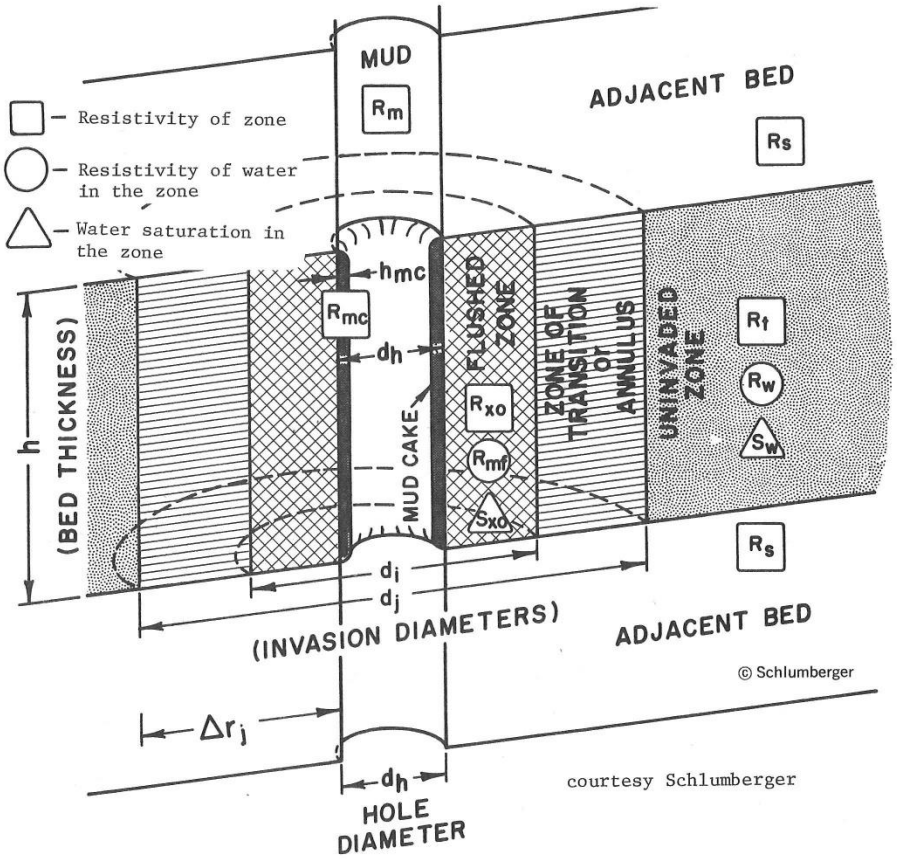
OPENHOLE LOG EVALUATION

Prepared By

Bob Gaddis

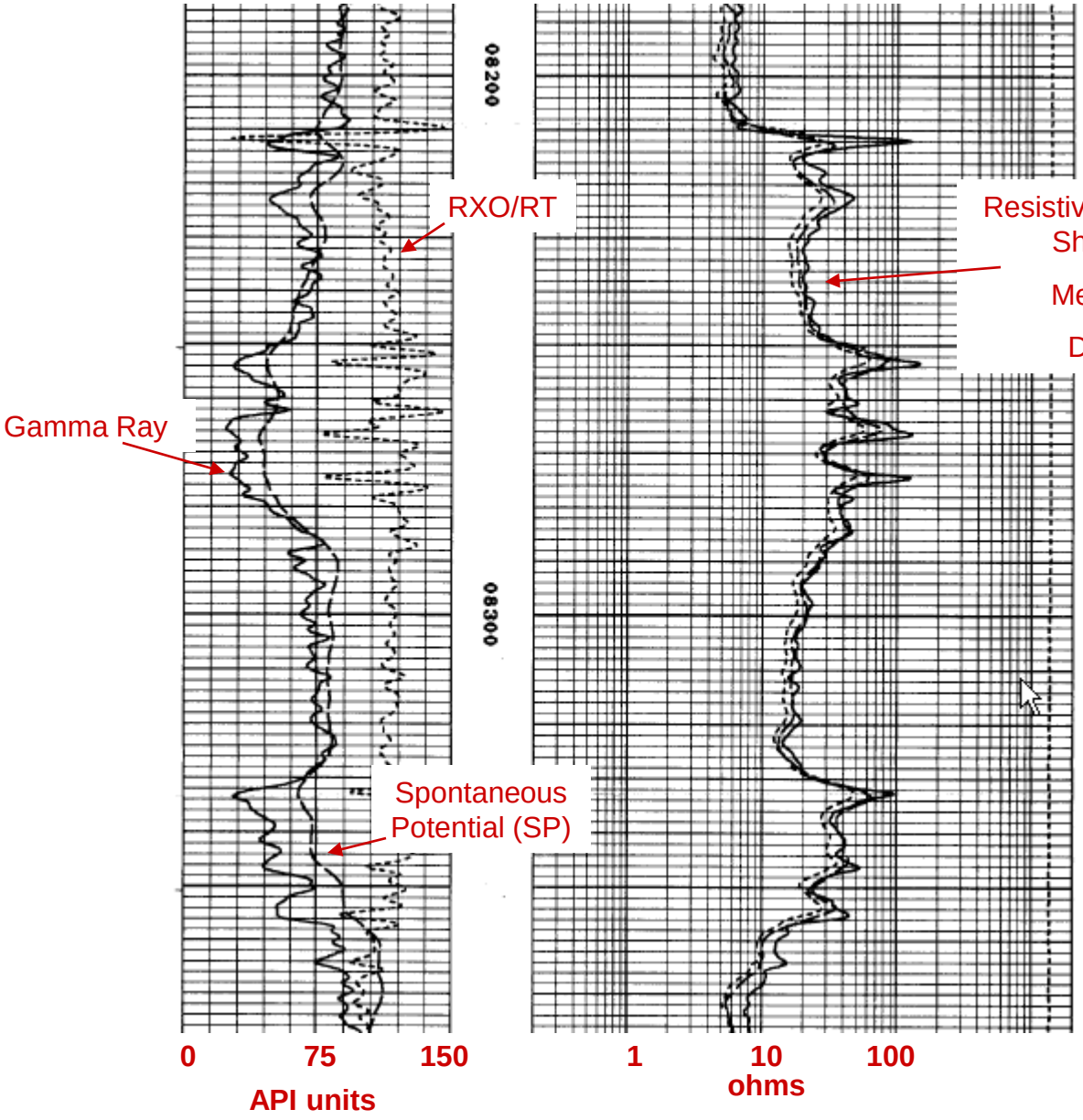
Figure 2-8 Schematic Cross Section of a Well Bore



Parameter	Flushed Zone	Transition zone	Virgin Zone
resistivity	Rxo	Ri	Rt
porosity	ϕ	ϕ	ϕ
water saturation	Sxo	Si	Sw
water	Rmf	Rz	Rw
equations	$Sxo = \sqrt{\frac{F_R \, Rmf}{Rxo}}$	$Si = \sqrt{\frac{F_R \, Rz}{Ri}}$	$Sw = \sqrt{\frac{F_R \, Rw}{Rt}}$

note: with invasion Sxo > Si > Sw unless all are 100%
no invasion Sxo = Si = Sw and Rw in all pores.

