Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM EXAMINATION – AUGUST 2024

Semester: Semester IV- DCET
Course Code: PET2002
Course Name: Fundamentals of Geophysical Logging Techniques
Program & Sem: B.Tech. & IV Sem (DCET-4PET-1)

Date:07-08-2024
Time: 09:30 AM – 12:30 PM
Max Marks: 100
Weightage: 50%

Instructions:
(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.
(iv) Do not write any information on the question paper other than Roll Number.
(v) ***Charts to be used for solving problems are printed herewith. Therefore, submit the Question Paper along with the Answer-script.***

PART A

ANSWER ANY FIVE QUESTIONS **(5QX 2M = 10M)**

1. Match the petrophysical data with their sources.

Petrophysical Data	Sources
1. Mud Log	A. Drill Core / Side-wall Core
2. Cased Hole Log	B. Well Production Data
3. Core	C. Log Data / Cuttings
4. Open Hole Log	D. Wireline / While drilling
	E. Borehole Seismic

(CO1) [Knowledge]

2. Fill in the Blank: The DNG Tool String combines three key tools, i.e., _____, _____, and _____. (CO2) [Knowledge]

3. Define the principle behind the SP log. (CO3) [Knowledge]

4. Write one limitation of the gamma ray log. (CO3) [Knowledge]

5. List down two key applications of production logging. (CO4) [Knowledge]

6. Recall a primary application of CBL/VDL logs. (CO4) [Knowledge]

7. Write one application of the sonic-density cross-plot in reservoir evaluation. (CO5) [Knowledge]

PART B

ANSWER ANY TWO QUESTIONS **(5QX 10M = 50M)**

8. Explain the role of well log analysts/petrophysicists in the oil and gas industry, and discuss how their work impacts exploration and production activities. (CO1) [Comprehension]

9. Illustrate the effects of borehole invasion on resistivity measurements and propose correction techniques to enhance data accuracy. (CO2) [Comprehension]

10. Summarize the impact of shale distribution on log measurements and discuss the implications for reservoir characterization. (CO2) [Comprehension]

11. Discuss the working principle of induction logging and assess its advantages over traditional resistivity logging methods. (CO3) [Comprehension]

12. Outline a well logging program for a deepwater drilling project, considering the unique challenges and required tools. Explain your choices. (CO3) [Comprehension]

13. Compare the various production logging tools and discuss their specific applications in different well conditions. (CO4) [Comprehension]

14. Explain the limitations of Sonic-Neutron cross-plots in highly shaly formations and propose methods to overcome these challenges. (CO5) [Comprehension]

PART C

ANSWER ANY ONE QUESTION **(2QX 20M = 40M)**

15. (a) Calculate the formation temperature at a depth of 2700 meters, given a surface temperature of 26°C and a geothermal gradient of 31°C/km. To calculate the formation temperature, use the formula: Tf = Ts + (Gg×D), where Tf = Formation Temperature, Ts = Surface Temperature, Gg = Geothermal Gradient, D = Depth.
NOTE: You may need to correct the given equation, if required.

Analyze how variations in the geothermal gradient can impact the estimation accuracy.

(b) Analyze the relationship between formation resistivity factor (F) and porosity (φ) using Archie's equation, given F = 1/φ^m. Calculate the formation resistivity factor for a formation with a porosity of 0.19 and a cementation exponent (m) of 2.
NOTE: You may need to correct the given equation, if required.

