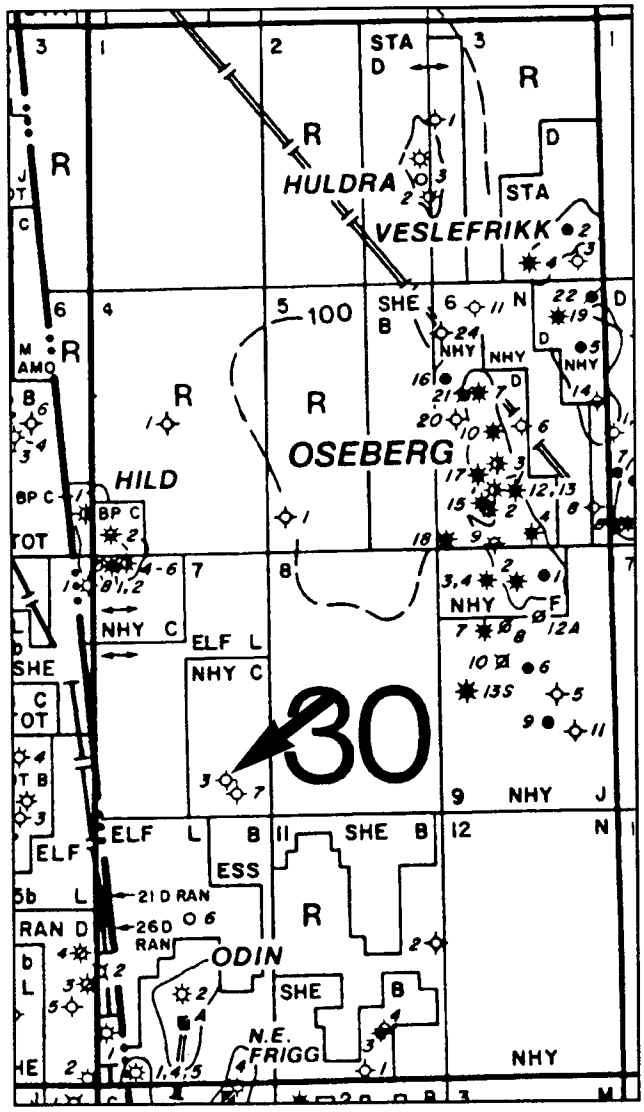
Norwegian Viking Graben Petrophysical Study

Final Well Report

30/07-03



Scientific Software Intercomp (UK) Ltd.
Monarch House
Crabtree Office Village
Eversley Way, Egham
Surrey TW20 8RY
Telephone 0784 430030 Facsimile 0784 431889