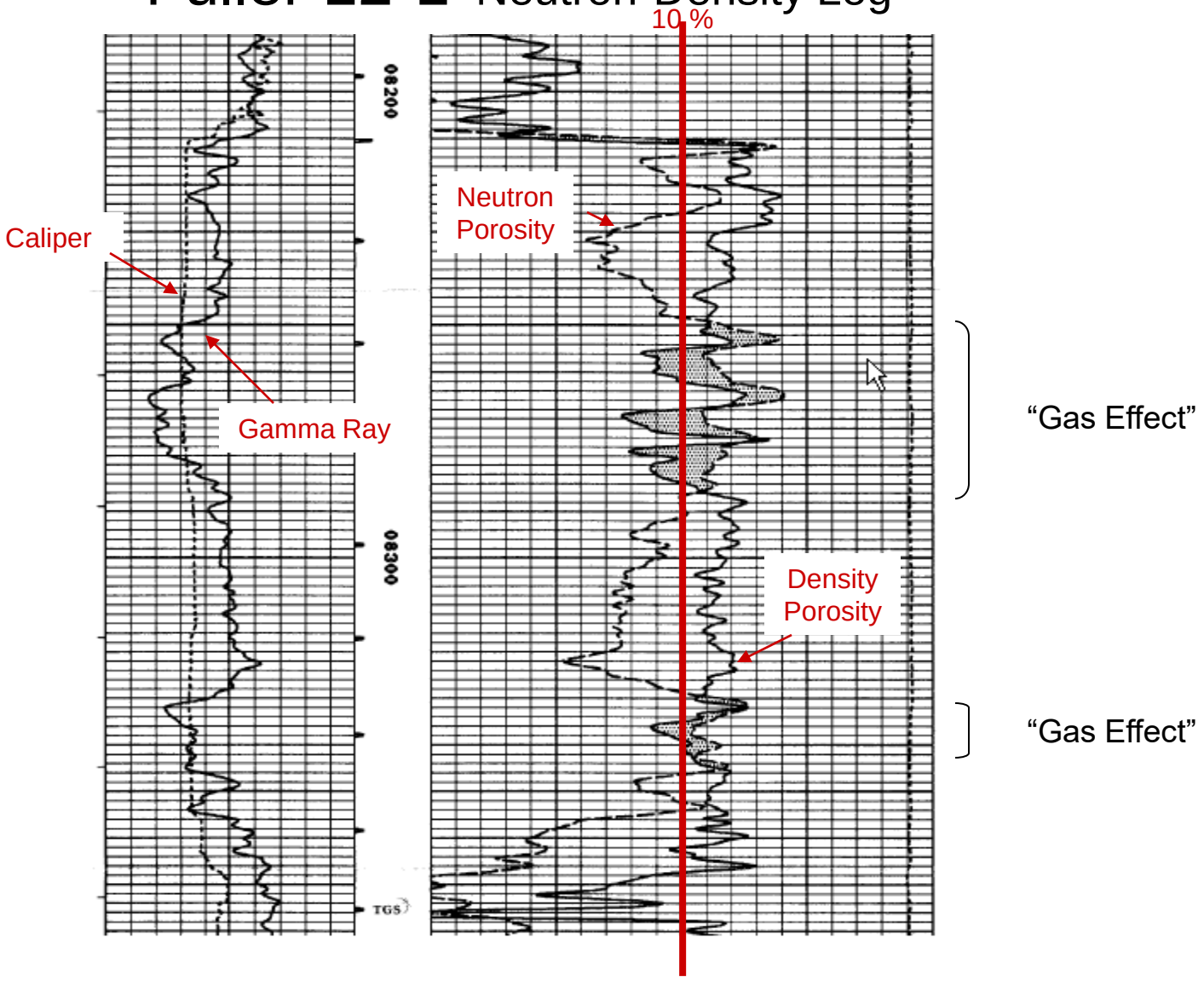
Fuller 12-1 Dual Induction Log



Tonkawa Sand

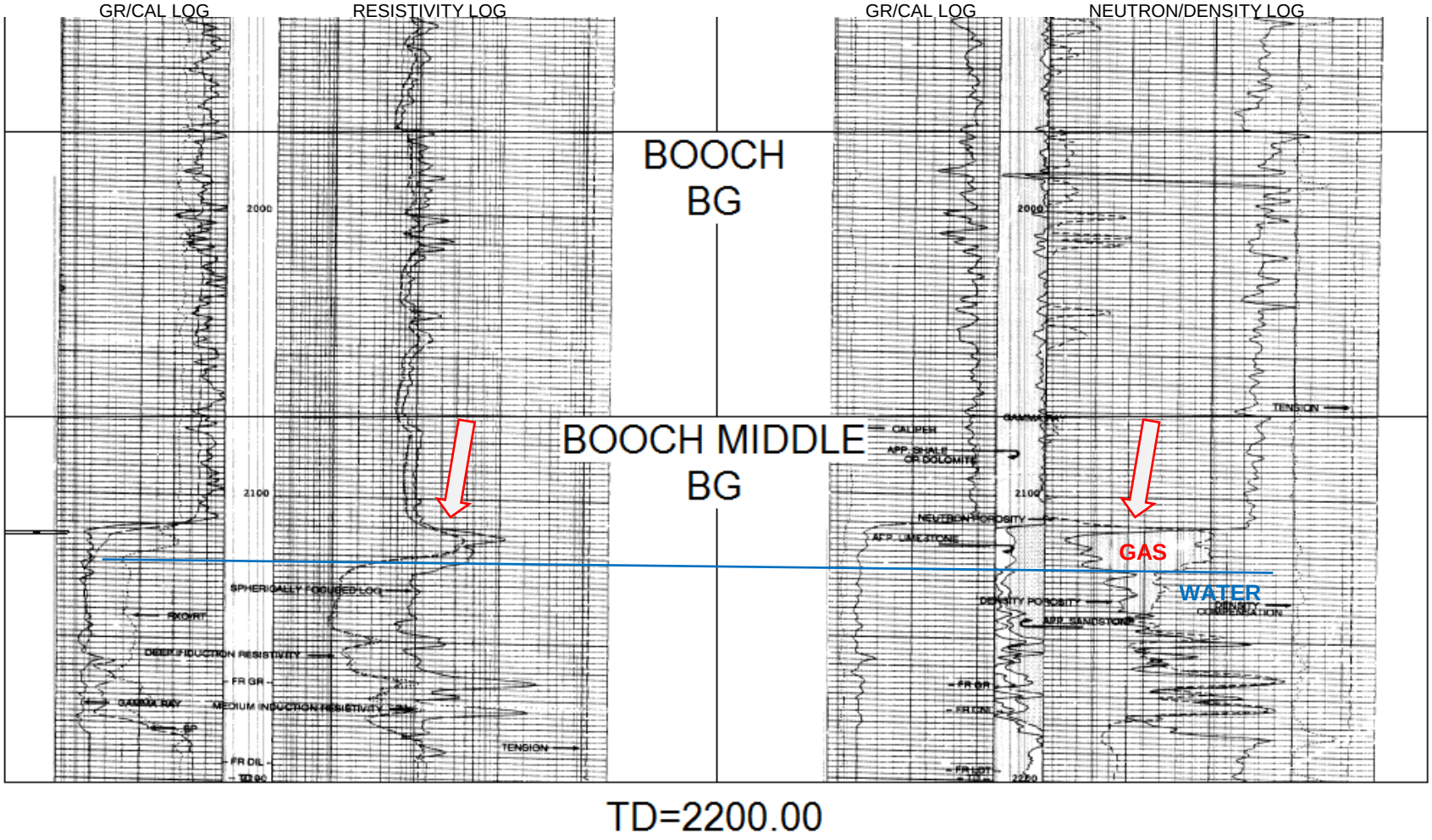
- Section 12-13N-19W, Custer Co., Okla.

Fuller 12-1 Neutron-Density Log

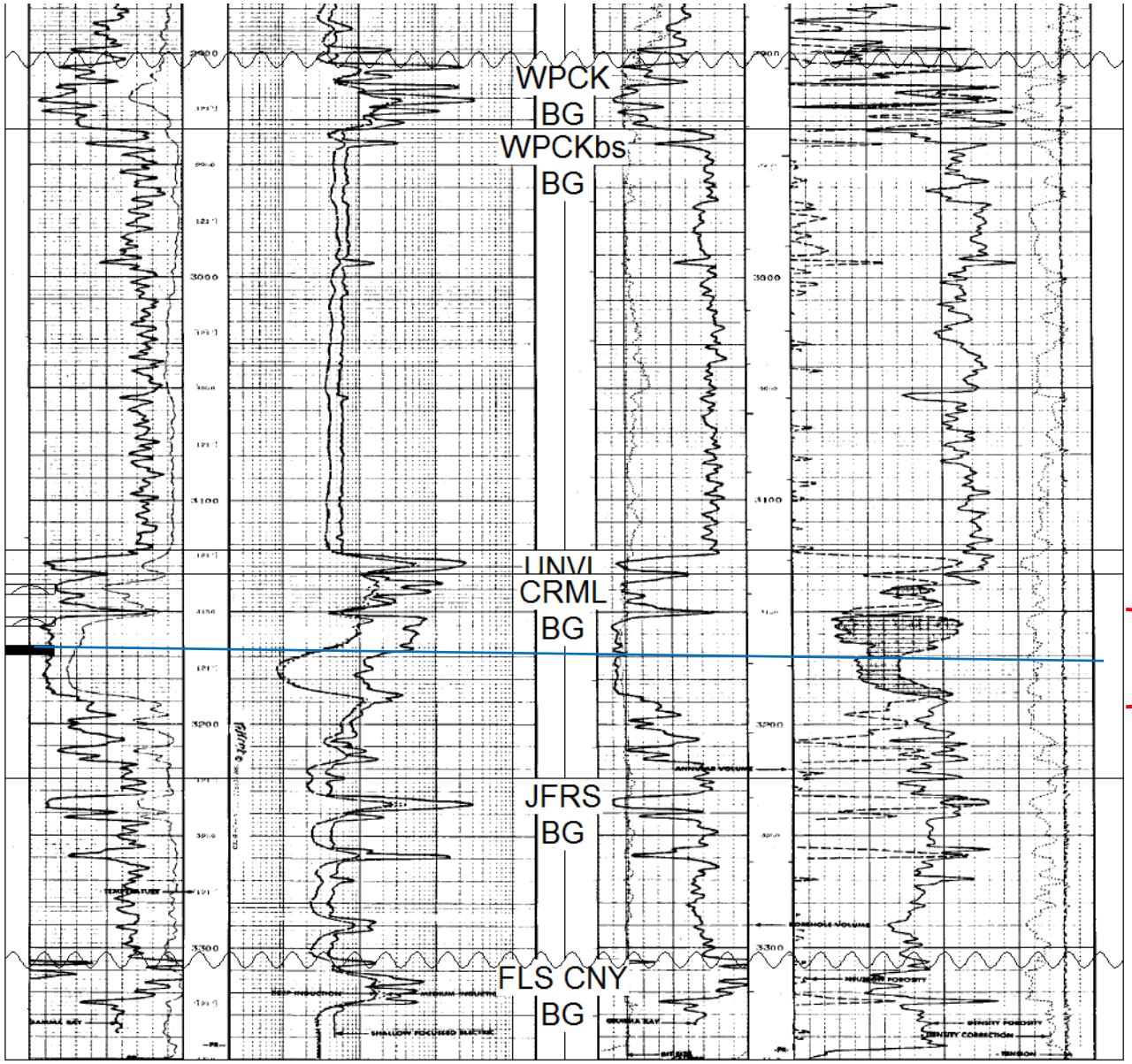


- Section 12-13N-19W, Custer Co., Okla.

