Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End Term Examinations – May/June 2026	
Date: 14 – 05- 2026	**Time:** 09:30am – 12:30pm

School: SOE	**Program:** B.Tech. (PET)	
Course Code: PET2113	**Course Name:** Fundamentals of Geophysical Logging Techniques	
Semester: IV	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	CO1	CO2	CO3	CO4	CO5	CO6
Marks	10	10	12	12	26	30

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

(iii) ***As informed, additional Charts will not be shared along with Question Paper. Therefore, use the Charts provided in the Question Paper to solve the problems and submit the Question Paper along with the Answer-script for Evaluation.***

Part A

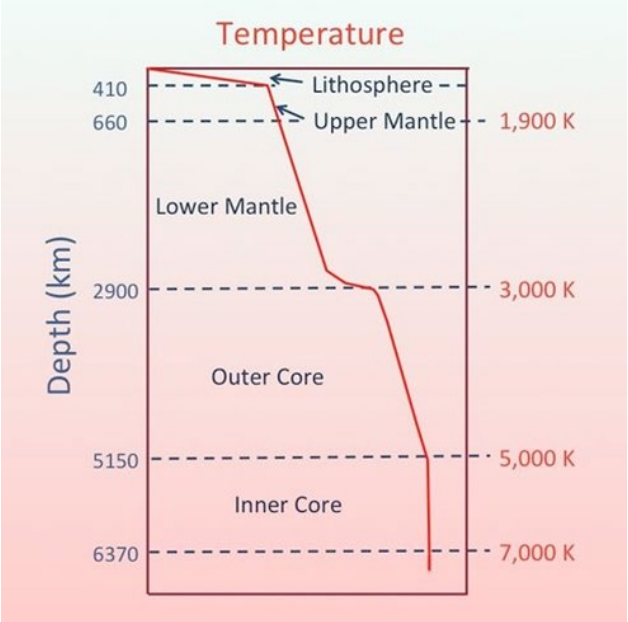
Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1.	Select the correct option: The option, _____, defines log measurements based on natural phenomena. A. Measurements obtained by transmitting electrical current into the formation B. Measurements that record naturally occurring properties of formations C. Measurements obtained only during drilling D. Measurements influenced only by borehole fluid	**2 Marks**	**L1**	**CO3**
2.	Identify and fill each blank with appropriate missing word: The formations commonly identified using resistivity logs are _____ zones and _____ zones.	**2 Marks**	**L1**	**CO4**
3.	Select the correct option: _____ tool is identified for evaluating cement bonding behind casing. A. RFT B. NMR	**2 Marks**	**L1**	**CO5**

	C. CBL D. FMS			
4.	Explain a Cement Bond Log (CBL).	**2 Marks**	**L2**	**CO5**
5.	Describe an Ultrasonic Imager Tool (USIT).	**2 Marks**	**L2**	**CO5**
6.	Select the correct option: Coss-plots are useful in lithology identification because _____. A. They eliminate the need for depth matching B. They combine responses of two independent logs C. They reduce borehole effects completely D. They replace core analysis	**2 Marks**	**L1**	**CO6**
7.	Explain the use of a cross-plot in well log interpretation.	**2 Marks**	**L2**	**CO6**
8.	Select the correct option: Compared to clean formations, shaly formations plot _____ on cross-plots. A. Along clean lithology lines B. Away from standard lithology trends C. With higher resistivity D. With lower sonic travel time	**2 Marks**	**L1**	**CO6**
9.	Describe two applications of cross-plots in reservoir evaluation.	**2 Marks**	**L2**	**CO6**
10.	Explain the significance of gas effect in Neutron–Density cross-plots.	**2 Marks**	**L2**	**CO6**

Part B

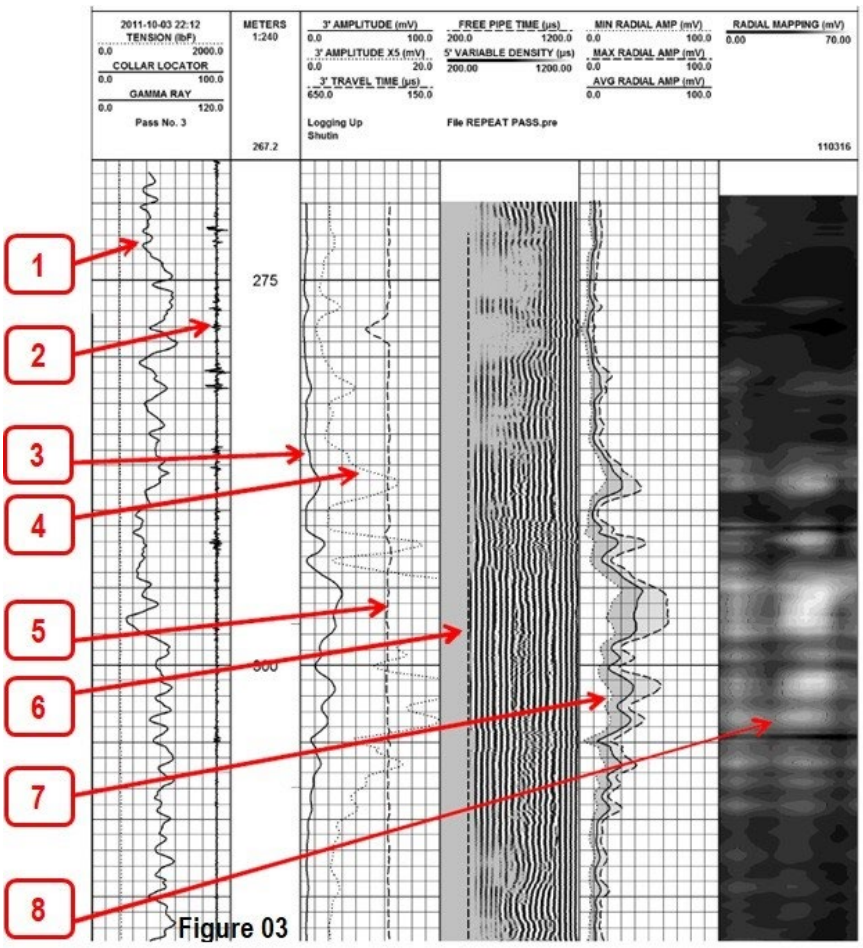
Answer the Questions. **Total Marks 80M**

11.	**a.**	Temperature profile of the Earth's layers is displayed in Figure X. Illustrate the Figure.  **Figure X**	**5 Marks**	**L3**	**CO1**
	b.	Determine NaCl concentration at 25°F and resistivity at 170°F when the resistivity of a given water sample is 0.94 ohm-m at 25°F using Chart 01 shared at the end of this Question Paper. **DO NOT FORGET TO SHARE THE CHART.**	**5 Marks**	**L3**	**CO1**