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ABBREVIATIONS

μ	micro
AV	Average
BADH	Bad Data Flag 0=Good 1=No
BH FMT	Bottom Hole Formation
BS	Bit Size (inches)
BVW	Bulk Volume Water (PHIE*SW)
BVXO	Bulk Volume Filtrate (PHIE*SXO)
CAL	Composite Caliper for Well
CALI	Caliper from FDC D.M.
cc	centimeters cubed
ccg	cc of gas
CGAM	Core Gamma D.M.
CGR	Gamma Ray From NGT
CNL	Compensated Neutron Log
CO	Cut off
COGD	Core Grain density D.M.
Comp.	Compaction
Core Desc.	Core Description
COSO	Core Oil saturation D.M.
COSW	Core Water saturation D.M.
CPO	Core Helium porosity D.M.
CPOV	Core Vertical Helium porosity D.M.
Cum.	Cumulative
D.M.	Depth Matched
D.P.No	Drilling Permit Number
D.Units	Depth Units
Dens.	Density
DIL	Dual Induction Log
DRHO	Density Correction (Δρ) D.M.
DST	Drill Stem Test
DT	Interval Transit Time D.M.
DTL	DT (long spacing)
Env. C.	Environmental Corrections
eq.	equivalent
Estim.	Estimate
Fact.	Factor
FDC	Compensated Formation Density
Fil.	Filtrate
ft	feet
FW	Formation Water
G. Res.	Gross Res.
GI	Gross Interval
gm	grams
GR	Gamma Ray
GRCO	GR Env. C.
GRES	Cum. G. Res.
GRI	Gamma Ray Induction
H-C	Hydrocarbon
HYCV	Cum. H-C P.V NP
ISF	Induction Spherically Focused
K	Arithmetic AV Estim. Horizontal Air Permeability
KB EL.	Kelly Bushing Elevation
KEV	Potassium Env. C.
Kh	Permeability Thickness
KHA	Core apparent permeability D.M.
KHAE	Estimated horizontal permeability
KHAK	Core Klinkenberg permeability D.M.
KHAL	Core apparent liquid permeability D.M.
KHAT	Core Cumulative permeability thickness
KVA	Core apparent vert. liquid permeability D.M.
KVAK	Core vert. Klinkenberg permeability D.M.
KVAL	Core app. vert. liquid permeability D.M.
LS	Limestone
m	meters
M	Cementation Exponent
Max.	Maximum
Mcc	1000 cc
md	milli darcies
(MD)	(Measured Depth)
Min.	Minimum
Minf	Special Mineral Detection Flag 1=coal, 2=tuff, 3=anhydride
MSFL	Micro Spherically Focused Log
mV	milli Volts
N	Saturation Exponent
NGT	Natural Gamma Ray Tool
NP	Net Pay
NPHI	Neutron Porosity Log D.M.
NR	Net Reservoir
P/A	Plugged and Abandoned
P.V.	Pore Volume
PAYN	Cum. NP
PEF	Photo-Electric Effect D.M.
PHIE	Effective porosity
PHIN	Neutron Env. C. LS
Por.	Porosity
Porv	Cum. P.V. NR
POTA	Potassium D.M.
ppm	parts per million
PSUM	Core summation Por. D.M.
PVNP	Cum. P.V. NP
Q	Lithology density total
R.C.A.	Routine Core analysis
R16	Short normal resistivity D.M.
Res	Reservoir
Resn	Cum. NR
RFOC	Shallow focused resistivity D.M.
RFT	Repeat Formation Tester
RHOB	Density log (ρb)
RHOC	Bulk density Env. C.
RILD	Deep Induction Resistivity
RILM	Medium Induction Resistivity
RLL3	Laterolog-3 resistivity D.M.
RLL7	Laterolog-7 resistivity D.M.
RLLD	Deep Laterolog D.M.
RLLM	Medium induction resistivity D.M.
RLLS	Medium Laterolog D.M.
RLLS	Medium laterolog D.M.
RMF	Resistivity of Mud Filtrate
RMFE	Resistivity Mud Filtrate (NaCl equivalent)
RMLL	Microlaterolog D.M.
ROMA	Density Matrix Log
RSFL	Spherically Focused Resistivity D.M.
RT	Deep resistivity invasion corrected
RUG	Rugosity of Hole
Rw	Formation Water Resistivity
RWA	Apparent Formation Water Resistivity
Rwe	Resistivity Formation Water (NaCl equivalent)
RXO	Flushed resistivity invasion corrected
s	seconds
Sal.	Salinity
SP	Spontaneous Potential
(SS)	(Sub Sea)
SS	Sandstone
SSP	Static Spontaneous Potential
Stof	Tool standoff from hole
SW	Water Saturation
SXO	Invaded zone water saturation
TD	Total Depth
Temp.	Temperature
TEND	Tension curve from density not D.M.
TENI	Tension curve from ISF/Sonic not D.M.
THEV	Thorium environmentally corrected
THOR	Thorium D.M.
UEV	Uranium environmentally corrected
URAN	Uranium D.M.
VCL	Volume clay
w/	with
Wat. Dep.	Water Depth
Wel. Dep.	Well Depth
Well	Well Name
WT	Water
wtr	water

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Table 1

Basic Well Data

Well	: 30/07 -03	Operator	: HYDRO
Field	: WILDCAT	Status	: P/A
D.P.NO	: 163	Completion:	25-10-1976
KB. EL.	: 24.0	TD. (MD)	: 4044.00
Wat. Dep.:	98.0	TD. (SS)	: -4020
BH FMT	: CROMER KNOLL	D. Units	: m
R.C.A.	: NO	Core Desc.:	NO

Reservoir Intervals

Heimdal
Top : 2115.00 Base : 2274.00 Gross : 159

Remarks

No tests reported.
Minimum log suite (ISF/DT). No prints available below 700.
Shows/Intervals of interest:

SS 400-1200	in Nordland. No shows. Lignitic. Cycle skipping on DT. Not processed.
SS/LS 2100-2400	in Rogaland. Gas and poor sample shows from SS and LS. Tuffaceous. DT poor in places due to cycle skipping. Balder & Heimdal interpreted.
SS/LS 2520-2575	in Shetland. No show. Poor/missing logs over some of interval. Bad/nulled shaley. Not processed.

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Table 2

Available Data

Well : 30/07 -03

Core Data

Interval One Top : 3918 Bottom : 3936 Number of cores : 1

Log Data

	MNEMONIC	RESERVOIR 1	2	3	4	5	6
Gamma Ray	GR	X					
Caliper	CAL						
Spontaneous Potential	SP	X					
Density	RHOB						
Neutron	NPHI						
Photo-Electric Effect	PEF						
Density Correction	DRHO						
Sonic	DT	X					
Deep Induction (ISF)	RILD	X					
Spherically Focused (ISF)	RSFL	X					
Deep Induction (DIL)	RILD						
Medium Induction (DIL)	RILM						
Deep Laterolog (DLL)	RLLD						
Shallow Laterolog (DLL)	RLLS						
Microspherically Focused	MSFL						
Spectral Gamma (NGT)							
EPT							

1 = Heimdal

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Table 3

Data Correction Record

Well : **30/07 -03** Data Source: **Digitised by Erico**

Log Verification: **NO**

No log prints available.

Core Data Shifts: **NO**

Log Data Shifts : **NO**

Base Log : Minor Shifts : **NO**

Data Editing : YES

Smoothed cycle skips 2160-2180.