PAREX PROD
QUINTON 1-17
SE SE NE SEC. 17-9N-11E
HUGHES CO.
35063230910000

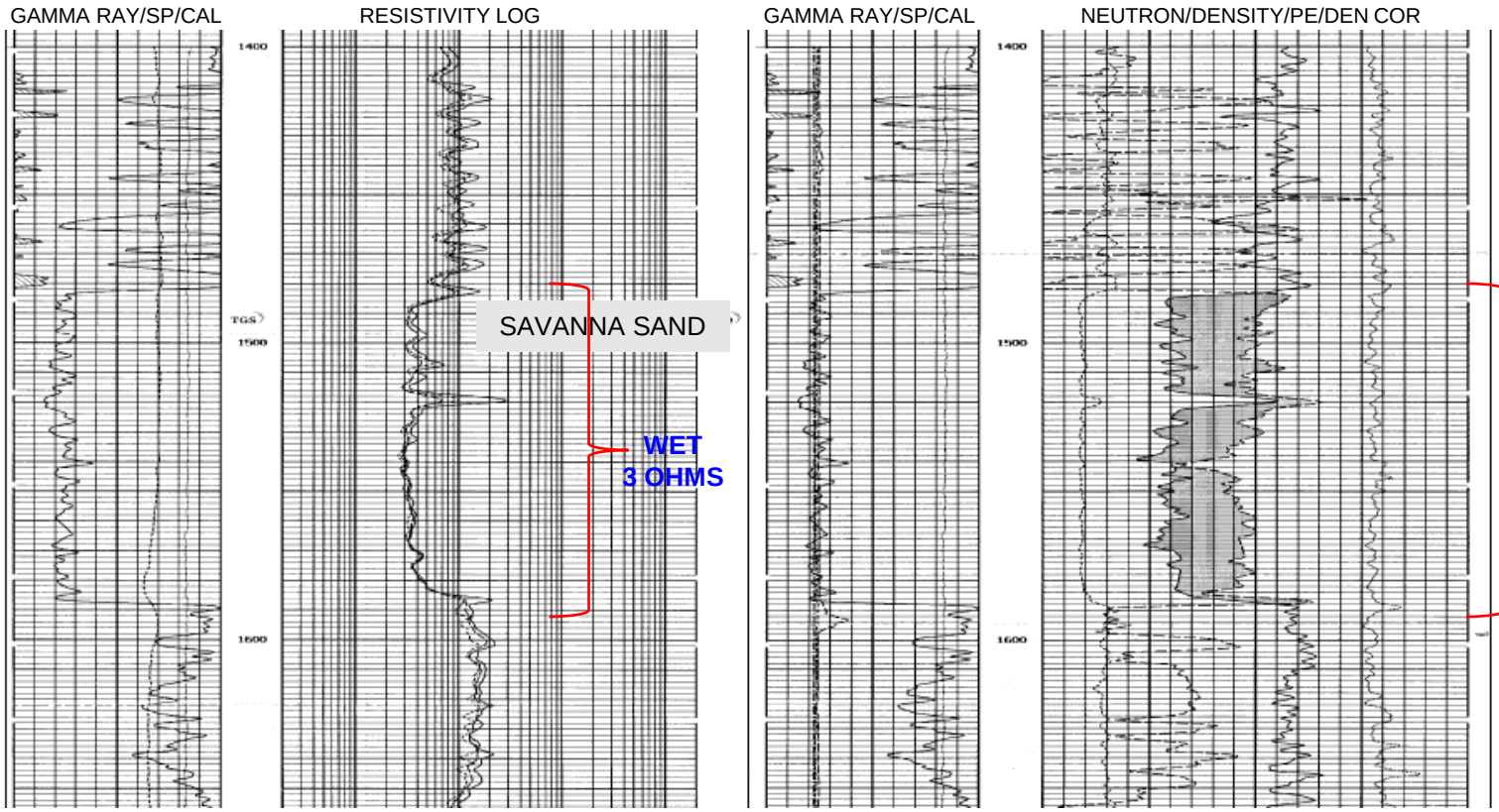


JORDAN O&G
ROSA 3-2
SE SE NE SEC. 2-9N-10E
HUGHES CO.
35063226050000



CROMWELL SAND
GAS ON WATER

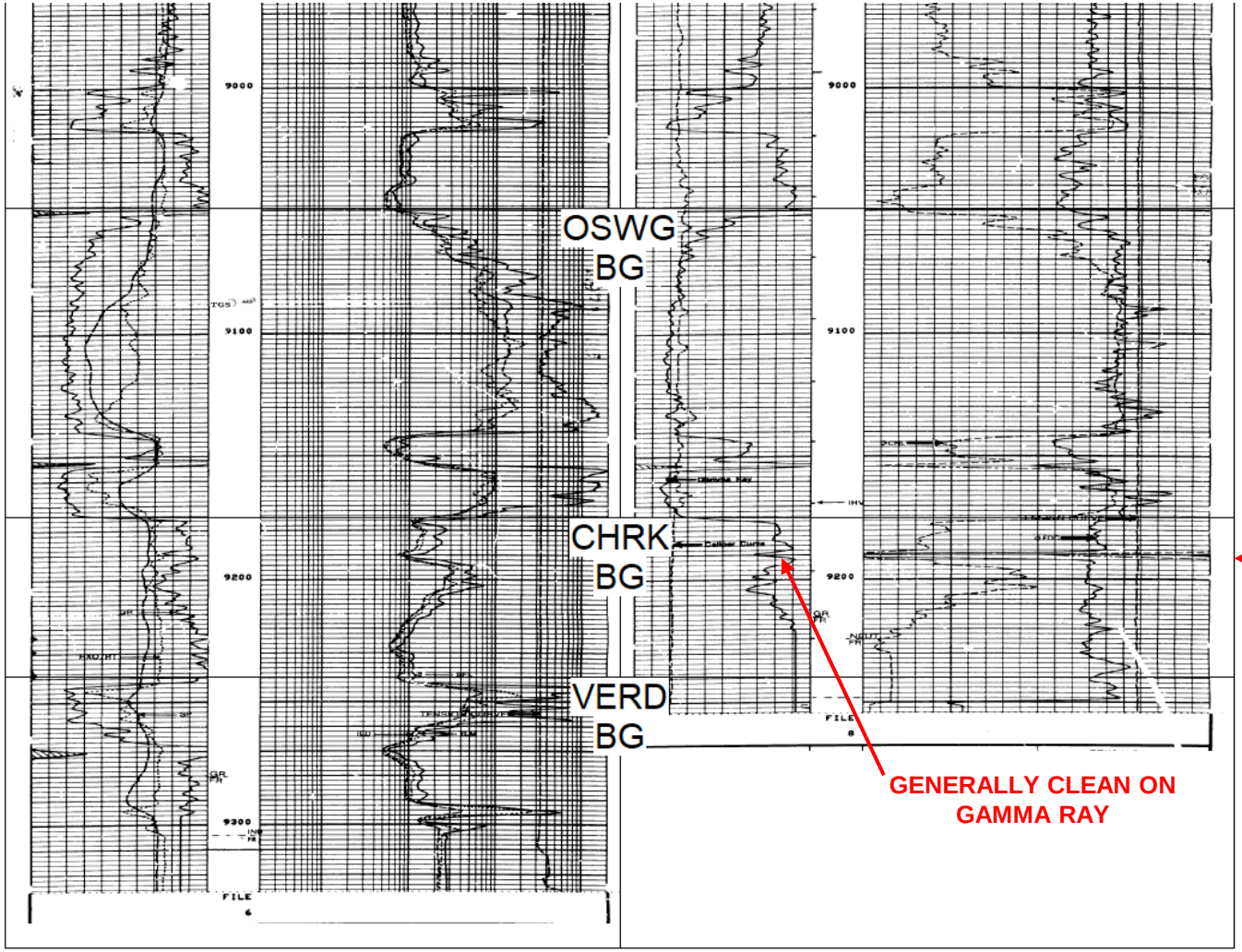
TILFORD PINSON
HOLT 1-15
SEC. 15-6N-13E
PITTSBURG CO.



NO, NOT "GAS EFFECT"
BUT A CLEAN WATER SAND

SO, THINK "CROSS-OVER", NOT "GAS EFFECT"