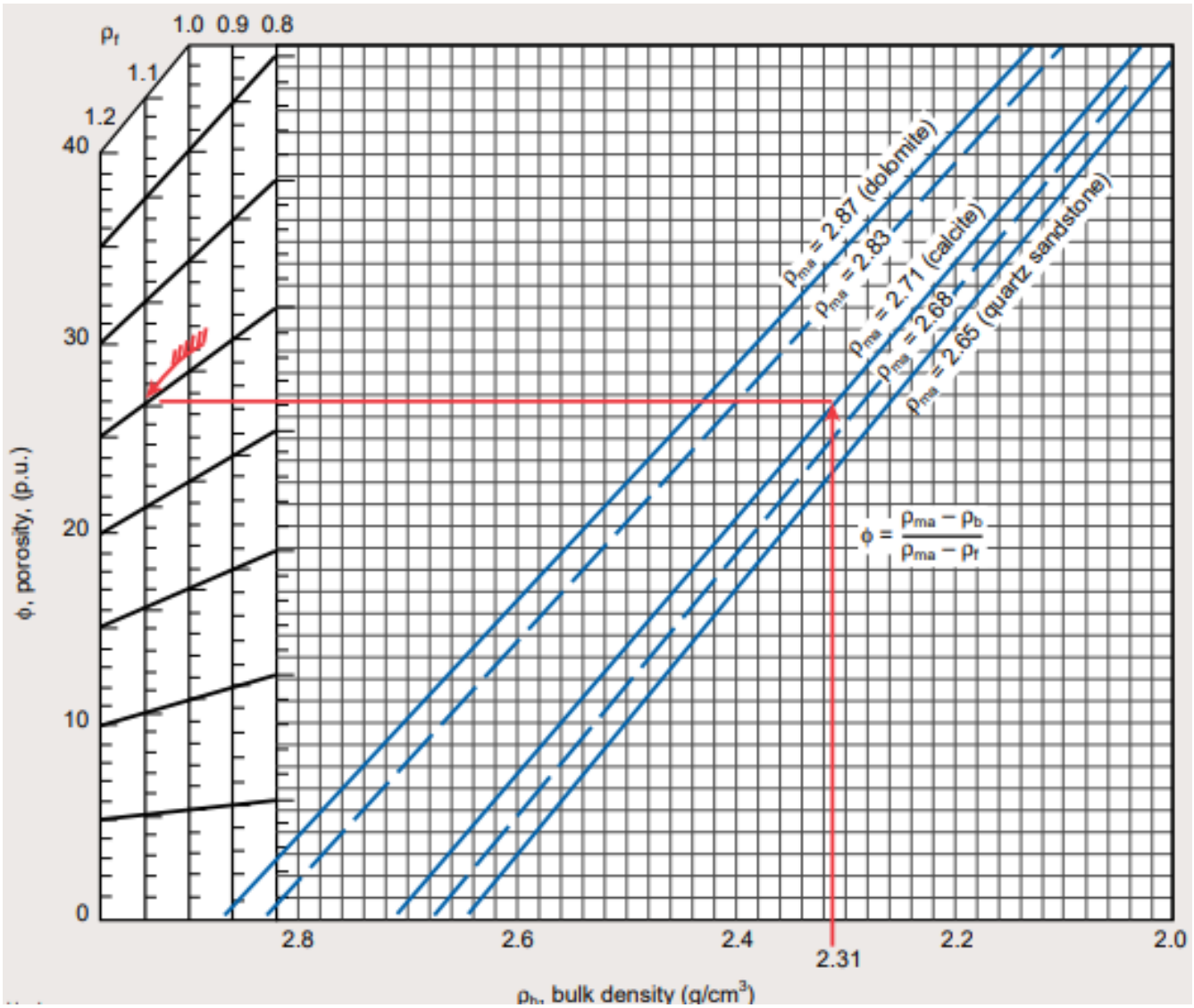
Evaluate the importance of the cementation exponent in this relationship.

[(5+5)+(5+5) Marks]
(CO2) [Application]

16. (a) Calculate Porosity (ϕ_D) from Formation Density Log (ρ_b) when,
    (i) ρ_b = 2.59 g/cc (Sandstone), ρ_{ma} = 2.71 g/cc (Calcite), and ρ_f = 0.80 g/cc
    (ii) ρb = 2.52 g/cm^3 (Sandstone), ρma = 2.87 g/cm^3 (Dolomite), and ρf = 1.2 g/cm^3
    (iii) ρb = 2.32 g/cc (Limestone), ρma = 2.65 g/cc (Quartz Sandstone)

(b) Estimate porosity by plotting the given data on Chart 3.

Chart 3:



[10+10 Marks]
(CO3) [Application]

17. The geophysical log data for PU Well 4 is shared below. Identify the correct charts and determine cross-plot porosity as well as lithology for the freshwater-invaded zone using the following cross-plot techniques.
    (a) Neutron Porosity – Bulk Density
    (b) Sonic Transit Time – Bulk Density

    Compare the results of all data points (i.e. Sl. No. 1 through 8) for both cross-plots as two different cross-plot techniques are used for determining the porosity and lithology of the same formation.