Remarks

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Table 4

Environmental Correction Data

Well	: 30/07 -03	Reservoirs	: **Rogaland-Shetland**
Top Depth	: **2000.0**	Bottom Depth	: **2600.0**

Bit Size	: **17.5**	GR Centered	: **NO**
ILD STD-Off	: **1.5**		

Mud Data

Mud Type	: **FRESH WTR/LIGNO.**	Mud WT. (gm/cc)	: **1.20**
Mud Res. (ohm-m)	: **0.300**	@ Temp. (°C)	: **23.9**
FIL. RES.(ohm-m)	: **0.225**	@ Temp. (°C)	: **23.9**
Cake Res.(ohm-m)	: **0.450**	@ Temp. (°C)	: **23.9**
@ Depth	: **2642**	Max. Temp. (°C)	: **85**

Mud Salinity	(ppm)	(from Header Resistivities)	: **19,800**
Mud Chlorides	(ppm)	(from Mud Log)	: **12,000**
Mud Sal.(ppm NaCl Eq)		(Mud Log Chlorides * 1.645)	: **19,740**

Remarks

No log prints available. Estimated mud properties from mud log. ISF/DT only. Missing intervals 2108-2113, 2289-2295,and 2546-2552.
1 % oil in mud.

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Table 5

Results Summary

Well	: 30/07 -03	Reservoir	: Heimdal
Top Depth	: 2115.0	Bottom Depth:	2274.0

Gross Interval : 159.00

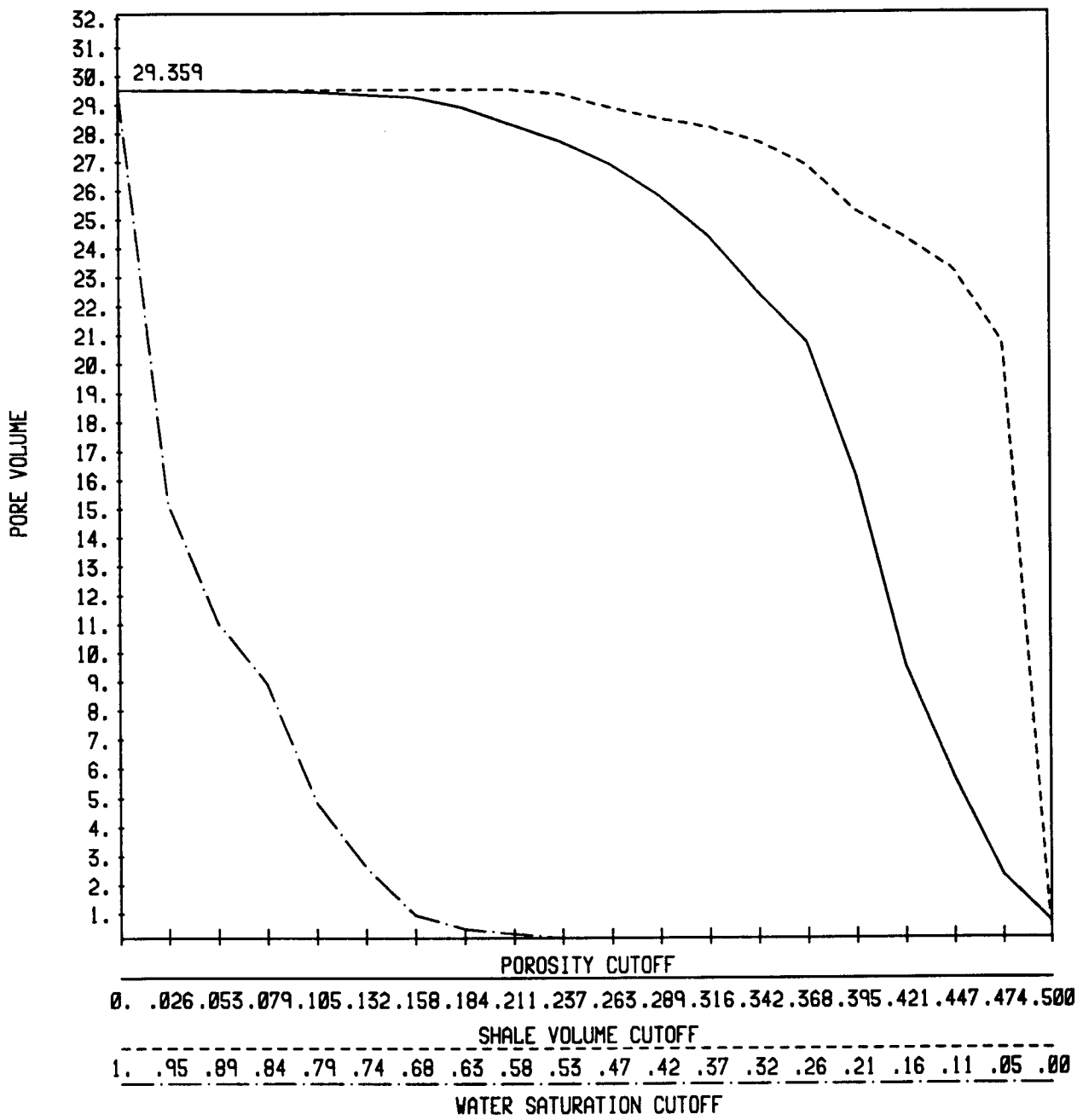
Gross Reservoir		**Shale Vol.C/O:**	**0.40**
Gross Res.	: 77.1	Gross Res/GR Int:	0.48
Net Reservoir		**Porosity C/O :**	**0.10**
Net Reservoir	: 76.8	Net Res/GR Res	: 1.00
Net Res/GR Int	: 0.48	AV SW Net Res	: 0.921
AV Porosity	: 0.368	Cumm. P.V.	: 28.25
Net Pay		**Wat. Sat. C/O:**	**0.60**
Net Pay	: 0.2	Net Pay/GR Res	: 0.00
Net Pay/Net Res	: 0.000	Aver. SW Net Pay:	0.594
Hydrocarbon P.V.:	0.03	P.V. of Net Pay	: 0.07