HPC
CLARK 1
SE NW SEC 29-13N-8W
CANADIAN CO.
35017223250000



PRUE FORMATION
@2' COAL

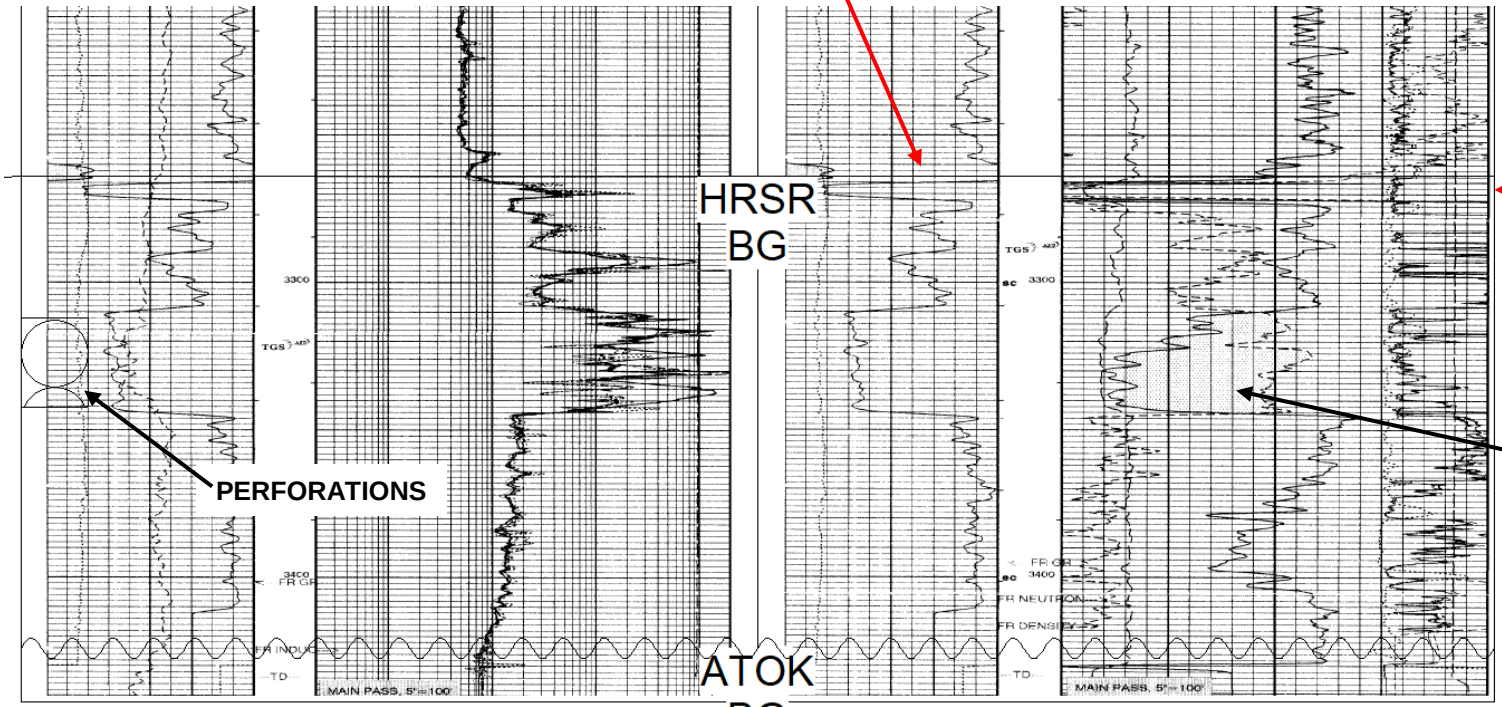
THE LOW DENSITY
IS EVIDENT

GENERALLY CLEAN ON
GAMMA RAY

TD=9350.00

DAVIS OPER
DONNA 1
NE SEC 16-5N-12E
PITTSBURG CO.
35121224330000

GENERALLY CLEAN ON
GAMMA RAY

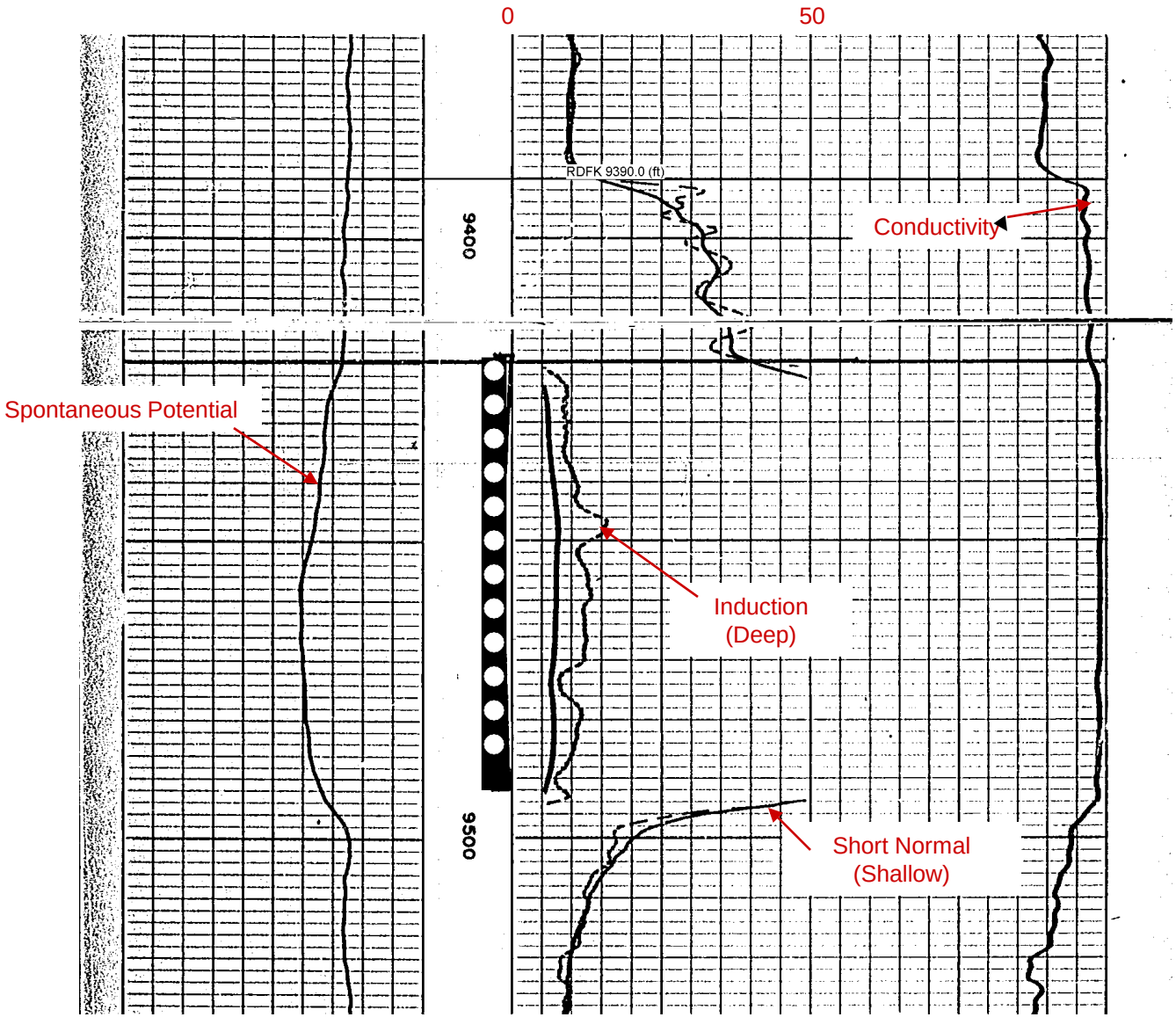


HARTSHORNE FORMATION
@4' COAL

THE LOW DENSITY
IS EVIDENT

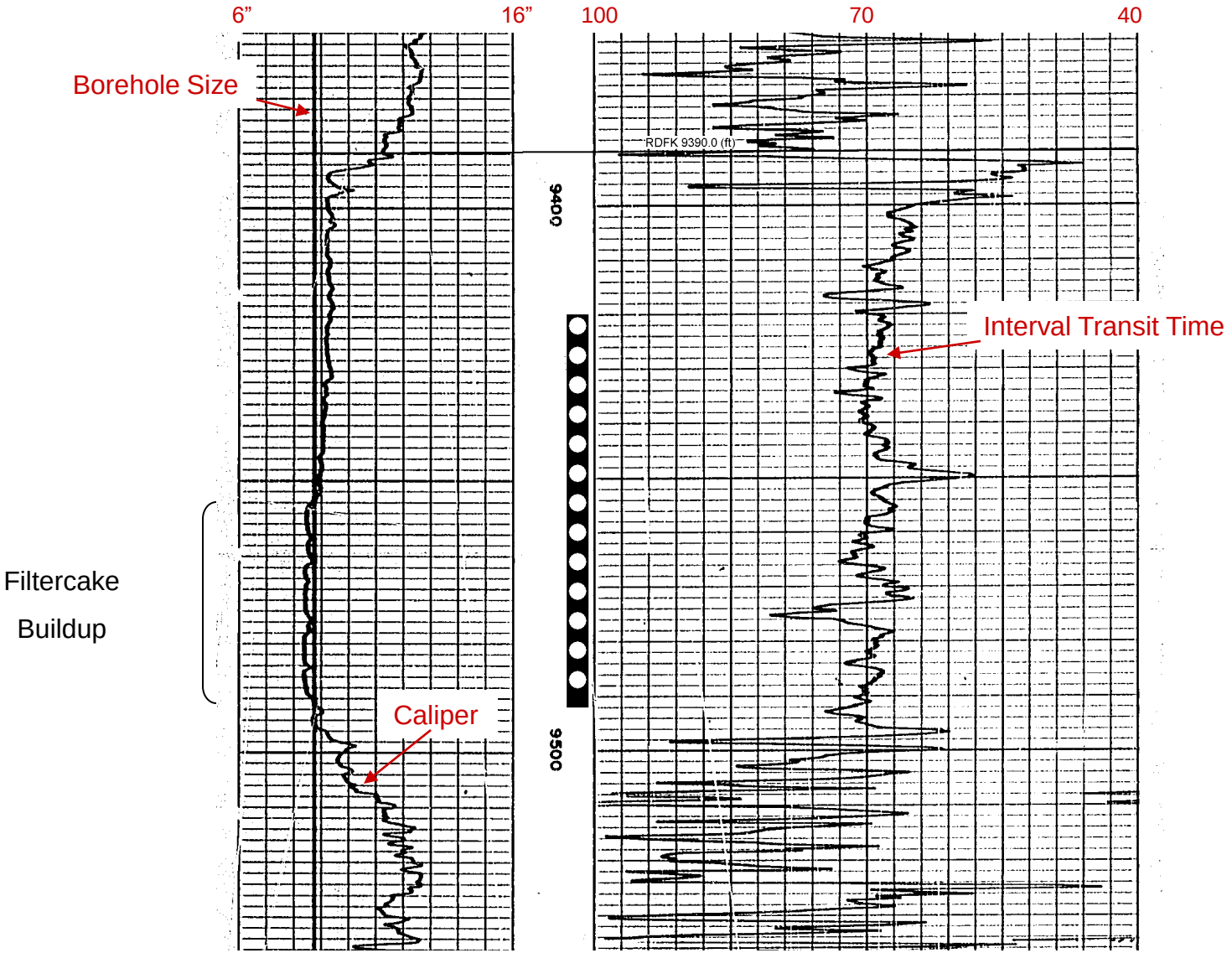
NOTE: NICE GAS-FILLED
PRODUCING
HARTSHORNE SAND

Fluitt 1 Induction Electric (IE) Log



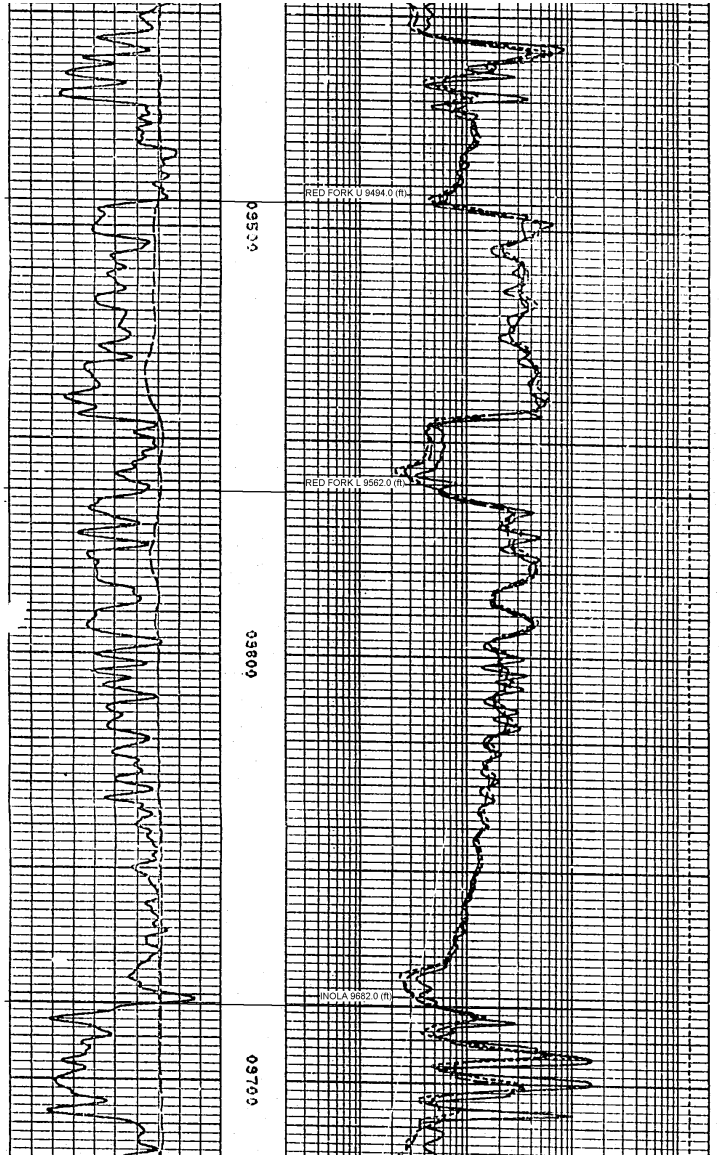
- Section 14-7N-4W, McClain Co., Okla.

Fluitt 1 Sonic Log



- Section 14-7N-4W, McClain Co., Okla.

Gambrel 1 Dual Induction Log



Pink Lime

Red Fork

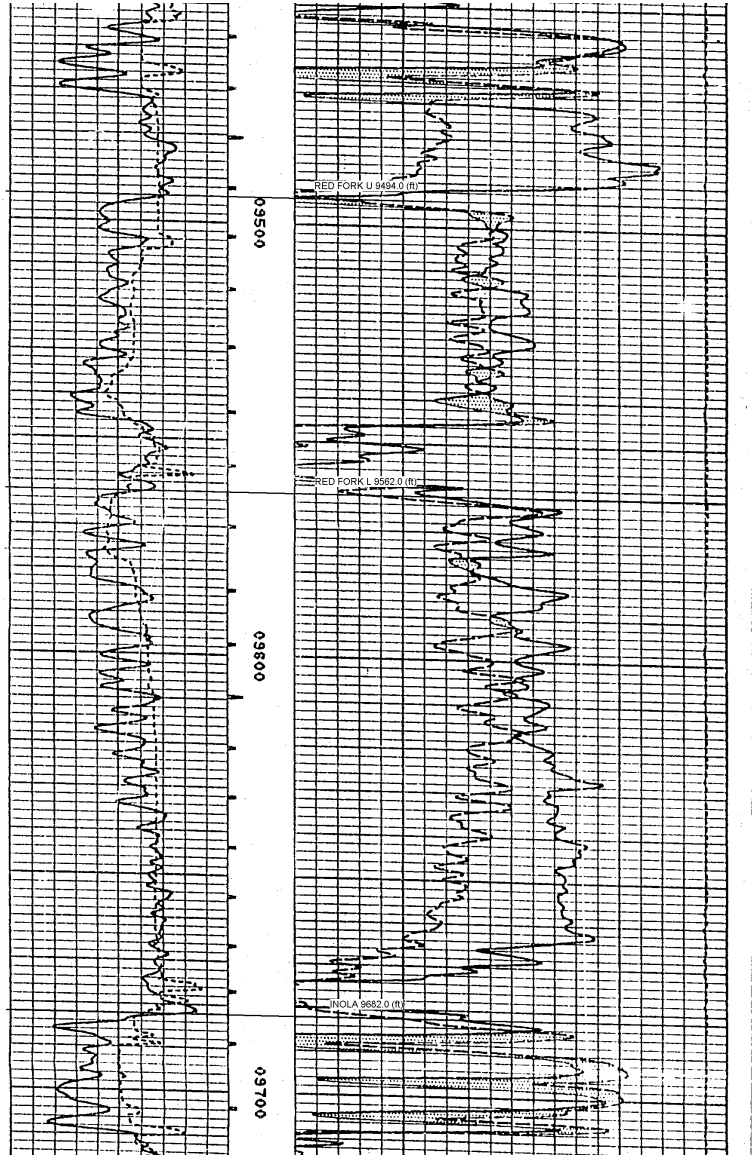
Upper

Lower

Inola Lime

- Section 13-17N-17W, Dewey Co., Okla.

Grambrel 1 Neutron/Density Log



- Section 13-17N-17W, Dewey Co., Okla.

Albers 1-34 Dual Induction Log

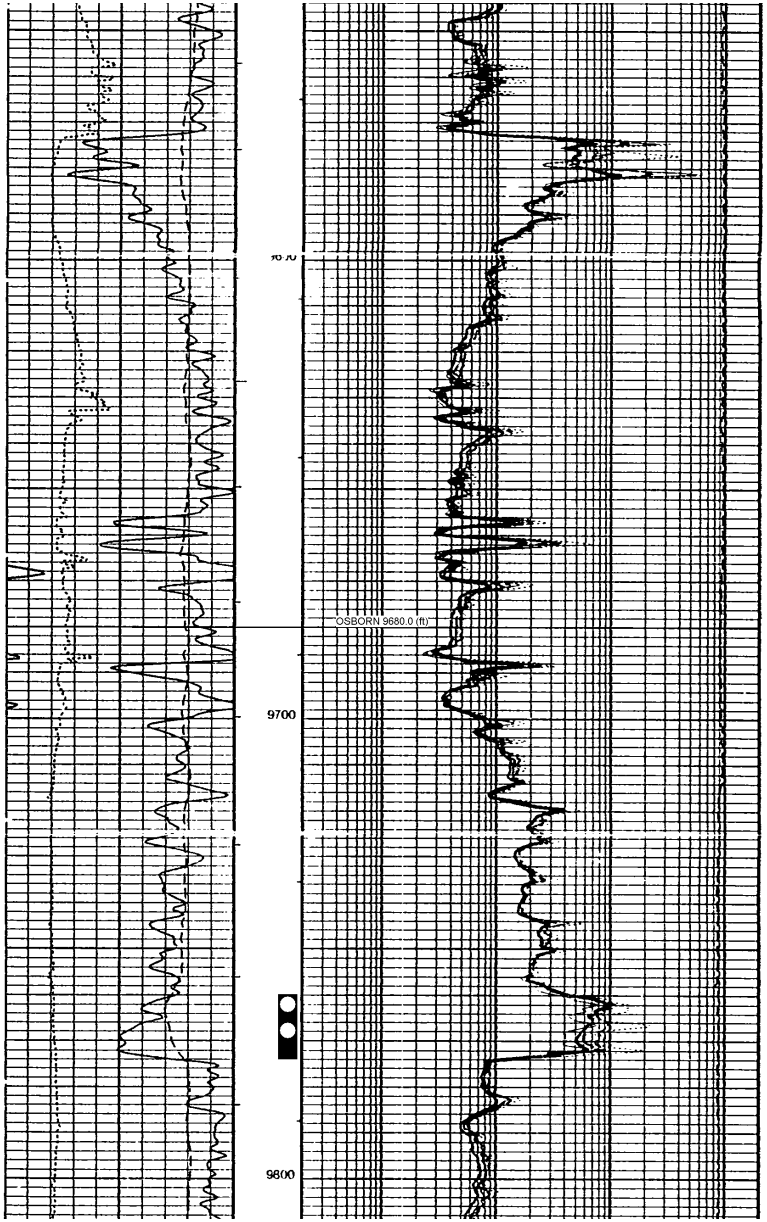
Near Shore Marine

7

NOTE THE “SEVENS”

“Osborn Mbr”

