WELL LOG-CASE STUDY

INDIAN INSTITUTE OF TECHNOLOGY(INDIAN SCHOOL OF MINES), DHANBAD

GROUP-4: Gorgonichthys-1

Created by

Ayush Babukumar

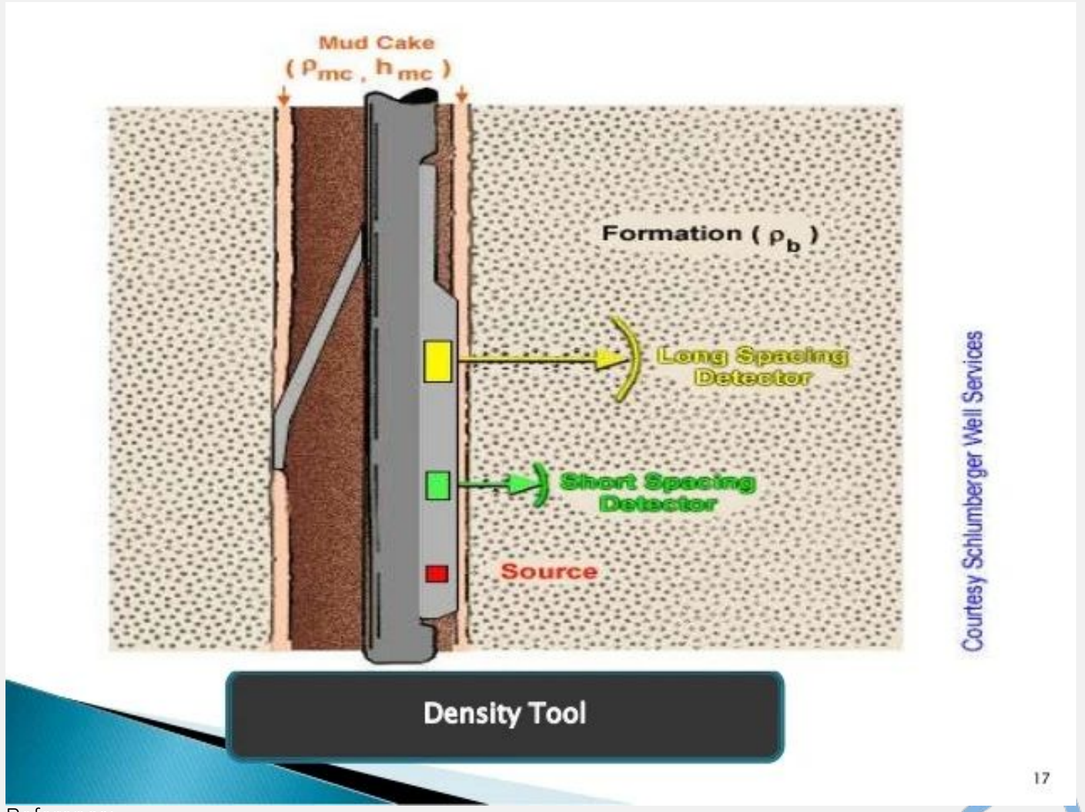
INSTRUCTOR

Dr. PARTHA PRATIM MANDAL

1) PROPOSE NECESSARY INSTRUMENTATION AND ECONOMIC REQUIREMENT TO DESIGN DENSITY TOOL IF DEPARTMENT WANTS TO BUILD IT.

- **Necessary instruments that one would need to build a Formation Density tool.**

1. A gamma-ray source
2. Gamma-Ray Detectors
3. Detector Electronics
4. Data Acquisition System
5. Telemetry System
6. Shielding Materials
7. Tool Housing
8. Calibration Blocks



Reference:
https://image.slidesharecdn.com/densitylog-130424014954-phpapp01/95/density-log-17-638.jpg?cb=1366768252

Component wise price distribution is given in the following table:-

Overall a basic field deployable research tool would cost between 10 to 20 Lacs .