Remarks

RESULTS SUMMARY PLOT

WELL NUMBER 685003007030.00

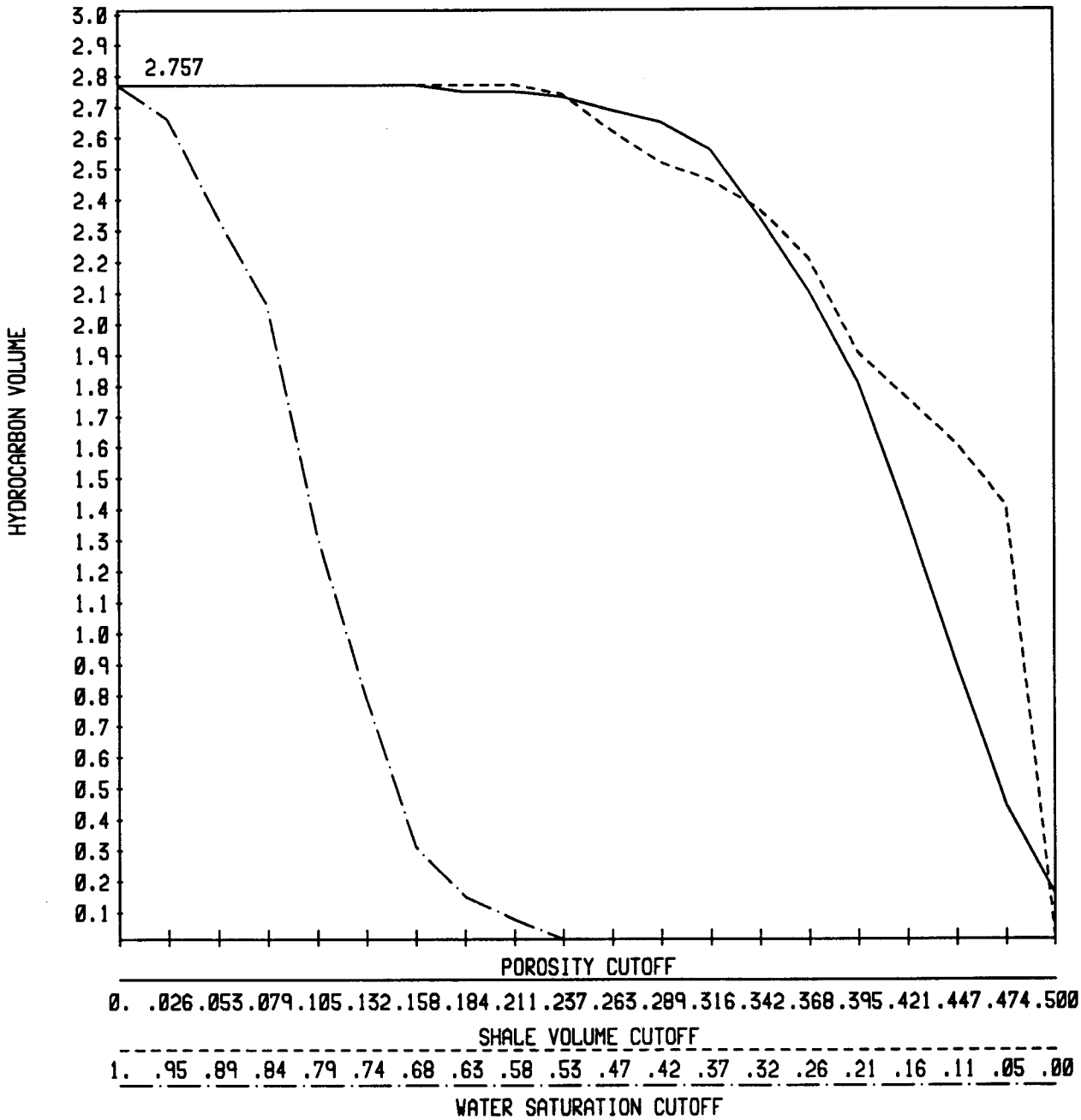
TOP DEPTH 2115.0 BOTTOM DEPTH 2274.0 GROSS INTERVAL 159.0



RESULTS SUMMARY PLOT

WELL NUMBER 685003007030.00

TOP DEPTH 2115.0 BOTTOM DEPTH 2274.0 GROSS INTERVAL 159.0



QUALITY CONTROL CHECKLIST

WELL NAME: 30/7-3 RESERVOIR: Heimdal

Data Preparation	Yes	No
Depth matching satisfactory?	X	
Environmental corrections satisfactory?	X	

Limitations of basic data:

Induction / sonic only. No log prints, so only estimated mud properties.