Fluvial Channel



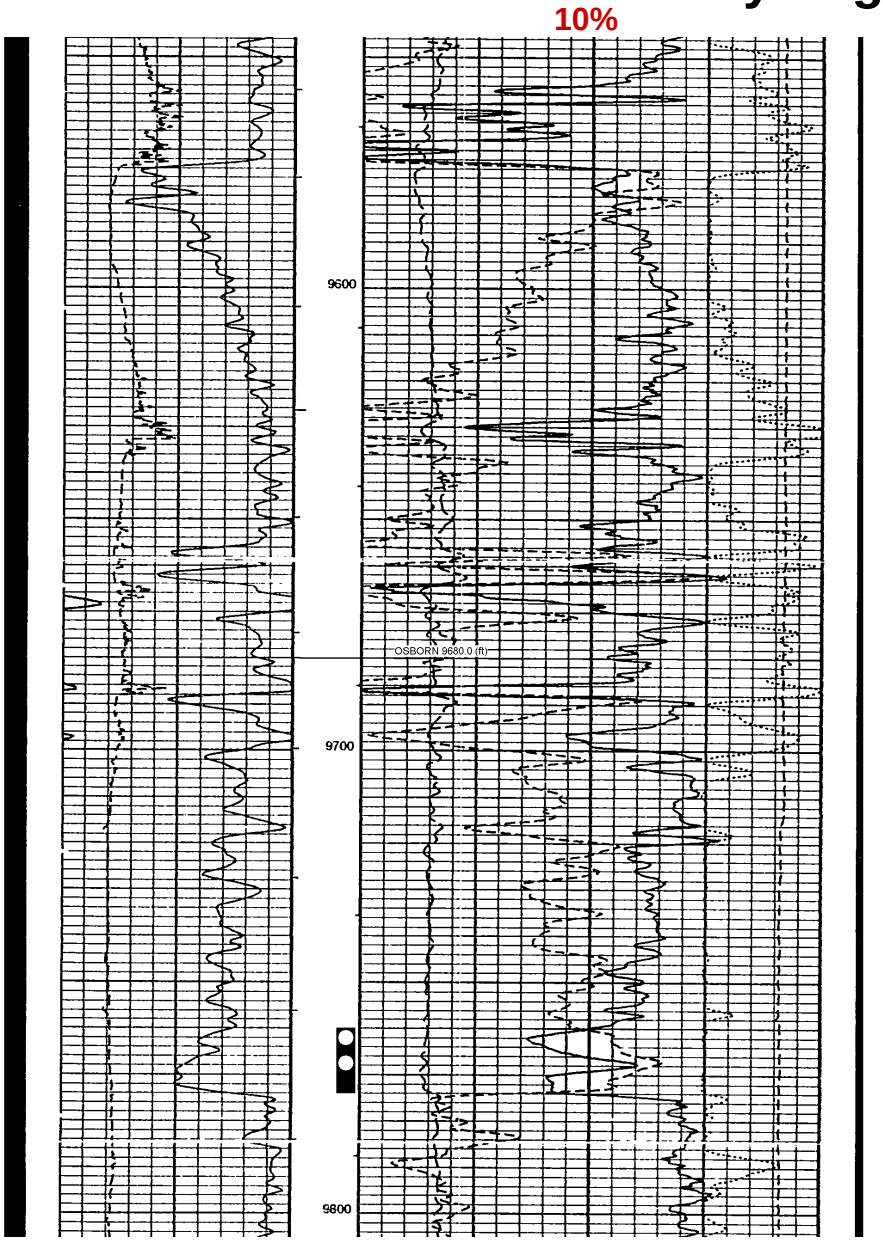
Lower Skinner Mbr.

Pink Lime

Red Fork

- Section 34-11N-7W, Canadian Co., Okla.

Albers 1-34 Neutron/Density Log

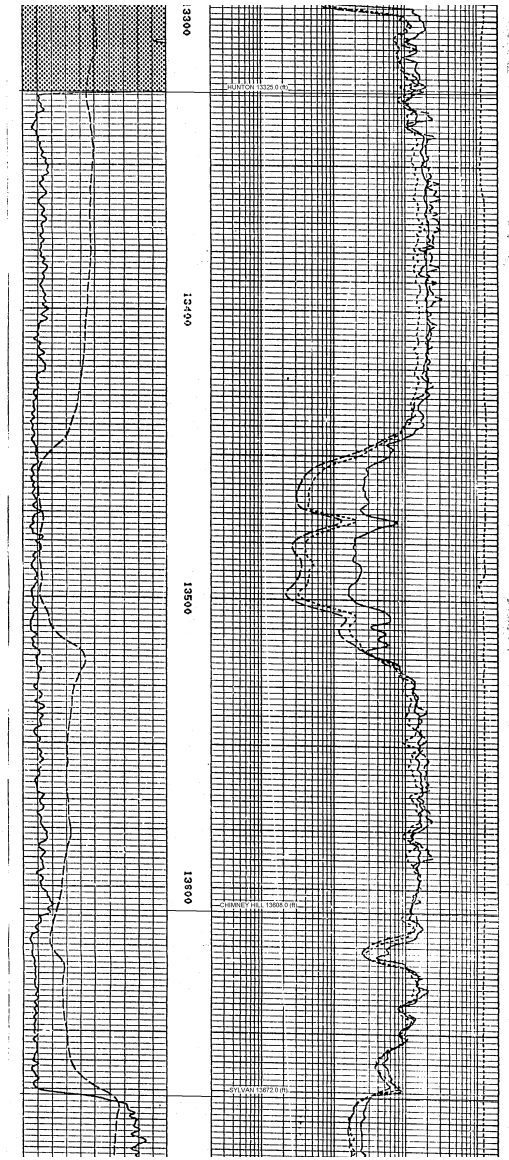


Lower Skinner Mbr.

Osborn Sand

- Section 34-11N-7W, Canadian Co., Okla.

Gambrel 1 Dual Induction Log



?

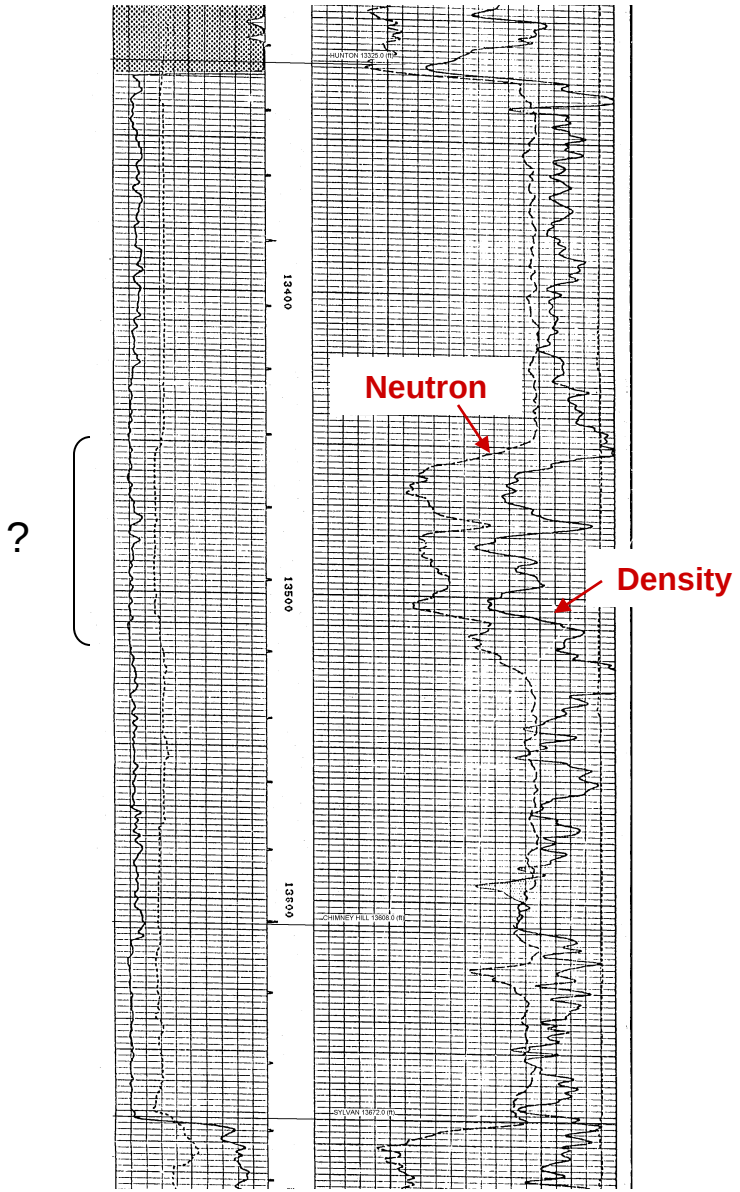
Woodford Shale

Hunton Lime

Sylvan Shale

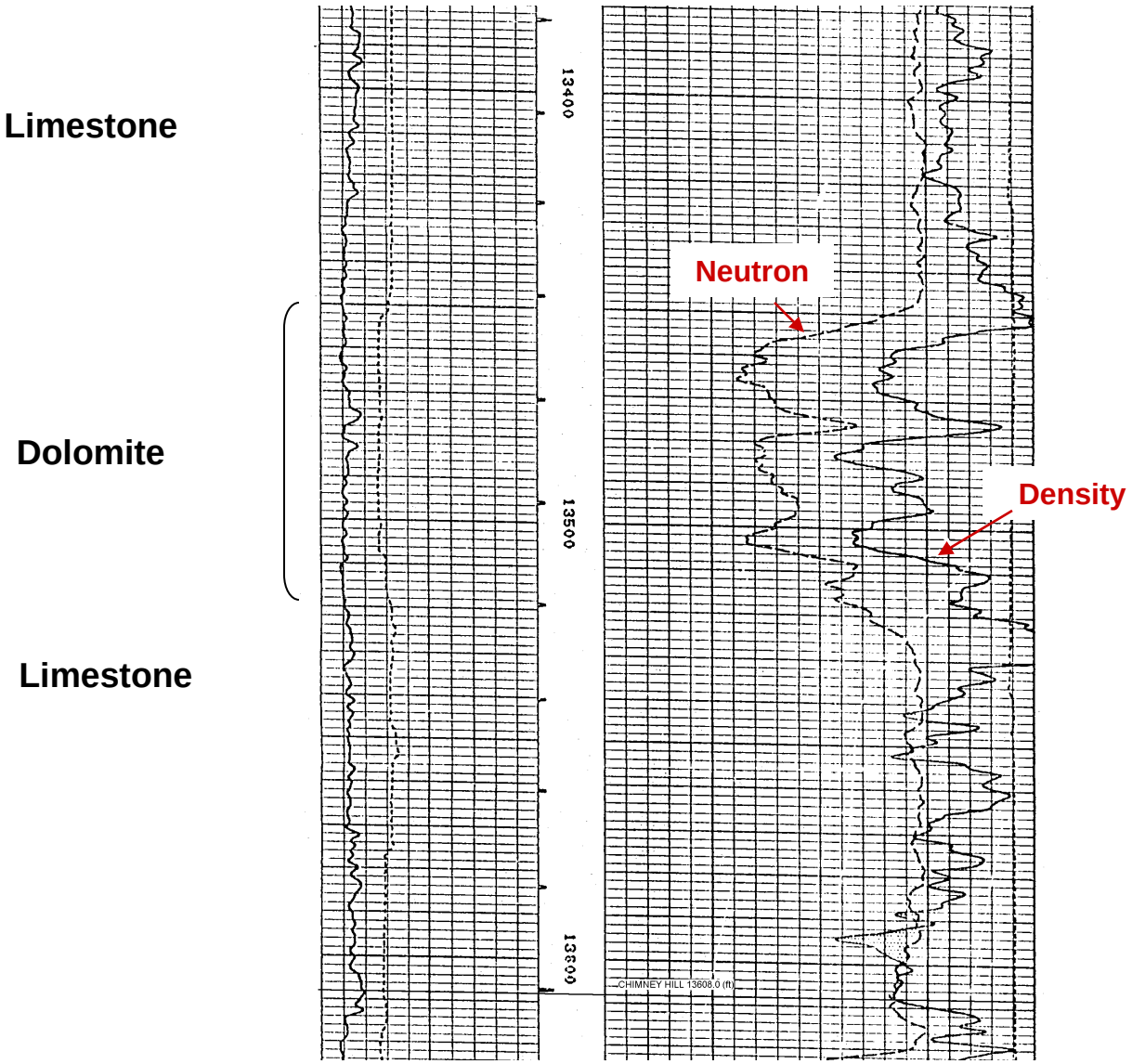
- Section 13-17N-17W, Dewey Co., Okla.