Equipment & Component Costs	
Cesium-137 Source	₹ 1,50,000-3,,00,0000
NaI(Tl) Scintillation Detector	₹ 1,00,000-2,50,000
Signal Conditioning Electronics	₹ 50,000–1,00,000
Data Acquisition System	₹ 30,000–70,000
Telemetry System	₹ 50,000–1,50,000
Lead Shielding / Collimator	₹ 20,000–60,000
Tool Housing (SS/Inconel)	₹ 50,000–1,00,000
Calibration Biocks	₹ 30,000–80,000
Mechanical Design & Machining	₹ 40,000–1,00,000
Lab Infrastructure & Safety	
Radiation Handling Setup	₹ 1,00,000+
Safety Gear & Mouitoring	₹ 30,000– 60,000
Licensing and Regulatory Fees	₹ 20,000– 50,000
Human & Academic Resources	
Faculty/Project Guide	—
Technicians, Research Students	—
Total Estimated Budget (INR)	
Basic Simulator (No Source	₹ 1 –2 Lakhs
Lab-Grade Prototype (With Source)	₹ 5 –10 Lakhs

Quality control of Wireline Logs

Pre Job QC:

- Tool calibration
- Tool functionality
- Logging plan review

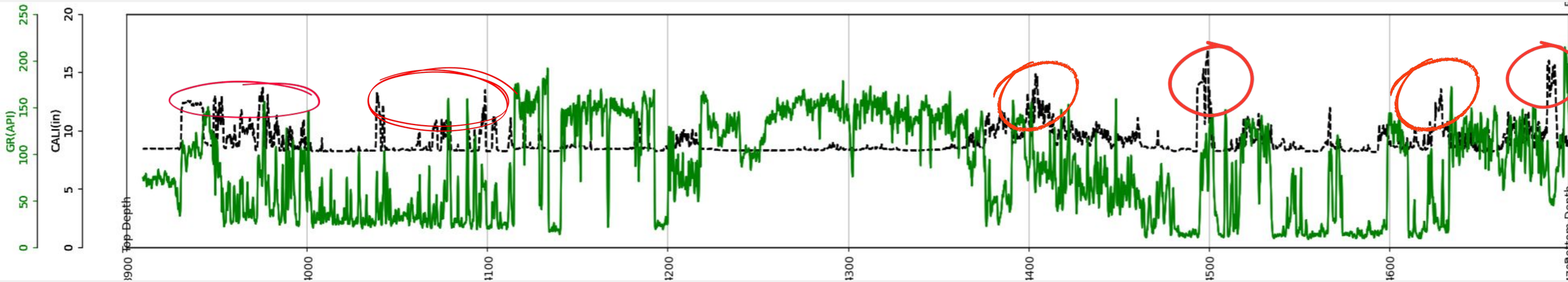
During Logging (Real-Time QC):

- Log response monitoring
- Depth control
- Tool speed
- Cable tension and movement
- Environmental corrections

Post-Job QC:

- Data validation
- Repeat section analysis
- Crossplot and cross-tool checks
- Log editing
- Documentation

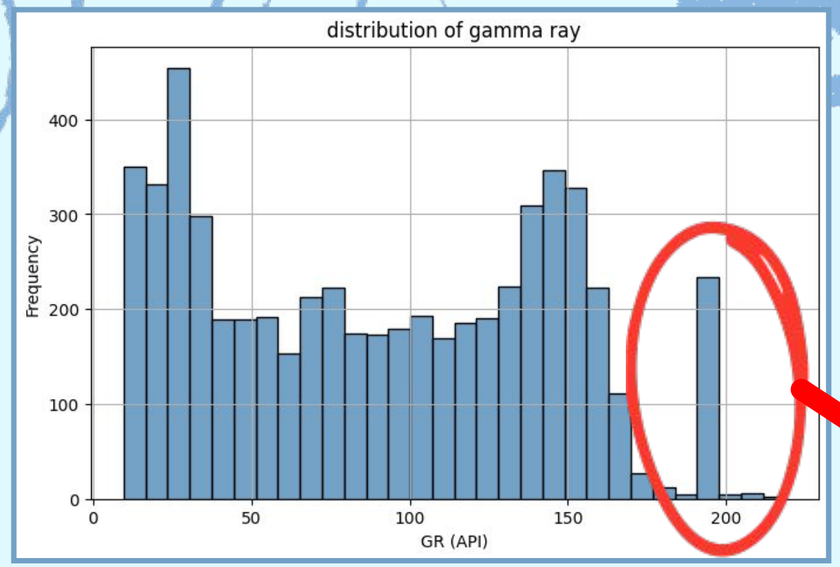
- Bit size is 8.5 inches over the depth zone and is constant
- The zones where the calliper is varying more than 2 inches are the bad borehole zone (washouts or borehole swelling)