		OR			
12.	**a.**	A well exhibits abnormal log responses due to borehole enlargement and mud invasion. Demonstrate how a Well Log Analyst / Petrophysicist would apply log interpretation principles to correct the data and estimate porosity and water saturation.	**5 Marks**	**L3**	**CO1**
	b.	During drilling of a highly deviated well, conventional wireline logging is not feasible. Apply your knowledge of basic log types to recommend an appropriate logging method and illustrate how the selected method ensures reliable formation evaluation.	**5 Marks**	**L3**	**CO1**
13.	**a.**	Calculate Formation Factor, when (a) Ø = 6%, m = 1.8, a = 0.81 (b) Ø = 10%, m = 2.2	**5 Marks**	**L3**	**CO2**
	b.	Apply the Chart 02 shared at the end of this Question Paper to find Formation Resistivity Factor when (a) Ø = 6%, m = 2.8, a = 1 (b) Ø = 10%, m = 1.6 **DO NOT FORGET TO SHARE THE CHART.**	**5 Marks**	**L3**	**CO2**
		OR			
14.	**a.**	A sandstone formation shows high porosity but moderate resistivity on logs. Apply your knowledge of rock composition and texture to explain why high porosity does not always correspond to high resistivity.	**5 Marks**	**L3**	**CO2**
	b.	A reservoir interval exhibits lower resistivity than expected from its porosity. Apply the concept of shaliness to explain how clay minerals can alter resistivity response.	**5 Marks**	**L3**	**CO2**
15.		Under some circumstances, the FDC (Compensated Formation Density) log and Litho-Density log must be corrected for borehole size, and the SNP (Sidewall Neutron) log must be corrected for mudcake thickness and Chart 03 provides those corrections. From the given Chart 03, predict the correct Formation Density, and Mudcake thickness for a mud-filled borehole where borehole diameter (d_h), formation density (ρ_b), mud density (ρ_m), SNP Apparent Porosity (ϕ_{SNP}), Caliper reading, and Bit Size are recorded as 12 in, 2.45 g/cm^3, 1.05 g/cm^3, 13 p.u., $7^{5/8}$ in, and $7^{7/8}$, respectively. **DO NOT FORGET TO SHARE THE CHART.**	**10 Marks** **[5 + 5]**	**L3**	**CO3**
		OR			
16.	**a.**	In a hostile well environment (high temperature and pressure), some logs show partial data loss. Interpret the limitations imposed by hostile environments on downhole tools and how tool design mitigates these challenges.	**5 Marks**	**L3**	**CO3**

	b.	A complex reservoir requires multiple petrophysical measurements in a single run. Demonstrate the advantages and limitations of tool combinations and tool string design in such situations.	**5 Marks**	**L3**	**CO3**

17.	**a.**	Identify Porosity (ϕ) with the help of Chart 04 and the data shared below in P1, and P2. (P1) ρ_b = 2.48 g/cc, ρ_{ma} = 2.65 g/cc, and ρ_f = 0.90 g/cc (P2) ρ_b = 2.70 g/cc, ρ_{ma} = 2.87 g/cc, and ρ_f = 1.20 g/cc **DO NOT FORGET TO SHARE THE CHART.**	**5 Marks**	**L4**	**CO4**
	b.	Calculate Porosity (ϕ) from Formation Density Log (ρ_b) using the data shared above in P1, and P2.	**5 Marks**	**L4**	**CO4**
OR					
18.	**a.**	Analyze the fundamental principle of resistivity logging and distinguish how it enables the identification of hydrocarbon-bearing formations.	**5 Marks**	**L4**	**CO4**
	b.	Compare Laterolog and Induction logging tools in terms of their operational mechanisms and suitability for different drilling environments.	**5 Marks**	**L4**	**CO4**

19.		Figure 03 displays the parameters measured and presented on the Radial Bond Log (RBL). Identify and illustrate any five of the parameters labelled 1 through 8 in Figure 03.  Figure 03	**20 Marks [10 + 10]**	**L4**	**CO5**

OR

20.	**a.**	Analyze the role of Formation MicroScanner (FMS) logs in identifying fractures, bedding planes, and structural features, and distinguish their importance in reservoir characterization.	**10 Marks**	**L4**	**CO5**
	b.	Analyze how integrating PLT, CBL/VDL, USIT, NMR, and FMS logs improves reservoir and well performance diagnosis compared to using individual logs independently.	**10 Marks**	**L4**	**CO5**

21. The geophysical log data for PU Well 1 is shared below. Appy your knowledge to identify the appropriate chart from Chart 05 through Chart 10 shared below (separately) and identify porosity as well as lithology for the freshwater-invaded zone using the Sonic Transit Time – Bulk Density cross-plot technique.

20 Marks [10 + 10] | **L4** | **CO6**

Sl. No.	Depth (ft)	GR (API)	RHOB (g/cc)	NPHI (frac)	RES_D (Ohm_m)	RES_S (Ohm_m)	RES_MICR	DT (us/ft)
1	617	94	2.65	0.11	16	18	20	74.78
2	626	30	2.47	0.07	16	16	8	75.61
3	643	28	2.39	0.11	2	2	2	70.94
4	653	45	2.55	0.08	4	4	5	70.82
5	667	60	2.67	0.11	2	2	3	68.56

Copy the following Table in the Answer-script and fill out predicted results:

Sonic Transit Time – Bulk Density Cross-plot			
Sl. No.	**Chart No.**	**Cross-plot Porosity**	**Lithology**
1			
2			
3			
4			
5			

DO NOT FORGET TO SHARE THE CHART.

OR

22.	**a.**	Identify the limitations of cross-plot interpretation in thinly bedded or invaded formations, and relate how environmental effects distort cross-plot responses.	**10 Marks**	**L4**	**CO6**
	b.	Examine how integrating multiple cross-plots (Neutron–Density, Sonic–Neutron, Sonic–Density) improves lithology discrimination and porosity estimation compared to using a single cross-plot.	**10 Marks**	**L4**	**CO6**

Chart 01:

