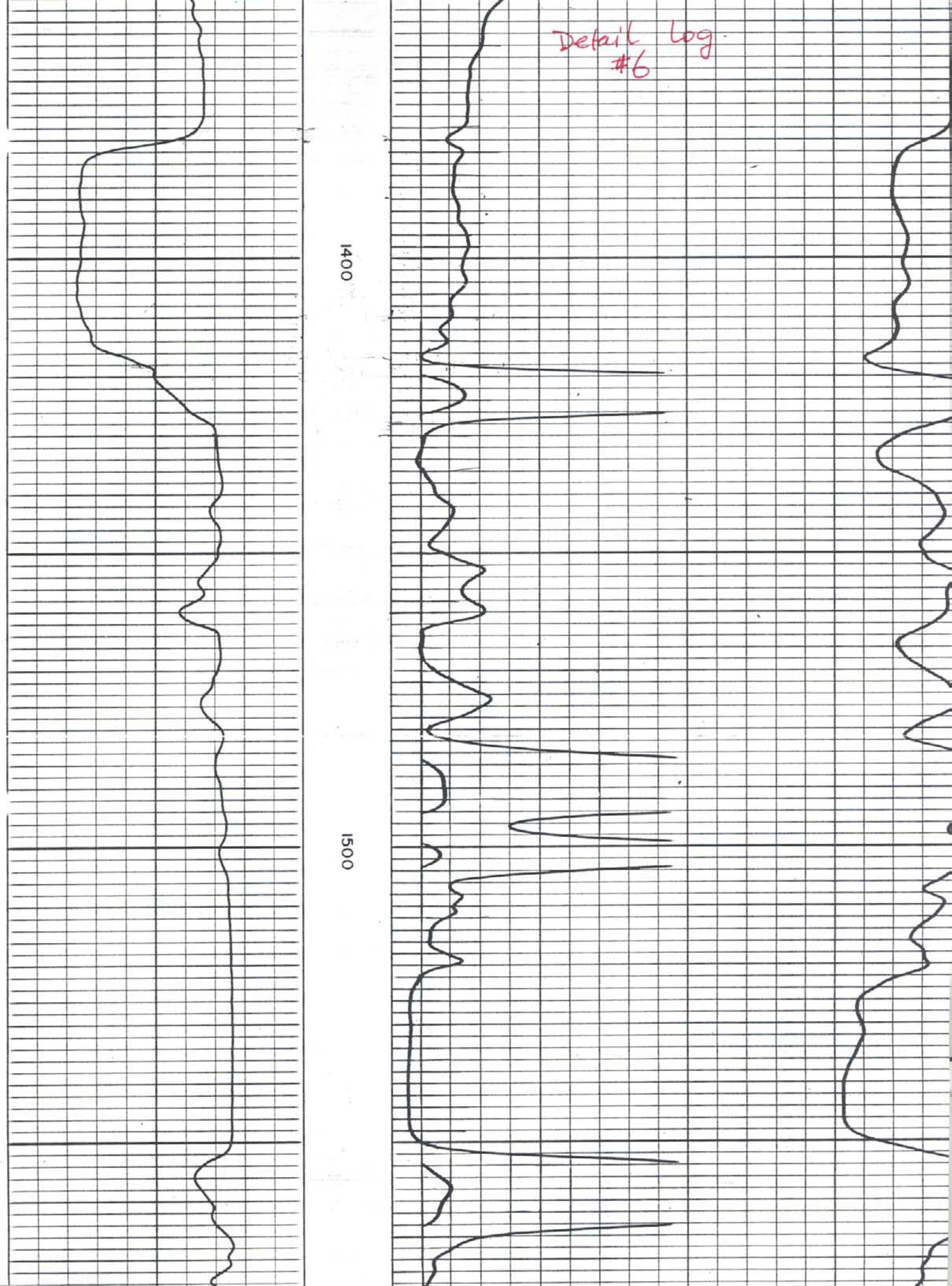
DATE	9-30-64			
RUN NO.	ONE			
DEPTH—DRILLER	1670			
DEPTH—LOGGER	1671			
BTM. LOG INTER.	1659			
TOP LOG INTER.	700			
CASING—DRILLER	8 5/8 @ 38	@	@	@
CASING—LOGGER	N.A.			
BIT SIZE	7 3/8			
TYPE FLUID IN HOLE	GEL			
DENS. | VISC.	10 | 37	|	|	|
pH | FLUID LOSS	N.A. | N.A. ml	| ml	| ml	| ml
SOURCE OF SAMPLE	PIT			
Rm @ MEAS. TEMP.	6.5 @ 66 °F	@ °F	@ °F	@ °F
Rmf @ MEAS. TEMP.	4.4 @ 73 °F	@ °F	@ °F	@ °F
Rmc @ MEAS. TEMP.	4.0 @ 73 °F	@ °F	@ °F	@ °F
SOURCE Rmf | Rmc	MEAS. | MEAS.	|	| ACKNOWLEDGED	|
Rm @ B.H.T.	5.5 @ 88 °F	@ °F	@ °F	@ °F
TIME SINCE CIRC.	1.5 HOURS		DEC 14 1964	
MAX. REC. TEMP.	88 °F	°F	°F	°F
EQUIP. | LOCATION	1952 | ROB.	|	|	|
RECORDED BY	F. MALCOM			
WITNESSED BY	C. VACCARO			