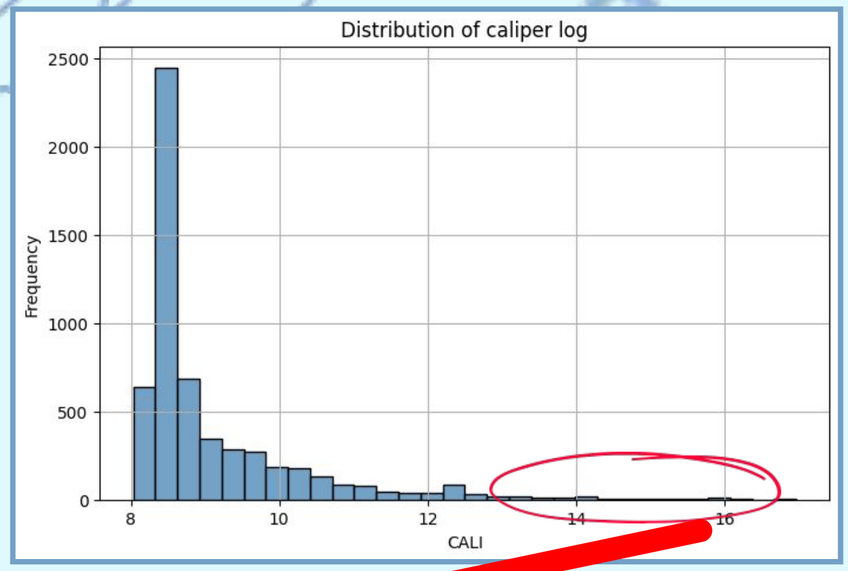


- Bad Borehole zones are not reliable since they hinder with the actual valuable data and create errors in our interpretation.