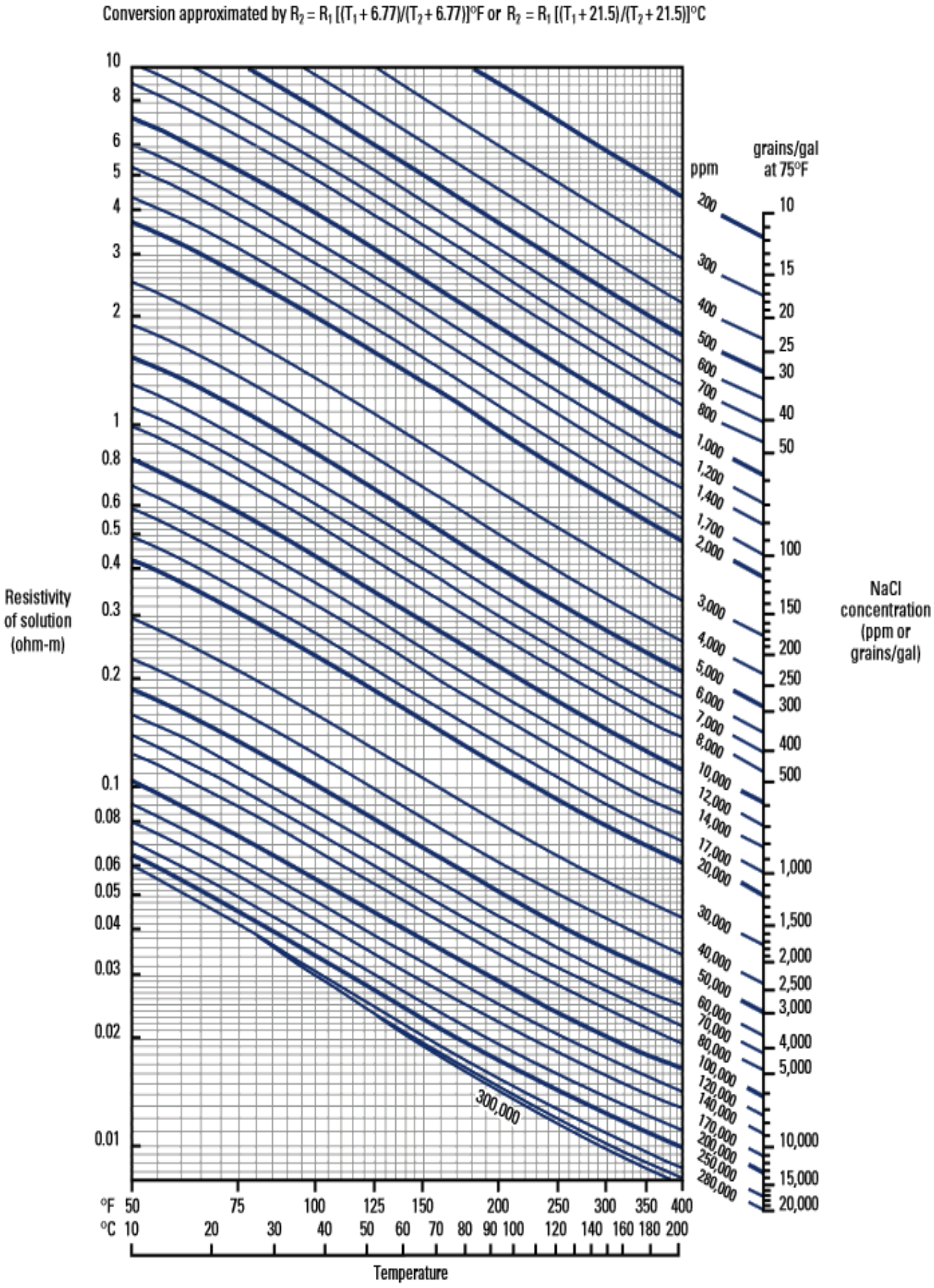

Conversion approximated by $R_2 = R_1 [(T_1 + 6.77)/(T_2 + 6.77)]$°F or $R_2 = R_1 [(T_1 + 21.5)/(T_2 + 21.5)]$°C
Resistivity of solution (ohm-m)
10
8
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
0.08
0.06
0.05
0.04
0.03
0.02
0.01
300,000
ppm
200
300
400
500
600
700
800
1,000
1,200
1,400
1,700
2,000
3,000
4,000
5,000
6,000
7,000
8,000
10,000
12,000
14,000
17,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
100,000
120,000
140,000
170,000
200,000
250,000
280,000
grains/gal at 75°F
10
15
20
25
30
40
50
100
150
200
250
300
400
500
1,000
1,500
2,000
2,500
3,000
4,000
5,000
10,000
15,000
20,000
NaCl concentration (ppm or grains/gal)
°F 50 75 100 125 150 200 250 300 350 400
°C 10 20 30 40 50 60 70 80 90 100 120 140 160 180 200
Temperature

Chart 02:

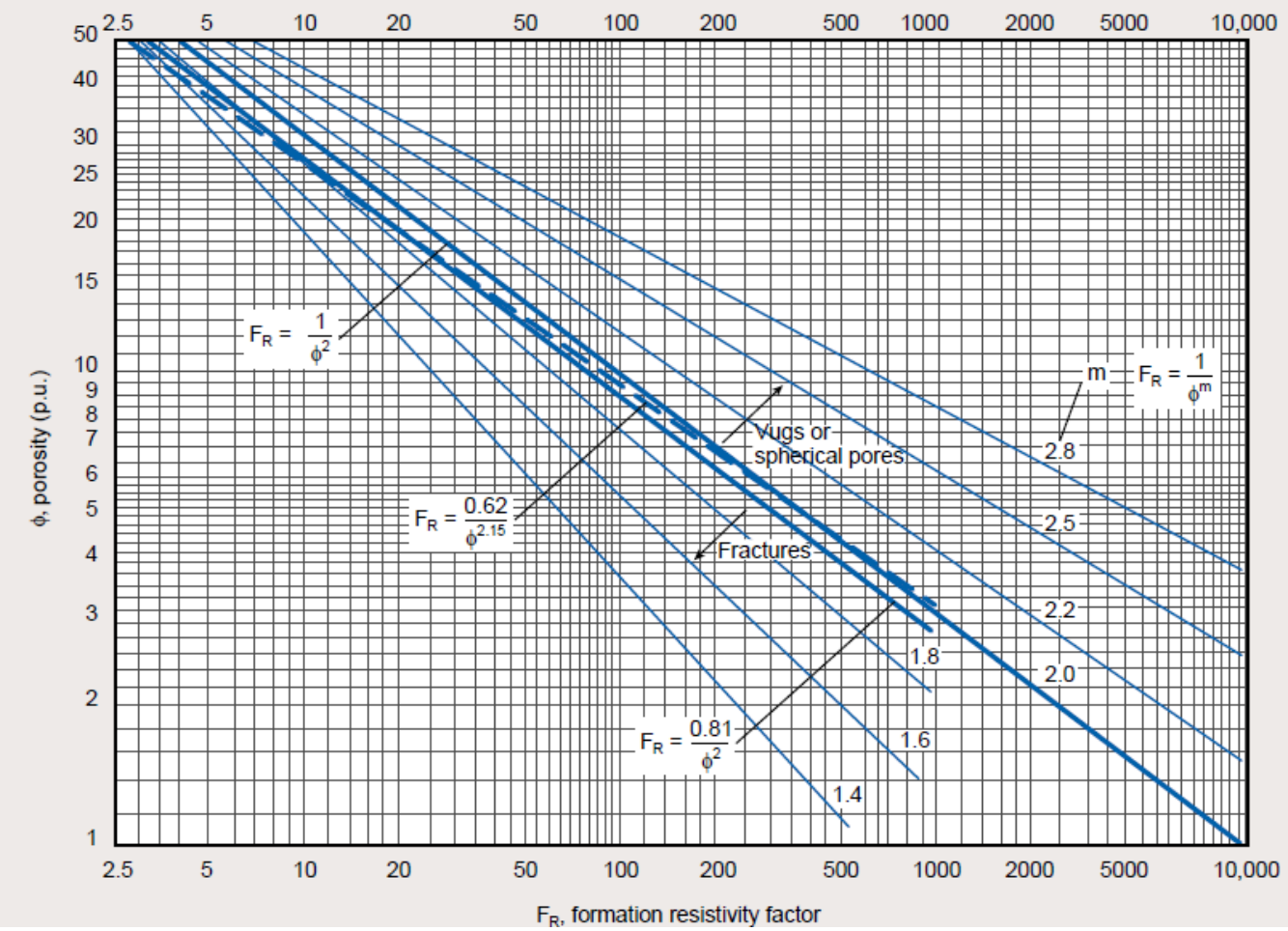
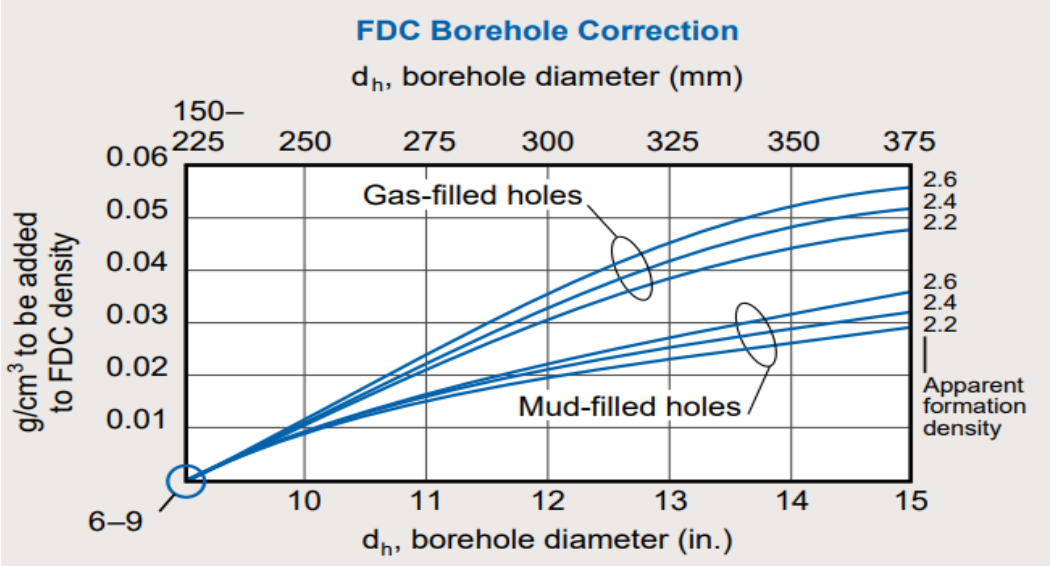
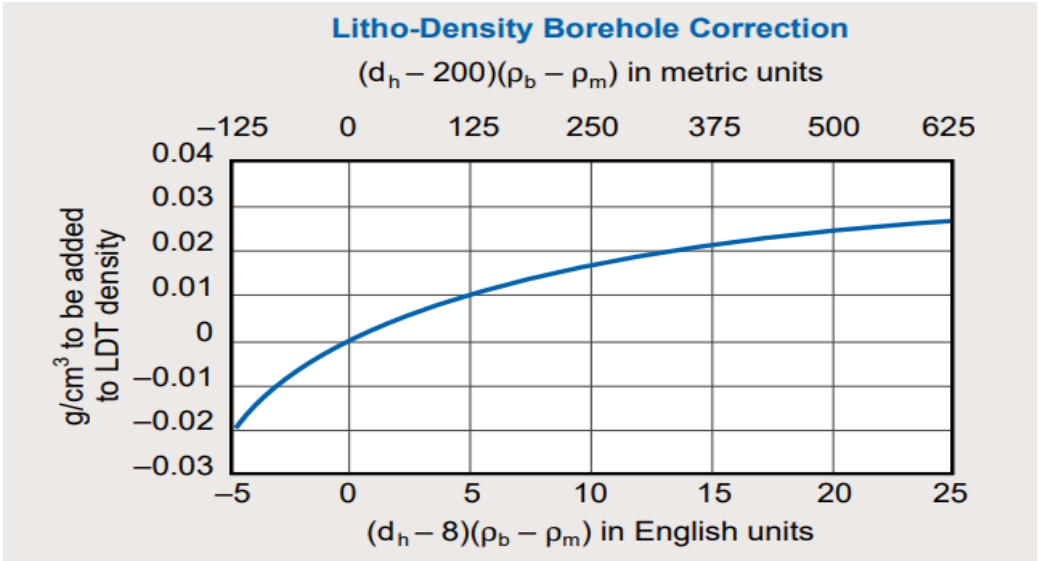