Gambrel 1 Neutron/Density Log



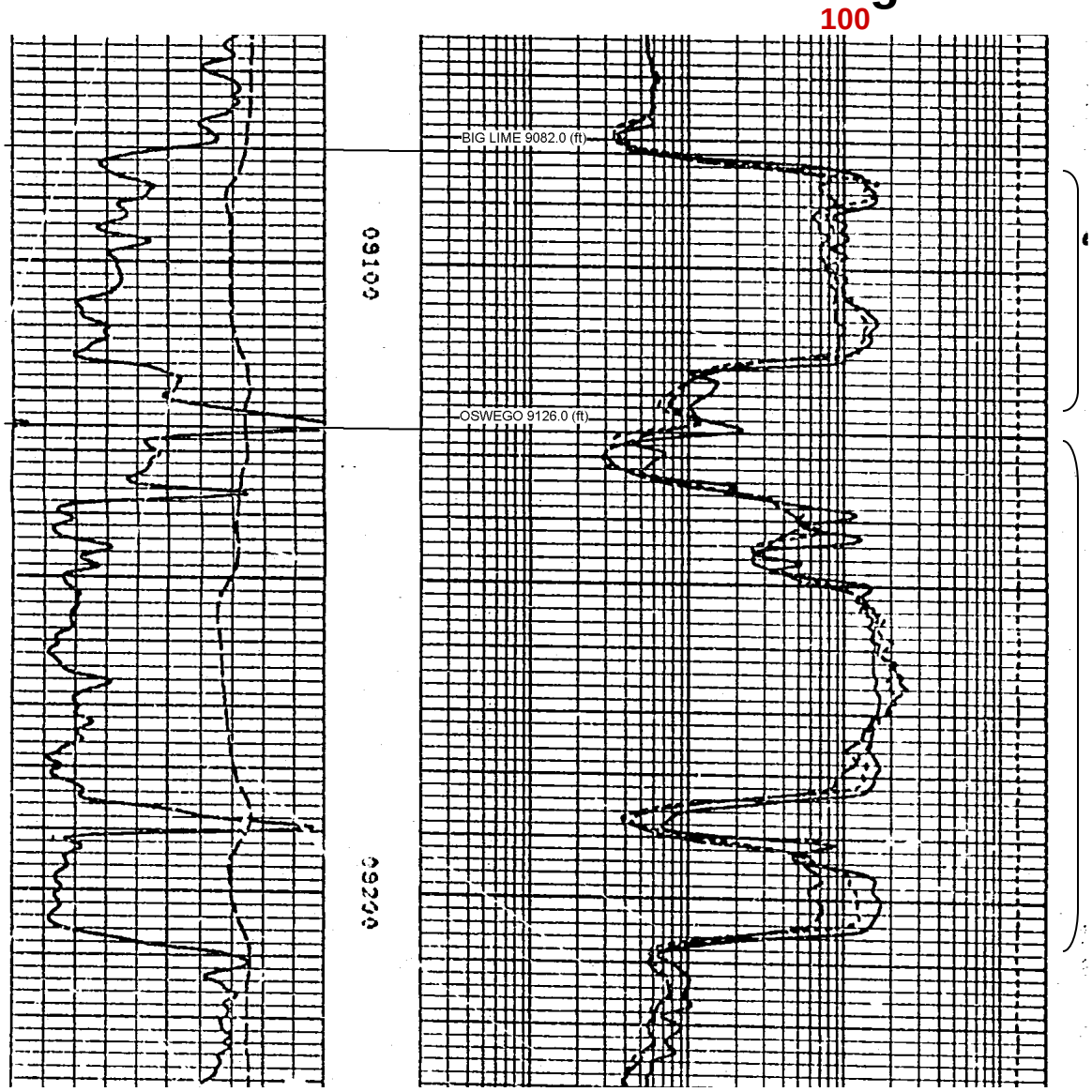
- Section 13-17N-17W, Dewey Co., Okla.

Gambrel 1 Neutron/Density Log



- Section 13-17N-17W, Dewey Co., Okla.

Gambrel 1 Dual Induction Log



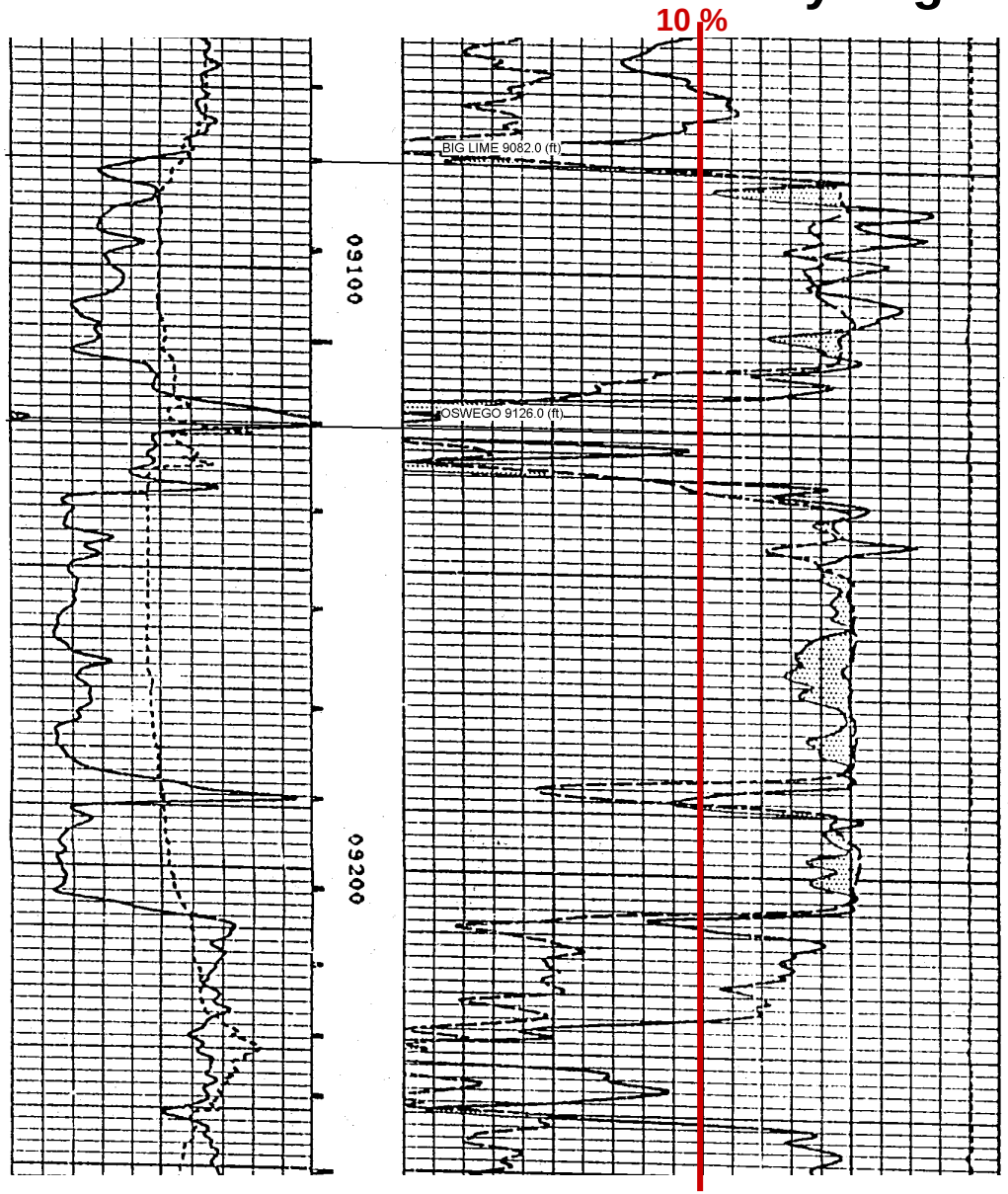
Lime Banks

Big Lime

Oswego Lime

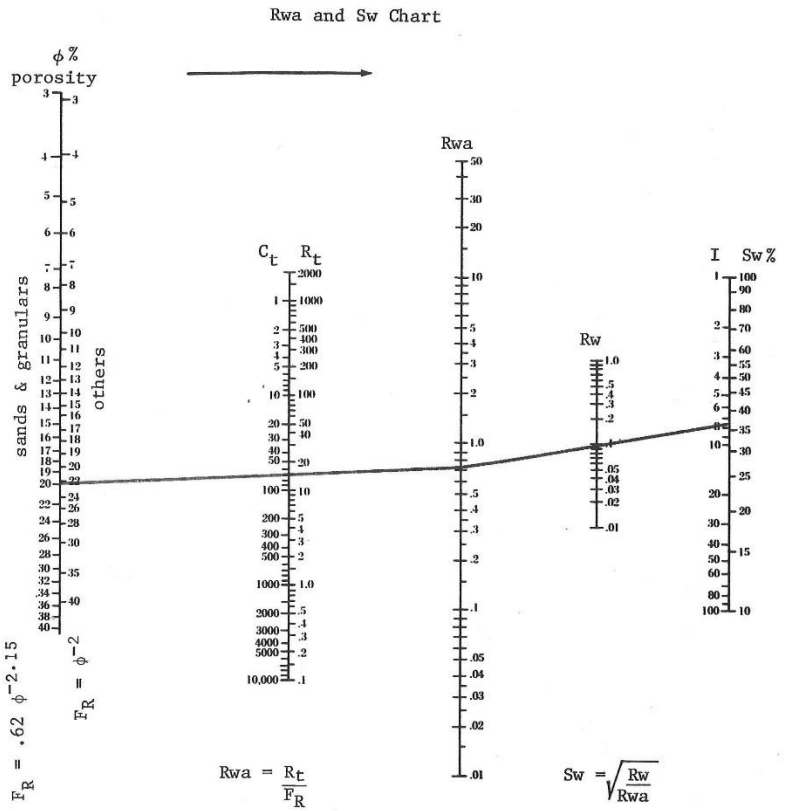
- Section 13-17N-17W, Dewey Co., Okla.

Gambrel 1 Neutron/Density Log



- Section 13-17N-17W, Dewey Co., Okla.