PU Well 4: Geophysical Log Data										
Sl. No.	**Depth (ft)**	**Cal (inch)**	**GR (API)**	**RHOB (g/cc)**	**NPHI (frac)**	**RES_ DEEP (Ohm_ m)**	**RES_ SHAL (Ohm_ m)**	**RES_ MICR (Ohm _m)**	**DT (µs/ft)**	**DTS**
1	616.46	9.21	97.17	2.65	0.12	19.74	21.77	22.50	70.16	158.65
2	623.16	8.79	48.66	2.54	0.05	13.04	15.58	23.72	63.15	115.85
3	626.97	8.56	33.51	2.48	0.07	16.58	16.57	7.79	64.39	110.51
4	637.95	8.68	82.60	2.58	0.06	19.58	23.02	25.06	68.28	148.22
5	643.59	8.63	26.04	2.39	0.12	2.41	2.36	1.85	68.16	113.36
6	647.85	8.60	22.92	2.40	0.12	0.99	0.81	1.18	68.92	121.84
7	653.80	8.60	45.37	2.50	0.09	4.35	4.39	2.60	70.68	134.80
8	668.27	8.90	60.00	2.68	0.17	8.83	8.28	19.87	68.28	137.26

Fill out the following Tables with your findings.

Table 1:

(a) Neutron Porosity – Bulk Density Cross-plot			
Sl. No.	**Chart No.**	**Cross-plot Porosity**	**Lithology**
1			
2			
3			
4			
5			
6			
7			
8			

Table 2:

(b) Sonic Transit Time – Bulk Density Cross-plot			
Sl. No.	**Chart No.**	**Cross-plot Porosity**	**Lithology**
1			
2			
3			
4			
5			
6			
7			
8			

Charts for Cross-plots:

Chart 1:

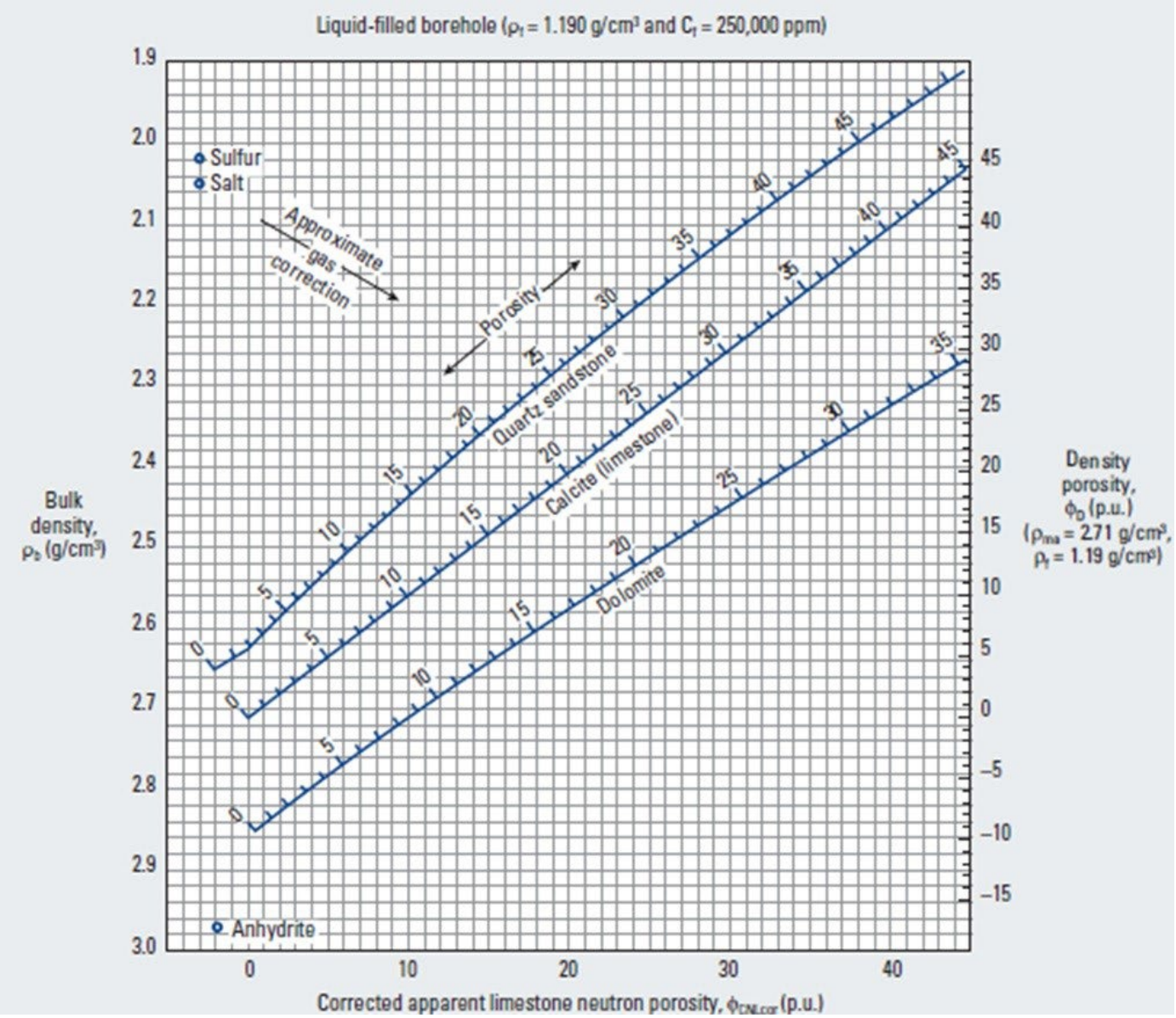


Chart 2:

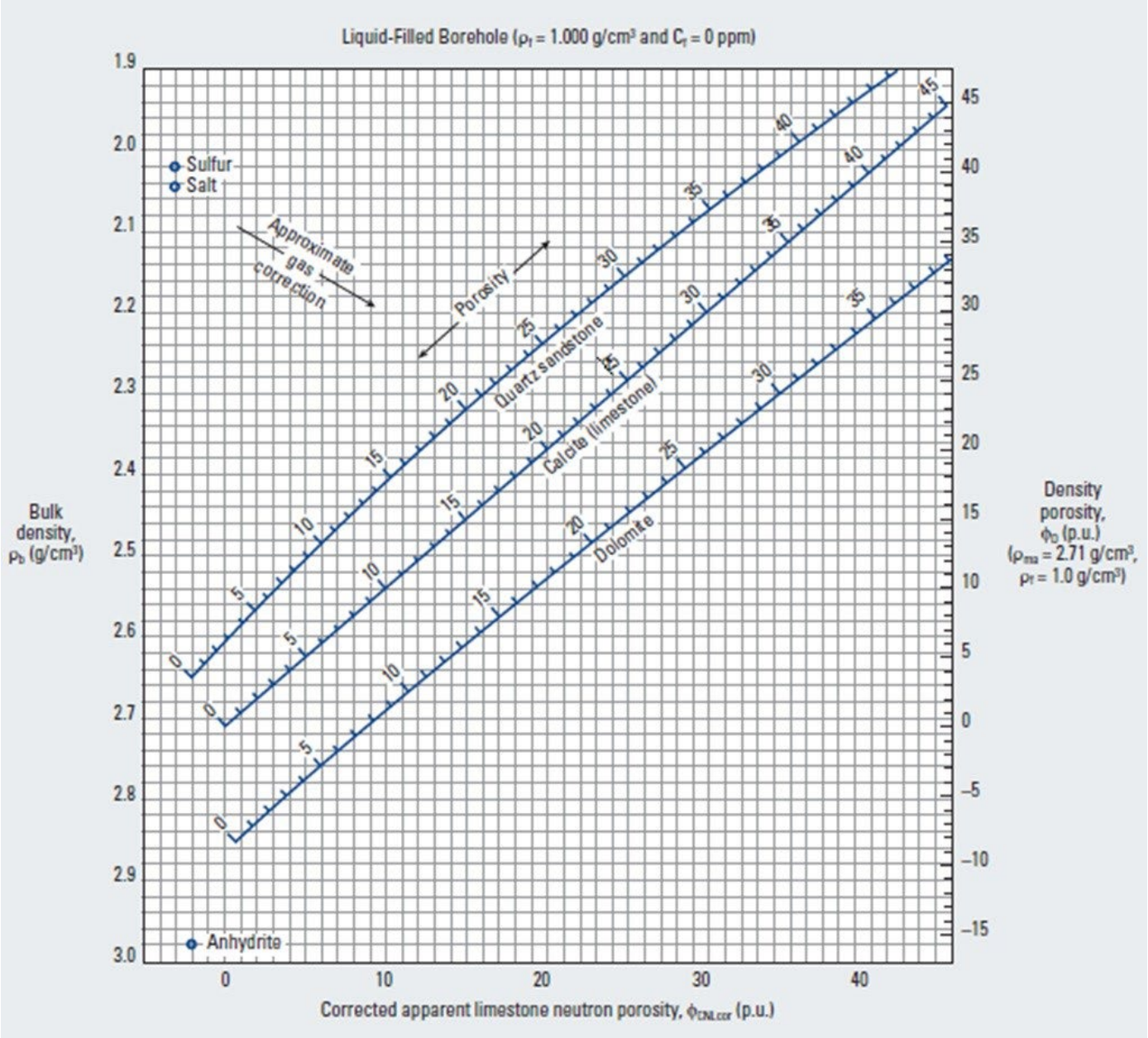

Liquid-Filled Borehole (ρ_f = 1.000 g/cm³ and C_f = 0 ppm)
Sulfur
Salt
Anhydrite
Approximate gas correction
Porosity
Quartz sandstone
Calcite (limestone)
Dolomite
Bulk density, ρ_b (g/cm³)
Density porosity, ϕ_D (p.u.) (ρ_{ma} = 2.71 g/cm³, ρ_f = 1.0 g/cm³)
Corrected apparent limestone neutron porosity,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

Chart 3:

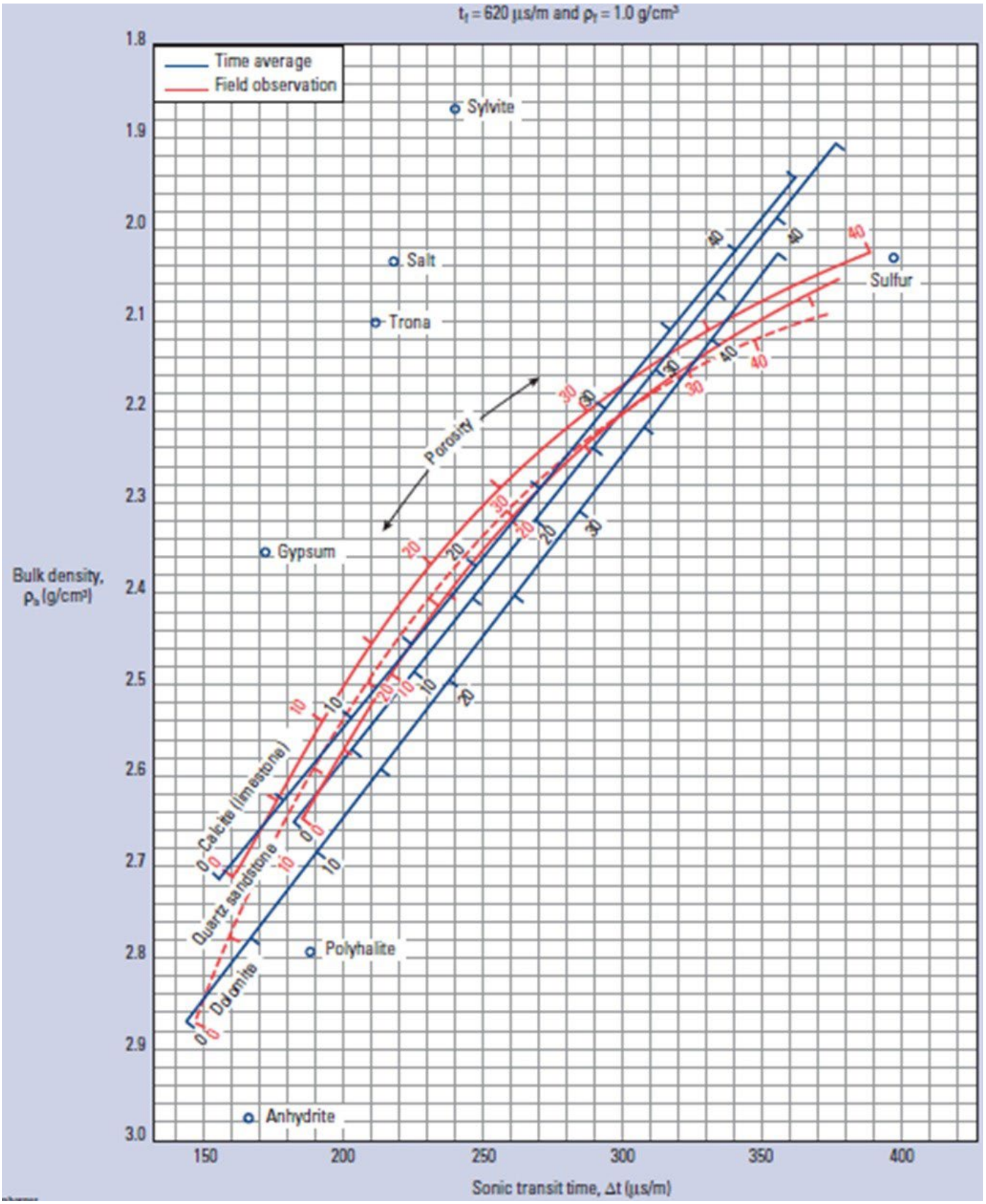
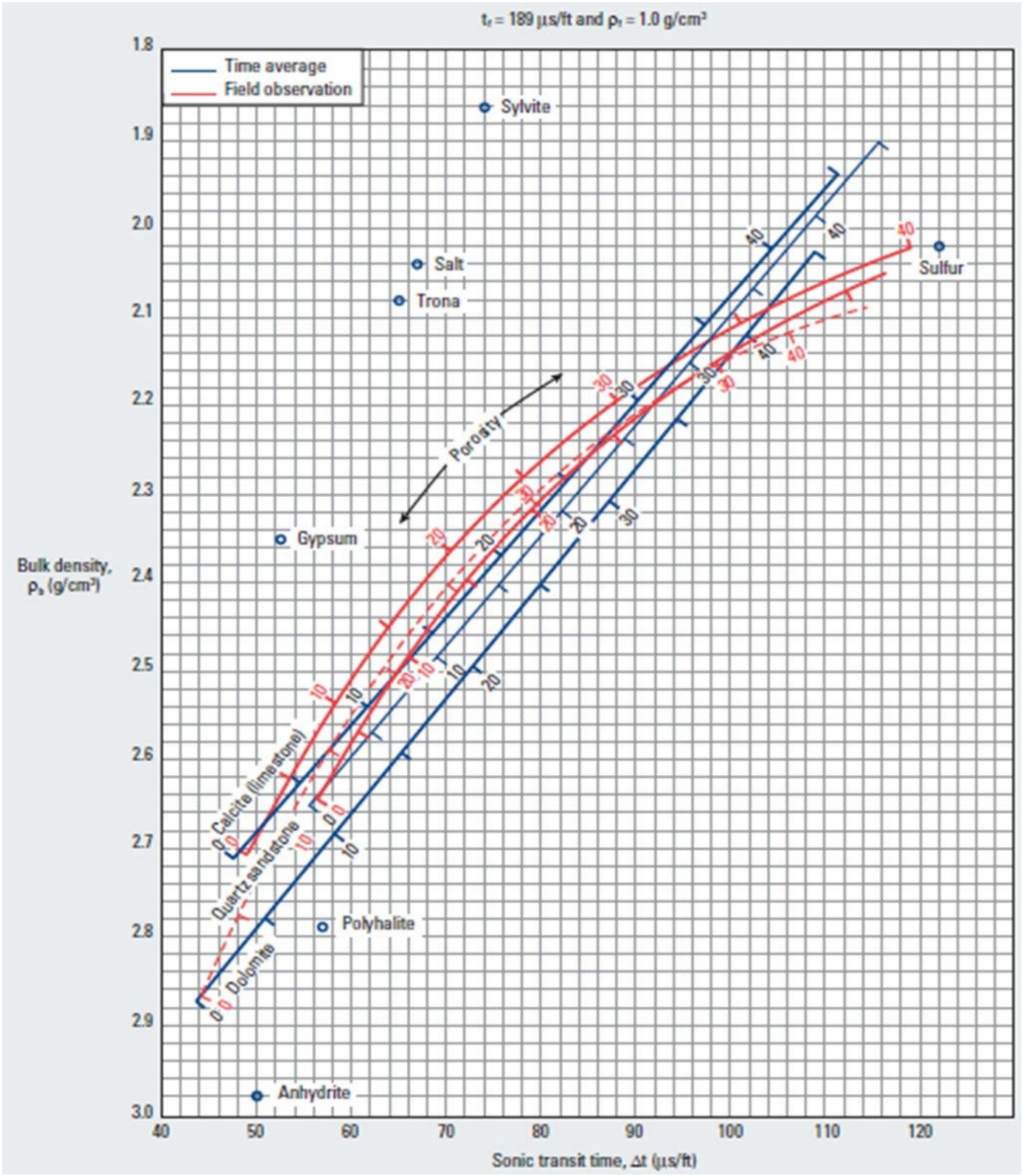

t_f = 620 µs/m and ρ_f = 1.0 g/cm³
Time average
Field observation
Sylvite
Salt
Trona
Sulfur
Gypsum
Polyhalite
Anhydrite
Porosity
Calcite (limestone)
Quartz sandstone
Dolomite
Bulk density, ρ_b (g/cm³)
Sonic transit time, Δt (µs/m)
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
150
200
250
300
350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

Chart 4:



(CO5) [Application]