Petrophysical Interpretation	Yes	No
Full use made of available data?	X	
Parameters acceptable?	X	
Model applicable?	X	
Results satisfactory?	X	

Comments

Porosity from sonic log only assuming sandstone. Hydrocarbon indications consistent with mud log.

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Table 6

Analysis Parameters

Well	: 30/07 -03	Reservoir	: Heimdal
Top Depth	: 2115.0	Bottom Depth:	2274.0

Fluid and Saturation Equation Parameters

RW. (ohms-m)	: 0.045	Temp. (°C)	: 73
FM.WT.Sal. (NaCl ppm)	: 70,000	Source of RW.	: SP
RW.@ 15.6°C(ohms-m)	: 0.110		
RMF. (ohms-m)	: 0.108	Temp. (°C)	: 73
Fil.Sal. (ppm 10-6)	: 0.027	Dens. FL.(g/cc)	: 1.04
Dens. H-C. (g/cc)	: 0.85	Sonic FL.(μs/ft)	: 189

Parameters

Matrix		Shale			
GR (api)	: 38	GR (api)	: 80	M	:
SP (mv)	: -47	SP (mv)	: -11		
Density (g/cc)	: 2.65	Density (g/cc)	:	N	:
Sonic (μs/ft)	: 56	Sonic (μs/ft)	: 124		
Neutron (lpu)	: -4	Neutron (lpu)	:	R.(ohms-m)	: 1.00

Sonic Compaction Factor : 1.00

Remarks

Rw from SP @ 2270m (73°C)
Rmf = 0.228 @ 24°C ≡ 0.108 @ 73°C
Rmfe = 0.092, SSP = -36
Rwe = 0.035, Rw = 0.045 (or 0.115 @ 60°F)

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Table 7

Analysis Methods

Well	: 30/07 -03	Reservoir	: **Heimdal**
Top Depth	: **2115.0**	Bottom Depth:	**2274.0**

The Lithology Model used was Sand Shale.

The Porosity Log used was: Sonic.

Shale Volume used Spontaneous Potential.

The water saturation equation was INDONESIAN.

Remarks

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Well : 30/07-03 Results for the Heimdal

Top : 2115.00 Base : 2274.00 GI : 159.00

A G. Res. of 77.11 with a shale CO of 0.40 G.Res./GI : 0.48

A NR of 76.81 with a Shale CO of 0.40, and Por. CO 0.10

NR/G.Res. : 1.00 NR/GI : 0.48 AV Por. : 0.37 P.V. : 28.25

AV SW : 0.92

NP with a Shale CO of 0.40, Por. CO of 0.10 and SW CO of 0.60

NP : 0.152 NP/G.Res. : 0.000 NP/NR : 0.000 AV Por. : 0.454

AV SW : 0.594 H-C P.V. : 0.028 P.V. : 0.069

Porosity Calculated From a Single Porosity Tool

1:500 SCALE PLOT

METRES

WELL NUMBER

68-500-30070-30

10-OCT-92 20:33:49

RESIDUAL
FLUSHED
FM. WAT.
CLAY
MATRIX
GRS. RES.
NET RES.
NET PAY

ESTIMATED PERM TO AIR 10000 (MD) .01
KHAE
CORE PERM TO AIR 10000 (MD) .01
KHA

BIT SIZE (IN) 5 25
BS
BOREHOLE DIAM (IN) 5 25
CAL
POROSITY BAD HOLE Ø FL 10
BADH

EFF. WAT.SAT INVADED ZONE 1 (FRACTION) Ø
SXO
EFF WAT.SAT. UNINVADED ZN 1 (FRACTION) Ø
SW

CORE POROSITY 50 (PERCENT) Ø
CPO
BULK VOL WAT INVADED ZONE .5 (FRACTION) Ø
BVXO
BULK VOL WAT UNINVADED ZN .5 (FRACTION) Ø
BVW
SPECIAL MIN. COAL-1 TUFF-2 Ø ANHYDRITE-3 20
MINF
EFFECTIVE POROSITY .5 (FRACTION) Ø
PHIE

EFFECTIVE POROSITY 1 (FRACTION) Ø
PHIE
VOLUME OF CLAY Ø (FRACTION) 1
VCL

GROSS RES. SHALE VOL 4 CUTOFF Ø
GROS
NET PAY SHALE/PHI/SW Ø CUTOFFS 4
NETP
NET RES. SHALE/PHI Ø CUTOFFS 4
NETR

CORE GR. DENS. (G/CC) 2.5 3
COGD
MATRIX DENS. (G/CC) 2.5 3
ROMA
MAT. DENSITY 2.71 (G/CC)
LIMLIN
MAT. DENSITY 2.65 (G/CC)
SNDLIN

2100 2120 2140 2160 2180 2200 2220 2240 2260 2280

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Well : 30/07-03 Wildcat

Depth Matched and Environmentally Corrected Data

Latitude : 60 17 09.24 N, Longitude 02 14 54.44 E.