Figure 2-6 Solution of Water Saturation Equation (2-10)



Example: Porosity is 20% in a sandstone. Rt is 15. These give you an Rwa of 0.72. If Rw is .095 then Sw = 36%

Density log:

$$\rho b = \Phi.\rho f + (1-\Phi).\rho ma$$

$$\Phi = \frac{(\rho ma - \rho b)}{(\rho ma - \rho f)}$$

ρma :	Quartz	2.65 gm/cc	ρf :	1.00
	Calcite	2.71		
	Dolomite	2.87		

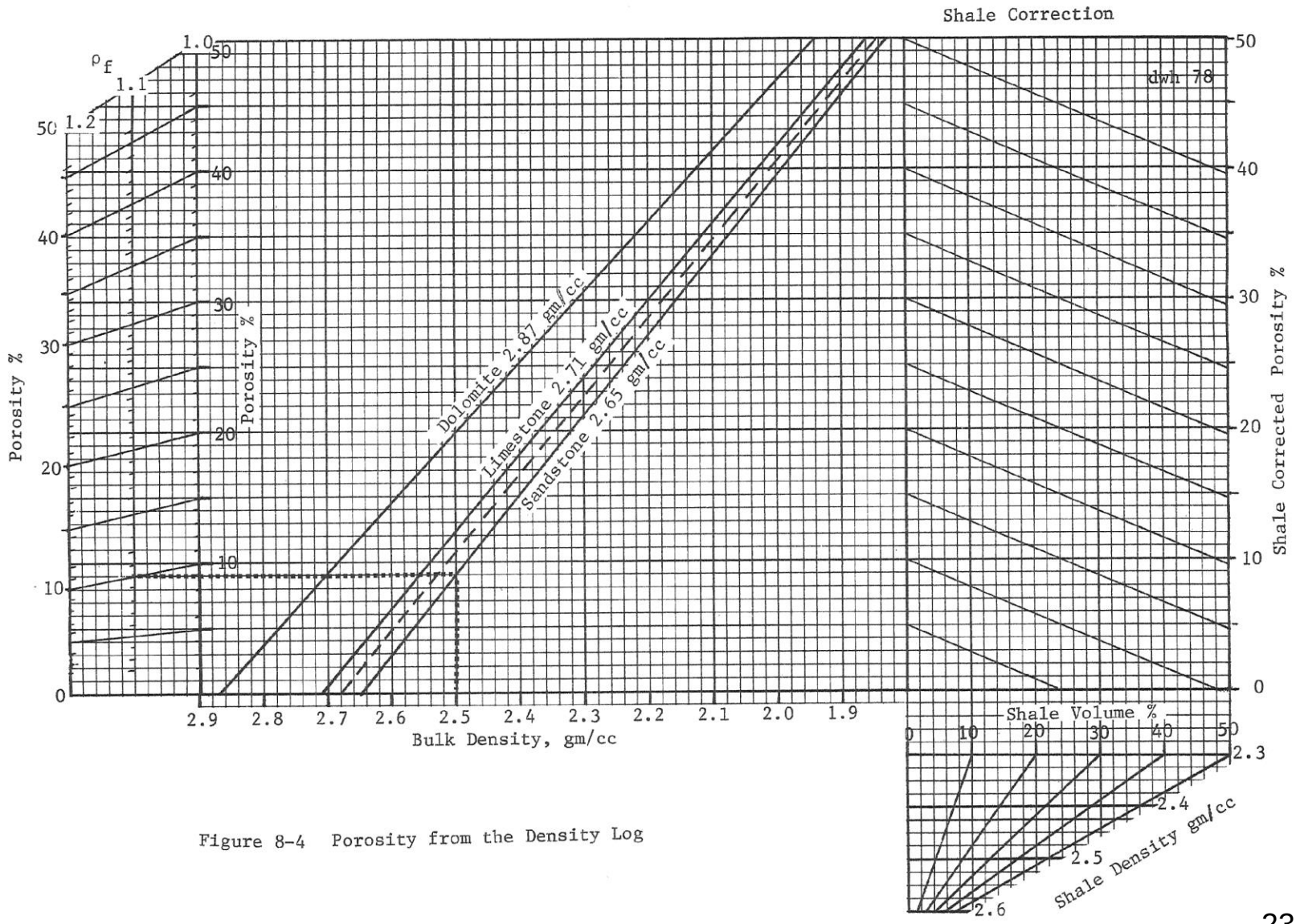


Figure 8-4 Porosity from the Density Log

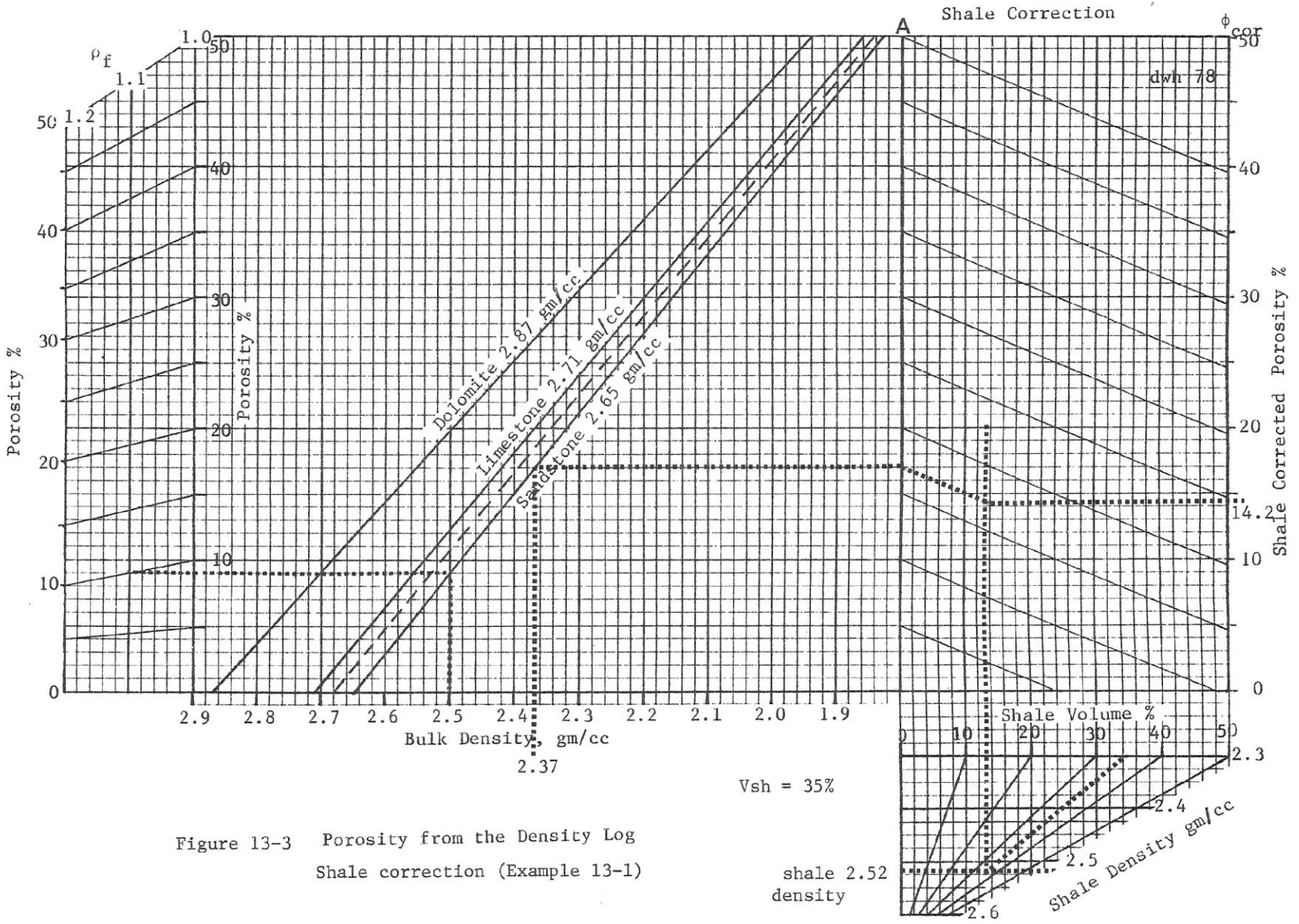


Figure 13-3 Porosity from the Density Log
Shale correction (Example 13-1)

Neutron log:

- The older neutron logs are either unscaled, recorded in "counts", or recorded in API units
- Most recent logs are recorded in *apparent* porosity units referred to either a sandstone, limestone, or dolomite scale. The default scale is limestone.

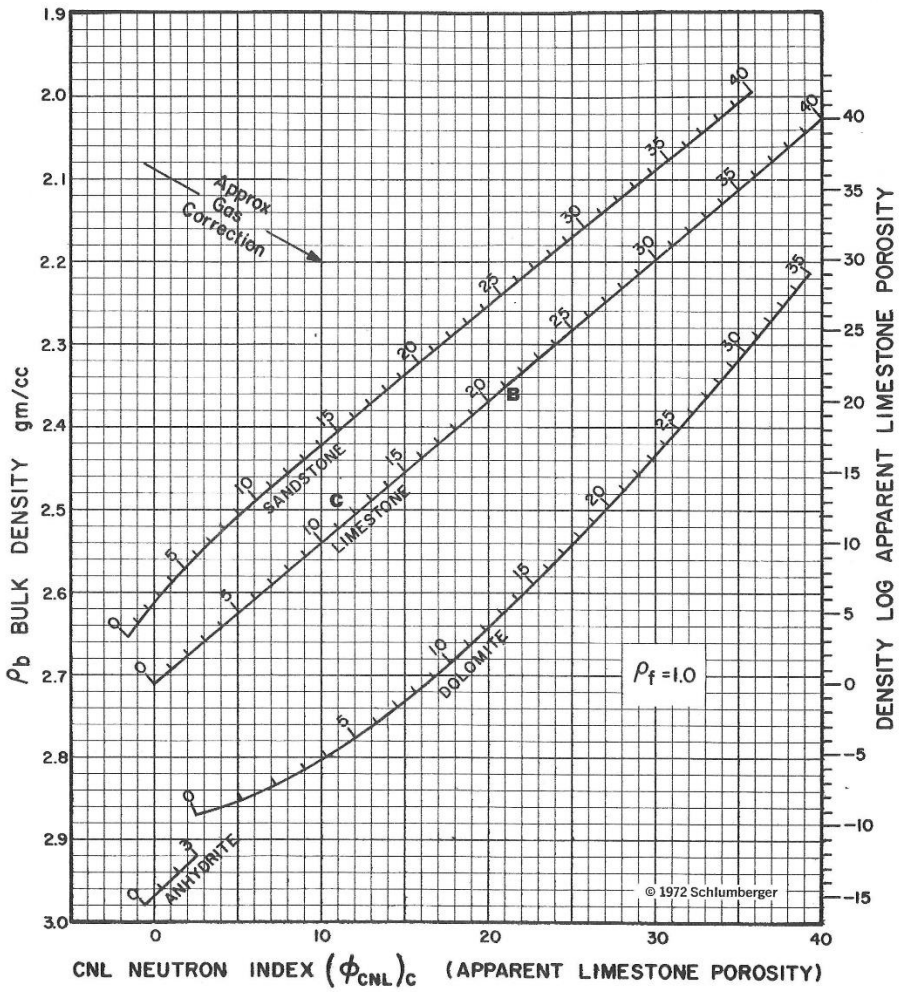
Neutron-density log combination:

When the neutron and density log are recorded as apparent porosity on a limestone scale, then a true volumetric porosity can be estimated by either:

$$\Phi = \frac{\Phi_n + \Phi_d}{2}$$

$$\Phi = \sqrt{\frac{(\Phi_n^2 + \Phi_d^2)}{2}}$$

Figure 10-2 Schlumberger density/compensated neutron crossplot
(courtesy Schlumberger)



Bob's Cheat Sheet

DENSITY LOG

LITHOLOGY	Pma	3%	5%	6%	7%	8%	10%	12%	15%
Dolomite	2.87	2.81	2.78	2.76	2.74	2.72	2.68	2.646	2.59
Limey Dolo.	2.80	2.75	2.71	2.69	2.67	2.66	2.62	2.58	2.53
Dolo. Limestone	2.75	2.70	2.66	2.65	2.63	2.61	2.575	2.54	2.49
Limestone	2.71	2.66	2.62	2.61	2.59	2.57	2.54	2.50	2.45
Limey Sandstone	2.68	2.63	2.60	2.58	2.56	2.546	2.51	2.48	2.43
Sandstone	2.65	2.60	2.57	2.55	2.53	2.52	2.485	2.45	2.40

Mineral	Density - gm/cc
Calcite	2.71
Dolomite	2.87
Quartz	2.65
Anhydrite	2.95
Gypsum	2.32
Halite (NaCl)	2.16
Sylvite (KCl)	1.98
Coal	1-0-1.8

$$\phi = \frac{Pma - Pb}{Pma - Pf}$$

SONIC LOG

LITHOLOGY	tm	3%	5%	6%	7%	8%	12%	15%
Dolomite	43.5	47.87	50.78	52.23	53.69	55.14	60.96	65.33
Limey Dolo.	44.5	48.84	51.73	53.17	54.62	56.06	61.84	66.18
Dolo. Limestone	45.5	48.8	52.68	54.1	55.55	56.98	62.7	67.03
Limestone	47	51.26	54.1	55.5	56.94	58.36	64.04	68.3
Limey Sandstone	52	56.1	58.85	60.22	61.59	62.96	68.44	72.55
Sandstone	55	59.02	61.7	63.04	64.4	65.7	71.1	75.1