THIS HEADING AND LOG CONFORM TO API RP-31 ®

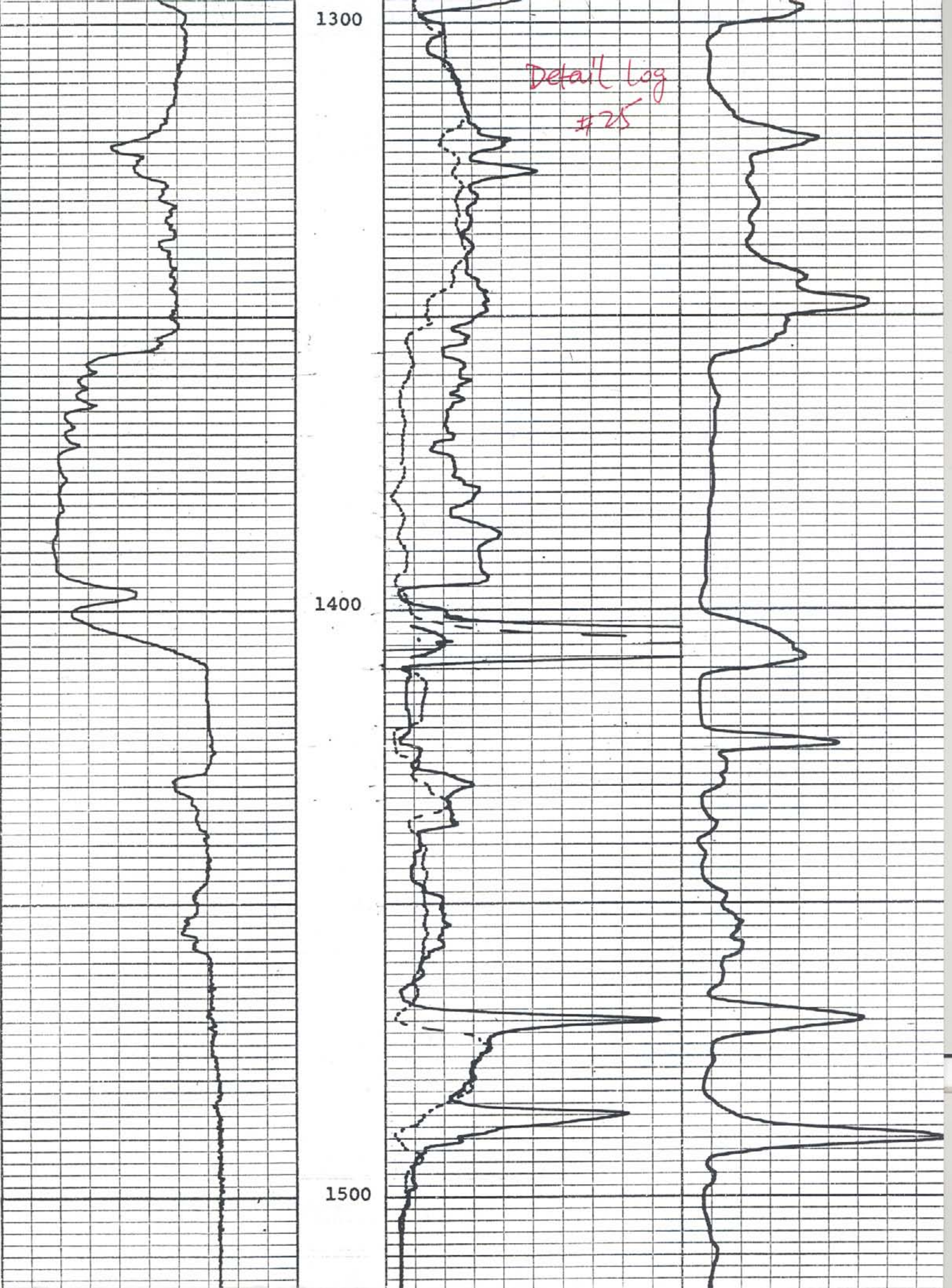

Detail log
1-A
1400
1500

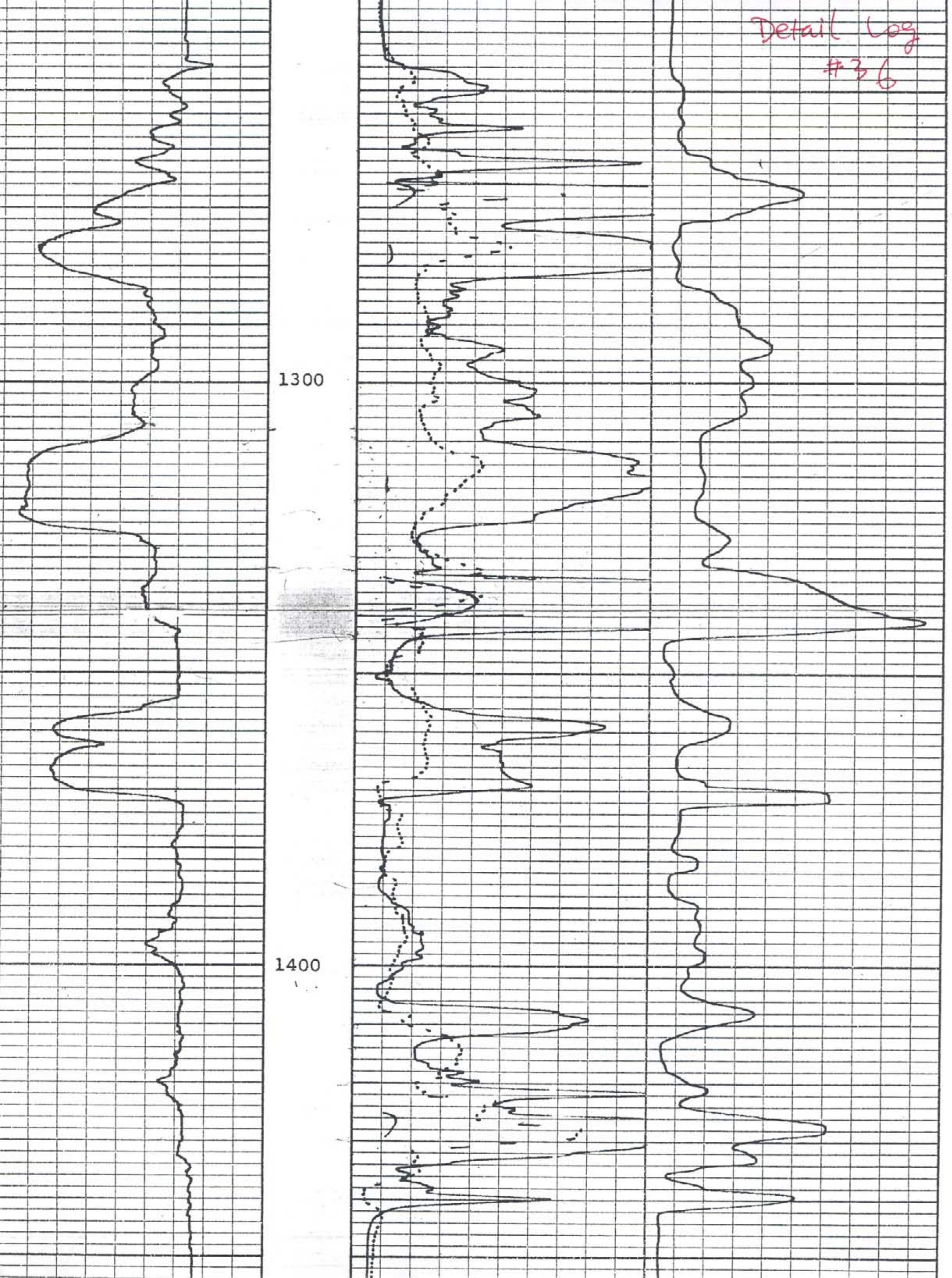

Detail Log
#4
rings Sand
ean Lime
da Lime & Shale
sh
1300
shly sd
sd wtr
hd
shly
sd
wtr
sd wtr
lm
1400
sh
&
shly
sd


Detail log #5
Tar Springs Sand
Glen Dean Lime
Galconda Lime & Shale
Barlow Lime
Cypress Sand
sh
sd wtr
1400
sh
lm
G.D.L.B
sh
&
shly
sd
lm
&
1500
sh
sh
lm
sh
1600
sd oil



Detail Log #6
1400
1500


1300
Detail Log
#25
1400
1500


Detail Log
#36
1300
1400