Reservoir(s) : Rogaland-Shetland
Interval 2000 m to 2600 m

Operator : HYDRO

Spud Date : 06-08-1976 Completion Date : 25-10-1976

TD : 4044 m Current Status : P/A.

Water Depth : 98 m KB Elevation : 24 m

Hole Fluid : FRESH WTR/LIGNO. Weight : 1.20 g/cc

RM 0.30 at 23.9 Deg. C.

RMF 0.23 at 23.9 Deg. C.

RMC 0.45 at 23.9 Deg. C.

Bottom Hole Temperature 85.0 Deg. C.

ENVIRONMENTALLY CORRECTED DATA

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68-500-30070-30

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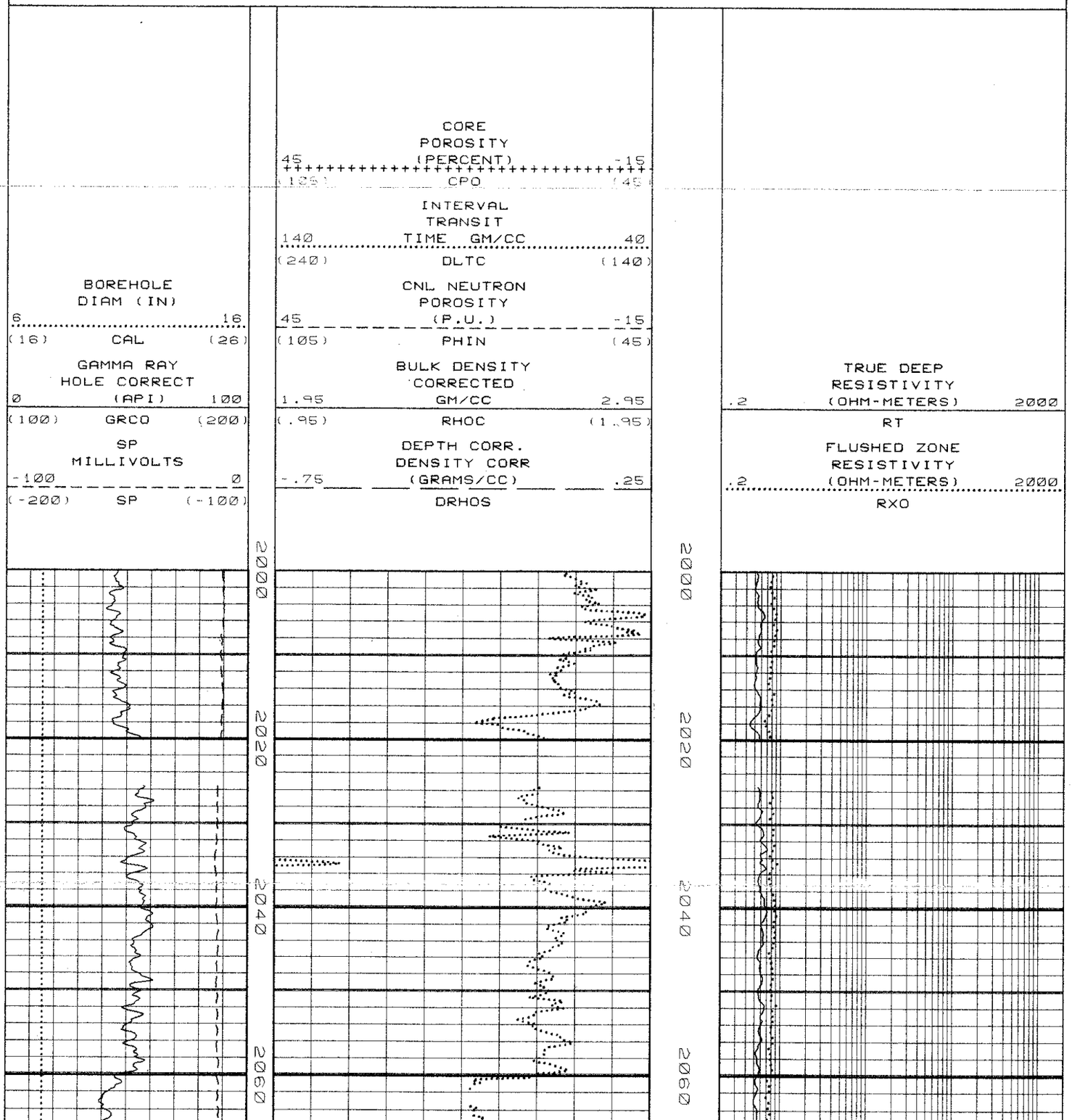