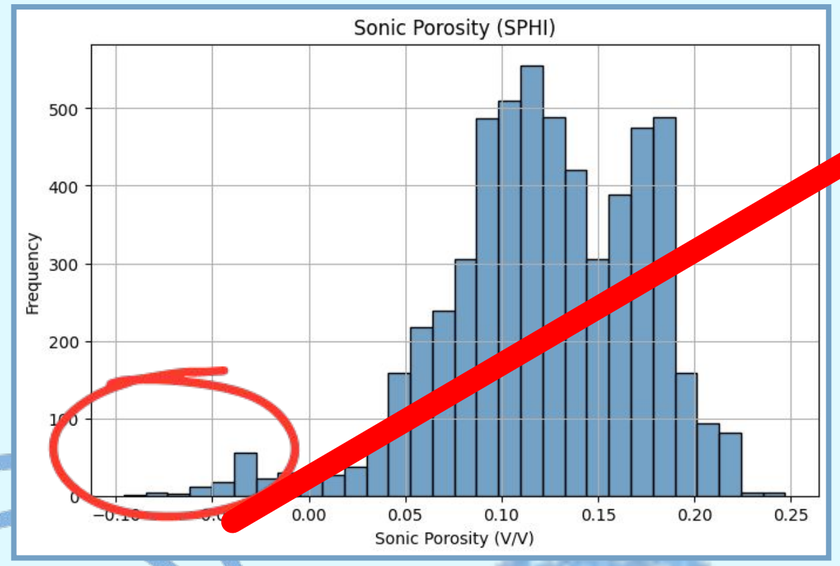
OUTLIERS

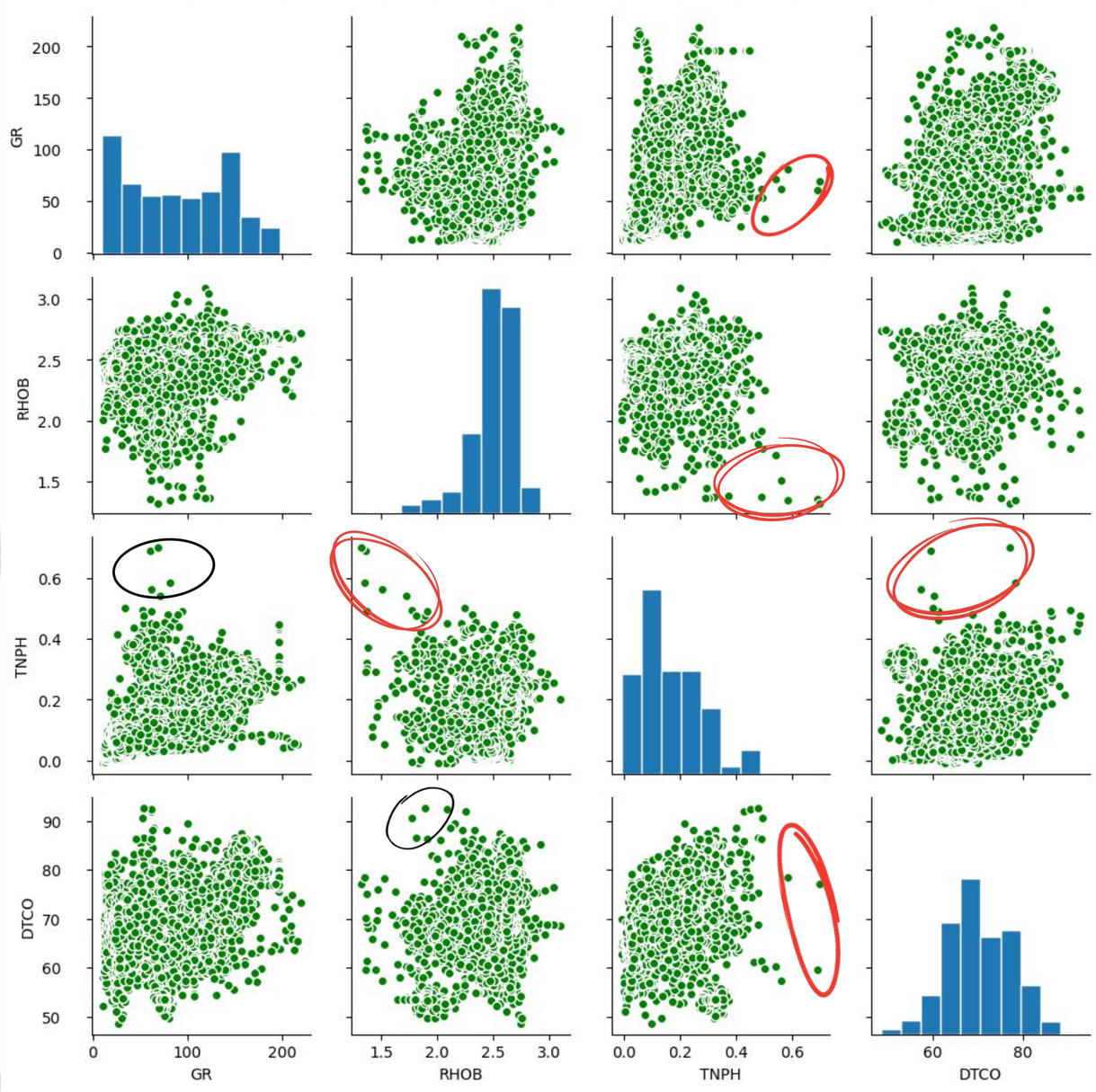
- An outlier is a data point that is significantly different from the rest of the data..
- These points are bad for our data and should be removed while we proceed with the interpretation.
- We can point out outliers from histograms, scatter plots or even cross plot


distribution of gamma ray
Frequency
GR (API)
0
50
100
150
200
0
100
200
300
400


Distribution of caliper log
Frequency
CALI
8
10
12
14
16
0
500
1000
1500
2000
2500