2.5
5
10
20
50
100
200
500
1000
2000
5000
10,000
50
40
30
25
20
15
10
9
8
7
6
5
4
3
2
1
ϕ, porosity (p.u.)
$F_R = \frac{1}{\phi^2}$
$F_R = \frac{0.62}{\phi^{2.15}}$
$F_R = \frac{0.81}{\phi^2}$
Vugs or spherical pores
Fractures
m
$F_R = \frac{1}{\phi^m}$
2.8
2.5
2.2
2.0
1.8
1.6
1.4
F_R, formation resistivity factor

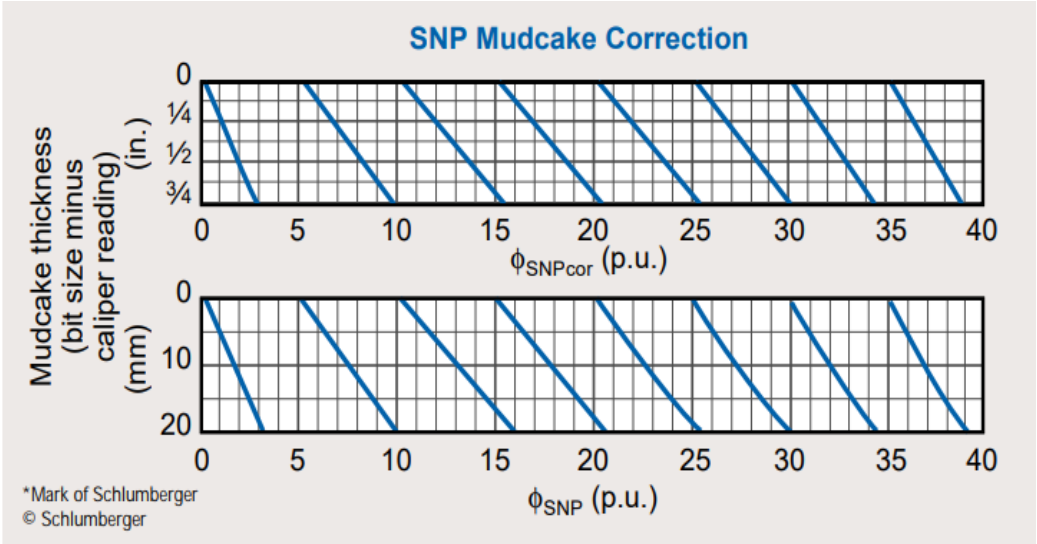
Chart 03:


FDC Borehole Correction
d_h, borehole diameter (mm)
150–225
250
275
300
325
350
375
0.06
0.05
0.04
0.03
0.02
0.01
g/cm³ to be added to FDC density
Gas-filled holes
Mud-filled holes
2.6
2.4
2.2
2.6
2.4
2.2
Apparent formation density
6–9
10
11
12
13
14
15
d_h, borehole diameter (in.)

(a)


Litho-Density Borehole Correction
$(d_h - 200)(\rho_b - \rho_m)$ in metric units
–125
0
125
250
375
500
625
0.04
0.03
0.02
0.01
0
–0.01
–0.02
–0.03
g/cm³ to be added to LDT density
–5
0
5
10
15
20
25
$(d_h - 8)(\rho_b - \rho_m)$ in English units

(b)


SNP Mudcake Correction
0
¼
½
¾
Mudcake thickness (bit size minus caliper reading) (in.)
0
5
10
15
20
25
30
35
40
ϕ_{SNPcor} (p.u.)
0
10
20
Mudcake thickness (mm)
ϕ_{SNP} (p.u.)
*Mark of Schlumberger
© Schlumberger

(c)

Chart 04:

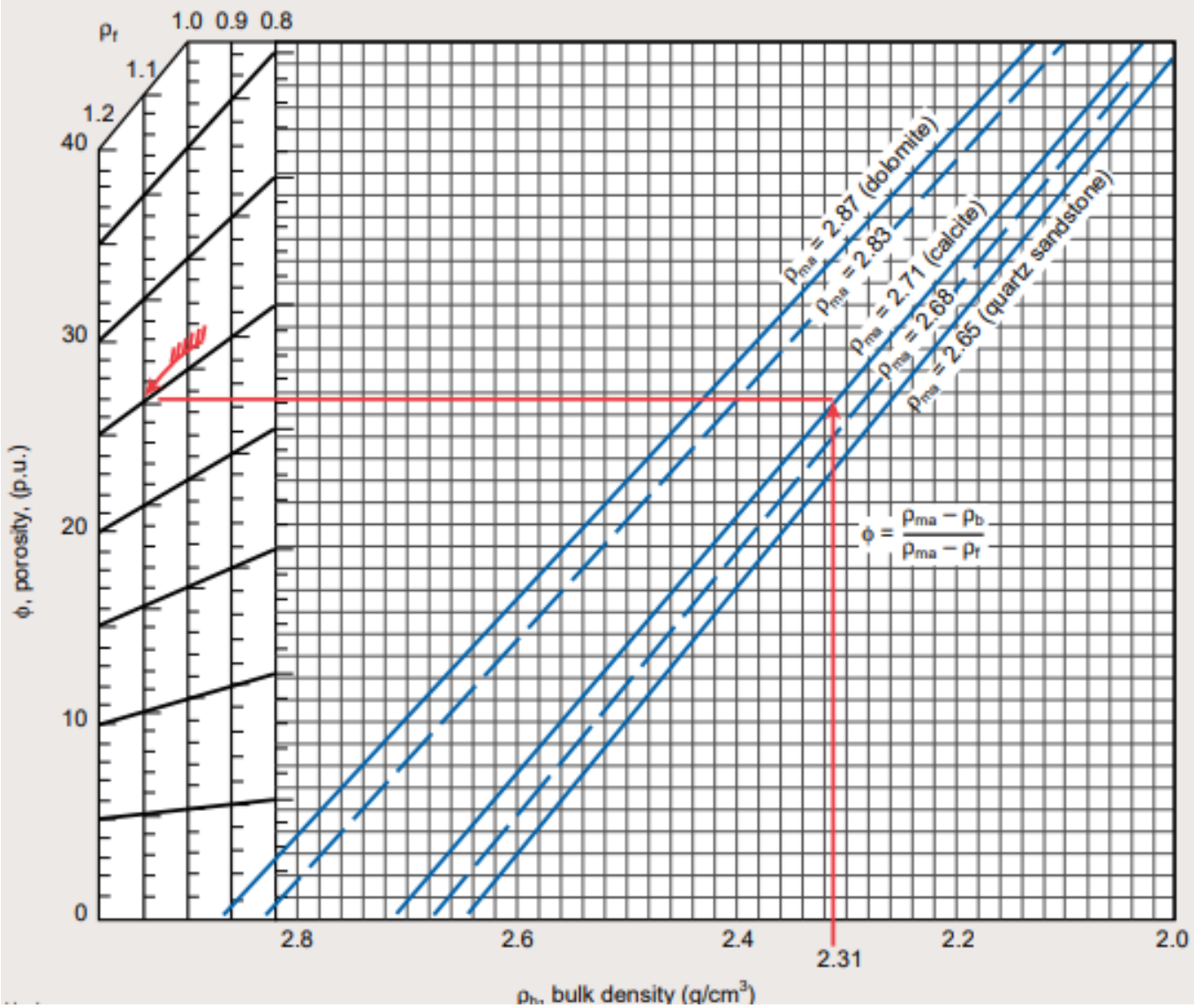

ρf
1.0 0.9 0.8
1.1
1.2
40
30
20
10
0
ϕ, porosity, (p.u.)
ρma = 2.87 (dolomite)
ρma = 2.83
ρma = 2.71 (calcite)
ρma = 2.68
ρma = 2.65 (quartz sandstone)
ϕ = (ρma − ρb) / (ρma − ρf)
2.8
2.6
2.4
2.31
2.2
2.0
ρb, bulk density (g/cm3)

Chart 05:

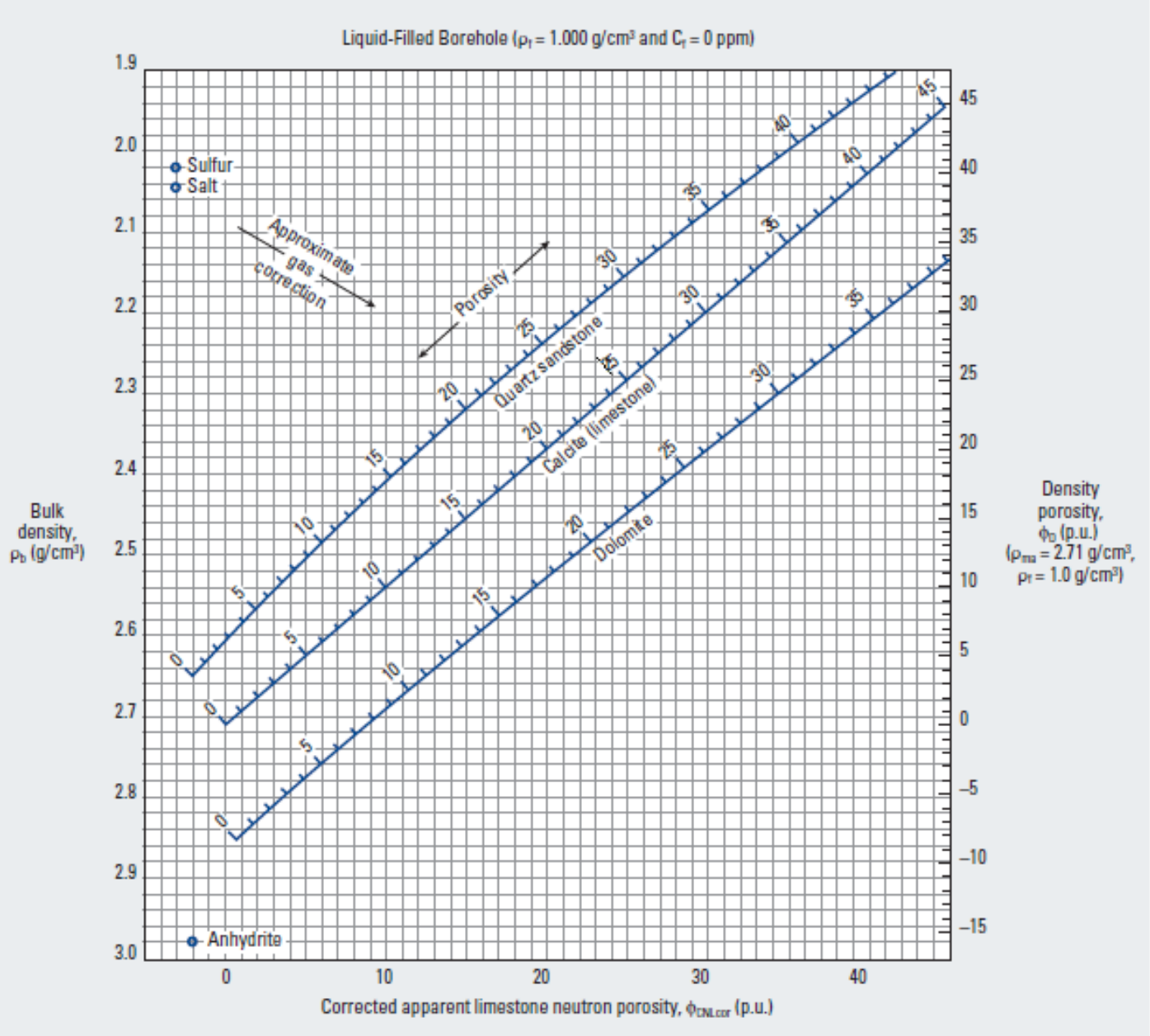

Liquid-Filled Borehole (ρ_f = 1.000 g/cm³ and C_f = 0 ppm)
Sulfur
Salt
Anhydrite
Approximate gas correction
Porosity
Quartz sandstone
Calcite (limestone)
Dolomite
Bulk density, ρ_b (g/cm³)
Density porosity, ϕ_D (p.u.) (ρ_{ma} = 2.71 g/cm³, ρ_f = 1.0 g/cm³)
Corrected apparent limestone neutron porosity, $\phi_{CNL,cor}$ (p.u.)