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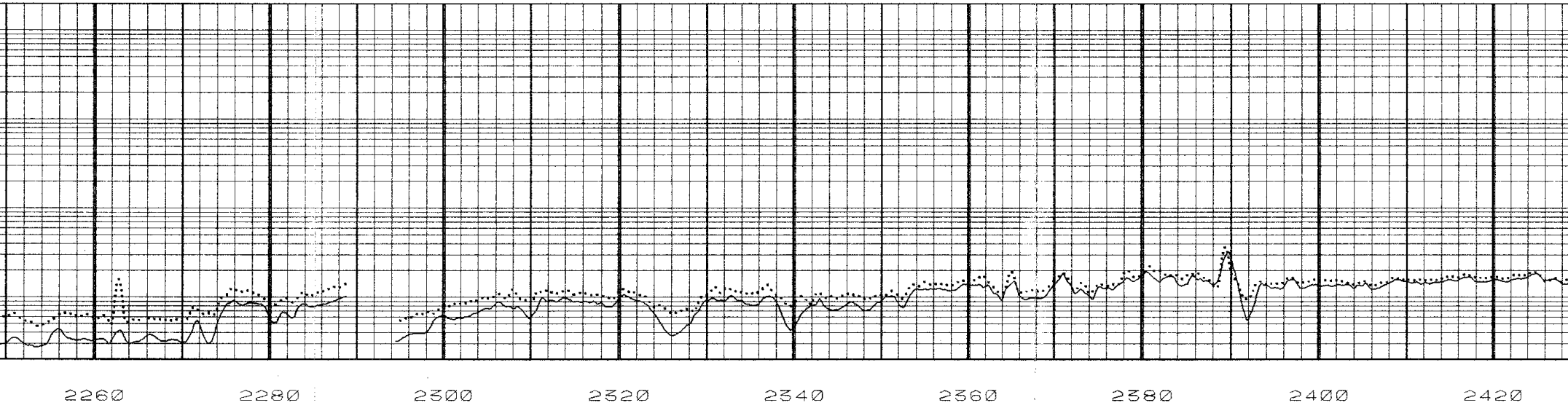
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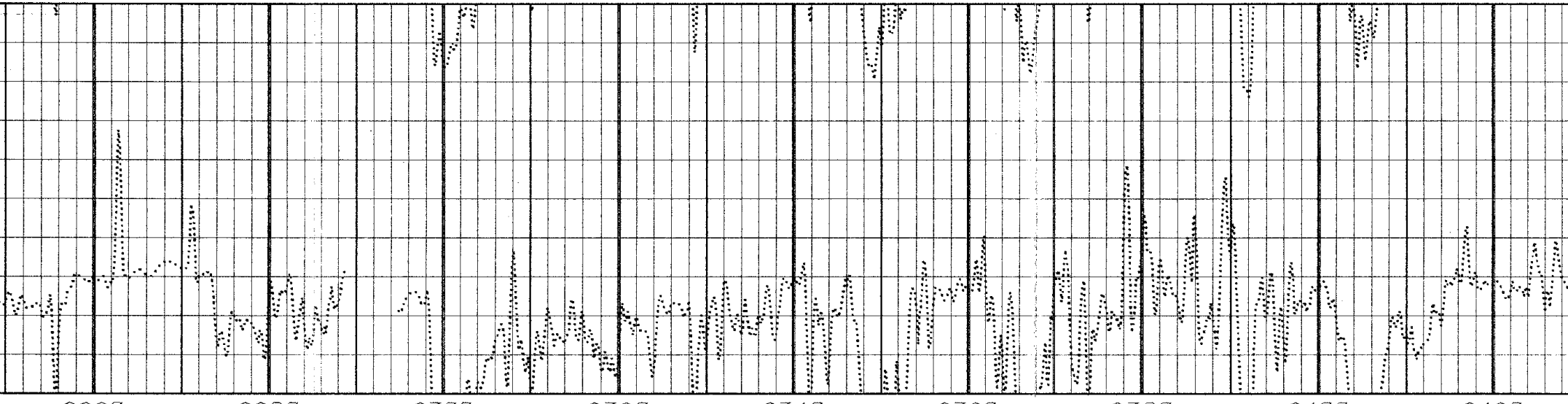
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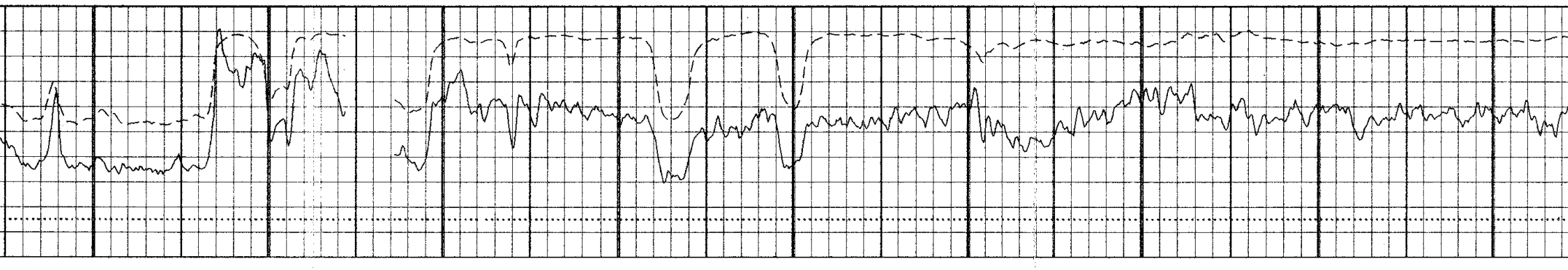