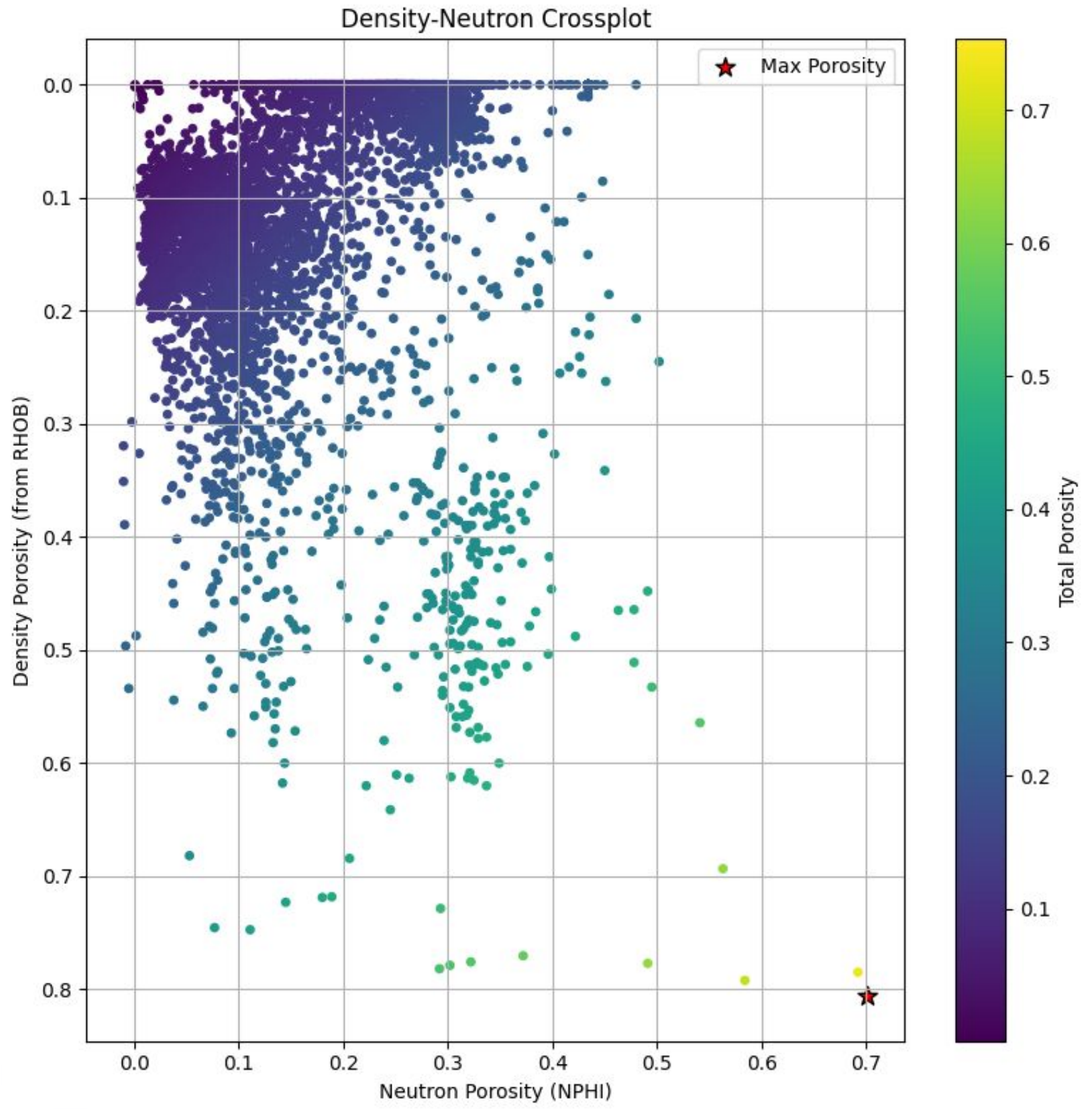
OUTLIERS


Sonic Porosity (SPHI)
Frequency
Sonic Porosity (V/V)
0.00
0.05
0.10
0.15
0.20
0.25
0
100
200
300
400
500



Some more outliers !!!

Calculation of total porosity and Max porosity from the density and neutron combination .



$$\varphi = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_{fl}}$$

ρ_{ma} = the density of the rock matrix

ρ_b = the bulk density of formation [from log]