Sandstone

$$F = \frac{.62}{\phi^{2.15}} \text{ or } \frac{.81}{\phi^2}$$

Carbonate

$$F = 1/\phi^2$$

$$F = \frac{Ro}{R_w}$$

$$Sw = Ro/R_t = \sqrt{\frac{FRw}{R_t}}$$

Sonic log:

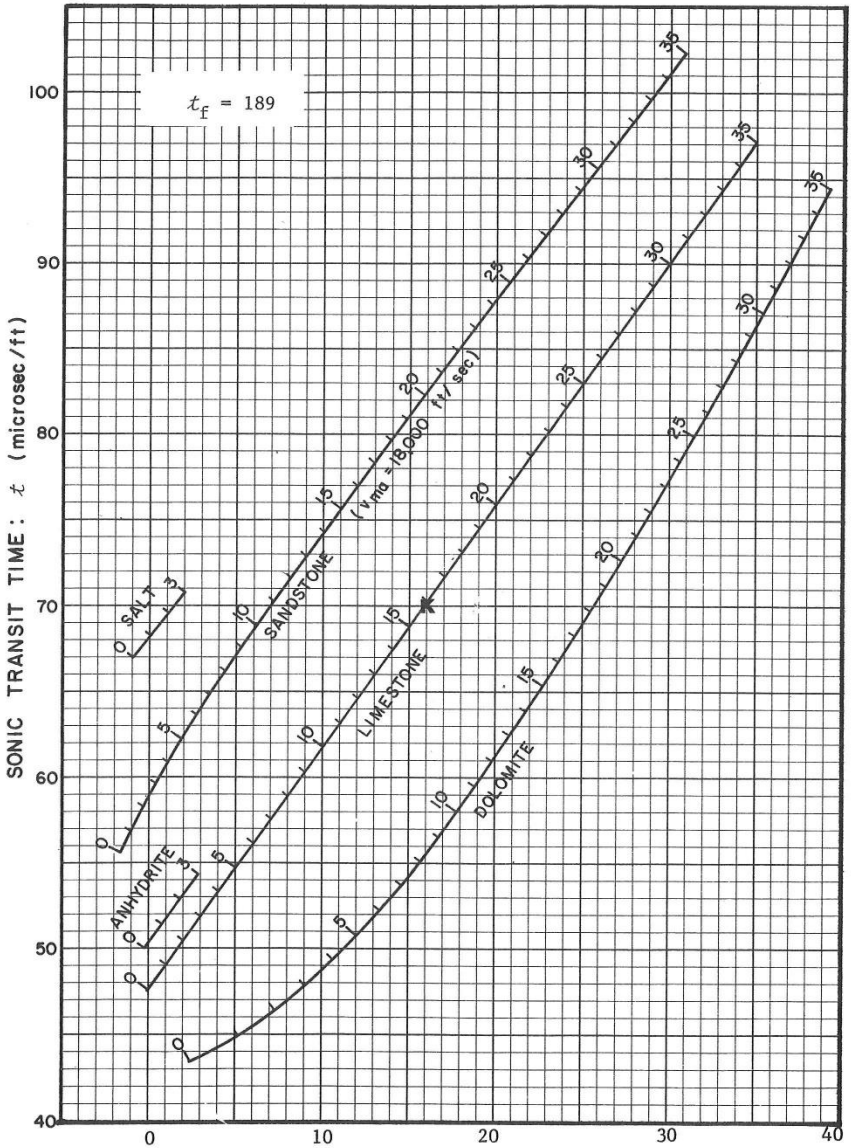
$$\Delta t = \Phi.\Delta t_f + (1-\Phi).\Delta t_{ma}$$

Wyllie time average equation:

$$\Phi = \frac{(\Delta t - \Delta t_{ma})}{(\Delta t_f - \Delta t_{ma})}$$

Δt_{ma} :	Quartz	55.5 μsec/foot	Δt_f :	189
	Calcite	47.5		
	Dolomite	43.5		

Figure 10-3 Schlumberger sonic/compensated neutron crossplot
(courtesy Schlumberger)



Compensated Neutron Apparent Limestone Porosity %

COUNTY	FORMATION	LOCATION SEC	TWP	RANGE	OPERATOR	LEASE	DEPTH	RW	TEMP	S
CANADIAN	BIG LIME	11	13 N	6 W	MIDWEST OIL	HOLLOMAN 1	7360	0.038	100	P
CANADIAN	BIG LIME	11	13 N	6 W	MIDWEST OIL	HOLLOMAN 1	7359	0.038	100	P
CANADIAN	BIG LIME	12	13 N	6 W	MIDWEST OIL	HODGES 1	7355	0.040	100	P
CANADIAN	BOIS D'ARC	1	14 N	5 W			6997	0.041	100	U
CANADIAN	BOIS D'ARC	1	14 N	5 W			6997	0.041	100	T
CANADIAN	BOIS D'ARC	13	14 N	5 W			7065	0.042	100	U
CANADIAN	BOIS D'ARC	13	14 N	5 W			7065	0.038	100	T
CANADIAN	BOIS D'ARC	13	14 N	5 W			7065	0.042	100	T
CANADIAN	BOIS D'ARC	13	14 N	5 W			7065	0.038	100	U
CANADIAN	BOIS D'ARC	25	14 N	5 W			7110	0.044	100	U
CANADIAN	BOIS D'ARC	25	14 N	5 W			6984	0.047	100	T
CANADIAN	BOIS D'ARC	25	14 N	5 W			7110	0.042	100	T
CANADIAN	BOIS D'ARC	25	14 N	5 W			6984	0.047	100	U
CANADIAN	BOIS D'ARC	25	14 N	5 W			7110	0.042	100	U
CANADIAN	BOIS D'ARC	25	14 N	5 W			7110	0.044	100	T
CANADIAN	BROMIDE	15	12 N	6 W				0.030	100	U
CANADIAN	HUNTON	17	11 N	5 W	MAGNESS PETR	KINDL 17-1	8825	0.060	100	P
CANADIAN	HUNTON	7	11 N	6 W	RAMSEY ENGR.	KIRKEGARD #1	9657	0.057	100	U
CANADIAN	HUNTON	36	13 N	6 W	OKLA NAT GAS CO	OKLA #1		0.063	100	P
CANADIAN	HUNTON	1	14 N	5 W			7110	0.042	100	U
CANADIAN	HUNTON	1	14 N	5 W			7110	0.038	100	T
CANADIAN	HUNTON	1	14 N	5 W			7110	0.042	100	P
CANADIAN	HUNTON	1	14 N	5 W			7110	0.042	100	T
CANADIAN	HUNTON	12	14 N	5 W			7007	0.043	100	T
CANADIAN	HUNTON	12	14 N	5 W			7007	0.043	100	U
CANADIAN	HUNTON	13	14 N	5 W			7096	0.044	100	U
CANADIAN	HUNTON	13	14 N	5 W			7065	0.038	100	P
CANADIAN	HUNTON	13	14 N	5 W			7096	0.044	100	T
CANADIAN	MORROW	16	11 N	9 W	WOODS PETR	THOMAS 1		0.241	100	P
CANADIAN	MORROW	16	11 N	9 W	WOODS PETR	THOMAS 1		0.241	100	P
CANADIAN	MORROW	21	11 N	9 W	WOODS PETR	WILLARD 1		0.229	100	P
CANADIAN	MORROW	29	11 N	9 W	WOODS PETR	NUGENT 1	11971	0.254	100	T
CANADIAN	MORROW	1	11 N	10 W	JONES & PELLOW	RINEHART GROVES 1	11400	0.182	100	P
CANADIAN	MORROW	21	11 N	10 W			12500	0.323	100	P
CANADIAN	MORROW	21	11 N	10 W				0.318	100	U
CANADIAN	MORROW	18	12 N	9 W	AMOCO PROD	WITCHER UNIT	11079	0.237	100	P
CANADIAN	MORROW	18	12 N	9 W				0.190	100	U

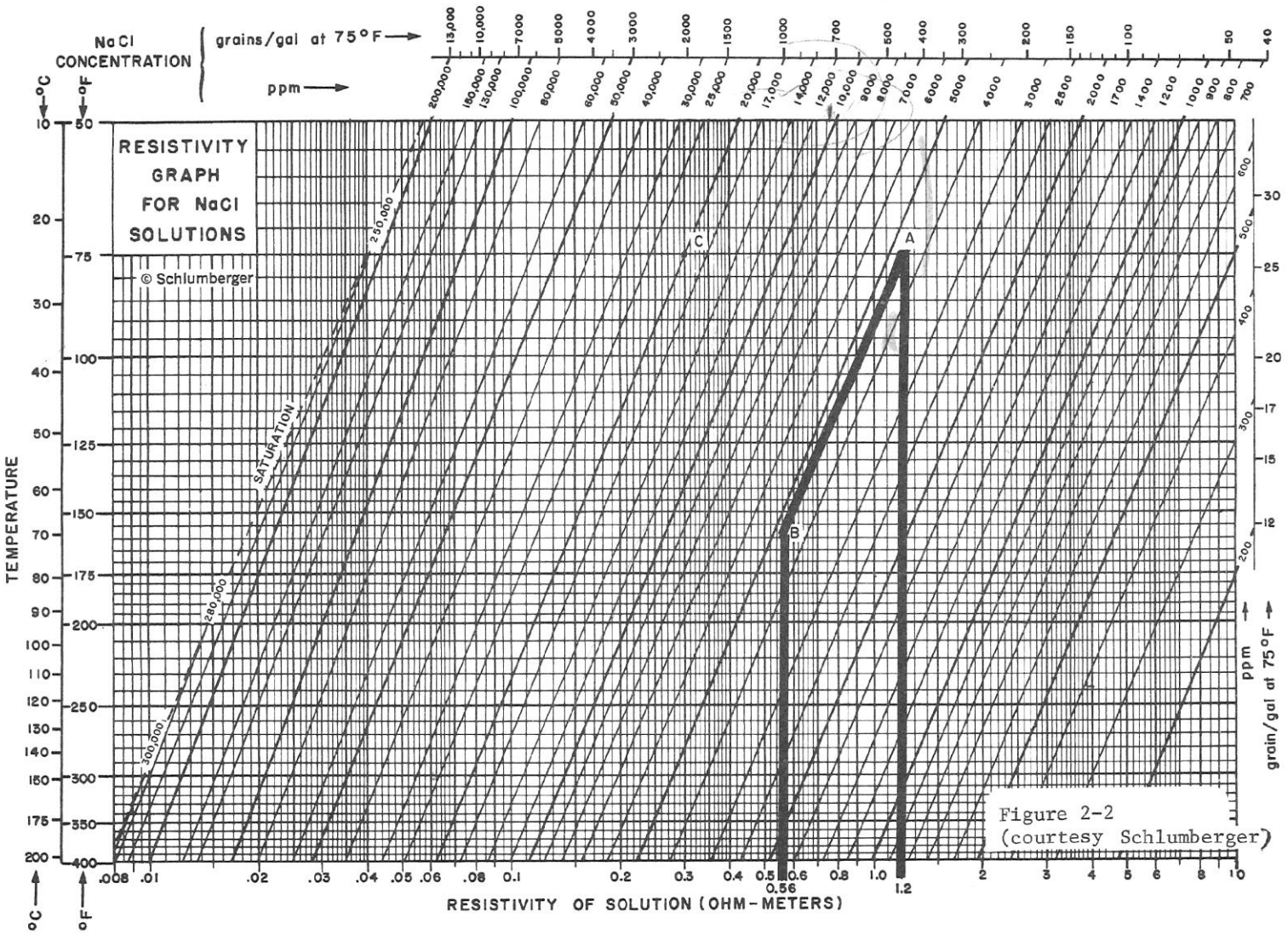


Figure 2-2
(courtesy Schlumberger)

Example: R_m is 1.2 at 75°F (point A on chart). Follow trend of slanting lines (constant salinities) to find R_m at other temperatures; for example, at Formation Temperature (FT) = 160°F (point B) read $R_m = 0.56$. The conversion shown in this chart is approximated by the Arps formula: $R_{FT} = R_{75°} \times (75° + 7)/(\text{FT (in °F)} + 7)$.

Photoelectric factor log