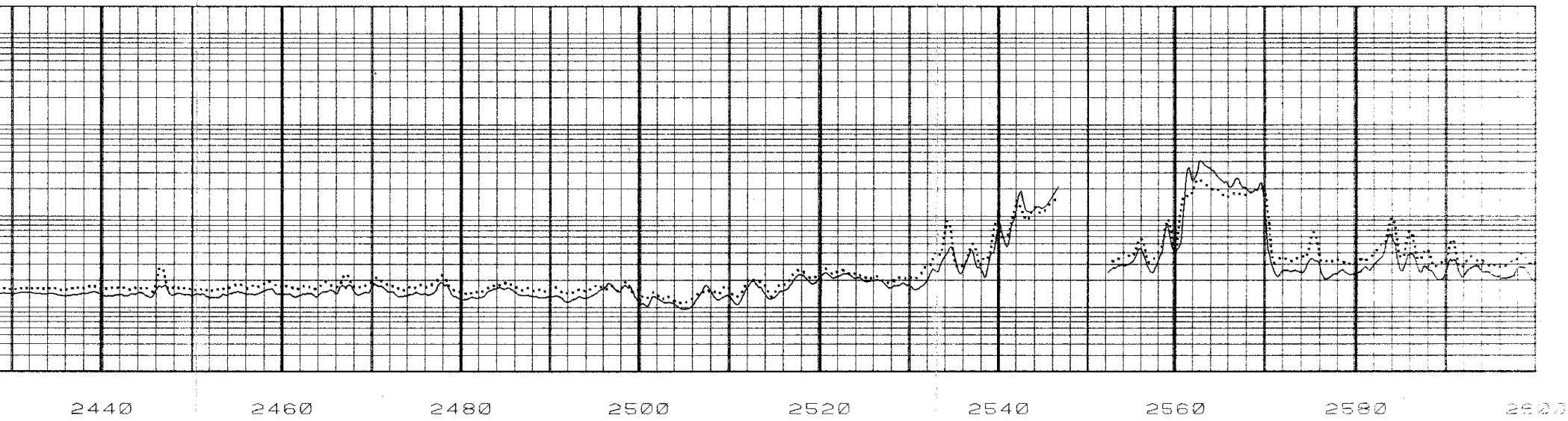
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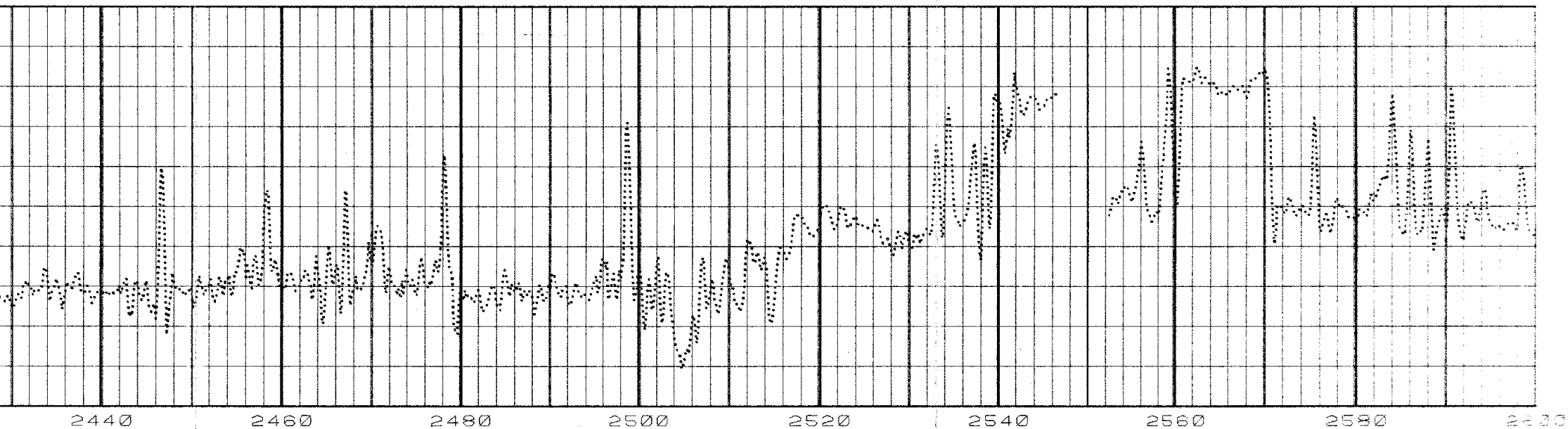
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