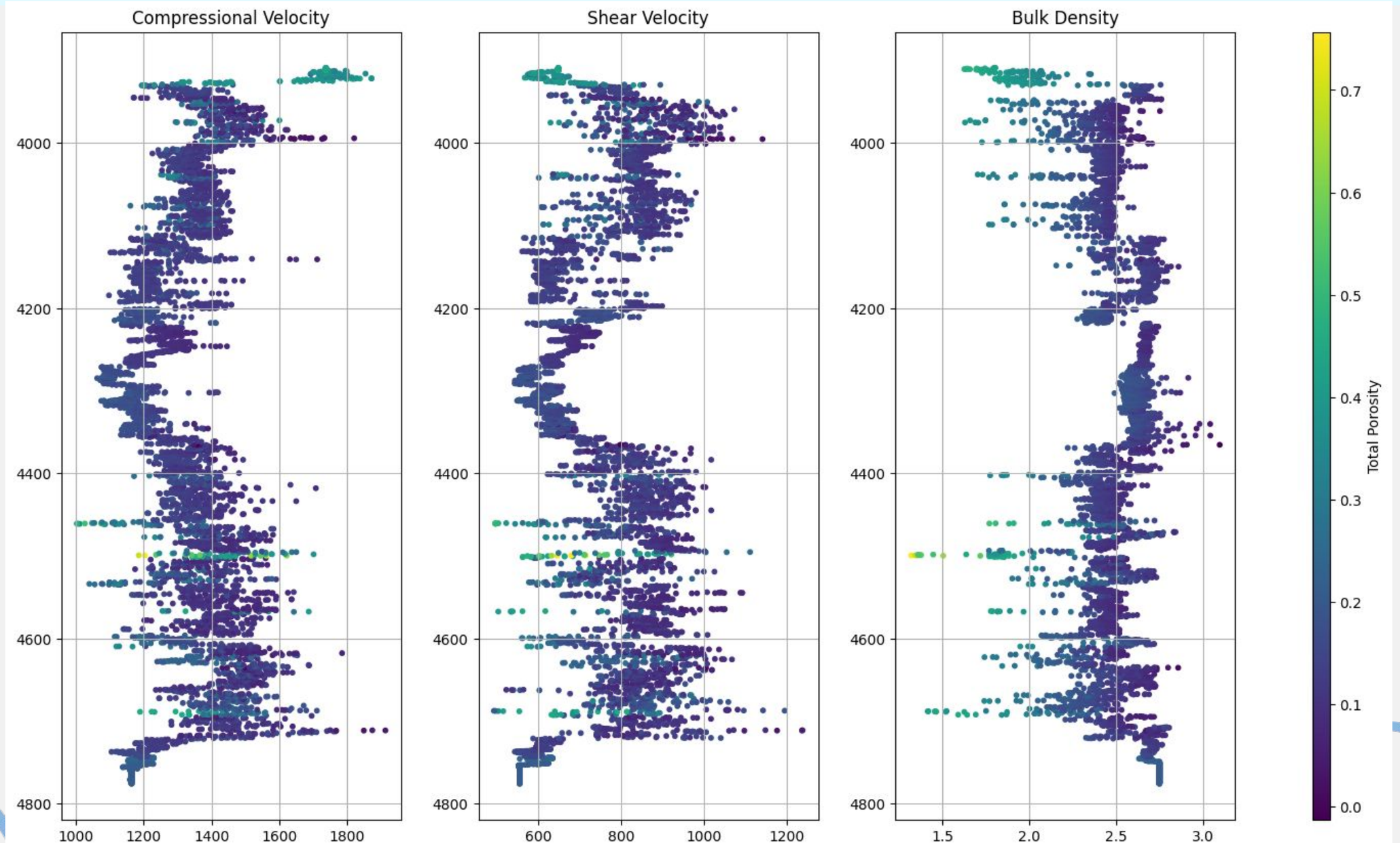
ρ_{fl} = the density of pore fluid

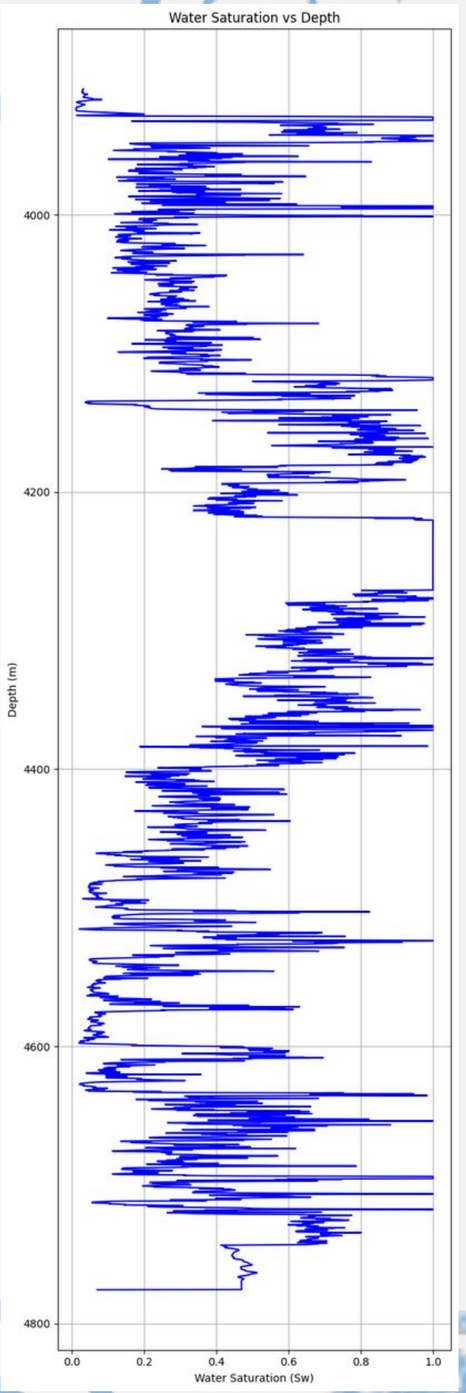
For gas bearing formation

$$\Phi_{N-D} = \sqrt{\frac{\Phi_N^2 + \Phi_D^2}{2}}$$

Max Porosity = 0.76 @4499.5m depth

VELOCITY AND DENSITY DEPTH PROFILE (COMPRESSIONAL, SHEAR AND BULK DENSITY LOG) COLOUR CODED WITH TOTAL POROSITY.