Chart 06:

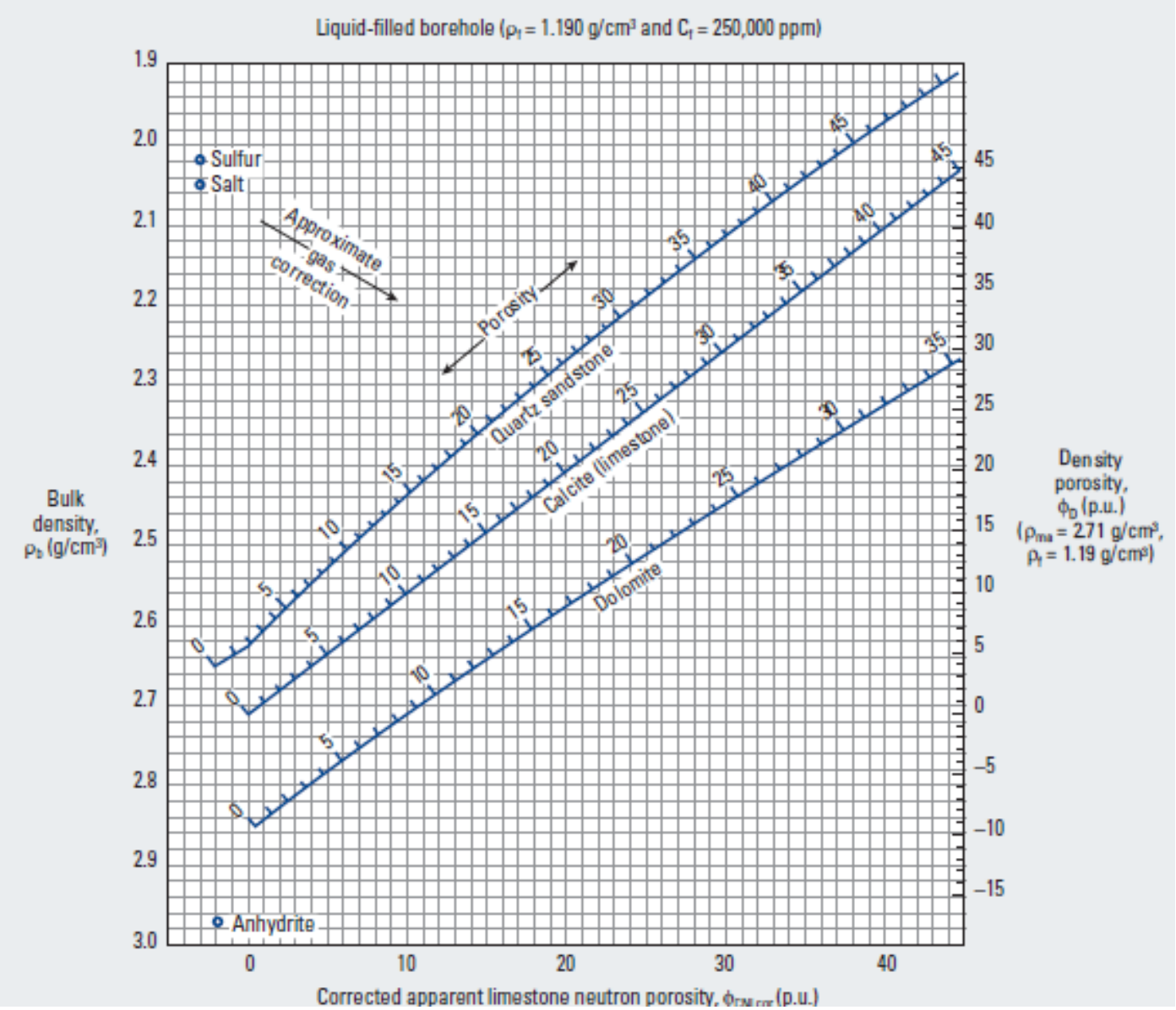

Liquid-filled borehole (ρ_f = 1.190 g/cm³ and C_f = 250,000 ppm)
Sulfur
Salt
Approximate gas correction
Porosity
Quartz sandstone
Calcite (limestone)
Dolomite
Anhydrite
Bulk density, ρ_b (g/cm³)
Density porosity, ϕ_D (p.u.) (ρ_{ma} = 2.71 g/cm³, ρ_f = 1.19 g/cm³)
Corrected apparent limestone neutron porosity, ϕ_{TNLcor} (p.u.)

Chart 07:

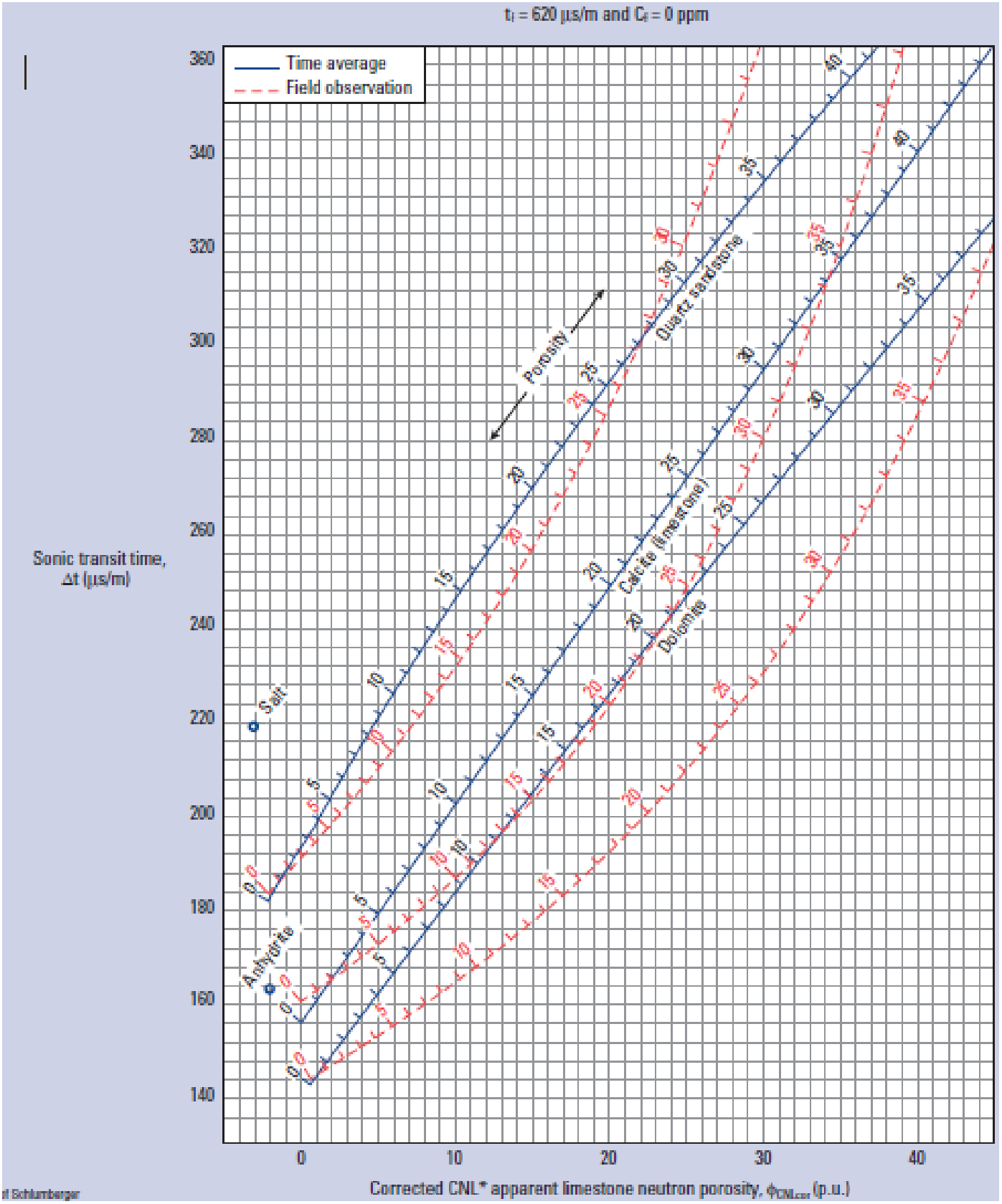

t_f = 620 µs/m and C_f = 0 ppm
Time average
Field observation
Porosity
Quartz sandstone
Calcite (limestone)
Dolomite
Salt
Anhydrite
Sonic transit time, Δt (µs/m)
Corrected CNL* apparent limestone neutron porosity, ϕ_{CNLcor} (p.u.)
360
340
320
300
280
260
240
220
200
180
160
140
0
10
20
30
40

Chart 08:

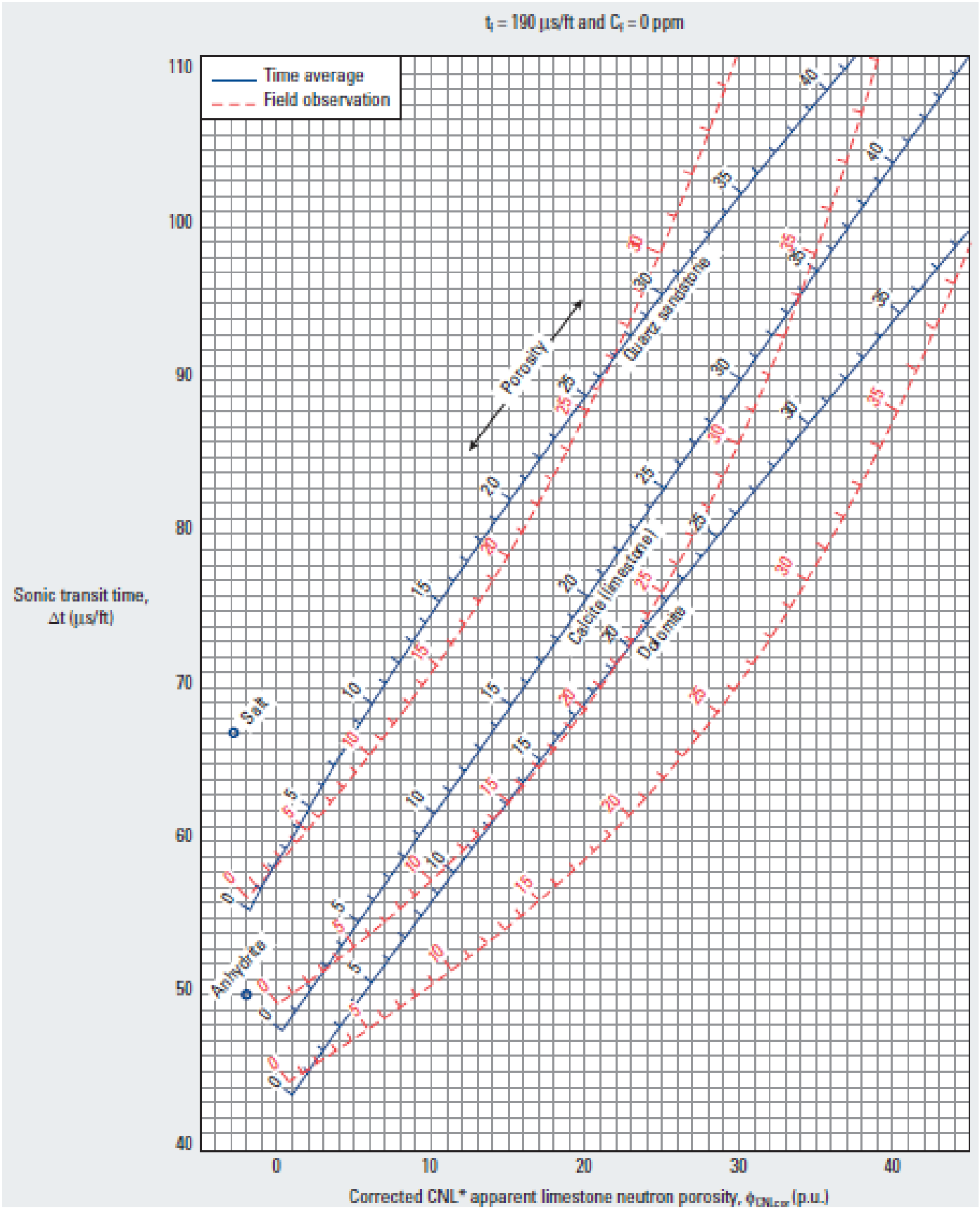

t_f = 190 µs/ft and C_f = 0 ppm
Time average
Field observation
Porosity
Quartz sandstone
Calcite (limestone)
Dolomite
Salt
Anhydrite
Sonic transit time, Δt (µs/ft)
Corrected CNL* apparent limestone neutron porosity, ϕ_{CNLcor} (p.u.)
110
100
90
80
70
60
50
40
0
10
20
30
40

Chart 09:

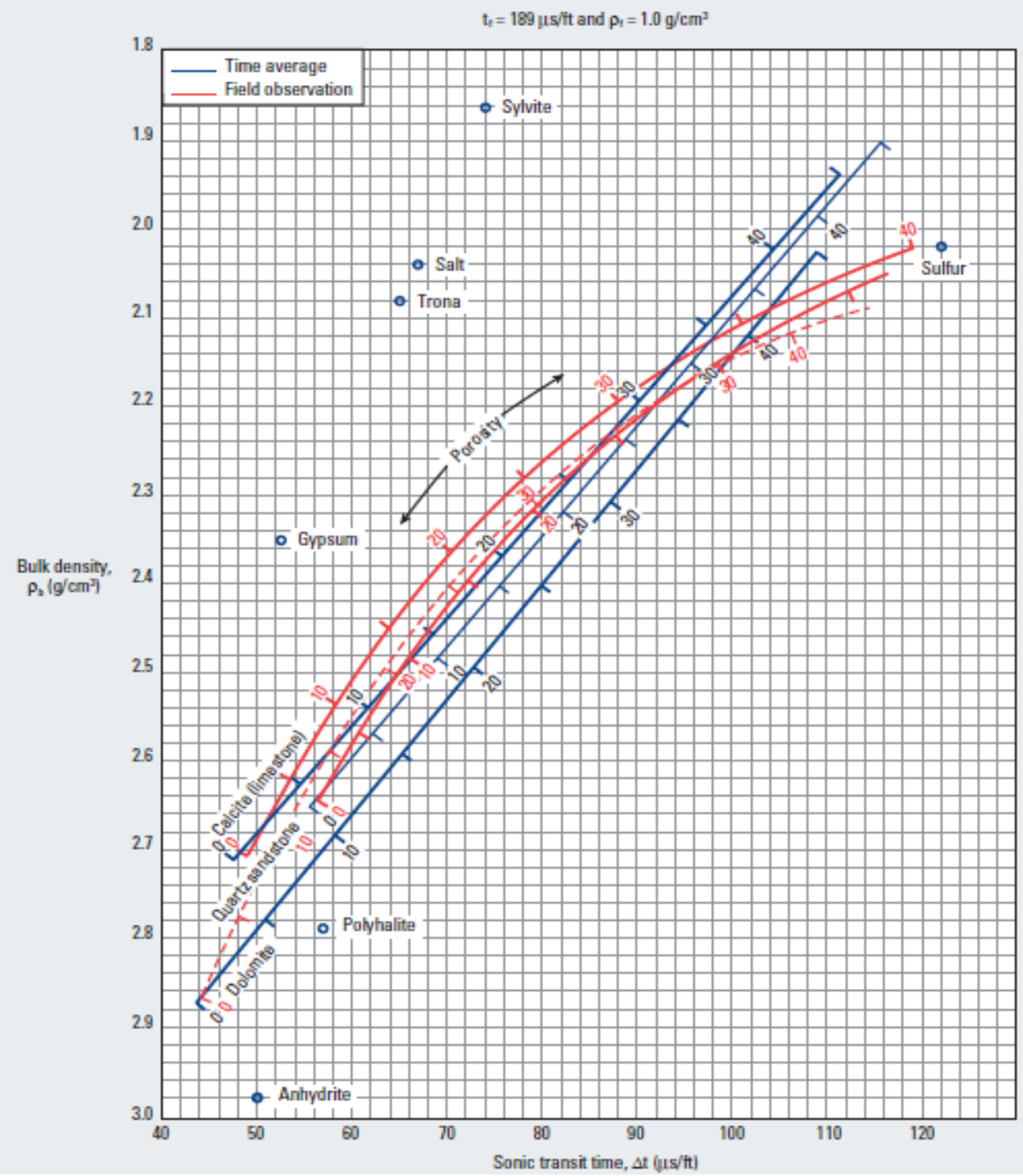
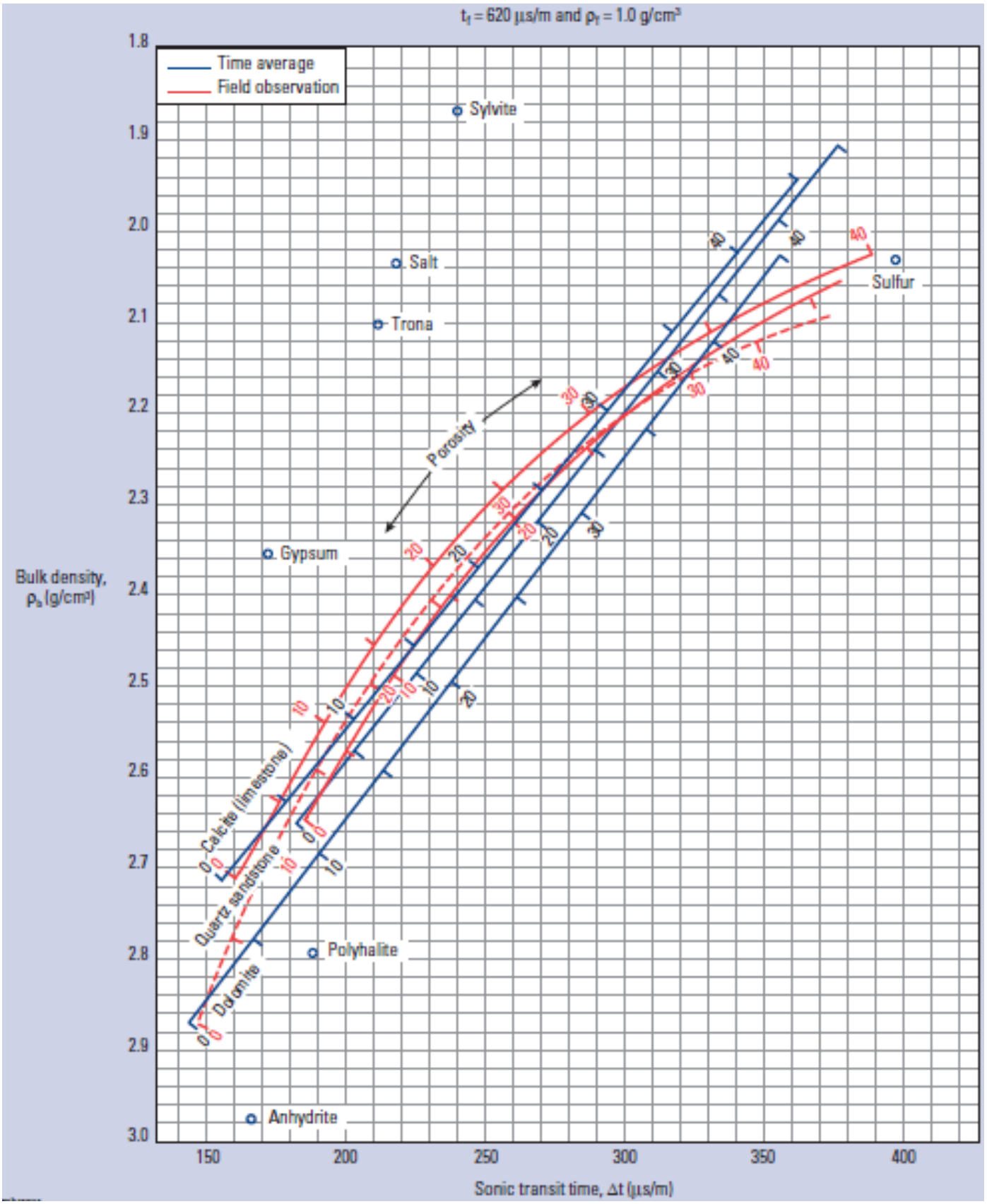

t_f = 189 µs/ft and ρ_f = 1.0 g/cm³
Time average
Field observation
Sylvite
Salt
Trona
Sulfur
Porosity
Gypsum
Polyhalite
Anhydrite
Calcite (limestone)
Quartz sandstone
Dolomite
Bulk density, ρ_b (g/cm³)
Sonic transit time, Δt (µs/ft)
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
40
50
60
70
80
90
100
110
120

Chart 10:


t_f = 620 µs/m and ρ_f = 1.0 g/cm³
Time average
Field observation
Sylvite
Salt
Trona
Sulfur
Gypsum
Polyhalite
Anhydrite
Porosity
Calcite (limestone)
Quartz sandstone
Dolomite
Bulk density, ρ_b (g/cm³)
Sonic transit time, Δt (µs/m)
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
150
200
250
300
350
400