ARCHIE'S EQUATION

FORMATION WATER RESISTIVITY

TORTUOSITY FACTOR

WATER SATURATION

$$Sw = \left[\frac{R_w}{R_t} x \frac{a}{\phi^m} \right]^{\frac{1}{n}}$$

SATURATION EXPONENT

CEMENTATION EXPONENT

FORMATION RESISTIVITY

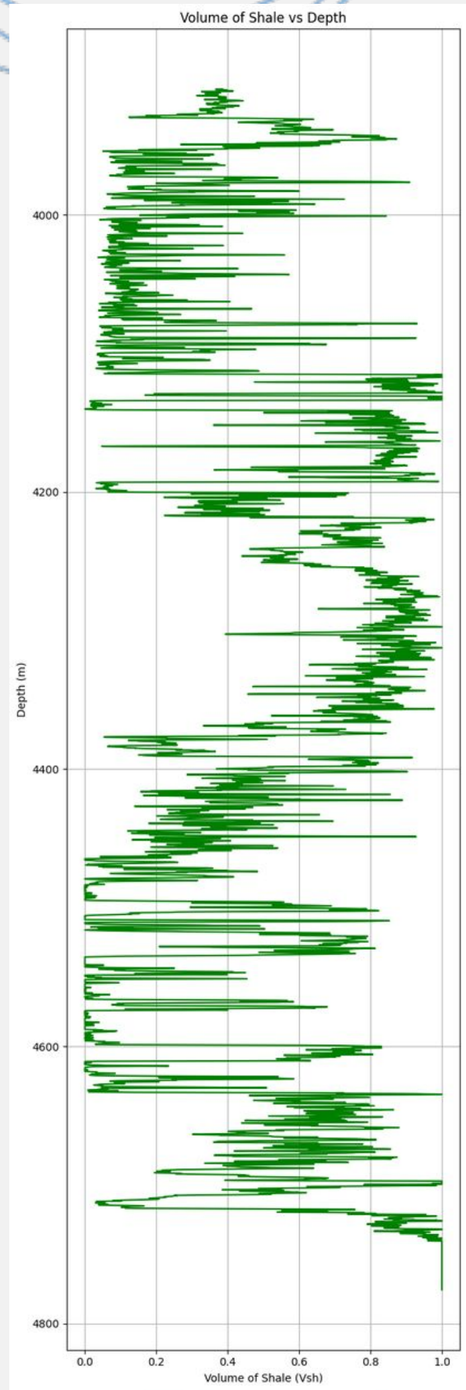
POROSITY

Where a=1

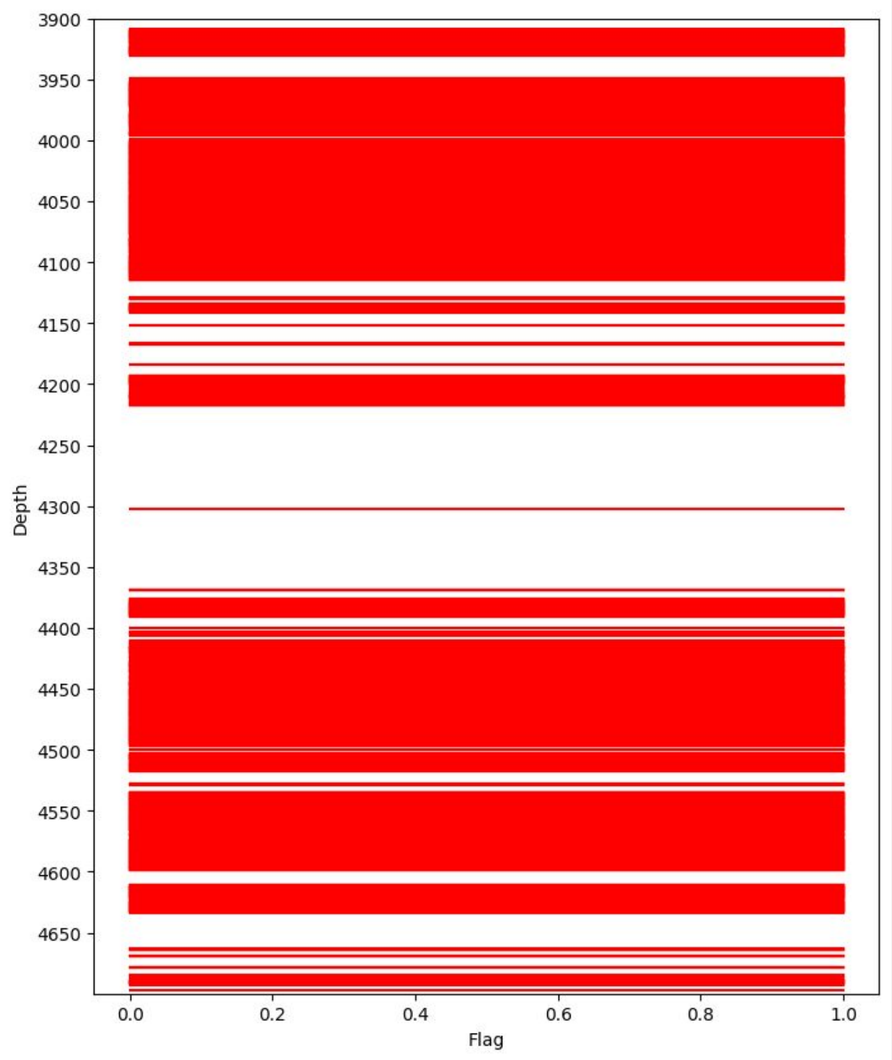
m=n=2

$$I_{GR} = \frac{GR - GR_{min}}{GR_{max} - GR_{min}}$$

$$Vshc = 0.33 \times (2^{(2 \times I_{GR})} - 1)$$



GENERATED RESERVOIR FLAG WHERE VOLUME OF SHALE, VSH <= 0.35 AND SW <= 0.7.



REPORT TOTAL POROSITY, WATER SATURATION, AND VSH WITH STANDARD DEVIATION OF THE RESERVOIR ZONE.

	DEPTH	Volume of Shale	Water Saturation	Total Porosity
0	4717.2372	0.330737	0.032171	0.418864
1	4717.0848	0.206753	0.032171	0.418864
2	4716.9324	0.137325	0.032171	0.418864
3	4716.7800	0.117112	0.032171	0.418864
4	4716.6276	0.112621	0.032171	0.418864
...	...	...	...	...
2279	3913.6320	0.343723	0.032171	0.418864
2280	3912.7176	0.347925	0.032171	0.418864
2281	3912.5652	0.343723	0.032171	0.418864
2282	3912.4128	0.337114	0.032171	0.418864
2283	3911.0412	0.326857	0.032171	0.418864

2284 rows × 4 columns

REFERENCE :-

- Google Collab workbook used for this case study
- Basic Petrophysics python file earlier provided during practical

Thank you very much!